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SECONDARY 4

Express Exam Paper

Pure Physics (Set A)

1	Anderson Sec	SA2
2	Nan Chiau High	SA2
3	Nan Hua High	SA2
4	St Joseph Inst	SA2
5	Broadrick Sec	SA2
6	Bukit Batok Sec	SA2
7	Compassvale Sec	SA2
8	Fuhua Sec	SA2
9	Peirce Sec	SA2
10	Queensway Sec	SA2
11	Whitley Sec	SA2
12	Yuying Sec	SA2

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ANDERSON SECONDARY SCHOOL
Preliminary Examination 2022
Secondary Four Express

CANDIDATE NAME:

CLASS: / INDEX NUMBER:

PHYSICS **6091/01**

Paper 1 Multiple Choice

12 September 2022

1 hour

0800 – 0900 h

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid/tape.
Write your name, class and index number on the Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question, there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

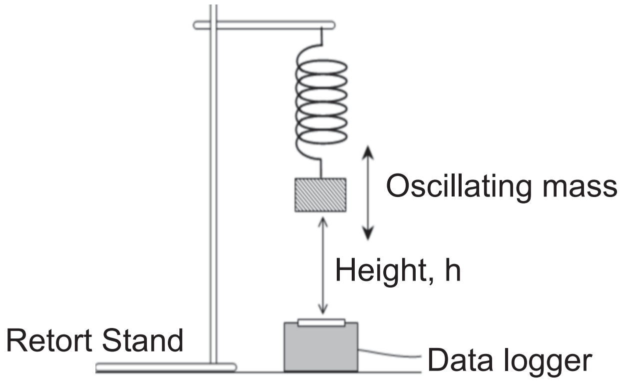
This document consists of **18** printed pages.

Setter: Mr Richmond Ang

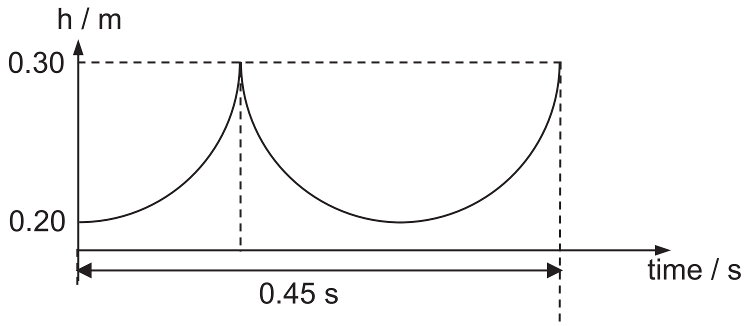
1 What is the typical size for a small atom?

A 0.1 cm **B** 0.1 km **C** 0.1 μm **D** 0.1 nm

2 The height, h, of an oscillating mass is measured by a data logger.



A graph of height, h, against time is shown below.



What is the period of the oscillation?

A 0.15 s **B** 0.30 s **C** 0.45 s **D** 0.60 s

3 A car driver immediately stepped on the brakes when he saw a cat dashing across the road.

The car decelerated at a constant rate of 10 m/s^2. The car finally came to a stop after it travelled for 45 m.

How long did the car take to come to a complete stop?

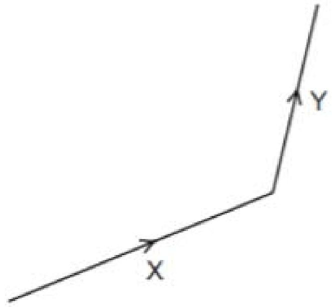
A 1.0 s

B 3.0 s

C 4.5 s

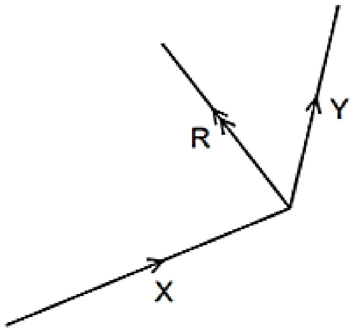
D 10 s

4 Two forces, X and Y, act upon an object O. The arrows represent the magnitudes and directions of the forces.

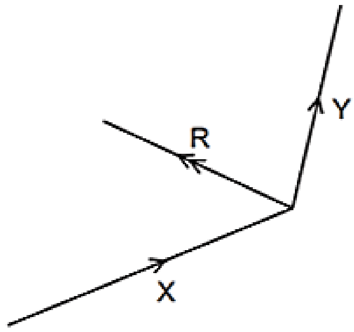


Which diagram shows the resultant force of **X** and **Y**?

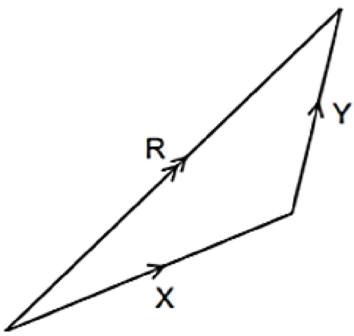
A



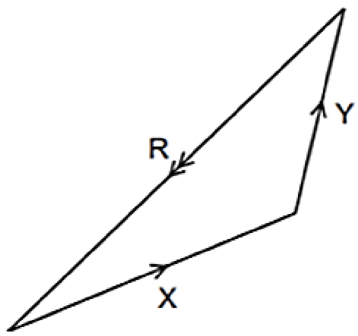
B



C



D



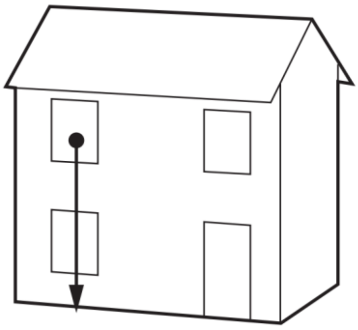
5 A man with an open parachute falls to Earth at constant speed.
The following forces act on different bodies:

P the air resistance acting on the man
Q the upward force of the man on the Earth
R the weight of the man
S the downward pull of the man on the parachute

Which two forces are action-reaction force pair?

A **P** and **Q** **B** **P** and **R** **C** **P** and **S** **D** **Q** and **R**

6 A tennis ball falls from the upstairs window of a house.



What can be said about the acceleration of the ball if air resistance is ignored?

A It depends on the mass of the ball.

B It increases as the density of the ball increases.

C It increases as the ball falls.

D It stays the same as the ball falls.

7 In a large container in an oil refinery, three oils of different densities are mixed. No chemical activity occurs.

The mixture consists of:

- 1200 kg of oil of density 1100 kg/m^3
- 1500 kg of oil of density 860 kg/m^3

What is the density of the mixture?

A 920 kg/m^3

B 950 kg/m^3

C 980 kg/m^3

D 1800 kg/m^3

8 Which object, a bowling ball at rest or a soccer ball flying towards the goal mouth at a very high speed, has a higher inertia?

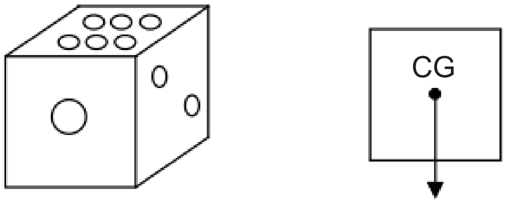
A The bowling ball has the higher inertia because it has the greater mass.

B The bowling ball has the higher inertia because it is not moving.

C The soccer ball has the higher inertia because it has the greater volume.

D The soccer ball has the higher inertia because it is moving very fast.

9 An unbiased dice is a cube with the centre of gravity at the middle as shown in the diagram.



Which action changes the position of the centre of gravity of the dice?

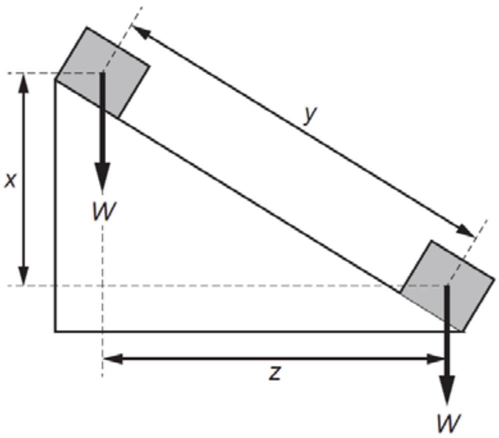
A Create the dice from a denser material.

B Drill a small hole at the side of the dice.

C Move it to a place with a larger gravitational field strength

D Rotate the dice 180° so that the top surface is now at the bottom

10 A heavy box of weight *W* is pushed up a frictionless slope.



What is work done by the weight *W* in moving from top to bottom?

A Wx **B** Wy **C** $W(y-z)$ **D** $W(x+z)$

11 Energy resources are used to produce electricity.

Which resource is non-renewable?

A hydroelectric

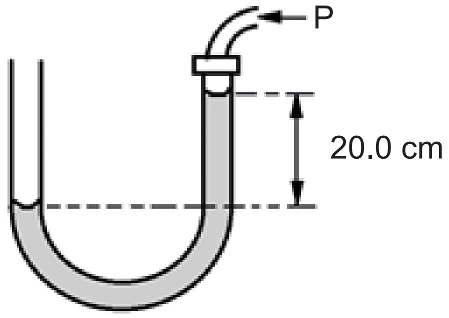
B nuclear fission

C tidal waves

D wind

12 A manometer is connected to an air pump, P as shown. The atmospheric pressure is 1.03×10^5 Pa and the density of the liquid used in the manometer is 1550 kg/m^3.

(The gravitational field strength is 10 N/kg)



What is the pressure at P?

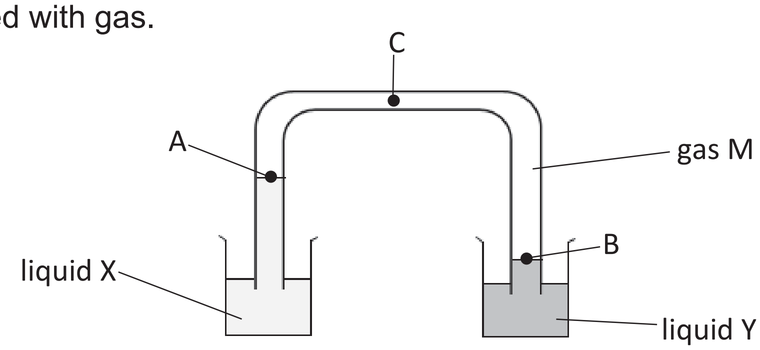
A 3.10×10^2 Pa

B 1.00×10^5 Pa

C 1.06×10^5 Pa

D 3.10×10^5 Pa

13 The diagram below shows a tube with its ends placed in liquid X and Y. The tube is filled with gas.



Which statement(s) is/are true?

I. Pressures at A, B and C are the same.
II. The density of liquid X is greater than that of liquid Y.
III. The gas pressure is greater than atmospheric pressure.

A I only

B III only

C I and II only

D II and III only

14 Illuminated smoke particles, suspended in air, are viewed under a microscope. They are seen to move randomly.

Which statement best explains the movement of the smoke particles?

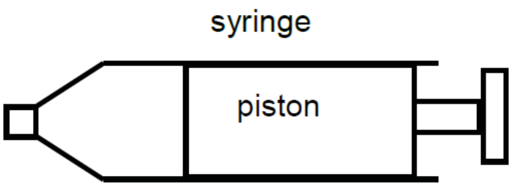
A The smoke particles are bombarded continuously by the air molecules.

B The smoke particles are gaining kinetic energy from the hot light bulb.

C The smoke particles are moving about due to convection currents.

D The smoke particles are vibrating more vigorously in their fixed positions.

15 A fixed mass of gas is heated in a frictionless syringe and expands at constant pressure.



Which statement about the gas is correct?

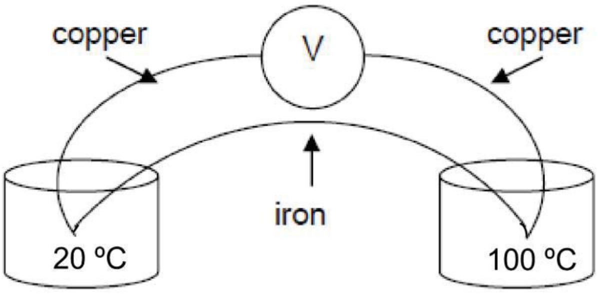
A The average distance between the gas molecules decreases.

B The average force of the molecules on the wall of the piston remains constant.

C The average speed of the gas molecules remains constant.

D The frequency of collisions of the gas molecules on the wall of the syringe decreases.

16 The diagram below shows a thermocouple with its two metal wires placed in solutions of different temperatures. The voltmeter reads 16 mV.



If the copper wire is replaced by an iron wire, what is the voltmeter reading?

A 0 mV

B 12 mV

C 16 mV

D 24 mV

17 A platinum resistance thermometer has a resistance of 100 Ω at 0 °C and resistance of 350 Ω at 100 °C.

What would the temperature be when the platinum wire has a resistance of 75 Ω?

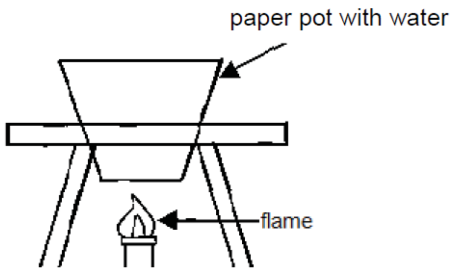
A -30 °C

B -10 °C

C 10 °C

D 30 °C

18 Some Japanese restaurants use paper pots for their customers to boil the food themselves.



Why does the paper pot not catch fire when in contact with the flame?

I. The paper is thin and heat is conducted quickly to the water in the paper pot.
II. Water has a boiling point lower than the burning temperature of the paper.
III. Water has a high specific latent heat

A I and II only

B I and III only

C II and III only

D I, II and III

19 Less thermal energy is needed to raise the temperature of 1.0 kg of copper by 1.0 °C than is needed to raise the temperature of 1.0 kg of water by 1.0 °C.

Which statement explains this?

A Copper has a higher melting point.

B Copper has a lower specific heat capacity.

C Copper has a smaller specific latent heat.

D Copper is a better conductor of thermal energy.

20 What is meant by the amplitude of a wave?

A the distance between the extreme points of a particle's motion

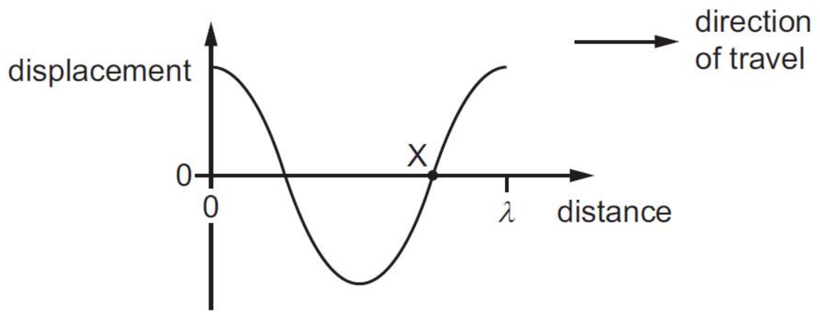
B the maximum distance a particle moves from its equilibrium position

C the maximum energy carried by the wave

D the maximum power of the vibrations carrying the wave

21 A transverse wave on a rope has wavelength λ and period T.

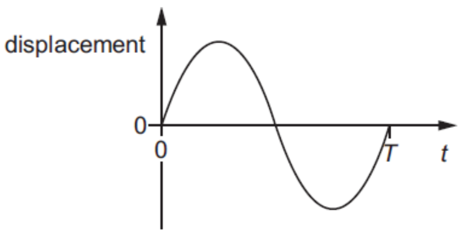
The graph shows the variation of the displacement of the particles of the rope with distance in the direction of travel of the wave at time t = 0.



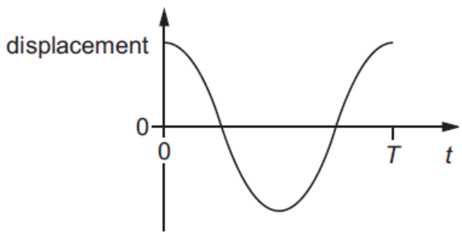
A particle X is labelled on the graph.

Which graph shows the variation of the displacement of particle X with time t?

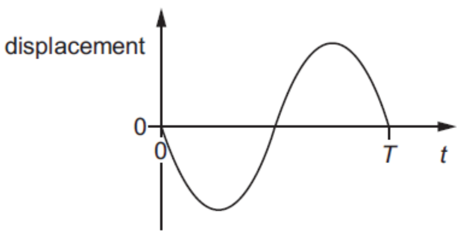
A



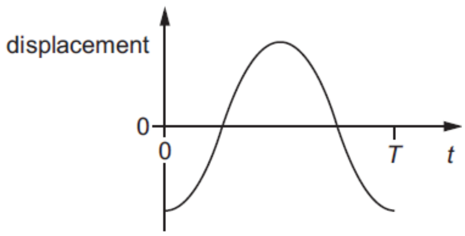
B



C



D



22 Which statement about electromagnetic waves in vacuum is correct?

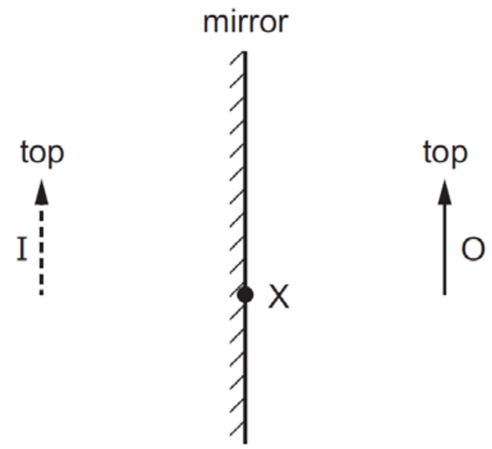
A Electromagnetic waves with longer wavelengths travel farther than those with shorter wavelengths.

B Electromagnetic waves with higher frequencies have shorter wavelengths.

C Gamma rays travel faster than radio waves as they have more energy.

D The speed of electromagnetic waves is proportional to their wavelength.

23 An object O is placed in front of a plane mirror. I is the image formed.



A light ray from the top of the object is incident on the mirror at X.

What happens to this light ray?

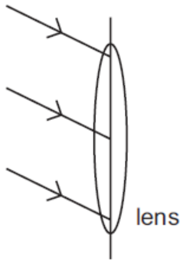
A It reflects and passes through the bottom of O.

B It reflects and passes through the top of O.

C It reflects as though it came from the bottom of I.

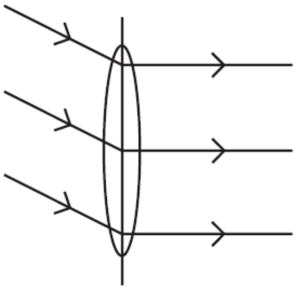
D It reflects as though it came from the top of I.

24 Three rays of light fall on a converging lens as shown.

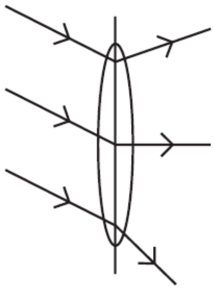


Which diagram shows the path of the rays after passing through the lens?

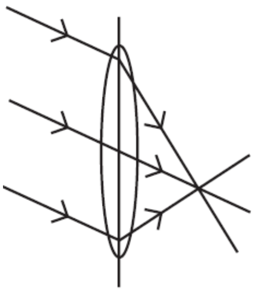
A



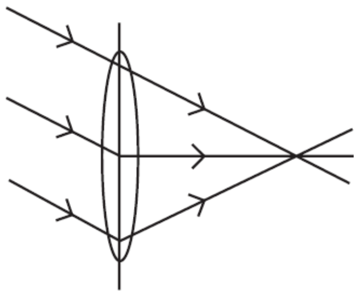
B



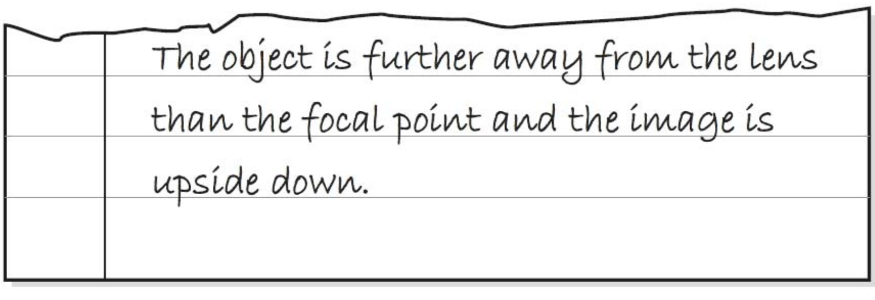
C



D



25 A piece of paper torn from an exercise book is shown.



Which process is being described?

A the formation of a virtual image by a diverging lens

B the formation of a virtual image by a converging lens

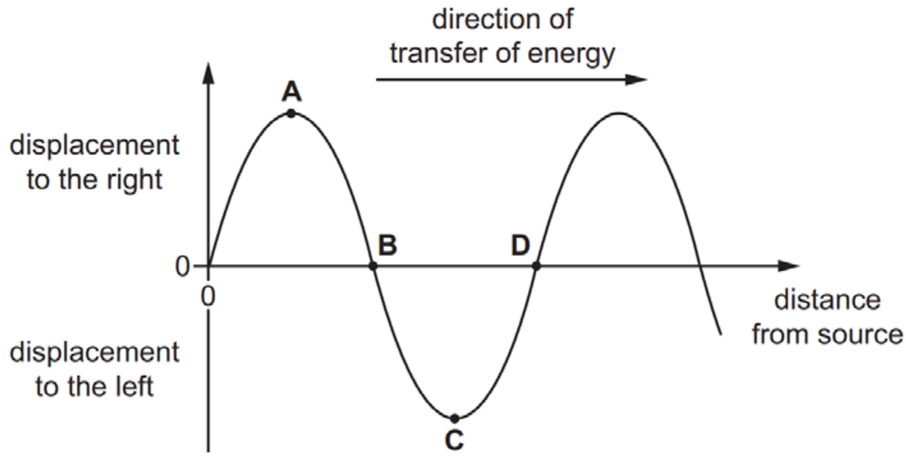
C the formation of a real image by a diverging lens

D the formation of a real image by a converging lens

26 A longitudinal wave travelling from left to right has vibrations parallel to the direction of transfer of energy by the wave.

The wave can be represented on a graph showing the variation with distance of the displacement of the particles from their equilibrium positions at one instant.

Which point on the graph is the centre of a compression?



27 Two notes of different pitch but the same loudness are played on a musical instrument.

The two sound waves produced will have

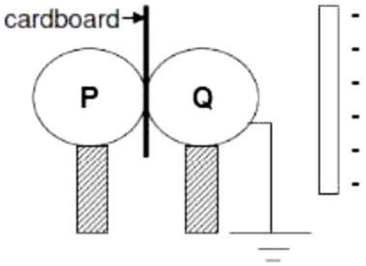
A different frequencies and different speeds.

B different frequencies but the same speed.

C different speeds but the same amplitude.

D different speeds and different amplitudes.

28 Two uncharged metal spheres P and Q are placed together with a thick cardboard inserted between them. Both spheres are supported by insulating stands and Q is earthed with a wire.



A negatively-charged rod is brought near the spheres as shown.

What would be the distribution of charges on spheres P and Q when the wire is removed followed by the charged rod?

	P	Q
A	negative	positive
B	negative	neutral
C	neutral	positive
D	neutral	neutral

29 A battery drives 300 C of charge round a circuit. The total work done is 600 J. What is the electromotive force of the battery?

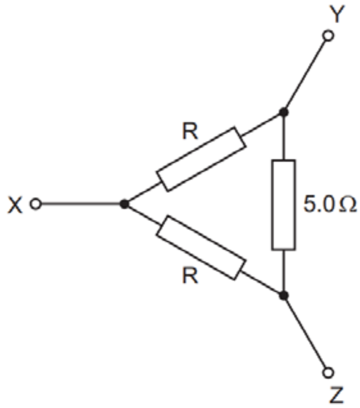
A 1.8 V **B** 2.0 V **C** 20 V **D** 450 V

30 A lightning strike transfers 1200 coloumbs of charge past a point in a time of 30 μs.

What is the average current during the lightning strike?

A 0.04 mA **B** 36 mA **C** 40 A **D** 40 MA

31 The diagram shows a network of three resistors. Two of these, marked R, are identical. The other resistor has a resistance of 5.0 Ω.



The resistance between Y and Z is found to be 2.5 Ω.

What is the resistance of R?

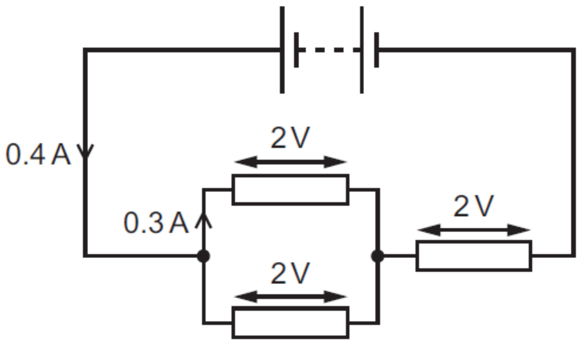
A 0.2 Ω

B 0.5 Ω

C 2.5 Ω

D 5.0 Ω

32 A battery is connected to three resistors, as shown.



The potential difference across each resistor is 2 V.

The current from the battery is 0.4 A and the current through one of the resistors connected in parallel is 0.3 A.

What is the total resistance of the circuit?

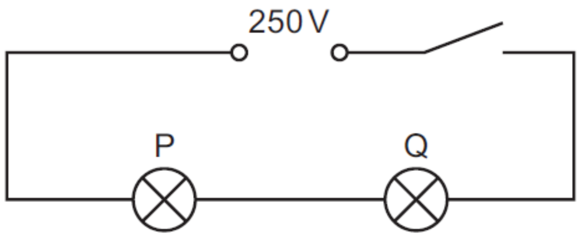
A 5.0 Ω

B 6.7 Ω

C 10 Ω

D 20 Ω

33 In the circuit shown, lamp P is rated 250 V, 50 W and lamp Q is rated 250 V, 200 W. The two lamps are connected in series to a 250 V power supply.



Assume that the resistance of each lamp remains constant.

Which statement most accurately describes what happens when the switch is closed?

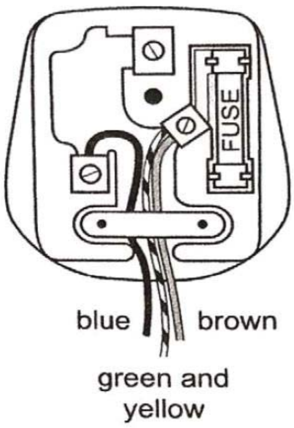
A Lamp P is brighter than lamp Q.

B Lamp P and Q will be equally bright.

C Lamp Q is brighter than lamp P.

D Lamp Q will not light up.

34 The plug of an electric toaster is wired as shown.



What happens when the switch is closed?

A The electric toaster does not work.

B The electric toaster catches fire.

C The fuse in the plug blows.

D The metal case of the toaster becomes live.

35 Which material is used for the needle of a plotting compass?

A aluminium **B** cobalt **C** iron **D** steel

36 A teacher wants to demagnetise a bar magnet and tries three different methods.

1 Heat the bar magnet to a high temperature and let it cool.
2 Place the bar magnet east to west and hammer it.
3 Place the bar magnet inside a coil that has a direct current in it and remove it from the coil slowly.

Which methods demagnetise the bar magnet?

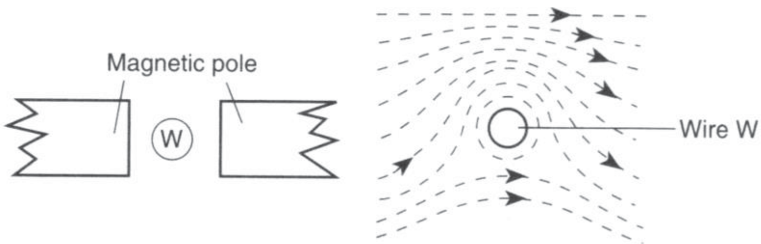
A 1 only

B 1 and 2 only

C 2 and 3 only

D 1, 2 and 3

37 A long straight wire W is placed between the poles of two magnets. The pattern of the magnetic field produced is as shown below.



Which arrangement will give rise to the pattern of magnetic field observed?

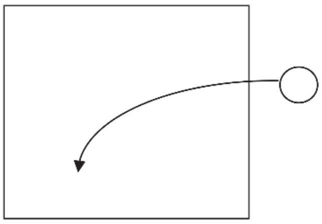
A

B

C

D

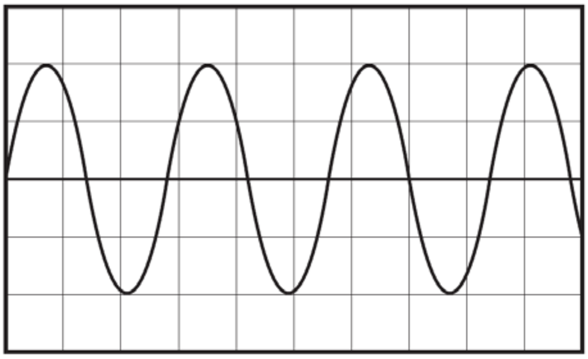
38 A beam of particles is observed to deflect through a certain region of space as shown in the diagram below.



Which row of conditions will not lead to the path above?

	Field	Direction of field	Particles
A	Electric	Into page	Negatively charged
B	Electric	Towards bottom of page	Positively charged
C	Magnetic	Into page	Negatively charged
D	Magnetic	Out of page	Positively charged

39 The diagram illustrates the trace obtained on the screen of a cathode ray oscilloscope (C.R.O) when a single signal of 71 Hz is applied to it.



What is the time-base setting of the C.R.O at this instant?

A 0.14 ms/div

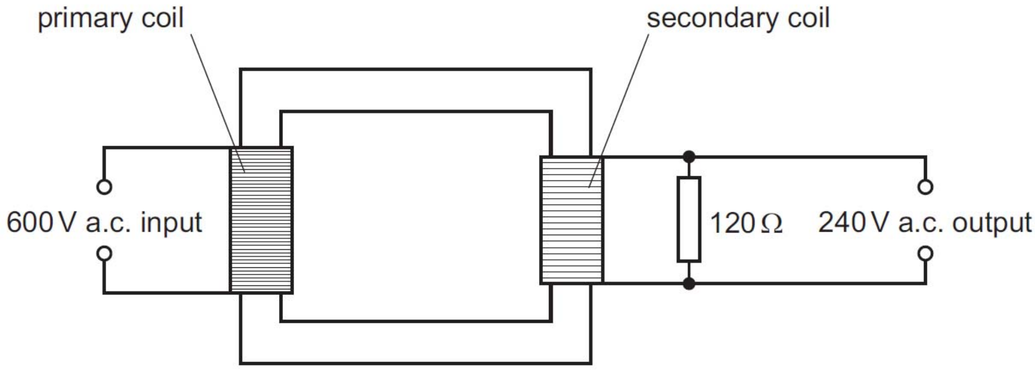
B 1.0 ms/div

C 5.0 ms/div

D 7.5 ms/div

40 A transformer with an efficiency of 100% has a primary voltage input of 600 V and a secondary voltage output of 240 V.

The secondary coil is attached to a resistor of resistance 120 Ω.



What is the current in the primary coil?

A 0.8 A **B** 2.0 A **C** 5.0 A **D** 300 A

End of paper

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ANDERSON SECONDARY SCHOOL
Preliminary Examination 2022
Secondary Four Express

CANDIDATE NAME:			
CLASS:	/	INDEX NUMBER:	

PHYSICS **6091/02**

Paper 2 Physics

17 August 2022

1 hour 45 minutes

1110 – 1255 h

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid/tape.

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 12 has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A [50]	
Section B [30]	
Total [80]	

This document consists of **26** printed pages.

Setter: Mr Richmond Ang

Section A

Answer **all** the questions in this section.

1 **(a)** Electric charge can be stated to be either positive or negative.

State and explain whether electric charge is a scalar or a vector quantity.

………………………………………………………………………………………

……………………………………………………………………………………….. [1]

(b) A potential difference is applied between a pair of horizontal metal plates in a vacuum as shown in Fig. 1.1.

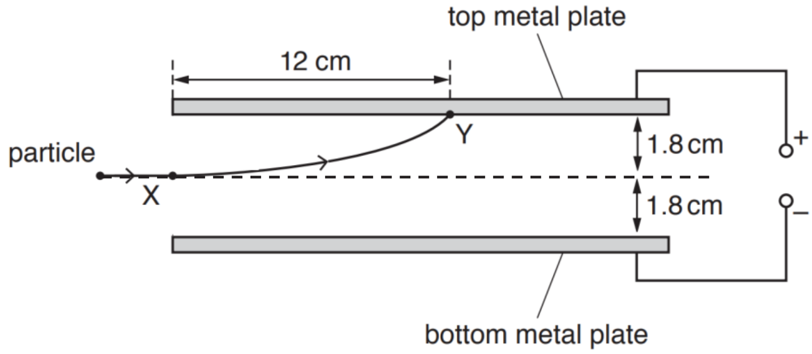

Fig. 1.1

A negatively charged particle enters the electric field at point X with a velocity of 0.75 m/s to the right.

The particle is deflected by the field and hits the top plate at point Y.

(i) Explain why the average velocity of the particle is lower than its average speed as it travels from point X to point Y.

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

……………………………………………………………………………… [2]

(ii) On Fig. 1.2, draw and label all the forces acting on the particle at point X.

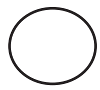

Fig. 1.2

[2]

2 A block of weight 15N hangs by a wire from a remotely controlled aircraft, as shown in Fig. 2.1.

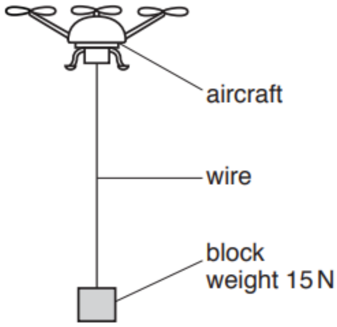

Fig. 2.1

The aircraft is used to move the block only in a vertical direction. The force on the block due to air resistance is negligible.

The variation with time *t* of the vertical velocity *v* of the block is shown in Fig. 2.2.

The velocity is taken to be positive in the upward direction.

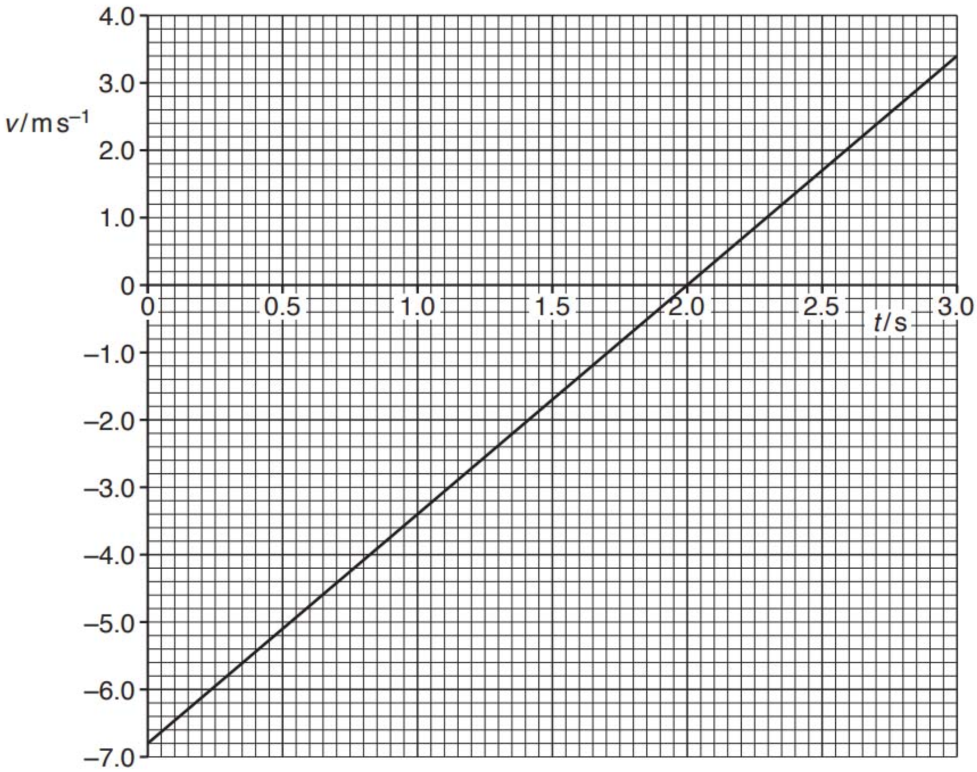

Fig. 2.2

(a) Determine the displacement of the block from time $t = 0$ to $t = 3.0$ s.

magnitude of displacement = ………………………

direction of displacement …………………..

[3]

(b) **(i)** Calculate the magnitude of the acceleration of the block at time $t = 2.0$s.

acceleration = …………………… [2]

(ii) Use your answer in **(b)(i)** to calculate the tension in the wire at time $t = 2.0$s.

The gravitational field strength acting on the block is 10 N/kg.

tension = …………………[2]

(c) The block is removed and replaced by a disc. The force on the disc due to air resistance is not negligible.

On Fig. 2.2, draw a possible velocity-time graph of the disc as the aircraft is lifting it until its velocity reaches zero. [1]

3 Fig. 3.1 below shows a device that can be used to ignite small pieces of combustible material. The device consists of a cylinder containing trapped air and a piston.

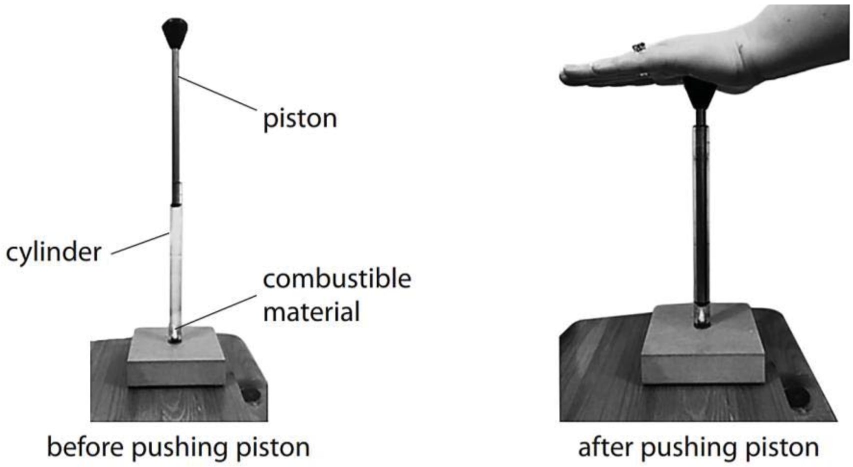

Fig. 3.1

A small piece of combustible material is placed at the bottom of the cylinder. When the piston is pushed quickly into the cylinder, the trapped air is compressed and heats up.

This increase in temperature is enough to ignite the combustible material.

The piston is quickly pushed down a distance of 14.5 cm.

The average force exerted on the piston is 4.7 N.

(a) Calculate the work done on the trapped air when the piston is quickly pushed down.

work done = ………….. [2]

(b) Suggest why the trapped air does not reach a high enough temperature to ignite the combustible material if the piston is slowly pushed into the cylinder.

…………………………………………………………………………………………

…………………………………………………………………………………………

………………………………………………………………………………….. [1]

4 Fig. 4.1 shows a diver using a canister of compressed air so that he can breathe underwater.

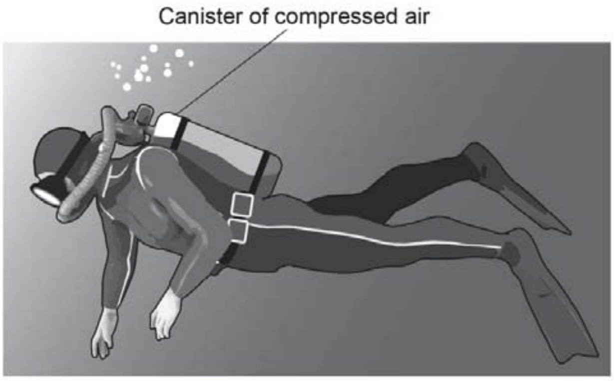

Fig. 4.1

(a) Describe the motion of the air particles in the canister.

……………………………………………………………………………………………

…………………………………………………………………………………….. [1]

(b) A canister of air was tested to find out how the pressure changed when it was used by a diver.

- Air was allowed to escape from the canister
- The pressure of the air inside the canister was recorded every 5 minutes for 80 minutes.

Fig. 4.2 shows the results.

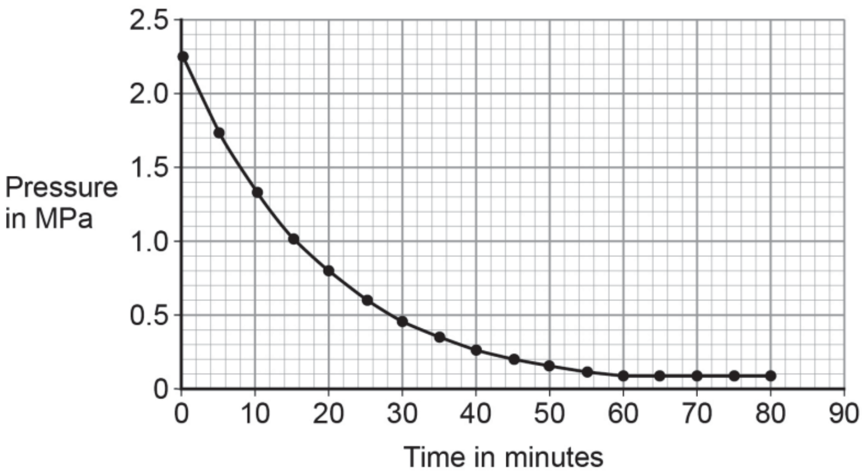

Fig. 4.2

(i) Using Fig. 4.2, estimate the atmospheric pressure.

atmospheric pressure = …………….. [1]

(ii) Divers can safely stay underwater as long as the pressure of the air in the canister is higher than the surrounding pressure.

Determine the maximum amount of time a diver can stay safe at 40 m below the surface of the sea.

The density of sea water is 1025 kg/m^3.

maximum amount of time= ……………… [2]

5 (a) State the principle of moments.

………………………………………………………………………………….........

………………………………………………………………………………….........

…………………………………………………………………………………....... [2]

(b) In a bicycle shop, two wheels hang from a horizontal uniform rod AC, as shown in Fig. 6.1.

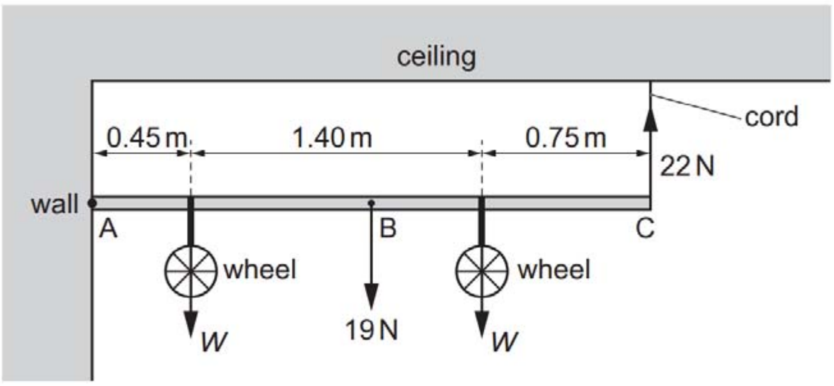

Fig. 6.1

The rod has weight 19N and is freely hinged to a wall at end A. The other end C of the rod is attached by a vertical elastic cord to the ceiling. The centre of gravity of the rod is at point B.

The weight of each wheel is W and the tension in the cord is 22N.

(i) By taking moments about end A, show that the weight W of each wheel is 14N.

[2]

(ii) Determine the magnitude and the direction of the force acting on the rod at end A.

force at end A = ... [1]

6 (a) In an experiment, a student inserts a wooden rod into the end of a brass tube as shown in Fig. 6.1.

Fig. 6.1

She then wraps a paper collar around the joint and heats the apparatus, as shown in the Fig. 6.2.

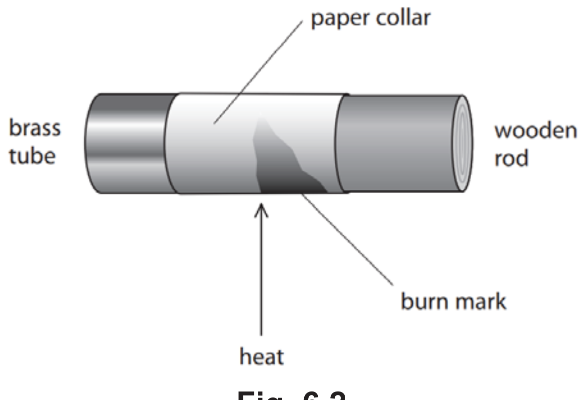

Fig. 6.2

Explain why the paper burns on the wooden rod, but not on the brass tube.

………………………………………………………………………………………..

………………………………………………………………………………………..

………………………………………………………………………………………..

………………………………………………………………………………….… [2]

(b) A man closes a plastic bag with some ice cubes inside, as shown in Fig. 6.3.

Fig. 6.3

(i) Describe briefly the processes on how the ice cubes inside the plastic bag gain thermal energy as they melt.

……………………………………………………………………………………...

……………………………………………………………………………………..….

……………………………………………………………………………………...

……………………………………………………………………………………… [2]

7 A ray of white light enters into a plastic tube which has a refractive index of 1.55 as shown in Fig. 7.1.

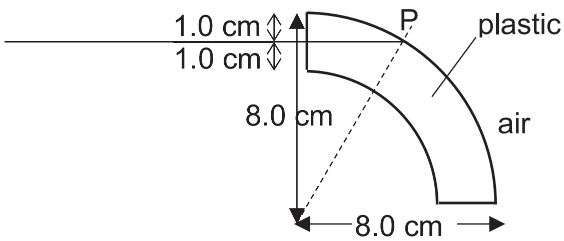

Fig. 7.1

(a) What is meant by a *refractive index of 1.55*?

………………………………………………………………………………………

……………………………………………………………………………………... [1]

(b) Determine the critical angle of the plastic tube.

critical angle = …………………….. [2]

(c) Find the angle of incidence at P.

angle of incidence = ………………… [2]

(d) On Fig. 7.1, complete the path of the light ray. [1]

8 Fig. 8.1 shows a charged rod brought towards a gentle stream of water from a tap.

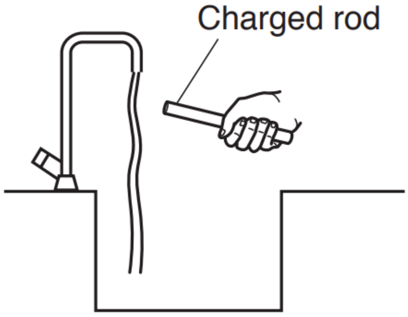

Fig. 8.1

(a) Explain how the charged rod affects the stream of water.

....

....

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....

....

.... [3]

(b) Fig. 8.2 shows the electric field between two charges, A and B.

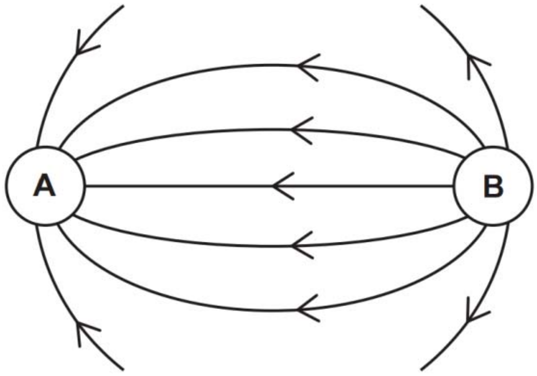

Fig. 8.2

(i) State and explain the charges of A and B.

……………………………………………………………………………....

……………………………………………………………………………....

……………………………………………………………………………....

…………………………………………………………………..…… [2]

(ii) Describe one similarity between the electric field line diagram and a magnetic field line diagram.

……………………………………………………………………………....

…………………………………………………………………..…… [1]

9 Fig. 9.1 shows a reed switch in the magnetic field of a strong permanent magnet.

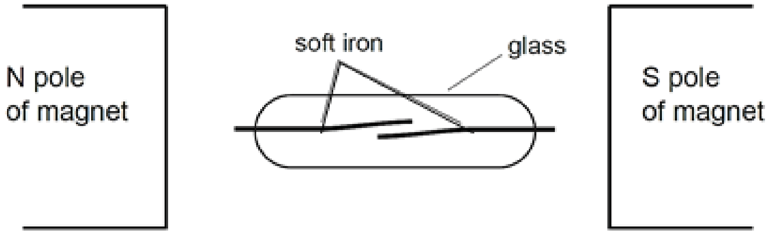

Fig. 9.1

(a) State and explain what happens to the soft iron in the reed switch.

....

....

....

....

.... [2]

(b) Fig. 9.2 shows two separate electrical circuits containing the reed switch.

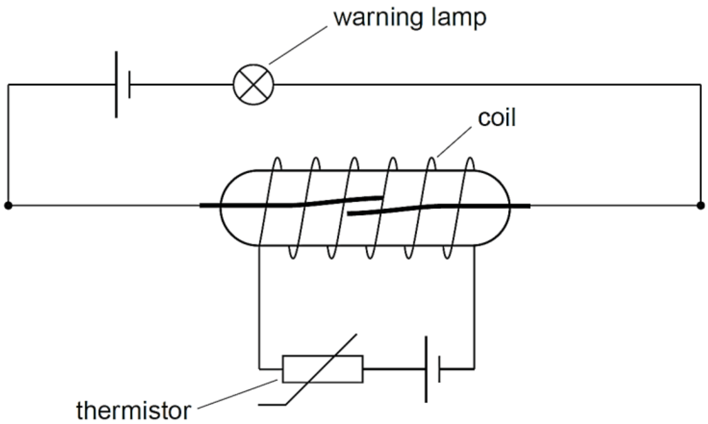

Fig. 9.2

Explain why the warning lamp lights up when the air temperature rises.

....

....

....

....

.... [2]

10 Fig. 10.1 shows the parts of an ammeter.

The pointer is connected to the coil so they can move together.

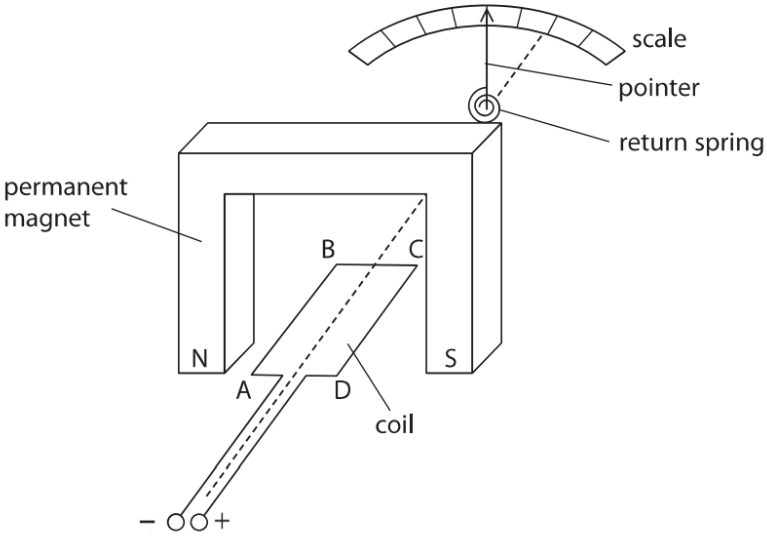

Fig. 10.1

(a) Explain how a current in the coil leads to a reading on the ammeter.

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....

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....

....

.... [3]

(b) Fig. 10.2 shows two metal rods **A** and **B** placed on two fixed smooth conducting rails.

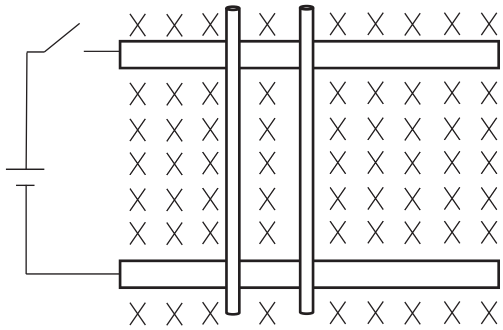


Fig. 10.2

There is a magnetic field pointing into the page.

Describe and explain the motion of the rods once the switch is closed.

....

....

....

....

.... [2]

Section B

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 13**.

11 A student wishes to determine the efficiency of an electric kettle that she has just bought.

Details about the experiment she conducted are shown in Table 11.1.

Mass of water poured into the kettle: 0.75 kg

Starting temperature of water: 25.5 °C

Time taken for the electric kettle to automatically switch 'OFF' after being switched 'ON' is 2 min 38 seconds.

Mass of water remaining in the kettle after boiling: 0.74 kg

A sticker at the bottom of the electric kettle shows the following

Model SG-620

240V ~ 50 Hz   2000W

DO NOT IMMERSE IN ANY LIQUID

She also found the following information while doing research for her experiment:

- Specific heat capacity of water = 4200 J/kg°C
- Specific latent heat of fusion = 334 kJ/kg
- Specific latent heat of vaporization = 2260 kJ/Kg

Table 11.1

(a) **(i)** Calculate the total energy transferred to the kettle while it was switched 'ON'.

total energy = ……………………….. [1]

(ii) Determine the efficiency of the kettle based on the information in Table 11.1

efficiency = ……………………….. [2]

(b) The student knows that her calculated efficiency is not accurate as thermal energy is lost by the water and the kettle during heating.

She decides to conduct a second experiment by placing 800 g of shaved ice at 0 °C into the kettle. She then switched 'ON' the kettle for the same amount of time as her earlier experiment. At the end of the experiment, she measured that 11.2 g of shaved ice remained in the kettle.

(i) Suggest a method for the student to ensure the shaved ice is at 0 °C without the use of a thermometer.

…………………………………………………………………………………………

…………………………………………………………………………………….. [1]

(ii) Determine the efficiency of the kettle based on her second experiment.

efficiency = …………………… [2]

(iii) Explain why the efficiency of the kettle is higher for her second experiment.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………….. [1]

(c) **(i)** The sticker label at the bottom of the kettle indicates that it has double insulation as shown by the logo.

Explain what is meant by double insulation.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………….. [2]

(ii) Suggest why the sticker label indicates "DO NOT IMMERSE IN ANY LIQUID" despite the electric kettle having double insulation.

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………….. [1]

12 (a) Fig. 12.1 shows the inside parts of the alternator.

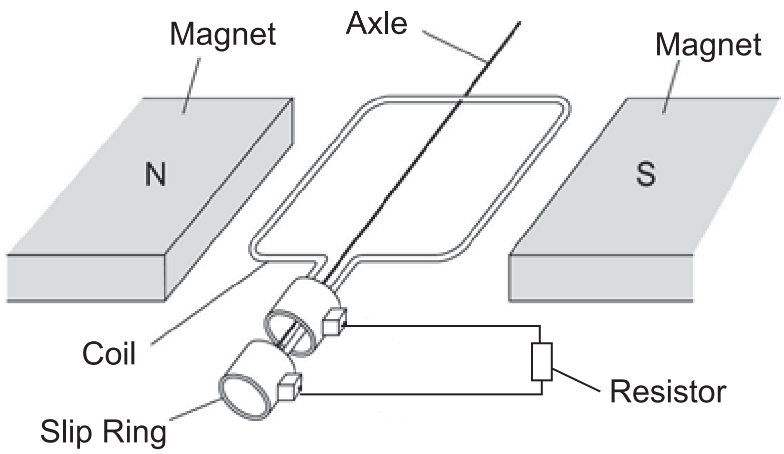


Fig.12.1

(i) The handle of the alternator is turned, causing the coil to rotate.

Explain why an alternating current is induced in the coil.

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………….…. [3]

(ii) State the purpose of the slip rings.

……………………………………………………………………………………

…………………………………………………………………………….…. [1]

(iii) The alternator from the portable power supply is disconnected from the resistor.

Explain why the handle of the alternator becomes much easier to turn.

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………… [2]

(b) A small coil is placed close to one end of a solenoid connected to a power supply. The plane of the small coil is normal to the axis of the solenoid, as illustrated in Fig. 12.2.

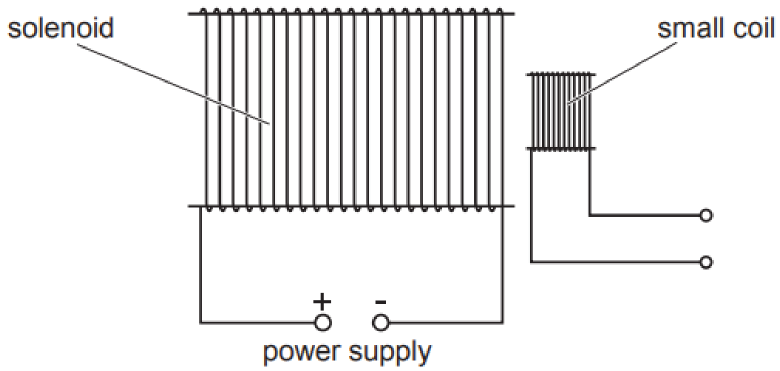


Fig.12.2

The power supply causes the current I in the solenoid to vary with time t as shown in Fig. 12.3.

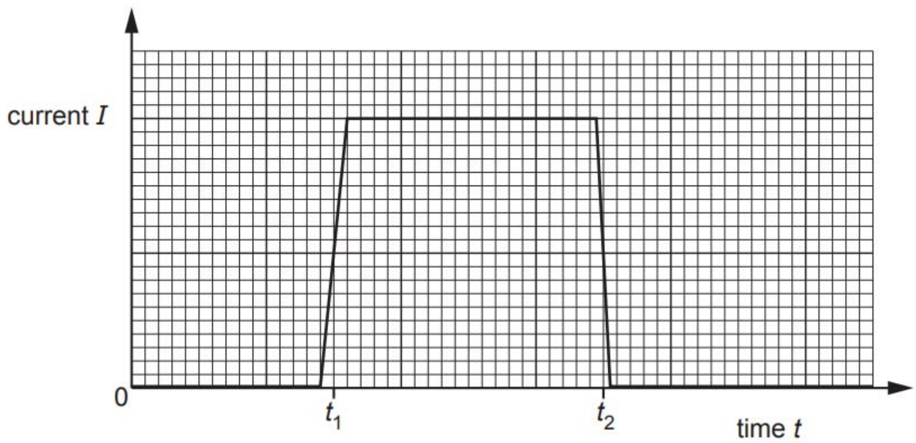


Fig. 12.3

(i) On Fig. 12.2, draw the magnetic field lines produced in the solenoid when the current is flowing. [1]

(ii) On the axes of Fig. 12.4, sketch a graph to show the variation with time *t* of the electromotive force (e.m.f.) induced in the small coil. (No values required)

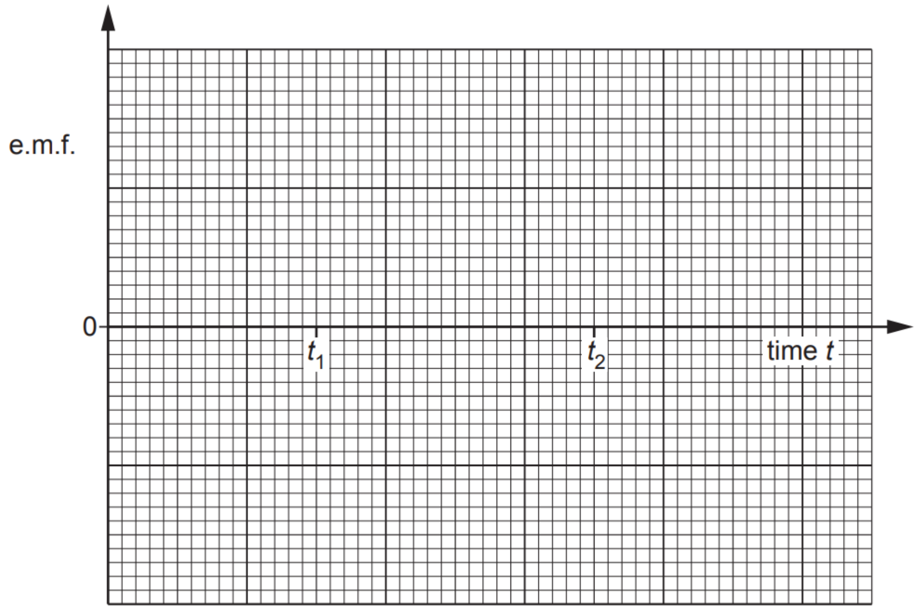


Fig. 12.4

[2]

(iii) Suggest how Fig.12.4 would be different if an iron core was placed inside the solenoid.

……………………………………………………………………………………..…

………………………………………………………..……………………[1]

13 EITHER

(a) In Fig. 13.1, a potential divider is made from a light-dependent resistor (LDR) and a 6.0 kΩ fixed resistor. The potential divider is connected in series with a 12 V d.c. power supply and a voltmeter is connected across the 6.0 kΩ resistor.

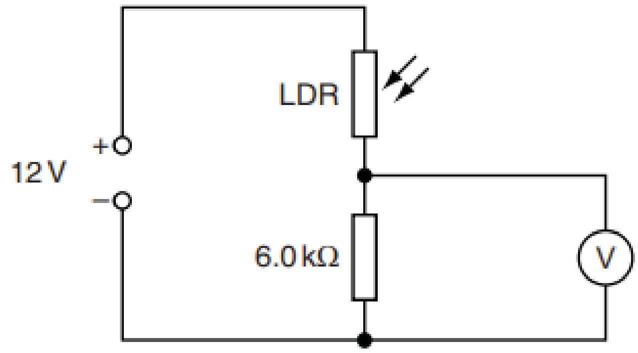


Fig. 13.1

(i) The circuit is placed on a rooftop at sunrise and left there until 12 noon on a clear sunny day.

Explain why the reading on the voltmeter increases.

....

....

....

....

.... [2]

(ii) A buzzer, which produces a sound when the potential difference across it goes above 4.5 V, is placed in parallel to the 6.0 kΩ resistor as shown in Fig. 13.2

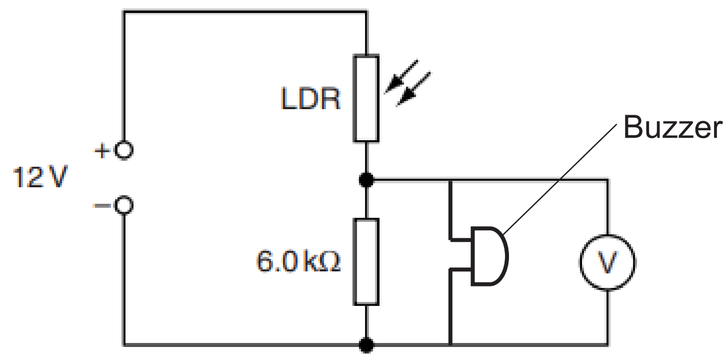


Fig. 13.2

The buzzer has a resistance of 1440 Ω.

Determine the minimum resistance of the LDR before the buzzer sounds.

minimum resistance = ………………………… [3]

(b) A student obtains the current–potential difference (p.d.) (I-V) graphs for a resistor, a thermistor and a filament lamp as shown in Fig. 13.2.

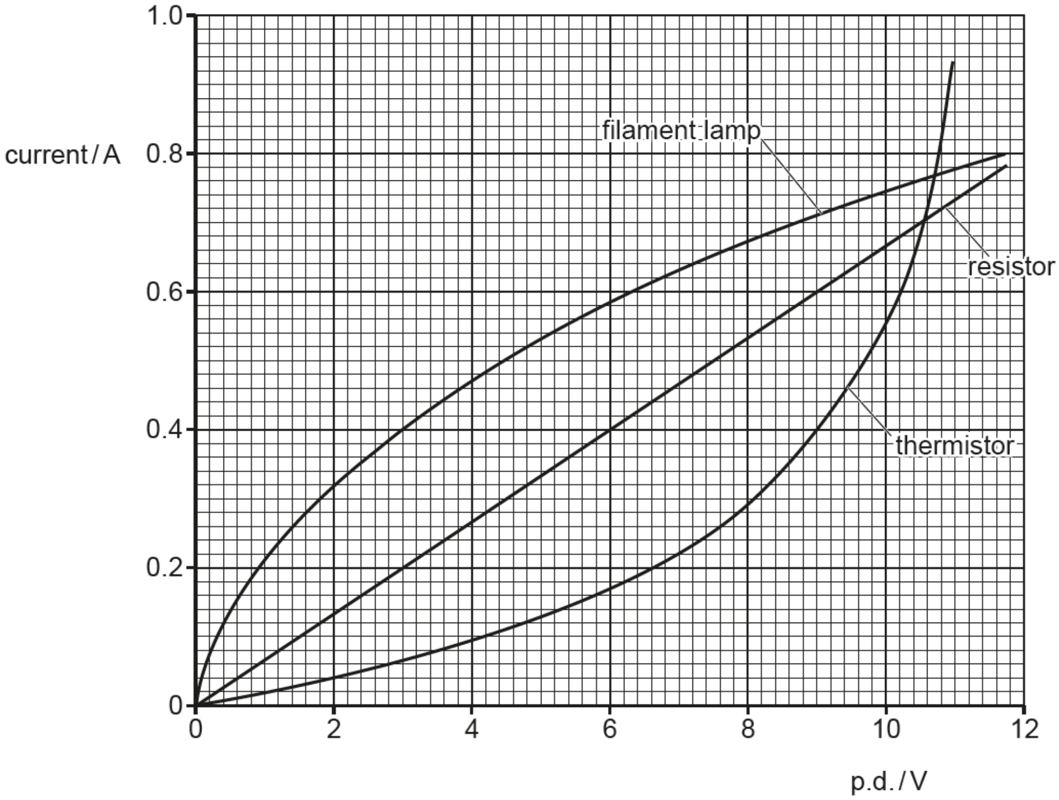


Fig. 13.2

(i) State what is meant by potential difference.

……………………………………………………………………………………

…………………………………………………………………………………… [1]

(ii) The student claims that the thermistor and filament lamp has the same resistance when a potential difference of 10.7 V is applied across them as their graphs intersect.

Using data from Fig. 13.2, explain whether this claim is correct.

………………………………………………………………………………..……

……………………………………………………………………….…………

………………………………………………………………………..………

………………………………………………………………..……….. [2]

(iii) The resistor, the thermistor and the filament lamp are connected in series with a d.c. power supply.

Using the graph in Fig. 13.2, determine the p.d. across the terminals of the power supply when the p.d. across the resistor is 6.0 V.

p.d. across terminals of power supply = ... [2]

13 OR

(a) Fig. 13.4 shows the pressure-distance graph of the particles at a particular instant when a sound wave passes through the particles.

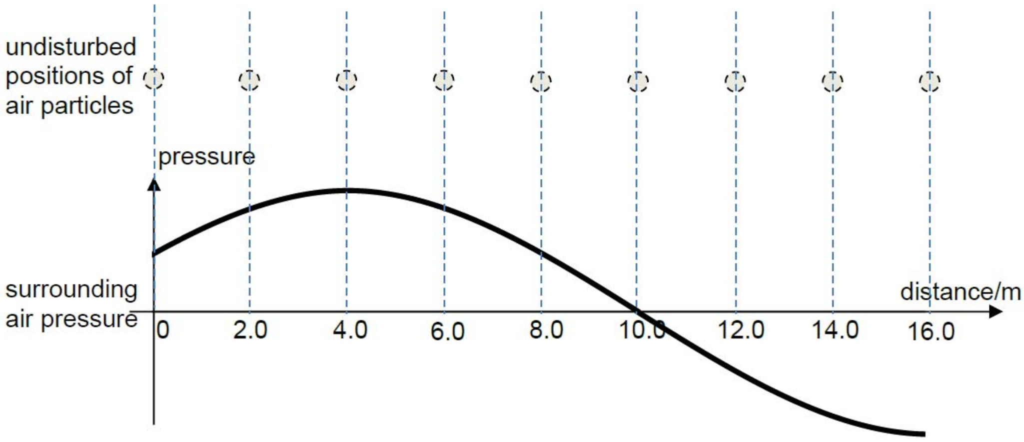


Fig. 13.4

(i) In the space above Fig. 13.4, draw the displaced positions of the particles corresponding to the pressure-distance graph.

The original undisturbed positions of the air particles are shown as a guide. [1]

(ii) The speed of sound in air is 330 m/s. Explain whether a person with normal range of audibility will be able to hear the sound in Fig. 13.4.

....

....

....

.... [2]

(iii) The same sound wave is played next to a swimming pool.

Describe the changes in the wave as it enters the water and explain whether a swimmer underwater will be able to hear the sound.

....

....

....

.... [2]

(b) Ultrasound waves can be used to create an image of part of the inside of a body.

Doctors can use an ultrasound scan to measure the diameter of a person's kidney as shown in Fig. 13.5.

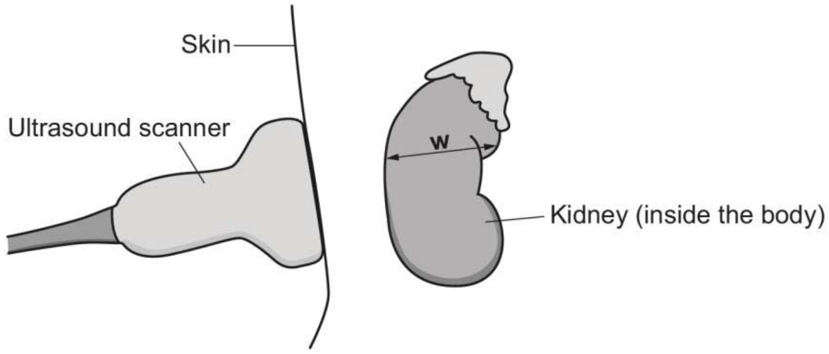


Fig. 13.5

(i) Explain how ultrasound waves are used to measure the diameter **w** of the kidney.

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

………………………………………………………………………………… [2]

(ii) The typical speed of sound in different tissues of the human body are shown below in Table 13.6.

Medium	Speed of sound (m/s)
fat	1450
kidney	1560
blood	1570
muscle	1580
bone	4080

Table 13.6

Using ideas about particles, explain why the speed of sound in bone is much higher than the speed of sound in other tissues.

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

………………………………………………………………………………… [2]

(iii) A doctor uses an ultrasound scan instead of X-rays to measure the kidneys.

Explain why.

……………………..…………………………………………………………

…………………………………………………………………………...……[1]

End of Paper

EXAM ANSWERS

Year:	**2022**
Exam:	**Prelim**
Level/Stream:	**4 Express**
Subject:	Pure Physics **6091/01**

Paper 1

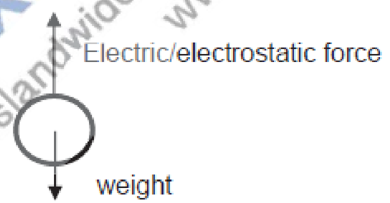
Qn	Answer
1.	D
2.	B
3.	B
4.	C
5.	D
6.	D
7.	B
8.	A
9.	B
10.	A
11.	B
12.	B
13.	A
14.	A
15.	D
16.	A
17.	B
18.	A
19.	B
20.	B
21.	C
22.	B
23.	D
24.	C
25.	D
26.	B
27.	B

28.	C
29.	B
30.	D
31.	C
32.	C
33.	A
34.	D
35.	D
36.	B
37.	C
38.	A, C, D
39.	C
40.	A

EXAM ANSWERS

Year:	**2022**
Exam:	**Prelim**
Level/Stream:	**4 Express**
Subject:	Pure Physics **6091/02**
s.f./d.p.:	No limit to deduction of s.f. & deduct 1 mark per s.f./d.p mistake

Paper 2 Section A

Qn	Answers	Marks	Comments
1a	Electric charge is a scalar quantity, as it has magnitude but no direction.	B1	Both needed for 1 mark
1bi	Average velocity is calculated by taking the total displacement over total time while average speed is the total distance travelled over the total time taken. The displacement of the particle is smaller as the straight line distance between X and Y is shorter than the curved path from X to Y which is the distance travelled.	B1 B1	1 mark for differentiating velocity and speed
1bii		B1 B1	1 mark for both forces correctly labelled 1 mark for the upward arrow larger than downward arrow

1

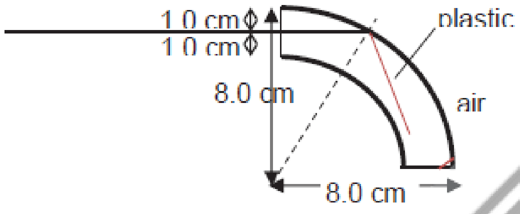
2a	0.5 x 6.8 x 2 – 0.5x 3.4 x 1.0 = 5.1 m downward	C1 A1 A1	Give max 1 mark if added 2nd mark not given if negative sign included Last mark given only if observed from working
2bi	A = 6.8 /2.0 = 3.4 m/s²	C1 A1	
2bii	M = w/g = 15/10 = 1.5 kg Resultant Force = 1.5 x 3.4 = 5.1N Tension = 15 + 5.1 = 20.1 = 20 N (2sf)	 C1 A1	Give ECF is 2bi is incorrect
2c	Initial velocity/acceleration is the same but line will continue with decreasing gradient v will reach zero after 2.0s.	B1	Marks are given as long as curve shape is correct
3a	Work done = 14.5/100 x 4.7 = 0.68 J	C1 A1	
3b	Since it is slower, there must have been less force applied which means less work done on the trapped air. Or	B1	

	More thermal energy is lost to the surroundings as there is more time for the energy to be conducted/radiated away *must mention longer time not just more thermal energy lost		
4a	The air particles are moving randomly at high speeds.	B1	
4b	0.1 MPa = 100000 Pa	B1	
4bii	Pressure at 40m underwater = 40x1025x10+100000 = 410 000 + 100000 = 510 000 Pa Based on graph time = 26-28 minutes	 C1 A1	Maximum 1 mark if student did not add atmospheric pressure and got 30-32 min
5a	For an object in equilibrium, the sum of clockwise moments about a pivot is equal to the sum of anti-clockwise moments about the same pivot.	B1 B1	
5bi	Sum of CM = sum of ACM 0.45W + 19 x 1.3 +1.85W = 2.6 x 22 2.3 W + 24.7 = 57.2 2.3 W = 32.5 W = 14.1 = 14 N (2sf)	 C1 A1	1 mark for correct substitution
5bii	F + 22 = 19 +28 F = 25 N upwards	 B1	Give full ECF

3

6a	Brass is a much better conductor of thermal energy than wood. The thermal energy is quickly conducted away by the brass rod and the paper doesn't reach a high enough temperature to start burning Or the thermal energy cannot be conducted away quickly enough by the wooden rod thus the paper reaches a sufficiently high temperature to start burning	C1 A1	1 mark for stating the difference between brass and wood
6b	The ice cubes gain thermal energy via radiation as the ice cubes are colder than the surroundings. Some thermal energy is also gained via conduction through the plastic bag from the surrounding air.	B1 B1	
7a	It means that the ratio of the speed of light in vacuum over the speed of light in the medium is 1.55	B1	Accepted speed of light in vacuum divided by speed of light in medium is 1.55
7b	$C = \sin^{-1}(1/1.55)$ $= 40.2°$ (3sf)	C1 A1	
7c	sin I = opposite/hypotenuse = 7.0 / 8.0 I = 61° accept 61.0°	 C1 A1	

4

7d		C1 A1	
8a	Particles in the stream of water with the same charge as the charged rod will be repelled away while those of the opposite charge will be attracted. As the force of attraction is stronger than the force of repulsion due to a shorter distance, the water will move towards the charged rod.	B1 B1 B1	
8bi	As the electric field line directions are by convention the same direction as what would happen to a positive test charge, thus B is positively charged, while A is negatively charged.	C1 B1	
8bii	The field lines for both cannot intersect with one another Or	B1	Did not accept both have lines/arrows

	The distance between the field lines indicate the strength of the electric/magnetic field		Did not accept force in lieu of field strength
9a	The soft iron inside the reed switch will be attracted towards each other. As both strands of soft iron become induced magnets, they will have opposite poles in the middle of the glass which attract each other.	B1 B1	
9b	As the temperature rises, the resistance of the thermistor decreases. Thus the current in the circuit increases. This increases the magnetic field strength of the coil which causes the reed switch to be attracted to each other thus closing the switch.	B1 B1	
10a	When the current flows through the coil, the circular magnetic field around the coil (or CD or AB) interacts with the magnetic field of the permanent magnet. This causes a downward force on CD (or next to South pole) **and** an upward force on AB (or next to North pole). The resulting clockwise moment causes the coil and the pointer to **rotate** (or turn) clockwise.	B1 B1 B1	
10b	Both rods will move/accelerate to the right.	B1 B1	FLHR must be mentioned in full

	According to **FLHR**, as the current flows down, the magnetic field is into the paper, the thumb which represents motion is pointed to the right.		No credit for contradicting the direction.

Paper 2 Section B

Qn	Answers	Marks	Comments
11ai	E = Pt = 2000 x 158 = 316000 J (accept 320 000 J)	 C1 A1	
11aii	Energy input = 316000 Energy output = 0.75 x 74.5 x 4200+0.01x2260000 = 257275 Efficiency = 257275/316000 = 81% or 81.4% (2sf)	 B1 B1	1st mark is given only if the energy output working is correct. 2nd mark can be given as long as it is calculated output/input (from 10bi). Credit given for displaying output/input

11bi	The student should only use the shaved ice once it **starts** melting but not completely liquid.	B1	
11bii	Energy output = (800-11.2)/1000 *334 000 = 263 459.2 J Efficiency = 263 459.2/316000 = 83% or 83.3% (accept 2 or 3 sf)	 C1 A1	Accept 82.3% if 320000 is used as the input.
11biii	The temperature difference is lower between 0°C and room temperature as compared to 100°C and room temperature. So the rate of thermal energy gain/loss is smaller.	B1	**Both points needed**
11ci	Double insulation means that the electrical cables are insulated from the internal components and the internal components are insulated from the external casing.	B1 B1	**All must be mentioned.**
11dii	The kettle may not be waterproof which means water can go inside the kettle and cause a short circuit/electrical fire if it comes to contact with the wires.	B1	
12ai	As the coil rotates, the magnetic flux linkage between the coil and the magnets change Or	B1	Concept of induced EMF

8

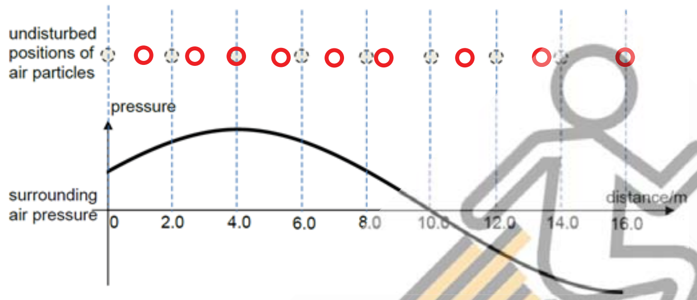
	As the coil rotates, it cuts the magnetic field lines between the magnets, an EMF is induced in the coil. Every 180° turn, the induced EMF in the coil reverses direction as the coil moves in the opposite direction. As the induced current flows as the coil is a closed circuit.	B1 B1	Concept of alternating Concept of load which turns EMF to current
12aii	Slip rings are connected to each side of the coil to maintain electrical contact and ensure induced current flows (to external circuit).	B1	
12aiii	When the transformer is disconnected, the **circuit** connected to the slip rings is **no longer closed**, thus there is no induced current flowing in the circuit. Hence, by Lenz' Law there is no magnetic effect opposing the rotation of the coil which produces the induced current (or no opposing force).	B1 B1	Accept "there is induced emf" in place of "no induced current".
12bi	Magnetic field lines (North Pole on the right side)	B1	Straight lines with correct arrows within solenoid

12bii	**Peaks** at t_1 and t_2 (one must be positive the other negative) Peak at t_2 must have twice the amplitude compared to t_1	B1 B1	
12biii	The amplitude of both the peaks at t_1 and t_2 will be higher.	B1	
13EITHER			
ai	As the light intensity increases, the resistance of the LDR decreases. This causes the fraction $(6000/6000+ R_{thermistor})$ to increase, thus the voltmeter reading $V = 12 \times (6000/6000+ R_{thermistor})$ increases. Or As the total resistance decreases, the current across the circuit increases. Thus as V = R x I, the voltmeter reading increases.	C1 A1	 Must explain how V is determined
aii	Total resistance of buzzer and resistor 1/R = 1/1440 + 1/6000 R = 1160 4.5 = 12 (1160/1160+R)	 B1 B1	 2nd and 3rd mark can be given if

10

	5220 + 4.5 R = 13920 R = 1930 (accept 1900 2sf)	B1	formula is correct
bi	Potential difference across a component is the work done in driving a unit charges across it.	B1	

bii	The claim is correct The resistance of the components can be found as <u>R = V/I</u> <u>Both the filament lamp and thermistor have a pd of 10.7 V and current of 0.77A</u>, hence R is also the same.	 B1 B1	Must quote current of 0.77 A
13biii	As the three components are in series, all have the same current flowing through. V lamp = 3.0V V thermistor = 9.0V Total pd supply = 3 + 6 + 9 = 18.0 V (accept 18V)	 C1 A1	1st mark for either V lamp or V thermistor correct.

13OR			
ai		B1	Particles at maximum and minimum pressure should have zero displacement
aii	The frequency of the wave is equal to 330/24 = 14 Hz. Which is below the human audibility range of 20-20000Hz, thus it cannot be heard.	B1 B1	
aiii	No it still cannot be heard. The sound wave will be faster and have a larger wavelength, but it will continue to have the same frequency. Thus it still cannot be heard by the swimmer.	 B1 B1	Give full ECF from aii

bi	Ultrasound waves are reflected by the kidney back to the ultrasound scanner. By measuring the time difference between the ultrasound coming back from the left and right side of the kidney. The diameter w can be calculated as 2w = time difference x speed of ultrasound.	B1 B1	
bii	Bone tissues have less liquid than the other tissues. Thus the particles in bone tissues are relatively more closely packed. Since sound travels through the collisions of particles, particles in bone tissues collide more frequently and transmits sounds at a faster rate.	B1 B1	Advised to state why the particles are more closely packed
biii	Ultrasound are not ionizing as compared to X-rays thus do not cause cell damage.	B1	Must state ionizing in the answer

Name: Register Number: Class:

For Marker's Use

南僑中學

NAN CHIAU HIGH SCHOOL
PRELIMINARY EXAMINATION 2022
SECONDARY FOUR EXPRESS

PHYSICS **6091/01**

Paper 1 Multiple Choice

30 Aug 2022
Tuesday

1 hour

Candidates answer on the OTAS.

INSTRUCTIONS TO CANDIDATES

Write your name, class and register number in the spaces provided at the top of this page.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the OTAS.

Each correct answer will score one mark.

The total marks for this paper is 40.

Take gravitational field strength of Earth = 10 N kg^{-1} and acceleration due to gravity = 10 m s^{-2}.

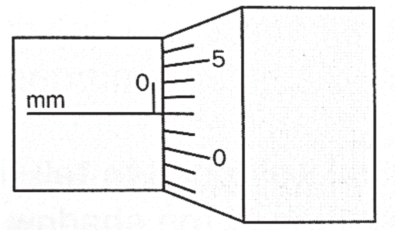
This paper consists of **16** printed pages including the cover page.

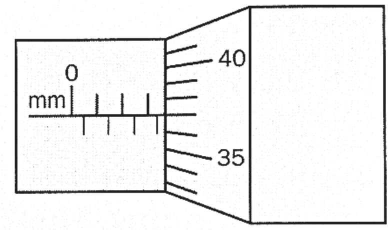
1 What is the order of magnitude of the mass of a typical motor car (without driver and passengers) in kg?

A 1 x 10 **B** 1 x 10^2
C 1 x 10^3 **D** 1 x 10^4

2 A micrometer screw gauge is used to measure the thickness of a coin.

The diagrams show the scales of the micrometer when the jaws are closed with no coin and when the jaws are closed with the coin respectively.

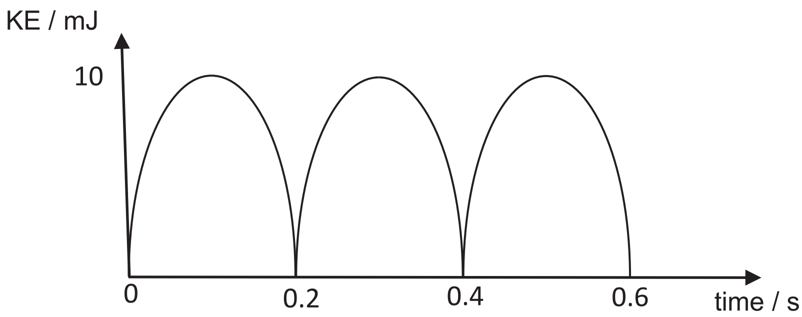




What is the thickness of the coin?

A 3.35 mm **B** 3.39 mm **C** 3.85 mm **D** 3.89 mm

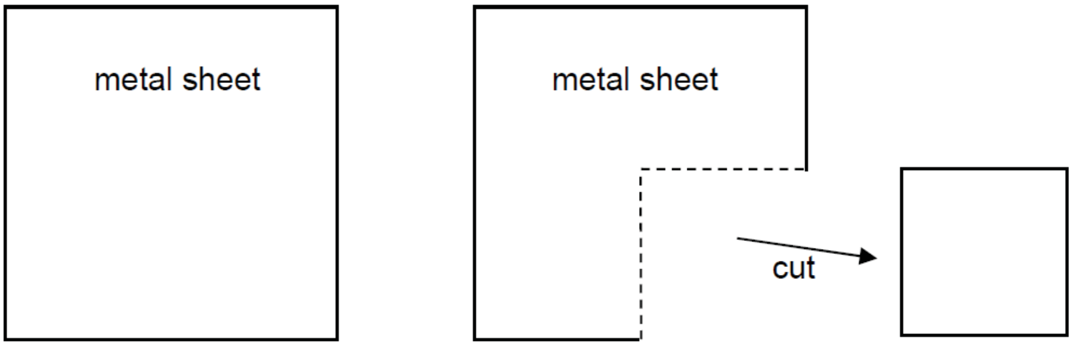
3 The diagram shows how the kinetic energy (KE) of the bob of an oscillating simple pendulum varies with time.



What is the period of the pendulum in second?

A 0.2 **B** 0.4
C 0.5 **D** 0.6

4 An uniform flat piece of metal sheet has a density of 8.0 g/cm^3. One quarter of the metal sheet is cut out as shown.



What is the density of the one-quarter metal sheet?

A 2.0 g/cm^3 **B** 4.0 g/cm^3 **C** 8.0 g/cm^3 **D** 32.0 g/cm^3

5 A car is moving in a straight line horizontally at a constant speed of 20 m/s. The car engine produces a constant power of 28,000 W. What is the frictional force acting on the car when the efficiency of the car engine is 71 %?

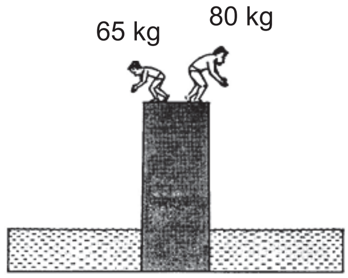
A 990 N **B** 2000 N **C** 20 000 N **D** 400,000 N

6 A boy pushes a box 10 m along a rough, horizontal floor with a force of 5.0 N. The frictional force between the floor and the box is 2.0 N.

What is the work done against the friction, the work done by the boy and the energy gained by the box?

	work done against friction/ J	work done by boy/ J	energy gained by box/ J
A	20	50	30
B	20	50	50
C	30	50	50
D	30	50	30

7 The diagram shows two divers of different masses diving with the same initial speed from the same height into a pool. Air resistance is negligible.



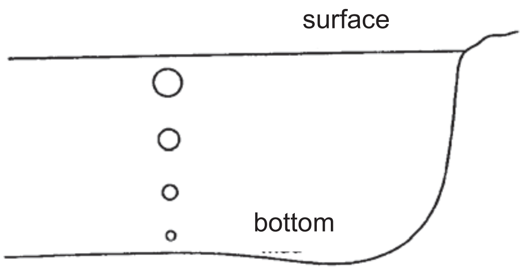
Which physical quantity is different between the divers just before they hit the water?

A acceleration
B duration of free fall
C kinetic energy
D speed

8 A parachutist has opened his parachute and is falling to Earth at constant speed. What is the principal energy conversion taking place as he falls?

A gravitational potential energy to kinetic energy
B gravitational potential energy to thermal energy
C kinetic energy to gravitational potential energy
D kinetic energy to thermal energy

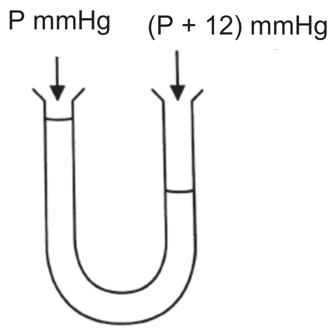
9 Bubbles of gas rise from the bottom to the surface of a deep lake.



As the bubbles rise, their volumes increase. Why is this so?

A Atmospheric pressure on the bubbles decreases.
B Atmospheric pressure on the bubbles increases.
C Water pressure on the bubbles decreases.
D Water pressure on the bubbles increases.

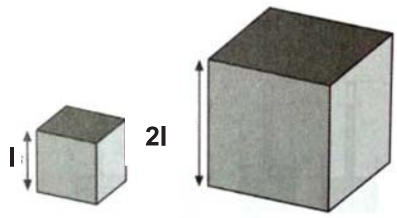
10 The diagram shows a mercury manometer. Pressures of (P + 12) mmHg and P mmHg are exerted at the right and left tubes respectively.



What will happen to the mercury level in the left tube when the pressure at the right tube decreases to (P + 6) mmHg?

A increases by 3 mm
B increases by 6 mm
C decreases by 3 mm
D decreases by 6 mm

11 Two solid cubes are made from the same material. One cube has sides that are two times as long as the other.



When placed on one side, the small cube exerts a pressure p on the ground.

What is the pressure exerted by the large cube standing on one of its faces?

A $2p$ **B** $4p$ **C** $8p$ **D** $13p$

12 A resistance thermometer has a resistance of 45.0 Ω at ice point and 295 Ω at steam point. What is its temperature when its resistance is 148 Ω?

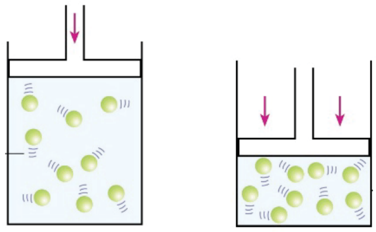
A 34.9 °C **B** 41.2 °C **C** 50.2 °C **D** 59.2 °C

13 When dust particles in air are observed in a microscope, they move in a random, zig-zag motion. The same dust particles are observed to move faster in the same random, zig-zag motion when room temperature is higher.

Why is it so?

A The dust particles gain kinetic energy and collide with the air molecules more vigorously and frequently.
B The air molecules gain kinetic energy and collide with the dust particles more vigorously and frequently.
C The increased temperature of the room creates a convention current that causes the dust particles to move faster.
D The increased temperature of the room causes chemical reactions to occur between the dust particles and air molecules.

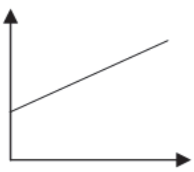
14 A fixed mass of helium gas is compressed to a smaller volume at constant temperature.



How do the following properties of the gas molecules change?

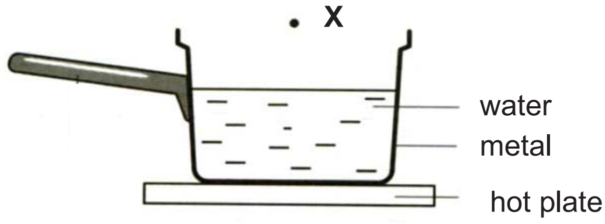
	average speed of the gas molecules	frequency of collisions with the walls of the container
A	increases	increases
B	increases	remains unchanged
C	remains unchanged	increases
D	remains unchanged	remains unchanged

15 The graph indicates properties of a fixed mass of ideal gas. Which of the following could describe what is plotted on the graph?



	horizontal axis	vertical axis	condition
A	temperature	pressure	constant volume
B	temperature	density	constant pressure
C	temperature	volume	constant density
D	volume	pressure	constant temperature

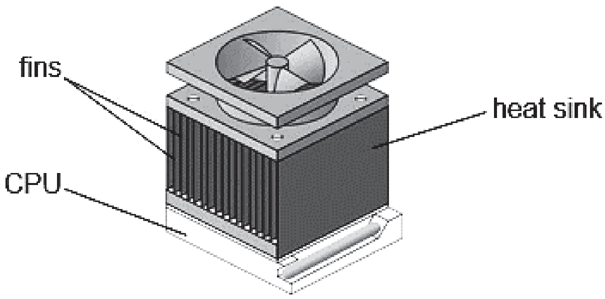
16 The diagram shows a metal saucepan filled with water and placed on a hot plate. After some time, the air at point **X** also becomes hot.



What are the main ways by which heat travels through the materials between the hot plate and point **X**?

	through base of the saucepan	through the water	through the air
A	Conduction	Convection	Radiation
B	Conduction	Convection	Convection
C	Radiation	Convection	Conduction
D	Radiation	Conduction	Convection

17 The figure below shows a heat sink placed on top of a central processing unit (CPU) chip in a computer. The heat sink is painted black and is designed to have many fins (layers with air spaces between them).



Heat is conducted from the CPU to the heat sink. The heat sink then transfers the heat to the surroundings.

Which statement about the heat sink is **not** correct?

A The fins is made of aluminium because aluminium is a good conductor of heat.
B The heat sink has many fins to increase the surface area for emission of radiant heat.
C The heat sink is painted black because black surfaces are good conductors of heat.
D The heat sink is painted black because black surfaces are good emitters of radiant heat.

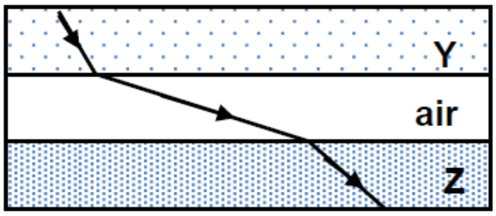
18 Water in a beaker is heated from 10 °C to 100 °C. The water starts boiling at 100 °C.

Which of the following is true for the internal potential energy (IPE) and the internal kinetic energy (IKE) of the water molecules during heating and boiling?

	heating from 10 °C to 100 °C	boiling at 100 °C
A	IKE increases slightly	IKE increases by a lot
B	IKE remains the same	IKE remains the same
C	IPE increase slightly	IPE increases by a lot
D	IPE remains the same	IPE remains the same

19 The diagram shows a light ray travelling from medium Y, through the air, to medium Z. The refractive indices of media Y and Z are denoted by n_y and n_z respectively.

Which relationship correctly describes the magnitude of n_y and n_z?



A $1 > n_z > n_y$

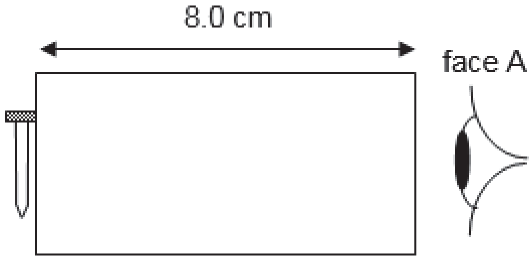
B $n_z > n_y > 1$

C $n_y > 1 > n_z$

D $n_y > n_z > 1$

20 A small nail is viewed through a rectangular glass block with parallel faces. The nail is 8.0 cm away from the face A of the glass block.

Which of the following describes how the image of the nail is seen by the observer?



A real and less than 8.0 cm away from face A
B real and more than 8.0 cm away from face A
C virtual and less than 8.0 cm away from face A
D virtual and more than 8.0 cm away from face A

21 A dipper which is moving up and down, makes water waves in a ripple tank.

What happens when the frequency of the dipper is increased?

A The wavelength of the wave decreases.
B The wavelength of the wave increases.
C The speed of the wave decreases.
D The speed of the wave increases.

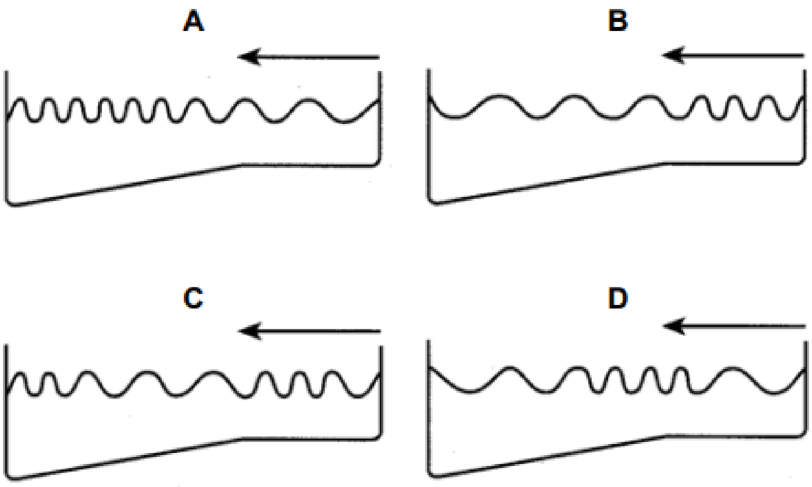
22 A wave generating machine produces a number of water waves per second. The generated wave travels 9.0 cm in 3.0 s and the distance between its 2 consecutive crests is 1.5 cm.

How many waves does the generator produce per second?

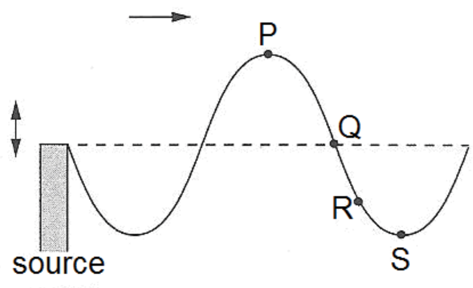
A 0.50 **B** 2.0
C 3.0 **D** 4.5

23 A ripple tank contains water waves of constant frequency moving from right to left in varying depths.

Which diagram correctly represents the water waves as they travel from the shallow to the deeper region?



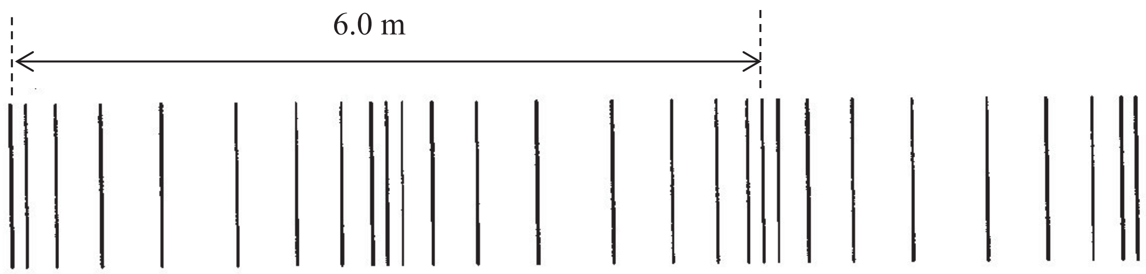
24 A source sets up a wave along a string. The wave is moving to the right.



Which of the following statements is **not** correct?

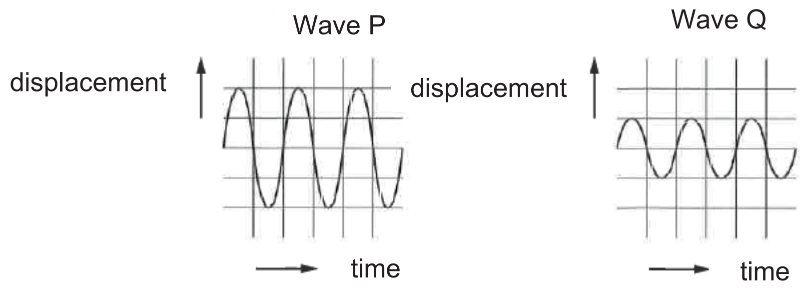
A Particle R is moving up.
B Particle Q is moving to the right.
C Particle P is momentarily at rest.
D Particle S is momentarily at rest.

25 The diagram shows a series of compressions and rarefactions of a sound wave in air. Given that the speed of sound is 300 m/s, what is the frequency of this sound wave?



A 25.0 Hz
B 50.0 Hz
C 100 Hz
D 150 Hz

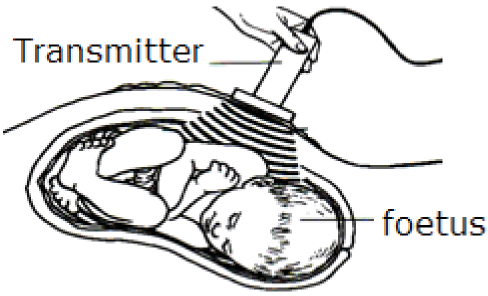
26 The diagams show sound waves P and Q.



How do the frequency and loudness of wave P compare with the frequency and loudness of wave Q?

	frequency of P	loudness of P
A	higher than Q	greater than Q
B	higher than Q	same as Q
C	same as Q	greater than Q
D	same as Q	same than Q

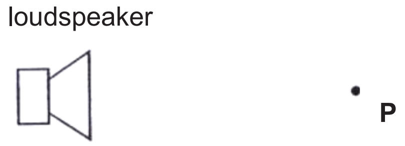
27 The diagram shows how ultrasound is used to scan a human foetus.



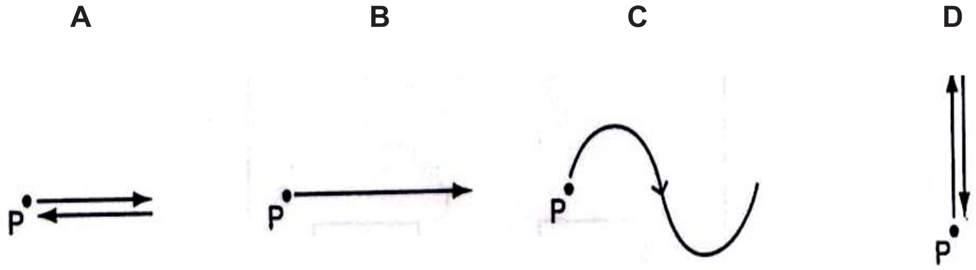
What is the likely frequency of the ultrasound used?

A 4.0 Hz **B** 2 000 Hz
C 20 000 Hz **D** 40 000 Hz

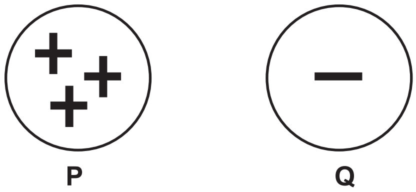
28 The diagram shows a loudspeaker that is producing a continuous sound wave of frequency 100 Hz in air.



Which of the following diagrams shows how the sound wave causes an air molecule at P to move during 0.010 s?



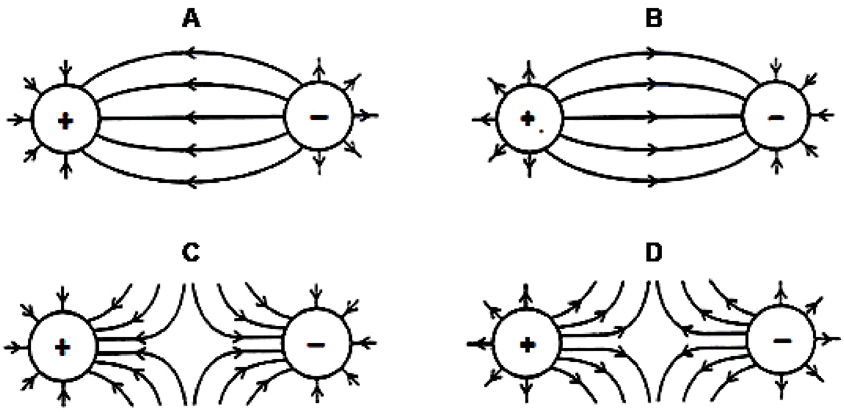
29 The diagram shows two identical isolated metallic spheres P and Q. Sphere P carries three *net* positive charges while sphere Q carries one *net* negative charge.



When sphere P touches sphere Q, which of the following describes the movement of the charge(s) correctly?

A Only one negative charge moves from Q to P.
B Only one positive charge moves from P to Q.
C Two negative charges move from Q to P.
D Two positive charges move from P to Q.

30 Which diagram correctly shows the electric field pattern between two charged spheres?

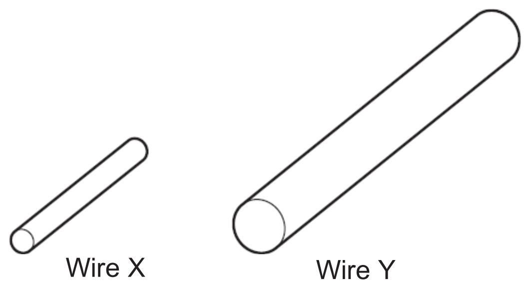


31 During a lightning strike that lasts 2.0×10^{-4} s, a total of 3.5×10^{21} electrons pass from the cloud to a tree. The size of the charge on an electron is 1.6×10^{-19} C.

What is the average current in the lightning strike?

A 8.0×10^{-16} A **B** 2.8×10^{6} A
C 3.2×10^{15} A **D** 1.8×10^{25} A

32 The diagram shows two resistance wires X and Y of the same material.



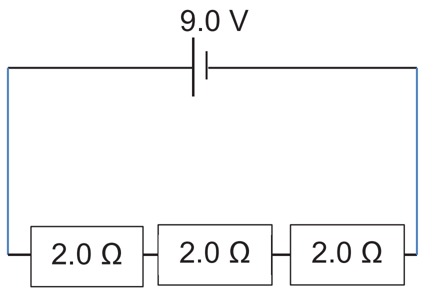
The cross-sectional area of wire Y is four times that of wire X. The length of wire Y is twice the length of wire X.

What is the ratio of the resistance of wire X to the resistance of wire Y?

A $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** 2 **D** 4

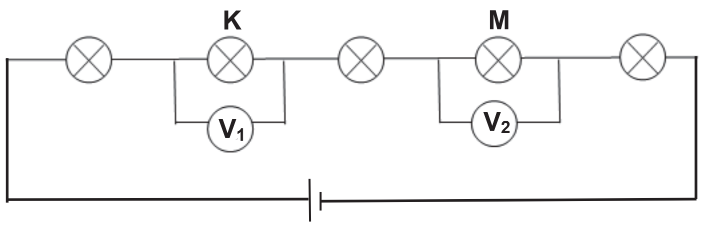
33 The diagram shows three identical resistors each of 2.0 Ω resistance connected in series to a 9.0 V electric cell.

What is the total amount of energy dissipated in the circuit when 2.0 C of charge passes through the resistors?



A 1.5 J **B** 3.0 J **C** 18 J **D** 54 J

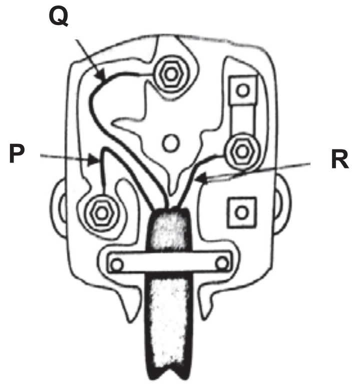
34 Five identical light bulbs are connected to a 60 V d.c. supply. Voltmeter V_1 is connected in parallel with light bulb K and voltmeter V_2 in parallel with light bulb M.



What will be the readings of the two voltmeters when light bulb M is short-circuited?

	V_1 / V	V_2 / V
A	0	60
B	12	0
C	12	12
D	15	0

35 A 24 Ω resistor is connected to a 240 V mains. What are the magnitudes of the currents flowing in wires P, Q and R?



	P	Q	R
A	0	10 A	10 A
B	10 A	0	10 A
C	0	10 A	0
D	0	0	10 A

36 A lamp rated at 280 V, 10 W is connected across a 240 V household mains power supply. What happens when the circuit is switched on?

A The lamp lights up with power less than 10 W.

B The lamp lights up with power equal to 10 W.

C The lamp lights up with power greater than 10 W.

D The lamp blows.

37 The metal casing of an electric heater is earthed. The live wire of the heater is connected to a correctly-rated fuse.

The cable to the heater becomes so worn out that the live wire makes electrical contact with the case.

What happens next?

A The current flows to earth and the fuse is not affected.

B The fuse melts and switches off the circuit.

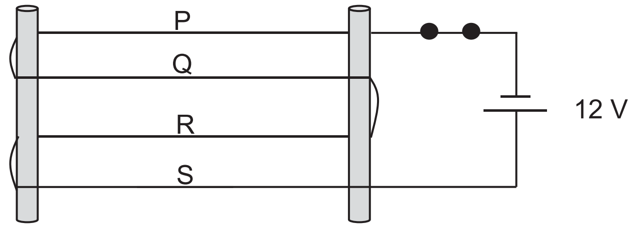
C The metal case becomes live and dangerous.

D The metal case becomes very hot.

38 The cost of 1.0 kWh of electricity is 20 cents. What is the cost of electricity of using a 2000 W heater for 3 hours and 3 minutes?

A 61 cents **B** 122 cents
C 163 cents **D** 2 120 cents

39 Four parallel lengths of bare wires, P, Q, R and S are created by wrapping a gold wire around two vertical wooden poles. The gold wire is connected to a switch and a 12 V d.c. battery.



When the switch is closed, which of the following is correct in terms of attraction and repulsion between wires P & Q and Q & R?

	P & Q	Q & R
A	attract	attract
B	attract	repel
C	repel	attract
D	repel	repel

40 Electric power cables transmit electrical energy over large distances using a high voltage, alternating current.

What are the advantages of using a high voltage and of using an alternating current?

	advantage of using a high voltage	advantage of using an alternating current
A	a higher current is produced in the cable	the resistance of the cable is reduced
B	a higher current is produced in the cable	the voltage can be changed using a transformer
C	a lower current is produced in the cable	the resistance of the cable is reduced
D	a lower current is produced in the cable	the voltage can be changed using a transformer

End of paper

Name: Register Number: Class:

For Marker's Use

Parent's Signature:

南僑中學

NAN CHIAU HIGH SCHOOL

PRELIMINARY EXAMINATION 2022
SECONDARY FOUR EXPRESS

PHYSICS **6091/02**

Paper 2 **23 Aug 2022 Tuesday**
1 hour 45 mins

Candidates answer on the Question Paper.
No additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces provided on the question paper.
You may use an HB pencil for any diagrams, graphs, tables or rough working.
Write in dark blue or black pen.
Do not use staples, paper clips, highlighters, glue or correction fluid or tape.
The use of an approved calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

Section A: 50 marks
Answer **all** questions.

Section B: 30 marks
Answer **all** questions. Question 12 has a choice of parts to answer.

The total mark for this paper is **80**.
Take gravitational field strength of Earth = 10 N kg^{-1} and acceleration due to gravity = 10 m s^{-2}.

This question paper consists of **20** printed pages, including this cover page.

Section A

Answer **all** the questions in this section

1 Fig. 1.1 (not drawn to scale) shows the side view of a steel ball 2.0 kg suspended by 2 strings attached to the ceiling. String 1 and string 2 are 35° and 55° from the vertical respectively. The tensions in strings 1 and 2 are T_1 and T_2 respectively.

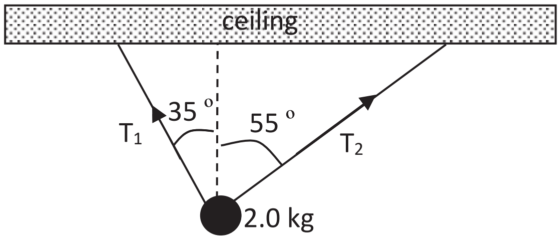


Fig. 1.1 (Side view)

(a) State and explain if the ball is at equilibrium. [2]

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(b) Calculate the weight of the ball. [1]

(c) Draw the weight and label it as **W** in Fig. 1.1. [1]

(d) By drawing a scaled vector diagram below, determine the magnitudes of tension $\mathbf{T_1}$ and tension $\mathbf{T_2}$. [3]

Tension T_1 = ______________

Tension T_2 = ______________

2 A rock is travelling in a straight line downwards at high speed in air when it enters a deep pond. Fig. 2.1 shows the speed-time graph of the rock from time t = 0 s to time t = 50 s.

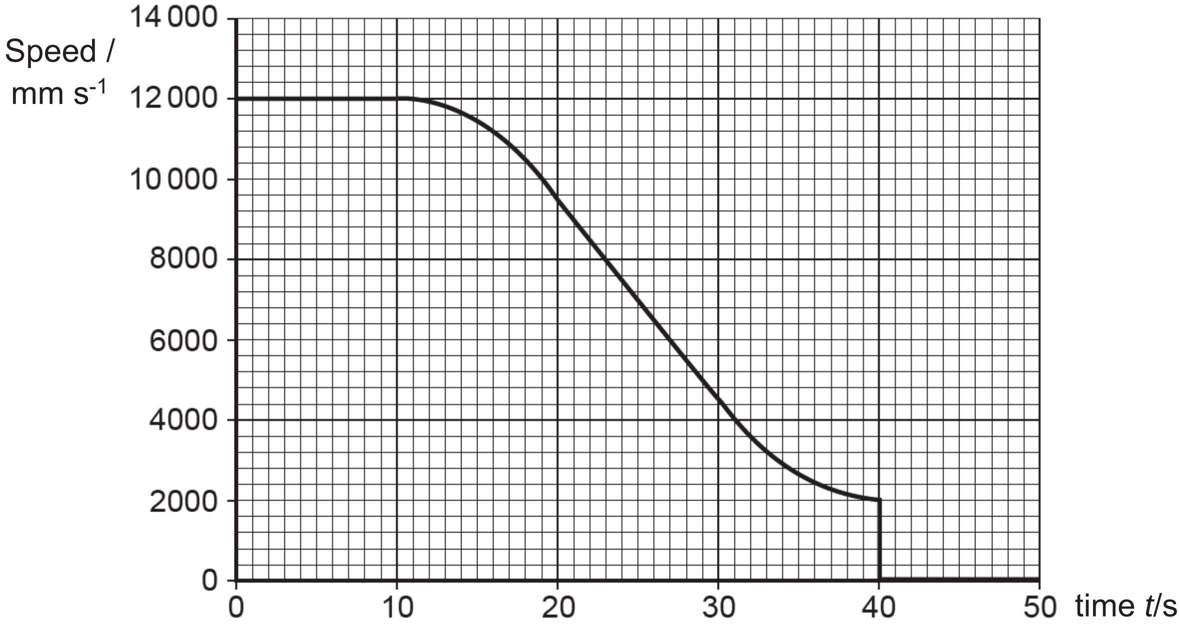

Fig. 2.1

(a) On Fig 2.1, mark on the graph with a point and label it **D**, when the rock has *increasing* deceleration. [1]

(b) Calculate the deceleration of the rock at t = 25 s. [2]

(c) Describe and explain what happens to the motion of the rock at t = 40 s. [2]

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3 Fig. 3.1 shows a 600 N man standing on the second rung of a 25 N ladder.

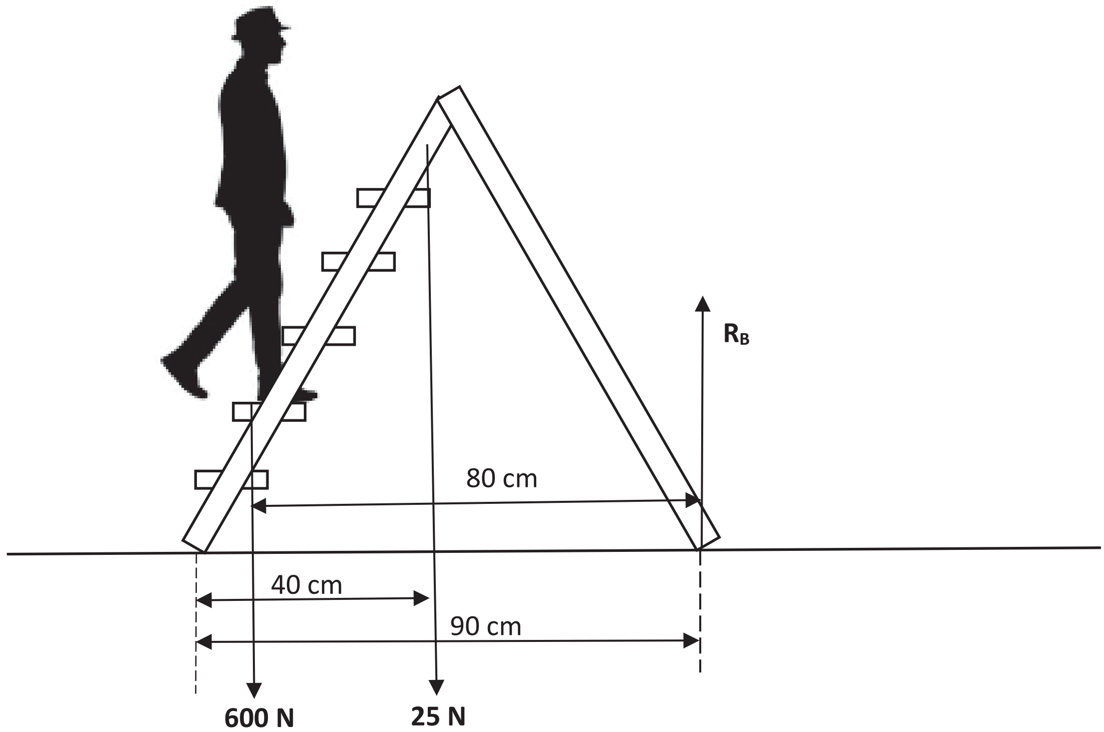

Fig. 3.1

(a) State the *Principle of Moments*. [2]

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(b) Calculate the normal reaction force $\mathbf{R_B}$. [2]

(c) The man climbs up the ladder. State what happens to the position of the centre of gravity and the stability of the man-ladder system. [2]

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4 Fig. 4.1 shows an experiment to analyse the motion of a 5.0 kg stone dropping from rest from two very different heights from the ground. In this experiment, air resistance is assumed to be negligible.

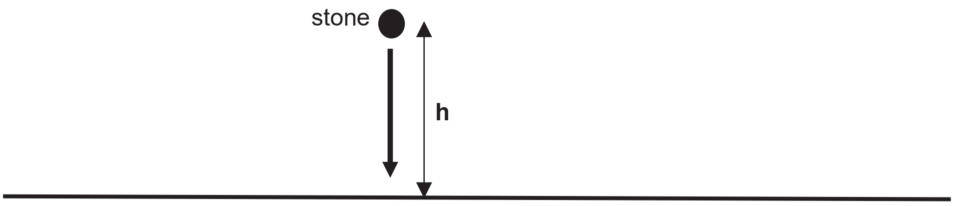

Fig. 4.1

(a) Define *gravitational field strength*. [1]

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(b) The stone is dropped from a height of 40 m from the ground.
On the axes given in Fig. 4.2, sketch the graph of the

(i) gravitational potential energy, label it as **P**, of the stone against the height, **h** from ground, and

(ii) kinetic energy, label it as **K**, of the stone against the height, **h** from the ground. [3]

The graphs drawn should clearly show the relationship between **P** and **K**. No numerical value is required for the graphs.

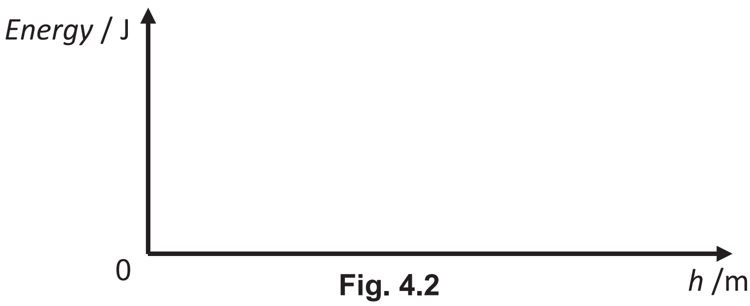

Fig. 4.2

(c) The gravitational field strengths of the Earth at heights of 40 m and at 40 km are 10 N kg^{-1} and 9.7 N kg^{-1} respectively.

Calculate the change in potential energy of the stone when it falls from 40 km to 40 m. [2]

5 Fig. 5.1 shows the landscape of a mountain. The reading of a mercury barometer at the foot of the mountain is 76.0 cmHg. On point **P**, the summit of the mountain, its reading drops to 70.0 cmHg. The density of mercury is 13 600 kg m^{-3} and the density of air is 1.23 kg m^{-3}.

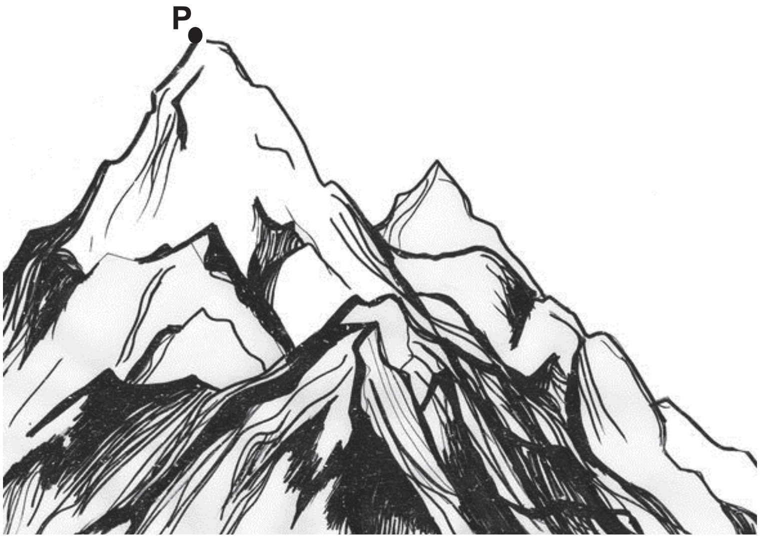

Fig. 5.1

(a) Calculate the height of the mountain. [3]

(b) Explain in terms of molecules, why the boiling point of pure water is not 100 ^{o}C at point **P**. [2]

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6 Fig. 6.1 shows an uncalibrated mercury thermometer first placed in a plastic box with 300 ml of crushed ice. After 10 seconds, the height of the mercury column was marked with a thick blue marker. The uncalibrated thermometer was then placed in 500ml of hot water heated over a stove at a constant 80 °C. When the height of the mercury column had stabilised after 2 minutes, the new height of the mercury column was marked with a thick red marker. The length between both markings were then divided into divisions of 10 °C and marked accordingly.

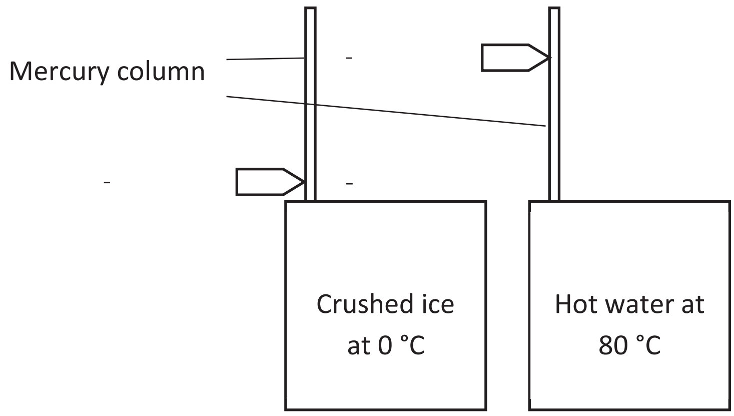

Fig. 6.1

Suggest three ways you can improve this calibration process. [3]

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7 Fig. 7.1 shows a negative charged metal plate X, an uncharged metal plate Y and a connection to earth. Plate X and Plate Y are on insulating stands.

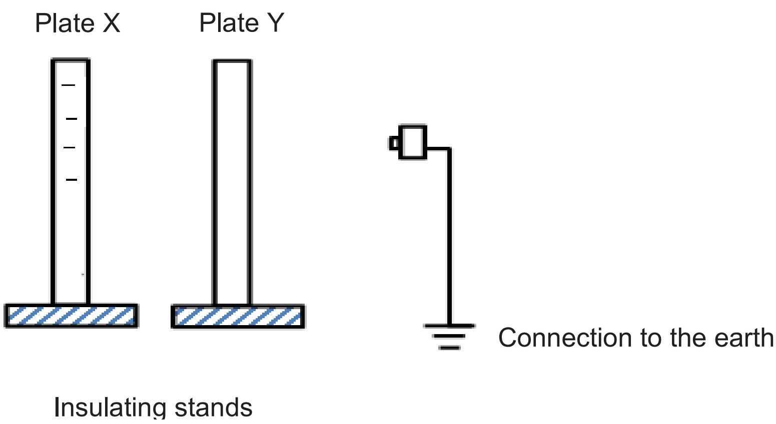

Fig. 7.1

(a) Explain what is meant by *electrostatic induction*. [1]

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(b) Explain why insulators **cannot** be charged by electrostatic induction. [1]

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(c) With the aid of the apparatus shown in Fig 7.1, describe clearly the steps to obtain a positively-charged plate Y. [2]

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8 The graphs in Fig. 8.1 show the relation between the current, I and the potential difference, V for a resistor and a lamp.

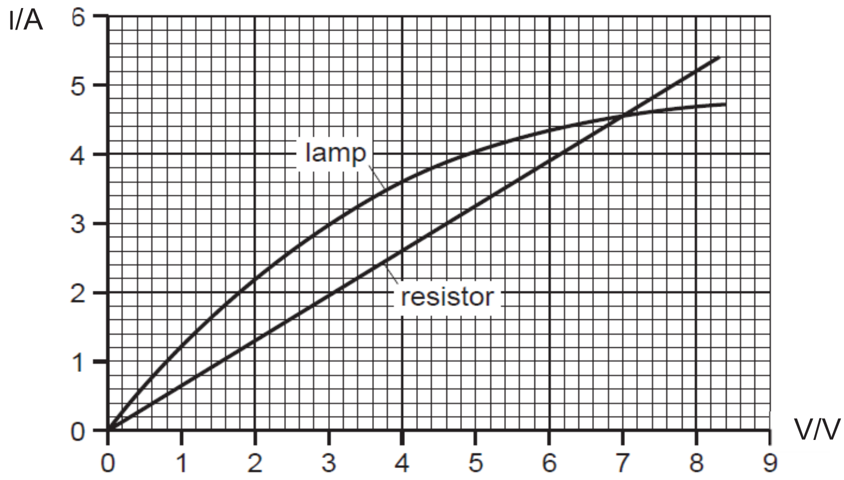

Fig. 8.1

(a) State and explain, for the resistor and the lamp, if they are *ohmic*. [3]

Resistor : ……………………………………………………………………………………………..…….

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Lamp : ……………………………………………………………………………………………………

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(b) Using Fig. 8.1, determine the potential difference across the lamp when it has the same resistance as the resistor. [1]

(c) The lamp is connected in series with the resistor and powered by a 7.6 V d.c. supply as shown in Fig. 8.2.

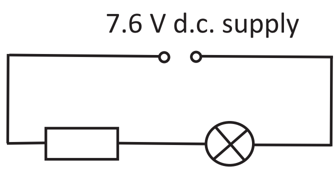

Fig. 8.2

Using Fig. 8.1, determine the resistance of the lamp in Fig. 8.2. [2]

9 A student finds an old iron bar and a magnet in a drawer.

(a) Iron is a magnetic material. State two properties of a *magnetic material*. [2]

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(b) He brings the iron bar near to a permanent magnet as shown in Fig. 9.1. The iron bar is attracted by the permanent magnet.

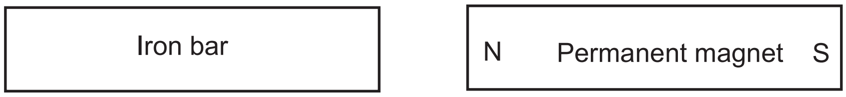

Fig. 9.1

(i) State the material the permanent magnet is made of. [1]

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(ii) Explain how the iron bar can be attracted by the permanent magnet. [2]

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(c) Describe, with an aid of a diagram, how you would de-magnetise a magnet using the electrical method. [3]

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Section B

Answer **all** the questions in this section.

10 **(a)** Fig. 10.1 shows an experimental set-up in which electrical energy from a heater is used to produce a measured rise in temperature of a liquid.

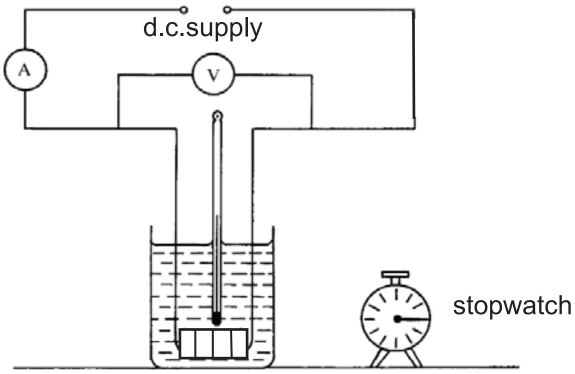

Fig. 10.1

The room temperature is 30 °C.

(i) Explain why the heater is placed at the bottom of the liquid. [2]

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(ii) The temperature of the liquid reaches 38 °C from room temperature in 12 minutes after the d.c. supply is switched on. The voltmeter and ammeter readings are 20 V and 5.0 A respectively. Calculate the combined heat capacity of the liquid and the container. [2]

(iii) A student suggests that in order to improve the accuracy of the heat capacity calculated in part (ii) above, the liquid and the container should be first cooled to 26 °C and the d.c. supply switched on until the temperature is 34 °C. Do you agree with the student's suggestion and why? [2]

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(b) Fig. 10.2 shows a graph of image distance against object distance of a converging lens.

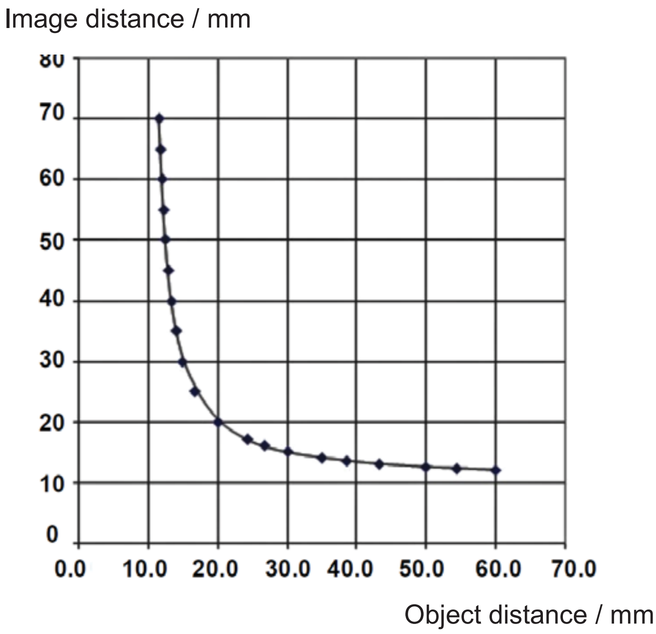

Fig. 10.2

(i) A student places an object 30.0 mm from the lens. State 3 properties of the image formed. [2]

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(ii) Using Fig. 10.2, determine the focal length of the lens. Explain your answer using either drawings, words or calculations. [2]

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11 **(a)** LASER is the acronym for Light Amplification by Simulated Emission of Radiation. Fig. 11.1 shows different brands of laser guns for industrial use and their specific wavelengths. All laser guns emit electromagnetic waves.

An enthusiastic laser user sorts out the different brands of laser guns into Types I, II and III.

He also discovers that the Red Beam laser gun emits a bright, red light.

Type	brand of laser gun	wavelength / x 10^{-7} m
I	Trace	3.2
II	Eagle Eye	4.9
	Fire Fly	5.5
	Red Beam	6.3
III	Sparrow Beak	9.8

Fig. 11.1

(i) State the type of electromagnetic waves emitted by Type I, Type II and Type III laser guns in the electromagnetic spectrum respectively. [2]

Type I : ……………………………………………………………………………………

Type II :……………………………………………………………………………………

Type III : …………………………………………………………………………………

(ii) State and explain which brand(s) of the laser guns listed in Fig. 11.1 can be used in a vacuum environment? [2]

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(b) A battery of e.m.f. 12 V, is connected to a light-dependent resistor (LDR), a lamp, two fixed resistors and ammeter as shown in Fig. 11.2. The resistances of the LDR is 180 Ω and 1800 Ω in bright and dark conditions respectively.

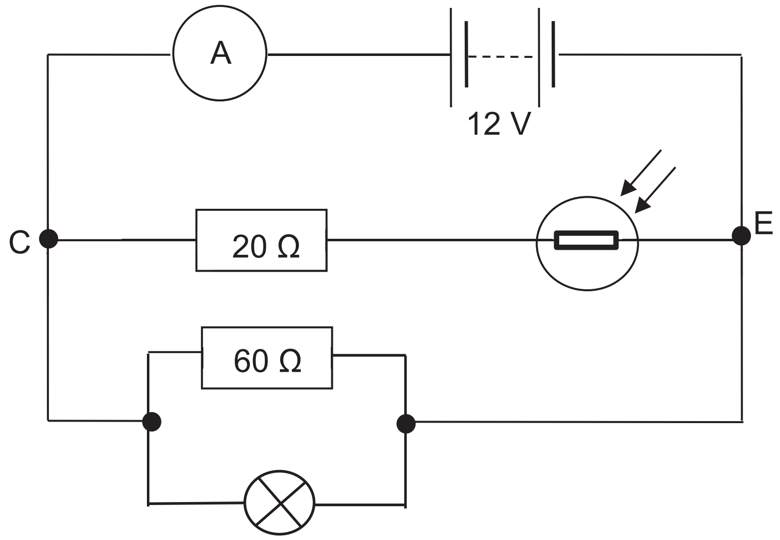

Fig. 11.2

(i) In bright condition, the ammeter reads 0.66 A. Calculate the resistance of the lamp in bright condition. [3]

(ii) The room is getting darker.

1. State and explain, if any, the changes in the brightness of the lamp. [2]

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2. State the changes if any, in the reading of the ammeter. [1]

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12 Either

(a) Fig. 12.1 shows the top view of two wires X and Y.
These wires carry equal currents vertically downwards through a piece of cardboard.

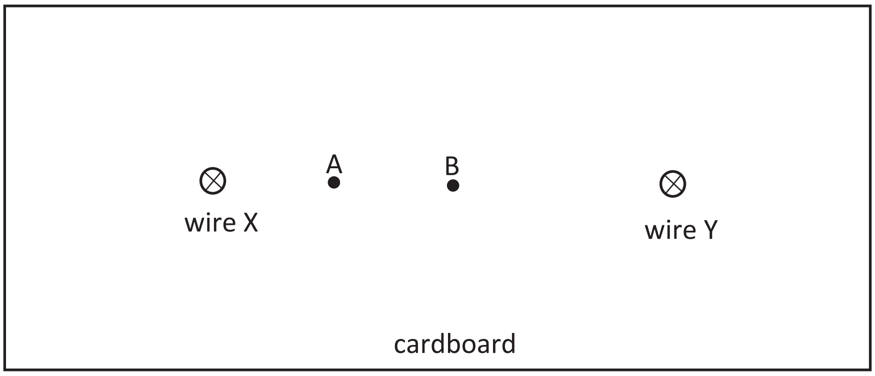

Fig. 12.1

In this question, ignore the effects of the Earth's magnetic field.

(i) On Fig 12.1, draw a complete magnetic field line that passes through point A due to the current in wire X. Mark the direction of this field line. [2]

(ii) Point B is midway between the two wires.
State and explain the direction of the magnetic field line, if any, at point B. [2]

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The current in wire Y is increased while the current in wire X is kept constant as before.

(iii) State the direction of magnetic field at point B now. [1]

....

(b) Fig. 12.2 shows a simplified d.c. motor.

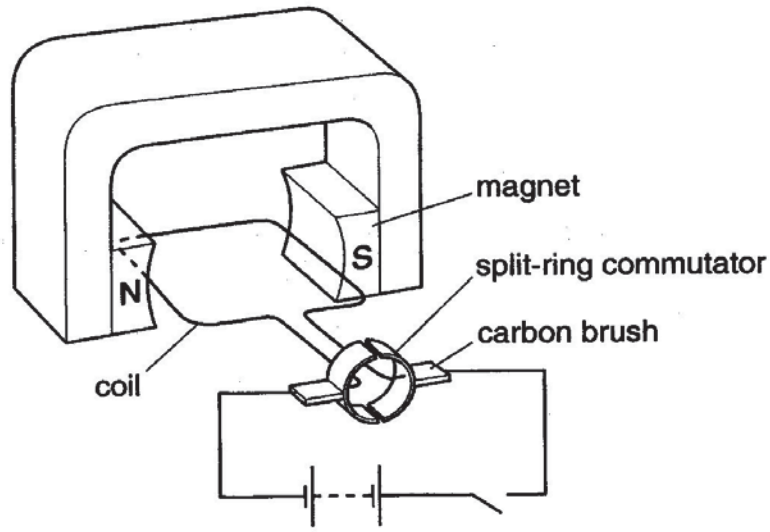

Fig. 12.2

(i) State the functions of the magnet and carbon brush. [2]

Magnet : ..……………………………………………………………………………..……..

Carbon brush : ………………………………………………………………………….....

(ii) Explain why the coil can turn continuously in the same direction. [3]

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12 OR

(a) Fig. 12.3 shows an anemometer, a device for measuring the speed and force of the wind.

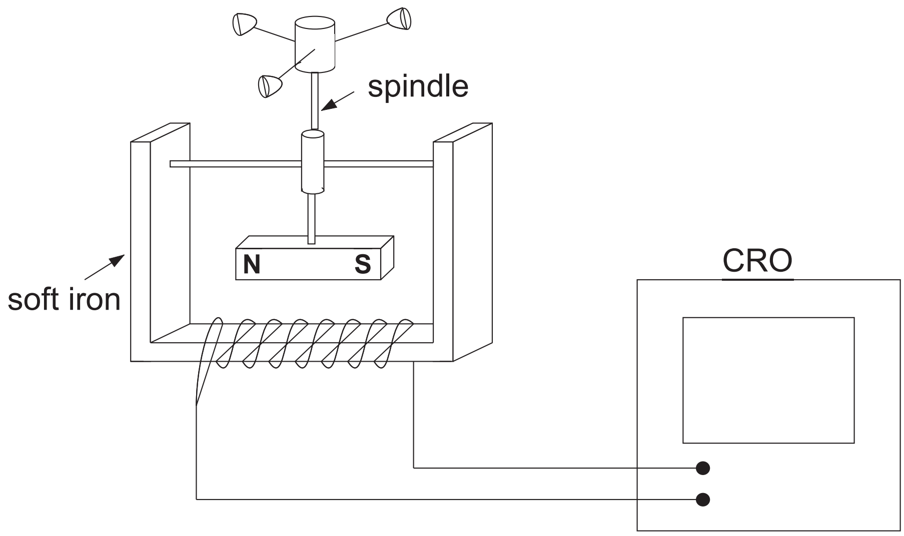

Fig. 12.3

The cups rotates about the spindle when a wind blows. The stronger the wind, the faster the spindle rotates. The spindle is also attached to a permanent magnet which is near a solenoid whose ends are connected to Cathode Ray Oscilloscope (CRO).The period of rotation is 0.50 s.

(i) Explain why an alternating electromotive force (e.m.f.) is produced in the oscilloscope when the spindle rotates. [2]

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(ii) The peak voltage of the induced e.m.f. is 0.40 V.

1. On Fig. 12.4, sketch the graph you will observe in the oscilloscope when the magnet rotates. The oscilloscope has a Y-gain of 0.10 V/div and a timebase of 0.10 s/div. [2]

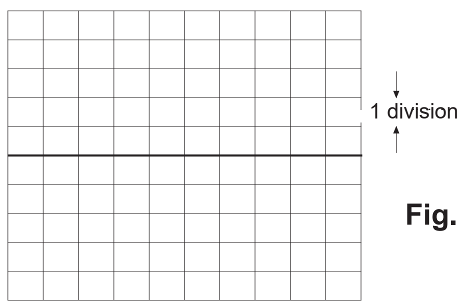

Fig. 12.4

2. On Fig 12.4, mark the instant when the magnet is in the position shown in Fig. 12.3. Label it as **A**. [1]

(iii) A semi-conducting diode is connected in series to the CRO as shown in Fig. 12.5.

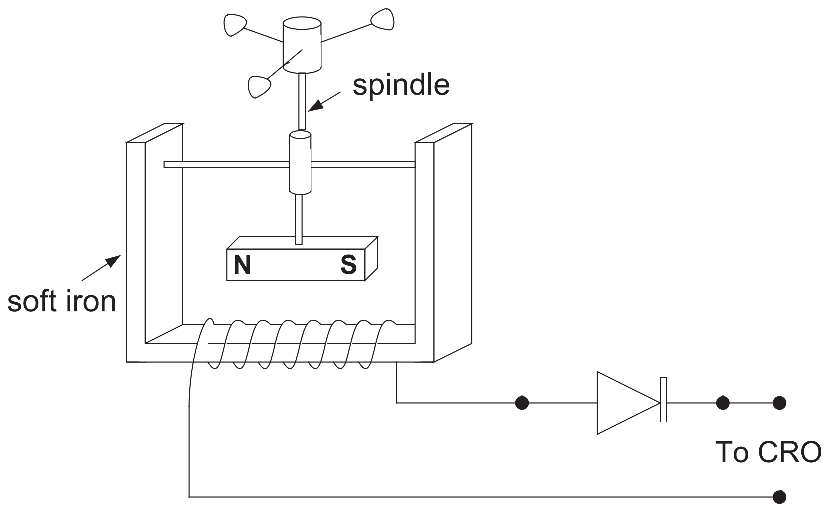

Fig. 12.5

On Fig. 12.6 below, sketch the graph shown on the CRO. [2]

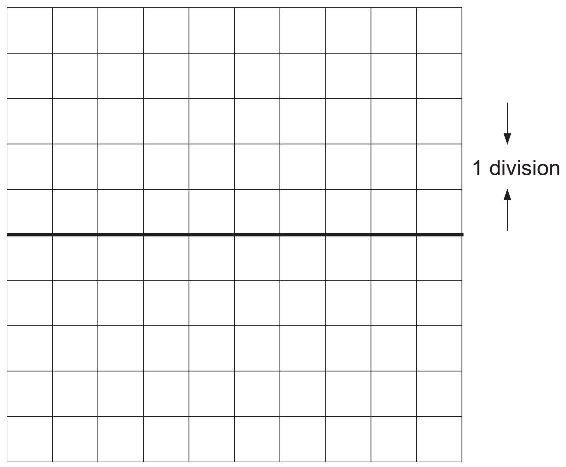

Fig. 12.6

(b) Fig. 12.7 shows a schematic diagram of a transformer.

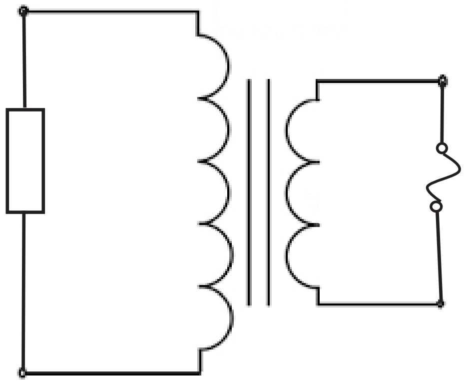

Fig. 12.7

(i) State whether it is a step-up or step-down transformer. [1]

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(ii) State one factor that will reduce this efficiency of a transformer and describe how you would improve the efficiency. [2]

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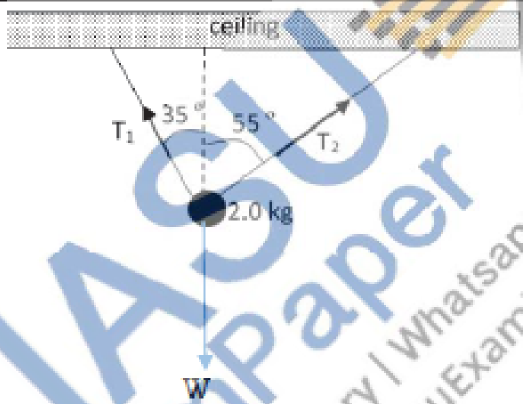
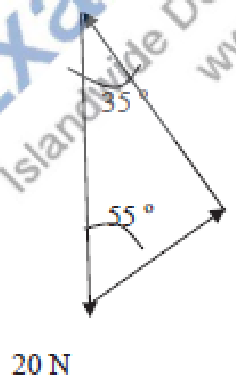
[End of Paper]

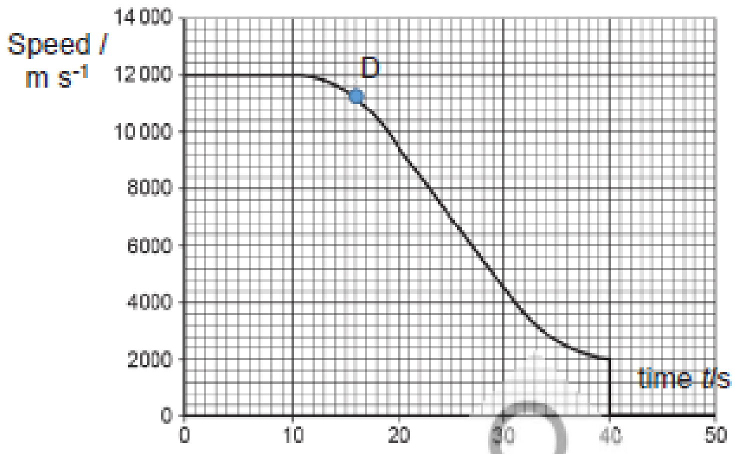
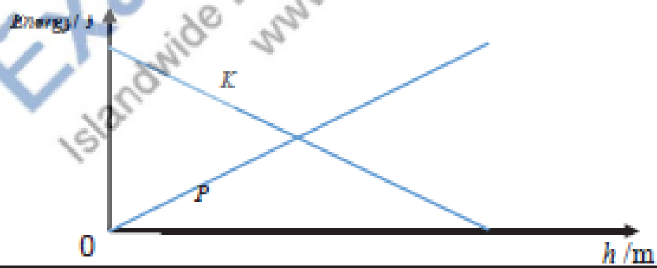
NAN CHIAU HIGH SCHOOL
Sec 4 Express Physics Papers 1, 2 and 3 Solutions
2022 Preliminary Examination

Paper 1 (40 marks)

1	2	3	4	5	6	7	8	9	10
C	C	B	C	A	A	C	B	C	C
11	12	13	14	15	16	17	18	19	20
A	B	B	C	A	B	C	C	D	C
21	22	23	24	25	26	27	28	29	30
A	B	B	B	C	C	D	A	C	B
31	32	33	34	35	36	37	38	39	40
B	C	C	D	B	A	B	B	D	D

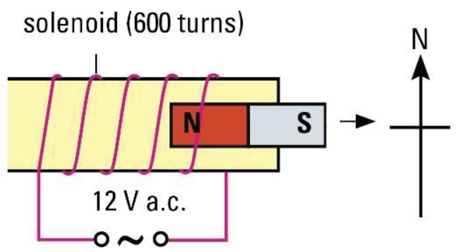
Paper 2 Section A (50 marks)

Question		Answer	Remarks
1	a	> The ball is at equilibrium as > it is at rest, no resultant moment/ no resultant forces / stationary / not moving.	B1 B1
	b	W = m.g = (2.0).(10) = 20 N (2sf)	
	c		The force must be from the centre of the ball and pointing downwards.
	d	1 cm = 1.0 N  T_1 = 16.4 N T_2 = 11.5 N	Deduct 1 mark each for: - No, wrong arrows; - Out of range; - Diagram too small,(minimum 1cm:2N - Wrong orientation *2 or 3sf is accepted

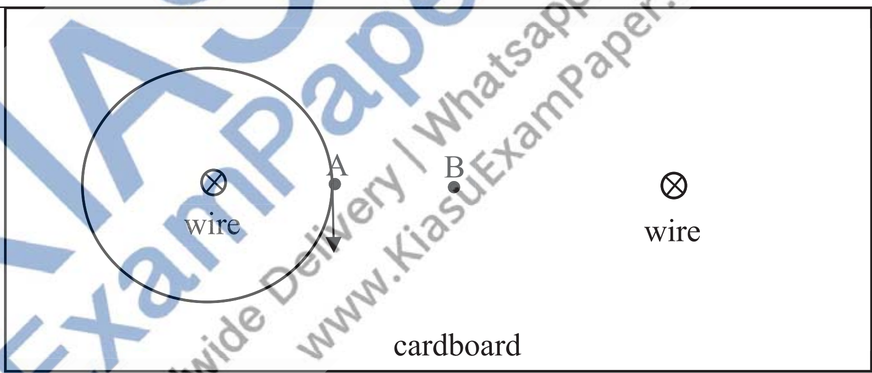
2	a		D should be between 12 to 18 secs
	b	(23, 8000), (31, 4000) acceleration = change of speed / time taken = (4000 – 8000) / (31- 23) = - 500 mm s^{-2} = -0.50 m s^{-2}. Deceleration = 0.50 m s^{-2} allowance for error 0.48 to 0.52 m s^{-2}	M1 A1
	c	> The rock is likely to have hit the bottom of the pond as > its speed changes from 2.0 m s^{-2} to 0 in an extremely short time, speed is zero, not moving (etc of the same meaning)	B1 (position) B1 (motion)
3	a	When an object is at equilibrium, the sum of clockwise moments about any point equal to the sum of anti-clockwise moments about the same point.	B1 B1
	b	Sum of anti-clockwise moments = sum of clockwise moments 90.R_B = (40).(25) + (90-80).(600) R_B = 77.77 N = 78 N (2 sf)	 M1 A1
	c	The position of the centre of gravity of the man-ladder system will rise and the system to be less stable. *do not accept "CG increase", as a position cannot increase. reasoning of system to be less stable must be correct also.	M1 A1
4	a	The force per unit mass acting on an object under gravity.	
	bi and bii		1m for both shapes correct 1m for both labels P and K correct 1m for total energy is constant
	c	GPE at 40 m = m.g.h = (5.0).(10).(40) = 2000 J GPE at 40 km = m.g.h = (5.0).(9.7).(40 000) = 1,940,000 J Difference in GPE = 1,940,000 – 2000 = 1,938,000 = 1,900,000 J (2 sf)	(both gpe must be correct to get 1m) 1m
5	a	(h.p.g)$_{air}$ + (h.p.g)$_{H\ at\ position\ P}$ = (h.p.g)$_{Hg\ at\ foot\ of\ mountain}$ h_{air}.(1.23).(10) = (0.760 – 0.700).(13600).(10) h_{air} = 663 m (No marks will be awarded if students only state pressure difference as 6.0 cm Hg)	M1 M1 A1

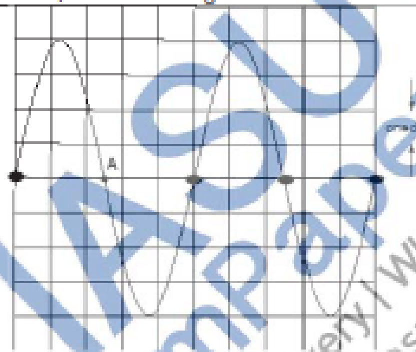
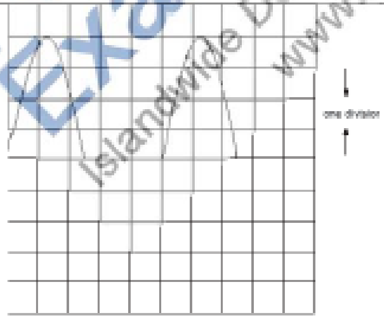
	b	As point P has a lower atmospheric pressure than at sea level, the molecules do not need to overcome so high downward force exerted by the atmospheric pressure than when it is at sea level, so less energy is needed to boil water a point P, so water boils at a lower temperature. Note: energy required to overcome intermolecular forces of attractions at P and at the foot of the mountain is constant thus the assumption by most students that less energy is required to overcome the intermolecular forces of attraction at P is incorrect.	1m 1m
6		➢The marker is too thick, thinner markers should be used. ➢Should divide the length into 100 equal divisions of 1 ºC, not 8 divisions. ➢Should use boiling point of water instead of 80 ºC as it is not easy to reproduce exactly 80 ºC. ➢Ice point was marked after only 10 s which is too fast, should mark after at least 2 min for the reading to be stabilised. ➢Placing the thermometer above the boiling water/in the steam and not inside the hot water. Do not accept : > use pure ice as 0 deg C is stated in the question > use equal mass/volume for 0 deg C ice/water and for 80 deg C water as it does not affect the temperature > repeating the experiment is not an improvement as there is no change to the setup > Any methods to reduce heat loss such as insulation is irrelevant.	1 m for each point, max 3 marks
7	a	It is a process of charging a conductor without contact between the charging body and the conductor.	
	b	The electrons (BOD: negative charges) inside insulators cannot move even in an electric field, so they cannot be charged by induction. OR Insulators have no mobile electrons.	
	c	➢Bring Plate X near to (BOD: close together) but not touching Plate Y, connect the earth wire to Plate Y. (Accept "connect earth wire first, then bring X near") ➢Disconnect the earth wire and bring Plate X far far way from Plate Y.	1 m 1 m
8	a	➢The resistor is ohmic as ➢its I-V graph is a straight line passing through the origin or Current is directly proportional to voltage or Resistance is constant. ➢The lamp is not ohmic as ➢its I-V graph is not a straight line or Current is not directly proportional to voltage or Resistance is increasing.	Minus 1 m for each wrong/ missing part Max minus 3 m
	b	From Fig. 8.1, the resistances of the lamp and of the resistor are equal (where the I-V graphs intercept) when the lamp has pd of 7.0 V (2 sf) and current of 4.6 A	
	C	➢From Fig. 8.1, when the total pd is 7.6 V and when current is the same for lamp and resistor, current of lamp is 3.0 A and pd across the lamp is 3.0 V. ➢Resistance of lamp = 3.0 V / 3.0 A = 1.0 Ω.	
9	a	➢It can be attracted by magnets. ➢It can be made to be magnets (or be magnetised).	1 m 1 m
	bi	Steel/ Cobalt/ Lodestone/ Nickel	
	bii	As the iron bar is placed near the permanent magnet, its right-hand side is induced a South pole and left-hand side a North pole. As unlike poles attract and like poles repel, the attractive forces between the North pole of the permanent magnet and the South pole of the induced magnet is stronger than the repulsive force between the North-pole of the permanent magnet	

3

		and North-pole of the induced magnet as the distance between the unlike poles are smaller, so there is a net attractive force.	
	c	 ➢ Place a magnet inside a solenoid connected to an alternating current (a.c.) supply ➢ Without switching off the current, withdraw the magnet slowly in the East-West direction.	1 m for correct diagram 1 m 1 m

Paper 2 Section B (30 marks)			
10	ai	When the heater is placed at the bottom, it heats up the liquid at the bottom. The liquid expands and becomes less dense, it then rises to the top. The colder, denser liquid sinks to the bottom. This creates a convection current in the liquid and will ensure the heat is distributed evenly.	
	aii	$I.V.t = C.\Delta\theta$ $C = (I.V.t) / \Delta\theta$ $= (5.0).(20).(12).(60) / (38 - 30)$ $= 9000$ J / °C	M1 A1 Deduct 1 mark if uses min or hour for time
	aiii	➢ Yes, the student is right. ➢ From 26 °C to 30 °C (room temperature), the liquid gain heat from the surrounding and from 30 °C to 34 °C, the liquid lose heat to the surrounding. ➢ The heat gained and loss from and to the surrounding can potentially cancelled off and the heat capacity calculate will be more accurate.	Max 2 marks No mark if stated yes but with wrong reasons.
	bi	➢ Real ➢ Diminished ➢ Inverted	1 m for 2 correct, 2 m for 3 correct.
	bii	➢ f = 10 mm. ➢ When object distance is 20 mm, image distance is also 20 mm, this means that the object size is equal to the image size, which means the object is placed at 2f from lens. So since 2f = 20 mm, f = 10 mm. ➢ $1/f = 1/u + 1/v$ $1/f = 1/30 + 1/15$ f = 10 mm	
11	ai	➢ Type I : ultraviolet radiation ➢ Type II : visible light ➢ Type III : infrared radiation	1 m for 2 correct, 2 m for 3 correct
	Aii	All the brands can be used in vacuum as all electromagnetic waves can travel in vacuum.	

	bi	I_{CE} (through LDR and 20 Ω resistor) = V / R = 12 / (20 + 180) = 0.060 A I_{CE} (through lamp and 60 Ω resistor) = 0.66 – 0.060 = 0.60 A $I_{60\Omega}$ = V / R = 12 / 60 = 0.20 A Therefore I_{lamp} =0.60 – 0.20 = 0.40 A R_{lamp} = 12 / I_{lamp} = 12 / 0.40 = 30 Ω *Alternatively,* $V/I = [1/(20 + R_{LDR}) + 1/60 + 1/R_{lamp}]^{-1}$ $12/0.66 = [1/(20+180] + 1/60 + 1/R_{lamp}]^{-1}$ $18.18 = [0.00500 + 0.0167 + 1/R_{lamp}]^{-1}$ $0.055 = 0.0217 + 1/R_{lamp}$ $0.0333 = 1/R_{lamp}$ R_{lamp} = 30 Ω	 B1 B2 A1 Deduct 1 m for each mistake
	bii1	No change in the brightness of the lamp as both potential difference and resistance of the lamp remains unchanged so power of lamp remains unchanged too.	
	bii2	The current measured by the ammeter decrease.	
12 Either	**ai**		
	aii	> There is no magnetic field at point B > because the magnetic field due to wire X at point B is downwards and the magnetic field due to wire Y at point B is upwards. Since point B is at the midpoint of wires X and Y and both X and Y carry the same amount of current, there is no magnetic field at point B	Need to mention either equal magnitude of magnetic field strength/equal current or mention direction of magnetic field strength due to wire X and wire Y to get the second mark
	aiii	Upwards Do not accept “clockwise” as it can be either upwards or downwards.	

	bi	Magnet : to provide magnetic field Carbon brush : to make contact between the slip rings and the external circuit. (Do not accept "to conduct electricity")	
	bii	From Fleming Left-hand Rule, the right-hand side of the coil experiences a downward force and the left-hand side an upward force. >The split-ring commutator reverses the direction of the current in the coil every half a revolution. >When the coil is at the vertical orientation, there is no current flowing in the coil, however, the inertia causes the coil to continue to turn clockwise. >once the coil crosses the vertical orientation, the force acting the right-hand side of the coil will be downward and left-hand side upwards, so the coil can turn clockwise continuously.	
12 Or	ai	➢ Based on Faraday's Law of Electromagnetic Induction, when the magnet rotates, the changing magnetic flux through the soft iron core causes a change in magnetic flux linking the coil, an e.m.f is induced across the coil. ➢ As the N-pole of the magnet approaches the left arm of the soft iron, by Lenz' Law, the induced current in the coil will produce a magnetic field to oppose the change in magnetic flux, thus the left of the coil will be a North pole, likewise, as the N-pole of the magnet moves away from A, based on Lenz's Law, the induced current in the coil will generate a magnetic field with a South pole at the left of coil. Thus, an alternating e.m.f is induced in the coil.	
	ai & aii		correct peak voltage : 1 m; correct period : 1 m; Deduct 1 m for wrong shape. "A" can be any point on the graph when the induced emf is 0.
	aiii		Shape : 1 m Period and amplitude : 1 m. ecf from aii for wrong amplitude, wrong period or wrong shape
	bi	Step-up transformer	
	bii	> Copper loss : use shorter, thicker wires OR >Magnetic flux leakage : use soft iron core to have better flux linkage OR >Loss due to Eddy current : use laminated iron core instead of one thick iron core OR > Hysteresis loss : reduce input source frequency.	

Name: ________________________________ (   )   Class : Sec 4 / (   )

南 华 中 学

NAN HUA HIGH SCHOOL

PRELIMINARY EXAMINATION 2022

Subject	**:**	**Physics**
Paper	**:**	**6091/1**
Level	**:**	**Secondary Four**
Date	**:**	**31 August 2022**
Duration	**:**	**1 hour**

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class and index number on the separate Answer Sheet in the spaces provided.

There are **forty** questions in this paper. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer sheet.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

This Question Paper consists of **16** printed pages.

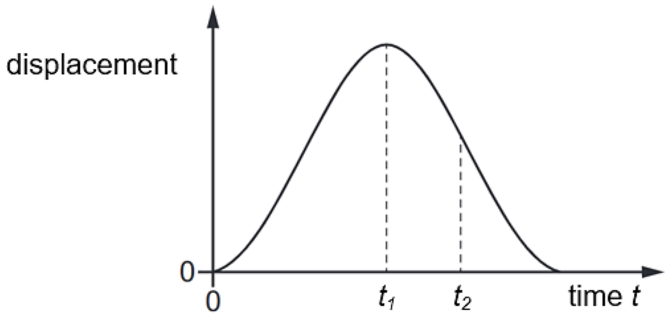
[Turn over]

1 The light year is defined as the distance light travels in 1 year.

Which of the following is the nearest estimate of 1 light year in gigameters (Gm)?

A 100 **B** 1,000 **C** 10,000 **D** 10,000,000

2 A train sets off from a station at time t = 0 s. The graph shows how the displacement between the train and the station varies with time.



Which statement about the movement of the train between time t_1 and t_2 is correct?

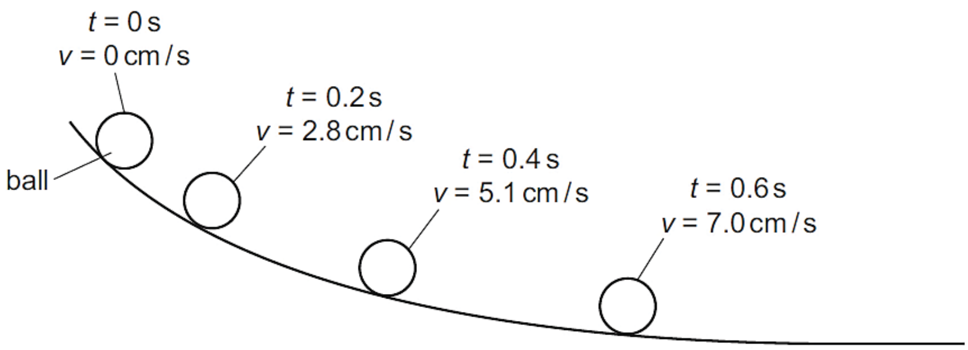
A Its speed is decreasing and it is moving away from the station.

B Its speed is decreasing and it is moving towards the station.

C Its speed is increasing and it is moving away from the station.

D Its speed is increasing and it is moving towards the station.

3 A student investigates the motion of a ball rolling down a slope. The diagram shows the speed v of the ball at different times t.



Which statement describes the motion of the ball?

A The velocity is constant.

B The speed is decreasing.

C The acceleration is constant.

D The acceleration is decreasing.

4 An object is pulled across a table at constant speed with an applied force of 7 N.

The applied force is increased to 14 N and the object now has an acceleration of 3.5 m / s^2.

What is the mass of the object?

A 0.70 kg **B** 1.4 kg **C** 2.0 kg **D** 4.0 kg

5 A player hits a ball with a racket. The action force is the impact of the racket against the ball.

What is the reaction to this force?

A the force of the ball against the racket
B the weight of the ball
C air resistance on the ball
D the grip of the player's hand against the racket

6 An object that has a mass of 15 kg on the Earth is taken to the Moon.
The gravitational field strength *g* on the Earth is 10 N / kg and on the Moon is 1.6 N / kg.

What are the mass and weight of the object on the Moon?

	mass / kg	weight / N
A	15	24
B	15	150
C	24	15
D	150	24

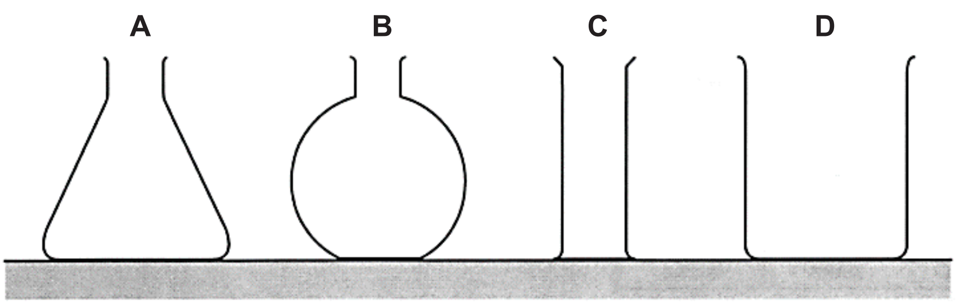
7 5000 kg of iron is melted and mixed with 2.0 m^3 of molten copper. Density of iron and copper are 7500 kg / m^3 and 9000 kg / m^3 respectively.

What is the approximate density of the mixture?

A 8.3 kg / m^3 **B** 7500 kg / m^3 **C** 8300 kg / m^3 **D** 8600 kg / m^3

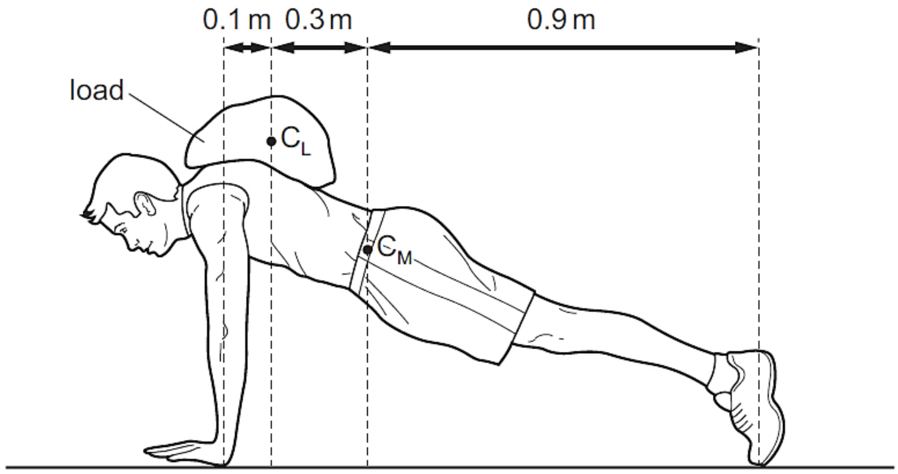
8 The diagram shows four containers made from glass of uniform thickness.

Which empty container is the **most** stable?



9 An athlete with weight 700 N trains by performing press-ups with a load on his back.

The diagram shows the perpendicular distances involved. The centre of gravity of the athlete is C_M and the centre of gravity of the load he is carrying is C_L.

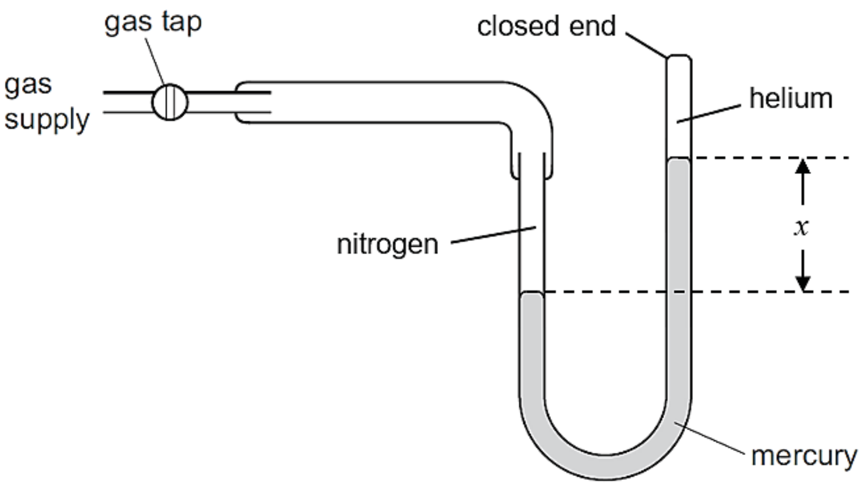


The weight of the load is 60 N.

What is the upward force exerted by his two arms?

A 54 N **B** 76 N **C** 540 N **D** 760 N

10 A closed U-tube is fitted to a gas supply with nitrogen in the left arm. In the right arm, there is helium gas at pressure P. The gases are separated by mercury of density ρ, with the heights of the mercury columns shown in the diagram.



Acceleration of free fall is g and atmospheric pressure is P_{atm}.

What is the pressure of the nitrogen gas?

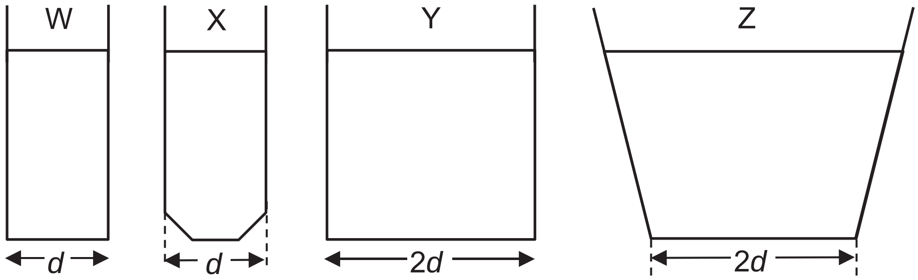
A $P - \rho g x$

B $P + \rho g x$

C $P_{atm} + \rho g x$

D $P + P_{atm} + \rho g x$

11 The diagram below shows the side view of 4 circular containers. Equal depth of water is added into the 4 containers.



Which of the following statements is correct?

A The water exerts the most pressure on the bottom of container X.

B The water exerts the most pressure on the bottom of container Z.

C The water exerts the same force on the bottom of each container.

D The water exerts the same pressure on the bottom of each container.

12 A ball of mass 30 g is dropped from a height of 30 m. As it falls, 25% of its initial gravitational potential energy is transferred to thermal energy.

The gravitational field strength *g* is 10 N / kg.

What is the speed of the ball just before it hits the ground?

A 6.71 m / s **B** 12.2 m / s **C** 21.2 m / s **D** 24.5 m / s

13 Sam exerts a horizontal force of 800 N on a box. Frictional force acting on the box is 200 N.

If it takes 5.0 s to move the box 4.0 m, what is the average useful power?

A 120 W **B** 480 W **C** 640 W **D** 800 W

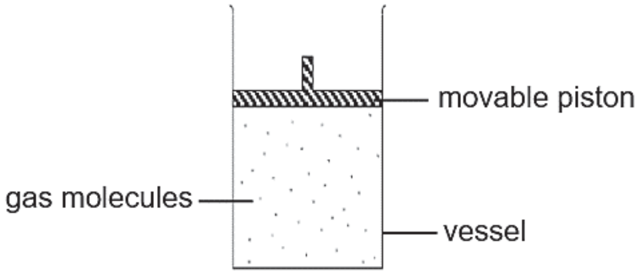
14 When one junction P of a thermocouple is placed in melting ice and the other junction Q in pure boiling water, the emf is 6.0 mV.

Junction Q is removed from boiling water and placed in a liquid bath at constant temperature while P remains in ice. The emf is now –1.5 mV.

What is the temperature of the liquid bath?

A –75 °C **B** –25 °C **C** 25 °C **D** 75 °C

15 Gas inside a vessel is heated slowly to a higher temperature. The pressure inside the vessel remains constant as the frictionless piston moves upwards.



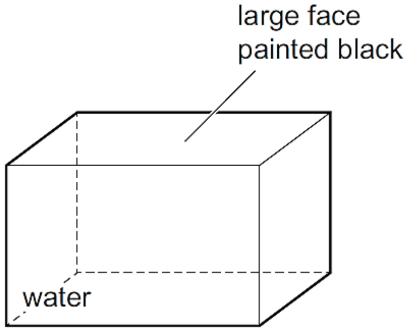
How do the speed of the gas molecules and their rate of collision with the piston compare with their initial values at the lower temperature?

	speed of molecules	rate of collision
A	increases	increases
B	increases	decreases
C	increases	stays constant
D	stays constant	increases

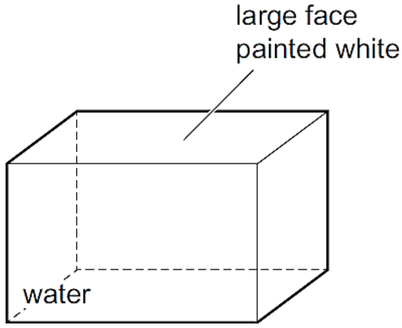
16 Four metal containers, with identical dimensions, are filled with water at 90 °C. All the faces, except one, of each container are covered with a very good insulator. The one exposed face on each container is painted either black or white.

In which container does the water cool the fastest?

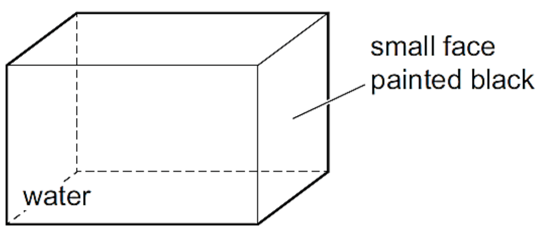
A



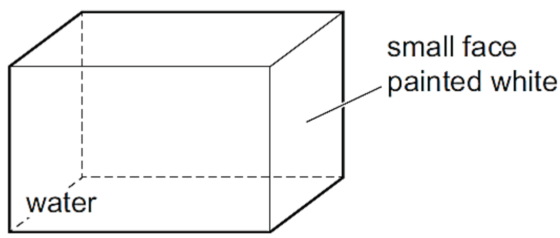
B



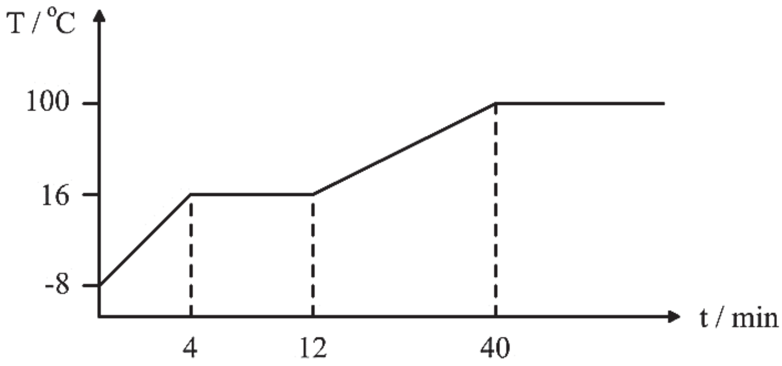
C



D



17 The diagram shows the heating curve of a substance in solid phase that is initially at –8 °C. It is known that the heating source provides constant amount of energy to the solid. Heat losses to the surroundings are negligible.



Assuming there is no loss in mass, which of the following statements is true?

A The melting point of the substance is 100 °C.

B The substance changes from solid to gaseous phase at 16 °C.

C The specific heat capacity is greater for the liquid phase than the solid phase.

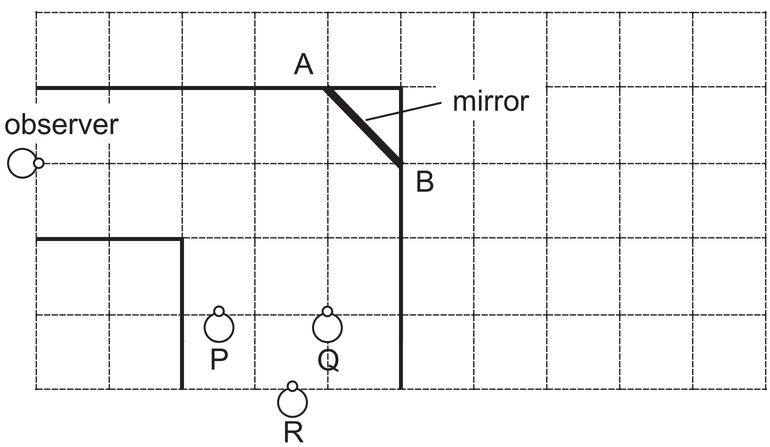
D The specific heat capacity increases linearly during the solid phase.

18 A 2.0 kW heater is used to heat a copper block of mass 3.0 kg for 9.0 s. The temperature change of the copper block is known to be 15°C.

What is the heat capacity of an identical copper block of mass 0.10 kg?

A 40 J / K **B** 120 J / K **C** 400 J / K **D** 1200 J / K

19 The diagram shows a scale drawing of a road with a plane mirror AB mounted across the corner of a 90° bend. P, Q and R respesent three cars approaching the bend.

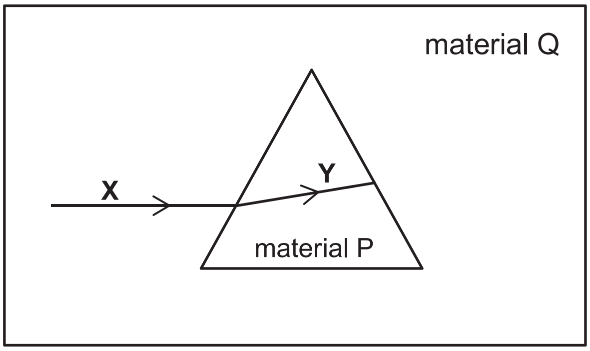


At this instant, which car(s) can the observer see through mirror?

A P and Q only **B** P and R only

C Q and R only **D** P, Q and R

20 A monochromatic light travels from X to Y through a block made from two different types of glass, P and Q as shown in in the diagram.



Which of the statement is true?

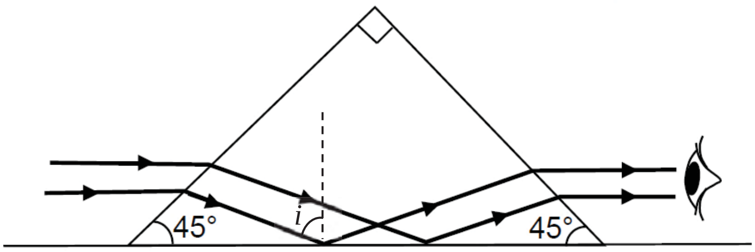
A Material P has a lower refractive index than material Q hence the speed of light in material P is faster.

B Ray Y will be refracted away from the normal as it enters to material Q.

C Material Q has a lower refractive index than material P hence the speed of light in material Q is slower.

D Ray Y will experience total internal reflection as light ray is travelling from optically denser medium to less dense medium.

21 Two parallel rays of light pass through an isosceles glass prism with refractive index 1.5.



Which of the following statement is correct?

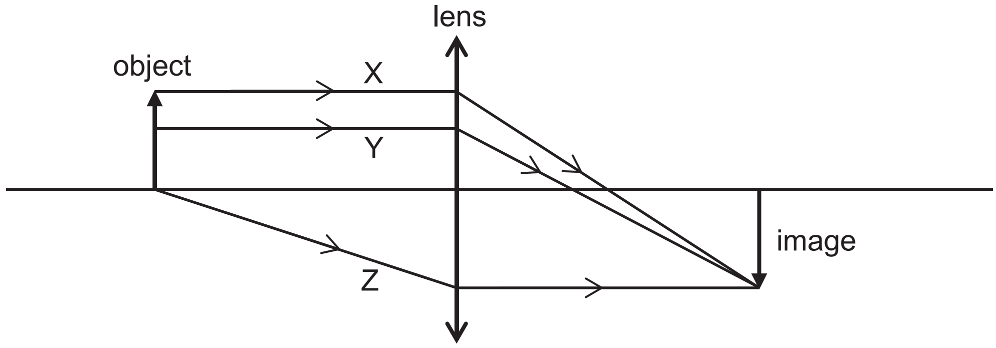
A Refraction occurs at the base of the prism.

B The angle of incidence i is less than 41 °.

C An object viewed through this prism in this way will appear upside down.

D An object viewed through this prism in this way will become smaller when the observer moves further from the prism.

22 The diagram shows a converging lens projecting an image of an illuminated object.



Which ray(s) is/are correctly drawn in the diagram above?

A ray X only

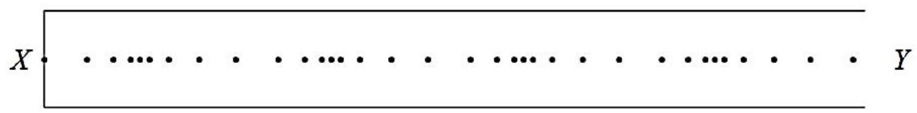
B ray Y only

C ray X and Y

D ray X, Y and Z

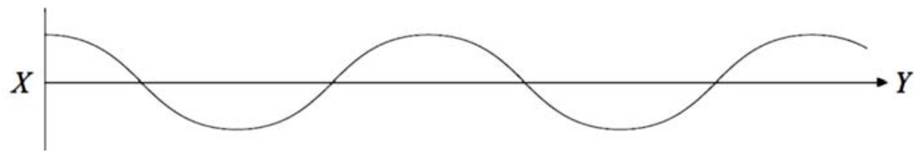
23 A longitudinal wave is set up in the air in a tube that is closed at one end.

At a particular instant of time, the positions of a row of particles along the axis of the tube are shown in the diagram. The particles in the row were initially evenly spaced.

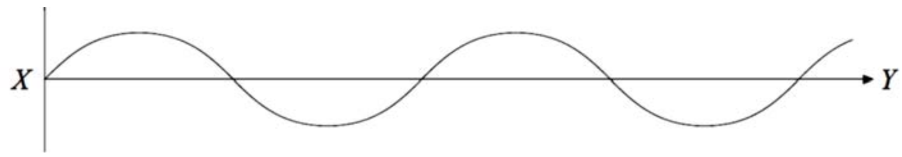


Which of the following diagrams best represents the displacement of the particles in the tube from their undisturbed positions?

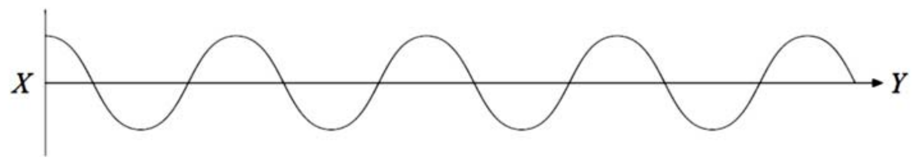
A



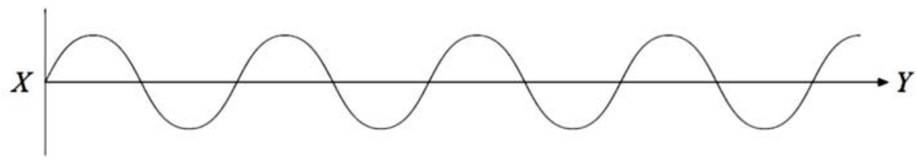
B



C

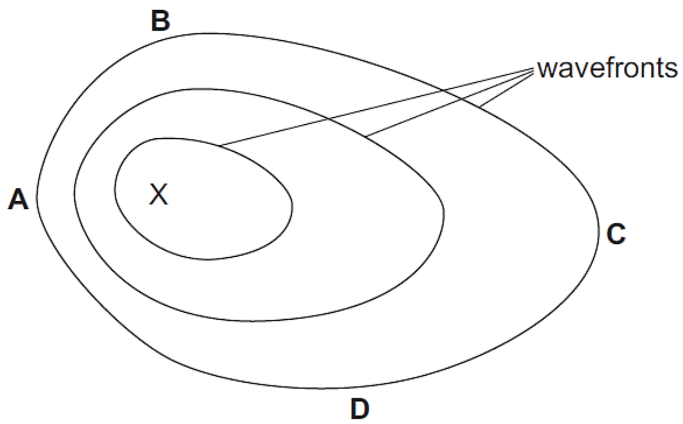


D



24 A stone is dropped at point X into a pool of varying depth. The diagram shows the first three wavefronts on the surface of the pool.

The region between X and which labelled point is likely to be the deepest?



25 A VHF radio station broadcasts at a frequency of 98.0 MHz.

What is the wavelength of the radio waves?

A 3.06 m **B** 6.12 m **C** 1.20×10^6 m **D** 3.06×10^6 m

26 A student plays a note on the piano. He then plays a second note that is softer and of a lower pitch.

How do the amplitude and frequency of the second note compare to the first?

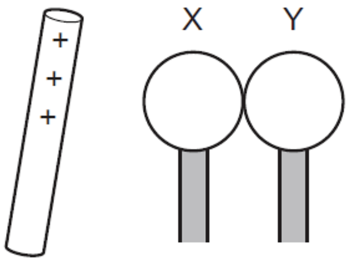
	amplitude	frequency
A	larger	lower
B	larger	higher
C	smaller	lower
D	smaller	higher

27 Y and Z are light bulbs with filaments made from tungsten.The filament of lamp Y is thicker and shorter than the filament of lamp Z.

When connected to the mains individually, which is the brighter bulb and which bulb has a larger resistance?

	brighter lamp	larger resistance
A	Y	Y
B	Y	Z
C	Z	Y
D	Z	Z

28 Two neutral conductors X and Y on insulating stands are initially in contact. A positively charged rod is placed near X. The spheres are then moved apart.



What is the charge on Y?

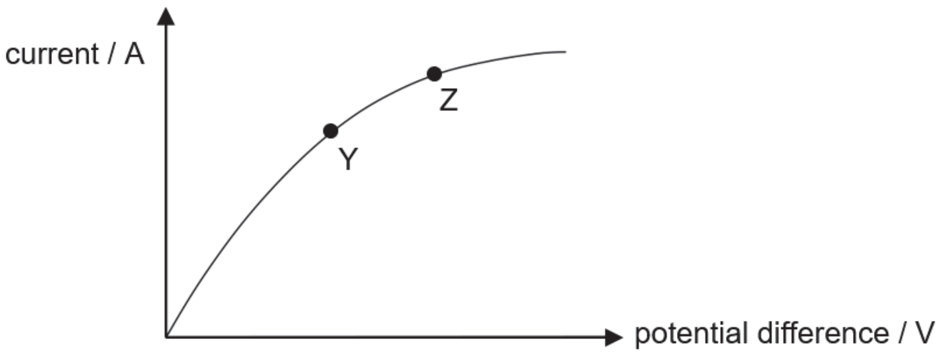
A negative and smaller than that on X

B negative and the same size as that on X

C positive and smaller than that on X

D positive and the same size as that on X

29 The graph shows how the current in a non-ohmic conductor depends on the potential difference across it.

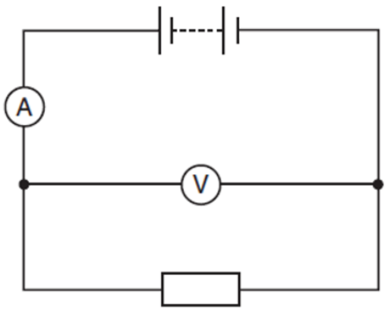


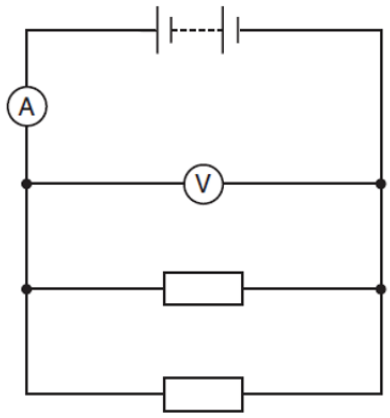
Which is correct at point Y and Z?

	temperature of conductor is	resistance of conductor is greater at point
A	higher at Y	Y
B	lower at Y	Y
C	lower at Z	Z
D	higher at Z	Z

30 Circuit 1 shows a resistor connected to a battery, an ammeter and a voltmeter. The ammeter reading is 0.5 A and the voltmeter reading is 3.0 V.

A second identical resistor is now connected in parallel with the first resistor, as shown in circuit 2.

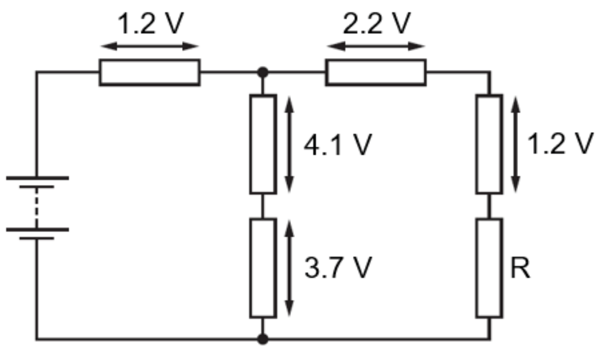

circuit 1


circuit 2

What are the ammeter and voltmeter readings in the circuit shown in circuit 2?

	ammeter reading / A	voltmeter reading / V
A	0.5	3.0
B	0.5	6.0
C	1.0	1.5
D	1.0	3.0

31 A battery is connected to a network of six resistors, as shown.



The potential differences across five of the resistors are labelled on the diagram.

What is the potential difference across resistor R?

A 4.4 V **B** 4.6 V **C** 6.6 V **D** 11.2 V

32 The metal case of an electric heater is earthed. The plug to the heater contains a 5 A fuse. There is a current of 4.0 A when the heater works normally.

The cable to the heater becomes so worn that the live wire makes electrical contact with the case.

What will happen?

A The current flows to earth and the fuse is not affected.

B The fuse melts and switches off the circuit.

C The metal case becomes live and dangerous.

D The metal case becomes very hot.

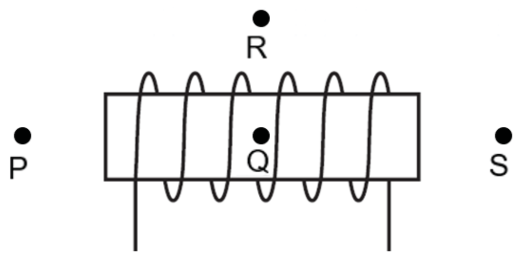
33 An electric vehicle has a battery that can supply 70 kWh of electrical energy.

The vehicle was charged using a charging station that supplies electrical energy at 11 kWh every hour. The cost of charging is \$0.50 per kWh. Assume the rate of charging to be constant.

Which is correct when the vehicle is charged from 20% to 80% of the battery's capacity?

	charging duration / h	charging cost / \$
A	3.8	21
B	6.4	35
C	3.8	5.5
D	6.4	3.3

34 A steady current is passed through a solenoid.

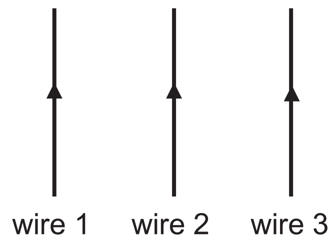


P, Q, R and S are four points near the solenoid. P, R and S are outside the solenoid. .

Which row indicates a possible direction of the magnetic field due to the current?

	P	Q	R	S
A	→	→	→	→
B	→	←	→	→
C	→	→	←	→
D	←	→	→	←

35 Three long vertical conducting wires have the same amount of current flowing through them in the direction shown. The distance between the wires are the same.



What is the direction of the resultant electromagnetic force acting on wire 2?

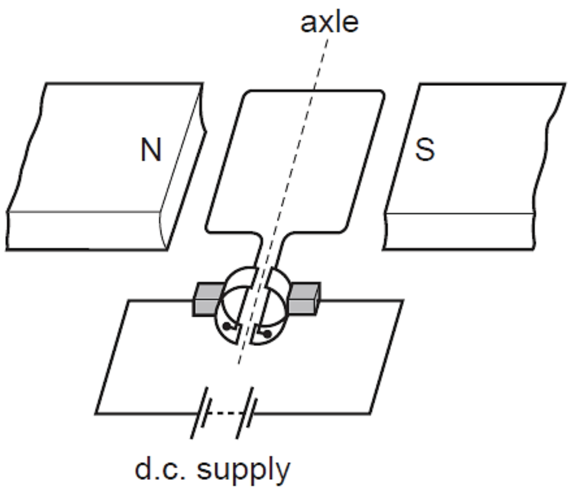
A resultant electromagnetic force is zero

B perpendicular to the plane of the paper

C to the right

D to the left

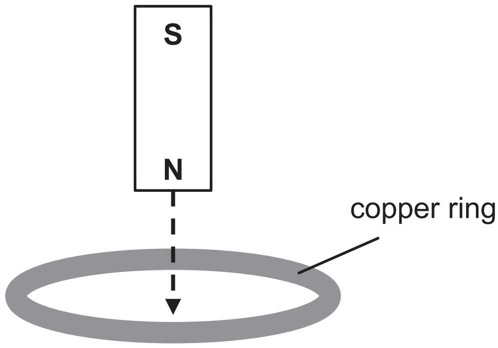
36 The diagram shows a two-pole single-coil electric motor. The split-ring commutator reverses the current in the coil as it rotates.



How many times is the current reversed if the coil is rotated 360° from the position shown?

A 1 **B** 2 **C** 3 **D** 4

37 A magnet is dropped vertically through a copper ring.



Which of the following statements is **incorrect**?

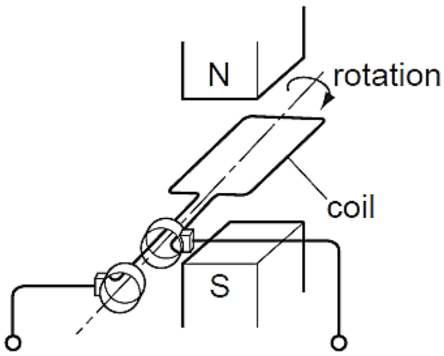
A A current flows in the ring just before the magnet passes through the ring.

B A current flows in the ring just after the magnet passes through the ring.

C The magnet slows down just before it passes through the ring.

D The magnet accelerates just after it passes through the ring.

38 The diagram shows an a.c. generator.



With the coil in the position shown as the starting point, when does the induced e.m.f. becomes maximum?

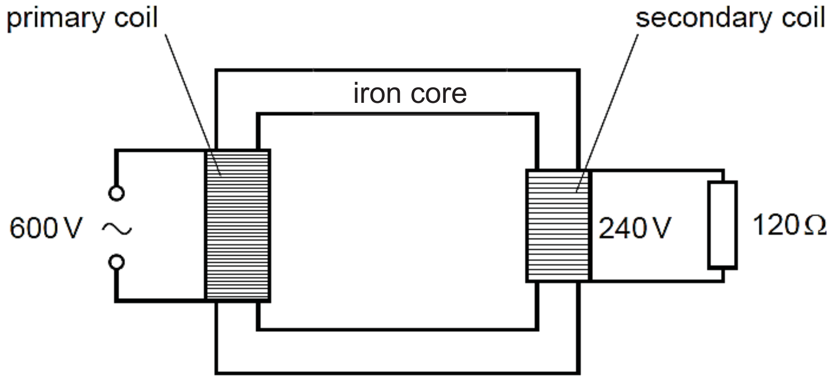
A when the coil has rotated 45°

B when the coil has rotated 90°

C when the coil has rotated 135°

D when the coil has rotated 180°

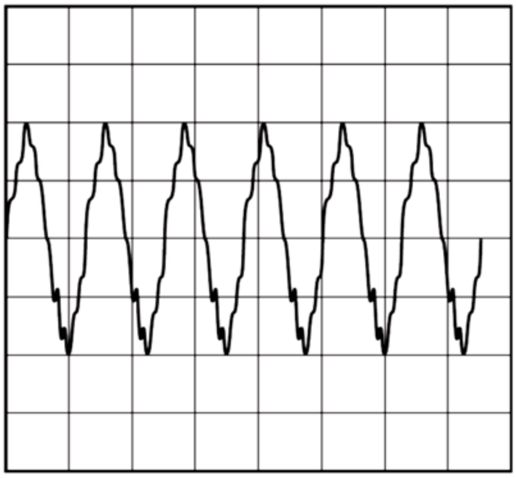
39 An ideal transformer has a primary voltage of 600 V and a secondary voltage of 240 V. The secondary coil is attached to a resistor of resistance 120 Ω.



What is the power dissipated in the resistor and the current in the primary coil?

	power / W	current / A
A	120	0.20
B	120	5.0
C	480	0.80
D	480	1.3

40 A sound wave is detected by a microphone connected to a cathode ray oscilloscope (c.r.o.). The trace is shown below.



The time base on the c.r.o. is set at 2 ms per division.

What is the frequency of the sound wave?

A 333 Hz **B** 400 Hz **C** 1600 Hz **D** 3000 Hz

Name: ____________________________________ (   )   Class: Sec 4 / (   )

南 华 中 学

NAN HUA HIGH SCHOOL

PRELIMINARY EXAMINATION 2022

Subject	**:**	**Physics**
Paper	**:**	**6091/02**
Level	**:**	**Secondary Four**
Date	**:**	**29 August 2022**
Duration	**:**	**1 hour 45 minutes**

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces at the top of this page.

Write in dark blue or black pen.

You may use soft pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question **11** has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiners' Use	
Section A	
Section B	
Total	

This document consists of **21** printed pages.

Section A (50 marks)

Answer **all** the questions in this section.

1 Fig. 1.1 shows a box supported by two spring balances that hang from a rod. The readings on spring balance 1 and 2 is 26.0 N and 40.0 N respectively.

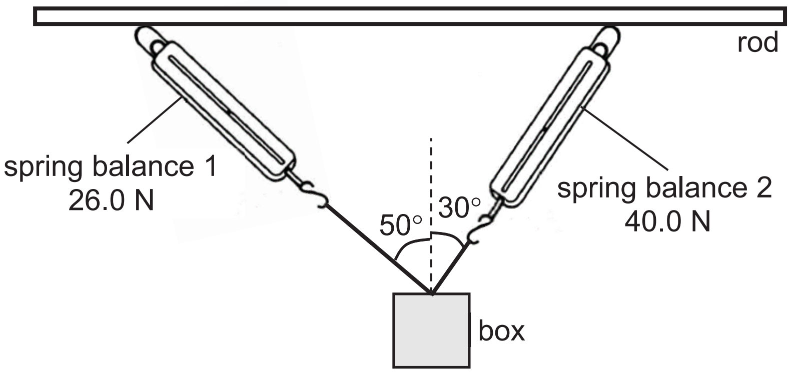


Fig. 1.1

(a) (i) By means of a scale labelled diagram, determine the size of the resultant force of the two spring balances.

resultant force = ... [3]

(ii) State the weight of the object.

weight = ____________________ [1]

(b) The experiment is conducted, with the same setup, in a lift which is accelerating downwards at 2.0 m / s^2. The gravitational field strength *g* is 10 N / kg.

(i) Calculate the resultant force on the box.

resultant force = ____________________ [2]

(ii) State and explain how this affects the size of the resultant force of the two spring balances in comparison to (a)(i).

-- [2]

2 Fig. 2.1 shows a block held on a smooth ramp. It is given a push at time t = 0 s and travels upwards along the ramp. The block reaches the maximum height and then slides downwards.

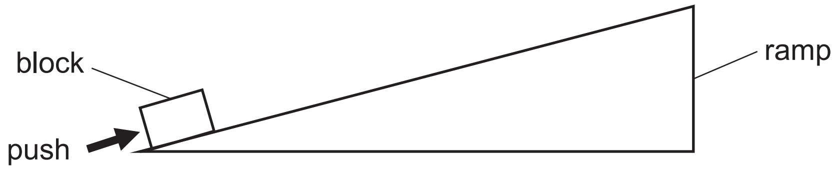


Fig. 2.1

Fig. 2.2 shows how the velocity of the block changes with time.

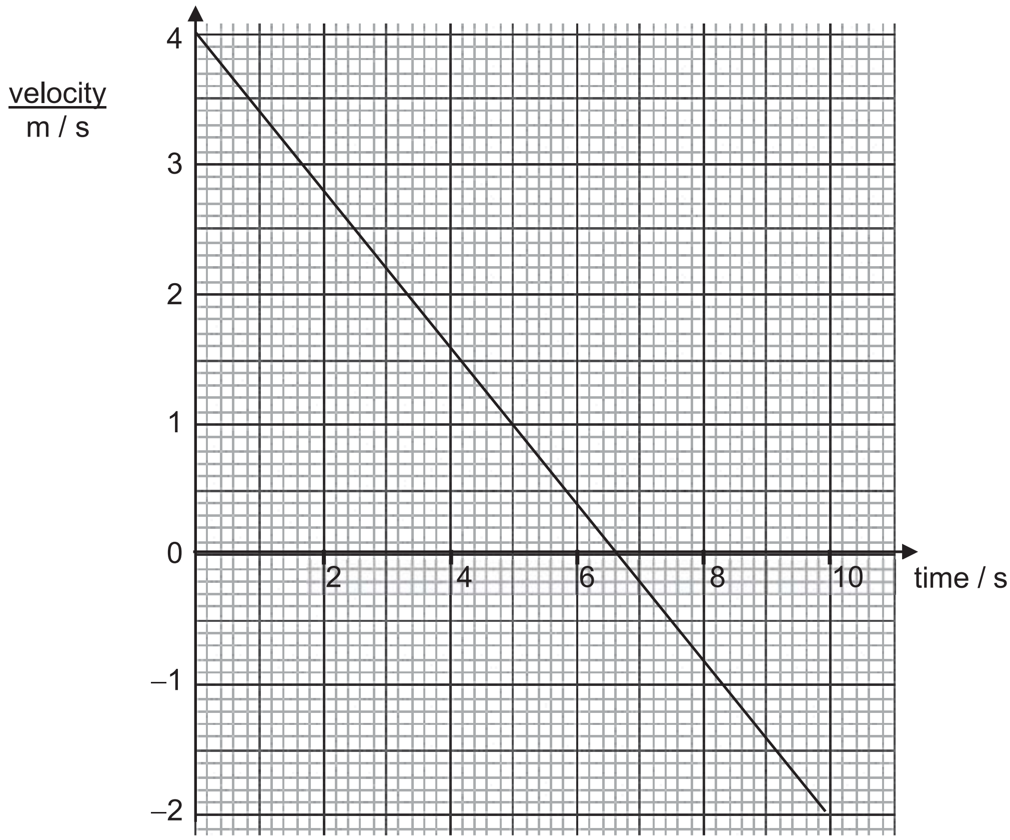


Fig. 2.2

(a) **(i)** State what is meant *uniform velocity*.

.... [1]

(ii) Determine the acceleration of the block.

acceleration = ... [2]

(b) **(i)** Determine the distance travelled by the block when it reaches the maximum height.

distance = ... [2]

(ii) On Fig. 2.3, sketch the displacement time graph for the block. [2]

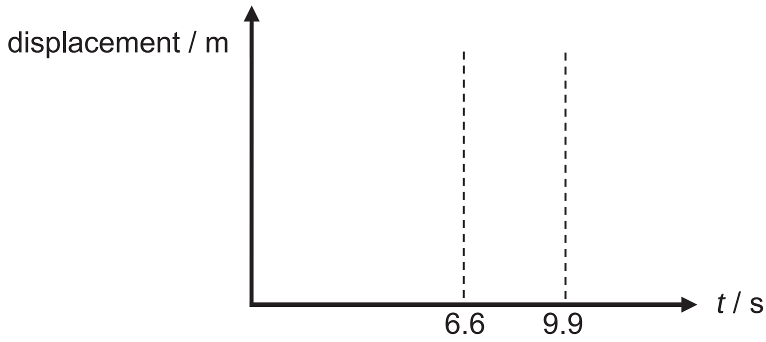


Fig. 2.3

3 Fig. 3.1 shows the cross-section of a submarine that is floating on seawater. The submarine has a ballast tank that can pump seawater in and out of the submarine.

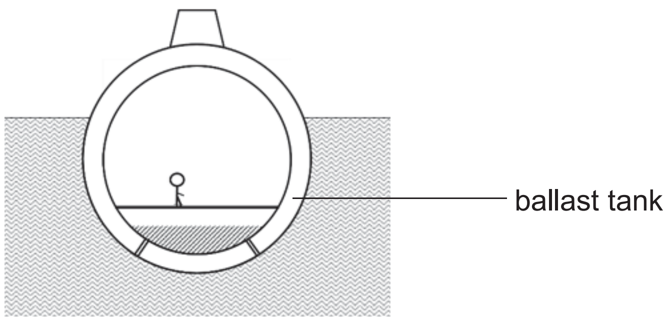


Fig. 3.1

(a) Explain why the submarine can float when its structure is made of steel which is denser than seawater.

....

....

....

.... [2]

(b) The submarine embarks on a mission.

Describe how the submarine dives underwater and then stays at the same depth below the water surface.

....

....

....

....

....

.... [3]

4 **(a)** When a liquid-in-glass thermometer with a linear scale is calibrated, two *fixed points* are used, the ice-point and steam-point.

(i) State what is meant by a *linear scale*.

....

.... [1]

(ii) One fixed point is the *ice point*.

State what is meant by the *ice point*.

....

.... [1]

(iii) In the space provided below, draw a labelled diagram to illustrate the experiment a student needs to perform to verify if the thermometer's ice-point is marked correctly. [2]

(b) Fig. 4.1 shows a mercury-in-glass thermometer. The thermometer has a linear scale.

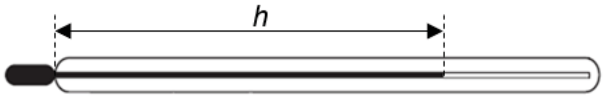


Fig. 4.1

At a temperature of 100 °C, h has a value of 28.0 cm. At 75 °C, h has a value of 23.0 cm.

Determine the value of h when the temperature is 15 °C.

h = ... [1]

5 **(a)** Fig. 5.1 shows a sealed glass syringe that contains air and many tiny, suspended dust particles.

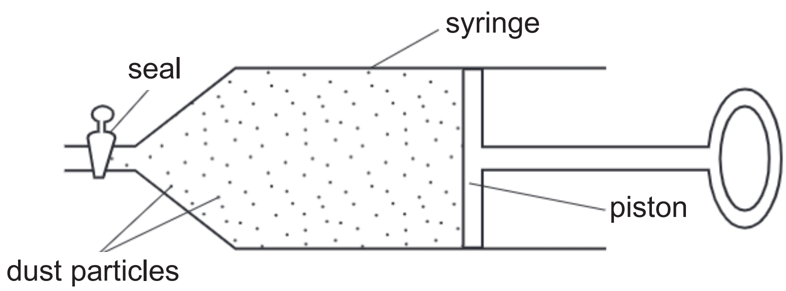


Fig. 5.1

Explain why the dust particles are suspended in the air and do not settle to the bottom.

....

....

.... [2]

(b) A pump is used to pump up balloons. A valve in the pump becomes blocked, as shown in Fig. 5.2.

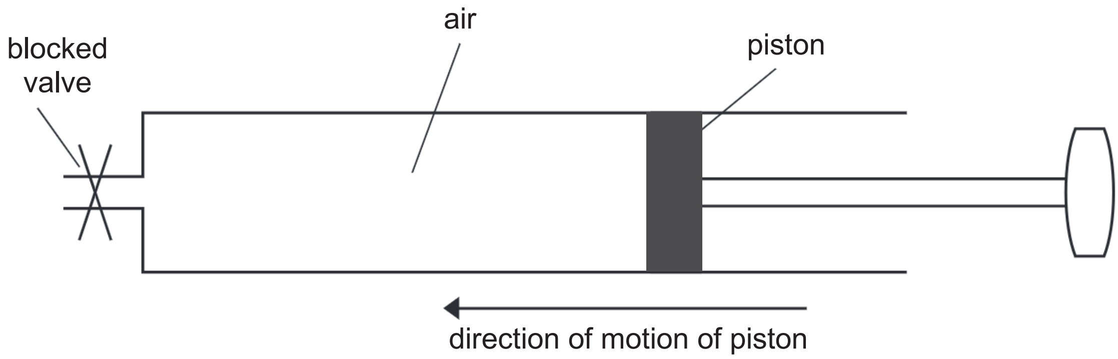


Fig. 5.2

(i) The piston of the pump is pushed in. Assume temperature remains constant.

State what happens to the pressure of the air trapped in the pump.

.... [1]

(ii) In terms of molecules, explain your answer to **(b)(i)**.

....

....

....

.... [2]

(iii) On Fig. 5.3 sketch the graph of pressure against $\frac{1}{\text{volume}}$ for the air in the pump. [1]

Fig. 5.3

6 Fig. 6.1 shows two rays of red light S and Z as they enter a transparent semicircular plastic block.

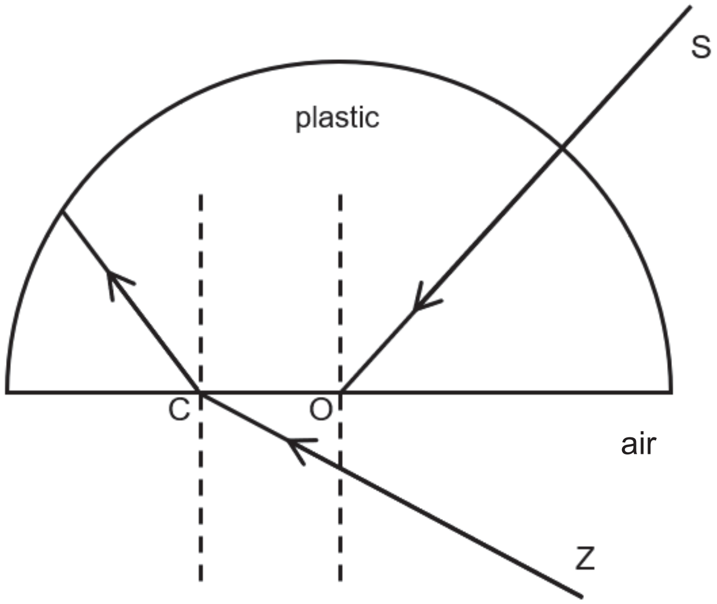


Fig. 6.1

The diagram is **drawn to scale**.

(a) Explain why the light ray S does not bend as it enters the plastic block.

--- [1]

(b) **(i)** Determine critical angle of the plastic.

critical angle = ------------------------------ [2]

(ii) **1.** On Fig. 6.1, measure and indicate the angle of incidence of light ray S at O. [1]

2. Hence, on Fig. 6.1, complete the path of light ray S till it leaves the block. [2]

(c) The angle of incidence of ray Z at point C increases gradually to 90 °.

State and explain if ray Z will undergo total internal reflection at point C.

--- [1]

7 **(a)** Fig. 7.1 shows a metal drum inside a photocopier. Initially, the surface of the drum is insulating and is charged positively. The inside of the drum is made of metal and is connected to earth. The regions where light strikes the drum become conducting.

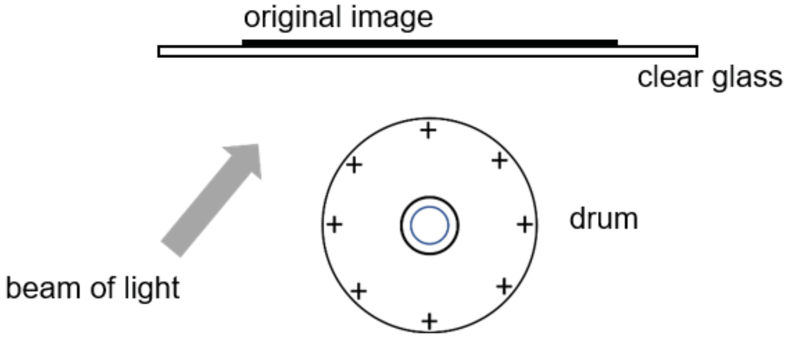


Fig. 7.1

The original image shown in Fig. 7.2 to be photocopied is placed on a sheet of clear glass above the drum.
An intense beam of light is shone on the original image as shown in Fig. 7.1.

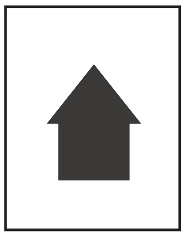


Fig. 7.2

(i) Explain how a charged image of Fig. 7.2 is formed on the drum surface.

....

....

....

.... [2]

(ii) Charged toner powder is sprayed onto the charged image formed on the drum. The sheet of paper to be printed on is passed over the drum's surface.

Explain why the sheet of paper to be printed on should be positively charged.

....

....

....

.... [2]

(b) Automobile manufacturers apply the principles of electrostatics to spray paint vehicles. The paint particles are first charged by friction as it come out of a spray gun and the vehicle to be painted is oppositely charged from the paint.

List two advantages of the above method.

1. ....

....

2. ....

.... [2]

8 Fig. 8.1 shows a coil ABCD that can turn between the two poles of a magnet. Bare metal paper clips support and pass current into and out of the coil.

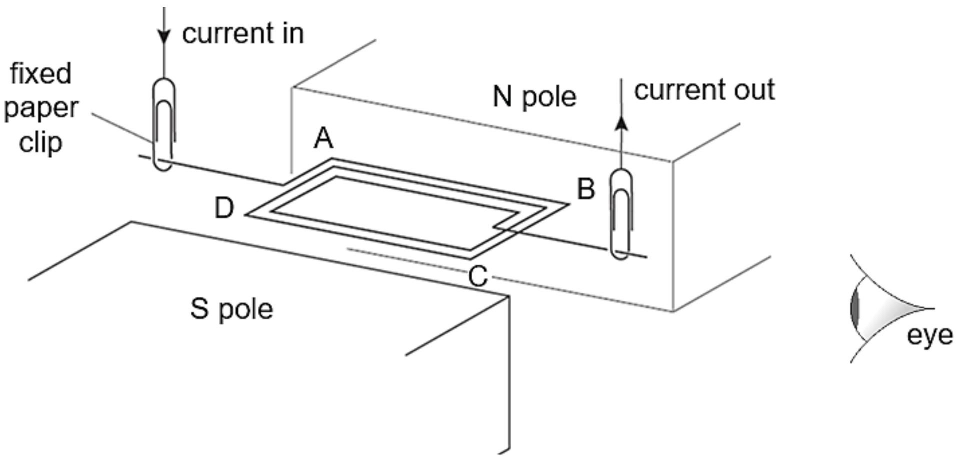


Fig. 8.1

(a) The coil rotates between the magnets when current flows through the coil.

(i) State the direction of rotation viewed from the position of the eye.

.... [1]

(ii) The coil does not rotate continuously. It stops when it is vertical.

Explain why the coil stops at this position.

....

....

....

.... [2]

(b) The coil is modified as shown in Fig. 8.2. The top half of the wire from C to the paper clip is coated with an insulator.

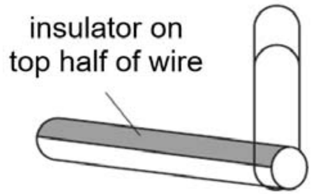


Fig. 8.2

(i) Explain why the coil can now rotate continuously.

....

....

....

.... [2]

(ii) The time taken for the modified coil in Fig. 8.2 to rotate one revolution is T.

On Fig. 8.3, sketch, for two complete revolutions of the coil, the graph of force on wire CD against time, from the position shown in Fig. 8.1. [1]

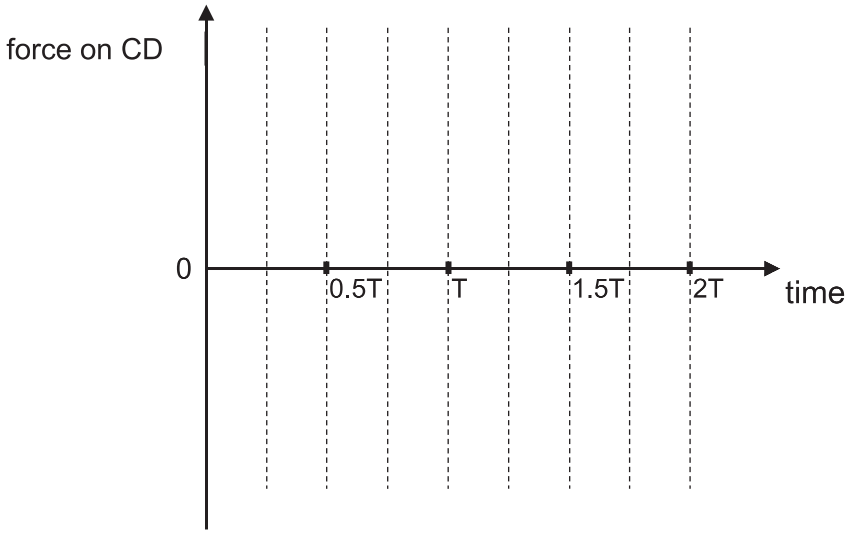


Fig. 8.3

Section B (30 marks)

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 11**.

9 Fig. 9.1 shows a slinky spring used to study the characteristics of a longitudinal wave.

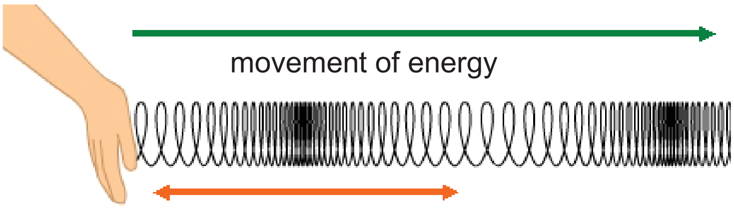


Fig. 9.1

Fig. 9.2 shows the rest positions of particles numbered '1' to '13' on the slinky before it is set into motion. The subsequent wave produced was found to have a period T of 4.0 s.

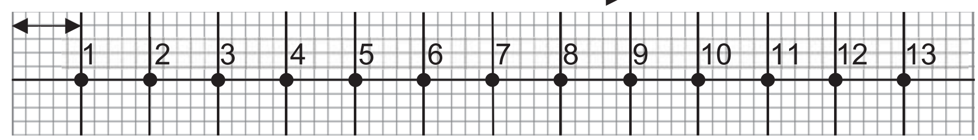


Fig. 9.2

Table 9.1 shows the displacement of the particles from the equilibrium positions at time ***t* = 0 s**. Displacement to the right is taken to be positive.

particle number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
distance from first particle d/cm	0	5	10	15	20	25	30	35	40	45	50	55	60
displacement s/cm	+4	+3	0	–3	–4	–3	0	+3	+4	+3	0	–3	–4

Table 9.1

(a) **(i)** Explain how the data in table 9.1 suggests that the particles are in longitudinal motion.

....

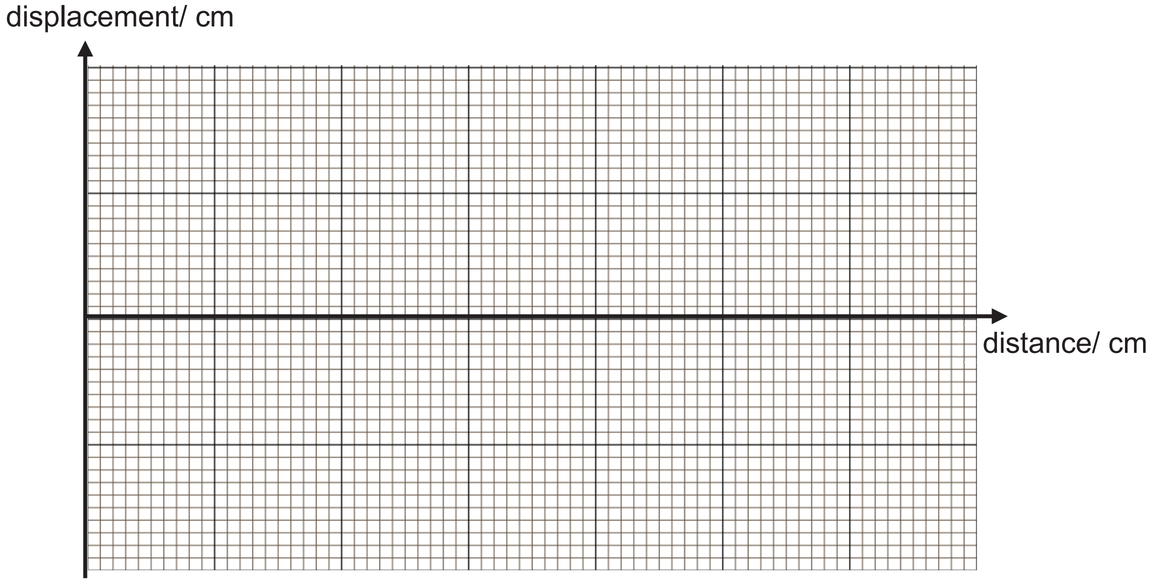
.... [2]

(ii) Describe what happens to the distance between adjacent particles, as the wave moves through the medium.

....

.... [2]

(b) **(i)** Sketch the displacement-distance graph of the wave at **t = 0 s** of all the 13 particles. Take the direction to the right as positive. Label clearly all values on the graph. [2]



(ii) Hence, state the wavelength of the wave.

wavelength = ... [1]

(iii) Determine the horizontal speed of the wave.

speed = ... [2]

(iv) On line P, in Fig. 9.3, draw the new position of all the particles at time ***t* = 4.0 s**. [1]

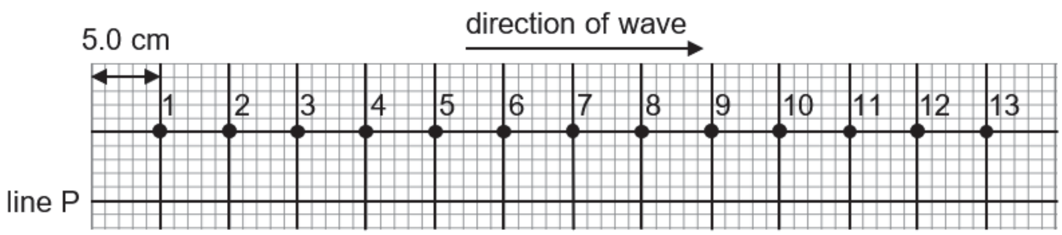


Fig. 9.3

10 Fig. 10.1 shows the outline of an a.c. generator.

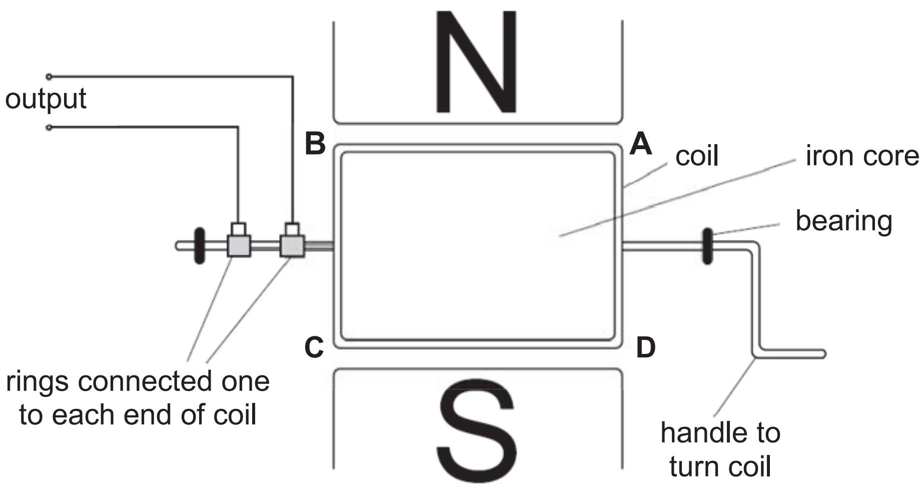


Fig. 10.1

(a) The peak output voltage of the generator is 6.0 V and the output has a frequency of 10 Hz.

Fig. 10.2 shows the axes of a voltage-time graph for the generator output.

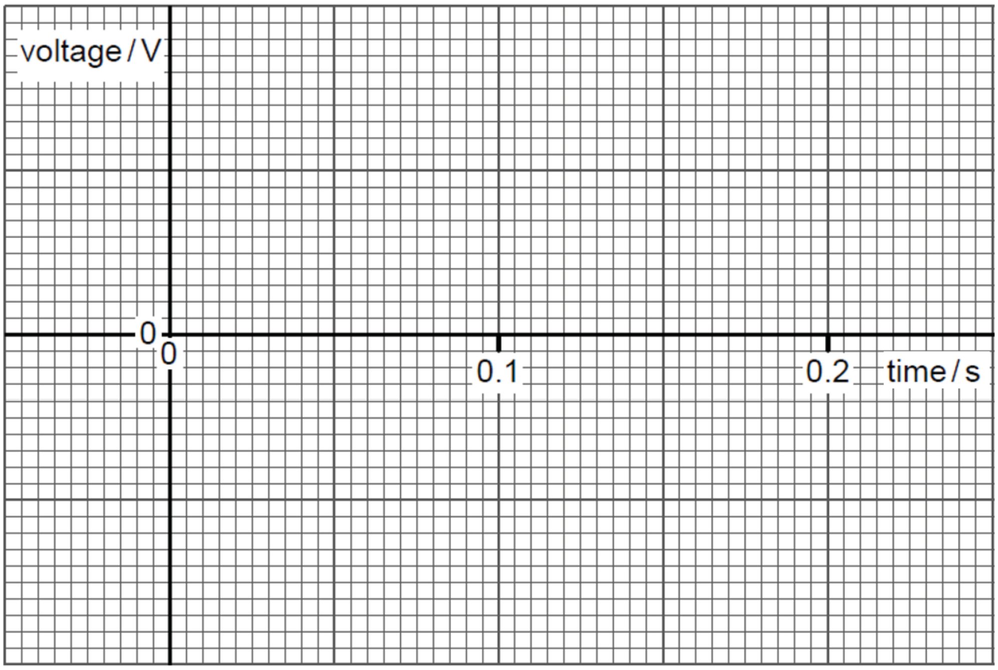


Fig. 10.2

On Fig. 10.2,

1. mark suitable voltage values on the voltage axis,
2. draw a graph of the generator output from t = 0 s to t = 0.2 s.

[3]

(b) **(i)** The generator shown in Fig. 10.1 works by electromagnetic induction.

Explain how this effect produces the output voltage.

....

....

....

....

.... [2]

(ii) State the energy changes that occur in the generator when it is producing output.

....

.... [1]

(c) In Fig. 10.1, side AB of the coil moves out of the paper as the handle turns.

(i) Draw an arrow on Fig. 10.1 to represent the direction of the induced current in the coil. [1]

(ii) Explain your answer for (c)(i).

....

....

....

.... [2]

(d) In Fig. 10.1, the coil rotates between fixed magnets.

However, we can also have an a.c. generator in which magnets rotate with respect to fixed coils. This type of a.c. generator is called a fixed coil generator.

State one advantage of a fixed coil generator.

....

....

.... [1]

11 EITHER

(a) An electric kettle consists of two heating elements shown in Fig. 11.1.

The heating elements can be connected to the electrical mains supply of 240 V in various ways to vary the heating power.

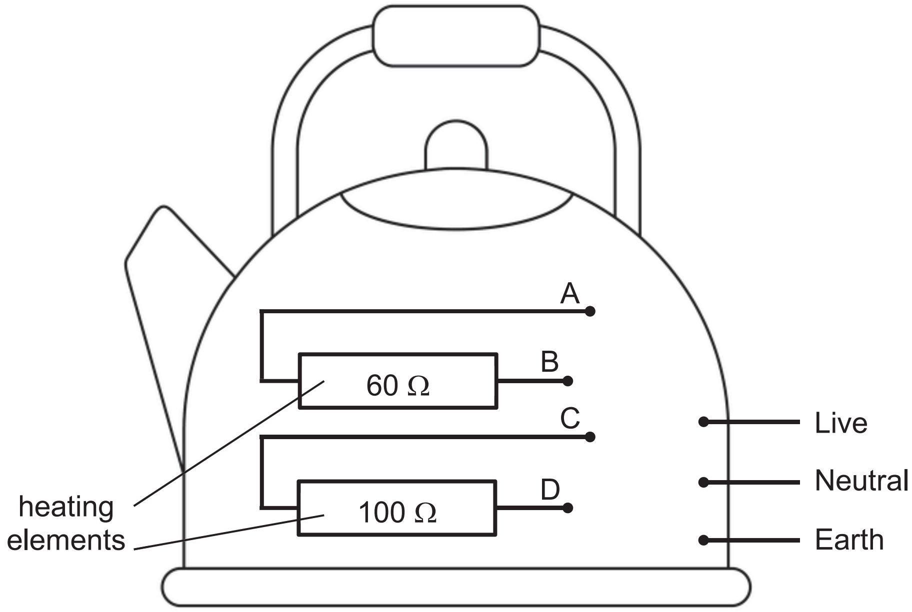


Fig. 11.1

(i) On Fig. 11.1, complete the circuit to show the connection of the heating elements that will give the lowest heating power. [2]

(ii) Calculate the power dissipated in (a)(i).

power = ... [1]

(b) A second electric kettle with a single heating element made up of a 200 Ω resistor is connected to the same electrical mains supply of 240 V.

(i) The electrical mains supply of 240 V is protected by a 13 A fuse.

Determine the maximum number of kettles that can be operated on this electrical mains supply.

maximum number = ... [2]

(ii) The fuse was incorrectly installed on the neutral wire.

Explain how this affects the kettle's:

1. normal operation: ....

.... [1]

2. safety: ....

....

.... [1]

(c) A third kettle labelled as "240 V, 800 W" is brought overseas and connected to an electrical mains supply of 120 V.

Calculate the cost of using the heater for 15 minutes each day for a week if 1 kWh of energy costs $0.40.

cost = ... [3]

11 OR

The brightness of a lamp L is controlled using two different circuits.

(a) Fig. 11.2 shows the first circuit that uses a variable resistor X, which can have any value between 0 Ω and 20.0 Ω by sliding the jockey J.

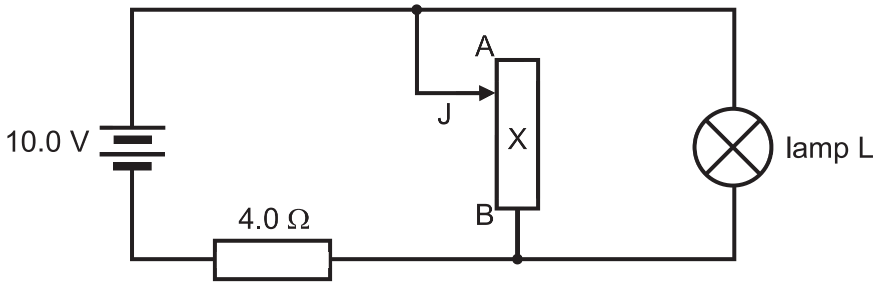


Fig. 11.2

(i) At the start of the experiment, jockey J of the variable resistor X is at position A. Subsequently, it is moved towards position B.

State and explain how the brightness of lamp L changes.

....

....

....

....

.... [2]

(ii) Jockey J is now placed such that it is at the midpoint AB. The resistance of Lamp L is 5.0 Ω.

Calculate the effective resistance of the circuit.

resistance = ... [2]

(iii) Hence, calculate the current drawn from the battery.

current = ... [1]

(b) Fig. 11.3 shows the first circuit being modified.

When no light falls on the LDR, its resistance is 2.0 Ω. In dim light, its resistance is 1.0 Ω. The jockey J is at the midpoint of AB and the resistance of Lamp L is 5.0 Ω.

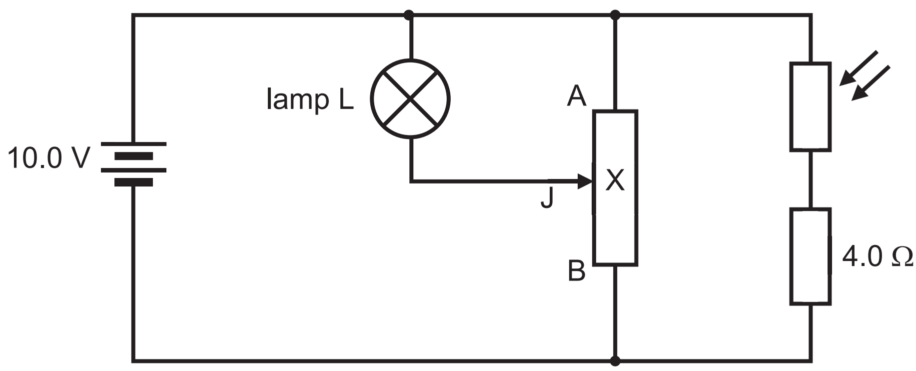


Fig. 11.3

(i) Calculate the potential difference across the LDR when no light falls on it.

potential difference = ... [2]

(iii) Hence, calculate the current through the LDR.

current = ... [1]

(c) State and explain the effect if any, on the bulb when the circuit is moved from a dimly lit room into a closed drawer where there is no light.

....

....

....

.... [2]

Marking Scheme for Physics Preliminary Examination 2022 (NHHS)_P1 and P2

Answer for Preliminary Examination Physics P1

1	2	3	4	5	6	7	8	9	10
D	D	D	C	A	A	D	A	C	B

11	12	13	14	15	16	17	18	19	20
D	C	B	B	B	A	C	A	C	A

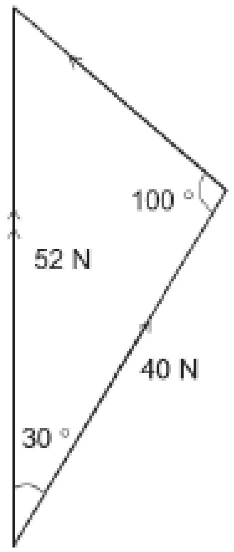
21	22	23	24	25	26	27	28	29	30
C	A	D	C	A	C	B	D	D	D

31	32	33	34	35	36	37	38	39	40
A	B	A	C	A	B	D	B	C	B

Marking Scheme for Physics Preliminary Examination 2022 (NHHS)_P2 and P1

Section A

1 (a) (i)



appropriate drawing	1
labels + directions of forces	1
resultant = **52.0 N** ± 5% (49.0 N to 55.0 N)	1

(ii) Weight = 52.0 N — 1

(b) (i) m = 5.20 kg — ecf from (a)(ii) — 1

F = m × a — 1

= 5.20 × 2.0 = **10 N or 10.4 N**

(ii) The size of the resultant force of the two spring balances would be *smaller* than in (a)(ii). — 1

To produce a downward resultant force on the box, resultant force from two spring balances must be smaller than weight of box. — 1

2 (a) (i) Constant rate of change of displacement. — 1

(ii) $a = \frac{v-u}{\Delta t} = \frac{-4}{6.6}$ — appropriate substitution — 1

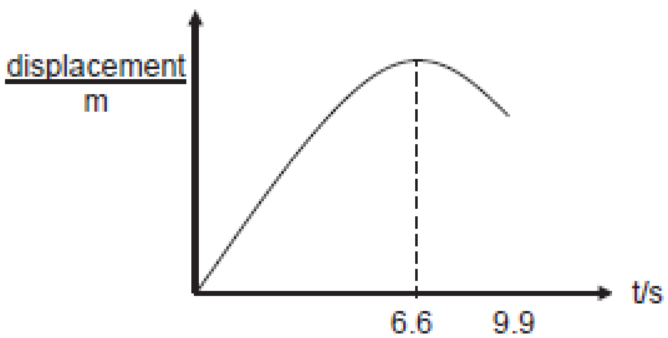
$= -0.61\ m/s^2$ — 1

(b) (i) $distance = \frac{1}{2} \times 4 \times 6.6$ — 1

$= 13\ m\ or\ 13.2\ m$ — 1

(ii) shape before 6.6 s — 1

shape after 6.6 s — 1



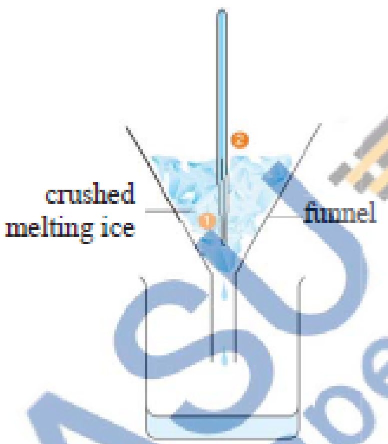
3 (a) Submarine contains air which is less dense than seawater. 1
Average density of submarine is less than seawater. 1

(b) To dive, submarine pumps in seawater so that average density is more than seawater. 1
Before it reaches the desired depth, submarine pumps out seawater, 1
so that at the desired depth, its average density is the same as seawater. 1

4 (a) (i) change in **length** of mercury on scale is proportional to **temperature** change 1

(ii) temperature of **pure melting ice (0 °C)** at **one atmospheric pressure** 1

(iii) appropriate setup 1
crushed, melting ice 1



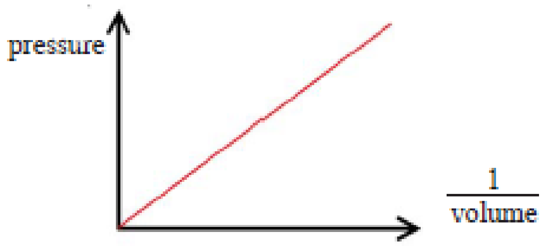
(b) (h – 28)/(15 – 100) = (23 – 28)/(75 – 100)
h = **11 cm** 1

5 (a) **Fast moving / high energy** air molecules hits 1
the dust particles **randomly and continuously** and keeps them suspended 1

(b) (i) pressure increases 1

(iii) The number of air molecules **per unit volume in** the pump increases. 1
The air molecules collide **more frequently** with the walls of the pump. 1

(iii) shape 1



6 (a) The light rays are incident normally at the surface (or i = 0°) 1

(b) (i) $n = \frac{\sin 62^{\circ}}{\sin 37^{\circ}} = 1.47$ able to calculate n using *sin i / sin r* 1

$$n = \frac{1}{\sin c} = 1.47$$

$$c = 42.9^{\circ}$$ 1

1. angle of incidence at O is (± 42°) 1
2. drawing:
   - refraction at point O 1
   - bends away from normal.by sight) 1

(b) No. Ray is travelling from optically less dense medium to optically denser medium, hence no total internal reflection for all values of angle of incidence. 1

7 (a) (i) Darker area of image reflects no light/ less light onto the drum, this region on the drum remains positive 1
Lighter areas of image reflect more light onto the drum, this region (become conducting) is discharged / lose its positive charge 1

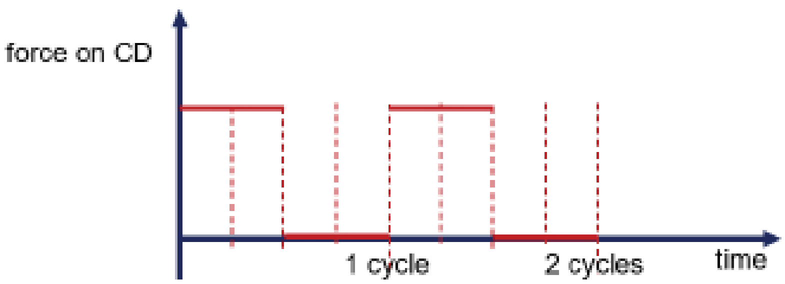
(ii) Toner is negatively charged. 1
So that the toner is attracted to the positively charged image on the drum and then paper attracts the toner, forming the image on paper. 1

(b) The vehicle has a uniform/even coat of paint (from textbook) 11
Less wastage of paint as particles are attracted to the vehicle
Others:
Long lasting finish/can reach corners/reduce production time/ more efficient/ Less $ spent on paint because less wastage of paint/ more adhesive / reduce VOC (volatile organic compound) emissions

8 (a) (i) clockwise 1

(ii) Forces on AB and CD of coil act through center of coil. 1
Moments due to the oppositely directed force on AB and CD is zero. (perpendicular distance is zero) 1

(b) (i) When the insulated side of the wire is in contact with clip, no current will flow through coil, hence no motor effect (force) on coil due to current. 1
Coil will continue to rotate in the same direction due to inertia/newton's 1st law/momentum. 1

(ii) 

1

Section B

9 (a) (i) The negative and positive displacement shows that the particles are vibrating left and right, 1
which is parallel to the motion of the wave moving to the right. 1

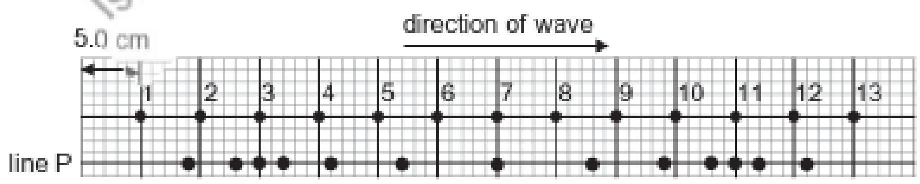
(ii) The distance between adjacent particles increases to <u>a maximum</u> 1
and then decreases to <u>a minimum</u> distance. 1

(b) (i) 

amplitude 1
wavelength 1

(ii) wavelength = 40 cm 1

(iii) speed = wavelength/period = 40/4 1
= 10 cm/s 1

(iv) 

1

{note t = 0 s and t = 4.0 s will be the same}

10	(a)		**1.** -6 V to 6 V labelled, graph is positive and negative	1
			2. correct shape (sinusoidal)	1
			2 complete waves with 1 complete wave every 0.1 s	1
	(b)	(i)	As coil rotates, it cuts the magnetic field and there is a **change in magnetic flux in the coil.**	1
			By Faraday's law, an emf is induced in the coil that changes direction	1
		(ii)	kinetic energy (or mechanical energy) is converted to electrical energy and heat energy	1
	(c)	(i)	On Fig. 10.1: induced current from B → A (or D → C)	1
		(ii)	By **FRHR**	1
			- magnetic field is downwards, force on AB is out of paper - current perpendicular to both magnetic field and force is from B to A appropriate description	1
	(d)		Acceptable advantages • It does not require carbon brushes and slip rings which wear out and need to be replaced • Less likely to break down from overheating as eroded connection between slip rings and carbon brushes has increased resistance, which can generate large amount of heat • More compact	1

11 EITHER

(a)	(i)	**both resistors connected in series** (B connected to C)	1
		A (or D) connection to live wire and D (or A) to neutral wire	1
	(ii)	Power $= V^2 / R$ $= 240^2 / (60 + 100) =$ **360 W**	1
(b)	(i)	$I = V / R$ $= 240 / 200 = 1.2$ A	1
		Max Number $= 13 / 1.2 = 10.8$ $=$ **10** (round down)	1
	(ii)	1. Normal operation of the kettle is not affected.	1
		2. Kettle will be a safety hazard, as it will remain live / at a high voltage / at a high electrical potential even after the fuse melts to break the flow of current.	1
(c)		$R = V^2 / P = 240^2/800 = 72\ \Omega$	1
		$P = V^2 / R = 120^2/72 =$ **200 W**	1
		Cost = (200/1000) × (15/60) × 7 × \$0.40 = **\$0.14**	1

11 OR

(a) (i) L becomes **dimmer.** 1
Resistance of X decreases and hence effective resistance of X and L decreases.X in parallel with L share 10 V with 4.0 Ω resistor. Hence, 1
voltage across L will decrease

(ii) R of variable resistor X = 10 Ω 1
effective resistance = $(1/10 + 1/5)^{-1} + 4$
= **7.3 Ω** 1

(iii) I = V/ R 1
= 10/ 7.3
= **1.4 A**

(b) (i) Pd across LDR = 2.0 / (2.0 + 4.0) × 10 potentiometer method 1
= **3.3 V or 3.33 V** 1

(ii) current = V/R 1
= 3.3 / 2
= 1.7 A or **1.67 A**

(c) **No effect.** 1
Voltage across bulb remain unchanged as the LDR is connected in parallel 1
to the branch with the bulb.

ST JOSEPH'S INSTITUTION
PRELIMINARY EXAMINATION 2022
(YEAR 4)

CANDIDATE NAME			
CLASS		INDEX NUMBER	

PHYSICS **6091/1**

13 September 2022

Paper 1 Multiple Choice

1 hour

Additional Materials: Multiple Choice Answer Sheet **(10:00 – 11:00)**

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue, or correction fluid.
Write your name, class and index number in the multiple choice answer sheet.

There are **forty** questions on this paper. Answer **all** questions.
For each question there are four possible answers **A, B, C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Multiple Choice Answer Sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done on this question paper.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **23** printed pages including this cover page.

1 What are the SI base units of pressure?

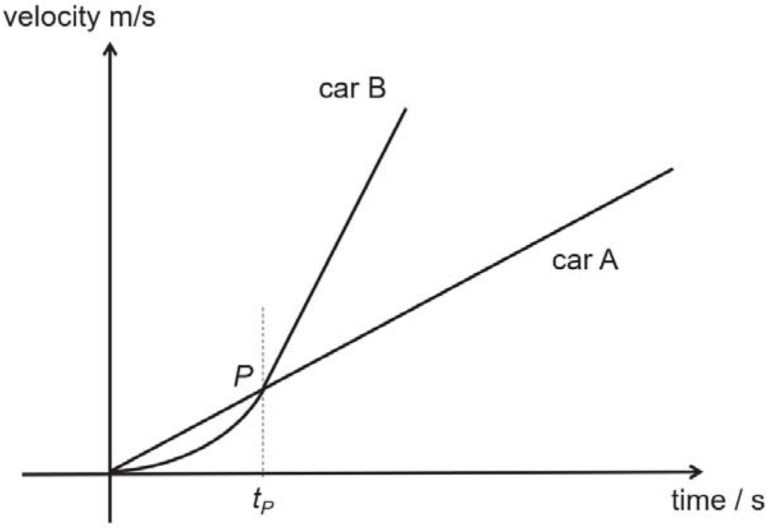
A N/m^2

B kg/m^2

C kgm/s^2

D kg/ms^2

2 The figure below shows the velocity-time graphs of two cars travelling side by side on a straight level road. The cars start their journey from the same starting line.

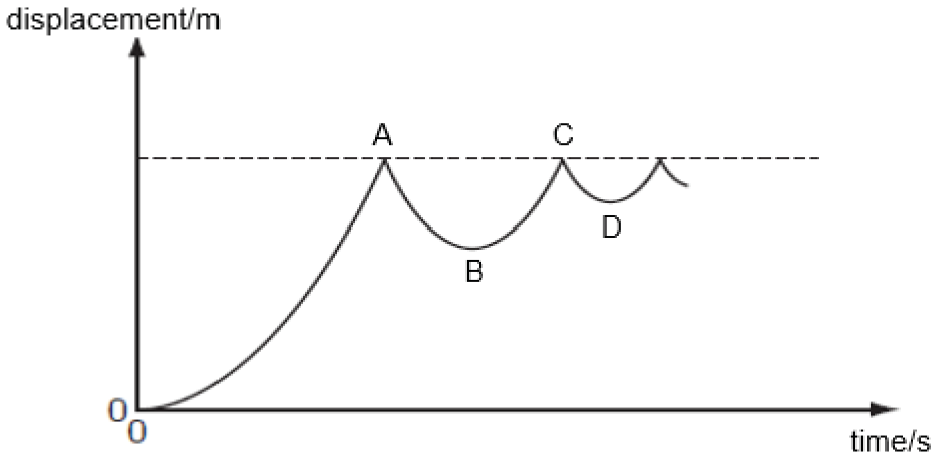


Which of the following statement(s) is/are correct?

1 Car B passes car A at $t = t_P$.
2 Both cars have equal velocity at $t = t_P$.
3 Car B has a higher acceleration than car A at $t = 0$.

A 1 and 3 only
B 2 only
C 2 and 3 only
D 1, 2 and 3

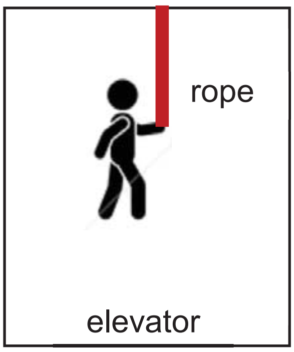
3 A steel ball is dropped from a height onto a hard floor. Taking the downward direction to be positive, the following displacement time graph describes the motion of the bouncing ball.



Which of the points, A, B, C or D indicates the second time that the ball hits the floor?

A point A **B** point B
C point C **D** point D

4 A child with a mass of 25 kg is hanging from the ceiling of an elevator by a rope.

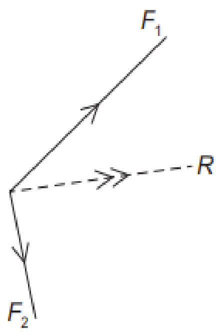


The elevator is travelling upwards at a constant deceleration of 1.0 m/s^2.
What is the force exerted by the rope on the child?

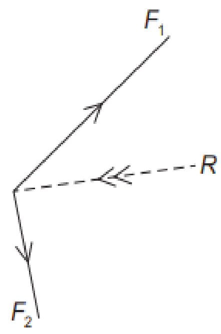
A 0 N **B** 225 N
C 250 N **D** 275 N

5 Which diagram shows the magnitude and direction of the resultant R of the two forces F_1 and F_2?

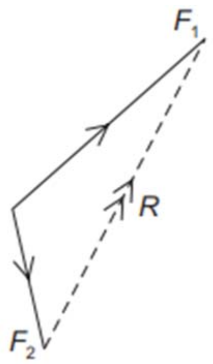
A



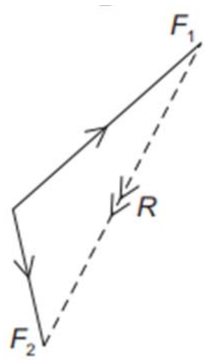
B



C



D

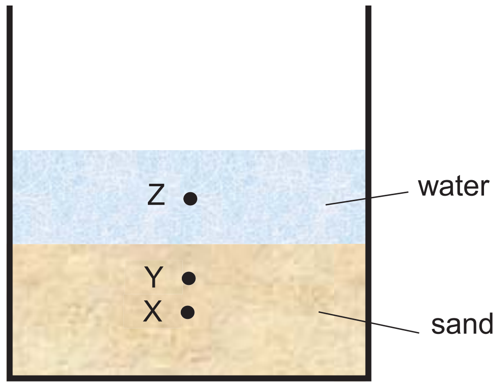


6 A momentary force is applied to a hockey puck on a frictionless skating rink.

Assuming air resistance is negligible, which of the following statements best describes the subsequent motion of the hockey puck?

A It accelerates uniformly.
B It decelerates to rest uniformly.
C It moves with uniform velocity.
D It stops abruptly.

7 The diagram shows a pail containing water and sand.



More sand is added to the pail. This affects the position of the centre of gravity of the pail and its contents, and the stability of the pail.

Which of the following shows how the position of the centre of gravity and the stability of the pail will be affected?

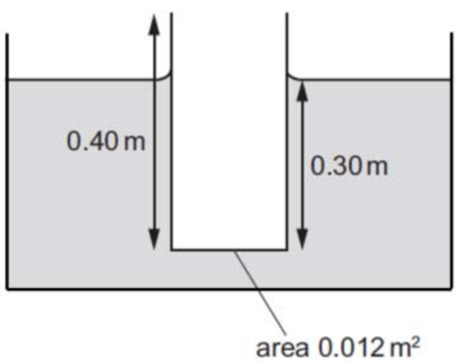
	centre of gravity	stability
A	moves from X towards Y	decreases
B	moves from X towards Y	increases
C	moves from Y towards Z	decreases
D	moves from Y towards Z	increases

8 An object is released from rest from a height h. The velocity of the object after falling a distance, $h/2$ is v_1. The velocity of the object after falling a distance, h is v_2.

If air resistance is negligible, what is the ratio of v_2 to v_1?

A 0.50 **B** 0.71 **C** 1.4 **D** 2.0

9 A beaker floats in a container of liquid as shown.



The cross-sectional area of the beaker is 0.012 m^2. The weight of the beaker is 32 N. What is the density of the liquid?

A 670 kg/m^3 **B** 890 kg/m^3
C 6700 kg/m^3 **D** 8900 kg/m^3

10 The lengths of the alcohol thread in a thermometer are 5.0 cm and 25.0 cm when the temperatures are 10 °C and 78 °C respectively. When the thermometer bulb is placed in a liquid, the length of the alcohol thread is 3.0 cm.

What is the temperature of the liquid?

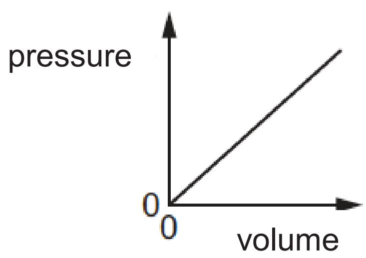
A 3.2 °C　　**B** 6.0 °C
C 6.8 °C　　**D** 10.2 °C

11 What surrounds the bulb of a thermometer during the marking the upper and lower fixed points?

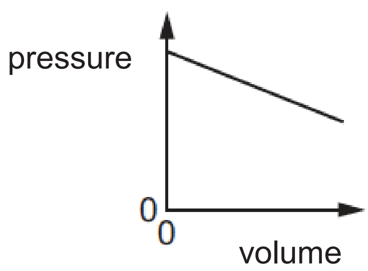
	upper fixed point 100 °C	lower fixed point 0 °C
A	boiling water	pure ice
B	boiling water	pure melting ice
C	steam	pure ice
D	steam	pure melting ice

12 Which graph shows the relationship between the pressure and the volume of a fixed mass of gas at constant temperature?

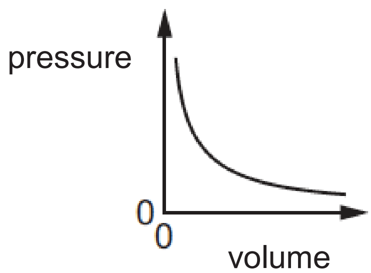
A



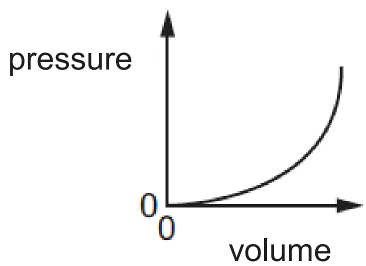
B



C

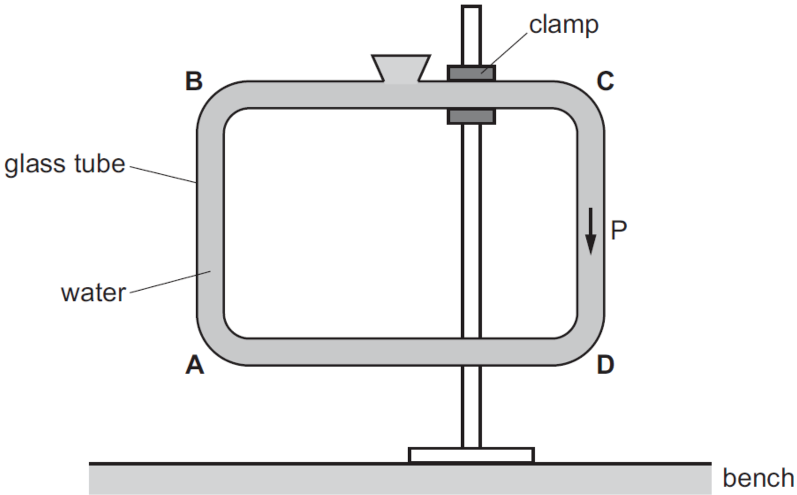


D



13 The diagram shows a glass tube filled with water and suspended above a bench. The water is free to circulate around the tube.

At point P, there is a convection current moving in a downwards direction. At which point is the tube heated to cause this convection current?

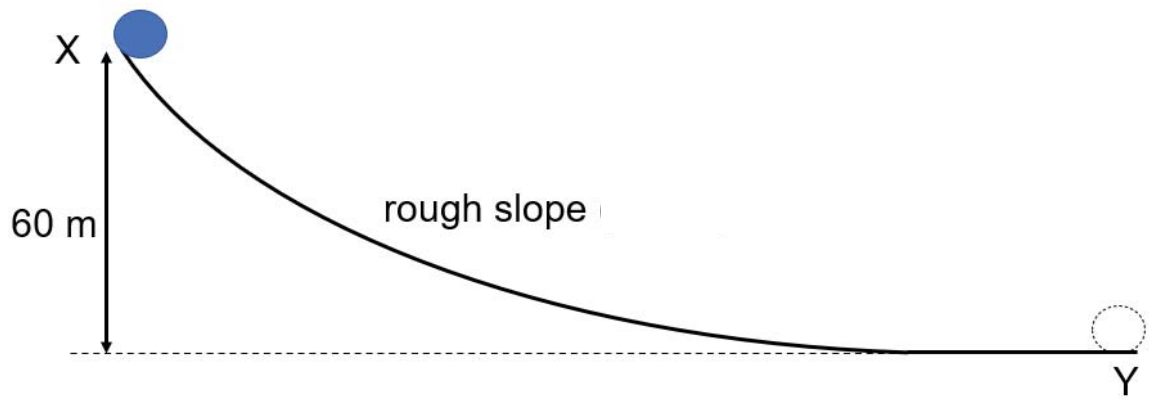


14 The fins of a car radiator system, as shown in the diagram, is very efficient in removing the heat generated from its engine.

Which of the following statements best explains this?

- **A** A high temperature difference between the radiator and surroundings allows a high rate of heat loss by conduction.
- **B** The design of the radiator allows heat to be transferred to the surroundings rapidly by convection.
- **C** The radiator fins increases surface area allowing a high rate of heat transfer.
- **D** The radiator is made of metal, which is a good thermal conductor.

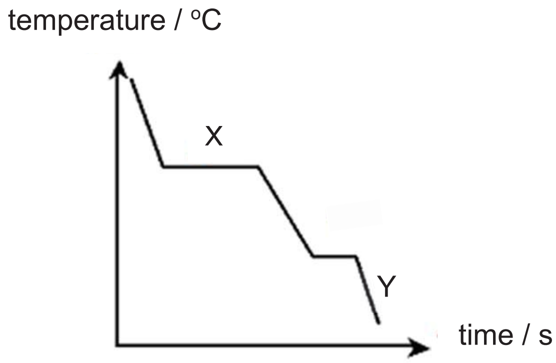
15 A 0.50 kg ball is released from rest from the top of a rough 200 m slope at X, as shown in the diagram. It comes to a stop at Y.
Assuming all the work done against friction is converted to the increase in the thermal energy of the ball, what will be the rise in the temperature of the ball?



The gravitational field strength g is 10N/kg and the specific heat capacity of the ball is 400 J/kg°C.

A 0.50 °C **B** 0.75 °C
C 1.5 °C **D** 3.0 °C

16 The diagram below shows how the temperature of a substance, initially in gaseous state, varied with time.



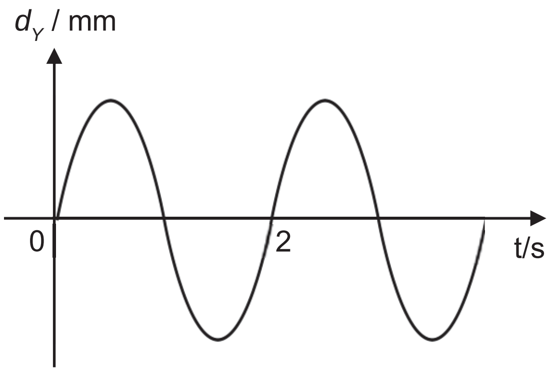
Which of the following correctly describes what happened to the internal kinetic energy and to the internal potential energy of the molecules of the substance during processes X and Y?

	internal kinetic energy		internal potential energy	
	X	Y	X	Y
A	constant	decrease	decrease	constant
B	constant	decrease	increase	constant
C	decrease	constant	increase	constant
D	decrease	decrease	increase	constant

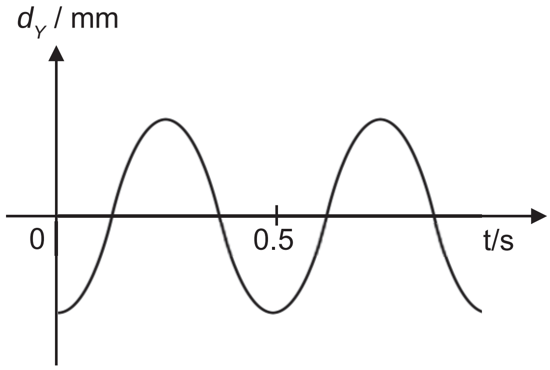
17 The diagram shows a water wave travelling at a speed of 20 cm/s to the right. At time = 0, particle X is at the crest of the wave. Particle Y is 30 cm to the right of particle X.

Which of the following shows a possible displacement-time graph of particle Y?

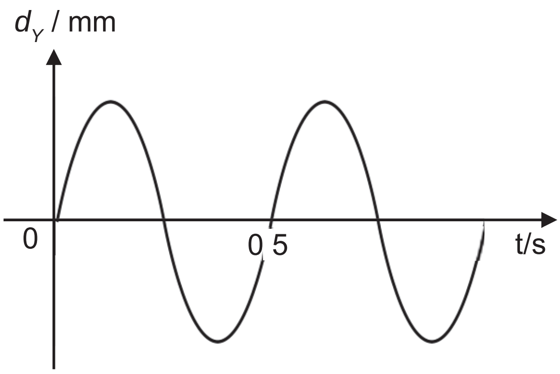
A



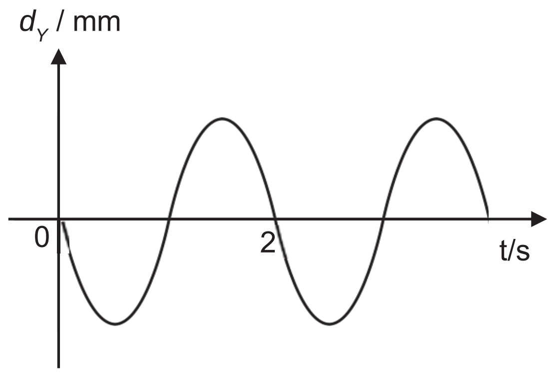
B



C



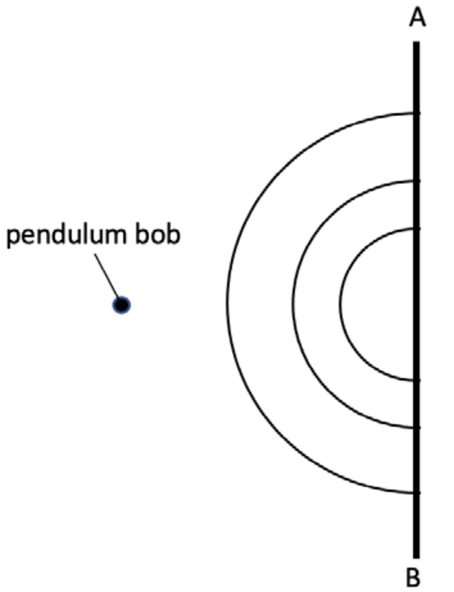
D



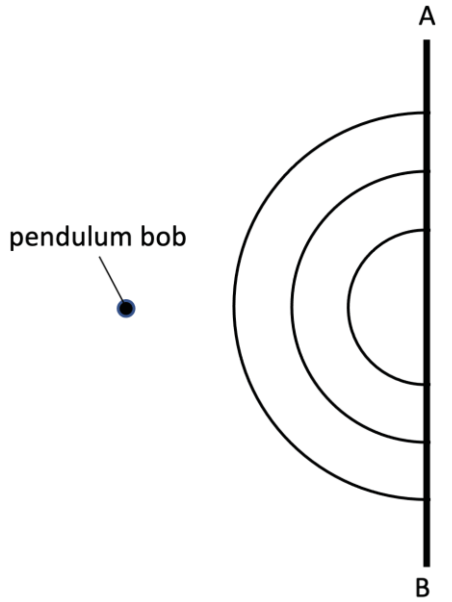
18 A pendulum bob oscillates above a water surface, creating a water wave moving towards a hard surface AB.

Which of the following shows the reflection of the water wave by the hard surface AB?

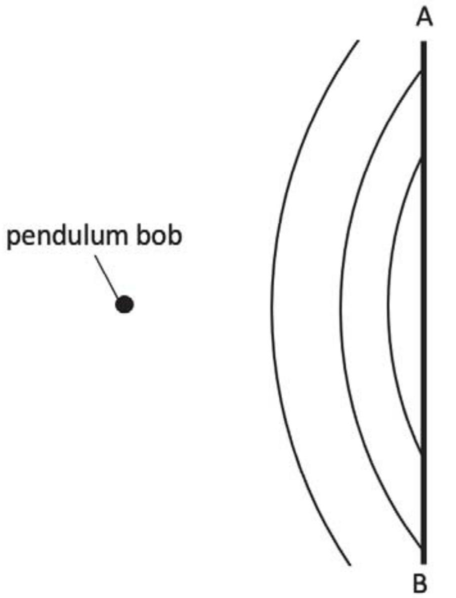
A



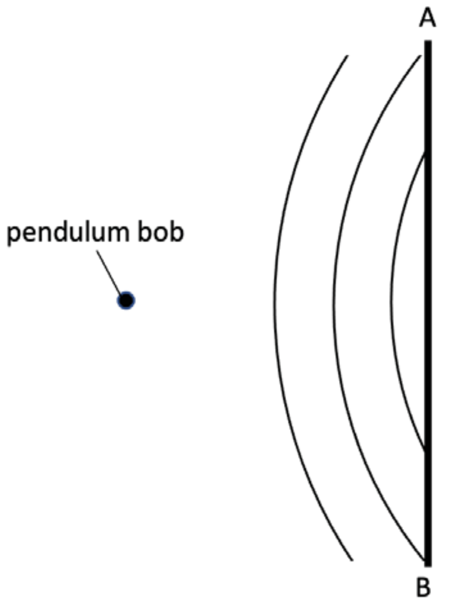
B



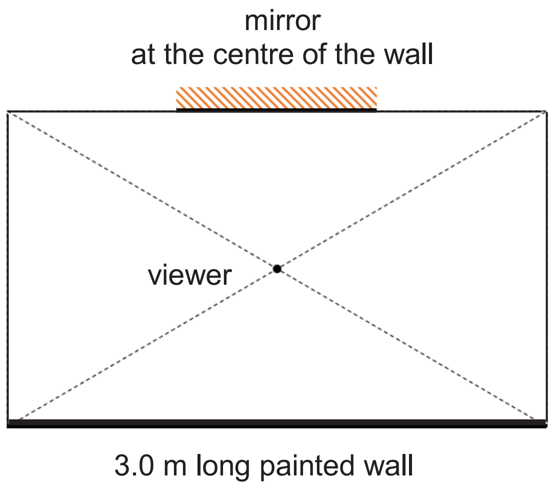
C



D



19 An art installation room consists of a mirror and a wall completely covered by a 3.0 m long painting. If a person stands at the centre of the rectangular room facing the mirror, he will be able to see the full length of the painting that was drawn on wall, behind him.



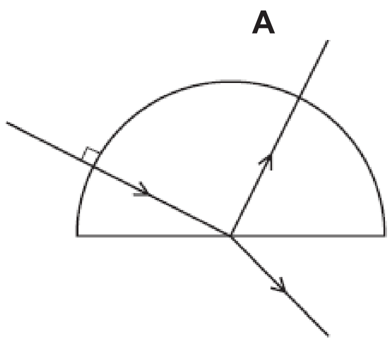
(diagram is not drawn to scale)

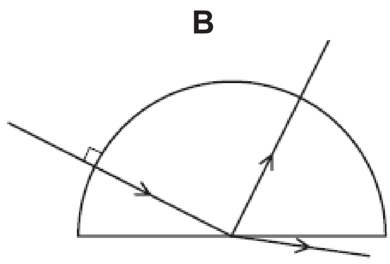
What is the shortest possible length of the mirror for the person to just be able to see the full length of the painting?

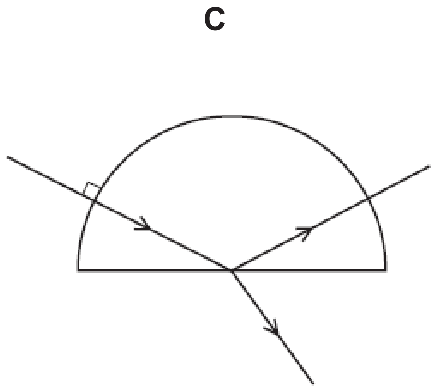
A 1.0 m **B** 1.2 m **C** 1.5 m **D** 2.0 m

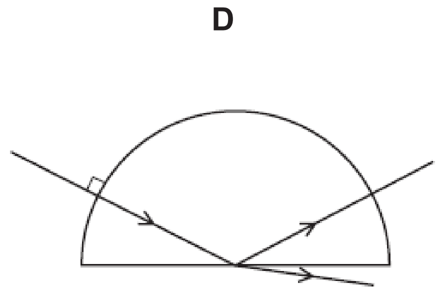
20 A ray of red light in air enters into a semi-circular glass block.

Which diagram shows the correct partial reflection and the refraction of the ray?

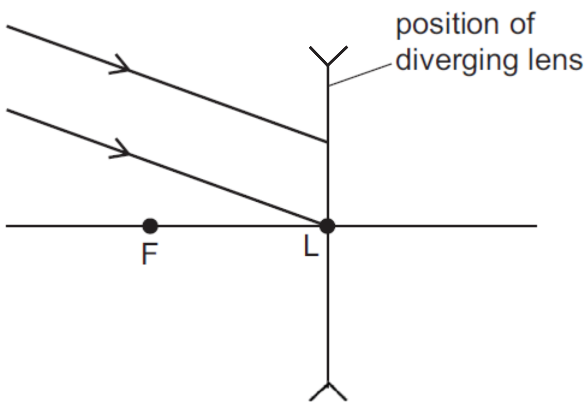






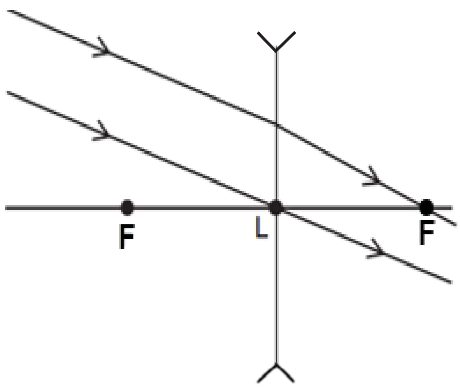


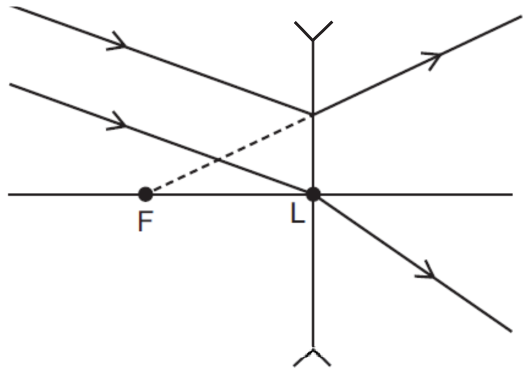
21 A parallel beam of light is incident on a thin diverging lens.
The focal length of the lens is FL, as shown in the diagram.



Which ray diagram shows how the beam bends after it has passed through the lens?

B

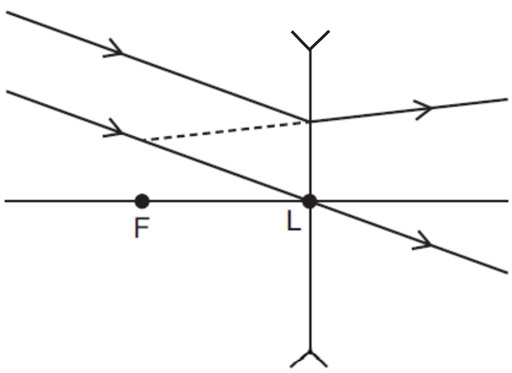


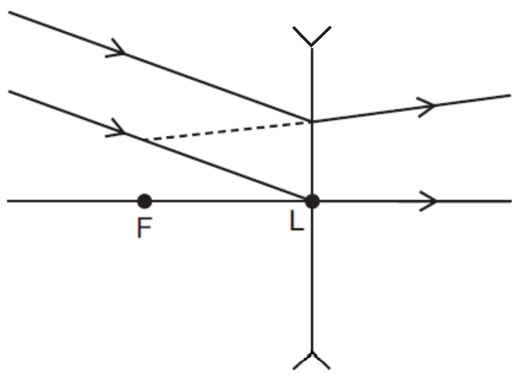


A

C

D





22 Which row lists the applications of parts of the electromagnetic spectrum?

	gamma ray	infra-red radiation	microwave
A	intruder alarm	satellite communication	sunbed
B	satellite communication	treatment of cancer	remote controller
C	treatment of cancer	intruder alarm	remote controller
D	treatment of cancer	remote controller	satellite communication

23 The diagram shows the electromagnetic waves arranged in the correct order.

radio waves	R	S	T	Q	X-rays	gamma rays

Which row lists the correct electromagnetic waves?

	S	T
A	infra-red radiation	visible light
B	infra-red radiation	ultra-violet radiation
C	microwaves	infra-red radiation
D	visible light	ultra-violet radiation

24 Statements 1, 2 and 3 are about the speeds and the frequencies of ultra-violet radiation, audible sound and ultrasonic sound.

statement	
1	The frequencies of audible sound and ultrasonic sound are the same, and is lower than the frequency of ultra-violet radiation.
2	The speeds of audible sound and ultrasonic sound are the same, and are lower than the speed of ultra-violet radiation.
3	The speeds of the three waves increase as they travel from gas into a solid.

Which statements are correct?

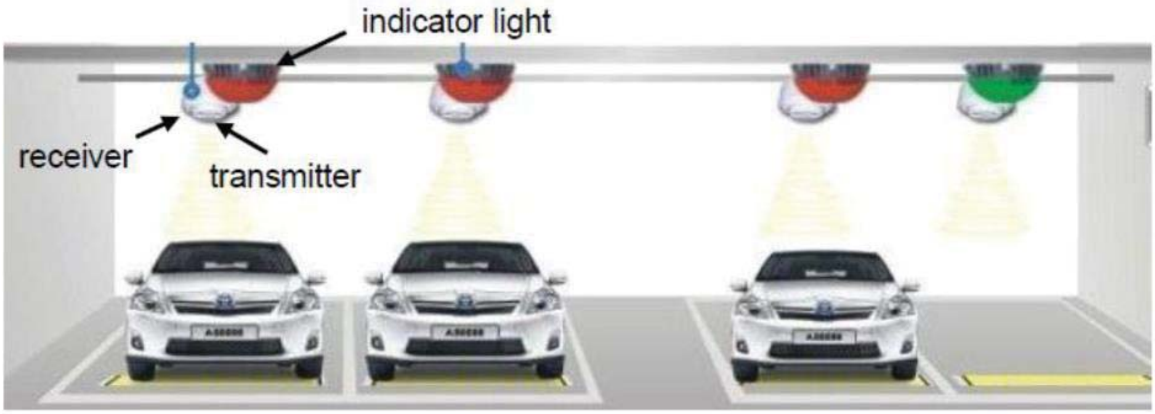
A statement 1 and 2

B statement 2 and 3

C statement 2 only

D statement 3 only

25 An ultrasonic sound transmitter and a receiver are installed at the ceiling of a carpark as shown in the diagram. They can be used to determine the height of a car. Diagram 1 shows the c.r.o. display when the lot is empty. Diagram 2 shows the c.r.o. display when a car is parked beneath the transmitter and receiver.



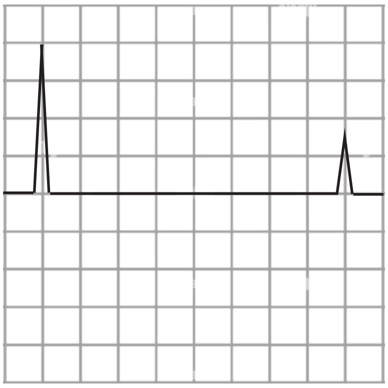


Diagram 1

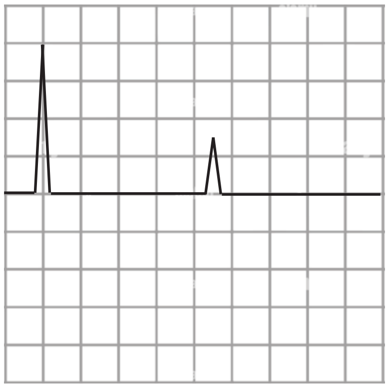


Diagram 2

The time-base of the c.r.o. is 2.5 ms/div. If the speed of ultrasound is 330 m/s, what is the height of the car?

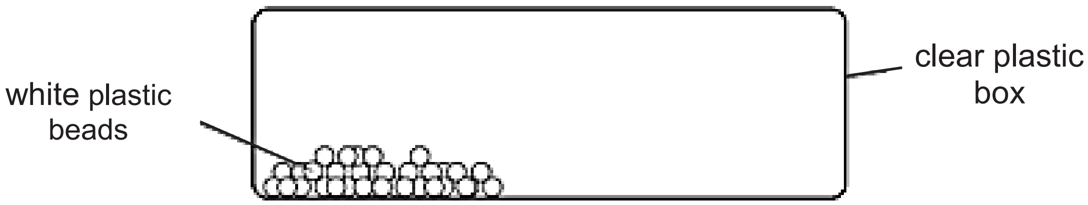
A 1.44 m **B** 1.86 m **C** 2.88 m **D** 3.30 m

26 A sound wave is transmitted in water. The shortest time duration for the water particles to move from its rest position to its maximum displacement is 2.5 ms. The distance from the centre of a compression to the adjacent centre of rarefaction is 7.5 m.

What is the distance travelled by the sound wave in 0.10 s?

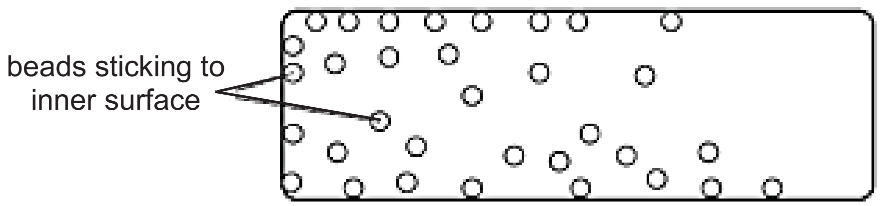
A 750 m **B** 1500 m **C** 3000 m **D** 6000 m

27 The diagram shows some white plastic beads of negligible mass in a clear plastic box.



side view

The box is shaken, causing the beads to rub against the box. The beads are then found to stick to the inner surface of the box.



side view

Which of the following statements is incorrect?

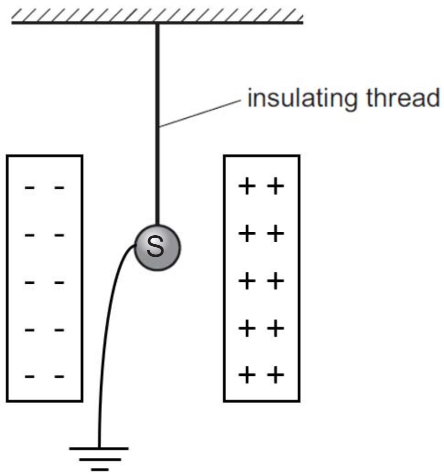
A All the charged beads have like charges.

B Fewer beads will stick to the inner surface of the box if the experiment is done in humid conditions.

C The box loses electrons and the beads gain electrons.

D The box and the beads both have like charges due to friction between them.

28 The diagram shows an uncharged sphere S coated with metallic paint. The ball is suspended from an insulating thread. It is placed in the middle of two equally and oppositely charged objects as shown.



S is then earthed with the two charged objects still in position. Which diagram shows the resulting charge distribution on S?

29 A metal electrical conductor has a resistance of 5.6 kΩ. A potential difference of 9.0 V is applied across its ends.

How many electrons pass a point in the conductor in one minute given that the magnitude of the charge of an electron is 1.6×10^{-19} C?

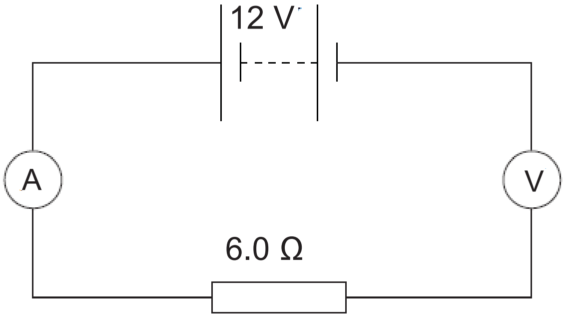
A 1.0×10^{16}

B 6.0×10^{17}

C 6.0×10^{20}

D 2.3×10^{23}

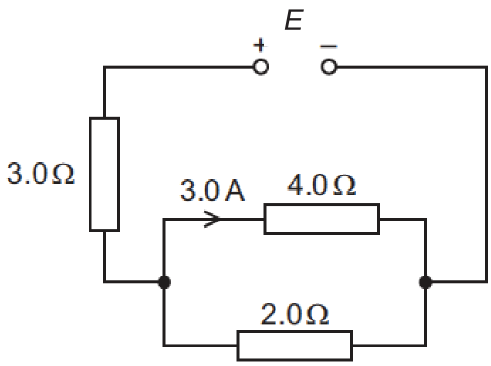
30 A 12 V battery is connected in series to an ammeter, a 6.0 Ω resistor, and a voltmeter as shown in the diagram.



What are the readings on the ammeter and on the voltmeter?

	ammeter reading / A	voltmeter reading / V
A	2.0	0
B	2.0	12
C	0.0	12
D	0.0	0

31 A power supply of electromotive force *E* and negligible internal resistance is connected in the circuit shown. There is a current of 3.0 A in the 4.0 Ω resistor.



What is the value of *E*?

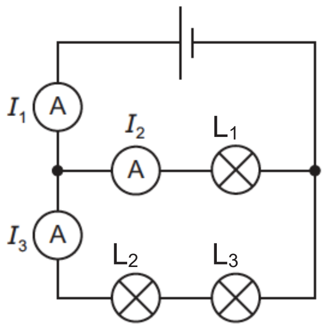
A 15 V

B 29 V

C 39 V

D 51 V

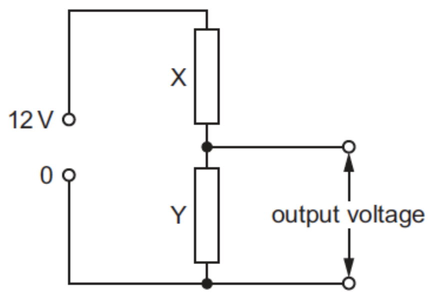
32 Three identical lamps and three ammeters are connected as shown. The readings on the ammeters are I_1, I_2 and I_3.



Which of the following describes the changes in the ammeter readings when L_3 blows?

	I_1	I_2	I_3
A	decrease	decrease	decrease
B	decrease	unchanged	decrease
C	increase	increase	decrease
D	unchanged	increase	increase

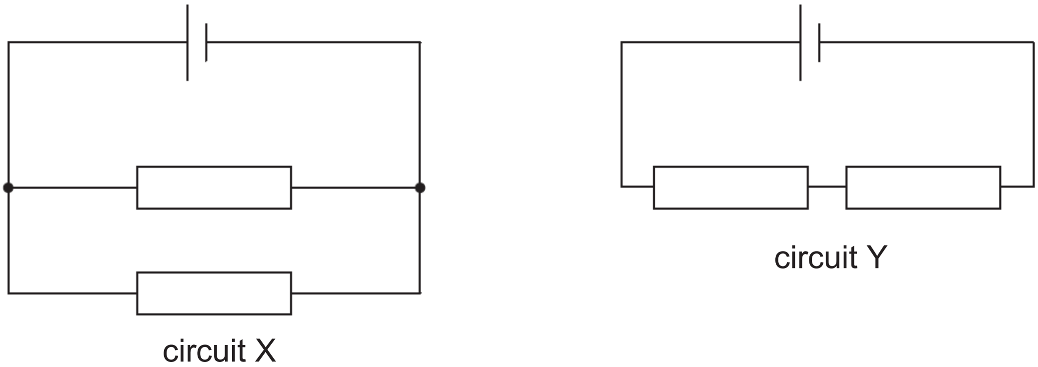
33 Two resistors X and Y are connected in series with a 12 V supply. The output voltage across Y is 4.0 V.



What is the output voltage when the resistance of Y is halved?

A 2.0 V
B 2.4 V
C 3.0 V
D 6.0 V

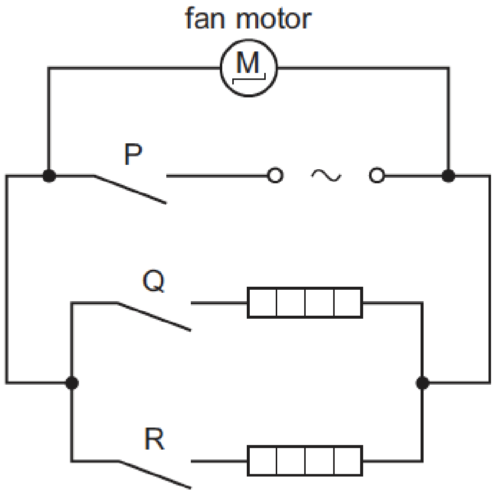
34 In the circuits below the cells have the same emf and the resistors are identical.



What is the ratio of the power dissipated in circuit X to the power dissipated in circuit Y?

A 1 : 2 **B** 2 : 1
C 1 : 4 **D** 4 : 1

35 The diagram shows the circuit for a hairdryer.



The fan motor has a power rating of 200 W and the heaters each has a rating of 500 W. The cost of electricity is 27 cents per kWh.

What is the cost of using the hairdryer for 30 minutes with switches P and Q closed and switch R opened?

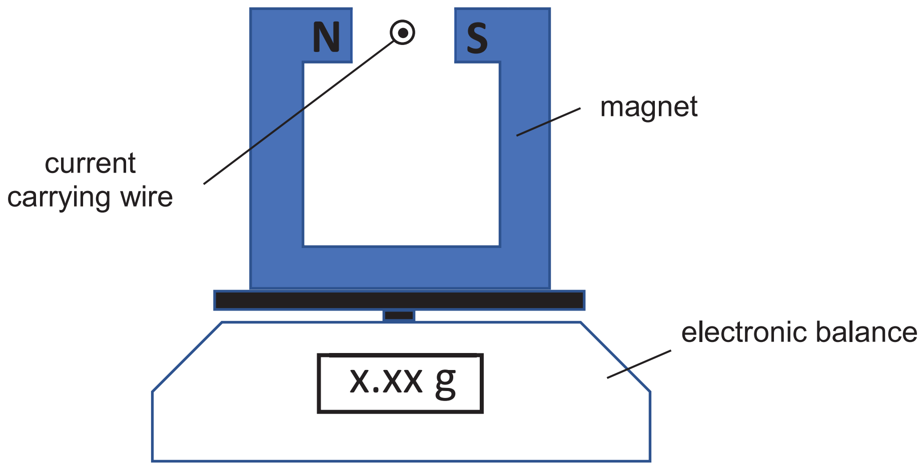
A 2.7 cents **B** 6.75 cents
C 9.45 cents **D** 13.5 cents

36 The cable to an electric fan becomes so worn that the live wire makes electrical contact with the metal case which is earthed. The plug to the fan contains a 5 A fuse. There is a current of 4 A when the fan works normally.

Which of the following would happen?

A The current causes the metal case to overheat.
B The current will flow to earth and the fan continues working normally.
C The fuse will melt and open the circuit.
D The metal case will become live and the fan continues working normally.

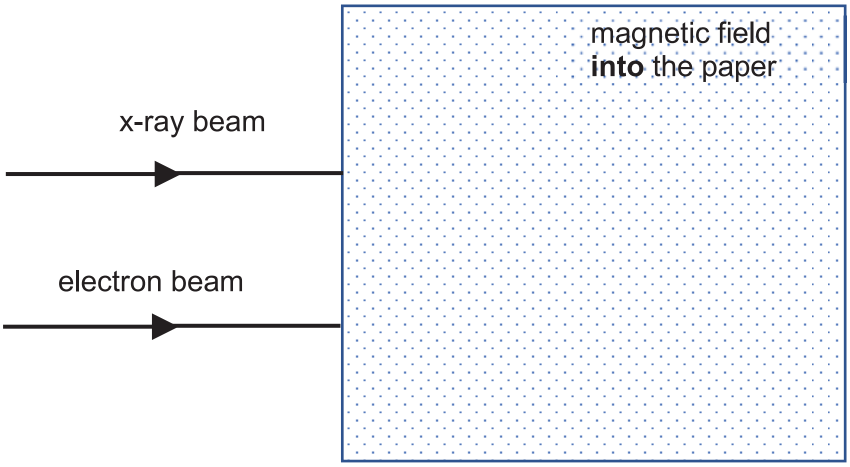
37 The diagram shows a magnet resting on an electronic balance. A wire is kept in the position as shown in the diagram.



If current flows through the wire (out of the paper) as shown in the diagram, how will it affect the reading of the electronic balance?

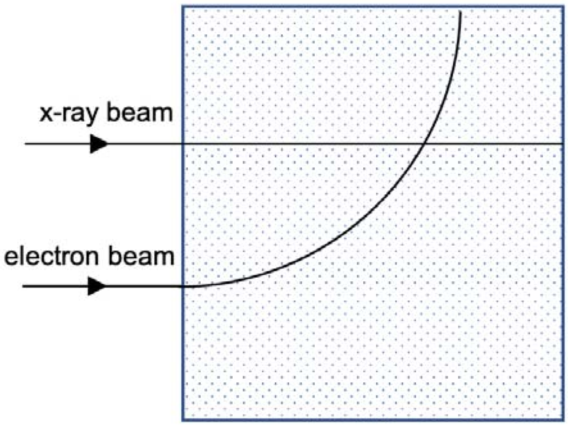
A decreases
B increases
C increase and then decreases
D no effect

38 The diagram shows an x-ray beam and an electron beam entering a magnetic field that is directed into the plane of the paper.

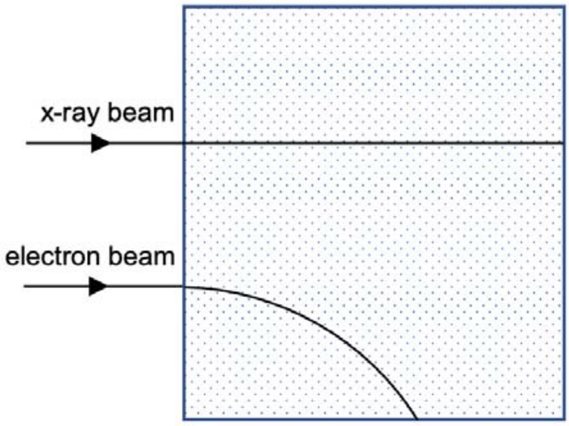


Which of the following shows the paths of the x-ray beam and the electron beam in the magnetic field?

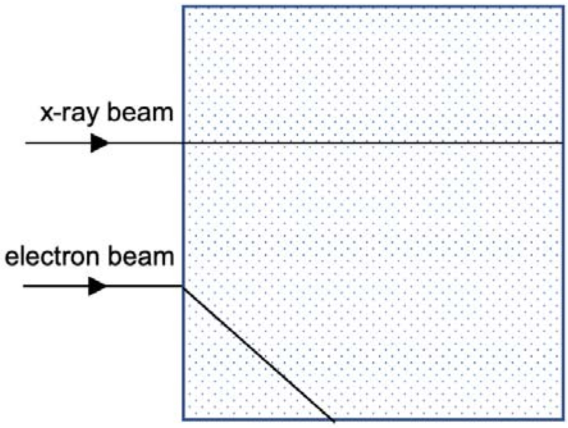
A



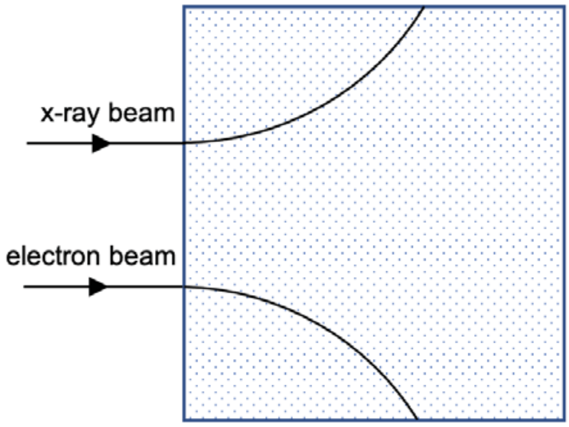
B



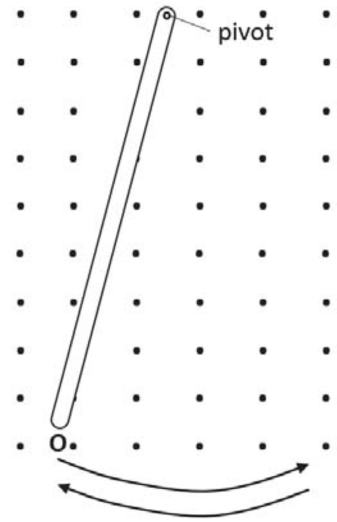
C



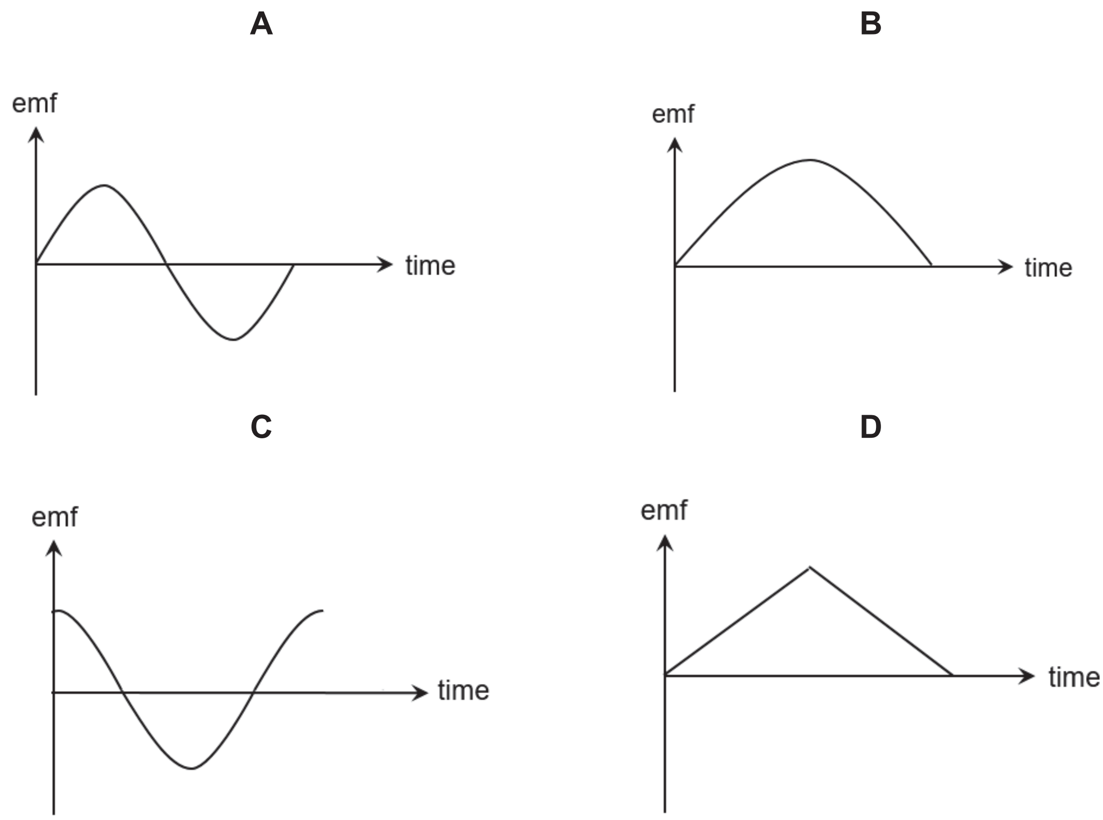
D



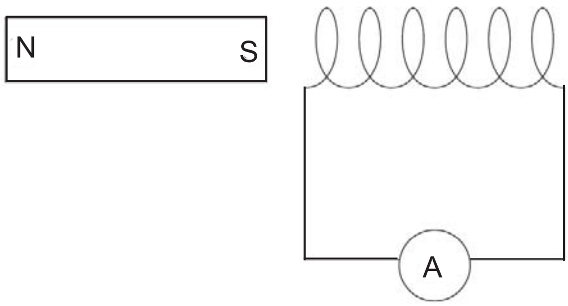
39 The diagram shows a metal bar swinging like a pendulum to-and-fro across a uniform magnetic field. The motion induces an emf in the bar.



Which graph could represent this emf during one complete to-and-fro oscillation of the bar, starting at position O?



40 A strong bar magnet is close to a coil that is connected to an ammeter.



The magnet and the coil are moved in the following ways.

1 Both the magnet and the coil move to the right with the same speed.
2 The magnet is stationary and the coil moves to the left.
3 The coil is stationary and the magnet moves to the left.

In which of the following will the ammeter indicate a current?

A	1 only	**B**	2 only
C	1 and 2 only	**D**	2 and 3 only

~ END OF PAPER ~

ST JOSEPH'S INSTITUTION
PRELIMINARY EXAMINATION 2022
(YEAR 4)

CANDIDATE NAME

CLASS

INDEX NUMBER

PHYSICS **6091/02**

Paper 2 **12 September 2022**

1 hour 45 minutes
(08:00 – 09:45)

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on the cover page of this Question Paper and all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions on the Question paper.

Section B
Answer **all** questions. Question 12 has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
Candidates are advised to show formulae and all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

The number of marks is given in brackets [ ] at the end of each question or part question.

Section A							
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8

For Examiner's Use	
Section A	/ 50
Section B	/ 30
Total	/ 80

This document consists of **24** printed pages including this cover page

Section A (50 marks)

Answer all questions in this section.

1 Fig. 1.1 shows how the speed of a rocket SpaceX varies with time as it enters the gravitational field of a new Planet Y with negligible atmosphere. SpaceX has a total mass of 1.8 x 10^6 kg. Once it enters the atmosphere of Planet Y, it undergoes free fall for 8.0 s before its engine fires a continuous thrust to bring it to a gentle upright landing on the surface of Planet Y.

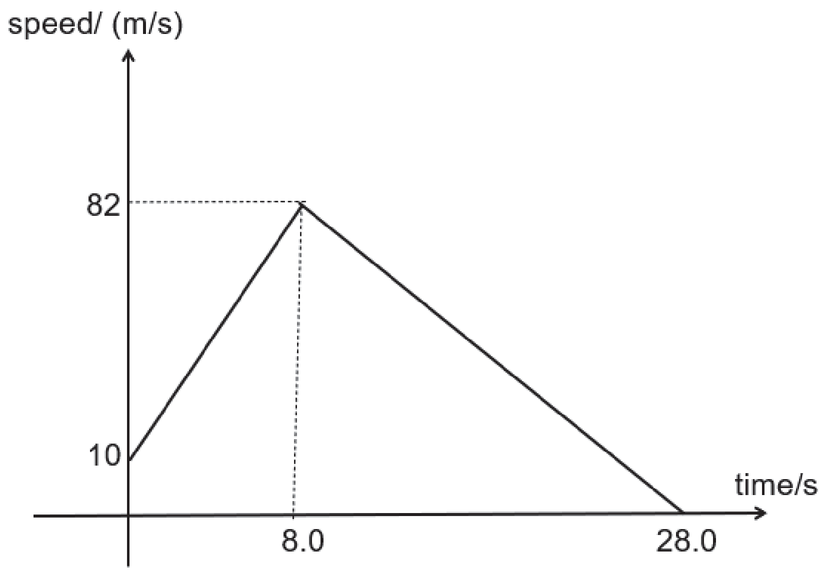


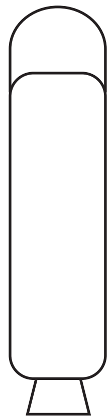
Fig 1.1

(a) Calculate the weight of Space X on Planet Y.

weight = ……………………..[2]

(b) At 8.0 s, significant amount of liquid Oxygen fuel undergoes combustion in the rocket engine to produce a constant thrust, T to decrease rocket's speed of descent.

(i) On Fig. 1.2, draw and label all the forces acting on SpaceX during its descent. You may ignore air resistance.



[1]

Fig. 1.2

(ii) Hence, calculate the magnitude of the thrust, T.

T = ………………….. [2]

(iii) With reference to the forces acting on SpaceX, explain why the deceleration from t = 8.0 s to t = 28.0 s increases in reality.

Assume that the thrust produced by the engine is uniform throughout the descent.

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………[1]

2 A man in a hot air balloon drops a ping pong ball out of the hot air balloon as the balloon accelerates upwards at 2.0 m/s^2. The speed of the balloon is 2.0 m/s at the moment the ping pong ball is released. Fig. 2.1 shows how the velocities of the hot air balloon and the ping pong ball vary with time.

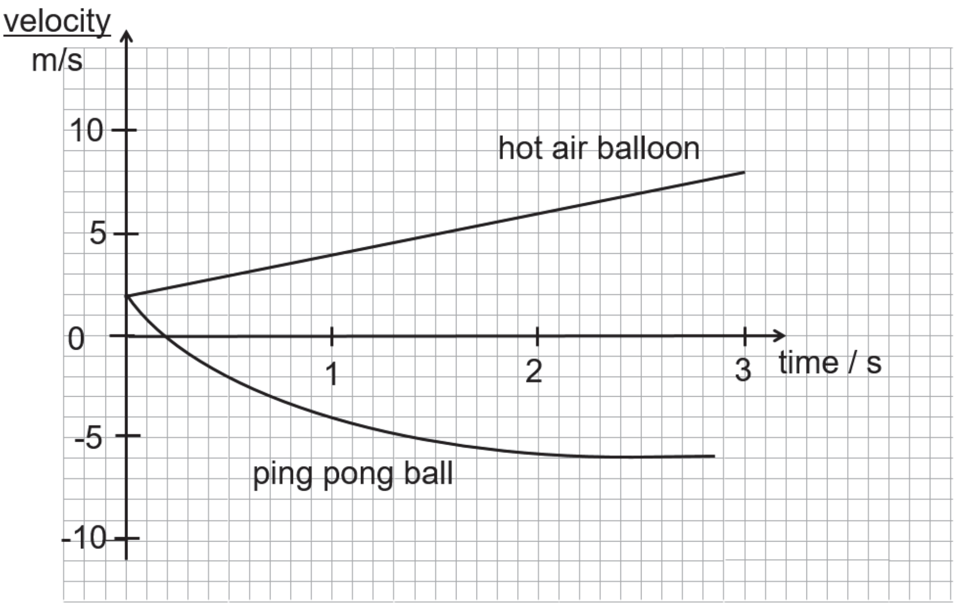


Fig. 2.1

(a) **(i)** Explain why the acceleration of the ping pong ball at its maximum height is 10 m/s^2.

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………………………………………………………………………[2]

(ii) Describe how the acceleration of the ping pong ball changes from the moment it is released until it reaches terminal velocity.

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………………………………………………………………………[2]

(b) Calculate the average velocity of the hot air balloon from t = 0 to t = 3.0 s.

average velocity = ………………………………….. [1]

3 Combustion engines in cars work by mixing air and fuel in suitable quantities before the mixture is drawn into a combustion chamber.

Fig. 3.1 shows the side view of a section of a combustion engine in a car. The section of the pipe connected to the fuel tank has a narrower diameter. The pressure of the air flowing into the horizontal section of the pipe decreases as the diameter of the pipe decreases at X.

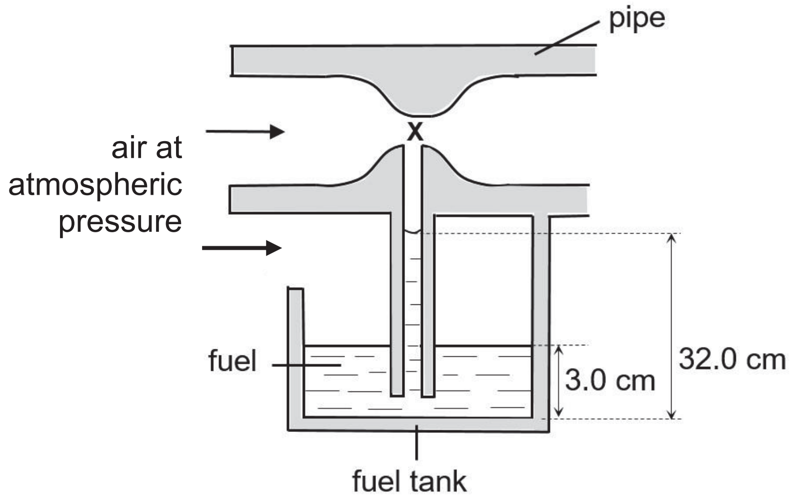


Fig. 3.1

Fig. 3.2 shows a mercury barometer used to measure the atmospheric pressure where the car is located.

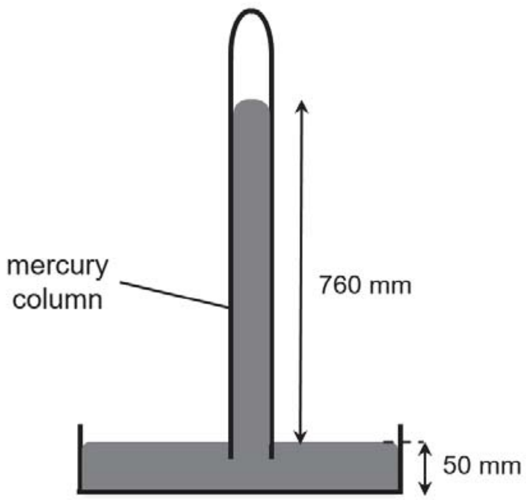


Fig. 3.2

The density of fuel is 850 kg/m^3 and the density of mercury is 13600 kg/m^3.
Take gravitational field strength g to be 10 N/kg.

https://commons.wikimedia.org/wiki/File:Venturi-tube.svg

(a) Explain how Fig. 3.1 shows that the air pressure in the pipe decreases with the diameter of the pipe.

..……………………………………………………………………………………..……

………………………………………………………………………….………...….[1]

(b) **(i)** Calculate the value of atmospheric pressure in Pa using Fig. 3.2.

atmospheric pressure = ………………………… [1]

(ii) Hence, determine the gas pressure at point X.

gas pressure = …………………….. [2]

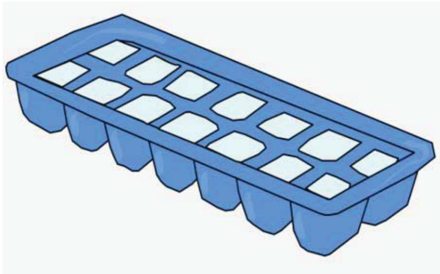
(c) Suggest how the combustion engine makes use of the pressure difference in the different sections of the pipe to mix fuel and air.

………………………………………………………………………………………

..……………………………………………………………………………………

..…………………………………………………………………………….... [1]

4 A student fills up an ice-cube tray with 200 g of water at 31 ^oC and placed it in the freezer unit of a refrigerator. It takes 20 minutes for the temperature of water in the tray to drop to its freezing point.



Specific heat capacity of water is 4200 J/kg^{o}C and the specific latent heat of fusion of water is 330 kJ/kg. The heat capacity of the ice-cube tray is 120 J/^{o}C.

(a) Calculate the average rate of thermal energy lost by the water and the ice-cube tray as the water cools down from 31 ^oC to its freezing point. Give your answer in Watt.

rate of thermal energy lost = ………………….. [2]

(b) Assuming that the rate of thermal energy lost by the water in the freezer unit is constant, calculate how much additional time is needed for the water in the ice-cube tray to be completely frozen.

time taken = ………………………………. [2]

(c) In reality, the time taken for the water in the ice-cube tray to be completely frozen from its initial temperature of 31^{o}C is longer. Explain why is this so.

………………………………………………………..……………………………

……………………………………………………………………..………………[1]

5 One method of making sandpaper is by passing a roll of paper through nylon friction pads. An aerosol sprays positively charged fine droplets of glue onto the paper, spreading it evenly on the surface of the paper. The resulting sticky paper is then pressed over a flat table covered with sand grains.

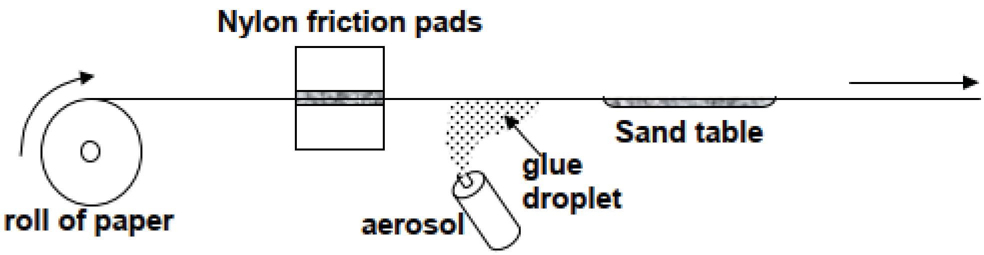


Fig. 5.1

(a) **(i)** Explain how the paper becomes negatively charged after it passes through the nylon friction pads.

....

....

....[1]

(ii) Explain how this method allows the glue droplets to spread out and stick to the paper easily.

....

....

....[2]

(b) Draw in Fig. 5.2 the electric field pattern between two identical glue droplets. [1]

Fig. 5.2

6 A girl lost one of her earrings when she swam in a swimming pool at midnight. She brought a torchlight and shone it into the pool to search for her lost earring. The ray from her torchlight forms a 36° angle with the water surface when the girl finally spotted the earring at the bottom of the pool.

Fig. 6.1

(a) Given that the refractive index of water is 1.3, calculate the angle of refraction of the ray in water.

(i) Calculate the angle of refraction of the ray in water.

angle of refraction = ………………………………. [1]

(ii) Sketch on Fig. 6.1, the path of the ray of light by which the girl is able to see her earring at the bottom of the pool.

Indicate clearly:

- the angle of incident, i
- the angle of refraction, r
- the apparent position of the earring with an 'X' [2]

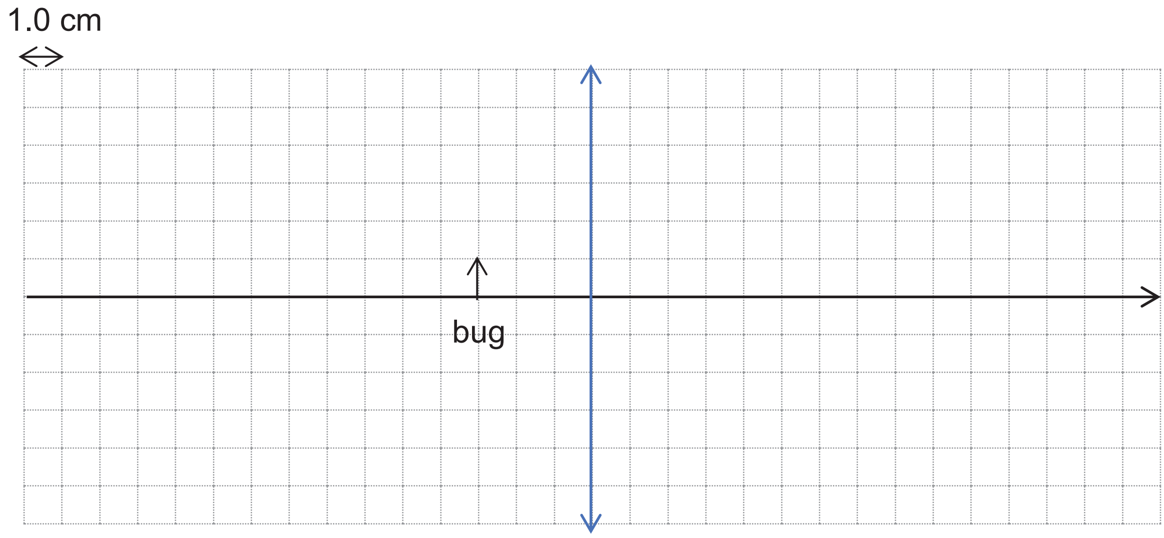
(iii) Explain why no matter where the girl shone her torchlight on the surface of the water, the ray will never undergo total internal reflection.

……………………………………………………………………………………

……………………………………………………………………………………..[1]

(b) As she walked away, the light from her torchlight shone on a bug resting on a wall. The bug was about 1.0 cm long. She placed a magnifying glass 3.0 cm away from the bug to observe it more closely. The magnifying glass gives a magnification of 4.0.

Draw a scaled diagram to determine the focal length of the lens in the space provided below.



[2]

focal length = ………………………….. [1]

7 A heater rated 300 W, 50 V is connected to a 50 V supply by two 100 m long connecting cables made of copper as shown in Fig. 7.1.

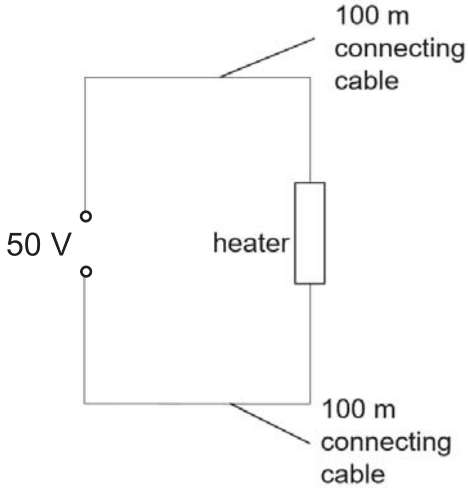


Fig. 7.1

(a) Calculate the resistance of the heater.

resistance = ………………………………. [1]

(b) Given that the resistivity of copper is 1.72×10^{-8} Ω m and the diameter of the wire is 0.734 mm, calculate the total resistance of the connecting cables.

resistance = ………………………………. [2]

(c) Calculate the actual power supplied by the heater in Fig. 7.1 given that its resistance is constant.

power = ………………………………. [2]

(d) The heater in Fig. 7.1 is replaced by a second heater, rated 1000 W, 240 V and connected to the household mains of 240 V.

Show, by means of calculations, why this heater is more efficient compared to the previous heater.

……………………………………………………………………………………….. [2]

(e) The heater is connected to the household mains and an earth wire and a fuse are included for safety reasons.

Describe how the fuse and earth wire protects the user and heater if the metal case of the heater becomes live due to some fault.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………………………………………………………………………….. [2]

8 Fig. 8.1 shows the side view of a rectangular coil of wire rotating anticlockwise at constant speed with its axle at right angles to a uniform magnetic field at a particular instant in time.

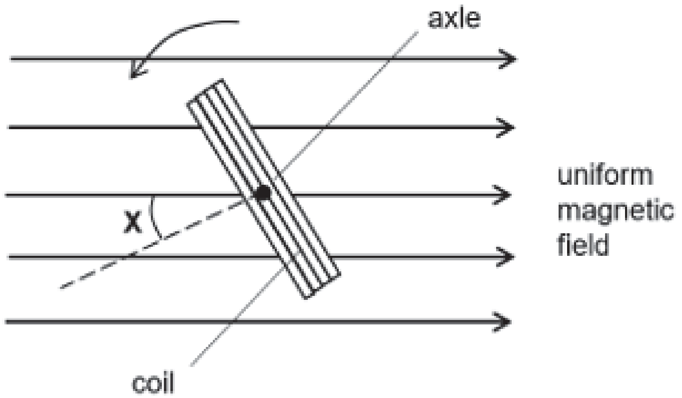


Fig. 8.1

(a) Explain why an electromotive force is induced across the coil of wire.

……………………………………………………………………………………………...

……………………………………………………………………………………………...

…………………………………………………………………………………………….. [1]

(b) State the smallest angle X such that the magnitude of the induced emf has a maximum value.

…………………………………………………………………………………………….. [1]

(c) The output terminals of the coil of wire is connected to a C.R.O via a pair of slip rings as shown in Fig.8.2.

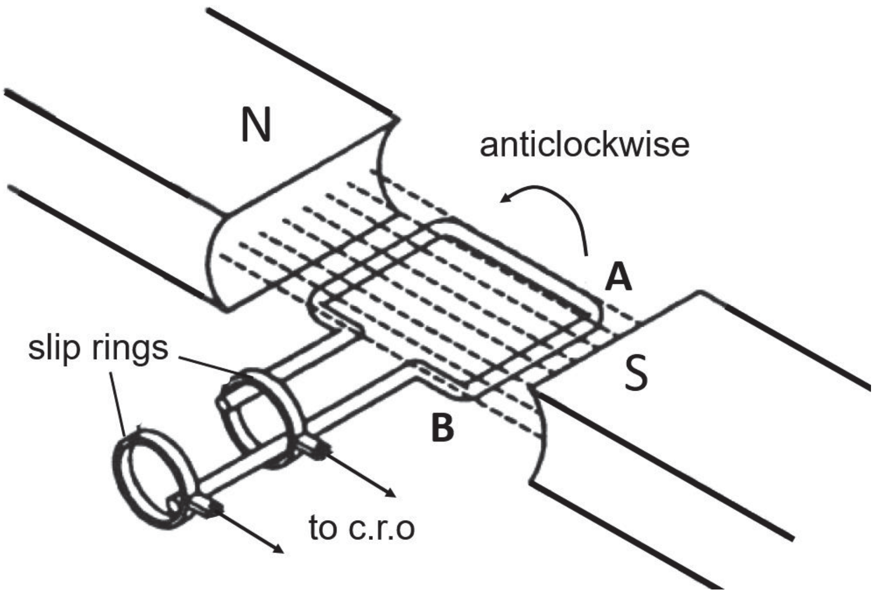


Fig. 8.2

(i) Explain the function of the slip rings.

……………………………………………………………………………………………

…………………………………………………………………………………………… [1]

(ii) Draw an arrow on side AB of the coil in Fig. 8.2 to indicate the direction of the induced current in AB. [1]

(iii) Explain how the induced current opposes the change that caused it.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [1]

(iv) The position of the coil in Fig. 8.2 is adjusted and set into rotation such that the trace in Fig. 8.3 is observed on the c.r.o. screen.

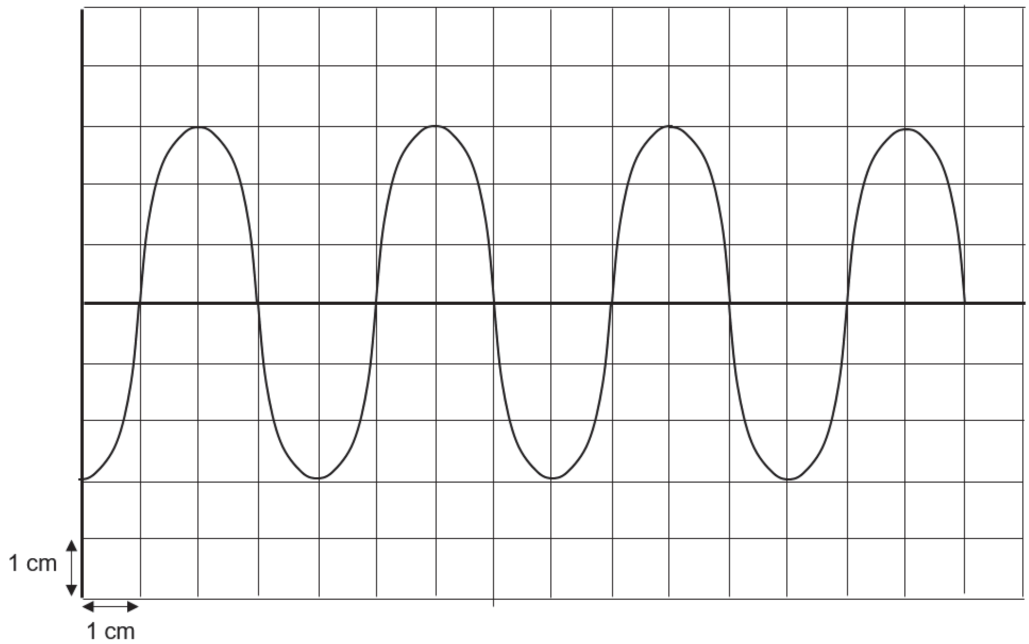


Fig. 8.3

(1) Determine the frequency of the induced emf given that the time-base setting is 10 ms/cm.

frequency = ………………………………… [2]

(2) Draw on Fig. 8.3, a possible trace obtained if the coil is turned through 90º before it is set into rotation and at half the speed. [2]

END OF SECTION A

CANDIDATE NAME	

CLASS						INDEX NUMBER		

Section B			
Q9	Q10	Q11E	Q11O

Section B (30 marks)
Answer all questions in this section.
Answer only one of two alternative questions in **Question 11**.

9 A lorry crane as shown in Fig. 9.1 is used in a construction site to lift concrete beams. The boom is pivoted onto the lorry such that the distance from the pivot point of the boom to the lorry's back wheel is 2.0 m.

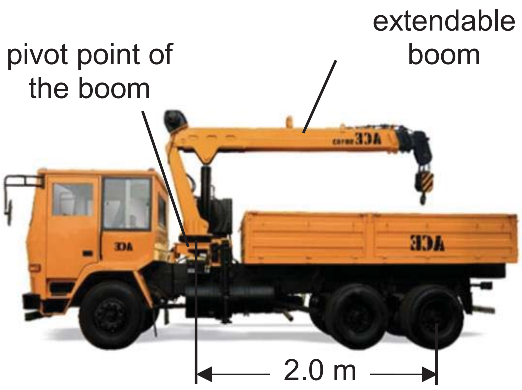


Fig. 9.1

http://www.acecrane.in/sb-163-lorry-loader-crane-4561877.html

Table 9.1 summarises the maximum load that the lorry crane can carry and the corresponding distances from the load to the lorry's back wheel when the boom is horizontal.

Table 9.1

length of boom / m	*distance from the load to the lorry's back wheel / m*	*maximum load / kg*
4.0	2.0	3000
6.0	4.0	1500
8.0	6.0	1000
10.0	8.0	750
12.0	10.0	600

(a) Using the data from Table 9.1, state and explain the relationship between the distance from the load to the lorry's back wheel and the maximum load that the lorry crane can carry.

……………………………………………………………………………………………..

……………………………………………………………………………………………..[2]

(b) The weight of the uniform boom is 10 000 N.

(i) Calculate the minimum weight of the lorry. Assuming that the distance from the centre of gravity of the lorry to the lorry's back wheel is 2.5 m.

weight = ... [2]

(ii) The actual weight of the boom is much heavier than 10 000 N. Explain why when the length of the boom is 4.0 m, the maximum load that can be lifted is the same as the maximum load shown in Table 9.1.

……………………………………………………………………………..

……………………………………………………………………………..[1]

(c) Lorry cranes have additional support extended sideways as shown in Fig. 9.2.

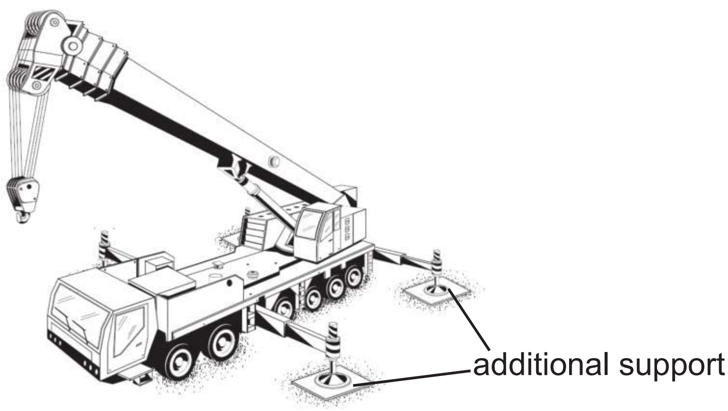


Fig. 9.2

https://www.cranes.org.nz/uploads/2/0/5/7/20572552/crane_stability_and_ground_pressure.pdf

Explain how the additional support increases the stability of the lorry crane.

……………………………………………………………………………………………..

……………………………………………………………………………………………..[1]

(d) The concrete beam is freely suspended as shown in Fig. 9.3.

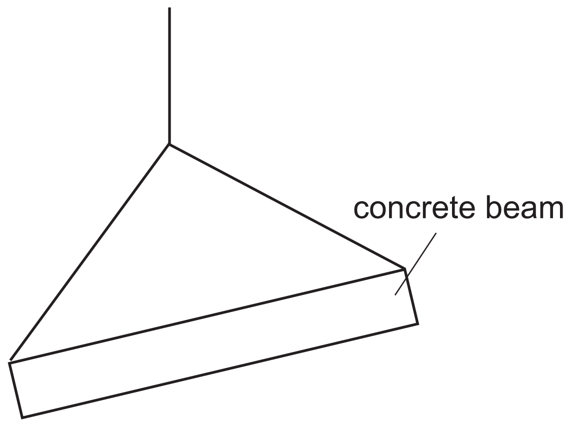


Fig. 9.3

(i) Mark the centre of gravity of the concrete beam with the letter 'x'. Explain your answer.

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………………………………………………………………………..[2]

(ii) The concrete beam is made of 10% steel and 90% concrete by volume. If the density of steel and concrete is 7800 kg/m^3 and 2400 kg/m^3 respectively, determine the average density of the beam.

average density = ... [2]

10 Fig. 10.1 shows a solenoid that is connected to a battery such that a north pole is induced at the right end of the solenoid.

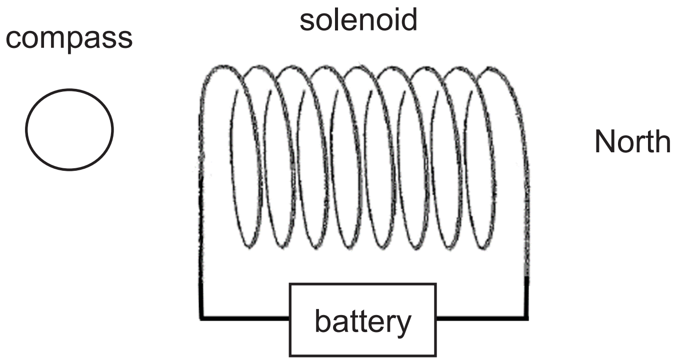


Fig. 10.1

(a) Draw an arrow at the left end of the solenoid to indicate the direction of the current flowing through the solenoid. [1]

(b) A compass is placed at the left side of the solenoid. Draw an arrow to show how will the compass needle point. [1]

(c) Fig. 10.2 shows a modified d.c. motor. The permanent magnet is replaced with the solenoid from Fig. 10.1.

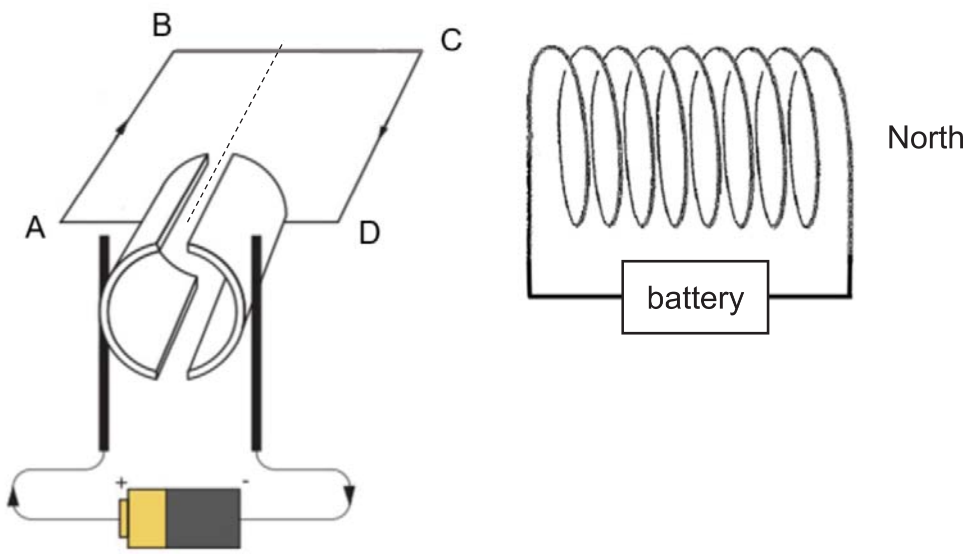


Fig. 10.2

(i) On Fig. 10.2, draw an arrow on wire AB to show the direction of the force induced on wire AB. [1]

(ii) Explain how a force is induced on wire AB.

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………..

…………………………………………………………………………………….[2]

(iii) The plane of coil is initially horizontal as shown in Fig. 10.2 and the coil rotates more than 90° from this starting position. It then continues to rotate in the same direction. State and explain which feature of the d.c. motor allows the coil to continue to rotate in the same direction.

……………………………………………………………………………………..

……………………………………………………………………………………..

…………………………………………………………………………………….[2]

(d) In a typical d.c. motor, soft iron core is added to the centre of the wire coil as shown in Fig. 10.3.

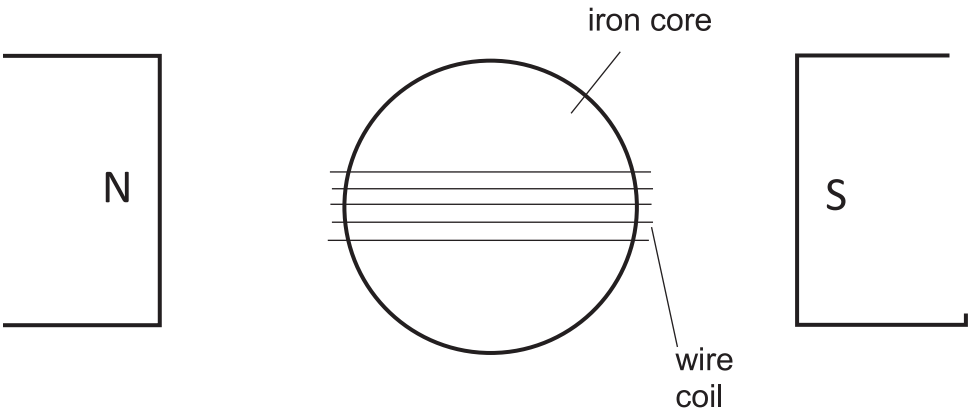


Fig. 10.3

(i) Explain how the soft iron core increases the turning effect of the d.c. motor.

……………………………………………………………………………………..

…………………………………………………………………………………….[1]

(ii) On Fig. 10.3, draw the magnetic field lines between the south pole of the magnet and the iron core when no current flows through the wire coil. [1]

(iii) Explain how the iron core is induced into a magnet.

………………………………………………………………………………………..

………………………………………………………………………………………..

……………………………………………………………………………………..[1]

11E Fig. 11.1 shows the track of a 500 kg roller coaster. An electric motor pulls the roller coaster along the track OABC. The efficiency of the electric motor is 80 % and it takes 2.0 min to pull the roller coaster from point A to point B at a constant speed.

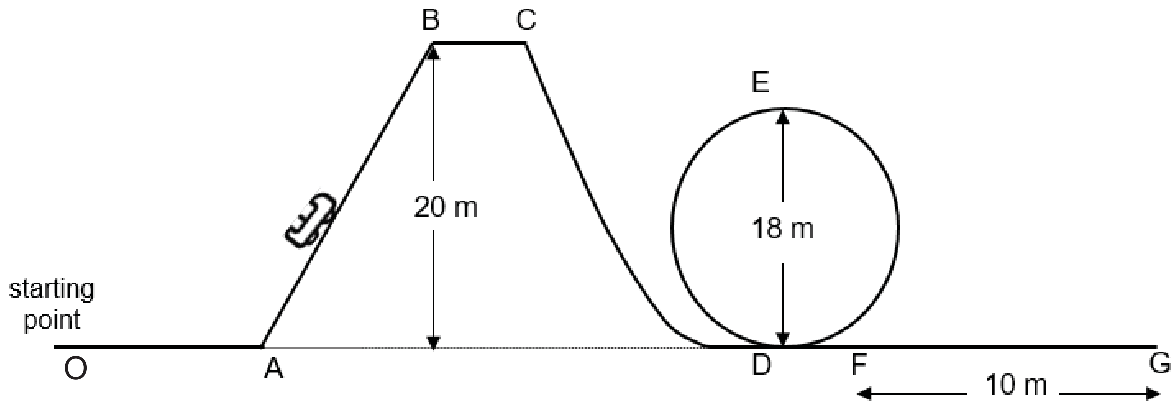


Fig. 11.1

(a) Describe how Principle of Conservation of Energy is applied as the roller coaster moves from point A to B.

………………………………………………………………………………………..

……………………………………………………………………………………..[2]

(b) Determine the power of the electric motor.

power = ... [2]

(c) The electric motor is replaced with one that gives a larger power to the roller coaster. Describe and explain the effect on the speed of the roller coaster if it still moves from A to B at a constant speed.

………………………………………………………………………………………………..

……………………………………………………………………………………….…..[1]

(d) At point C, the speed of the roller coaster is 0.20 m/s and it continues to move down the track due to gravity. Assume that along the track C to F, the frictional force is negligible.

(i) Calculate the speed of the roller coaster at point E.

speed = ... [2]

(ii) In reality the speed of the roller coaster is smaller than the speed calculated in **(b)(i)**. Explain why the actual speed is lower.

………..……………………………………………………………………….……..

………………….……………………………………………………………….…..[1]

(e) At point F, the speed of the roller coaster is 15 m/s. The average resistive force experienced by the roller coaster along FG is 4000 N. It is observed that the 10 m track FG is not long enough for the roller coaster to come to a stop at end of track FG.

To overcome this issue, the end of track FG has to be elevated. Calculate the height of elevation of FG so that the roller coast can come to a stop at the end of the track.

height = ... [2]

11O A student uses a water tank to study the behaviour of a water wave as it travels from region A to region B of different water depths. A powerful light source placed above the water tank produces regions of bright and dark bands of light at the base of the water tank, as shown in Fig. 11.2.

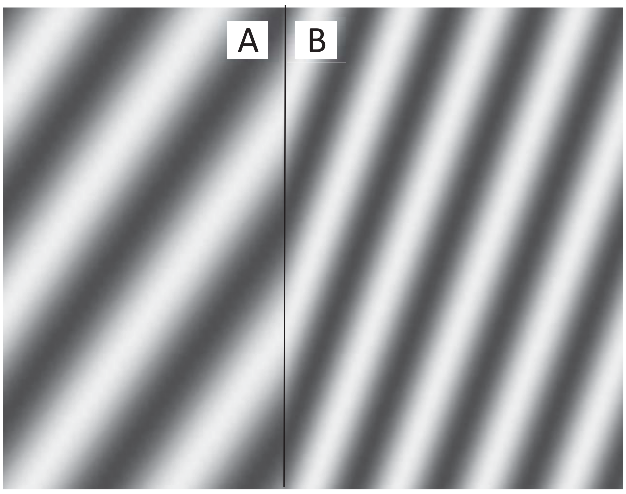


Fig. 11.2

https://web2.ph.utexas.edu/~vadim/Classes/2014f/refraction.html

(a) Explain why water waves are transverse waves.

…………………………………………………………………………………………..

……………………………………………………………………………………..…..[1]

(b) After passing through the water, light rays converge to form bright bands of light at the base of the water tank.

(i) On Fig. 11.2, mark a distance equal to the wavelength of the water wave in region A. Label the wavelength with 'λ'. [1]

(ii) State and explain which region is deeper.

…………………………………………………………………………………..

…………………………………………………………………………………..

…………………………………………………………………………………..[2]

(c) At time = 0, a ping pong ball is found to be at the centre of a dark band. If the speed of the water wave is 20 cm/s and the wavelength is 10 cm, draw on Fig. 11.3, how the displacement of the ping pong ball changes with time for 2 complete oscillations. Indicate the time when the displacement = 0 mm. The amplitude of the water wave is A. [2]

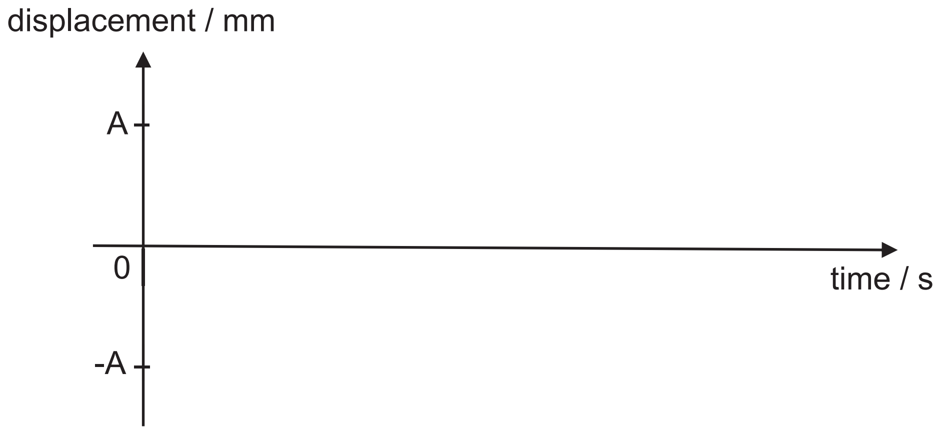


Fig. 11.3

(d) The water wave in Fig. 11.2 is produced by dropping a concrete beam into the water tank. When the beam hits the base of the tank, sound is produced. Fig. 11.4 shows the displacement-time graph of a water particle as sound is transmitted through the water.

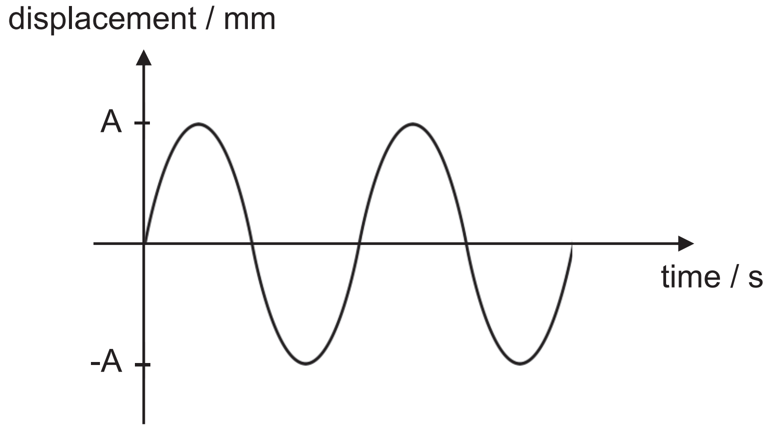


Fig. 11.4

(i) Explain how sound energy is transferred through the water without transferring matter.

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………..[2]

(ii) A metal nail is also dropped into the water tank. The loudness of the sound produced by the metal nail is half that of the sound produced by the beam. The frequency of the sound produced by the metal nail is twice that of the sound produced by the beam.

Draw on Fig. 11.4, how the displacement of a water particle will change with time as the sound produced by the metal nail is transmitted through the water. [2]

END OF PAPER

2022 Physics Prelim Exam Marker's Report

Paper 1

1	D	11	D	21	C	31	C
2	B	12	C	22	D	32	B
3	C	13	A	23	A	33	B
4	B	14	C	24	C	34	D
5	A	15	C	25	A	35	C
6	C	16	A	26	B	36	C
7	C	17	D	27	D	37	B
8	C	18	D	28	C	38	B
9	B	19	A	29	B	39	A
10	A	20	D	30	C	40	D

Paper 2

1 Fig. 1.1 shows how the speed of SpaceX, a rocket varies with time as it enters the gravitational field of a new Planet Y with negligible atmosphere. SpaceX has a total mass of 1.8×10^6 kg. Once it enters the atmosphere of Planet Y, it undergoes free fall for 8.0 s before its engine fires a continuous thrust to bring it to a gentle upright landing on the surface of Planet Y.

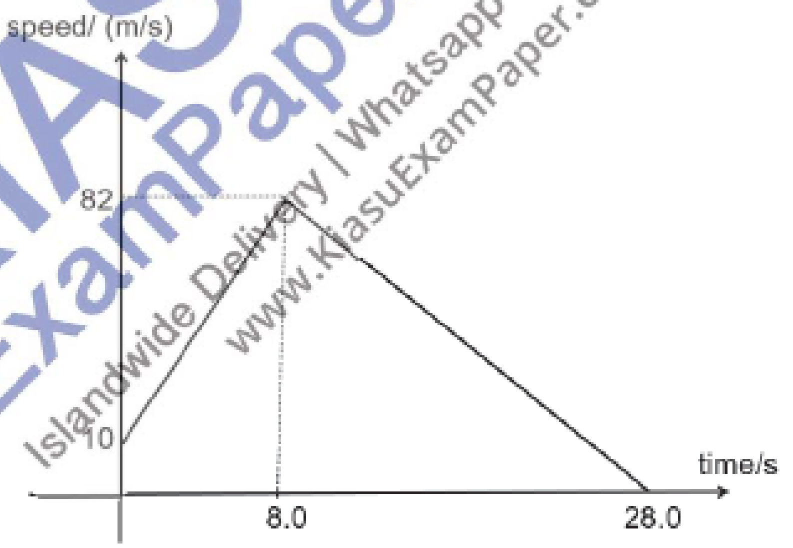


Fig 1.1

(a) Calculate the weight of Space X on Planet Y.

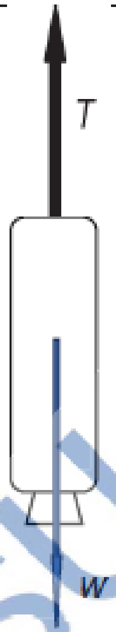
a=(v-u)/t
= (82-10)/8 = 9.0 m/s^2

W=mxg = 1.8×10^6 kg x 9.0 N/kg
=1.62×10^7 N

weight = ...[2]

(b) At 8.0 s, significant amount of liquid Oxygen fuel undergoes combustion in the rocket engine to produce a constant thrust, *T* to decrease space X's speed of descent.

(i) On Fig. 1.2, draw and label all the forces acting on SpaceX during its descent. You may ignore air resistance.



[1]

Fig. 1.2

(ii) Hence, calculate the magnitude of the thrust, *T*.

Taking upward as the positive direction

$F_{resultant} = T - W$

1.8×10^6 kg x 4.1 N/kg = T – (1.62×10^7N)

R =23.58×10^6 N

= 2.36 or 2.4×10^7 N

ecf allowed from (a) for W

T = ... [2]

(iii) In reality, from t = 8.0 s to t = 28.0 s, the deceleration of SpaceX is increasing. Assuming that the thrust produced by the engine is uniform, explain in terms of forces why this is so.

As the shuttle lands, its <u>mass/weight decreases</u> due to the burning of fuel, hence the upright <u>resultant force is increasing</u> (as thrust is constant) and deceleration is increasing

....[1]

2 A man standing in a hot air balloon dropped a ping pong ball as the balloon accelerated upwards at 2.0 m/s^2. The speed of the balloon is 2.0 m/s at the moment the ping pong ball is released. Assuming that the ping pong ball has the same velocity as the balloon when it is released. Fig. 2.1 shows how the velocities of the hot air balloon and the ping pong ball vary with time.

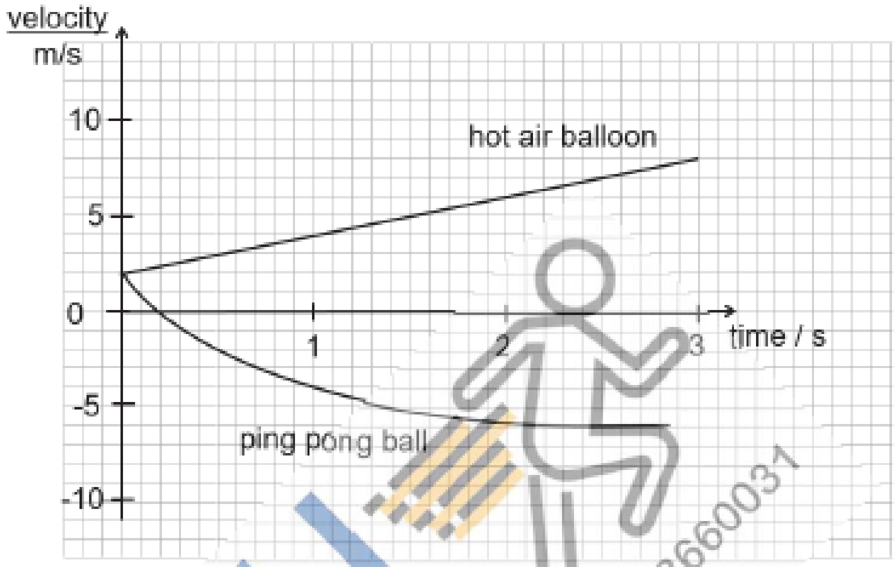


Fig. 2.1

(a) (i) Explain why the acceleration of the ping pong ball at its maximum height is 10 m/s^2.

- The ping pong ball is momentarily at rest, hence there is no air resistance acting on it.
- The only force acting on the ball is weight as such it experiences acceleration due to gravity only which is 10 m/s^2.

....[2]

(ii) Describe how the acceleration of the ping pong ball changes from the moment it is released until it reaches its terminal velocity.

- The gradient of the graph decreases to 0 at 2.2 s. Showing that acceleration is decreasing throughout the motion.
- The acceleration is zero (a= 0 m/s^2) at t=2.2 s.

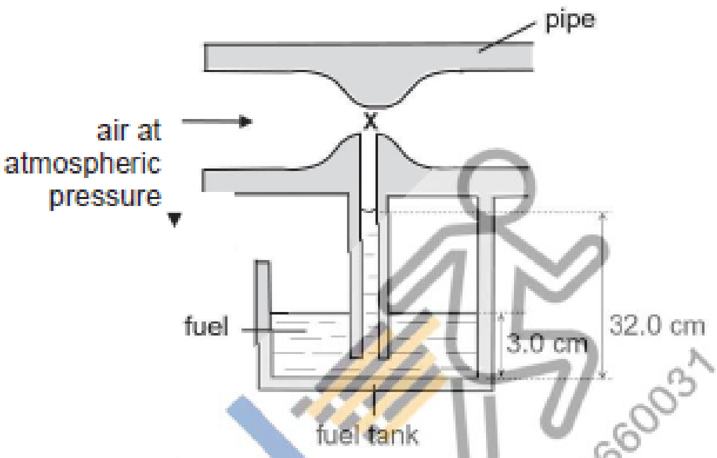
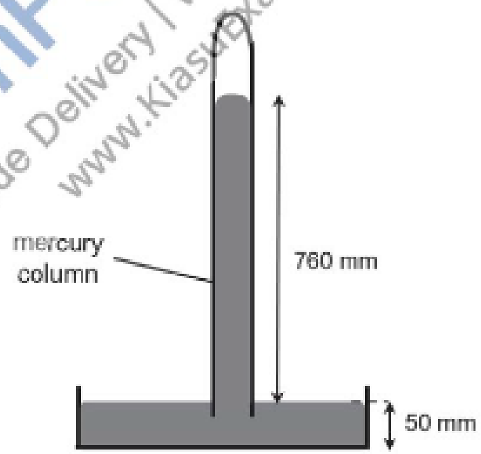
....[2]

(b) Calculate the average velocity of the hot air balloon from t = 0 to t = 3.0 s.

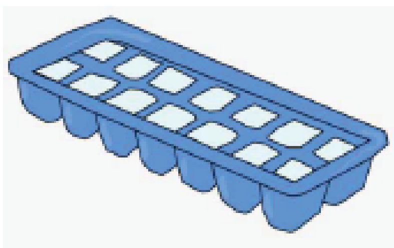
Average velocity =(½ (2 + 8) x 3) /3= 5.0 m/s

[1]

3

3	Combustion engines in cars work by mixing air and fuel in suitable quantities before the mixture is drawn into a combustion chamber. Fig. 3.1 shows the side view of a section of a combustion engine in a car. The section of the pipe connected to the fuel tank has a narrower diameter. The pressure of the air flowing into the horizontal section of the pipe decreases as the diameter of the pipe decreases at X.  **Fig. 3.1** Fig. 3.2 shows a mercury barometer used to measure the atmospheric pressure where the car is located.  **Fig. 3.2** The density of fuel is 850 kg/m^3 and the density of mercury is 13600 kg/m^3. Take gravitational field strength g to be 10 N/kg.

	(a)	Explain how Fig. 3.1 shows that the air pressure in the pipe decreases with the diameter of the pipe.	
		Height of fuel in vertical pipe is higher than fuel in the tank. this shows that the pressure at X is lower than atm P in tank	
	(b)	(i)	Calculate the value of atmospheric pressure in Pa using Fig. 3.2.
			$P_{atm} = \rho gh = 13600 \times 10 \times 0.76 = 103\ kPa$ atmospheric pressure = ... [1]
		(ii)	Hence, determine the gas pressure at point X.
			$P_{gas} = P_{atm} - P_{3.0cm}$ $= 103\ kPa - 0.29(10)(850) = 101\ kPa$ gas pressure = ... [2]
	(c)	Suggest how the combustion engine makes use of the pressure difference in the different sections of the pipe to mix fuel and air.	
		• The section with lower pressure is connected to the fuel tank. • The lower pressure in the pipe results in a net upward force to act on the fuel causing it to rise up and enter the horizontal section of the pipe.	
		.... [1]	

4	A student fills up an ice-cube tray with 200 g of water at 31°C and placed it in the freezer unit of a refrigerator. It takes 20 minutes for the temperature of water in the tray to drop to its freezing point.  Specific heat capacity of water is 4200 J/kg°C and the specific latent heat of fusion of water is 330 kJ/kg. The heat capacity of the ice-cube tray is 120 J/°C.	
	(a)	Calculate the average rate of thermal energy lost by the water and the ice-cube tray as it cools down from 31°C to its freezing point. Give your answer in Watt.

		$Pxt = mxcx\Delta\theta + Cx\Delta\theta$ P x (20 x 60)s = 0.2 kg x 4200 J/kg °C x 31 °C + 120 J/°C x 31 °C P= 29760 J/1200s = 24.8 W rate of thermal energy lost = ………………….. [2]
	(b)	Assuming that the rate of thermal energy lost by the water (and ice cube tray) in the freezer unit is constant, calculate how much additional time is needed for the water in the ice-cube tray to be completely frozen.
		ecf allowed from (a) 24.8 W x t = 0.2 kg x 330 000 J/kg t = 2661 s = 44 minutes Also accepted: P x (20 x 60)s = 0.2 kg x 4200 J/kg °C x 31 °C P=21.7W 21.7 W x t = 0.2 kg x 330 000 J/kg t = 3041 s = 50.7 minutes time taken = ……………………………… [2]
	(c)	In reality, the time taken for the water in the ice-cube tray to be completely frozen is longer than the calculated time in (b). Explain why is this so.
		The rate of thermal energy lost <u>decreases</u> as the <u>difference in the temperature of the water in the tray and its surrounding decreases</u>.
		…………………………………………………………………………………..……………[1]

5	One method of making sandpaper is by passing a roll of paper through nylon friction pads. An aerosol sprays positively charged fine droplets of glue onto the paper, spreading it evenly on the surface of the paper. The resulting sticky paper is then pressed over a flat table covered with sand grains.		
(a)	(i)	Explain how the paper becomes negatively charged after it passes through the nylon friction pads.	
		Due to friction electrons are transferred from the pads to the paper, charging it negatively.	
		....[1]	
	(ii)	Explain how this method allows the glue droplets to spread out and stick to the paper easily.	
		The glue droplets are charged oppositely to the paper (positively) and unlike charges attract hence the droplets are attracted paper easily	
		The droplets also repel each other, as like charges repel hence it spread out and stick to the paper evenly.	
		....[2]	

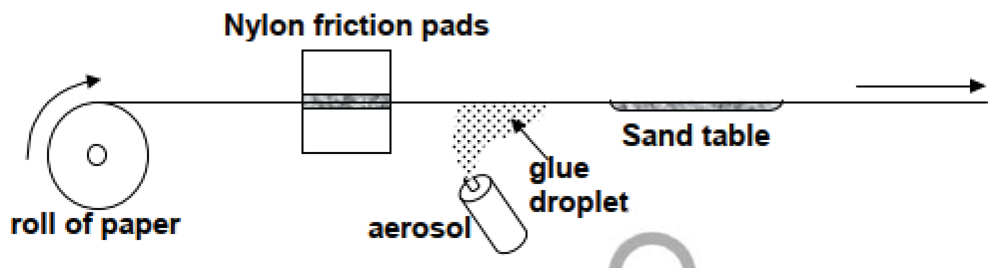
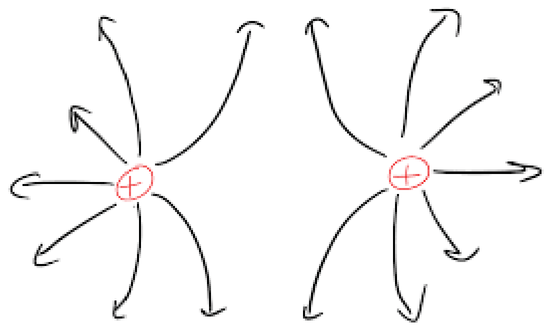


Fig. 5.1

(b) Draw in Fig. 5.2 the electric field pattern between two identical glue droplets.



[1]

Same number of field lines and spacings, direction outwards.
Shape of field.

Fig. 5.2

6 A girl lost one of her earrings when she swam in a swimming pool at midnight. She brought a torchlight and shine it into the pool to search for her lost earring. Fig 6.1 shows how the narrow beam of light from her torchlight was incident at a point 1.5 m away from the edge of the pool. The angle between the light beam and the water surface was 36°.

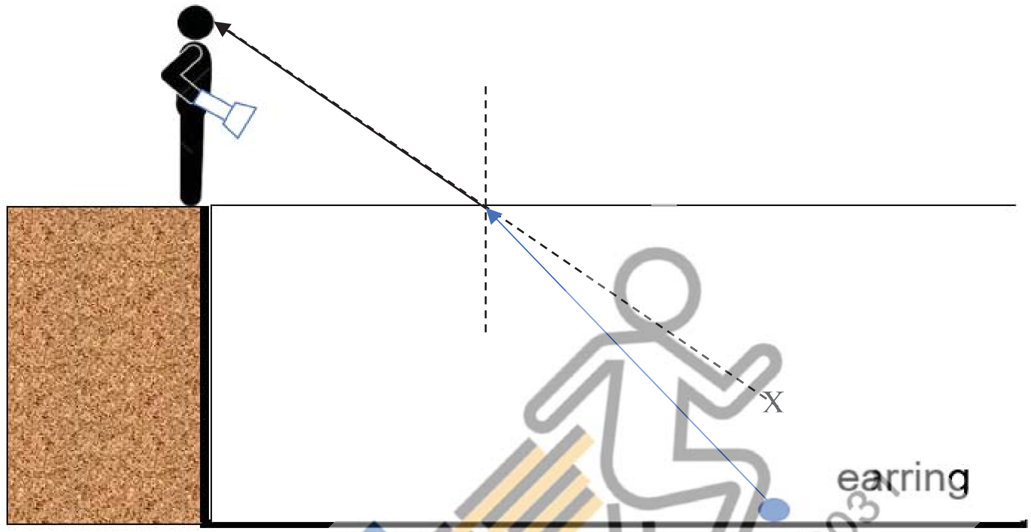


Fig. 6.1 (not to scale)

Show a bending of light towards the normal in the water.
The apparent image must be vertically above the earring.

(a) Given that the refractive index of water is 1.3, calculate the angle of refraction of the light beam in water.

(i) Calculate the angle of refraction of the light beam in water.

$n_1 \sin \theta_1 = n_2 \sin \theta_2$

$1 \sin 54 = 1.3 \sin \theta_2$

$\theta_2 = 38.5°$

angle of refraction = ………………………………… [1]

(ii) Sketch on Fig. 6.1, the path of the ray of light by which the girl is able to see her earring at the bottom of the pool.

Indicate clearly:

- the angle of incident, i
- the angle of refraction, r

the apparent position of the earring with an 'X'
[2]

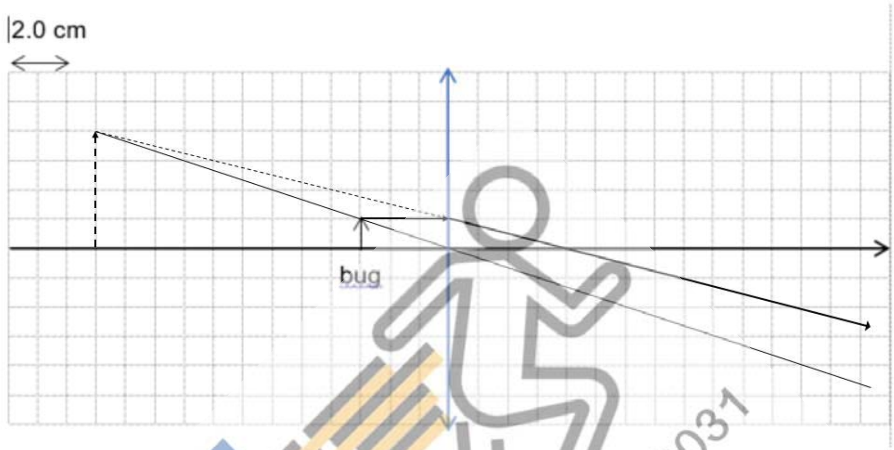
(iii) Explain why no matter where the girl shone her torchlight on the surface of the water, it will never undergo total internal reflection.

The light is moving from an optically <u>less dense medium</u> to a denser medium.

……………………………………………………………………………………….[1]

(b) As she walked away, the light from her torchlight shone on a bug resting on a wall. The bug was about 1.0 cm long. She placed a magnifying glass 3.0 cm away from the bug to observe it more closely. The magnifying glass gives a magnification of 4.0.

Draw a scaled diagram to determine the focal length of the lens in the space provided below.



[2]

focal length = …………4.0 cm……………….. [1]
acceptable range (3.5 - 4.5 cm)

7 A heater rated 300 W, 50 V is connected to a 50 V supply by two 100 m long connecting cables made of copper as shown in Fig. 7.1.

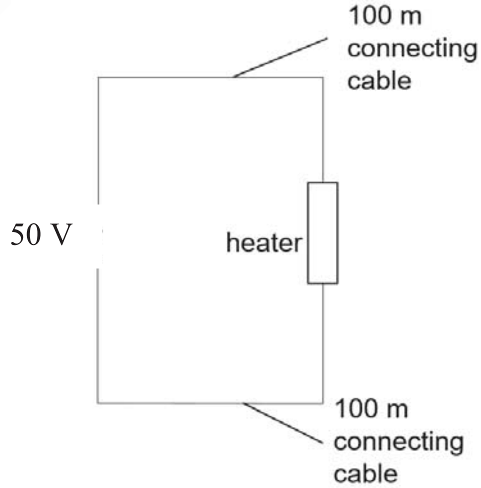
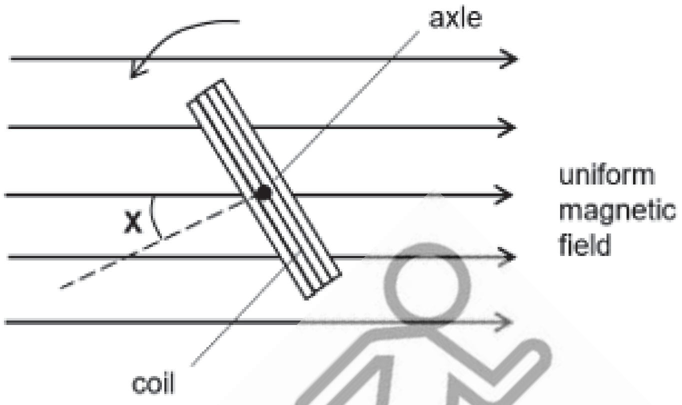
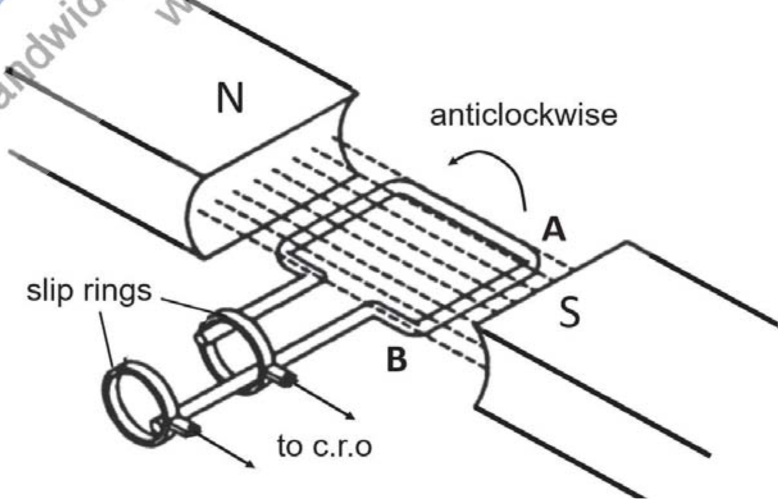
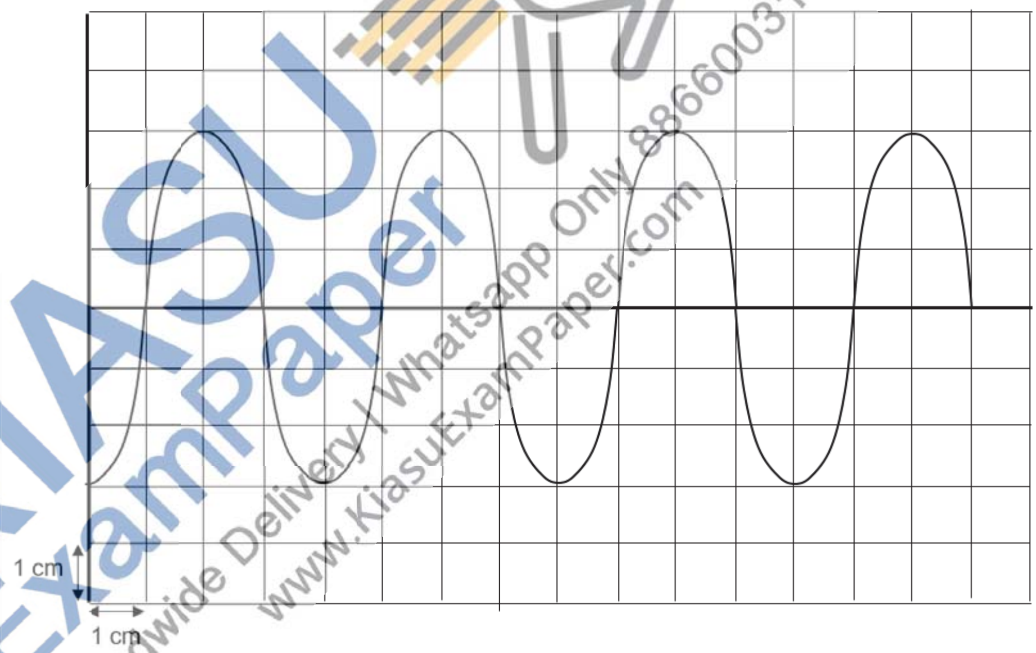


Fig. 7.1

	(a)	Calculate the resistance of the heater.
		$P = V^2/R$ $300 = 50^2/R$ $R = 8.3\ \Omega$ resistance = ... [1]
	(b)	Given that the resistivity of copper is $1.72 \times 10^{-8}\ \Omega$m and the diameter of the wire is 0.734 mm, calculate the total resistance of the connecting cables.
		$R = \frac{\rho L}{\pi r^2} = (1.72 \times 10^{-8} \times 200)/(\pi \times 0.000367^2)$ $= 8.1\ \Omega$ [-1 mark if area not calculated correctly] resistance = ... [2]
	(c)	Calculate the actual power supplied by the heater in Fig. 7.1.
		$I = 50/(8.1 + 8.3) = 3.0$ A $P = 3.0^2 \times 8.3 = 75$ W power = ... [2]
	(d)	The heater in Fig. 7.1 is replaced by a second heater, rated 1000 W, 240 V and connected to the household mains of 240 V. Explain why this heater is more efficient compared to the previous heater.
		• Larger total resistance so current is lower • ratio of power (IV) supplied by heater to rated power of heater is higher so power loss is reduced. Accept answer if shown mathematically $R = 58\ \Omega$ $I = 240/(58 + 8.1) = 3.6$ A $I^2R = 3.6^2(58) = 751$ W Efficiency = 751/1000 = 75.1% compared to previously 75/300 = 25%
		.... [2]
	(e)	The heater is connected to the household mains and an earth wire and a fuse are included for safety reasons. Describe how the fuse and earth wire protects the user and heater if the metal case of the heater becomes live due to some fault.
		• Current flows from metal case through earth wire to ground, user will not get electrocuted if he touches casing. • If current exceeds fuse rating, fuse blows and opens the circuit, isolating the heater from the high voltage mains, protecting the appliance.
		.... [2]

8	Fig. 8.1 shows the side view of a rectangular coil of wire rotating anticlockwise at constant speed with its axle at right angles to a uniform magnetic field at a particular instant in time.  **Fig. 8.1**	
	(a)	Explain why an electromotive force is induced across the coil of wire.
		Magnetic flux linking/cutting the turns of the coil changes as the coil rotates, inducing an emf across the coil of wire.
		…………………………………………………………………………………………… [1]
	(b)	State the smallest angle X such that the magnitude of the induced emf has a maximum value.
		90° [1]
	(c)	The output terminals of the coil of wire is connected to a C.R.O via a pair of slip rings as shown in Fig.8.2.
		 **Fig. 8.2**

		(i)	Explain the function of the slip rings.
			The generator's AC output voltage can be transferred from the slip rings through the brushes to an external circuit.
		(ii)	Draw an arrow on side AB of the coil in Fig. 8.2 to indicate the direction of the induced current in AB. [1]
			Arrow from B to A
		(iii)	Explain how the induced current opposes the change that caused it.
			• The magnetic field produced by the induced current interacts with the external field to induce a force
			• that acts in a direction opposite to the direction of rotation of the coil causing the coil to slow down
			……………………………………………………………………………….… [1]
		(iv)	The position of the coil in Fig. 8.2 is adjusted and set into rotation such that the trace in Fig. 8.3 is observed on the c.r.o. screen.  **Fig. 8.3**
		(1)	Determine the frequency of the induced emf given that the time-base setting is 10 ms/cm.
			T = 40 ms f = 1/0.040 = 25 Hz
			f=…………………….. [2]
		(2)	Draw on Fig. 8.3, a possible trace obtained if the coil is turned through 90° before it is set into rotation and at half the speed. [2]
			Negative or positive sine curve [1] 1/2 amplitude and 2 times period [1]

SECTION B

9 A lorry crane as shown in Fig. 9.1 is used in a construction site to lift concrete beams. The boom is pivoted onto the lorry such that the distance from the pivot point of the boom to the lorry's back wheel is 2.0 m.

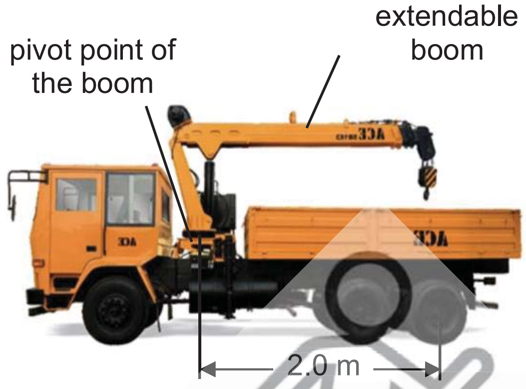


Fig. 9.1

http://www.acecrane.in/sb-163-lorry-loader-crane-4561877.html

Table 9.1 summarises the maximum load that the lorry crane can carry and the corresponding distances from the load to the lorry's back wheel when the boom is horizontal.

Table 9.1

length of boom / m	*distance from the load to the lorry's back wheel / m*	*maximum load / kg*
4.0	2.0	3000
6.0	4.0	1500
8.0	6.0	1000
10.0	8.0	750
12.0	10.0	600

(a) Using the data from Table 9.1, state and explain the relationship between the distance from the load to the lorry's back wheel and the maximum load that the lorry crane can carry.

……………………………………………………………………………………………..[2]

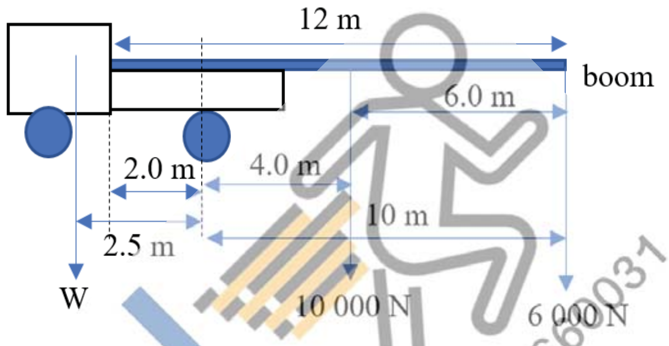
9	(a)		
		• The distance from the load to the lorry back wheel is inversely proportional to the load.	1
		• The product of the distance from the load to the lorry back wheel and the load is always 60000 Nm.	1

(b) The weight of the uniform boom is 10 000 N.

(i) Calculate the **minimum weight of the lorry**. Assuming that the distance from the centre of gravity of the lorry to the lorry's back wheel is 2.5 m.

weight = ... [2]

	(b)	**(i)**	(10 000 N)(4.0 m) + (6 000 N)(10 m) = W (2.5 m) W= 40 000 N **Distance from the centre of gravity of the lorry to the lorry's back wheel is 2.5 m**. **Distance from the pivot point of the boom to the lorry's back wheel is 2.0 m.** *The values in the diagram are taken from the last row of table 9.1 (all the values would give the same answer for W)	1 1



(ii) The actual weight of the boom is much heavier than 10 000 N. Explain why when the length of the boom is 4.0 m, the maximum load that can be lifted is the same as the maximum load shown in Table 9.1.

………………………………………………………………………………………..

……………………………………………………………………………………….[1]

		(ii)	The c.g. of the boom is right above the lorry's back wheel. When taking moments about the lorry back wheel, the moment due to the weight of the boom is 0 Nm as the perpendicular distance from the line of action of the weight to the pivot (back if the back lorry's wheel) is 0 m.	1

(c) Lorry cranes have additional support extended sideways as shown in Fig. 9.2.

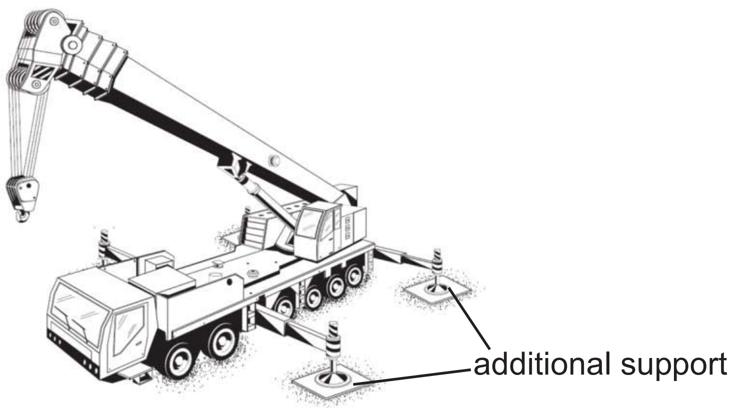


Fig. 9.2

https://www.cranes.org.nz/uploads/2/0/5/7/20572552/crane_stability_and_ground_pressure.pdf

Explain how the additional support increases the stability of the lorry crane.

………………………………………………………………………………………………..

……………………………………………………………………………………….[1]

	(c)	Increases the base area, as such the lorry crane can rotate more before the c.g. of the lorry crane is out of the base area.	1

(d) The concrete beam is freely suspended as shown in Fig. 9.3.

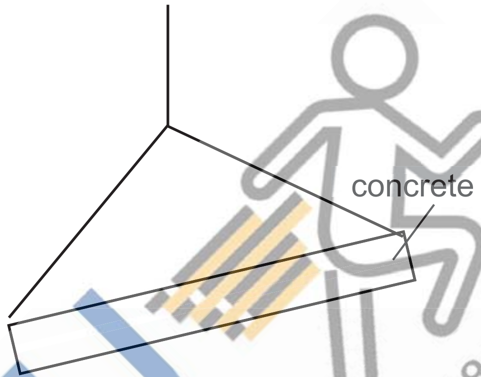


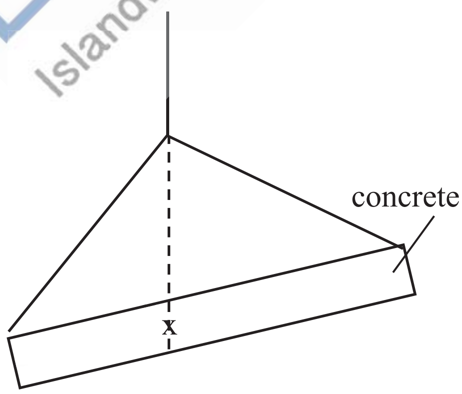
Fig. 9.3

(i) Mark the centre of gravity of the concrete beam with the letter ‘x’. Explain your answer.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………[2]

	(d)	i	 When taking moment about the intersected point of the string, the perpendicular distance of all the forces acting on the beam is 0 m. As such the resultant moment is 0 Nm.	1 1

(ii) The concrete beam is made of 10% steel and 90% concrete by volume. If the density of steel and concrete is 7800 kg/m^3 and 2400 kg/m^3 respectively, determine the average density of the beam.

$$\rho = \frac{7800\frac{kg}{m^3} \times 0.1V + 2400\frac{kg}{m^3} \times 0.9V}{V} = 2940\frac{kg}{m^3}$$

average density = ... [2]

10 Fig. 10.1 shows a solenoid that is connected to a battery such that a north pole is induced at the right end of the solenoid.

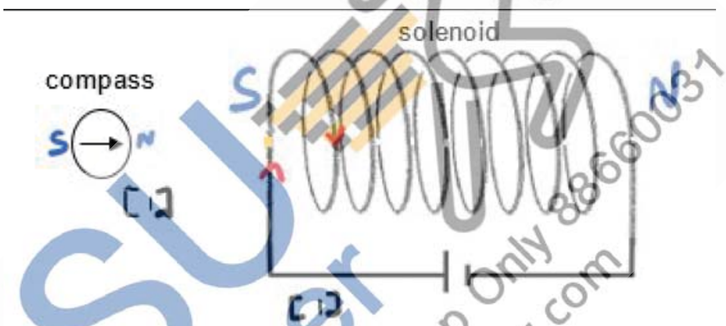


Fig. 10.1

(a) Draw an arrow at the left end of the solenoid to indicate the direction of the current flowing through the solenoid. [1]

(b) A compass is placed at the left side of the solenoid. Draw an arrow to show how will the compass needle point. [1]

(c) Fig. 10.2 shows a modified d.c. motor. The permanent magnet is replaced with the solenoid from Fig. 10.1.

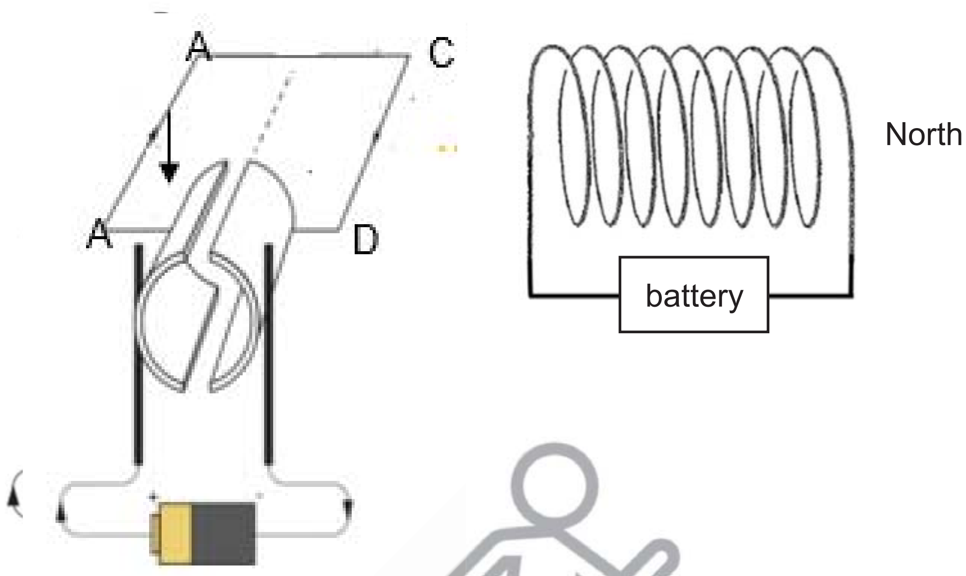


Fig. 10.2

(i) On Fig. 10.2, draw an arrow on wire AB to show the direction of the force induced on wire AB. [1]

(ii) Explain how a force is induced on wire AB.

....[2]

The magnetic field induced by the current interacts with the magnetic field induced by the electromagnet to form an unbalanced resultant magnetic field.
The resultant magnetic field above the wire is stronger than the resultant magnetic field below the wire.

(iii) The plane of coil is initially horizontal as shown in Fig. 10.2 and the coil rotates more than 90° from this starting position. It then continues to rotate in the same direction. State and explain which feature of the d.c. motor allows the coil to continue to rotate in the same direction.

....[2]

- Split-ring commutator.
- It changes the direction of the current in the coil every ½ cycle, changing the direction of the force but still creating moment in the same direction.

(d) In a typical d.c. motor, soft iron core is added to the centre of the wire coil as shown in Fig. 10.3.

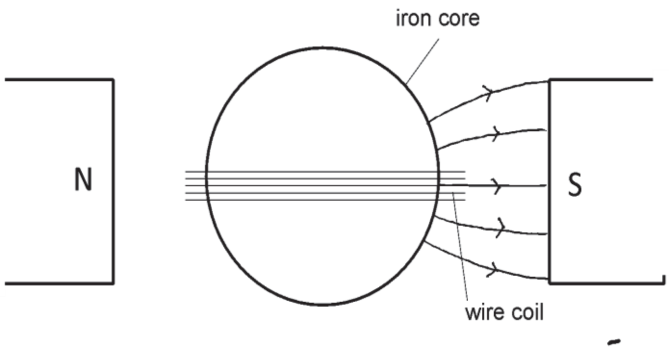


Fig. 10.3

(i) Explain how the soft iron core increases the turning effect of the d.c. motor.

……………………………………………………………………………………………

……………………………………………………………………………………………[1]

The iron core concentrates the magnetic field lines of the magnet, maximising the interaction between the magnetic fields due to the current and the permanent magnet, creating a larger induced force and hence moment.

(ii) On Fig. 10.3, draw the magnetic field lines between the south pole of the magnet and the iron core when no current flows through the wire coil. [1]

(iii) Explain how the iron core is induced into a magnet.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………[1]

The magnetic domains of the iron core will be aligned in the direction of the magnetic field lines of the magnet concentrating through the iron core.

11E Fig. 11.1 shows the track of a 500 kg roller coaster. An electric motor pulls the roller coaster along the track OABC. The efficiency of the electric motor is 80 % and it takes 2.0 min to pull the roller coaster from point A to point B at a constant speed.

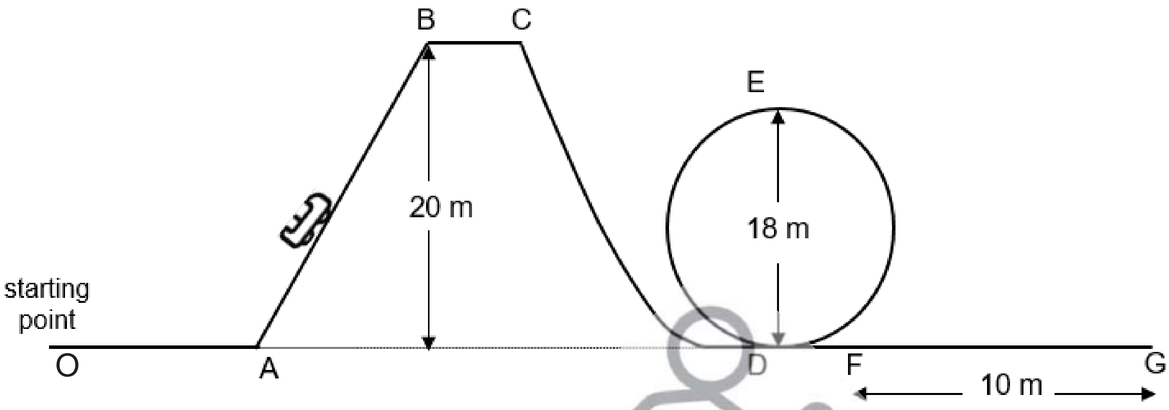


Fig. 11.1

(a) Describe how Principle of Conservation of Energy is applied as the roller coaster moves from point A to B.

....

....[2]

11E (a)
- Electrical energy is converted to GPE gained by the roller coaster and heat and sound transferred to the surrounding.
- The amount of electrical energy is equal to the gain in GPE by the roller coaster and heat and sound transferred to the surrounding.

(b) Determine the power of the electric motor.

power = ... [2]

(b) $gain\ in\ GPE = mgh = 500kg \times 10N/g \times 20m = 100000J$

$$Eff = \frac{useful\ pwr\ output}{total\ pwr\ input} \times 100\%$$

$$80\% = \frac{\frac{100000}{120s}}{P_{motor}} \times 100\%$$

$P_{motor} = 1040$ W

(c) The electric motor is replaced with one that gives a larger power to the roller coaster. Describe and explain the effect on the speed of the roller coaster if it still moves from A to B at a constant speed.

....[1]

(c) It will move up faster. As power is higher, the gain in GPE per unit time is larger. Since the gain in GPE is the same, the time has to be shorter. As such the speed must be higher.
or: larger power → larger force → larger initial acceleration hence speed increases

(d) At point C, the speed of the roller coaster is 0.20 m/s and it continues to move down the track due to gravity. Assume that along the track C to F, the frictional force is negligible.

(i) Calculate the speed of the roller coaster at point E.

speed = ... [2]

(d) **(i)** lost GPE = gain KE
$(500kg)(10N/kg)(2.0m) = ½(500kg)v^2 + ½(500kg)(0.20m/s)^2$
v = 6.32 m/s

(ii) In reality the speed of the roller coaster is smaller than the speed calculated in **(b)(i)**. Explain why the actual speed is lower.

....

....[1]

There are resistive forces acting on the roller coaster. The resistive force is doing work against the roller coaster, hence less gain in kinetic energy.

(e) At point F, the speed of the roller coaster is 15 m/s. The average resistive force experienced by the roller coaster along FG is 4000 N. It is observed that the 10 m track FG is not long enough for the roller coaster to come to a stop at end of track FG.

To overcome this issue, the end of track FG has to be elevated. Calculate the height of elevation of FG so that the roller coast can come to a stop at the end of the track.

height = ... [2]

	(e)	work done due to friction = lost KE – gain GPE $(4000\ N)(10\ m) = ½(500\ kg)(15\ m/s)^2 – 0 – (500\ kg)(10\ N/kg)h$ h = 3.25 m or 3.3 m	 1 1

11 O A student uses a water tank to study the behaviour of a water wave as it travels from region A to region B of different water depths. A powerful light source placed above the water tank produces regions of bright and dark bands of light at the base of the water tank, as shown in Fig. 11.2.

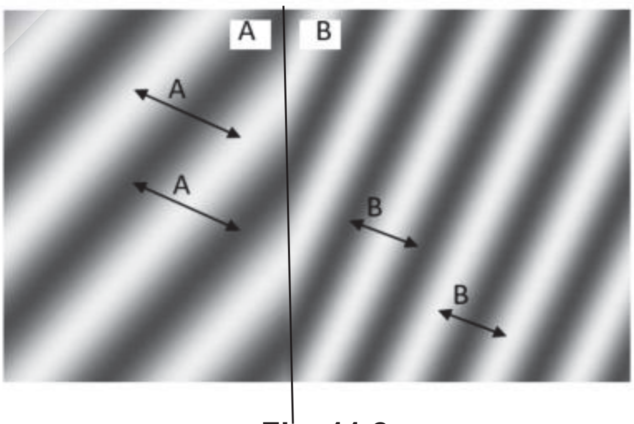


Fig. 11.2

https://web2.ph.utexas.edu/~vadim/Classes/2014f/refraction.html

(a) Explain why water waves are transverse waves.

………………………………………………………………………………………………

……………………………………………………………………………………….[1]

11 O **(a)** The water particle oscillate about a fixed point perpendicular to the wave direction.

(b) After passing through the water, light rays converge to form bright bands of light at the base of the water tank.

(i) On Fig. 11.2, mark a distance equal to the wavelength of the water wave in region A. Label the wavelength with 'λ'. [1]

(ii) State and explain which region is deeper.

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………………[2]

(c) At time = 0, a ping pong ball is found to be at the centre of a dark band. If the speed of the water wave is 20 cm/s and the wavelength is 10 cm, draw on Fig. 11.3, how the displacement of the ping pong ball changes with time for 2 complete oscillations. Indicate the time when the displacement = 0 mm. The amplitude of the water wave is A. [2]

Fig. 11.3

(c)
- cosine curve (at the centre of the dark band is the trough of the wave)
- Period indicated correctly (0.50s) (speed is 20 cm/s and the wavelength is 10 cm)
- correct amplitude
- 2 complete cosine wave (2 complete oscillation).

(d) The water wave in Fig. 11.2 is produced by dropping a concrete beam into the water tank. When the beam hits the base of the tank, sound is produced.

Fig. 11.4 shows the displacement-time graph of a water particle as sound is transmitted through the water.

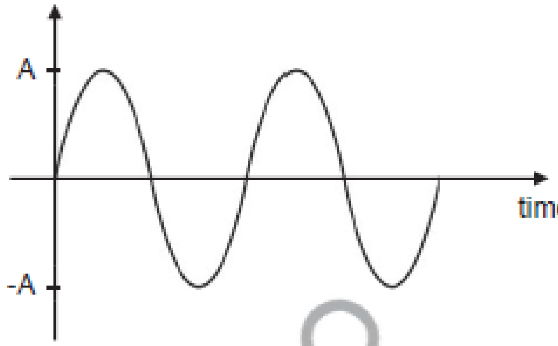


Fig. 11.4

(i) Explain how sound energy is transferred through the water without transferring matter.

....

....

....[2]

(d) (i)
- The energy of the stone is transferred to the base of the tank causing it to vibrate. The vibration at the base of the water tank causes the water particles to vibrate about a fixed point parallel to the wave direction.
- This causes a series of compression and rarefaction to be transmitted from the source outwards.

(ii) A metal nail is also dropped into the water tank. The loudness of the sound produced by the metal nail is half that of the sound produced by the beam. The frequency of the sound produced by the metal nail is twice that of the sound produced by the beam.

Draw on Fig. 11.4, how the displacement of a water particle will change with time as the sound produced by the metal nail is transmitted through the water. [2]

		(ii)	• half the amplitude • half the period	1 1

Name	Class				Index Number		

BROADRICK SECONDARY SCHOOL
SECONDARY 4 EXPRESS
PRELIMINARY EXAMINATION 2022

PHYSICS 6091/01

Paper 1 Multiple Choice September 2022

Additional Materials: Multiple Choice Answer Sheet 1 hour

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, index number and class on the OTAS answer sheet.

There are **forty** questions in this paper. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate OTAS answer sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This question paper consists of **19** printed pages including this page.

Setter: Ms Amanda de Souza

1 Which expression gives a base quantity?

A charge per unit time

B energy per unit time

C force per unit area

D mass per unit volume

2 A pair of Vernier calipers is used to measure the diameter of a golf ball.

Diagram 1 shows the scale when the jaws are fully closed.
Diagram 2 shows the scale when the golf ball is secured between the jaws.

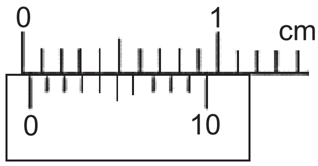


Diagram 1

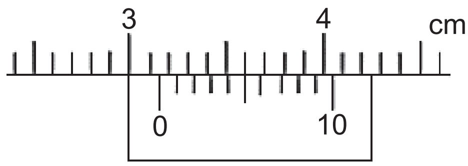


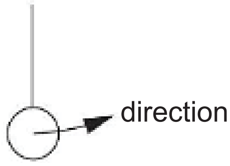
Diagram 2

What is the diameter of the golf ball?

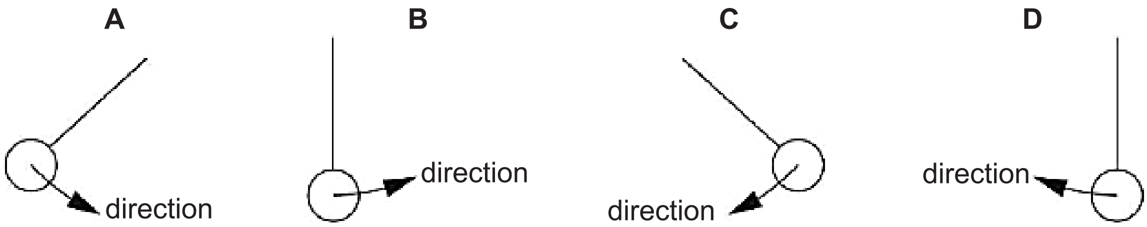
A 3.01 cm **B** 3.11 cm **C** 3.15 cm **D** 3.19 cm

3 A pendulum has a period of 1.6 s.

A stopwatch is started when the pendulum is vertical and moving to the right as shown.



Which diagram shows the position and direction of the pendulum 4.0 s later?



4 Two vector quantities are added to produce a resultant.

Which statement about the resultant is correct?

A The direction of the resultant is always different from the directions of the two original vectors.
B The direction of the resultant is always the same as the direction of one of the original vectors.
C The magnitude of the resultant is always different from the magnitudes of the two original vectors.
D The magnitude of the resultant may be zero.

5 A car travels east at a velocity of 25 m / s along a straight horizontal track.

At time t = 5 s, its velocity starts to change and its acceleration is – 2.0 m / s^2.

How is the car moving at time t = 15 s?

A travelling east with decreasing speed
B travelling east with increasing speed
C travelling west with constant speed
D travelling west with increasing speed

6 Object X of mass m is released from a height h.

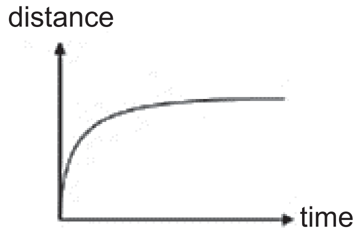
Another object Y of mass 3m is released from a height 3h simultaneously.

If both objects fall freely, taking air resistance as negligible, which of the following statements is true?

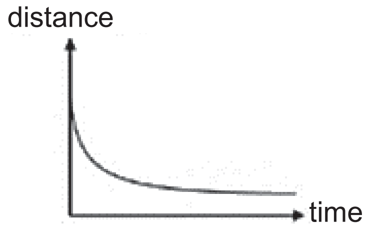
A The acceleration of both objects increases.
B The distance between object X and Y decreases and Y overtakes X.
C The distance between object X and Y remains constant before object X hits the ground.
D The velocities of both objects remain constant.

7 Which distance time graph best represents a sky diver jumping off a plane and reaching terminal velocity?

A



B



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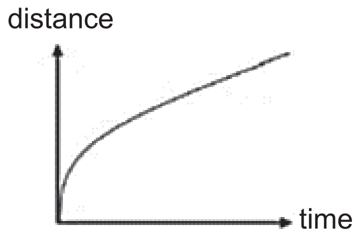

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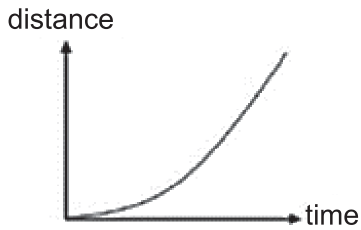


8 Four of the gravitational forces that act between bodies in our Solar System are listed below.

P : the force on the Moon due to the Earth
Q : the force on the Earth due to the Sun
R : the force on the Earth due to the Moon
S : the force on the Moon due to the Sun

Which two forces are an action-reaction pair?

A P and R **B** P and S **C** Q and R **D** Q and S

9 A piece of plasticine is first shaped into a solid sphere, before being rolled out into a sheet.

What can be said about the densities of the sphere and the sheet?

A The densities of the sphere and the sheet are the same.

B The densities of the sphere and the sheet cannot be compared as the volumes are unknown.

C The density of the sphere is greater than the density of the sheet.

D The density of the sphere is less than the density of the sheet.

10 An astronaut lands on a planet where the gravitational field strength at its surface is lower than that on Earth.

Which of the following will remain the same as on Earth?

A The ease with which a stationary pendulum can be made to start moving.

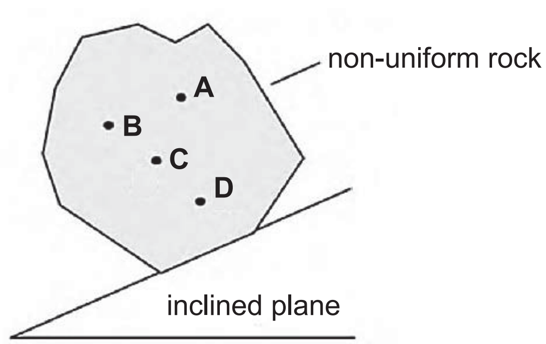
B The height reached by the astronaut when he jumps up with the same initial velocity.

C The period of a simple pendulum.

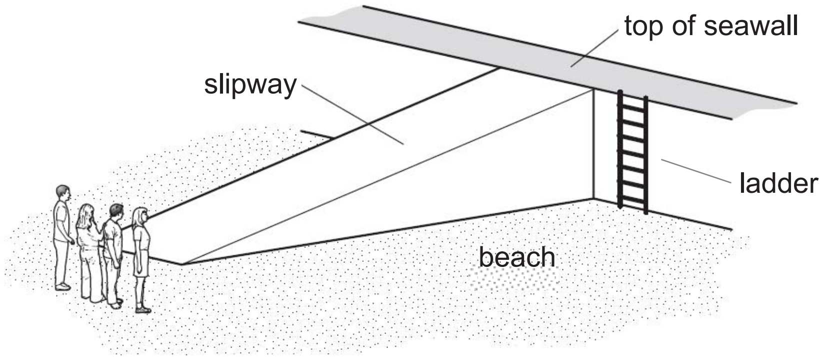
D The weight of the spacecraft.

11 A non-uniform rock is placed on an inclined plane. The object is just about to topple.

Which position is the centre of gravity of the rock?



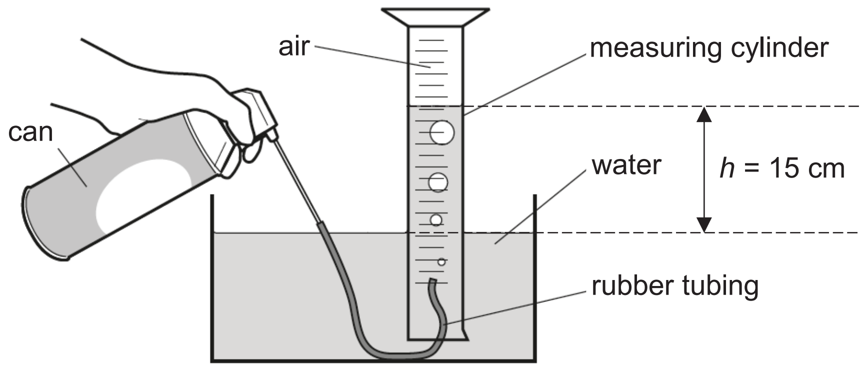
12 Four people of equal weight use different routes to get from a beach to the top of a sea wall.



Which person produces the greatest average power?

person	route	time taken / s
A	runs across the beach, then climbs up the ladder	16
B	runs up the slipway	8
C	walks across the beach, then climbs up the ladder	32
D	walks up the slipway	25

13 A measuring cylinder is inverted in a water trough.



Initially the inverted measuring cylinder is full of water. When the student presses the top of the can, air passes through the rubber tubing into the inverted measuring cylinder until no more air is able to leave the can.

The height h of the water column is 15 cm, the atmospheric pressure is 1.0×10^5 Pa, the density of water is 1000 kg / m^3 and the gravitational field strength is 10 N / kg.

What is the pressure of the air in the measuring cylinder when no more air is able to leave the can?

A 1.50×10^3 Pa **B** 9.85×10^4 Pa **C** 1.00×10^5 Pa **D** 1.02×10^5 Pa

14 A bowl of hot rice is covered with a lid and left to cool.

Which statement best explains why it is difficult to lift the lid when the rice is cold?

A The force between the water molecules and lid is strong.

B The number of air molecules in the bowl decreases as the rice cools.

C The pressure of the air inside the bowl is lower than the atmospheric pressure.

D The water vapour that condenses on the lid makes the lid heavy.

15 In a Brownian motion experiment involving smoke particles in air, heavy smoke particles settle quickly but very light smoke particles remain suspended for long periods.

Which statement best explains why the smaller smoke particles do not settle?

A Air molecules randomly bombard the very light smoke particles.

B Atmospheric pressure has a smaller effect on very light smoke particles.

C Earth's gravitational field strength does not act on very light smoke particles.

D Very light smoke particles have the same density as air.

16 The particles of a gas, in a container of fixed volume, are supplied with more energy.

What effect does this have on the gas?

A Both the pressure and temperature of the gas increase.

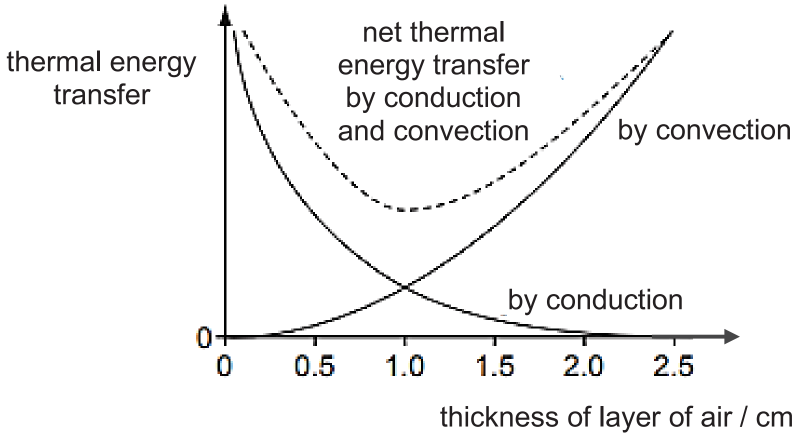
B Neither the pressure nor the temperature of the gas increase.

C Only the pressure of the gas increases.

D Only the temperature of the gas increases.

17 A double-glazed window has two layers of glass separated by a layer of air.

The amount of thermal energy transferred by conduction and convection through the layer of air varies with the thickness of the layer of air, as shown in the graph.



Which thickness of the layer of air is the most effective for a double-glazed window?

A 0.5 cm **B** 1.0 cm **C** 1.5 cm **D** 2.0 cm

18 A cup made from silver is filled with boiling water from a kettle.

Why does the outer surface of the cup feel extremely hot to the touch?

A Boiling water gives out latent heat.

B Convection currents are formed in the boiling water.

C Shiny surfaces are good emitters of infra-red radiation.

D Silver is a good conductor of heat.

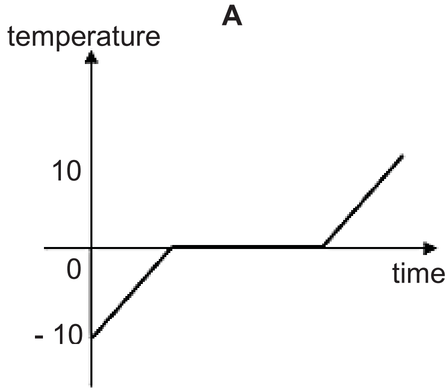
19 In which of the following scenarios would a piece of wet cloth dry the fastest?

	cloth is spread out	colour of cloth	humidity	presence of wind
A	no	dark	high	yes
B	no	white	low	no
C	yes	dark	low	yes
D	yes	white	high	no

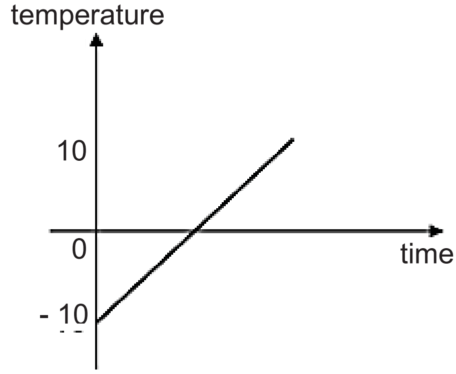
20 A block of ice at – 10 °C was heated to 10 °C.

Given that ice has a lower specific heat capacity than water, which of the following heating curves is correct?

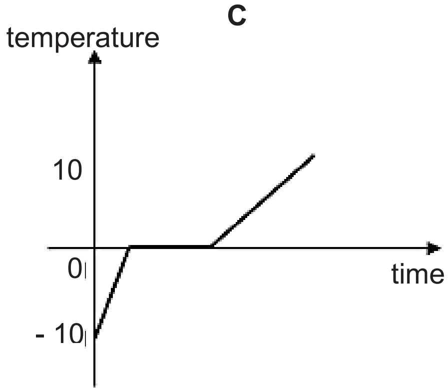
A



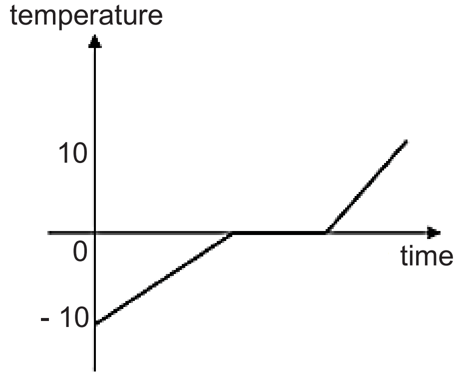
B



C



D



21 Some physical properties of materials can be used to determine the temperature of an object.

Which of the following physical properties is not suitable for this purpose?

A expansion of a metal

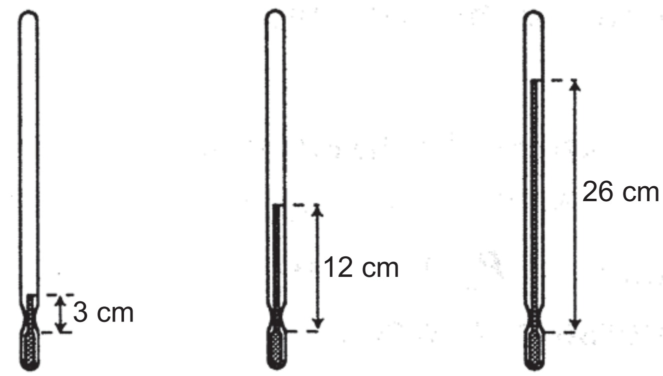
B mass of a liquid

C resistance of a metal

D volume of a gas at constant pressure

22 An uncalibrated thermometer is placed in pure melting ice, unknown liquid X and in steam.

The corresponding lengths of alcohol in the thermometer are measured and labelled.

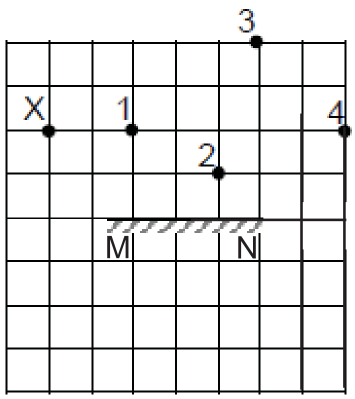


Given that the temperatures of pure melting ice and steam are 0 °C and 100 °C respectively, what is the temperature of unknown liquid X?

A 34.6 °C **B** 39.1 °C **C** 46.2 °C **D** 52.2 °C

23 A student stands at point X as shown.

There are 4 objects placed at positions 1, 2, 3, 4 in front of a mirror labelled MN.

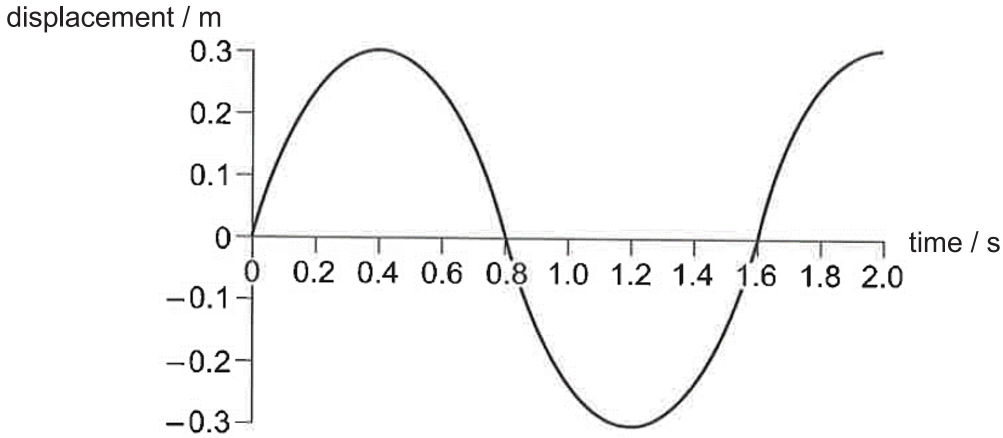


Which objects will the student be able to see in the mirror from point X?

A 1 and 2 only. **B** 1, 2, 3 only **C** 2, 3, 4 only **D** 1, 2, 3, 4

24 A buoy oscillates on a water wave.

The graph shows how the displacement of the buoy from its equilibrium position varies with time.



What characteristics of the wave can be deduced from the graph?

A The amplitude is 0.3 m and the frequency is 0.625 Hz.

B The amplitude is 0.6 m and the period is 1.6 s.

C The period is 1.6 s and the speed is 0.375 m / s

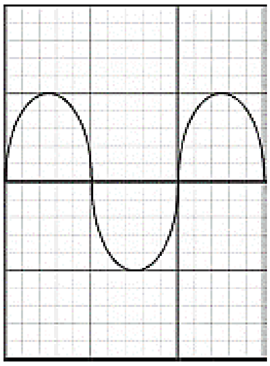
D The wavelength is 1.6 m and the speed is 0.188 m / s.

25 In the electromagnetic spectrum shown below, which quantity decreases from left to right?

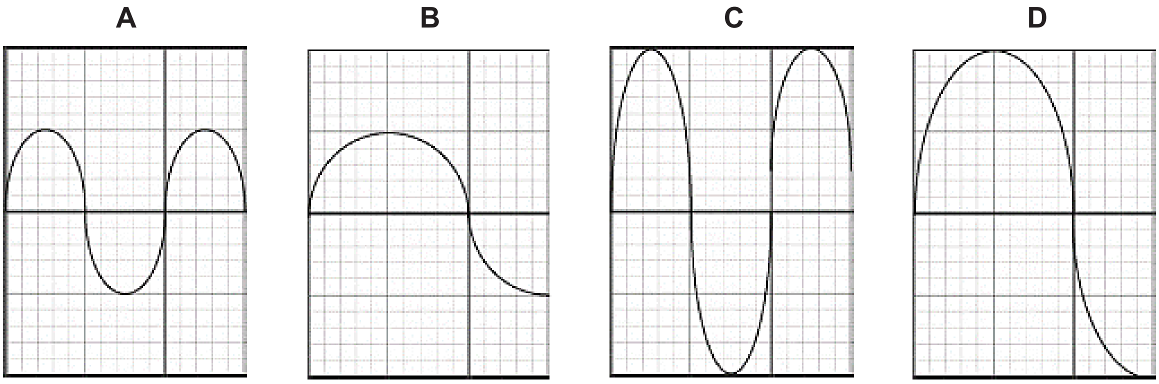
Radio waves	Microwaves	Infra-red radiation	Visible light	Ultraviolet radiation	X rays	Gamma rays

A amplitude **B** frequency **C** velocity **D** wavelength

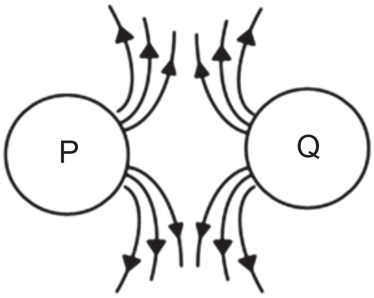
26 The diagram shows the trace on a cathode-ray oscilloscope (c.r.o.).



Which trace is obtained when the sound wave is change to a louder sound of lower pitch?



27 The electric field pattern between two electric charges P and Q is shown.



Which statement is correct?

A P and Q are both negative charges.

B P and Q are both positive charges.

C P is a negative charge while Q is a positive charge.

D P is a positive charge while Q is a negative charge.

28 Which quantity is equivalent to electromotive force?

A The power used in driving a unit charge around a complete circuit.

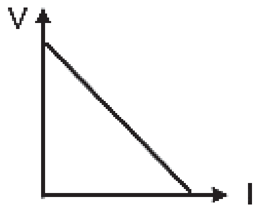
B The power used in driving one electron around a complete circuit.

C The work done in driving a unit charge around a complete circuit.

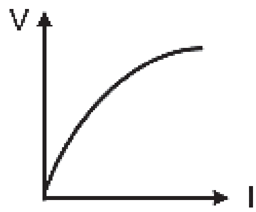
D The work done in driving one electron around a complete circuit.

29 Which of the following graphs shown how voltage varies with current for a filament lamp?

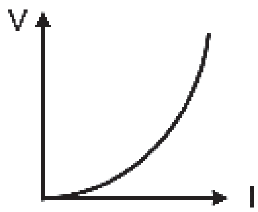
A



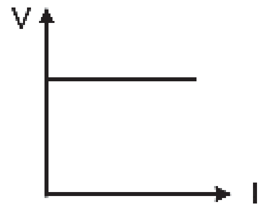
B



C



D

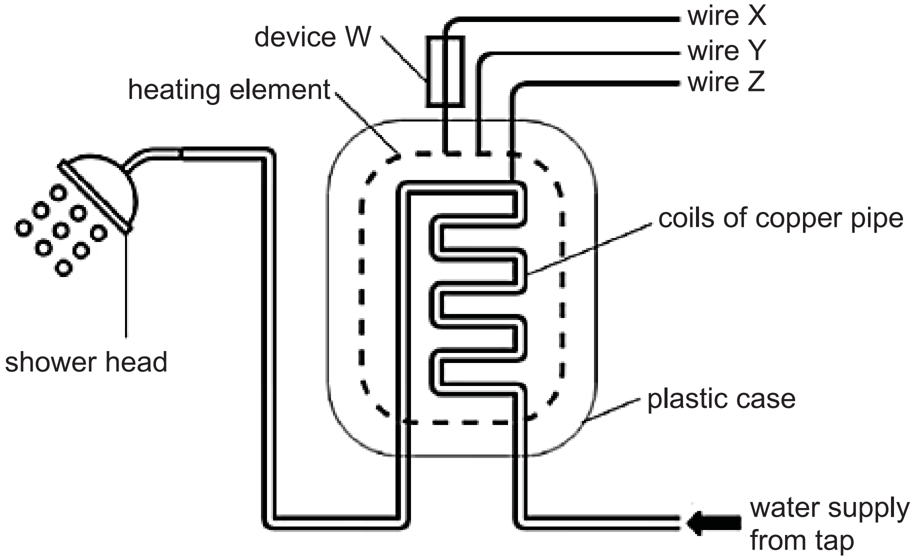


30 Four lamps have filaments made from the same material. The lamps are connected in series with a battery.

Which lamp converts the most energy into heat and light per second?

lamp	length of filament	cross-sectional area of filament
A	l	A
B	l	4A
C	$2l$	A
D	$2l$	2A

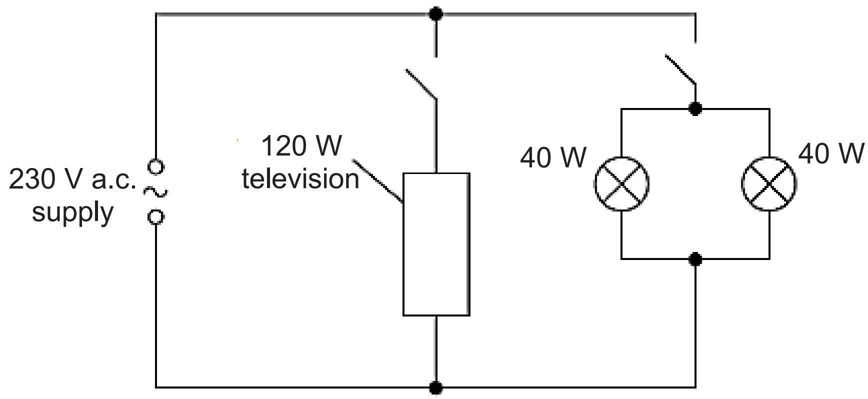
31 An electric heater is used to heat up water for hot showers.



Which row describes device W, wire X, Y and Z correctly?

	device W	wire X	wire Y	wire Z
A	fuse	live	earth	neutral
B	fuse	live	neutral	earth
C	thermistor	earth	live	neutral
D	thermistor	neutral	live	earth

32 A circuit containing a 230 V a.c. supply is connected to a 120 W television and two 40 W lamps.

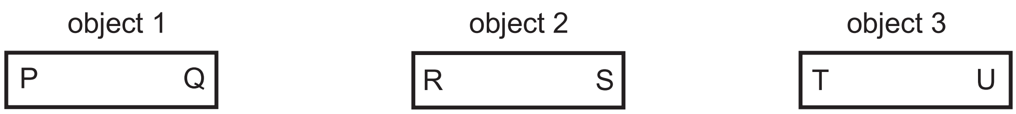


In normal operation, both switches are closed.

What is the cost of using this circuit in normal operation for 24 hours if the cost of electricity is 30.17 cents per kilowatt-hour?

A $ 1.16 **B** $ 1.45 **C** $ 144.82 **D** $ 217.22

33 Three objects are tested for their magnetic properties.



She made the following observations:

P repels T.
P attracts U.
R is attracted by both P and U.

Which of the following conclusions is true?

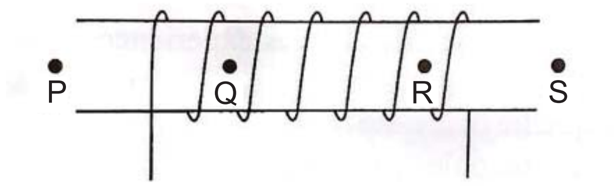
A Object 1 and 2 are magnets while object 3 is a magnetic material.

B Object 1 and 3 are magnets while object 2 is a magnetic material.

C Object 2 and 3 are magnets while object 1 is a magnetic material.

D Object 1, 2 and 3 are all magnets.

34 A steady current is passed through a solenoid.

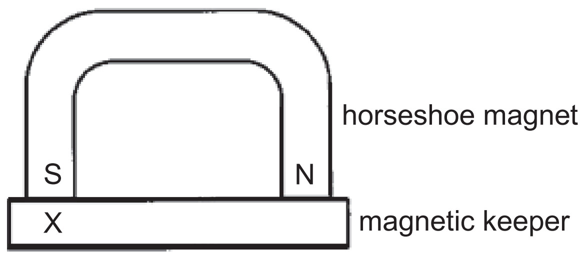


P, Q, R and S are four points on the axis of the solenoid. Q and R are inside the solenoid.

Which row indicates a possible direction of the magnetic field due to the current?

	P	Q	R	S
A	→	←	←	→
B	→	→	←	←
C	←	←	←	←
D	←	→	→	←

35 A permanent horseshoe magnet and soft magnetic keeper are arranged as shown.



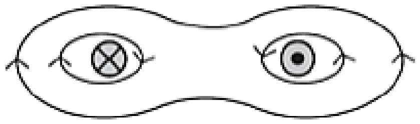
Which row describes the materials used and polarity of end X correctly?

	magnet	keeper	polarity of X
A	iron	iron	north
B	iron	steel	south
C	steel	iron	north
D	steel	steel	south

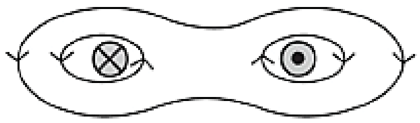
36 Each of the diagrams below is a cross-section of two parallel current-carrying conductors.

Which diagram correctly shows the magnetic field pattern formed by the currents flowing in the two conductors?

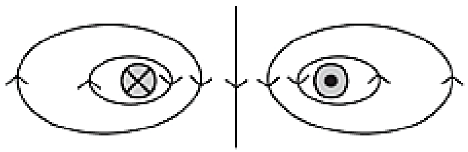
A



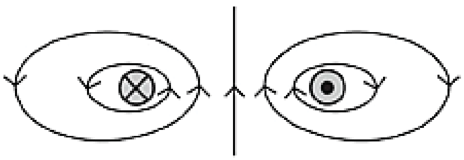
B



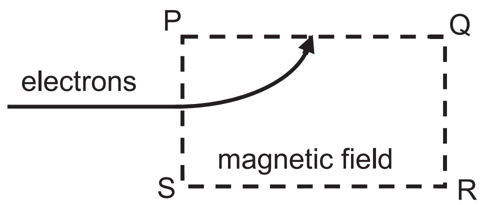
C



D



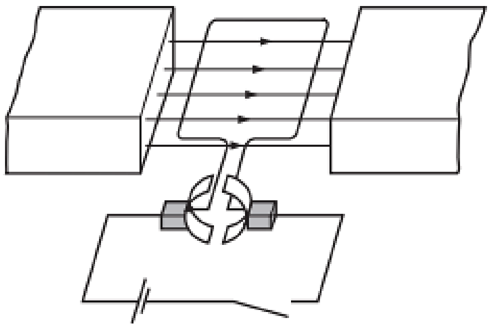
37 The motion of a stream of fast-moving electrons is changed when it enters a magnetic field in the dotted area PQRS as shown.



What is the direction of the magnetic field in the dotted area PQRS?

A into the page **B** out of page **C** side PS to QR **D** side QR to PS

38 In a simple d.c. motor, the switch is closed and the coil rotates within the poles of a magnet.



Which of the following changes will make the coil rotate in the opposite direction and at a faster rate?

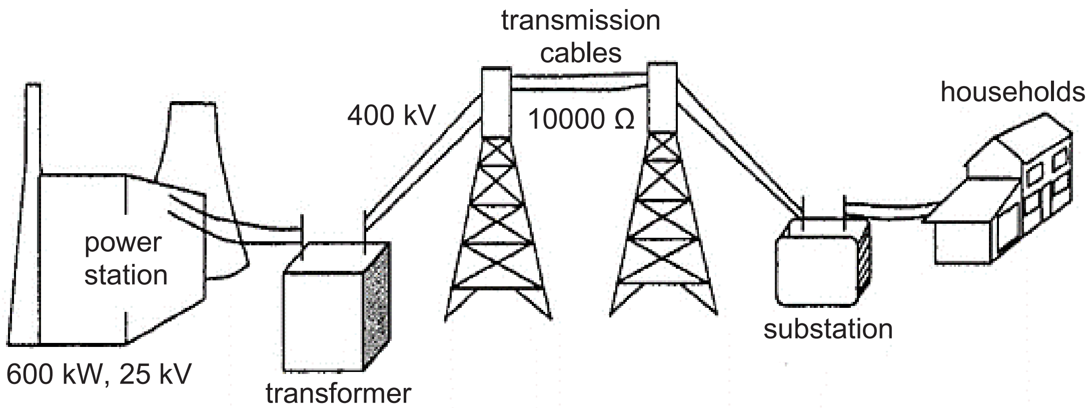
A Decrease the current in the coil and reverse the magnetic field.

B Increase the current in the coil and insert a soft iron core.

C Reverse both the magnetic field and the direction of the current in the coil.

D Reverse the magnetic field and increase the number of turns in the coil.

39 Electricial energy generated in power stations is transmitted through overhead cables to subtations for household usage.



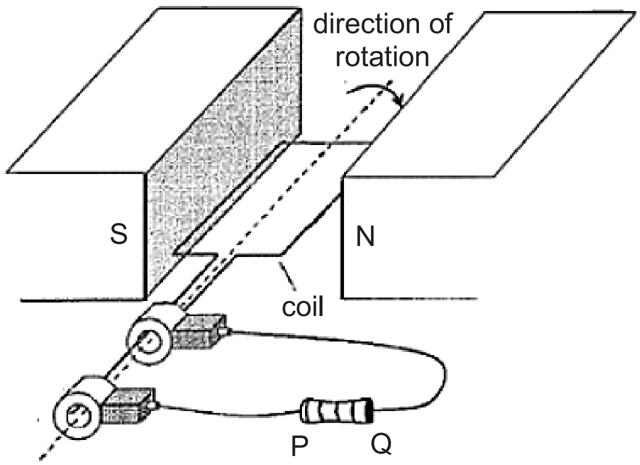
600 kW of electrical power is supplied by the power station at a voltage of 25 kV. During transmission, the voltage is stepped up to 400 kV and the resistance of the overhead transmission cables is 10000 Ω.

What is the power loss in the overhead transmission cables?

A 15.0 kW **B** 16.0 kW **C** 22.5 kW **D** 37.5 kW

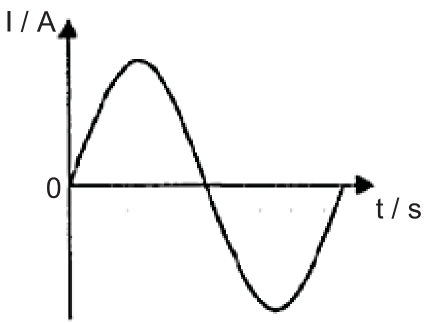
[Turn over

40 The position of the coil in an a.c. generator at time t = 0 s is shown.



If the current is positive when it flows from P to Q through the load, which of the following graphs shows the variation of the current with time as the coil rotates?

A



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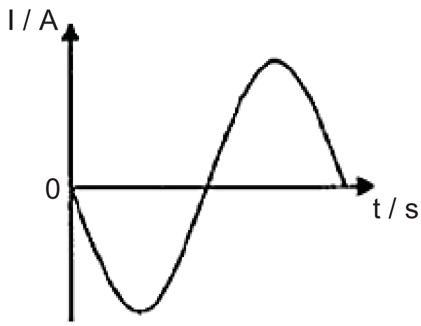

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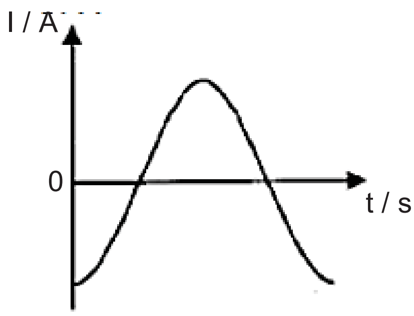

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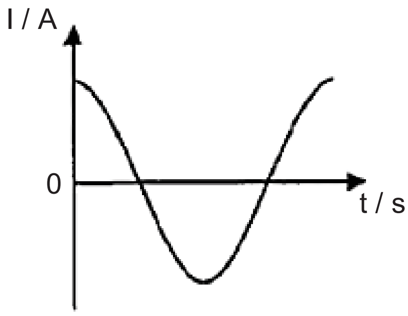


End of paper

Name	Class				Index Number		

BROADRICK SECONDARY SCHOOL
SECONDARY 4 EXPRESS
PRELIMINARY EXAMINATION 2022

PHYSICS

6091/02

Paper 2 Theory

September 2022

Candidates answer on the Question Paper

No Additional Materials are required.

1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 11 has a choice of parts to answer.

Candidates are reminded that all quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use		
Paper 1		/40
Paper 2	Section A	/50
	Section B	
	Q 9	/12
	Q 10	/8
	Q 11	/10
Total		/120

This question paper consists of **20** printed pages including this page.

Setter: Ms Amanda de Souza

[Turn over

Section A [50 marks]
Answer **all** questions in the spaces provided.

1 (a) (i) Circle the value of the prefix *Mega*.

10^{-9} 10^{-6} 10^{-3} 10^{-2} 10^{-1} 10^{3} 10^{6} 10^{9} [1]

(ii) Rearrange the following prefixes in order from the largest to the smallest value.

μ d G n

____ [1]

(b) Fig. 1.1 and Fig. 1.2 show two ways of hanging a picture frame, weighing 16 N, on a wall.

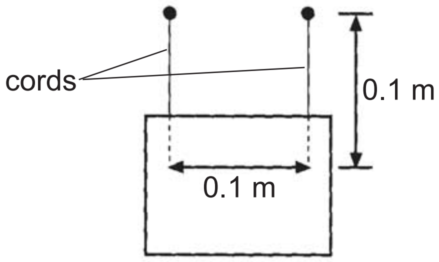


Fig. 1.1

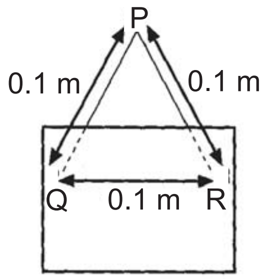


Fig. 1.2

In Fig. 1.1, the frame is hung from two identical cords, each of length 0.1 m, spaced 0.1 m apart. In Fig. 1.2, a similar cord, of length 0.2 m, is used to suspend the frame from a single point P, such that points Q and R are also spaced 0.1 m apart.

(i) State the tension in each cord in Fig. 1.1.

tension = ………………………….. [1]

(ii) In the space below, draw a labelled diagram to determine the tension in the parts of the cord, PQ and PR, in Fig. 1.2.

tension in PQ = …………………………..

tension in PR = ………………………….. [3]

2 Fig. 2.1 is a graph describing the motion of a car.

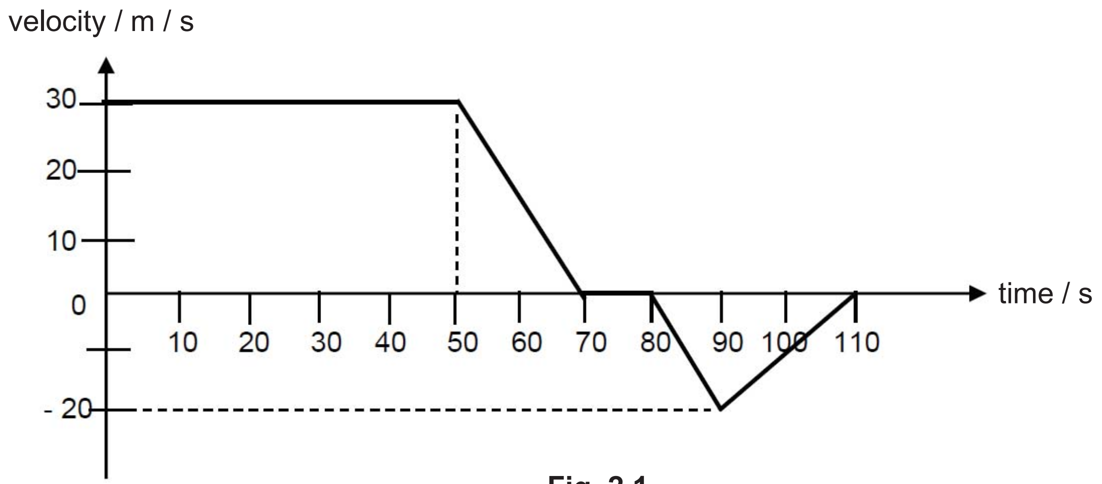


Fig. 2.1

(a) Explain, in terms of forces acting, why the car moves at constant speed for the first 50 seconds.

____

____ [1]

(b) Describe the motion of the car from the 50th to the 90th second.

____

____

____ [3]

(c) Calculate the displacement of the car at 110 s.

displacement = ………………………….. [2]

(d) Calculate the average speed of the car for the entire journey.

average speed = ………………………….. [2]

3 Fig. 3.1 shows a bird cage hanging on a uniform wooden pole of length 1.8 m and mass 10 kg.

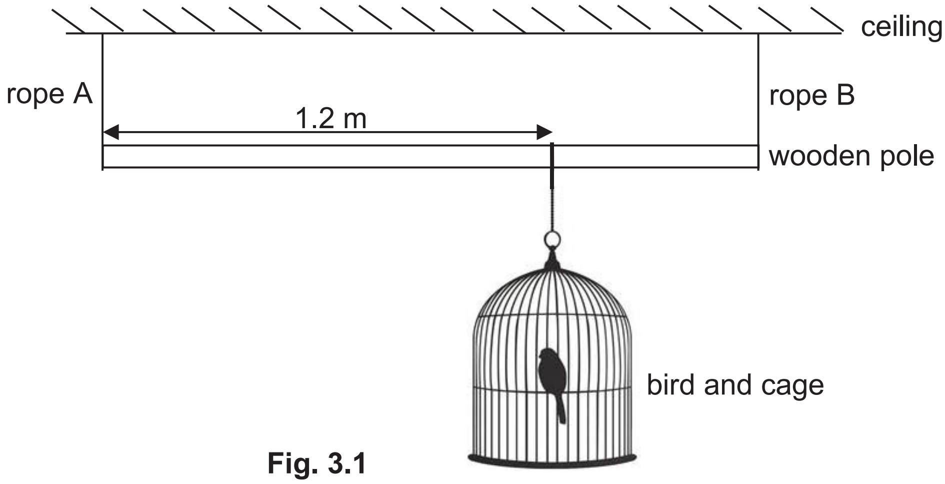


Fig. 3.1

The pole is kept horizontal by two ropes, A and B, each tied at the ends of the pole.
The bird and the cage have a total mass of 6 kg and is suspended 1.2 m away from rope A.
The gravitational field strength *g* is 10 N / kg.

(a) Describe the difference between *mass* and *weight*.

____

____ [1]

(b) Using the principle of moments or otherwise, calculate the tension in rope A and B.

tension in rope A = ……………………………..

tension in rope B = …………………………….. [3]

(c) The bird keeper wants to suspend another bird cage of weight 30 N on the pole without increasing the tension in rope B as he is afraid rope B will snap.

Suggest and explain where he should suspend this second bird cage.

____

____ [2]

4 Fig. 4.1 shows a water gun that makes use of pressure exerted on a trigger to spray water out of a nozzle.

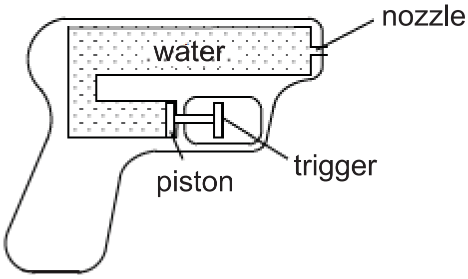


Fig. 4.1

(a) The cross-sectional areas of the piston and nozzle are 2.0 cm^2 and 0.08 cm^2 respectively.

If a force of 5 N is exerted on the trigger, calculate the force exerted on the water leaving the nozzle.

force = ………………………….. [2]

(b) When the force of 5 N is applied, the piston moved a distance of 0.6 cm.

(i) Determine the mass of water moved by the piston, given that the density of water is 1 g / cm^3.

mass = ………………………….. [1]

(ii) Calculate the work done on the water in the water gun.

work done = ………………………….. [1]

(iii) Hence, determine the speed of the water leaving the nozzle.

speed = ………………………….. [2]

5 One type of renewable energy source is shown in Fig. 5.1.

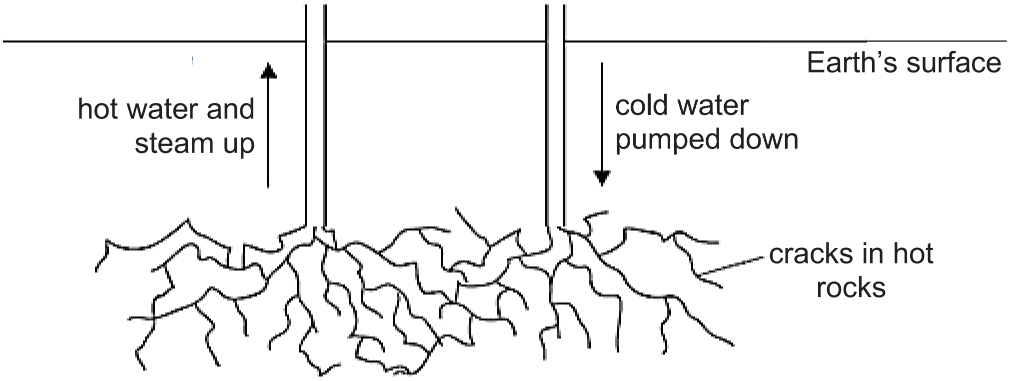


Fig. 5.1

(a) State the name of the renewable energy source shown in Fig. 5.1.

______________________________ [1]

(b) 100 kg of cold water of a temperature of 20 °C is pumped down to the hot rocks.
The water returns partly as steam and partly as hot water, both at a temperature of 100 °C.
The specific heat capacity of water is 4200 J / (kg °C).
The specific latent heat of vaporisation of water is 2200 kJ / kg.

Calculate the total energy needed to raise the temperature of the water from 20 °C to 100 °C and to vaporise 40 kg of the water into steam.

total energy needed = ………………………….. [3]

(c) Using ideas about molecules and internal energy, explain why more energy is released when 1 kg of steam cools to 20 °C than when 1 kg of hot water cools to 20 °C.

____

____

____

____

____

______________________________ [4]

6 A thin converging lens, with a focal length of 3.0 cm, is shown in Fig. 6.1.
An object O is placed in front of the lens.

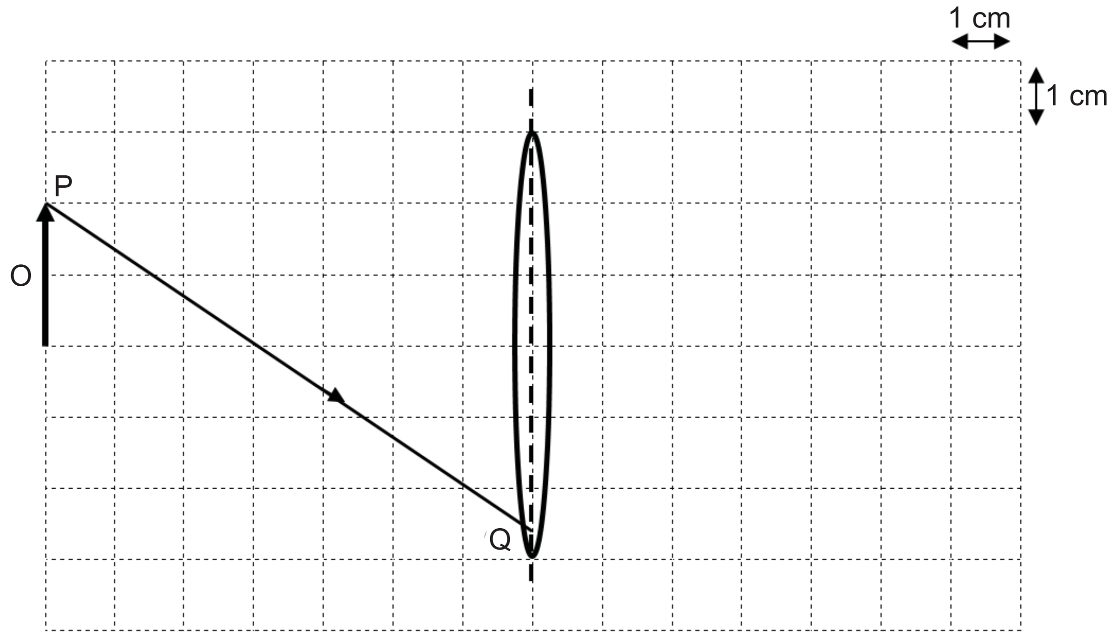


Fig. 6.1

(a) On Fig. 6.1,

(i) draw 2 more rays from the top of the object to locate the top of the image.
Draw the whole image and label it as I. [2]

(ii) complete the path of the ray PQ. [1]

(b) The object is moved closer to the lens.

Describe two possible changes this causes to the image.

____

____

____

____ [2]

7 Fig. 7.1 shows a Van de Graaff generator which is used to produce charges.

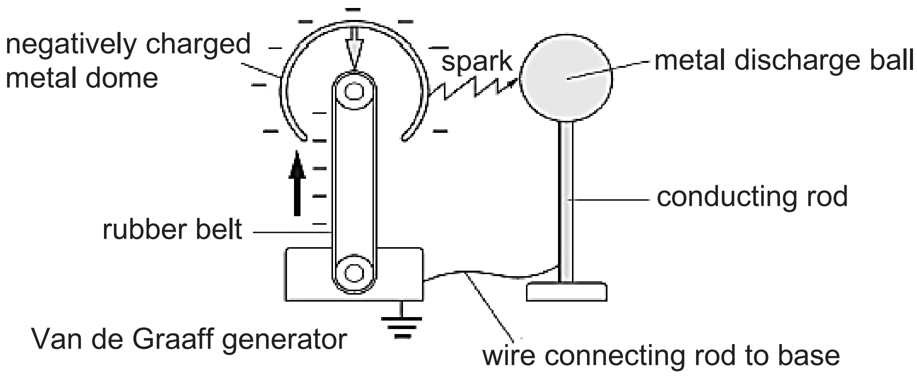


Fig. 7.1

The rubber belt carries negative charges to the dome, making it negatively charged.
When a metal discharge ball is moved near the metal dome, sparks are produced.

(a) On Fig. 7.1, draw the charges induced on the metal discharge ball just before a spark is produced. [1]

(b) Explain how these charges are induced on the metal discharge ball.

____

____

____

____ [2]

(c) When sufficient negative charges have accumulated on the dome, a spark will jump from the metal dome to the discharge ball. For each spark, a charge of 0.57 mC moved through the spark in 0.013 s.

Calculate the average current in each spark.

current = …………………………….. [2]

8 **(a)** Fig. 8.1 shows the structure of a relay.
Fig. 8.2 shows a circuit that includes the relay shown in Fig. 8.1.

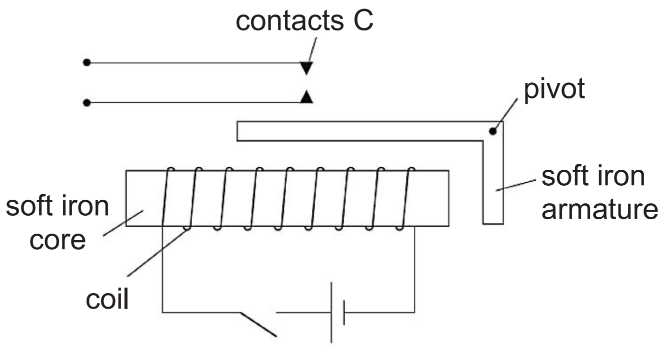


Fig. 8.1

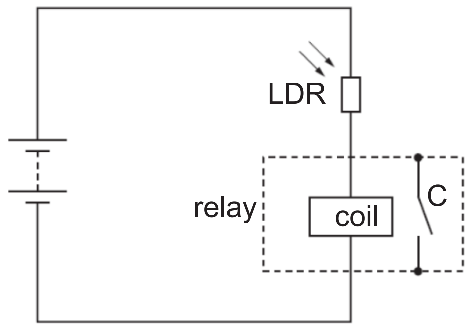


Fig. 8.2

When light shines on the light-dependent resistor (LDR), the relay contacts C close.

(i) Deduce what happens to the resistance of the LDR when light shines on it.

____

____ [1]

(ii) Hence, explain why the relay contacts C close when light shines on the LDR.

____

____

____

____

____

____ [3]

(b) Fig. 8.3 shows a coil ABCD suspended between two poles of a magnet.

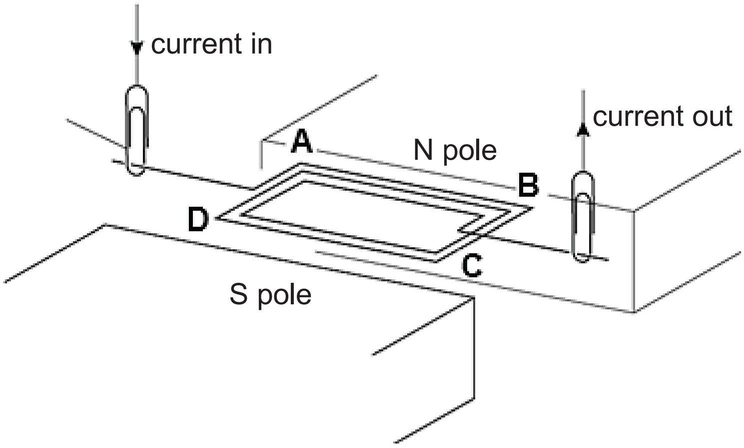


Fig. 8.3

The coil ABCD is free to turn on two bare metal paper clips which support and pass current into and out of the coil.

Fig. 8.4 shows a conversation between two students, Adrien and Benny.

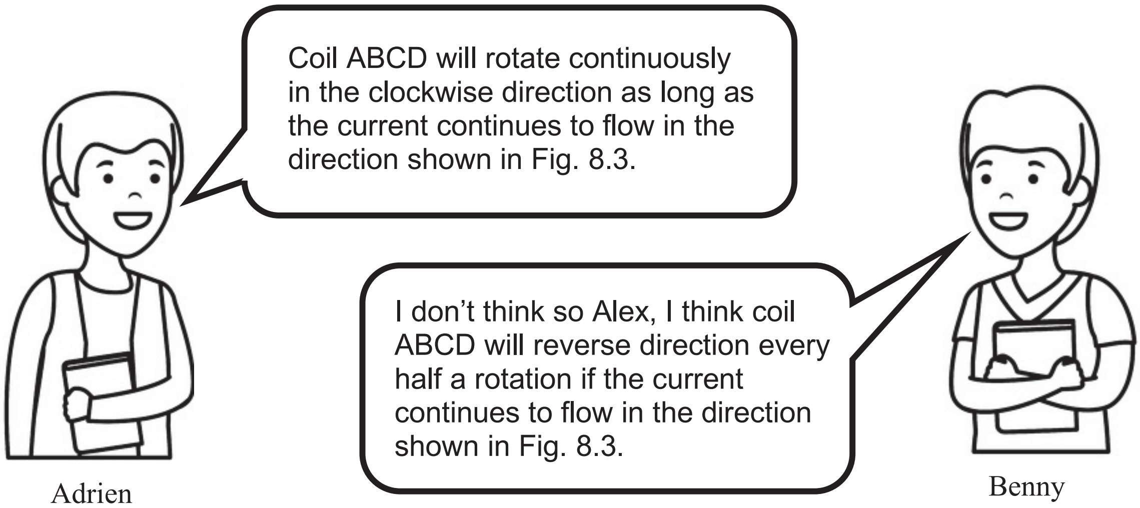


Fig. 8.4

Explain whether Adrien's or Benny's description of the rotation of coil ABCD is correct.

____

____

____

____

____ [2]

Section B [30 marks]

Answer **all** questions in this section.

Answer only one of the two alternative questions in **Question 11**.

9 Fig. 9.1 shows an optical fibre made of glass of uniform refractive index coated in a layer of cladding.

Fig. 9.1

Fig. 9.2 shows three rays of light entering the fibre from air. Each of these rays follows one of three possible paths through the fibre.

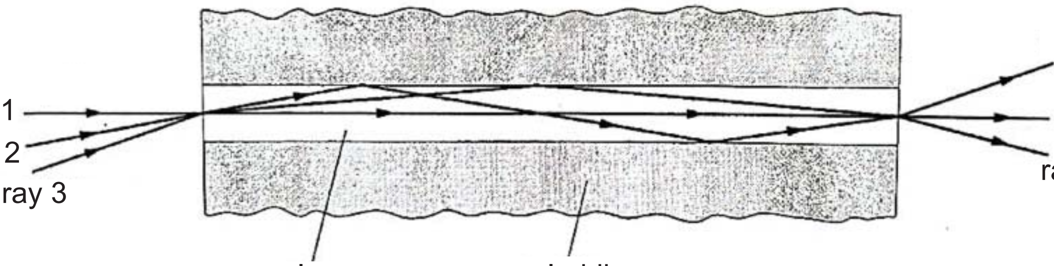


Fig. 9.2

The three rays travel different distances and take different times to pass through the fibre.

Table 9.3 gives information about the three rays and their paths in two cables of lengths 1 km and 2 km respectively.

ray	angle of incidence on entry / °	angle of refraction on entry / °	distance covered in 1 km cable / m	time spent in 1 km cable / μs	distance covered in 2 km cable / m	time spent in 2 km cable / μs
1	0	0	1000	5.0	2000	10.0
2	20	*X*	1020	5.1	2060	10.3
3	35	*Y*	1080	5.4	2180	10.9

Table 9.3

(a) Using ideas about refractive index, angle of incidence and critical angle, explain why rays 1, 2 and 3 take the paths shown in Fig. 9.2.

____

____

____

____

____ [3]

(b) Using the data in Table 9.3, calculate

(i) the refractive index of the glass, given that the speed of light in air is 3.0×10^8 m / s,

refractive index = ………………………….. [2]

(ii) the angle of refraction *X* for ray 2.

angle of refraction = ………………………….. [2]

(c) At time t = 0, a single pulse of light enters the optical fiber of length 2 km. The pulse lasts 0.1 μs. A photodiode is used to convert the pulses of light that leave the fibre into electrical pulses.

Fig. 9.4 shows the voltage trace obtained on a c.r.o. with a time base set at 0.1 μs / div.

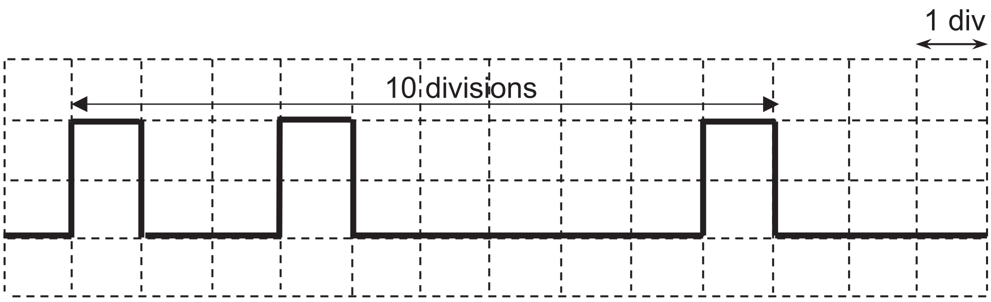
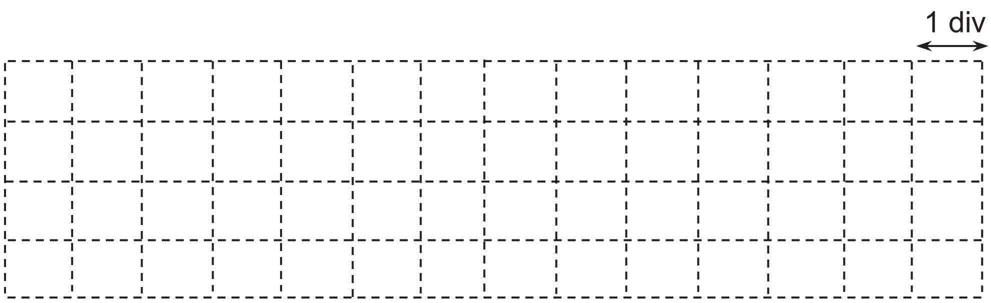


Fig. 9.4

(i) At t = 0, a single pulse of light enters the optical fibre of length 1 km. This pulse also lasts 0.1 μs.

On Fig. 9.5, draw the corresponding voltage trace obtained on a c.r.o. with the same Y-gain as Fig. 9.4 but a time base set at 0.05 μs / div.



[2]

Fig. 9.5

(ii) Fig. 9.4 shows that a pulse of light, lasting 0.1 μs when it enters the 2 km optical fibre, becomes three pulses lasting in total 1.0 μs when it leaves.

In the transmission of data, it is important that no light from one pulse overlaps light from the next pulse. A second pulse of 0.1 μs must enter the fibre at least 1.0 μs after the first pulse.

Determine the maximum number of pulses of light that can enter the 2 km optical fibre in one second.

number of pulses per second = ………………………….. [1]

(d) State two advantages of using optical fibres over copper wires in the transmission of information.

1. ______________________________

____

2. ______________________________

______________________________ [2]

10 Fig. 10.1 shows the structure of a transformer.

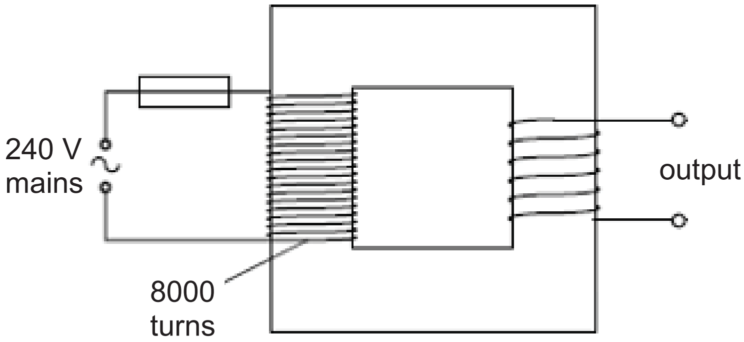


Fig. 10.1

The primary coil is connected to an alternating current supply of voltage 240 V and an output voltage is induced in the secondary coil. There are 8000 turns on the primary coil.

(a) Describe what is meant by *alternating current*.

____

____ [1]

(b) Explain why an output voltage is induced in the secondary coil.

____

____

____

____

____

____ [2]

(c) The output voltage is 6 V.

Calculate the number of turns on the secondary coil.

number of turns = ………………………….. [2]

(d) A 200 mA fuse is connected in series with the primary coil.

(i) Explain why the fuse is connected in series rather than in parallel with the primary coil.

____

____ [1]

(ii) A maximum of three identical lamps rated 6 V, 12 W can be connected in parallel across the secondary coil.

Calculate the maximum efficiency of the transformer when the three lamps are connected.

efficiency = ………………………….. [2]

11 EITHER

(a) Fig. 11.1 shows a ship traveling above a seabed from positions A to F.

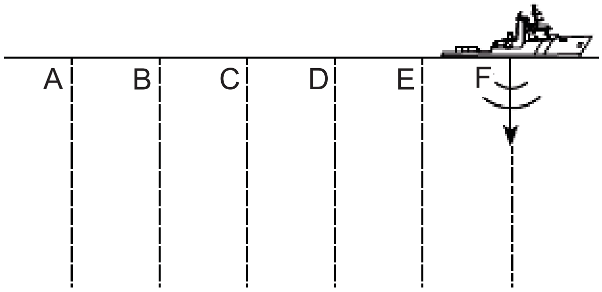


Fig. 11.1

At each point, the ship transmits an ultrasound pulse of frequency 50 kHz to the seabed to determine its depth. The speed of sound in sea water is 1500 m / s.

Fig. 11.2 is the intensity time graph which shows the time interval between each transmitted pulse and reflected pulse received by the ship.

The thick lines represent the transmitted pulse while the thin lines represent the reflected pulse.

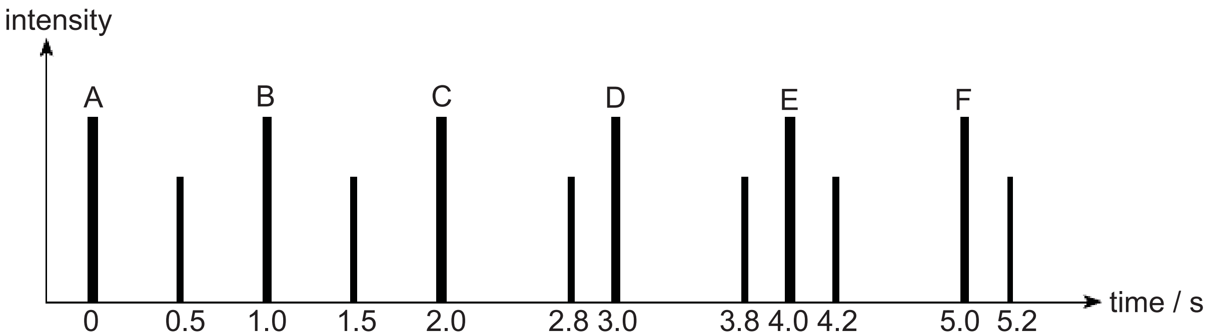


Fig. 11.2

(i) Explain why there is a difference in the amplitude of the transmitted pulse and the reflected pulse.

____

____ [1]

(ii) Calculate the deepest depth of the seabed between points A and F.

depth = ………………………….. [2]

(iii) Determine the number of wavelengths within the distance calculated in **(a)(ii).**

number of wavelengths = ………………………….. [2]

(iv) Explain how the number of wavelengths will change if the ultrasound waves were transmitted through solid rock instead of water, for the same distance calculated in **(a)(ii)**.

[2]

(b) Line X in Fig. 11.3 represents the water particles at time *t* when the ultrasound wave from the ultrasound transceiver travels from the surface of the water to the seabed.

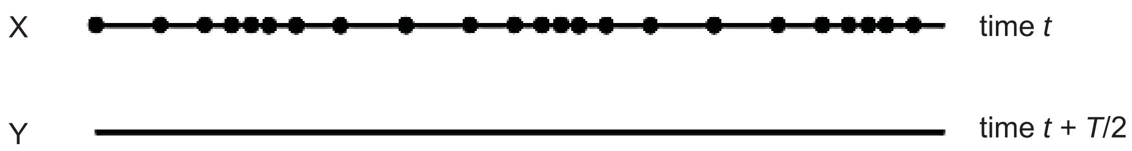


Fig. 11.3

The time taken for one complete vibration of a particle is *T*.

On line Y in Fig. 11.3, mark the centres of two compressions at time *t* + *T*/2.
Label these positions as "C". [1]

(c) State one similarity and one difference between ultrasound waves and ultraviolet rays.

[2]

11 OR

(a) In the circuit diagram in Fig. 11.4, a current of 12 A is flowing into junction J and out of junction M.

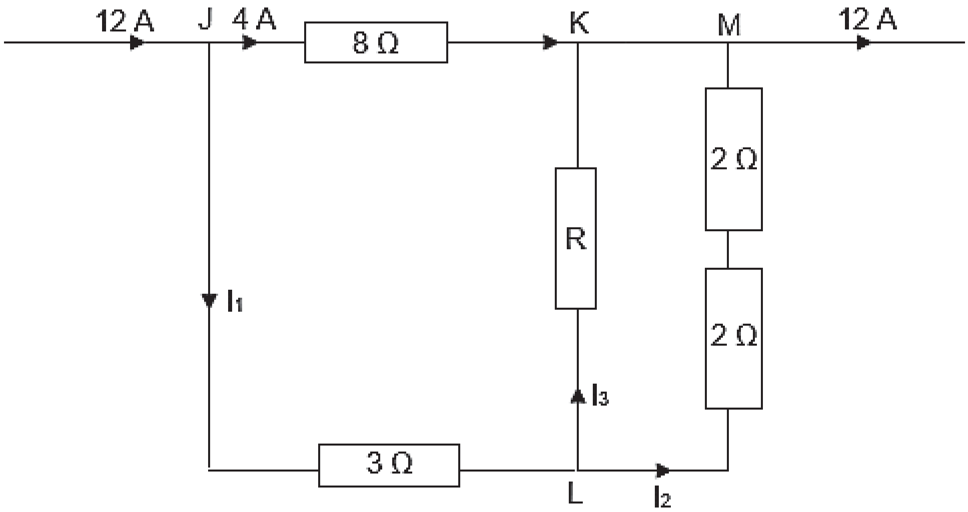


Fig. 11.4

Calculate the currents I_1, I_2, I_3 and the unknown resistance, R.

I_1 = …………………………..

I_2 = …………………………..

I_3 = …………………………..

R = ………………………….. [4]

(b) Fig. 11.5 shows how the resistance, R, of a thermistor varies with temperature, T.

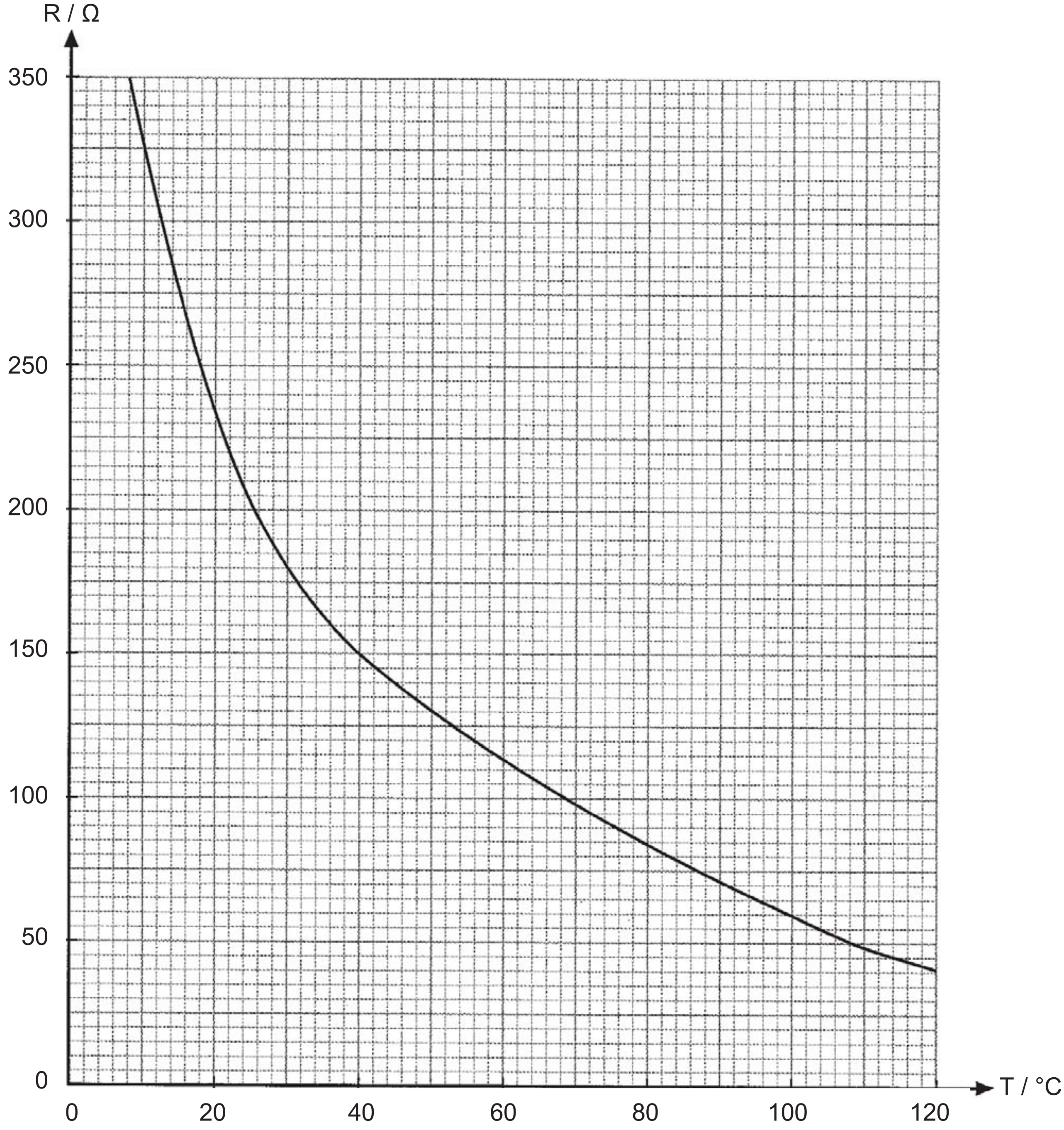


Fig. 11.5

Fig. 11.6 shows the thermistor connected in a circuit.
The e.m.f. of the battery is 9 V and the resistance of the fixed resistor is 200 Ω.

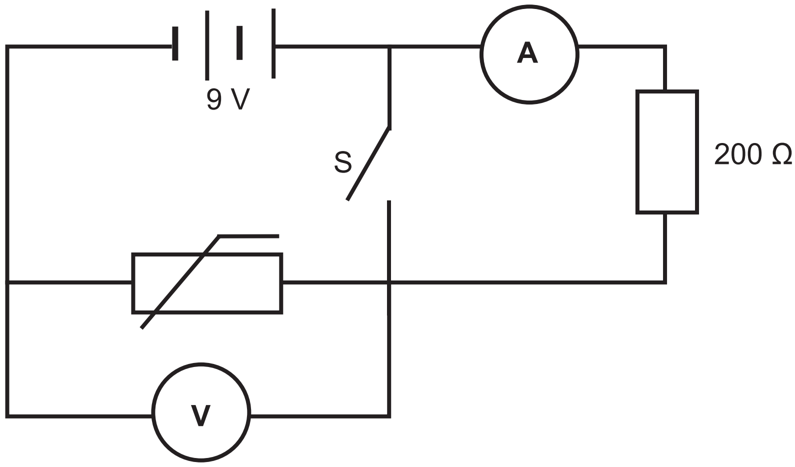


Fig. 11.6

(i) Explain why the ammeter reading decreases to zero when switch S is closed.

____

____ [1]

(ii) Determine the potential difference across the 200 Ω fixed resistor when the temperature of the thermistor is at 40°.

potential difference = ………………………….. [2]

(iii) The voltmeter is replaced with a bulb.

Determine how the brightness of the bulb will change as the temperature of the thermistor increases.

____

____

____

____

____ [3]

End of Paper 2

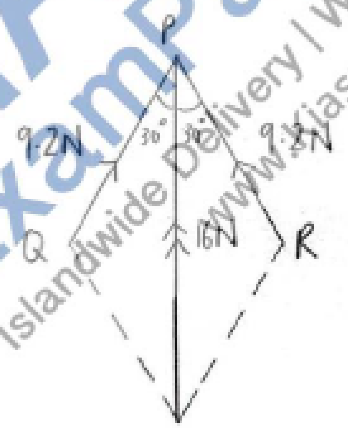
4E Physics Prelim 2022 Marking Scheme

Paper 1 (40 Marks)

1	2	3	4	5	6	7	8	9	10
A	B	D	D	A	C	D	A	A	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	B	B	C	A	A	B	D	C	C
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
B	B	C	A	D	D	B	C	C	C
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
B	B	B	C	C	C	B	D	C	D

Paper 2 Section A (50 Marks)

Qn		Solution	Marks
1	(ai)	10^8	[1]
	(aii)	G d μ n	[1]
	(bi)	Tension = 16 ÷ 2 = 8 N	[1]
	(bii)	Vector Diagram	



1cm : 4N

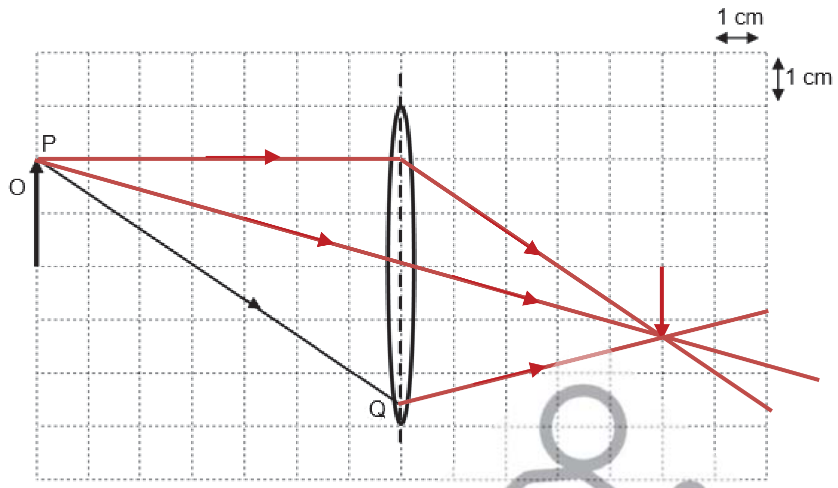
2.3cm : 2.3×4

= 9.2N

Qn		Solution	Marks
	(bii)	Correct parallelogram / tip-to-tail diagram drawn [M1]	[1]
		Resultant force labelled with double arrowhead, tensions labelled with arrowhead [A1]	[1]
		Tension in PQ = Tension in PR = 9.2 N (+/- a range) (both answers)	[1]

Qn	Solution		Marks
2	(a)	When the **driving force is equal to the frictional forces and air resistance acting on the car**, the car experiences **zero resultant force and zero acceleration**, hence it moves at constant speed.	[1]
	(b)	From 50 s – 70 s, the car moves with a **constant deceleration of 1.5 m / s^2 until it comes to a stop**, From 70 s – 80 s, the car **remains stationary / at rest**, From 80 s – 90 s, the car moves with **constant acceleration of 2 m / s^2 but in the opposite direction**.	[1] [1] [1]
	(c)	Displacement = area under graph A – area under graph B $= \frac{1}{2}(50+70)(30) - \frac{1}{2}(30)(20)$ = **1500 m**	[1] [1]
	(d)	Average speed = total distance / total time $= \frac{\frac{1}{2}(50+70)(30)+\frac{1}{2}(30)(20)}{110}$ **= 19.1 m / s**	[1] [1]
3	(a)	**Mass is the amount of matter in a body** while **weight is the gravitational force acting on the mass**.	[1]
	(b)	Taking moments about the pivot at rope B, sum of anticlockwise moments = sum of clockwise moments Tension A × 1.8 = 60 × 0.6 + 100 × 0.9 Tension A = $\frac{60 \times 0.6 + 100 \times 0.9}{1.8} = \mathbf{70\ N}$ Tension B = 100 + 60 – 70 = **90 N**	[1] [1] [1]
	(c)	He should suspend this second bird cage **directly below rope A**. Taking moments about the pivot at rope A, since there is **no perpendicular distance between the pivot and the weight of the second bird cage, there will not be an additional turning effect about A**, hence it will not increase the tension in Rope B. *i.e. suspending the second bird cage directly below rope A only increases the tension in rope A by 30 N.*	[1] [1]

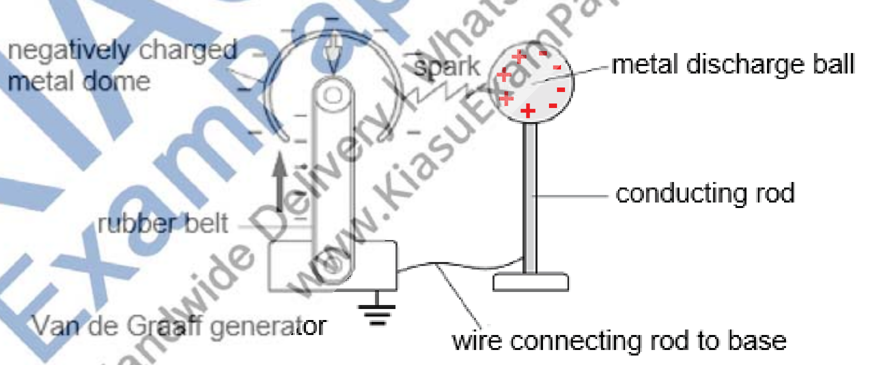
Qn		Solution	Marks
4	**(a)**	$\frac{F_1}{A_1} = \frac{F_2}{A_2}$ $\frac{5}{2} = \frac{F_2}{0.08}$ $F_2 = \frac{5}{2} \times 0.08 = \mathbf{0.2\ N}$	 [1] [1]
	(bi)	Mass = density × volume = 1 × 2 × 0.6 = **1.2 g**	[1]
	(bii)	Work done = force × distance = 5 × 0.6 x 10^{-2} = **0.03 J**	[1]
	(biii)	By principle of conservation of energy, KE of water = work done $\frac{1}{2}mv^2 = 0.03$ $\frac{1}{2}\left(\frac{1.2}{1000}\right)v^2 = 0.03$ $v = \sqrt{\frac{0.03}{\frac{1}{2}\left(\frac{1.2}{1000}\right)}} = \mathbf{7.07\ m/s}$	 [1] [1]
5	**(a)**	**Geothermal energy**	[1]
	(b)	Energy needed = mcΔθ + ml_v = (100)(4200)(100-20) + (40)(2200 × 1000) = **121600000 J = 1.216 × 10^8 J**	 [1], [1] [1]
	(c)	When 1 kg of steam cools to 20 °C, it first experiences a **change of state from gaseous to liquid state** to become hot water which cools to 20 °C. As the molecules which are **very far apart** in the gaseous state **come closer together to form strong bonds** in the liquid state, the **internal potential energy of the molecules decreases,** and latent heat of vaporisation of 2200 kJ / kg is released. When 1 kg of hot water cools to 20 °C, there is **no change of state.** As the **molecules move less vigorously within the liquid,** the **internal kinetic energy of the molecules decreases,** releasing only 4200 J / °C.	 [1] [1] [1] [1]

<table>
<tr><th>Qn</th><th colspan="2">Solution</th><th>Marks</th></tr>
<tr><td>6</td><td>(ai)
(aii)</td><td></td><td>[1] - rays

[1] - image

[1] - PQ</td></tr>
<tr><td></td><td>(b)</td><td>If the object is moved to a distance > f,
- image becomes larger
- image distance from centre of the lens increases

If the object is moved to a distance < f,
- image becomes magnified
- image becomes virtual
- image becomes upright
- image is on same side of lens as object

(any of these two corresponding changes)</td><td>[1]
[1]</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>7</td><td>(a)</td><td></td><td>[1]</td></tr>
<tr><td></td><td>(b)</td><td>Since like charges repel,
the negative charges on the metal dome repel the electrons on the metal discharge ball away, leaving excess positive charges on the side of the metal discharge ball near the dome.</td><td>[1]

[1]</td></tr>
<tr><td></td><td>(c)</td><td>$I = \frac{Q}{t}$

$= \frac{0.57\times10^{-3}}{0.013}$

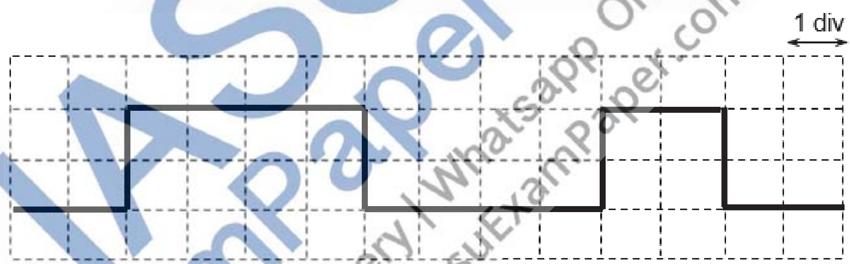
$= \mathbf{0.0438\ A}$</td><td>

[1]

[1]</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>

Qn	Solution		Marks
8	(ai)	The **resistance of the LDR decreases** when light shines on it.	[1]
	(aii)	When light shines on the LDR, the **effective resistance of the circuit decreases** and **current flowing through the relay coil increases**. The current flowing through the coil turns the **soft iron core into an electromagnet** and **creates a magnetic field**. The **soft iron armature becomes an induced magnet** and is **attracted** to the soft iron core in the coil. As it **turns about the pivot, it pushes the relay contacts C close**.	[1] [1] [1]
	(b)	**Benny**'s description of the rotation of coil ABCD is correct. When the current flows in the direction shown in Fig. 8.3, **by Fleming's left hand rule**, side **AB will experience downward force** while side **DC will experience an upward force**, causing the coil to **turn in a clockwise direction**. When side AB rotates to the other side, the current direction remains the same and side **AB will still experience a downward force** while side **DC will still experience an upwards force**, causing the coil to **turn in an anticlockwise direction after half a rotation**. *i.e. the coil will reverse direction every half a rotation if the current continues to flow in the direction shown in Fig. 8.3.*	[1] [1]

Paper 2 Section B (30 marks)

Qn	**Solution**		**Marks**
9	**(a)**	Ray 1 passes straight through the glass as the **angle of incidence between the air-glass boundary is 0°**, so the light ray does not bend. Ray 2 and 3 experience **total internal reflection** within the glass as the **angle of incidence at the glass-cladding boundary is more than the critical angle** and the **refractive index of the glass is higher than that of the cladding**.	[1] [1] [1] - both pts
	(bi)	Speed of light in glass = $\frac{distance}{time} = \frac{1000}{5.0\times10^{-6}} = 2\times10^{8}$ m / s Refractive index = $\frac{c}{v} = \frac{3.0\times10^{8}}{2.0\times10^{8}} = \mathbf{1.5}$	[1] [1]
	(bii)	$n = \frac{\sin i}{\sin r}$ $1.5 = \frac{\sin 20}{\sin r}$ $r = \sin^{-1}(\frac{\sin 20}{1.5}) = \mathbf{13.2}°$	[1] [1]
	(ci)		[1] -Y-gain [1] - time-base
	(cii)	Number of pulses per second = $\frac{1}{1.0\times10^{-6}} = \mathbf{1000000}$	[1]
	(d)	1. **Higher carrying capacity** (ability to carry larger amounts of information) 2. **Less signal degradation** (information integrity and quality is better maintained) **3. Lightweight** **4. Lower costs** *(any two advantages)*	[1] [1]

Qn	Solution		Marks
10	**(a)**	An alternating current is a **current that reverses directions at a regular frequency**.	[1]
	(b)	The alternating voltage in the primary coil **produces a constantly changing magnetic field within the soft iron core**. The secondary coil in turn experiences **constantly changing magnetic flux** which **induces an emf** in the secondary coil. *i.e. by Faraday's law of Electromagnetic Induction, the induced emf is proportional to the rate of change of magnetic flux in the secondary coil.*	[1] [1]
	(c)	$\frac{Ns}{Np} = \frac{Vs}{Vp}$ $\frac{Ns}{8000} = \frac{6}{240}$ $Ns = \frac{6}{240} \times 8000 = \mathbf{200}$	[1] [1]
	(di)	The function of the fuse is to disconnect the transformer from the mains in the event of a surge of current in the primary coil. It must be connected in series with the primary coil **to experience the surge in current and break the circuit when the current exceeds the fuse rating**. It will not work if it is connected in parallel and does not experience the same surge in current.	[1]
	(dii)	Input power = VI = 240 × 200 × 10^{-3} = 48 W Output power = 3 × 12 = 36 W Efficiency = $\frac{output\ power}{input\ power} \times 100\%$ $= \frac{36}{48} \times 100\% = \mathbf{75\%}$	[1] - for both [1]

Qn	Solution		Marks
11 E	(ai)	As the transmitted pulse travels to and from the seabed, some energy is dissipated to the water and seabed, hence the reflected pulse is weaker than the transmitted pulse.	[1]
	(aii)	Deepest depth at C or D $= \frac{s \times t}{2} = \frac{1500 \times 0.8}{2}$ $= \mathbf{600\ m}$	[1] [1]
	(aiii)	$v = f\lambda$ $\lambda = \frac{1500}{50000} = 0.03\ m$ number of wavelengths $= \frac{600}{0.03} = \mathbf{20000}$	[1] [1]
	(aiv)	As the speed of sound wave in solid rock increases, the wavelength of the wave in solid rock increases. Hence, there will be a smaller number of wavelengths in the same distance of solid rock.	[1] [1]
	(b)	 *(any two)* *i.e. the compression will move into the place of the next rarefaction after half a period*	[1]
	(c)	Similarity: Ultrasound waves and ultraviolet rays both transfer energy from one point to another. Difference: Ultrasound waves cannot travel in a vacuum while ultraviolet rays can travel in a vacuum. Ultrasound waves are longitudinal waves while ultraviolet rays are transverse waves. The speed of ultrasound waves in air is much lower than the speed of ultraviolet rays in air. *(any difference)*	[1] [1]

Qn	Solution		Marks
11 O	(a)	$I_1 = 12 - 4 = 8$ **A**	[1]
		p.d. across JK = IR = 4 × 8 = 32 V	
		p.d. across JL = IR = 8 × 3 = 24 V	
		p.d. across LM = 32 – 24 = 8 V	
		$I_2 = V / I = 8 \div (2 + 2) = $ **2 A**	[1]
		$I_3 = 8 - 2 = $ **6 A**	[1]
		$R = V / I = 8 \div 6 = $ **1.33 Ω**	[1]
	(bi)	When switch S is closed, **current will flow through switch S** instead of through the resistor and ammeter and **cause a short circuit.**	[1]
	(bii)	p.d. $= \frac{200}{200+150} \times 9$	[1]
		= 5.14 V	[1]
	(biii)	As the temperature of the thermistor increases, the **resistance of the thermistor decreases and the potential difference across the thermistor decreases** too.	[1]
		Since the bulb is arranged in parallel to the thermistor, **the potential difference across the bulb will also decrease.**	[1]
		By V = RI, when potential difference decreases, **current decreases** and the **brightness of the bulb drops.**	[1]

End of marking scheme

Name: ………………………………………… Index no.: ………. Class………..

Bukit Batok Secondary School

GCE O LEVEL PRELIMINARY EXAMINATIONS 2022

SECONDARY 4 EXPRESS

PHYSICS **6091/01**

Paper 1 Multiple Choice

31 Aug 2022

1 Hour

1005 – 1105 h

Additional Materials: Multiple Choice Answer Sheet (OAS)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, index number and class in the spaces provided at the top of this page.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the OAS.

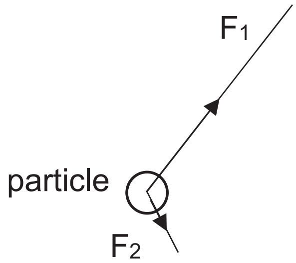
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This Question paper consists of 17 printed pages including this cover page.

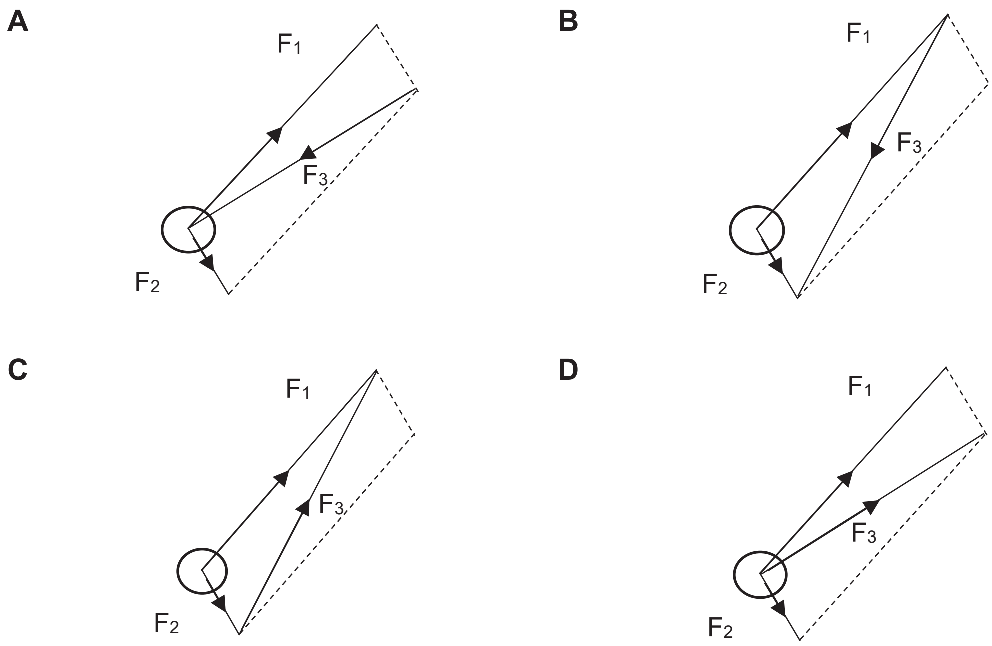
1 What is the conversion factor for converting gigametres (Gm) to millimetres (mm)?

A 10^3 **B** 10^6 **C** 10^9 **D** 10^{12}

2 Two forces, F_1 and F_2, act on a particle as shown.



Which diagram correctly shows the force F_3 that would keep the particle stationary?

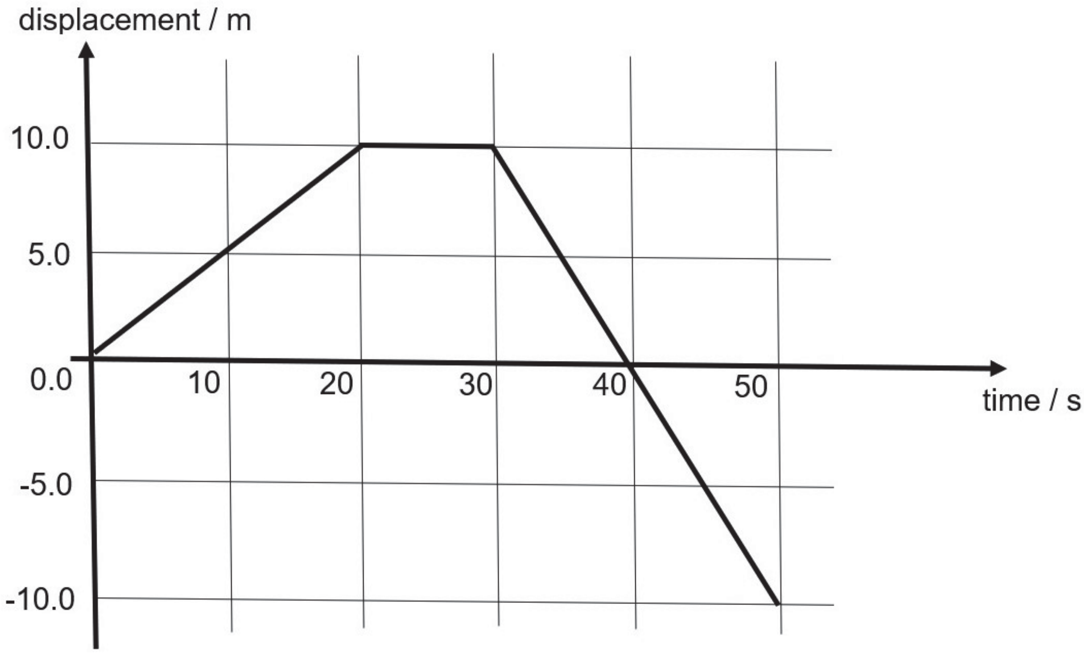


3 An object is falling under gravity with terminal velocity.

Which of the following statements is correct?

A The acceleration of the object will decrease to zero.
B The force on the object due to air resistance will decrease to zero.
C The resultant force on the object is zero.
D The speed of the object will decrease at a constant rate to zero.

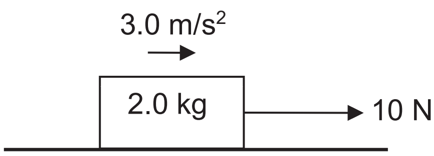
4 The diagram shows the displacement-time graph of a car traveling on a straight, horizontal road.



What is the total distance travelled by the car in 50 s?

A - 10 m
B 0 m
C 30 m
D 300 m

5 A block of mass 2 kg is pulled by a constant force of 10 N. It moves with an acceleration of 3.0 m/s^2 on a horizontal ground as shown below. At a certain instant during its motion, the 10 N force is removed.

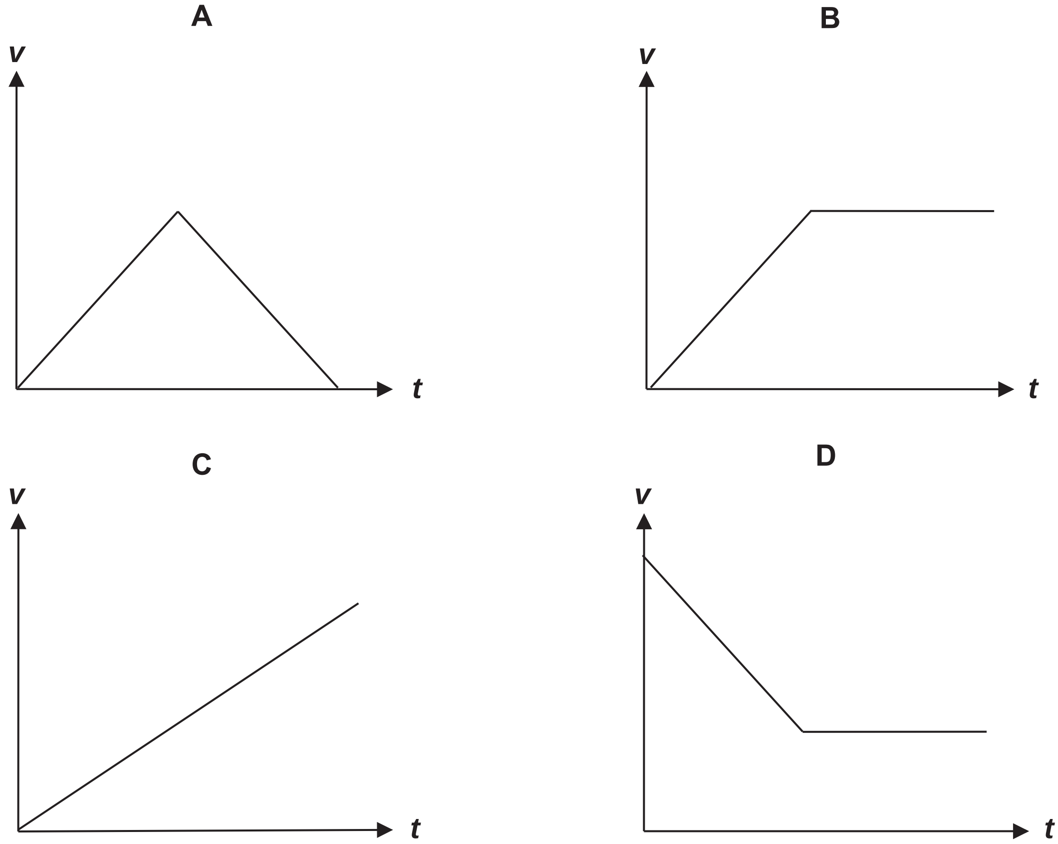


What is the motion of the block immediately after the 10 N force is removed?

A accelerates in the opposite direction
B continue to move forward with a constant velocity
C continue to move forward with a deceleration
D immediately comes to a stop

6 The diagram below shows a ball being released on a frictionless track from rest at point L.

Assuming negligible air resistance, which graph correctly shows how the speed of the ball varies with time from L to M ?



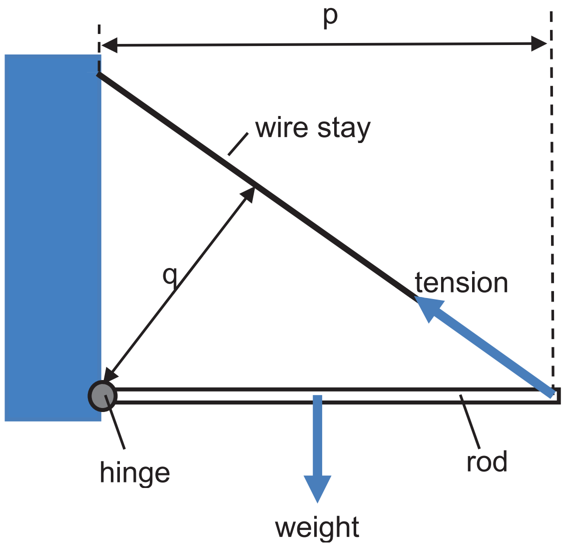
7 A metal cube has a mass of 15 g. Each side measures 4.0 cm. The density of the metal is 3000 kg / m^3.

There is empty space in the middle of the cube.

Which is the volume of the empty space?

A 5.0 cm^3 **B** 11 cm^3 **C** 19 cm^3 **D** 59 cm^3

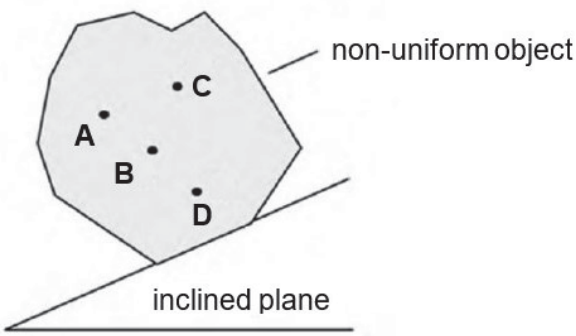
8 The diagram below shows a hinged uniform rod that is held horizontal by a wire stay.



Which expression to calculate the tension in the wire stay is correct?

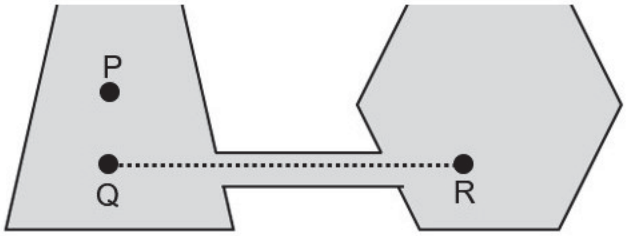
A tension = weight x (p / 2) ÷ p
B tension = weight x (p / 2) ÷ q
C tension = weight ÷ (p / 2) x q
D tension = weight ÷ (p / 2) ÷ q

9 A non-uniform object is placed on an inclined plane. The object is just about to topple.



Which position is the centre of gravity?

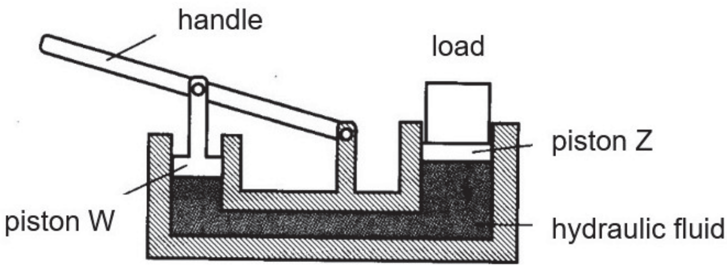
10 Two vessels are joined together with a tube and filled with water. Both vessels are open at the top.



How does the water pressure at point Q compare to the water pressures at P and R?

	pressure at P	pressure at R
A	lower than at Q	greater than Q
B	same as at Q	greater than Q
C	lower than at Q	same as at Q
D	same as at Q	same as at Q

11 The diagram below shows a simple hydraulic jack.



Which modifications will enable heavier loads to be lifted?

	diameter of W	diameter of Z
A	doubled	halved
B	doubled	remains the same
C	halved	doubled
D	remains the same	halved

12 A truck is travelling at a steady speed along an expressway.

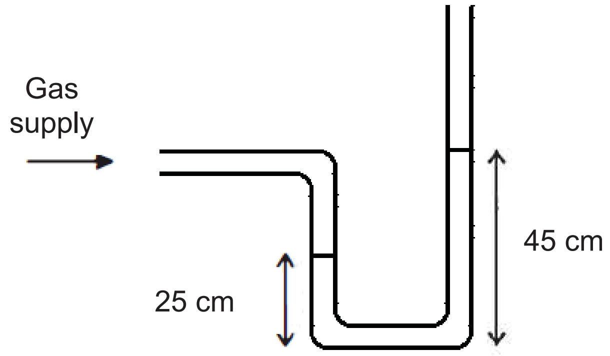
The forward force is 4000 N and the power produced is 10 000 W.

How far does the truck travel in one minute?

A 2.5 m **B** 24 m **C** 150 m **D** 66 km

13 A manometer is filled with a liquid of density 880 kg/ m^3.

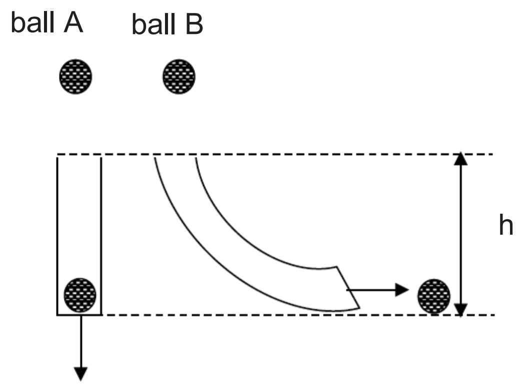
The gravitational field strength *g* is 10 N/ kg.



What is the excess pressure of the gas supply compared to atmospheric pressure?

A 1760 Pa
B 2200 Pa
C 3960 Pa
D 17 600 Pa

14 Two balls of equal mass are dropped down a frictionless chute from the same height as shown below. As the balls emerge, ball A travels perpendicular to the ground and ball B travels parallel to the ground. Ignore energy losses to the surroundings.



Which of the statements on the energy of the two balls as they emerge from the chutes is correct?

A Kinetic energy of ball A is equal to ball B.
B Kinetic energy of ball A is lower than ball B.
C Gravitational energy of ball A is at its maximum and equal to ball B.
D Gravitational energy of ball A is lower than ball B.

15 The input power to a motor is 300 W. In 20 s, it lifts a load of 400 N through a height of 6.0 m.

What is the efficiency of the motor?

A 12 %
B 25 %
C 40 %
D 75 %

16 In the Brownian experiment, smoke particles are viewed under a microscope.

Which row describes and explains Brownian motion?

	description	explanation
A	random	air molecules cannot be seen under a microscope and bombard the smoke particles
B	random	air molecules can be seen under a microscope and bombard the smoke particles
C	random	smoke particles can be seen under a microscope and bombard the air molecules.
D	vibrate	both smoke particles and air molecules can be seen under a microscope and smoke particles bombard the air molecules

17 A fixed mass of gas is kept at constant temperature. When the volume of the gas decreases, the pressure increases.

Why is this?

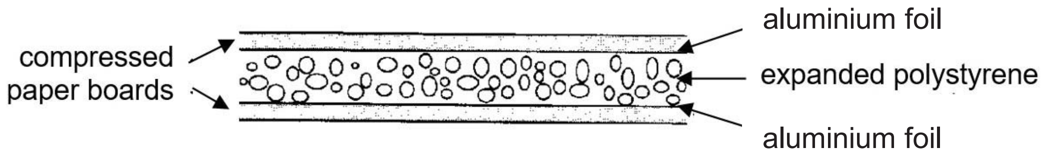
A The molecules are closer together and they collide more frequently.
B The molecules are closer together and they move faster.
C The molecules move more quickly and they collide more frequently.
D The molecules move more quickly and the hit each other harder.

18 Physical properties of materials are used in the measurement of temperature.

Which physical property is **not** suitable for this purpose?

A expansion of a metal
B mass of a liquid
C resistance of a metal
D volume of a liquid

19 The diagram shows a section through a particular type of building board.



Which best explains why such boards provide good heat insulation?

	aluminium foil	expanded polystyrene	compressed paper boards
A	is a good conductor	is a good reflector	has high thermal conductivity
B	is a good conductor	is a poor reflector	has high thermal conductivity
C	is a good reflector	is a good conductor	has low thermal conductivity
D	is a good reflector	is a poor conductor	has low thermal conductivity

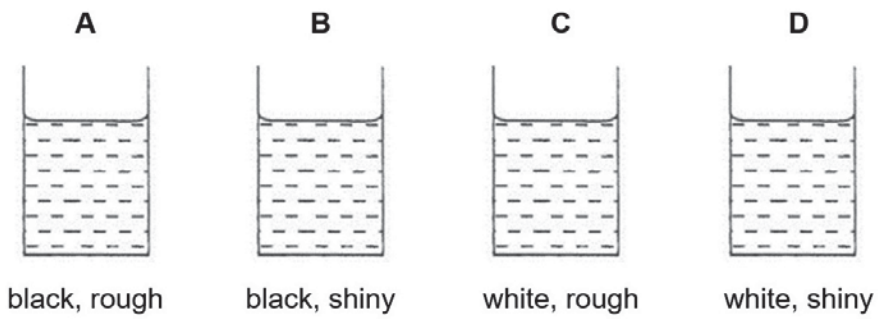
20 The cooling unit of an air conditioner is always placed at the top of rooms. The air conditioner takes in warm air and gives out cold air.

Which statements explains this?

A A cool air molecule is denser that a warm air molecule and sinks.
B A cool air molecule is less dense than a warm air molecule and rises.
C The cool air is denser than the warm air and sinks.
D The cool air is less dense than the warm air and sinks.

21 Four metal cans are identical except for the colour and texture of their outer surface. 100 cm^3 of water at 70 °C is poured into each can.

In which metal can will the water cool most rapidly?



22 An iron block of mass 10 kg is kept at room temperature.

If the mass of the iron block is reduced to half which statement about the specific heat capacity and heat capacity is correct?

	specific heat capacity	heat capacity
A	lesser	lesser
B	same	lesser
C	lesser	same
D	same	same

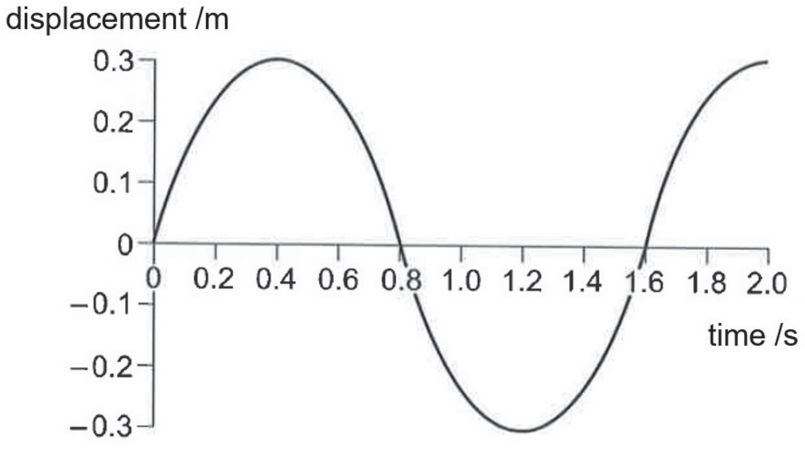
23 1.5 kg of liquid X is heated up by an immersion heater of power 100 W for 7.5 min in a vessel of heat capacity 20 J/°C. The temperature of X and the vessel is raised from 20 °C to 30 °C and 600 J of energy is lost to the surroundings.

What is the specific heat capacity of X?

A 2950 J/kg °C
B 3000 J/kg °C
C 4430 J/kg °C
D 5900 J/kg °C

24 The boat oscillates vertically as the water wave passes.

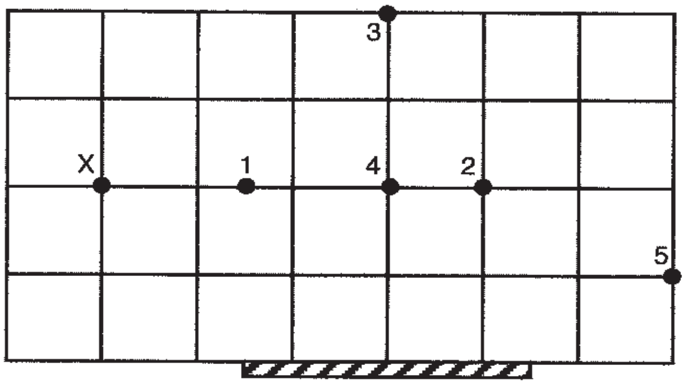
The graph shows how the displacement of the boat from its equilibrium position varies with time.



What characteristics of the wave can be deduced from the graph?

A Its amplitude is 0.3 m and its speed is 0.75 m/s.
B Its amplitude is 0.3 m and its period is 1.6 s.
C Its wavelength is 1.6 m and its speed is 0.75 m/s.
D Its wavelength is 1.6 m and its period is 1.6 s.

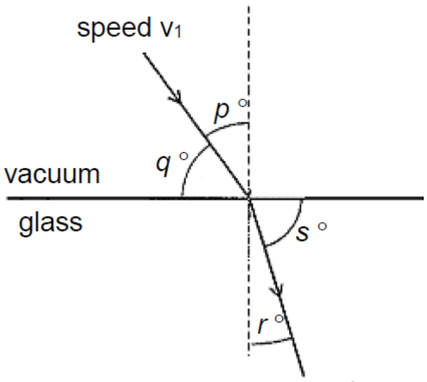
25 A person stands at point X as shown in the diagram below.



Which of the pins (1, 2, 3, 4, 5) will the person be able to see in the mirror?

A pins 1 and 3
B pins 2 and 4
C pins 2, 3 and 5
D pins 2, 4 and 5

26 A ray of light travels from vacuum into glass.

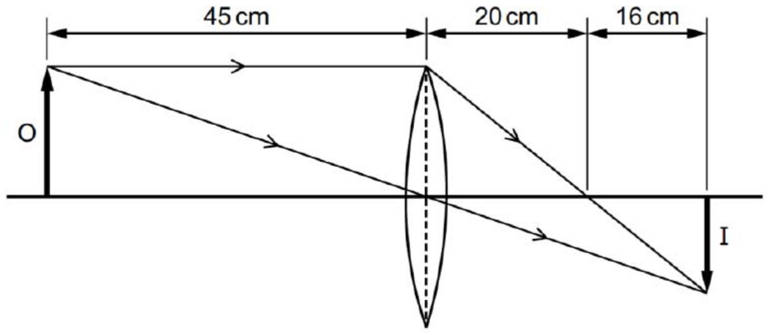


Which quantity gives a constant value as the angle of incidence of the ray changes?

A $\dfrac{\sin(p°)}{\sin(s°)}$ **B** $\dfrac{\sin(p°)}{\sin(r°)}$

C $\dfrac{\sin(q°)}{\sin(s°)}$ **D** $\dfrac{\sin(q°)}{\sin(r°)}$

27 In the diagram, a convex lens forms an image I of an object O. The diagram is not drawn to scale.



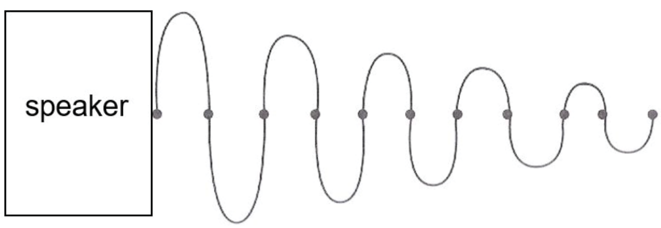
What happens as the object is moved towards the focal point?

A The image moves further than 36 cm from the lens and decreases in size.
B The image moves further than 36 cm from the lens and increases in size.
C The image moves towards the lens and decreases in size.
D The image moves towards the lens and increases in size.

28 Which row does **not** show a correct application of the stated electromagnetic wave?

	electromagnetic wave	application
A	x-rays	detection of bone fractures
B	radio waves	satellite television
C	gamma-rays	medical treatment
D	ultraviolet radiation	sterilisation

29 The diagram shows the resulting sound wave produced by a speaker.



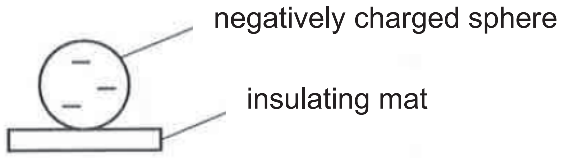
How does the sound produced by the speaker vary as time passes?

A The pitch of the sound becomes higher.
B The pitch of the sound becomes lower.
C The sound becomes less loud.
D The sound becomes louder.

30 What **always** experiences a force when places in an electric field?

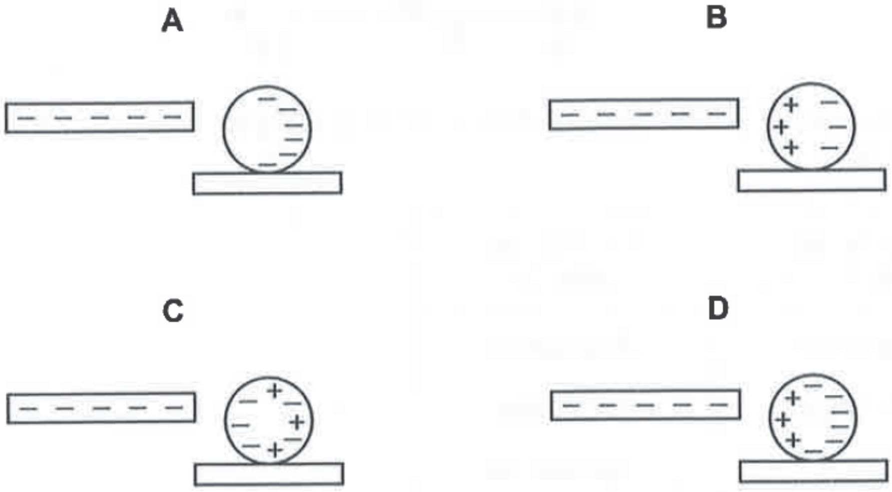
A a solenoid
B a magnet
C a piece of wood
D an electric charge

31 A negatively charged copper sphere rests on an insulating mat.



A negatively charged polythene rod is brought near to the copper sphere.

Which diagram best shows the distribution of charge on the sphere?



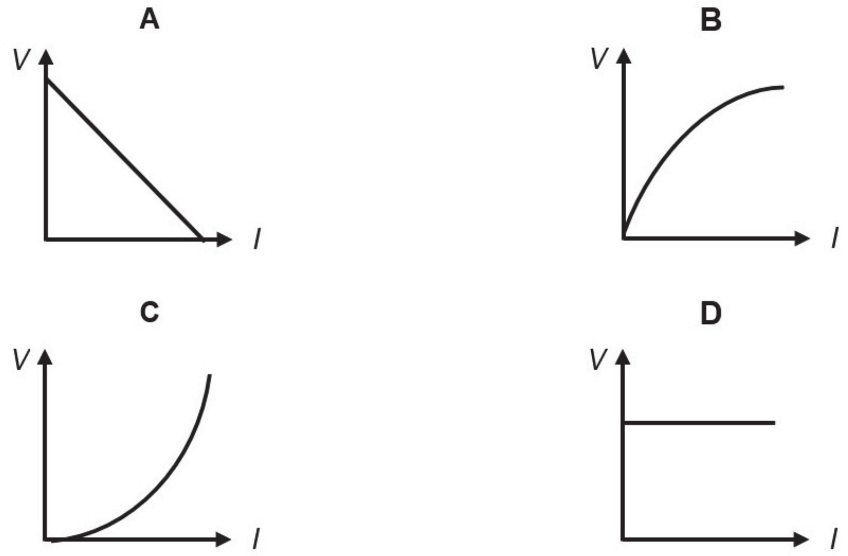
32 The voltage produced by a generator is 20 000 V. The ammeter records a current of 0.00060 A. If each electron carries a charge of 1.6×10^{-19}C,

how many electrons passes through the ammeter in 2.0 s?

A 3.3×10^{7}
B 7.5×10^{14}
C 3.8×10^{14}
D 7.5×10^{15}

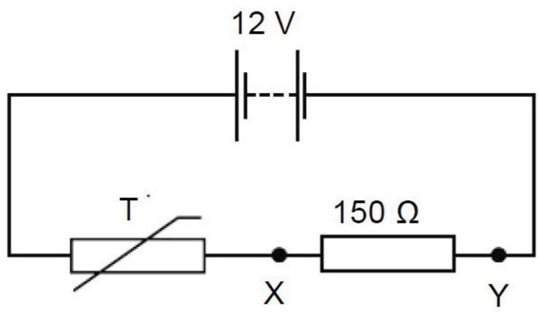
33 The diagrams show the voltage-current graphs for four electrical devices.

Which diagram shows the resistance increasing as the current rises?



34 A thermistor T increases in resistance as temperature decreases and is used in a fire alarm system.

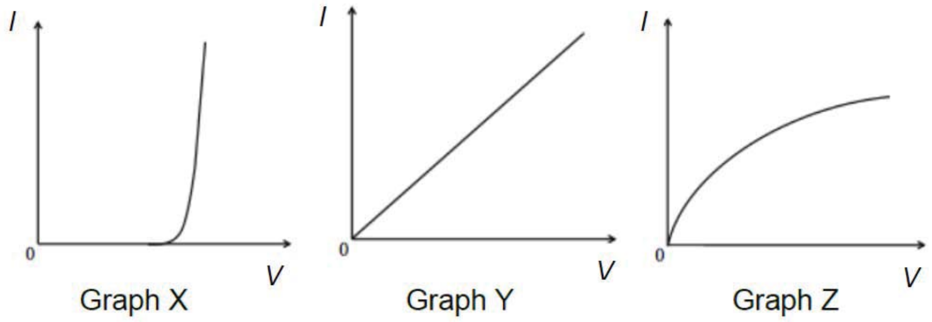
The alarm is triggered when the potential difference between X and Y is 4.5 V.



What is the resistance of T when the alarm is triggered?

A 90 Ω
B 250 Ω
C 400 Ω
D 550 Ω

35 The graphs show the variation of current *I* with potential difference *V* for a metal wire at constant temperature, a semiconductor diode and a filament lamp.



Which row correctly identifies these graphs?

	metal wire	semiconductor diode	filament lamp
A	X	Z	Y
B	Y	X	Z
C	Y	Z	X
D	Z	X	Y

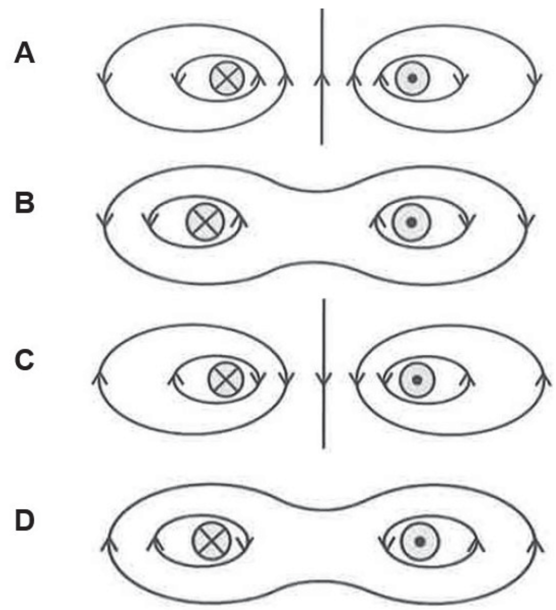
36 The power produced in a resistor P. The voltage across the resistor is then doubled.

What is the new power produced in the resistor?

A $\frac{P}{2}$
B P
C $2P$
D $4P$

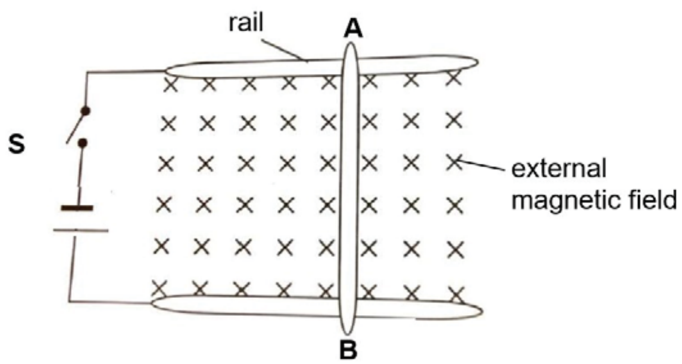
37 Each of the diagrams below is a cross-section through two parallel current-carrying current.

Which diagram correctly shows the magnetic field pattern formed by the currents in the two conductors?



38 A metal rod **AB** is placed on two smooth horizontal metal rails on the bench.

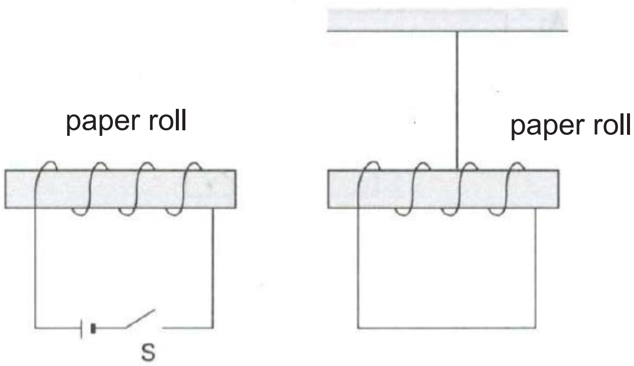
The rail and the rod are subjected to an external magnetic field. The top view of the setup is shown below.



When switch S is closed, in which direction will rod **AB** move?

A into the page
B out the page
C to the right of the page
D to the left of the page

39 The diagram shows a fixed solenoid near a coil hung free to move.
The material within the coil and solenoid is a paper roll.



What happens to the coil when switch S is closed?

A attracted to the solenoid and then returns to rest
B repelled by the solenoid and then returns to rest
C remains at rest
D swings back and forth

40 A transformer is used with an a.c. supply to power a 12 V lamp at its correct rating. The transformer has an efficiency of 100%.

What supply voltage, number of turns on the primary coil and number of turns on the secondary coil are suitable?

	supply voltage/ V	number of turns on primary coil	number of turns on secondary coil
A	24	200	1000
B	24	200	10 000
C	240	2000	10
D	240	2000	100

End of Paper

Name: ………………………………………… Index no: ………. Class: ………..

Bukit Batok Secondary School

GCE 'O' LEVEL PRELIMINARY EXAMINATIONS 2022
SECONDARY FOUR EXPRESS

PHYSICS **6091 / 02**

Paper 2 Theory

23 Aug 2022

1105 – 1250 h

1 hour 45 minutes

Candidates answer on the Question Paper

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class, and class register number on all the work you hand in.
Write in dark blue or black ink.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions in the space provided.

Section B
Answer **all** questions in the space provided. Question 12 has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

At the end of examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

FOR EXAMINER'S USE	
Section A	
Section B	
TOTAL	

This Question Paper consists of **22** printed pages.

Section A

Answer **all** the questions in this section.

1 A motor-boat travels due north at a steady speed of 3.0 m/s through calm water in which there is no current.

The boat then enters an area of water in which a steady current flows at 2.0 m/s in a south-west direction as shown in Fig. 1.1. Both the engine power and the course setting remain unchanged.

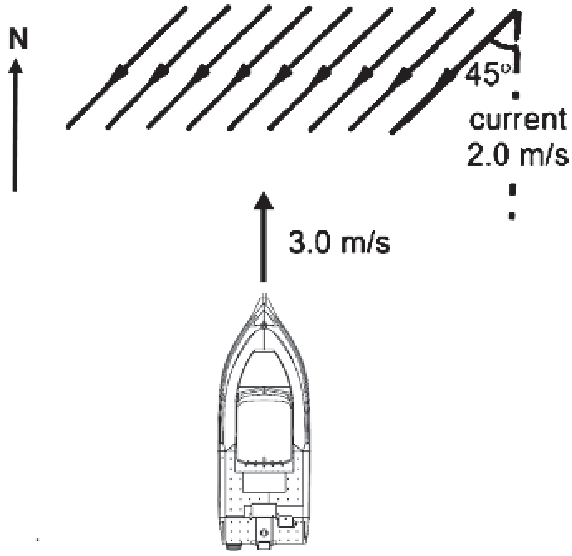


Fig. 1.1

In the space below, draw a vector diagram to determine

- the magnitude of the resultant velocity of the boat,
- the angle between due north and the resultant velocity of the boat.

State the scale that you use for your vector diagram.

scale: ……………………………………………..

magnitude = …………………………

angle = ………………………… [4]

2 Fig. 2.1 shows an athlete throwing a discus. The mass of the discus is 1.0 kg. The discus is held at arm's length. She turns in a circle before releasing the discus. In completing one circle the discus travels 6.0 m in 1.5 s. At the instant the discus is released, it has a speed of 54 km/h.

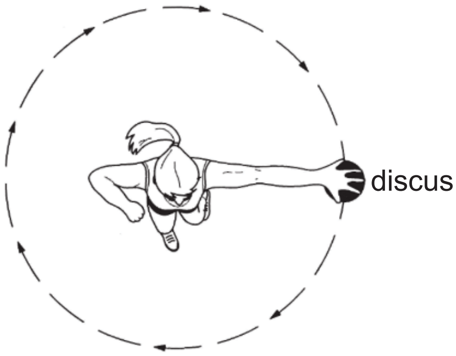


Fig. 2.1

(a) **(i)** Calculate the average speed of the discus before it is released. Give your answer to an appropriate number of significant figures.

average speed = ………………………… [2]

(ii) It is known that speed is a scalar quantity and velocity is a vector quantity. Explain why the average speed and average velocity of the discus is different.

………………………………………………………………………………………

……………………………………………………………………………………… [1]

(b) Calculate the kinetic energy of the discus when it is released. Give your answer to an appropriate number of significant figures.

kinetic energy = ………………………… [3]

3 Fig. 3.1 shows the horizontal forces acting on a car when it is moving on level road. The sum of air resistance and friction is known as the total resistive force.

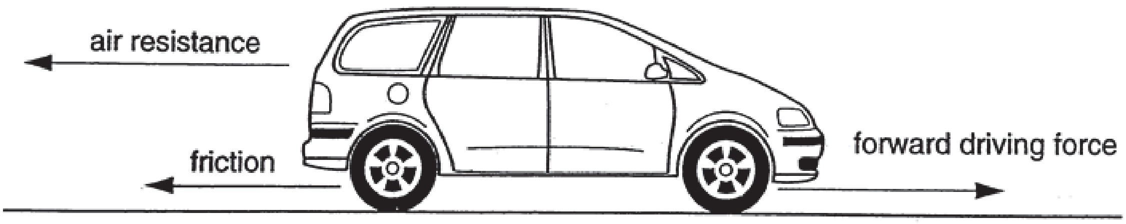


Fig. 3.1

A graph of total resistive force against time t is shown in Fig. 3.2.

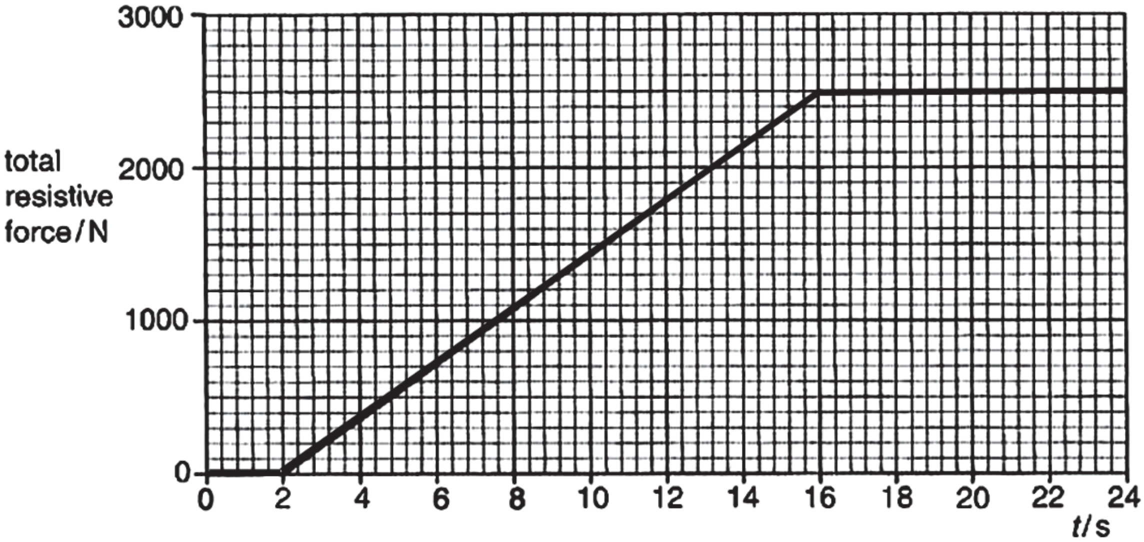


Fig. 3.2

The car is at rest at t = 0 s.
The forward driving force acting on the car is zero until t = 2.0 s.
From t = 2.0 s to t = 24 s, the driving force has a constant value of 2500 N.
The car has a mass of 850 kg.

(a) **(i)** During which two time intervals are the forces on the car balanced?

.... [1]

(ii) Describe the motion of the car during these two time intervals.

....

....

.... [2]

Question continues on next page…

(b) **(i)** Calculate the acceleration of the car at t = 2.0 s.

acceleration = ………………………… [2]

(ii) Calculate the value of time t when the acceleration of the car is 2.0 m/s^2.

t = ………………………… [3]

4 Fig. 4.1 shows a sack truck supporting a box.

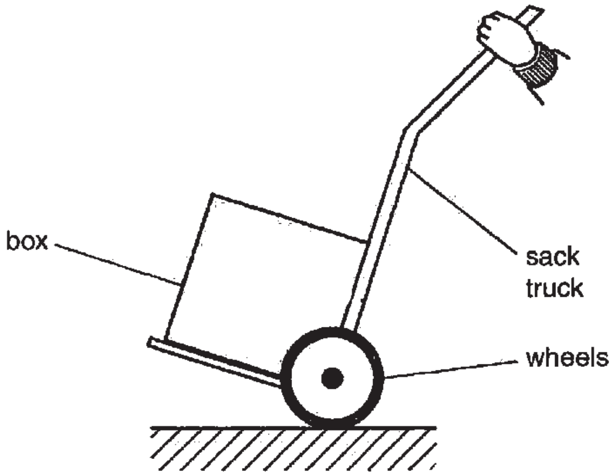


Fig. 4.1

Three of the forces acting on the truck are

- the weight **W** of the box,
- the effort force **E** provided by the hands,
- the force **F** between the ground and the wheels.

(a) On Fig. 4.1, mark and label these three forces. Show clearly where each force acts and the direction of each force. [3]

(b) By applying the principle of moments, explain how the design of the truck makes it easier to lift the box.

……………………………………………………………………………………………...

……………………………………………………………………………………………...

……………………………………………………………………………………………... [2]

5 Fig. 5.1 shows a syringe that contains a gas at the same pressure as the air outside. The piston moves freely along the cylinder without any friction. No gas escapes. The sealed end has a smaller cross-sectional area than the piston.

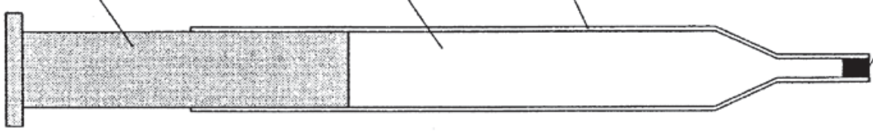


Fig. 5.1

(a) Use ideas about molecules, explain why

(i) the gas exerts a pressure on the cylinder.

....

....

.... [2]

(ii) the gas exerts the same pressure on the piston as it does on the sealed end.

....

.... [1]

(b) As the syringe is heated from 20 °C to 100 °C, the piston moves outwards to the left. It stops moving when the temperature is steady. State how the value of each of the following quantities compares at 100 °C, after the piston stops, with its value at 20 °C.

For each quantity you should only write *greater*, *the same* or *less*.

(i)	average distance between gas molecules		[1]
(ii)	pressure of the gas after the piston stops		[1]
(iii)	average speed of the gas molecules		[1]
(iv)	frequency of collision between gas molecules and cylinder		[1]

6 The displacement-time graph of a particle X of a transverse wave is as shown in Fig. 6.1.

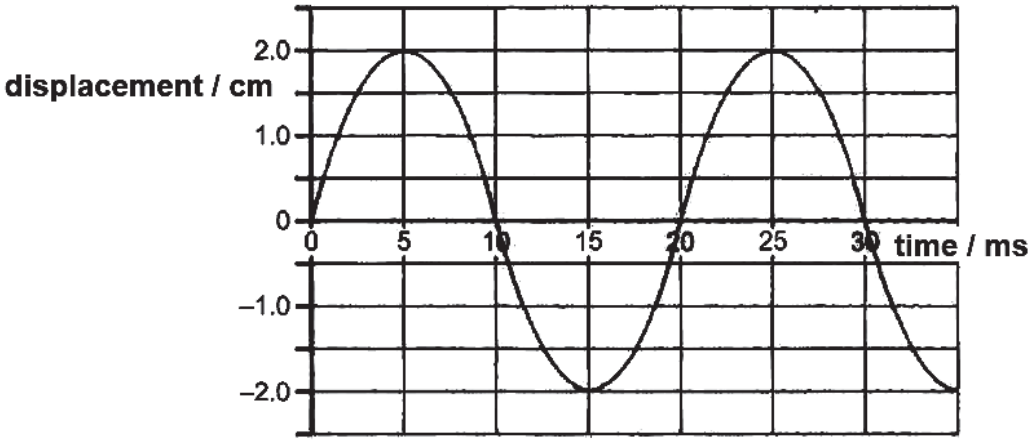


Fig. 6.1

Fig. 6.2 shows some wavefronts of the same wave.

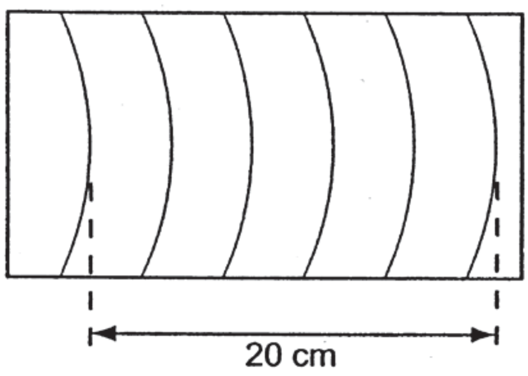


Fig. 6.2

(a) Based on Fig. 6.1, describe the movement of particle X for one complete cycle, starting from time t = 0.

……………………………………………………………………………………………...

……………………………………………………………………………………………...

……………………………………………………………………………………………... [3]

(b) State what is meant by the wavefront of a wave.

……………………………………………………………………………………………...

……………………………………………………………………………………………... [1]

Question continues on next page…

(c) Use the wave equation to calculate the speed of propagation of the wave. Express your answer in SI unit.

speed = ………………………… [2]

7 Fig. 7.1 shows words seen through a lens. Fig. 7.2 shows the same words without the lens.

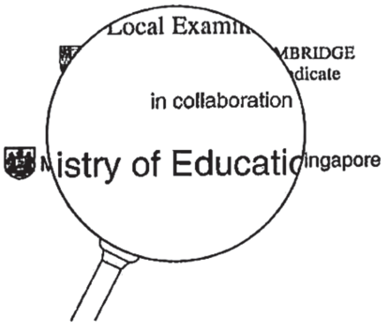


Fig. 7.1

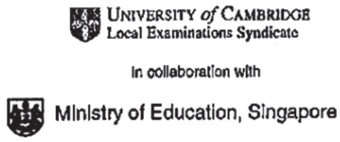


Fig. 7.2

(a) Based on Fig. 7.1, state **two** properties of the image formed by the lens.

……………………………………………………………………………………………... [1]

(b) On Fig. 7.3, draw a ray diagram to show how the image in Fig. 7.1 was formed by the lens. Mark clearly the focal length (f) of the lens and the image formed.

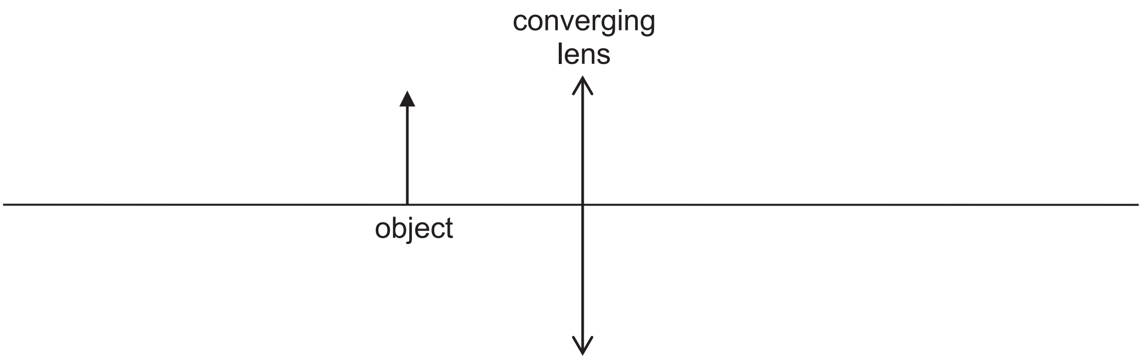


Fig. 7.3 [4]

(c) The lens is then replaced by another lens of smaller diameter but of the same focal length.
Describe any change to the image formed by the smaller lens.

……………………………………………………………………………………………... [1]

8 Fig. 8.1 shows an electric circuit containing two resistors.

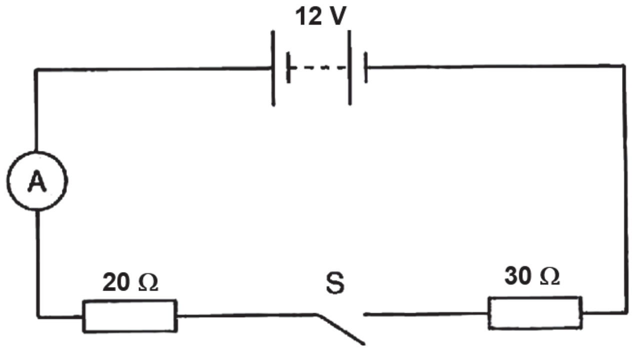


Fig. 8.1

(a) When switch S is open, the ammeter reading is zero.
State the value of the potential difference (p.d.) across switch S.

p.d. = ………………………… [1]

(b) Switch S is now closed.

(i) Calculate the current through the 20 Ω resistor.

current = ………………………… [2]

(ii) Calculate the potential difference (p.d.) across the 30 Ω resistor.

p.d. = ………………………… [1]

(iii) State the value of the potential difference (p.d.) across switch S.

p.d. = ………………………… [1]

9 A straight wire AB is connected to a centre-zero sensitive ammeter and move vertically downwards, towards a pair of strong permanent magnets as shown in Fig. 9.1.

In doing so, the needle of the centre-zero sensitive ammeter deflects momentarily to the right (deflects to the right briefly and returns to zero).

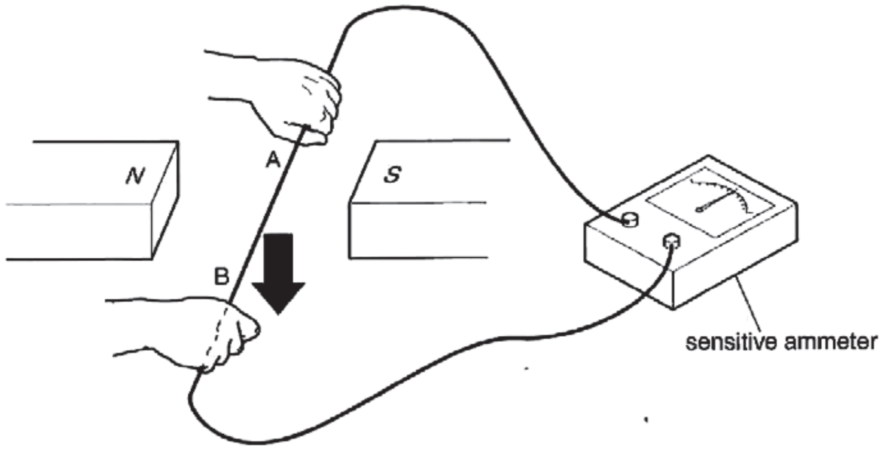


Fig. 9.1

(a) Explain what causes this momentary deflection.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………………… [2]

(b) State what happens to the needle of the sensitive ammeter when wire AB is moved vertically upwards at a greater speed.

………………………………………………………………………………………………… [1]

Section B

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 12**.

10 Some information is given below for an electric car for use in a town.

	with a load of 80 kg	with a load of 160 kg
maximum speed	10.9 m/s	10.9 m/s
initial acceleration	2.00 m/s^2	1.82 m/s^2

mass of car without any load	900 kg
furthest distance travelled by car at maximum speed without recharging	49 km
average power produced by battery at maximum speed	4.24 kW
e.m.f. of battery	48 V
maximum charging current	95 A

(a) **(i)** When the load in the car doubles from 80 kg to 160 kg, the initial acceleration of the car decreases.
Explain what caused this decrease in acceleration to occur.

....

....

....

....

.... [2]

(ii) Explain, in terms of the forces acting on the car, why the car has a maximum speed.

....

....

....

....

....

....

.... [3]

Question continues on next page…

(b) The car travels the furthest distance at the maximum speed without recharging.

Calculate

(i) the time taken,

time = ………………………… [1]

(ii) the energy provided by the battery,

energy = ………………………… [1]

(iii) the minimum time taken to fully recharge the battery.

time = ………………………… [2]

(iv) State **one** assumption that you made in calculating **(b)(iii)**.

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………………… [1]

11 **(a)** Fig. 11.1 shows a small plotting compass placed above a copper wire. When there is no current in the wire, the plotting compass points towards the North.

Fig. 11.2 shows the same set-up as shown in Fig. 11.1 but a large direct current now flows through the wire.
The direction of the direct current is as shown in Fig. 11.2.

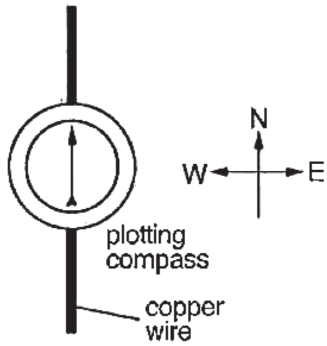


Fig. 11.1

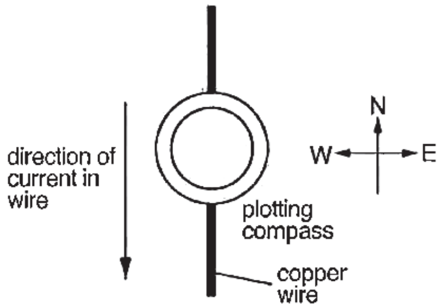


Fig. 11.2

(i) State what happens to the needle of the plotting compass.

.... [1]

(ii) An alternating current of frequency 50 Hz now flows through the wire.
State and explain what is observed in the needle of the plotting compass.

....

....

.... [2]

(b) Fig. 11.3 shows the diagram of a simple d. c. motor.

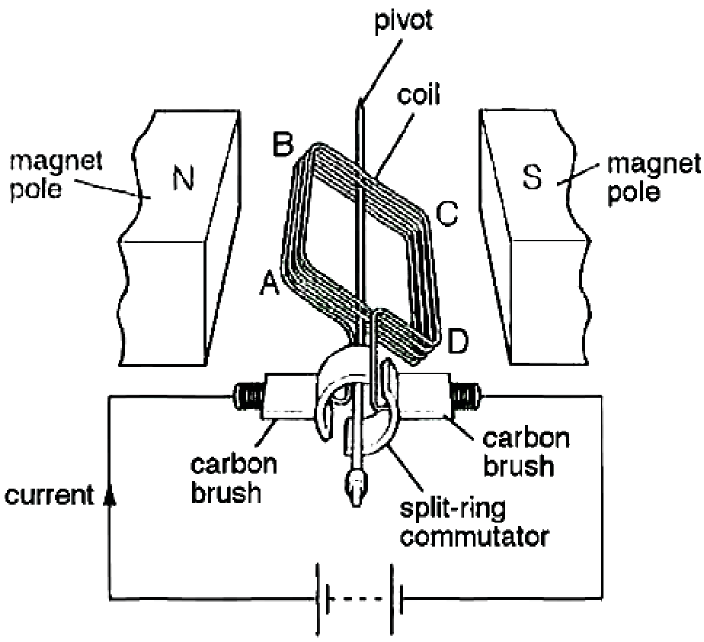


Fig. 11.3

The gap between the two halves of the split-ring commutator is so wide that a carbon brush can only touch one half of the split-ring at any time. This protects the circuit. It also means that sometimes the motor will not start when switched on.

The coil is rotated by vertical forces that act downwards on side AB and upwards on side CD. The current causes a constant force of 3.0 N on each side. The moment created by these forces varies as the coil turns.
The moment is zero when the coil is vertical.

The distances AD and BC are both 0.065 m.

(i) Explain what would happen if the carbon brushes touch both halves of the split-ring at the same time.

………………………………………………………………………………………

……………………………………………………………………………………… [1]

(ii) Suggest a reason why sometimes the motor will not start when switched on, even if there is no friction.

………………………………………………………………………………………

……………………………………………………………………………………… [1]

(iii) Define the moment of a force.

………………………………………………………………………………………

……………………………………………………………………………………… [1]

(iv) Calculate the value of the maximum moment created in the coil.

maximum moment = ………………………… [1]

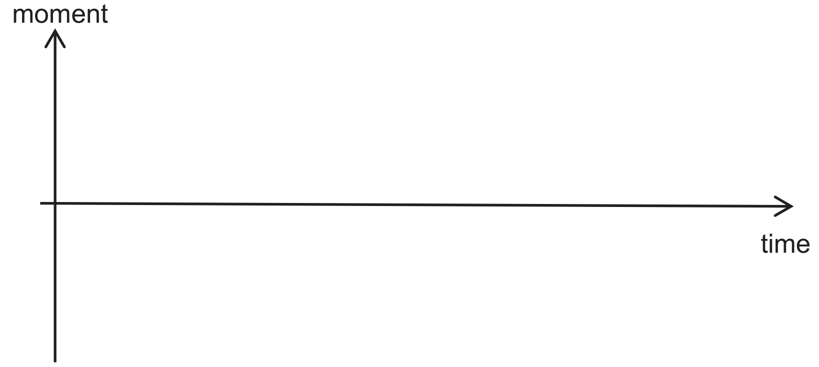
(v) Explain why the moment is zero when the coil is vertical.

………………………………………………………………………………………

……………………………………………………………………………………… [1]

Question continues on next page…

(vi) In the axes below, sketch a graph to suggest how the moment acting on the coil varies with time as the coil rotates from a horizontal position at constant speed. On the horizontal axis, mark clearly the time (T) taken for one revolution of the coil. [2]



12 EITHER

(a) The boiling point of pure water at normal atmospheric pressure is 100 °C.

(i) Define what is meant by the phrase "boiling point".

.... [1]

(ii) Describe any changes to the arrangement of water molecules during boiling.

.... [1]

(iii) Normal atmospheric pressure is conveniently taken to be 100 kPa.
It is usually measured by a barometer like the one shown in Fig. 12.1.
Describe how the barometer can be used to measure normal atmospheric pressure.

In your account,

- show clearly on Fig. 12.1 any measurements that are taken,
- explain how atmospheric pressure in pascal is calculated from the readings.

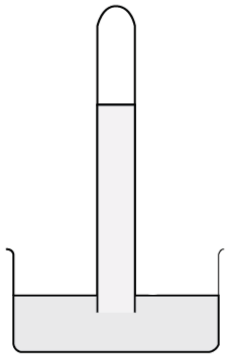


Fig. 12.1

....

....

....

....

....

.... [3]

(b) A small electrical heater is used to heat water in a plastic cup, without a lid. Fig. 12.2 shows how the temperature varies for 30 minutes after the heater is switched on.

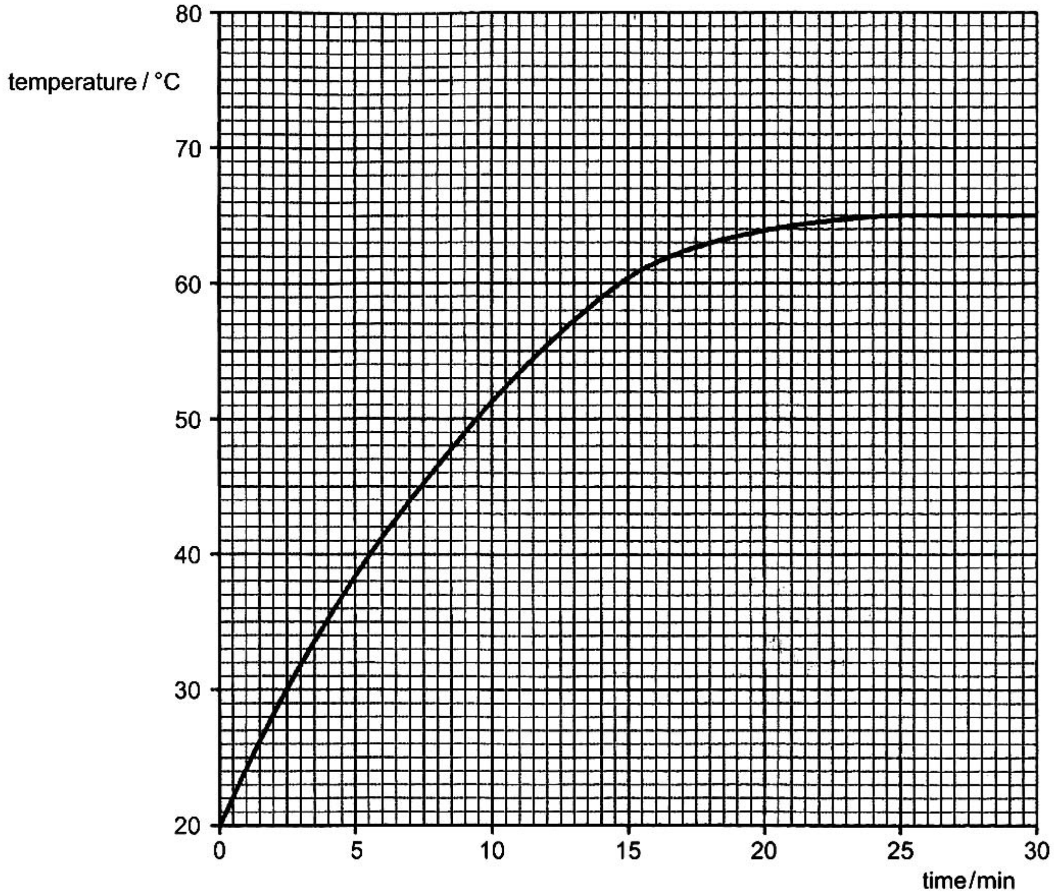


Fig. 12.2

(i) Based on Fig. 12.2, determine the initial rate of rise in temperature, giving your answer in °C/min.
Show any necessary construction lines on Fig. 12.2.

rate of rise in temperature = ………………………… °C/min [1]

(ii) The heater provides a constant amount of energy per minute to the water.
The mass of the water in the cup is 50 g.
The specific heat capacity of the water is 4.2 J/(g°C).
Using your answer to part **(b)(i)**, calculate the energy supplied to the water per minute.

energy supplied per minute = ………………………… [2]

Question continues on next page…

(iii) After 25 minutes the temperature has stopped rising, even though heat is still supplied at the same rate to the water.

Explain why.

…………………………………………………………………………………………

…………………………………………………………………………………………

………………………………………………………………………………………… [2]

12 OR

(a) A 2.4 kW electric heater, which is enclosed in a metal case, is connected to a 240 V supply.

Fig. 12.3 shows the heater and the cable that connects the heater to the power supply. The cable has three wires in it: the *live*, the *neutral* and the *earth*.

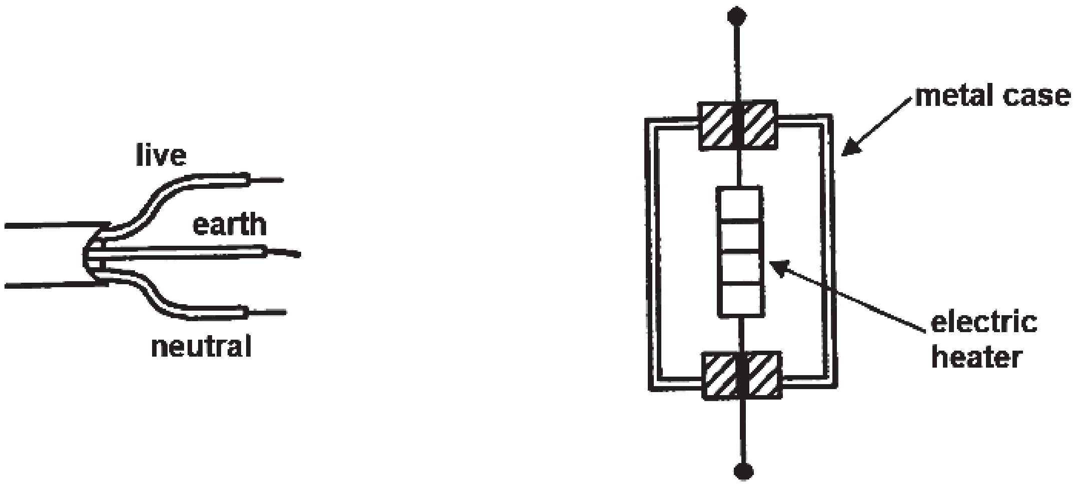


Fig. 12.3

(i) Calculate the current flowing through the heater,

current = ………………………… [2]

(ii) Calculate the resistance of the heater.

resistance = ………………………… [2]

(iii) By drawing on Fig. 12.3, show how the wires in the cable should be safely connected to the electric heater.
Include a switch and a fuse in your drawing. [3]

(b) Two resistors R_1 and R_2 are connected first in series, as shown in Fig. 12.4, and then in parallel, as shown in Fig. 12.5.

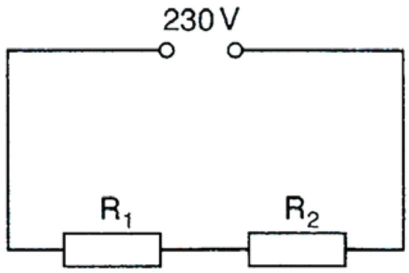


Fig. 12.4

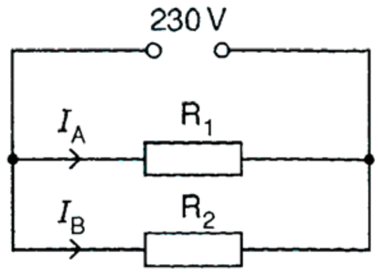


Fig. 12.5

There is no other resistance in either circuit.
The resistance of R_1 is larger than the resistance of R_2.

(i) Without any calculation, explain why

1. in the circuit shown in Fig. 12.4, the power output of R_1 is larger than the power output of R_2.

....

....

....

.... [1]

2. in the circuit shown in Fig. 12.5, the power output of R_1 is smaller than the power output of R_2.

....

....

....

.... [1]

(ii) In the circuit shown in Fig. 12.5, the resistor R_1 is replaced with another resistor R_3.
The resistance of R_3 is greater than the resistance of R_1.

Complete the table below to show how the replacement changes the current I_A and the current I_B.

effect on I_A	effect on I_B

[1]

***** END OF PAPER *****

Name: ……………………………………………… Index no.: ………. Class………..

Bukit Batok Secondary School

GCE O LEVEL PRELIMINARY EXAMINATIONS 2022

SECONDARY 4 EXPRESS MARK SCHEME

PHYSICS **6091/01**

Paper 1 Multiple Choice 30 Aug 2022

1 Hour

0820 – 0920 h

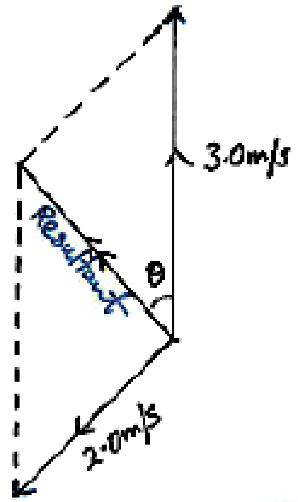
Paper 1 MCQs

1	D	11	C	21	A	31	D
2	A	12	C	22	C	32	D
3	C	13	A	23	A	33	C
4	C	14	A	24	B	34	B
5	C	15	C	25	D	35	B
6	B	16	A	26	B	36	D
7	D	17	A	27	B	37	C
8	B	18	B	28	B	38	D
9	B	19	D	29	C	39	B
10	C	20	C	30	D	40	D

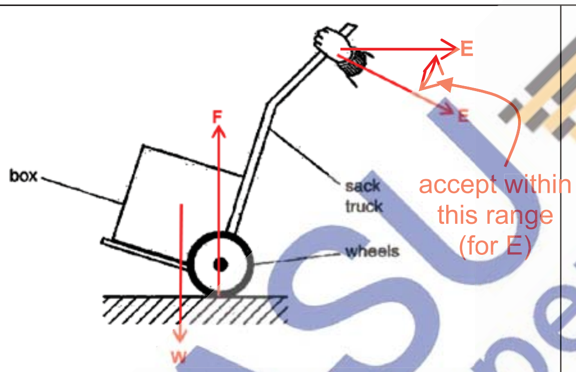
2022 BBSS SEC 4E PHYSICS (6091) O PRELIM EXAM
MARK SCHEME – PAPER 2 (FOR TEACHERS ONLY)

PAPER 2: (W = working), (C/F = concept / formula), (A & U = answer & unit)

- **Penalize** 1 mark **per question** for no / wrong unit.
- **Penalize** 1 mark **per question** for failure to show concept / formula clearly **and explicitly** at the beginning of each mathematical working, **except Q11b(iv)**.
- Mark for s.f. in **Q2a and Q2c only**.

Q	Suggested Answer		Remarks
1	 	[1]: *Diagram*: either parallelogram or triangle and all vectors must be correctly labelled and in correct direction. [1]: *Scale* • At least "1.0 cm represents 0.50 m/s" • *Reject* "1.0 cm to 1.0 m/s or 2.0 m/s" – vector diagram will occupy less than half of allocated space. • *Reject* weird scale (e.g., 3.0 cm to 1.0 m/s) [1]: *Magnitude of resultant velocity* between 2.0 m/s and 2.2 m/s inclusive. [1]: *Angle between north and resultant velocity* between 39° and 43° inclusive.	
2a (i)	Average speed = total distance / total time = 6.0 m / 1.5 s = **4.0 m/s** [–1 mark if final answer not in 2 s.f.] (*Accept* answer in km/h if correct)		[1]: W & C/F [1]: A & U
2a (ii)	Any one of the following: • Discus not travelling in straight line and so total displacement not the same as total distance • Total displacement (with respect to start point of discus) is zero. *Reject* if student mentions "direction" without further explanation. *Reject* if student merely writes down definitions of speed and velocity without further explanation.		[1]
2b	54 km/h = 54 000 m / 3600 s = 15 m/s KE = ½mv² = ½(1.0)(15)² = 112.5 J = **110 J** (to 2 s.f.) [–1 mark if final answer not in 2 s.f.]		[1] [1]: W & C/F [1]: A & U
3a(i)	t = 0 s and t = 2 s **and** t = 16 s to t = 24 s. [Do not penalize for no unit / wrong unit]		[1] for **both**
3a(ii)	• Between t = 0 s and t = 2 s : car at rest • Between t = 16 s and t = 24 s : car moves at constant velocity (*accept* "terminal velocity") (*reject* "constant speed") [–1 mark if student describes motion correctly but fail to state the corresponding time interval]		[1] [1]
3b(i)	From the question, it is not clear if driving force is 2500 N at t = 2 s. Hence, we accept either one of the following two possible answers: *Version 1(forward driving force = 2500 N at t = 2 s)* Resultant force = Forward driving force – total resistive force = 2500 – 0 = 2500 N		

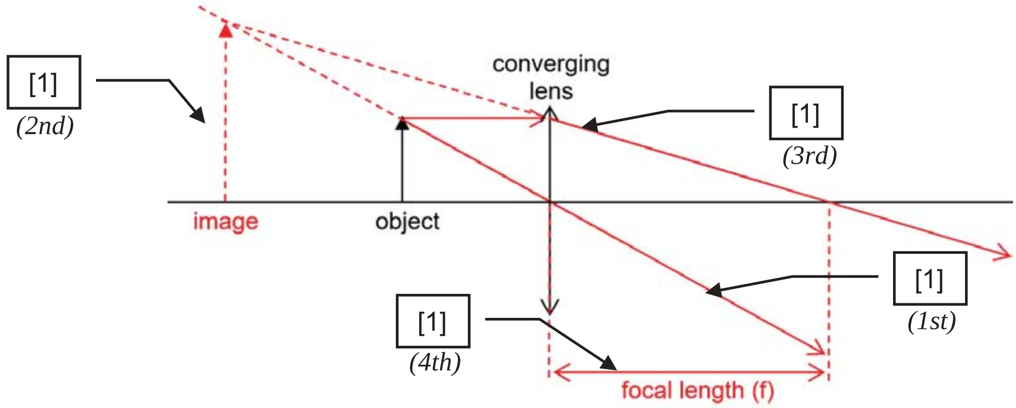
	Thus, acceleration (a) = F / m = 2500 / 850 = **<u>2.94 ms^{-2}</u>** (accept 2.9 m/s^2) *<u>Version 2 (forward driving force = 0 N at t = 2 s)</u>* Resultant force = Forward driving force – total resistive force = 0 – 0 = 0 N Thus, acceleration (a) = F / m = 0 / 850 = **<u>0 ms^{-2}</u>**. **<u>NOTE</u>**: penalize 1 mark if - formula "F = ma" not written in the working. - capital letter "A" is used to represent acceleration.	[1]: W & C/F [1]: A & U
3b(ii)	Resultant force = ma = 850 × 2.0 = 1700 N But resultant force = forward driving force – total resistive force 1700 = 2500 – total resistive force Hence, total resistive force = 2500 – 1700 = 800 N From the graph given in the question, when total resistive force = 800 N, time t = 6.4 s (**<u>accept 6.4 s to 6.6 s</u>**)	[1] [1]: W & C/F [1]: A & U

4a	 NOTE: ignore lengths of arrows	[1] *<u>Force W</u>* : arrow originates from centre of box (visual inspection suffices) and acts vertically downwards. [1] *<u>Force E</u>* : arrow originates from hand and is approximately perpendicular to distance between centre of wheel and hand (visual inspection suffices) and acts in the direction shown. [1] *<u>Force F</u>* : arrow originates from base of wheel and acts vertically upwards.
4b	• Perpendicular distance between centre of wheel (pivot) and line of action of (effort) E **<u>is larger than</u>** perpendicular distance between centre of wheel (pivot) and line of action of W (weight of box). • Hence, (effort) E **<u>is smaller than</u>** W (weight of box).	[1] [1]

5a (i)	• Gas molecules move randomly at high speeds and collide with cylinder. • Summation of force exerted on unit area of cylinder constitutes the pressure.	[1] [1]
5a (ii)	(Randomly moving) gas molecules have equal chance to collide against unit area of piston or unit area of sealed end.	[1]
5b	(i) greater (ii) the same (iii) greater (iv) less	[1] [1] [1] [1]

6a	• Particle X vibrates (***reject*** "moves", "travels") perpendicular to direction of wave travel. • amplitude = 2.0 cm / maximum displacement = 2.0 cm. • Completes one cycle in 20 ms / period of 20 ms.	[1] [1] [1]
6b	Imaginary line on a wave that joins all adjacent points that are in phase.	[1]
6c	Frequency (f) = 1 / T = 1 / 20 ms = 50 Hz Wavelength (λ) = 20 / 5 = 4.0 cm = 0.040 m v = $f\lambda$ = (50)(0.040) = **<u>2.0 m/s</u>** (allow for ecf of wrong frequency)	[1] [1]: W, C/F, A & U

7a	**<u>upright</u>** and **<u>magnified</u>** (reject "virtual" as it cannot be seen from Fig 7.1 and Fig. 7.2)	[1]

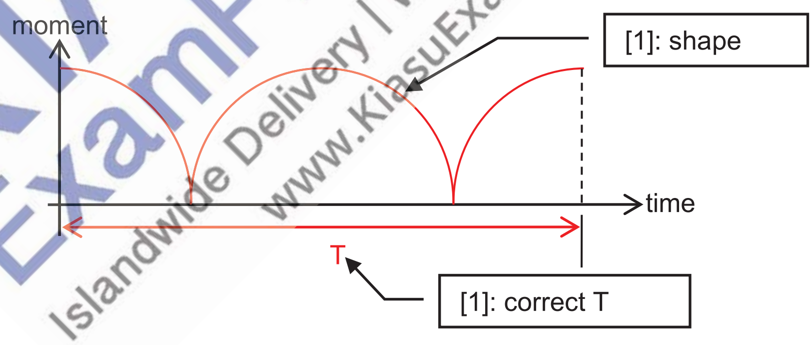
7b	 **NOTE:** If student draws ray diagram of a real image instead of the above, then: - Award for light ray that originates from top of object and passes through the origin straight throughout (see "1st" indicated in above diagram). - Award for focal length if it is correct (see "4th" indicated in above diagram).	
7c	Image is **dimmer** than before (***accept*** "less bright" in lieu of "dimmer")	[1]

8a	12 V	[1]
8b (i)	I = V / R = 12 / 50 (award 0 mark if R = 20 Ω or 30 Ω) = **0.24 A**	[1]: W & C/F [1]: A & U
8b (ii)	*EITHER:* V = IR = (0.24)(30) = **7.2 V** (allow for ecf from 8b(i)) *OR (by applying p.d.p.):* V = (30/50) × 12 = **7.2 V**	[1]
8b (iii)	0 V	[1]

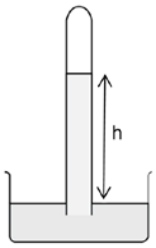
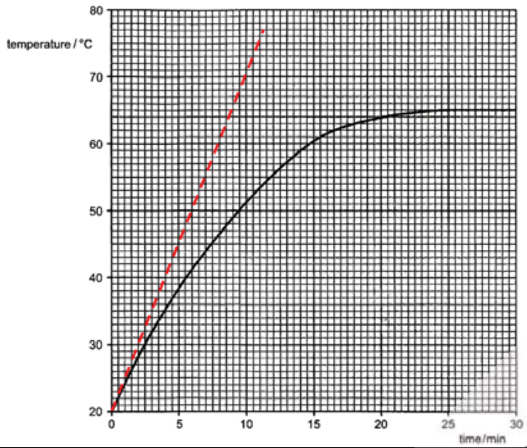
9a	• Rate of change of magnetic flux linked to wire AB (***accept*** "conductor" in lieu of "wire AB") / change of magnetic flux linked to wire AB per second. • Induces an electromotive force (e.m.f.) across wire **and** induced current flows in wire. ***Penalize 1 mark*** if sequence of above points is wrong (e.g., an e.m.f. is induced across wire AB and this causes a change in magnetic flux linked to wire AB per second).	[1] [1]
9b	**Larger momentary deflection** to the **left** / larger deflection to the left **and** returns to zero.	[1]

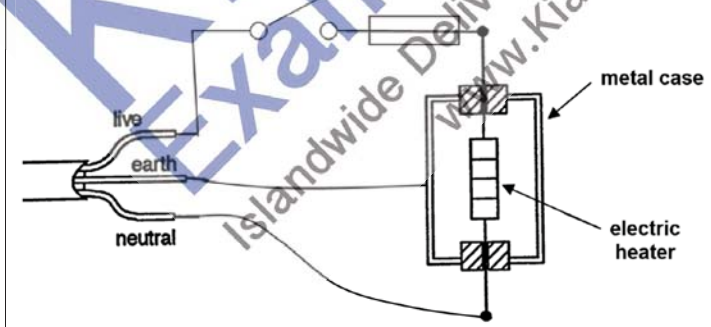
10a (i)	• **Resistive force** (friction, air resistance, etc.) acting on the car **increases**. • (Assume car's engine thrust force is constant) **Decrease in car's net force** (and increase in car's mass) decreases initial acceleration of the car.	[1] [1]
10a (ii)	• Constant engine thrust force and increasing resistive force decreases the net force acting on the car. • Eventually, engine thrust force and resistive force are equal in magnitude and opposite in direction (***reject*** "engine thrust force is **equal** to resistive force") • Car has zero acceleration and a constant maximum speed.	[1] [1] [1]
10b (i)	Time = distance / speed = 49000 m / 10.9 ms^{-1} = 4495.412844 s = **4500 s**. (to 2 s.f.) ***Accept*** answers in hours, hours and minutes if correct.	[1]
10b (ii)	(Change in) energy (E) = power × time = 4240 W × 4495.412844 s = 19 060 550.4587 J = **19 MJ** (to 2 s.f.) or **19.1 MJ** (to 3 s.f.) ***Accept*** answers in kilowatt-hours (kWh) if correct.	[1]

10b (iii)	(Change in) energy (E) = Pt = IVt 19 060 550.4587 = (95 A)(48 V)(t) Time t = 4179.945276 = **<u>4200 s</u>** (2 s.f.), **<u>4190 s</u>** (3 s.f.) or **<u>4180 s</u>** (3 s.f.) ***Accept*** answers in hours, hours and minutes if correct.	[1]: W & C/F [1]: A & U
10b (iv)	Any <u>one</u> of the following: • No electrical energy is converted to thermal energy / lost to the surroundings. (***Reject*** "heat energy") • Current **<u>and</u>** voltage stays constant during charging. • Battery / Battery charger is 100% efficient.	[1]

11a (i)	Needle points to the west / left.	[1]
11a (ii)	• Needle will remain in the same orientation as in Fig. 11.1. (Also accept "needle vibrates slightly whilst pointing north") • (Direction of electric current reverses 50 times per second leads to) direction of magnetic field around wire reverses 50 times per second **<u>and</u>** inertia of needle does not allow it to alternate between pointing east and west 50 times per second.	[1] [1]
11b (i)	Short circuit **<u>and</u>** the current will bypass / not flow through the rectangular coil.	[1]
11b (ii)	Open circuit and carbon brushes not in contact with (either half of) the split-ring (commutator).	[1]
11b (iii)	Product between the force and the perpendicular distance between the pivot and the line of action of the force.	[1]
11b (iv)	Maximum moment = F $\times$ d = (3.0)(0.065 / 2) + (3.0)(0.065 / 2) = **<u>0.195 Nm</u>** (accept 0.20 Nm (to 2 s.f.)) (DO NOT penalise for no formula as it has been tested in (b)(iii)).	[1]
11b (v)	Any <u>one</u> of the following: • Zero perpendicular distance between pivot and line of action of 3.0 N force. • No current through rectangular coil due to carbon brushes not touching split ring (hence no force)" ***Reject*** if student merely writes "no force" or "no current" without further explanation.	[1]
11b (vi)	 **<u>NOTE</u>**: • Graph must start from maximum and not zero (Refer to diagram. If coil starts turning from horizontal position, then moments should be maximum initially). • Graph: accept "straight lines" in lieu of curves.	

12 (EITHER)		
a(i)	Temperature at which a substance changes from liquid state to gaseous state. • ***Accept***: temperature at which a substance changes from liquid to gas. • ***Reject***: temperature at which a liquid changes to a gas (vague: any liquid? Any gas?)	[1]
a (ii)	Average distance between water molecules increases / Water molecules more spaced out. ***Reject***: "more disorderly arranged".	[1]

a (iii)		[1]: height h shown correctly in Fig. 12.1 [1]: Atmospheric pressure P = hρg [1]: height h to be expressed in metres **and** density of liquid (ρ) to be expressed in kg/m^3 **and** g = gravitational field strength.
b(i)		<u>[1]:for all the following done</u> • Tangent (red dotted line) drawn should cut the graph at (0,20), • Find the gradient of this tangent. • Rate of rise in temperature = gradient of this gradient **<u>based on student's input</u>**. *<u>Sample reading</u>*: (70 – 20) / (10 – 0) = **<u>5.0 °C/min</u>**
b(ii)	Q = mc$\Delta\theta$ Q/t = mc($\Delta\theta$/t) (note "$\Delta\theta$/t" = value of gradient from (b)(i) above) = (50)(4.2)(5.0) ← based on sample reading in (b)(i) above (allow for ecf) = **<u>1050 J/min</u>**	[1]: W & C/F [1]: A & U
b(iii)	• Rate of flow of thermal energy into water = rate of flow of thermal energy out of the water to the surroundings (water has reached thermal equilibrium with the surroundings). • No **<u>net</u>** gain of thermal energy by water (per second).	[1] [1]

12 (OR)		
a (i)	I = P / V = 2400 / 240 = 10 A	[1]: W & C/F [1]: A & U
a (ii)	R = V / I = 240 / 10 = **<u>24 Ω</u>**, or R = V^2/P = (240)^2 / 2400 = **<u>24 Ω</u>**	[1]: W & C/F [1]: A & U
a (iii)		[1]: earth wire connects to metal case. [1]: live, neutral wires and heater form a closed circuit. [1]: switch and fuse on live wire **<u>and</u>** correct symbols of switch and fuse.
b(i) 1	• Current (I) constant in series circuit. • Hence power output (P) is directly proportional to resistance R (since P = I^{2}R).	[1] for all
b(i) 2	• Voltage (V) constant in parallel circuit. • Hence power output (P) is inversely proportional to resistance R (since P = V^2/R).	[1] for all
b(ii)	• Current I_A decreases. • Current I_B remains unchanged.	[1] for all

康　柏　中　学

COMPASSVALE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2022
PHYSICS 6091/01

Paper 1 Multiple Choice

Secondary Four Express

Name: ____________________________ Duration: 1 hour

Index No: ____________________________ Date: 26 August 2022

Class: Sec 4 E5 Marks: ______ / 40

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name and index number on the optical mark sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question, there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the optical mark sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

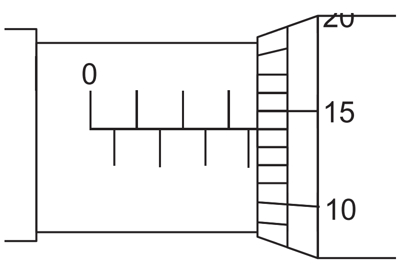
This paper consists of **17** printed pages including this page. Setter: Mr Ng JunJie

1 Which order shows the units of energy in the correct order of increasing size?

A	J	→	kJ	→	mJ	→	nJ	→	μJ
B	mJ	→	nJ	→	μJ	→	kJ	→	GJ
C	MJ	→	mJ	→	J	→	kJ	→	GJ
D	nJ	→	μJ	→	mJ	→	kJ	→	MJ

2 A student measures the thickness of 20 sheets of metal with a micrometer.

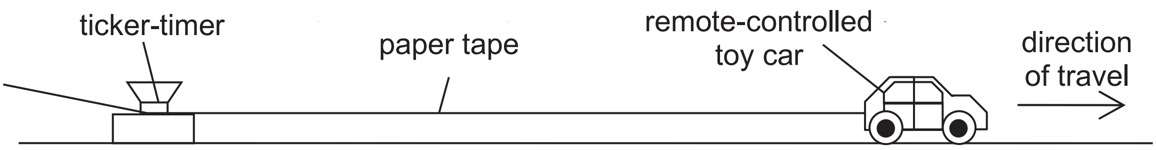
The diagram shows the reading on the micrometer.



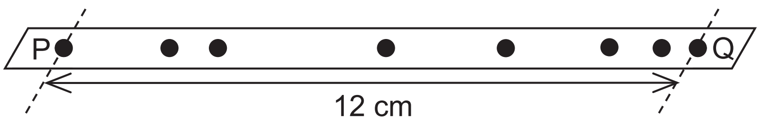
What is the average thickness of one sheet of metal?

A 0.157 mm **B** 0.182 mm **C** 0.207 mm **D** 0.357 mm

3 A student uses a ticker-timer to investigate the movement of a remote-controlled toy car.



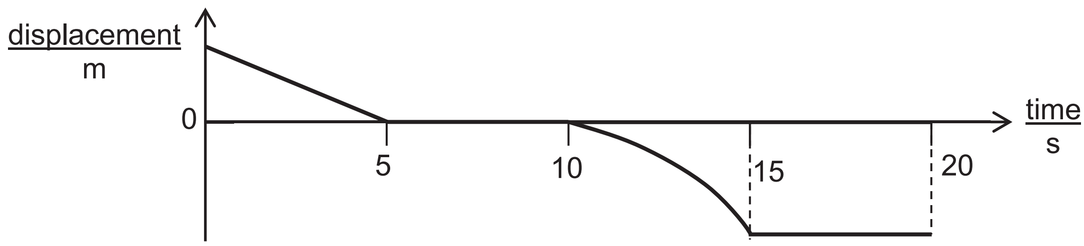
The ticker-timer vibrates at 10 Hz as the paper tape is pulled through the ticker-timer by the car and the diagram shows a section of the tape that was cut out to analyse its motion.



What is the average speed of the toy car between the two markings P and Q?

A 17 cm/s **B** 15 cm/s **C** 9.6 cm/s **D** 8.4 cm/s

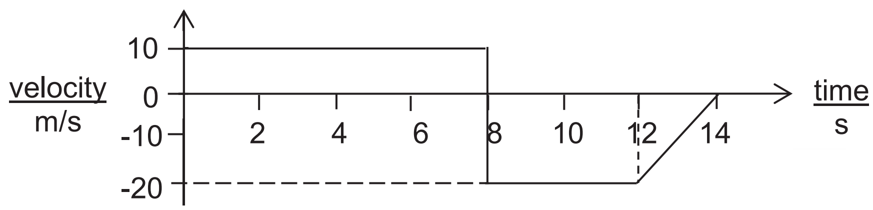
4 The graph shows how the displacement of a car changes with time.



Which row describes the car's motion for each five-second period?

	0 to 5 s	5 to 10 s	10 to 15 s	15 to 20 s
A	uniform deceleration	at rest	decelerating	uniform velocity
B	uniform velocity	at rest	accelerating	at rest
C	uniform velocity	at rest	accelerating	uniform velocity
D	uniform velocity	at rest	decelerating	at rest

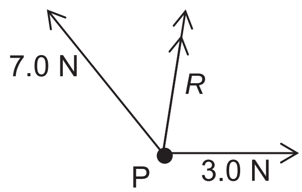
5 The graph shows how the velocity of a particle moving along a straight line, changes with time.



What is the displacement of the particle at the end of 14 s?

A 180 m **B** 20 m **C** - 20 m **D** - 100 m

6 The diagram shows the resultant *R* of a 3.0 N and a 7.0 N force that act at a point P.



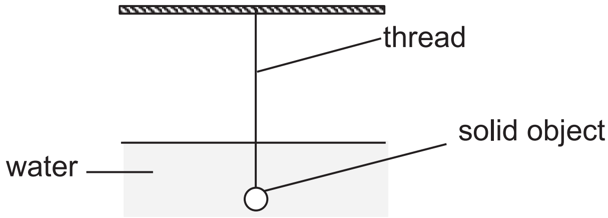
The angle between the 3.0 N force and the 7.0 N force can be any value from 0° to 180°.

Which value of R is not possible?

A 2.0 N **B** 4.0 N **C** 6.0 N **D** 8.0 N

7 A solid object, immersed in water, hangs from an elastic thread.

Three forces act on the object: its weight W, the tension in the thread T, and an upward force F from the water.



Which equation is correct when the object is stationary?

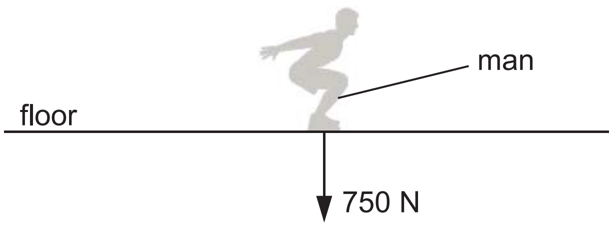
A $F + W = 0$

B $F - T = 0$

C $F - T - W = 0$

D $F + T - W = 0$

8 A man jumps vertically upwards by exerting a force of 750 N on the floor.



The man has a mass of 60 kg and the gravitational field strength g is 10 N/kg.

What is the acceleration of the man as he just leaves the floor?

A $-2.5\ \text{m/s}^2$ **B** $1.25\ \text{m/s}^2$ **C** $2.5\ \text{m/s}^2$ **D** $12.5\ \text{m/s}^2$

9 An astronaut in a space station orbits the Earth.

When he places his camera at eye level and lets go of it, it stays at his eye level.

At the height at which he orbits, the earth's gravitational field strength is 5.0 N/kg.

Which statement correctly describes the situation?

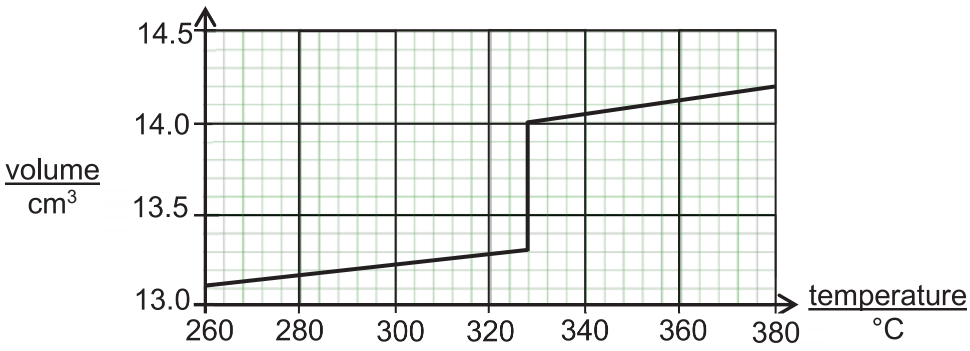
A The camera has mass and no weight.

B The camera has no weight and no mass.

C The camera has weight and mass.

D The camera has weight but no mass.

10 The graph shows how the volume of a sample of solid X changes with temperature as it is heated.



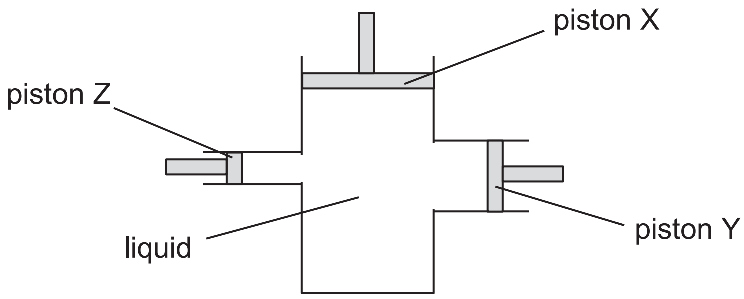
The mass of the sample of solid X is 160 g.

What is the density of the liquid X at 328 °C?

A 11.1 g/cm^3 **B** 11.4 g/cm^3 **C** 11.7 g/cm^3 **D** 12.0 g/cm^3

11 Piston X is pushed into a hydraulic cylinder. Piston X produces a pressure P_X in the liquid in the cylinder.

The diagram shows the cylinder viewed from above.



view from above

There are two other pistons, Y and Z, in the cylinder.

The pressures on piston Y and Z are P_Y and P_Z.

What is the relationship between P_X, P_Y and P_Z?

A $P_X = P_Y + P_Z$

B $P_X > P_Y > P_Z$

C $P_X < P_Y < P_Z$

D $P_X = P_Y = P_Z$

12 Blood pressure can be measured by using a mercury manometer.

Blood pressure varies by 5.5 kPa as a heart beats.

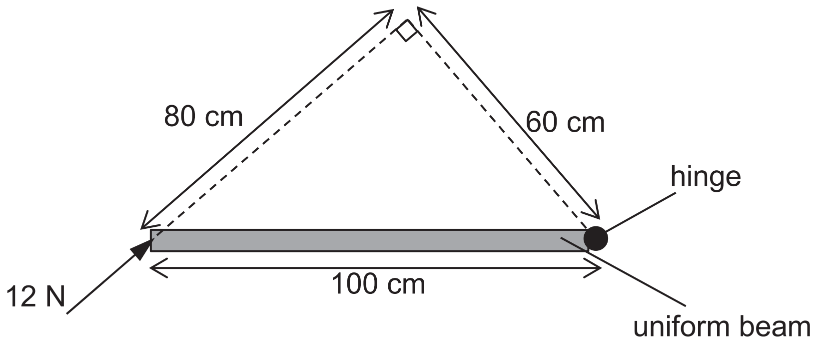
The density of mercury is 13600 kg/m^3 and the gravitational field strength g is 10 N/kg.

What is the change in the height difference between the levels in the manometer during a heartbeat?

A 40.4 mm **B** 80.9 mm **C** 404 mm **D** 809 mm

13 A uniform beam of length 100 cm is hinged at one end.

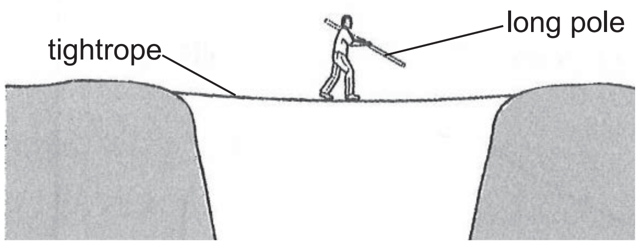
It is kept horizontal by applying a force of 12 N as shown.



What is the weight W of the beam?

A 7.2 N **B** 9.6 N **C** 14.4 N **D** 19.2 N

14 A man walks along a tightrope, carrying a long pole.



He carries the long pole to

A make it easier for him to keep his centre of gravity above the tightrope.

B raise his centre of gravity and make him more stable.

C reduce the pressure he exerts on the tightrope.

D spread out his weight.

15 A braking force *F* is applied on a car moving at a constant speed of 10 m/s. The car travelled a distance of 10 m before coming to rest.

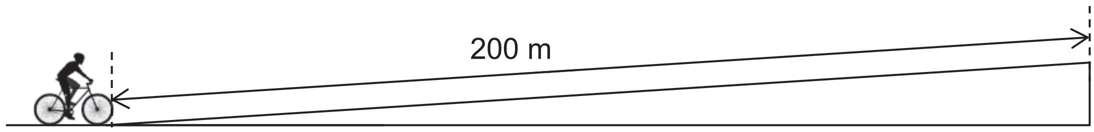
The car now travels at a constant speed of 30 m/s and the same braking force *F* is applied.

What is the distance travelled by the car before coming to rest?

A 17 m **B** 30 m **C** 52 m **D** 90 m

16 A cyclist, of weight 800 N, takes 10 s to cycle 200 m at a constant speed along a road.

The road rises vertically 1.0 m for every 50 m measured along the road.



Given that work done against friction by the cyclist is negligible, what is the average power produced by the cyclist?

A 32 W **B** 160 W **C** 320 W **D** 1600 W

17 When a thermometer is calibrated, the fixed points are marked.

What are fixed points?

A all the marks on the temperature scale which cannot be removed

B all the marks of the temperature scale

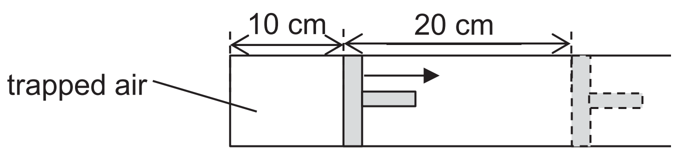
C the lowest and highest temperatures shown on the thermometer

D two temperatures of known value which are easily reproduced

18 Air is trapped in a cylinder by a piston. The pressure of the air is *P* and the length of the column of air is 10 cm.

The piston is moved outwards, and the length of the air column increases by 20 cm.

The temperature of the air remains constant.



What is the new air pressure?

A $\frac{P}{2}$ **B** $\frac{P}{3}$ **C** $2P$ **D** $3P$

19 A substance can exist in three different states: solid, liquid or gas

Each of the two statements below describe a change in state.

change 1 Molecules move closer together but continue to travel throughout the substance.

change 2 Molecules stop travelling throughout the substance and just vibrate about fixed positions

Which changes of state do these statements describe?

	change 1	change 2
A	condensation	melting
B	condensation	solidification
C	solidification	condensation
D	solidification	melting

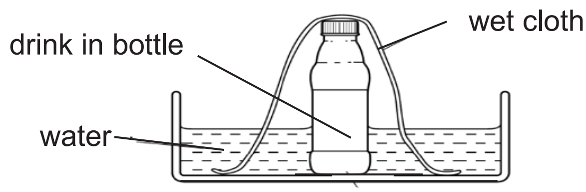
20 Solar panels are used to heat water with a mass of 5000 kg.

The total area of the solar panels is 10 m^2 and the average power output from each square metre of the panels is 300 W. The specific heat capacity of water is 4200 J/(kg °C).

Assuming that there is no thermal energy loss, what is the increase in the water temperature after 8.0 hours?

A 41 °C **B** 5.1 °C **C** 4.1 °C **D** 0.69 °C

21 On a hot day, the drink in a bottle can be kept cool by standing the bottle in a bowl of water and placing a wet cloth over it.



The drink is kept cool because

A water evaporating from the wet cloth cools the drink in the bottle.

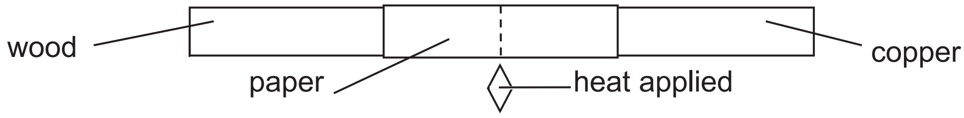
B the cloth prevents absorption of thermal energy from the surroundings.

C the cloth conducts thermal energy away from the bottle into the water.

D cool air cannot escape from the bottle.

22 A wooden bar and a copper bar are joined together at one end with a piece of paper wrapped tightly around the center as shown in the diagram.

Heat is applied strongly at the paper and the paper goes brown on one side only.

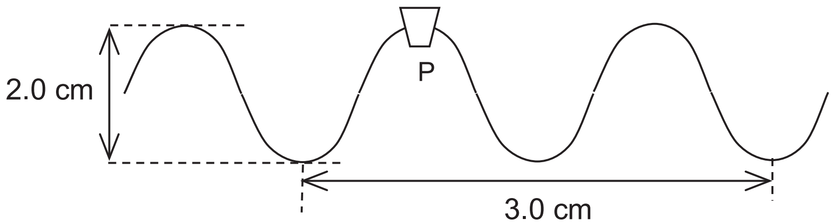


Which side of the paper goes brown and what can we conclude about wood and copper?

	brown side	wood	copper
A	copper	good conductor of heat	insulator of heat
B	copper	insulator of heat	good conductor of heat
C	wood	good conductor of heat	insulator of heat
D	wood	insulator of heat	good conductor of heat

23 In deep water, water waves cause a small cork P to rise up and down through one complete oscillation every 0.20 s, as shown in the diagram.

The water waves move into shallow water.

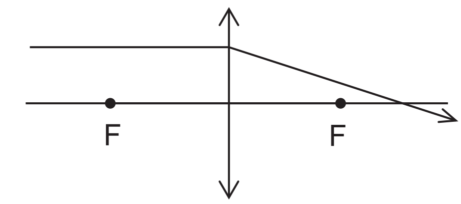


Which of the following describes the wavelength, frequency and speed of the water waves as they move from deep to shallow water?

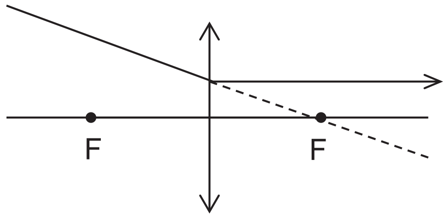
	wavelength	frequency	speed
A	decreases below 1.0 cm	remains at 5.0 Hz	decreases below 5.0 cm/s
B	decreases below 1.5 cm	remains at 5.0 Hz	decreases below 7.5 cm/s
C	increases above 1.5 cm	decreases below 5.0 Hz	remains at 7.5 cm/s
D	increases above 3.0 cm	decreases below 5.0 Hz	remains at 15 cm/s

24 Which diagram shows the correct action of a converging lens on a light ray passing through the lens?

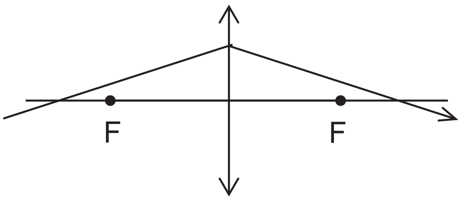
A



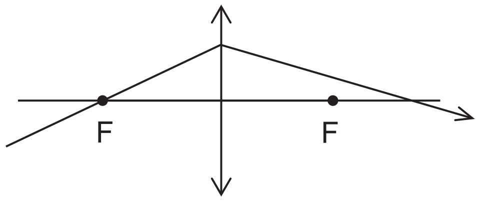
B



C



D

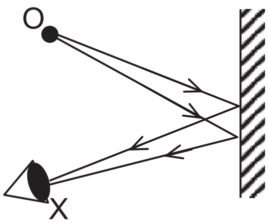


25 An object O is placed in front of a plane mirror.

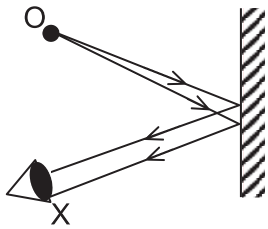
A person looks into the mirror from position X.

Which diagram shows the paths of the light rays from object O to the person at X?

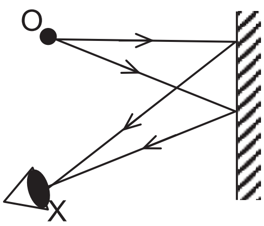
A



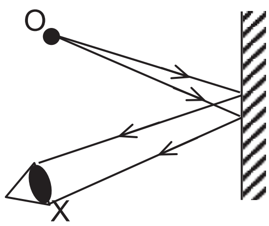
B



C



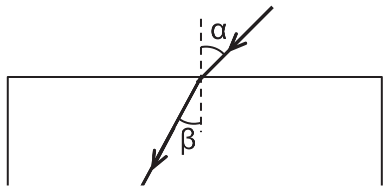
D



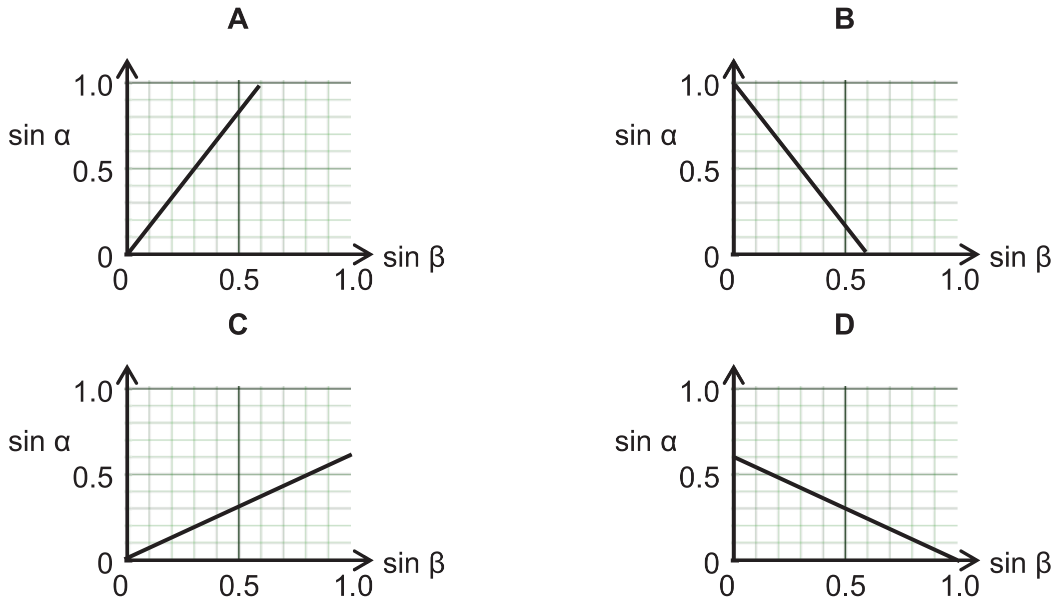
26 The speed of light in a glass block is 1.8×10^8 m/s.

A student shines a beam of light through the glass block at different angles of incidence.

The angle of incidence α and the corresponding angle of refraction β are measured and a graph of sin α against sin β is plotted.



Which graph is correct?



27 A sound wave of frequency 400 Hz travels through air with velocity of 320 m/s.

The frequency of the sound wave in air is doubled to 800 Hz.

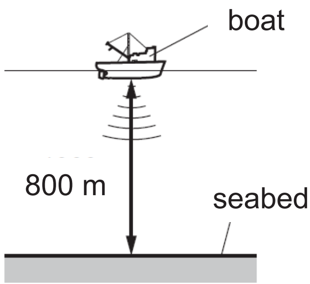
Which row describes the 800 Hz sound wave?

	velocity m/s	wavelength m
A	320	0.40
B	320	2.50
C	640	0.80
D	640	1.25

28 A pulse of sound is produced at the bottom of a boat. The sound travels through the water and is reflected from the seabed.

The sound reaches the boat again after 1.4 s.

The seabed is 800 m below the boat.



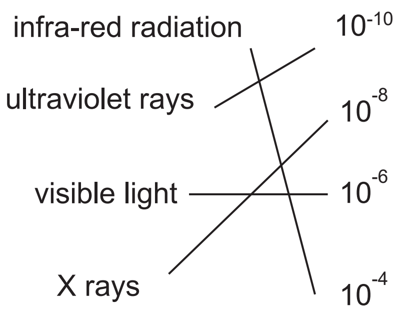
What is the speed of sound in the water?

A 286 m/s **B** 571 m/s **C** 1140 m/s **D** 2290 m/s

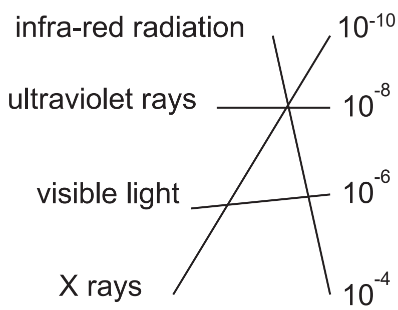
29 In a test, four students linked the different types of electromagnetic waves on the left with the order of magnitude of their wavelengths on the right.

Which student matched them all correctly?

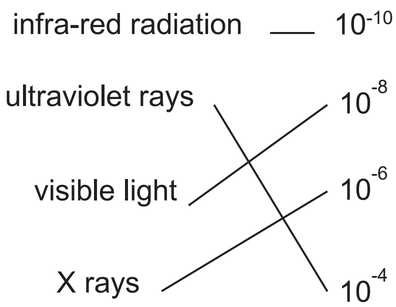
A



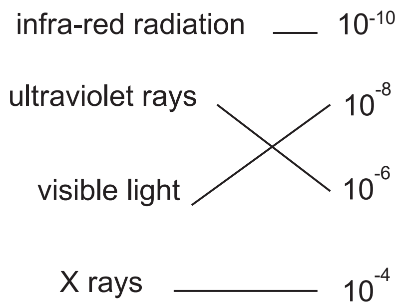
B



C

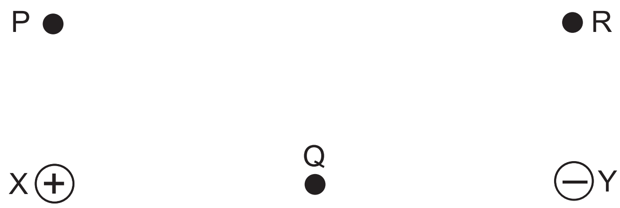


D



30 The diagram shows isolated positive and negative point charges. These point charges are of equal magnitude.

P, Q, R and the point charges X and Y are located on a single vertical plane.



Which statement best describes the electric field lines between the two point charges?

A The field lines are horizontal at P and horizontal at Q.

B The field lines are horizontal at P and vertical at R.

C The field lines are vertical at Q and horizontal at R.

D The field lines are vertical at R and horizontal at Q.

31 In 3.0 s, 2.5×10^{19} electrons pass through a resistor.

As the electrons pass, thermal energy is produced in the resistor at a rate of 4.0 W.

The charge on the electron is 1.6×10^{-19} C.

What is the potential difference across the resistor?

A 3.0 V **B** 4.0 V **C** 12 V **D** 36 V

32 X and Y are lamps with filament made of the same material.

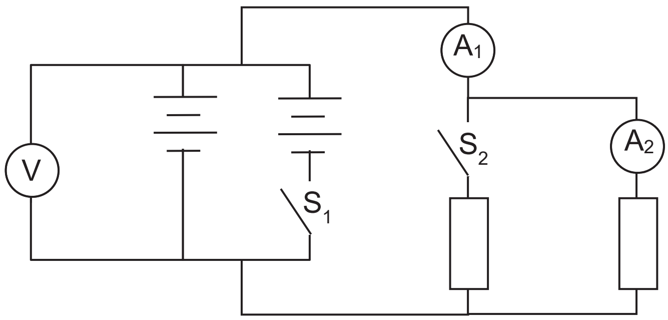
The filament of lamp X has a cross sectional area of 2*A* and a length of *L*. The filament of lamp Y has a cross sectional area of *A* and a length of 2*L*.

Each lamp is connected to the mains and switched on.

Which is the brighter lamp and which lamp has a filament of larger resistance?

	brighter	larger resistance
A	X	X
B	X	Y
C	Y	X
D	Y	Y

33 The diagram shows a circuit containing two identical resistors and two switches.

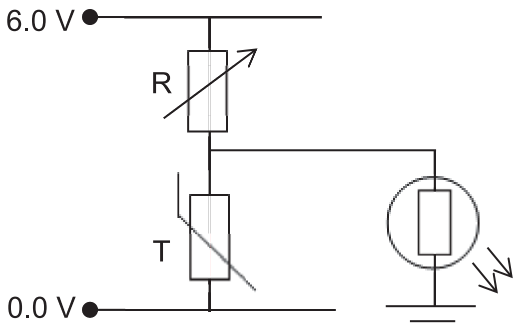


Switches S_1 and S_2 are closed.

Which row shows the changes in the readings of the two ammeters and the voltmeter?

	reading on A_1	reading on A_2	reading on voltmeter
A	decreases	increases	increases
B	increases	increases	unchanged
C	increases	decreases	increases
D	increases	unchanged	unchanged

34 The diagram shows a circuit comprising of three electrical components.



It is observed that when the temperature is low, the LED in the circuit lights up.

This is because in cold weather,

A the voltage of T increases while that of R decreases.

B the voltage of T decreases while that of R increases.

C the voltages of both T and R increase.

D the voltages of both T and R decrease.

35 An electrical cable contains three wires: live, neutral and earth.

The cable is correctly wired to a plug which contains a 3 A fuse. The insulation becomes damaged and bare metal wires show.

Five possible events can occur.

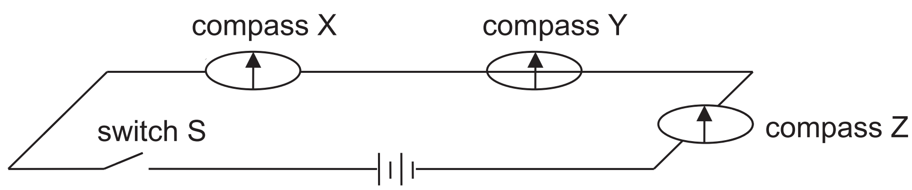
- A person touches the earth wire.
- A person touches the neutral wire.
- A person touches the live wire.
- The live wire touches the neutral wire.
- The live wire touches the earth wire.

How many of these five events cause the fuse in the plug to blow?

A one **B** two **C** three **D** four

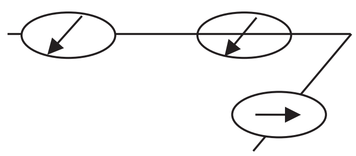
36 The diagram shows a circuit with a wire connected to a battery through switch S.

The compasses X and Z are placed above the wire and compass Y is placed below the wire.

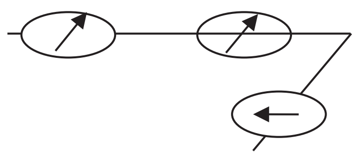


Which of the following diagrams show the correct orientation of the compass needles when switch S is closed?

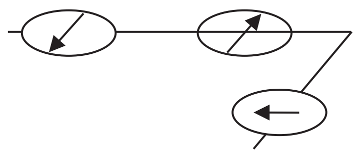
A



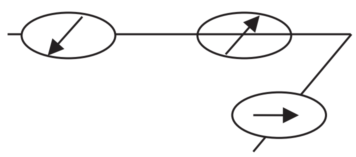
B



C



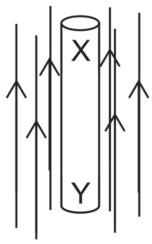
D



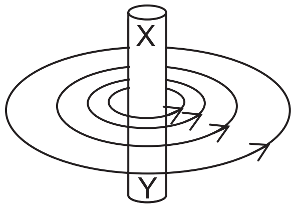
37 There is an upward current in a vertical wire XY. This produces a magnetic field in the region around XY.

Which diagram shows the pattern of the magnetic field lines produced by the current?

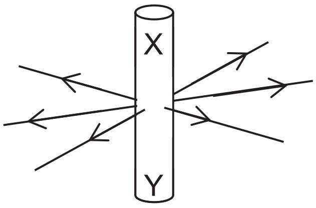
A



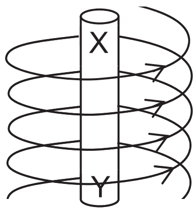
B



C

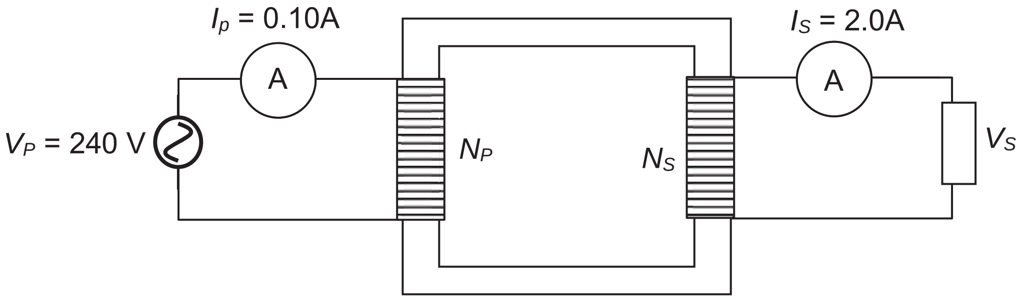


D



38 An ideal transformer supplies power to a load.

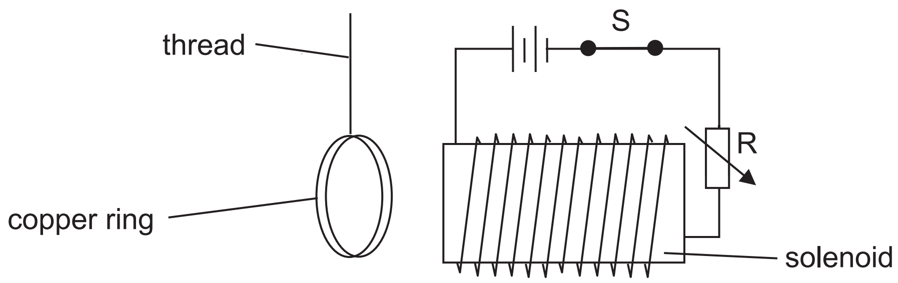
In order to deliver a current of 2.0 A to the load, the primary coil draws a current of 0.10 A from the 240 V mains.



Which row shows the correct set of values for the transformer?

	turns in primary coil, N_P	turns in secondary coil, N_S	potential difference, V_s / V
A	300	6000	12
B	300	6000	4800
C	6000	300	12
D	6000	300	4800

39 A copper ring is placed next to a solenoid.



At the moment the switch S is opened, the copper ring

A moves towards the coil.

B remains stationary.

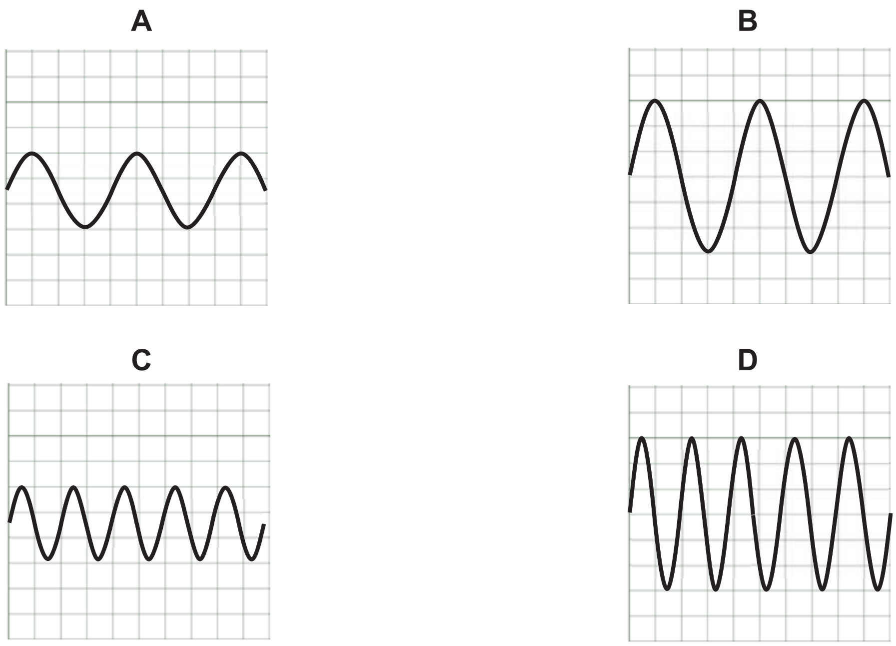
C repels away from the coil.

D rotates momentarily.

40 The Y-input terminals of an oscilloscope are connected to a supply of peak value 15 V and of frequency 50 Hz.

The time-base setting is 10 ms per division and the Y-gain at 5.0 V per division.

Which trace could be obtained?



康　柏　中　学

COMPASSVALE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2022
PHYSICS 6091/02
Paper 2 Theory
Secondary Four Express

Name	: ____________________	Duration:	1 h 45 min
Index No	: ____________________	Date:	29 August 2022
Class	: Sec 4 E5	Marks:	_____ / 80

READ THESE INSTRUCTIONS FIRST

Write your name and index number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 12 has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This paper consists of **20** printed pages including this page. Setter: Mr Ng JunJie

Section A (50 marks)

Answer **all** questions in the spaces provided.

1 Para-sailing is a leisure pursuit where a person is attached to a parachute and pulled over the sea by a tow-rope.

The tow-rope is attached to a motor boat as shown in Fig. 1.1.

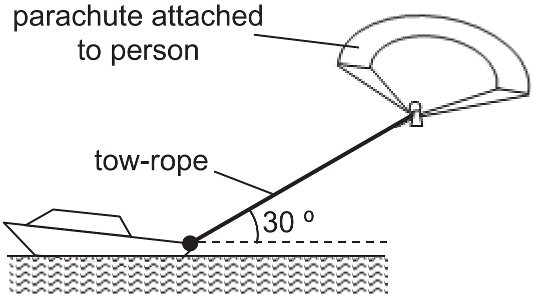


Fig. 1.1

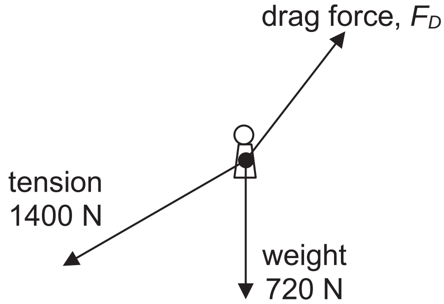


Fig. 1.2

(a) Fig. 1.2 shows the directions of the forces acting on a person when being pulled horizontally across the sea at a constant speed.

The weight of the person is 720 N and the tension in the tow-rope is 1400 N.

Determine the drag force F_D acting on the person using a scale drawing.

drag force, F_D = ... [3]

(b) The tow-rope is released at X and the path of the person with the parachute after the release of the tow-rope is shown by the dashed line in Fig. 1.3.

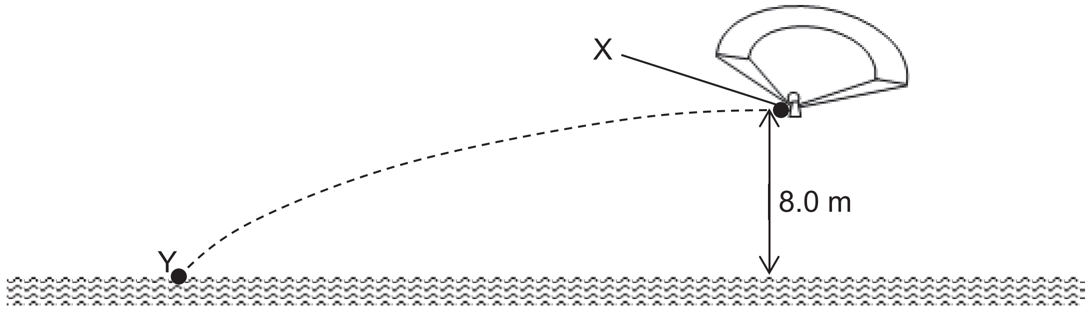


Fig. 1.3

The speed of the person with the parachute is the fastest at X, at the moment the tow-rope is released.

(i) Describe the energy changes from the moment the tow-rope is released at X until the person reaches the surface of the sea at Y.

....

....

....[2]

(ii) The vertical height between X and Y is 8.0 m and the speed of the person at X is 12 m/s.

As the person moves from X to Y, 10 kJ of work is done against air resistance.

Determine the speed of the person at Y.

The gravitational field strength *g* is 10 N/kg.

speed at point Y = ... [3]

(iii) A student suggests that the speed of the person at Y does not depend on his mass.

Explain briefly whether the suggestion is correct.

....

....[1]

2 A horizontal, uniform beam is balanced on supports P and Q of a stand when a weighted toy is placed on the beam.

(a) Fig. 2.1 shows the forces acting on the horizontal beam and the distances between these forces when the weighted toy is placed on the beam and the beam is balanced on the stand.

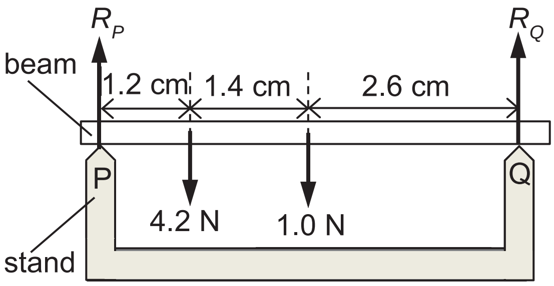


Fig. 2.1

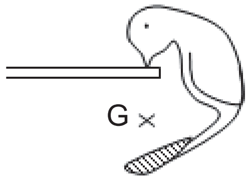


Fig. 2.2a

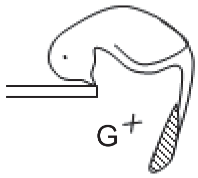


Fig. 2.2b

(i) State the *principle of moments.*

……………………………………………………………………………………………………

……………………………………………………………………………………………[2]

(ii) The weight of the horizontal beam is 1.0 N and the weight of the weighted toy is 4.2 N.

Determine the forces R_P and R_Q acting on the horizontal beam.

Rp = ...

R_Q = ... [3]

(b) Fig. 2.2a and Fig. 2.2b show the rest position of the weighted toy balanced on its beak and the displaced position of the same toy respectively.

G is the position of the centre of gravity of the weighted toy.

By making reference to the centre of gravity, explain why the weighted toy returns to its rest position when displaced and released.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………[2]

3 **(a)** Fig. 3.1 shows a mercury barometer used to measure atmospheric pressure on a particular day and the scale alongside the barometer is marked in cm.

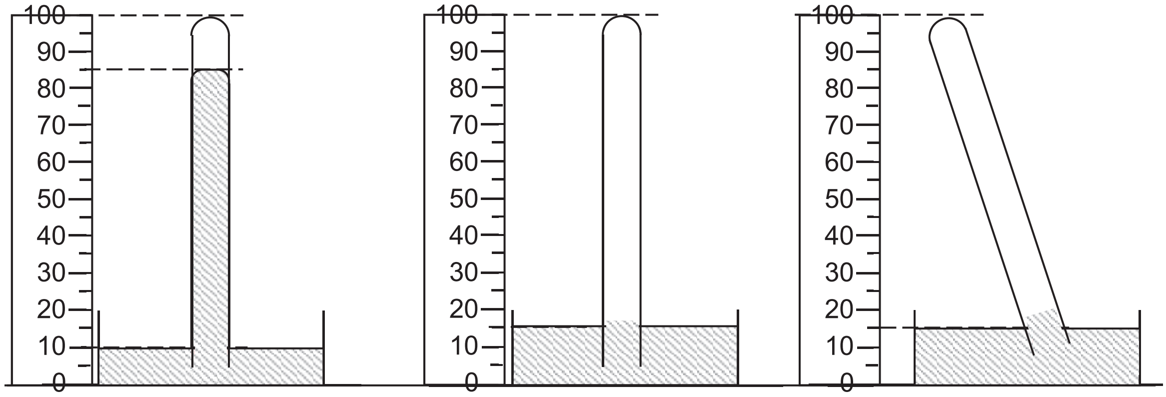


Fig. 3.1 **Fig. 3.2** **Fig. 3.3**

Fig. 3.2 and Fig. 3.3 shows two other mercury barometers located next to that in Fig. 3.1.

(i) On Fig. 3.2, draw the level of mercury inside the tube after more mercury is poured into the reservoir. [1]

(ii) On Fig. 3.3, draw the level of mercury inside the tube after the tube is tilted from the position shown in Fig. 3.2. [1]

(b) A student attempts to build his own barometer by lowering an inverted glass tube vertically into a mercury bath at the same location.

Some air is trapped in the sealed end of the inverted glass tube.

(i) Explain why the reading obtained using his own barometer is lower from the actual atmospheric pressure obtained using the mercury barometer in Fig. 3.1.

……………………………………………………………………………………………………

……………………………………………………………………………………………………[1]

(ii) Suggest and explain using ideas about molecules, how the reading obtained using his own barometer will change if the student pushes the inverted glass tube further into the mercury bath.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

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……………………………………………………………………………………………………[3]

4 Light is incident on a glass prism, as shown in Fig. 4.1.

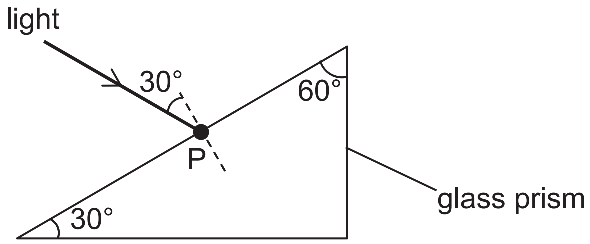

Fig. 4.1

(a) The refractive index of the glass prism is 1.5.

The ray of light enters the glass prism at point P and the angle of incidence at point P is 30°.

Calculate the angle of refraction of the ray of light at point P.

angle of refraction = ... [2]

(b) Another glass prism is used to allow light from the Sun into a room which is below ground level, as shown in Fig 4.2. The prism is made using the same glass as the prism in Fig. 4.1.

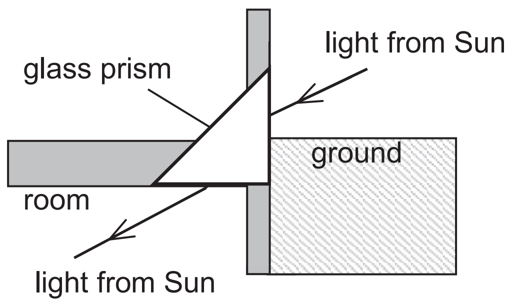

Fig. 4.2

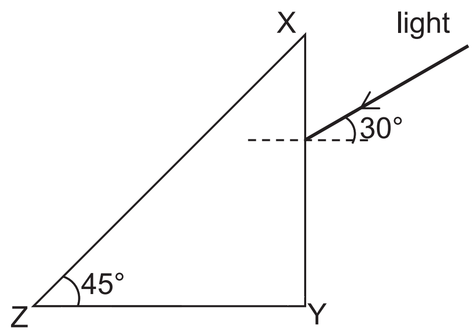

Fig. 4.3

The critical angle of the glass prism is 42°.

On Fig. 4.3, draw the path of the ray of light as it passes through side XY and emerges from the prism into the room which is below ground level from side YZ. [1]

5 A piece of metal foil is attached to a metal rod as shown in Fig. 5.1.

Both metal foil and metal rod are initially uncharged.

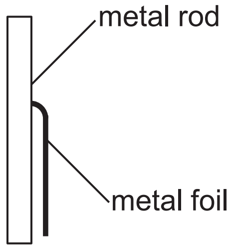

Fig. 5.1

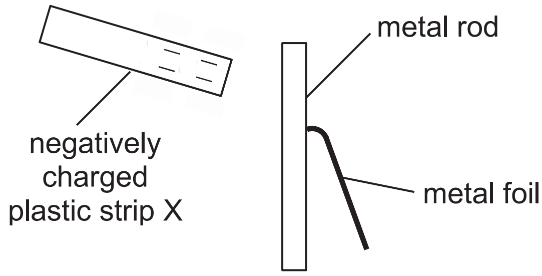

Fig. 5.2

A negatively charged plastic strip X is held close to the top of the metal rod. The metal foil moves away from the metal rod as shown in Fig. 5.2.

(a) Explain why the metal foil moves away from the metal rod.

....

....

....

....

....[2]

(b) Another strip Y is brought near the top of the metal rod. It is held next to the negatively charged plastic strip X without touching the plastic strip as shown in Fig. 5.3.

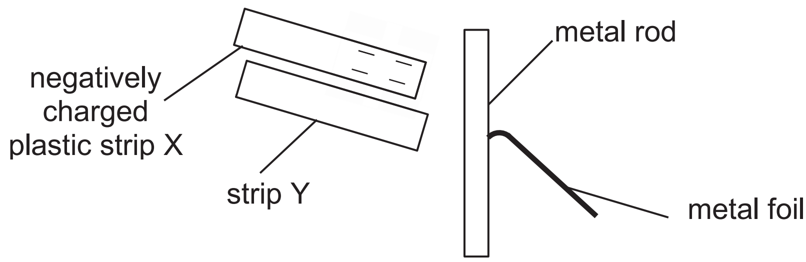

Fig. 5.3

The metal foil moves further away from the metal rod as shown.

State and explain what can be deduced about strip Y.

....

....

....

....[2]

6 Fig. 6.1 shows the I/V characteristic graphs for a light-emitting diode (LED) and for a filament lamp.

The LED is a semiconductor diode that emits light.

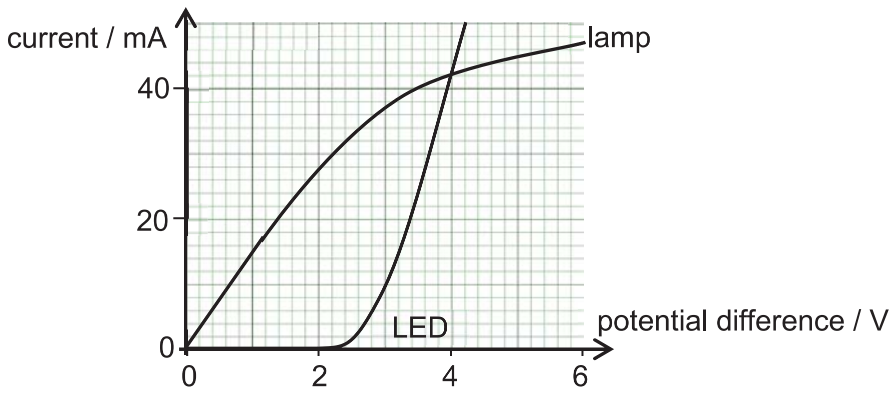

Fig. 6.1

(a) Describe how the resistance of the LED changes as the potential difference increases from zero.

....

....

....[2]

(b) A student uses the lamp and the LED whose characteristics are as shown in Fig. 6.1.

He connects the lamp and the LED to a d.c. power supply. All three components are in parallel.

The current in the LED is 20 mA.

Using Fig. 6.1, determine

1. the current through the power supply,

total current = ... [1]

2. the effective resistance of the LED and the lamp in parallel.

effective resistance = ... [2]

7 Fig. 7.1 shows an apparatus that is used to measure the acceleration of a falling card.

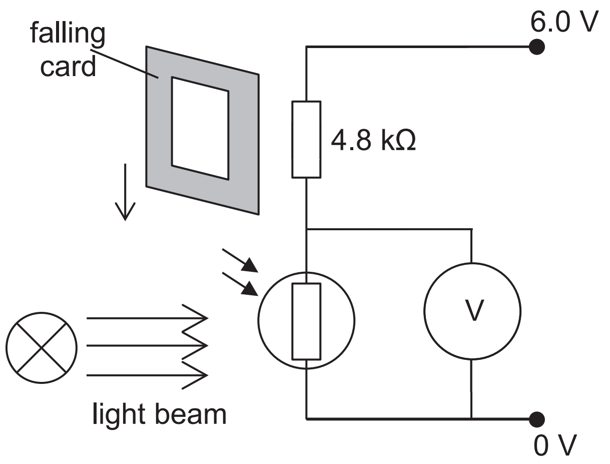

Fig. 7.1

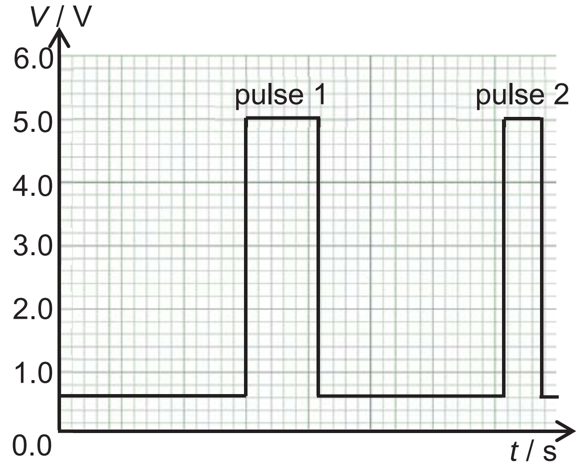

Fig. 7.2

There is a square hole in the centre of the falling card. When the card blocks the light beam, no light reaches the LDR (light-dependent resistor).

The variation of the potential difference *V* with time elapsed *t* after releasing the card is shown in Fig. 7.2.

(a) Describe and explain the changes in the voltmeter reading as the card falls.

....

....

....

....[2]

(b) Determine the resistance of the LDR when the card blocks the light beam.

resistance of LDR = ... [2]

(c) Explain briefly, the difference between pulse 1 and pulse 2 in Fig. 7.2.

....

....

....[1]

8 A reed switch is one type of switch for an electrical circuit.

The reed switch contains two metal strips that are not in contact unless a magnet is close to them, as shown in Fig. 8.1.

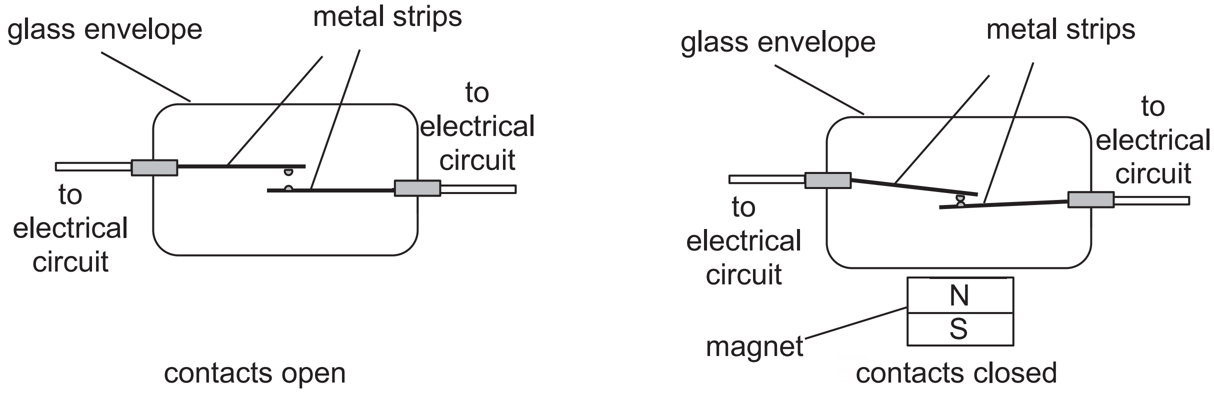

Fig. 8.1

(a) Explain why bringing the magnet close to the reed switch will cause the metal strips to come into contact and close the reed switch.

....

....

....

....

....[2]

(b) Suggest why the metal strips will not lose contact when the magnet is removed if the strips are made of steel.

....

....

....

....

....[2]

(c) Suggest a modification to the reed switch so that the reed switch would be normally closed unless a magnet is brought close to it.

....

....[1]

9 Fig. 9.1 shows a d.c. motor.

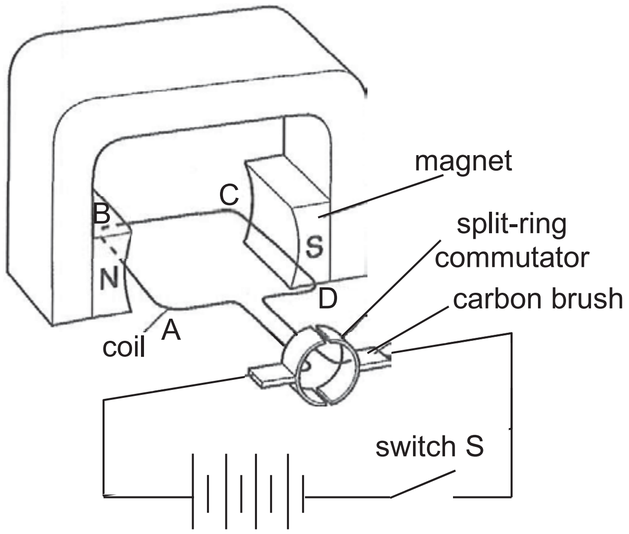

Fig. 9.1

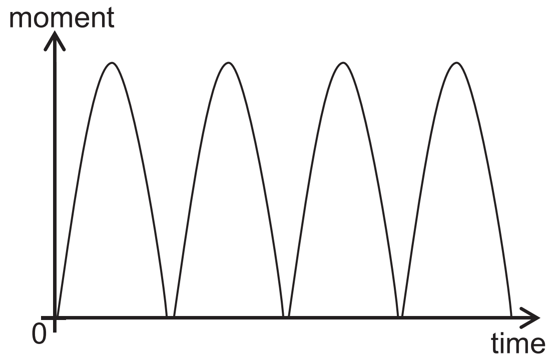

Fig. 9.2

The coil is horizontal, as shown in Fig. 9.1.

(a) **On Fig. 9.1**, draw the forces that act on sides AB and CD of the coil when the switch S is closed. [1]

(b) Explain why the coil turns when the switch is closed.

....

....

....

....

....[2]

(c) Explain why the coil continues to turn in the same direction when it has turned 180°.

....

....

....

....[2]

(d) Fig. 9.2 shows how the moment acting on the coil changes with time.

Sketch, **on Fig. 9.2**, how the moment acting on the coil changes with time if the e.m.f. of the battery is halved. [1]

Section B (30 marks)

Answer **all** the questions from this section.

Answer only one of the two alternative questions in **Question 12**.

10 A vertical-axis wind turbine (VAWT) that can be installed on top of buildings to generate electricity using a renewable energy source.

(a) State what is meant by a *renewable energy source*.

....

....[1]

(b) Fig. 10.1 shows the structure of a VAWT installed on a building.

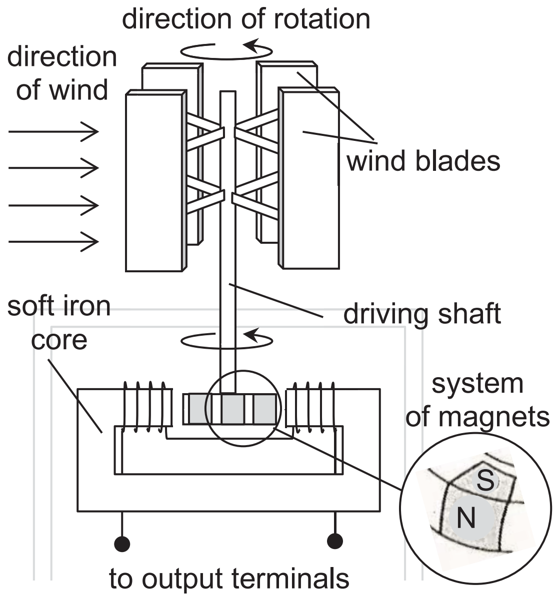

Fig. 10.1

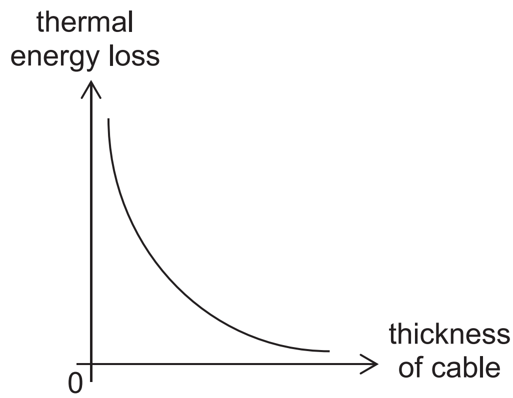

Fig. 10.2

The turbine consists of four blades which catches the wind and turns the driving shaft.

A system of magnets connected to the end of the driving shaft, is placed within a soft-iron core wound with coils of wires. These coils of wires are connected to the output terminals leading to the building.

Explain how the wind produces an alternating electromotive force (e.m.f.) across the output terminals in Fig. 10.1.

....

....

....

....

....[3]

(c) Fig. 10.2 shows how the loss of thermal energy from a transmission cable from the output terminals to the building varies with the thickness of the cable.

Explain why the loss of thermal energy is less if the transmission cable is thicker.

....

....

....

....[2]

(d) Fig. 10.3 shows how the power output of a single unit of the VAWT varies with wind speed.

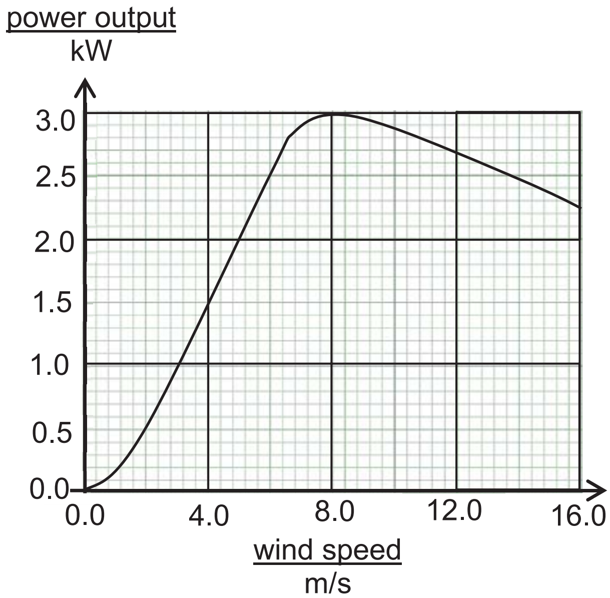

Fig. 10.3

time min	wind speed m/s
0	2.0
1	4.0
2	8.0
3	14.0
4	14.0
5	8.0
6	12.0
7	6.0
8	5.0
9	3.0

Table 10.1

The wind speed is recorded at one minute intervals, as shown in Table 10.1.

(i) Use the data in Fig. 10.3 and Table 10.1 to estimate the total energy produced in the ten minute interval by a single VAWT. Give your answer in joules.

energy = ...J [3]

(ii) Explain why your answer in **(i)** is only an estimate.

……………………………………......……………………………………………………………..............

……………………………………......……………………………………………………………..............

……………………………………......…………………………………………………………..........[1]

(iii) Five VAWTs are installed on top of another building where the average wind speed varies between 0 to 8.0 m/s daily.

The unit cost of electricity is 32 cents.

Using the data in Fig. 10.3, calculate the estimated cost savings from the electricity generated from the five VAWTs in a day.

cost savings = ... [2]

11 Ultrasound and X-rays are used to provide information about structures inside the human body.

(a) Fig. 11.1 shows ultrasound being used to detect a cyst, which is a sac may be filled with air, fluids or other materials, in a human body.

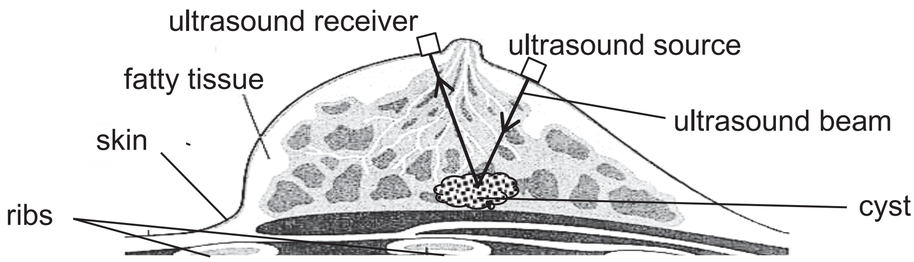

Fig. 11.1

(i) Explain how the vibrations of the source produce waves of ultrasound.

....

....

....

....

....

....[2]

(ii) Suggest how these waves of ultrasound are transmitted through the body tissue to the receiver.

....

....[1]

(iii) Ultrasound used in medicine has a frequency that is about 100 times higher than the maximum frequency that can be heard by humans.

The speed of ultrasound in the human body is 1500 m/s.

Determine the wavelength of the ultrasound used in medicine.

wavelength = ... [2]

(b) The wavelength of X-rays used to detect fractures is roughly the size of an atom.

(i) Determine the frequency of the X-rays.

State the value of any constant used.

frequency = ... [2]

(ii) Describe the effects on living cells and tissues when X-rays cause ionization.

....

....

....[1]

12 EITHER

A standing steam iron uses hot steam to loosen the bonds of the fabric and reduces the appearance of wrinkles and creases.

(a) Fig. 12.1 shows the standing steam iron connected to the mains supply.

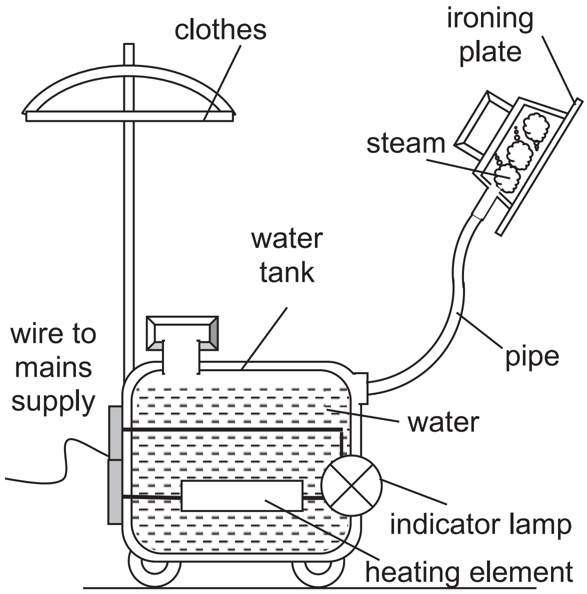

Fig. 12.1

<u>Specifications of standing iron</u>
Power: 2.0 kW
Operating voltage: 240 V
Capacity: 1.5 litre
Heat-up time: 45 s
<u>Thermal properties of water</u>
Specific heat capacity:
4.2 J / (g °C)
Specific latent heat of vaporisation:
2.3 kJ / g

Table 12.1

Table 12.1 shows data relevant to the standing steam iron.

The appliance is filled with 1.5 litres of water at 32 °C. The mass of 1.0 litre of water is 1.0 kg.

The appliance is used until 80% of the water has been turned to steam and released through the ironing plate.

(i) Calculate the amount of energy used to raise the temperature of the water in the tank to its boiling point.

energy used = ... [2]

(ii) Calculate the amount of energy used to produce the steam released.

energy used = ... [2]

(iii) Suggest a reason, other than thermal energy loss to the surroundings, why the actual amount of energy used is more than the calculated values in **(a)(i)** and **(a)(ii)**.

....

....[1]

(b) To ensure that no damage or injury is caused, the standing steam iron has a 10 A fuse connected to the live wire.

Explain why replacing the 10 A fuse with a 15 A fuse presents a risk of damage or danger.

....

....

....[1]

(c) Fig. 12.2 shows some key design features of the water tank of the standing steam iron.

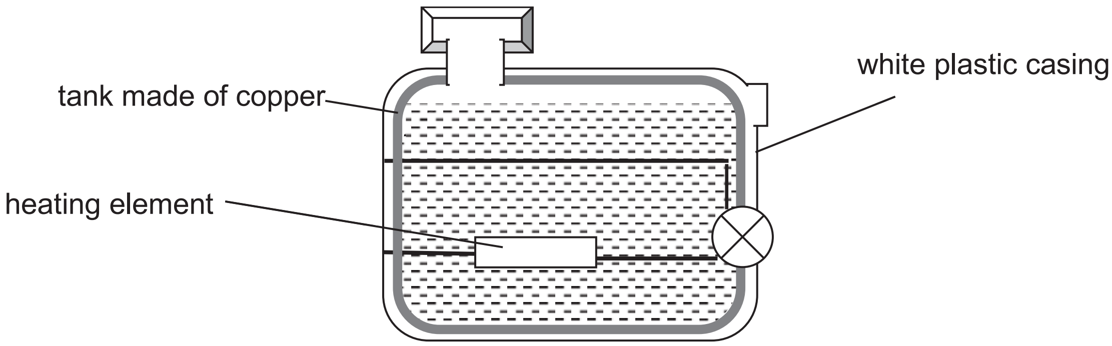

Fig. 12.2

(i) Describe how all of the water in the tank is heated up by the heating element.

....

....

....

....[2]

(ii) Explain how these key design features of the water tank help to reduce thermal energy loss to the surroundings.

....

....

....

....[2]

12 OR

(a) A stationary swimmer starts to swim by pushing off from one side of a swimming pool.

Fig. 12.3 shows the velocity-time graph of the swimmer's motion with four points indicated.

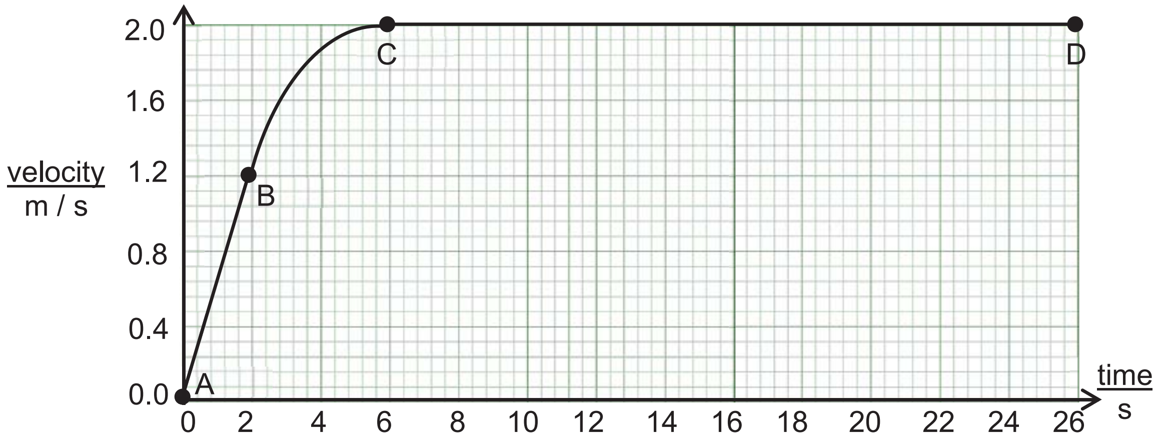

Fig. 12.3

(i) The mass of the swimmer is 80 kg and the resistive forces acting on him at between A and B is 320 N.

Determine the force exerted by the swimmer on the water between A and B.

force exerted = ... [3]

(ii) The distance between A and D is 50 m. The displacement of the swimmer is zero at point A.

On Fig. 12.4, sketch the displacement-time graph for the motion. [3]

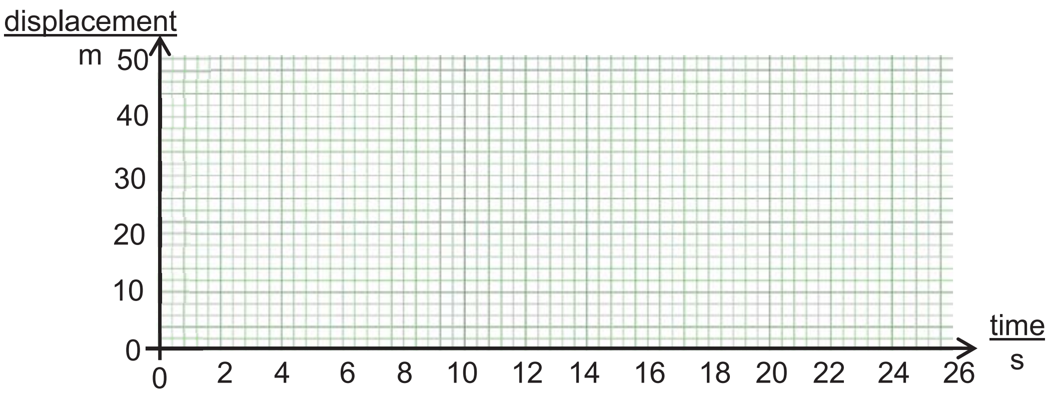

Fig. 12.4

(b) The swimmer reaches the wall at the other end of the swimming pool and turns around under the water.

Fig. 12.5 shows the swimmer immediately after turning around.

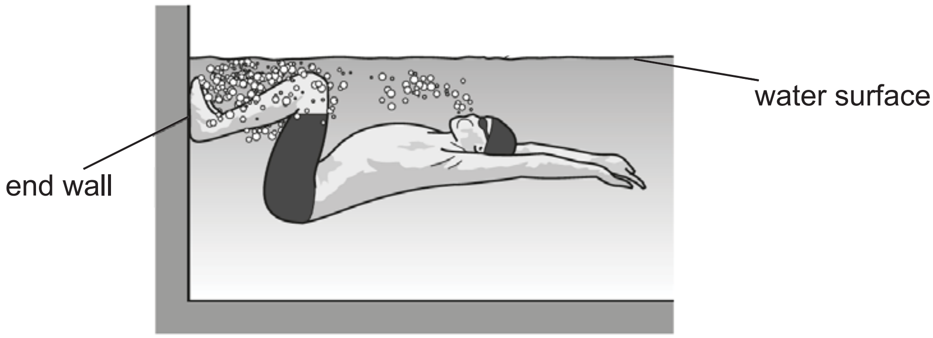

Fig. 12.5

(i) The swimmer pushes against the end wall of the swimming pool with his legs.

Explain, in terms of Newton's law(s), why the swimmer accelerates away from the end wall.

....

....

....

....

....[2]

(ii) While swimming, there is a constant forward force on the swimmer.

His velocity increases until eventually he reaches a constant velocity.

Explain, in terms of forces, why he reaches a constant velocity.

....

....

....

....

....[2]

- END OF PAPER -

2022 Sec 4 Express Preliminary Examinations Answers

Paper 1 MCQ [40 marks]

1	2	3	4	5	6	7	8	9	10
D	B	A	B	C	A	D	C	C	B

11	12	13	14	15	16	17	18	19	20
D	A	C	A	D	C	D	B	B	C

21	22	23	24	25	26	27	28	29	30
A	D	B	C	D	A	A	C	B	D

31	32	33	34	35	36	37	38	39	40
A	B	D	A	B	C	B	C	A	D

Paper 2 Section A [50 marks]

1 (a) Appropriate scale (at least half of space given)

Correct scale drawing with correct direction of arrows [B2]

drag force F_D: 1870 N (1600 N to 2150 N) & 40 ° (38 ° to 42 °) from vertical [A1]

(b) (i) Kinetic energy of the person with parachute decreases and his gravitational potential energy decreases to zero [1] as work is done against air resistance and energy is converted to thermal energy [1].

(ii) By conservation of energy,

total energy at X = total energy at Y [M1]

$\frac{1}{2} \times 72 \times (12)^2 + 72 \times 10 \times 8 = \frac{1}{2} \times 72 \times v^2 + 10000$ [M1]

$\frac{1}{2} \times 72 \times v^2 = 944$

$v = 5.1$ m/s (to 2 sf) [A1]

(iii) The suggestion is incorrect.

Since there is work done against air resistance, the speed of the person at Y will be faster if the person has a larger mass [accept any other sensible suggestion or reference made to working in (ii)] [1]

2 (a) (i) The *principle of moments* states that for an object in equilibrium [1], the sum of clockwise moments about any point as the pivot is equal to the sum of anti-clockwise moments about the same point as pivot. [1]

(ii) Taking moments about Q,

$1.0 \times 2.6 \text{ cm} + 4.2 \times (1.4 + 2.6) \text{ cm} = R_P \times (1.2 + 1.4 + 2.6) \text{ cm}$ [M1]

$R_P = 3.730769231 \approx 3.7 \text{ N}$ [A1]

Total upward force = total downward force

$R_P + R_Q = 4.2 + 1.0$

$R_Q = 1.469230769 \approx 1.5 \text{ N}$ or [A1]

Taking moments about P,

$1.0 \times 2.6 \text{ cm} + 4.2 \times (1.2 + 1.4) = R_Q \times (1.2 + 1.4 + 2.6)$

$R_Q = 1.469230769 \approx 1.5 \text{ N}$

(b) When the toy is displaced, its centre of gravity is displaced upward and to the right and the weight now has a turning effect about the pivot [1].

The moment of the weight about the pivot would cause the toy to turn clockwise and return to its rest position [1].

3 **(a)**

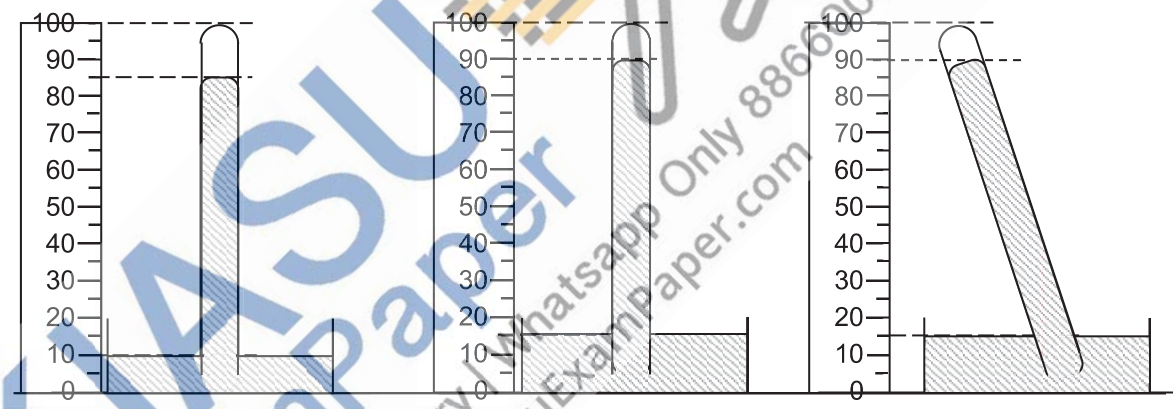

Fig. 3.1 **Fig. 3.2** **Fig. 3.3**

(i) B1 for h = 75 cm (at 90 cm mark on metre rule)

(ii) B1 for h = 75 cm (at 90 cm mark on meter rule, horizontal line)

(b) **(i)** The trapped air exerts a pressure on the column of mercury in the inverted glass tube, causing the level of mercury in the tube to be lower. (or equivalent) [1]

(ii) The reading obtained using his own barometer will become lower. [1]

When the student pushes the inverted glass tube further into the mercury bath, the volume of trapped air becomes smaller and the number of molecules per unit volume increases. [1] The frequency of collisions between the molecules and the walls of the glass tube and mercury increases, causing the pressure of the trapped air to increase and the level of mercury in the glass tube to become lower. [1]

4 **(a)** $n = \sin i / \sin r$

$1.5 = \sin 30 / \sin r$ [M1]

$r = \sin^{-1} (\sin 30° / 1.5)$

$= 19.47122063 \approx 19°$ [A1]

(b)

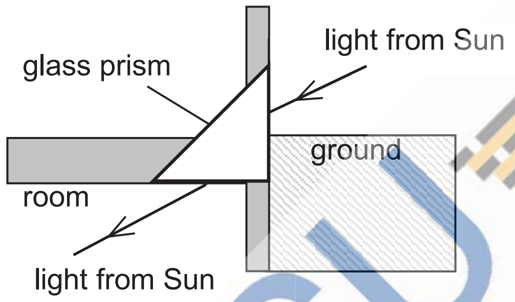

Fig. 5.2

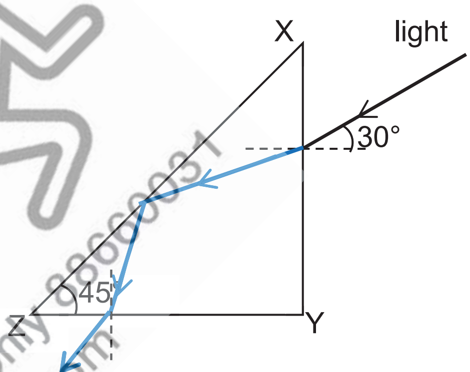

Fig. 5.3

B1 for TIR at XZ and correct bending at XY and YZ

5 **(a)** Electrons in the metal foil and rod are repelled away by the negative charges on the plastic strip, leaving the sides nearer to the strip positively charged and the sides furthest from the strip negatively charged. [1]

The repulsion between like charges on the furthest end of the rod and foil causes the metal foil to move away from the metal rod. [1]

(b) Strip Y is negatively charged. [1] Since the metal foil moves further away from the metal rod, the repulsion between like charges on the furthest end of the rod and foil is stronger when strip Y is brought close so strip Y must be charged negatively like strip X [1]

6 **(a)** As the potential difference (p.d) increases from zero to 2.0 V, resistance of LED remains undefined/infinitely large (since current through LED remains at 0 A). [1]

As the p.d. increases from 2.0 V to 4.2 V, resistance of LED decreases as current increases (since ratio of V to I decreases). [1] or

As the p.d increases from 2.0 V to 3.0 V, resistance of LED decreases (since ratio of V to I decreases). As the p.d increases from 3.0 V to 4.2 V, resistance of LED remains constant (since ratio of V to I remains constant). [1]

(b) 1. Current through power supply = 20 + 40

= 60 mA [A1]

2. Reff = V / I

$= 3.4 / (60 \times 10^{-3})$ [M1]

$= 56.66666.. \approx 57\ \Omega$ [A1]

7 **(a)** When the card falls but does not block the light, the resistance *R* of the LDR remains constant and the potential difference *V* across the LDR remains at 0.60 V. [1]

As the card continues falling, whenever the light is blocked by the card, the resistance *R* of the LDR increases and potential difference *V* across the LDR increases from 0.60 V to 5.0 V since $V_{LDR} = \frac{R_{LDR}}{R_{LDR}+4000} \times 6$ [1] or equivalent

(b) $V = \left(\frac{R_{LDR}}{R_{LDR}+4800}\right) \times 6.0$

$5.0 = \left(\frac{R_{LDR}}{R_{LDR}+4800}\right) \times 6.0$ [M1]

V = 24000 Ω [A1]

(c) Pulse 2 has a shorter duration than pulse 1. As the card falls, it accelerates and falls at faster speed so the time that the light is blocked by the upper part of the card of the same length would become shorter. [1]

8 **(a)** When the magnet is brought close to the reed switch, the metal strips become induced magnets such that the side closer to the magnet is a South pole and the side further from the bar magnet is a North pole. [1]

Attraction between unlike poles induced on the two metal strips causes the metal strips to come in contact and close the reed switch.

(b) Steel does not lose its magnetism easily/ retains its magnetism. [1]

The metal strips made of steel would retain its magnetism and the sides of the metal strips facing each other will still attract each other and not lose contact even when the bar magnet is removed since unlike poles attract. [1]

(c) Install/Place a bar magnet on the glass envelope. [1]

9 **(a)** B1 for both arrows in correct direction (see Fig. 9.1)

(b) The combined magnetic fields due to the magnets and the current in the coil ABCD results in AB experiencing a downward force and CD experiencing an upward force by Fleming's Left Hand Rule. [1].

Both forces produce anti-clockwise moments about the centre of the coil and as a result, the coil ABCD would rotate in an anti-clockwise direction. [1]

(c) When the coil has turned 180°, the split-ring commutator reverses the current in the coil (i.e. from ABCD to DCBA). [1]

According to Fleming's Left Hand Rule, the direction of force acting on AB and CD is reversed such that both forces produce anti-clockwise moments about the centre of the coil and the coil will continue to rotate in the same direction. [1]

(d) B1 for correct graph with amplitude and frequency halved (period doubled) (see Fig. 9.2)

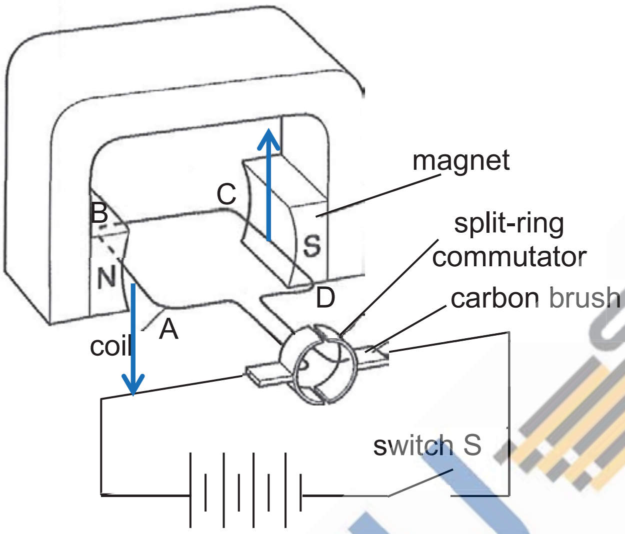

Fig. 9.1

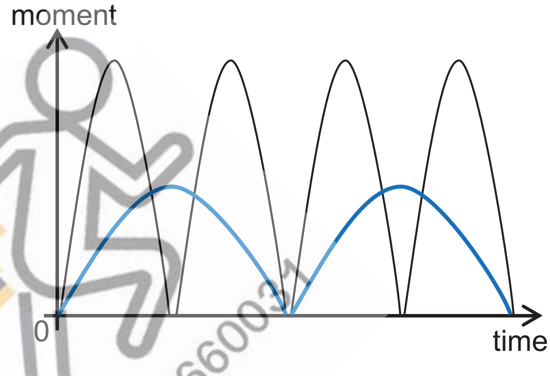

Fig. 9.2

Paper 2 Section B [30 marks]

10 **(a)** A renewable source of energy is a source of energy that can be replenished / replaced / renewed. [1]

(b) The wind turns the turbine/driving shaft and the system of magnets as the blades catch the wind. [1]

As the driving wheel turns and the system of magnets rotate such that the N-pole is moving from the position shown out of the plane of the paper (or moving in one direction), the change in the magnetic field lines cutting the coil induces an e.m.f in one direction. [1]

When the system of magnets continues to rotate such the N-pole is now moving into the plane of the paper (or moving in the opposite direction) , the change in the magnetic field lines cutting the coil induces an e.m.f in the opposite direction. [1]

(c) When the transmission cable is thicker, the cross-sectional area *A* of the cable is larger. [1]

This results in the thicker transmission cable of the same length having a lower resistance (since $R = \frac{\rho L}{A}$) and the loss of thermal energy would be lesser for the same current given that $P_{loss} = I^2R$. [1]

(d) (i)

time /min	wind speed /m s^{-1}	power / kW	energy / J
0	2.0	0.5	0.5 x 1000 x 60
1	4.0	1.5	1.5 x 1000 x 60
2	8.0	3.0	3.0 x 1000 x 60
3	14.0	2.5	2.5 x 1000 x 60
3	14.0	2.5	2.5 x 1000 x 60
5	8.0	3.0	3.0 x 1000 x 60
6	12.0	2.7	2.7 x 1000 x 60
7	6.0	2.5	2.5 x 1000 x 60
8	5.0	2.0	2.0 x 1000 x 60
9	3.0	1.0	1.0 x 1000 x 60
total energy			1 272 000 J ≈ 1.3 x 10^6 J

1m for obtaining correct values of power from graph based on table.

1m for calculating correct values of energy per second (their P x 1000 x 60)

1m for calculating correct total energy

(ii) The wind speed may not be constant throughout the one-minute interval following the measurement. The power output will not be constant as a result of the different wind speed so the calculation of the total energy is only an estimate.

(iii) Average power = 1.5 kW

Total energy = 5 x 1.5 kW x 24 h

= 180 kWh [M1]

Cost savings = 180 x 32

= 5760 cents or $57.60 [A1]

11 (a) (i) Vibrations of the source causes the layers of particles around/next to the source to be displaced. [1]

These layers of particles which are displaced, vibrates parallel to the direction of travel of the ultrasound beam (at frequencies higher than 20 kHz), forming alternating regions of compression and rarefactions and produce waves of ultrasound. [1]

(ii) These waves of ultrasound are transmitted from the source as longitudinal waves that are reflected off structures (such as the cyst) in the body and through the body tissue to the receiver. [1]

(iii) $v = f\lambda$

$1500 = (100 \times 20\,000)\,\lambda$ [M1]

$\lambda = 7.5 \times 10^{-4}$ m [A1]

(b) (i) $v = f\lambda$

$3.0 \times 10^8 = f\,(10^{-10} / 10^{-11})$ [M1]

$f = 3.0 \times 10^{17}$ or 3.0×10^{18} Hz [A1]

(ii) Ionising radiation absorbed by human tissues may result in damage to proteins, nucleic acids and other vital molecules found in cells. [1] or
Ionising radiation may also cause damage to chromosomes and an abnormal pattern of cell division possibly leading to cancers such as leukaemia [1]

12 EITHER

(a) (i) Energy to raise temperature $Q_1 = mc\Delta\theta$

$= (1.5 \times 1000) \times 4.2 \times (100 - 32)$ [M1]

$= 428\,400 \approx 430\,000$ J [A1]

(ii) Energy to produce steam $Q_2 = ml_v$

$= (80/100 \times 1.5 \times 1000) \times 2.3 \times 1000$ [M1]

$= 2\,760\,000 \approx 2\,800\,000$ J [A1]

(iii) The heat capacity of the appliance was not included/considered in the calculated values in **(a)(i)** and **(a)(ii)**. [1]

(b) The appliance has a working/operating current of 8.3 A. A fuse rating of 15 A is much higher than the working current so the fuse may not melt when there is excessive current, and the appliance may overheat and be damaged. [1]

(c) (i) The water near the heating element gets heated up, expands, become less dense and rises while the cooler water sinks/gets displaced downwards and gets heated, in turn. [1 for description of density changes] This sets up a convection current in the water and all the water inside the tank gets heated up by convection. [1]

(ii) Plastic is a poor conductor of thermal energy so thermal energy transfer from water through the copper tank to the plastic casing to the surroundings by conduction is reduced. [1] White is a poor emitter of radiant heat so thermal energy transfer from the water tank to the surroundings by radiation is reduced. [1]

12 OR

(a) (i) $a = (v - u) / t$

$= (1.2 - 0) / 2$ [M1]

$= 0.60$ m/s^2

$F_{net} = ma$

$F - 320 = 80 \times 0.60$ [M1]

$F = 368 \approx 370$ N [A1]

(ii) 1 m for each section of motion (see Fig. 12.4)

AB – curve with increasing gradient (from (0,0) to (2,1.2)

BC – curve with decreasing gradient (from (2,1.2) to (6,10)

CD – straight line with positive gradient (from (6,10) to (26, 50)

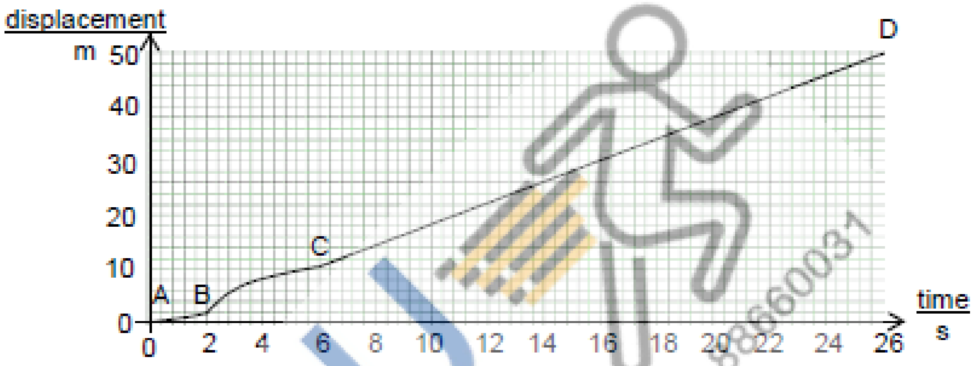

Fig. 12.4

(b) (i) By Newton's third law, when the swimmer pushes against the end wall with his legs, the end wall exerts an equal and opposite force on the swimmer. [1]

By Newton's Second Law, since an object will accelerate in the direction of the resultant force acting on the object, the swimmer will accelerate away from the end wall due to the resultant force (the force exerted on him by the end wall) acting on him. [1]

(ii) As his velocity increases, the resistive forces acting on the swimmer increases. [1]

When the the resistive forces acting on the swimmer is equal and opposite to the constant forward force, the resultant force acting on the swimmer becomes zero and he reaches a constant velocity, by Newton's first law. [1]

8

2022 Sec 4 Express Preliminary Examinations Answers

Paper 3 Practical [40 marks]

1	(a)		**MMO** h_0 measured to nearest 1 mm with unit	1
	(b)		**MMO** h_1 measured to nearest 1 mm with unit	1
	(c)		**ACE** correct calculation of *m* and values within 10%	1
	(d)		**ACE** correct calculation of *f* and values within 10%	1
			PDO *f* to 3 sf	1
	(e)		**P** correct constant variable (lens, distance from lens to eye) and correct independent variable (distance from card to lens, u) Keeping key variables constant, varies independent variable, *u and* measures h_1 to determine corresponding *m* plots suitable graph: graph of *u* against *m* correct sketch of graph given correct relationship	5

MMO: 2, ACE: 2, PDO: 1, P: 5

2	(a)	(i)	**MMO** *L* measured to nearest 0.1 cm with units	1
		(ii)	**MMO** $I_{standard}$ measured to 0.01 A with unit V_L measured to 0.05 V with unit	2
	(b)		**MMO** V_1 and V_2 measured to 0.05 V with units and correct trend between V_1 and V_2	1
	(c)	(i)	**ACE** R_1 calculated correctly with units and R_1 within 10%	1
			PDO R_1 to 3 sf	1
		(ii)	**ACE** R_2 calculated correctly with units and R_2 within 10%	1
			PDO R_2 to 3 sf	1
	(d)		**ACE** any one from to explain difference between R_1 and R_2: Kinks in wire causes *x* and *L* to be inaccurate Wire heats up after some time, affects values of *I* and *V*	2

MMO: 4, ACE: 4, PDO:2

3	(a)	(i)	**MMO** *L* measured to nearest 0.1 cm with units *d* measures to nearest 0.1 cm with units	2
		(ii)	**MMO** *l* measured to nearest 0.1 cm with units	1
		(iii)	**ACE** correct calculation of *x* to 0.1 cm with correct units	1

			ACE correct calculation of F to 2 sf with correct units	1
(b)		**MMO** 5 sets of data (including 0 g) with correct trend		1
		PDO table with quantities with correct units		1
		PDO m to nearest 100 g		1
		PDO L, d measured to nearest 0.1 cm with units		1
		ACE correct calculation of x to 1 dp		1
		ACE correct calculation of F to 2/3 sf		1
(c)	**(i)**		**PDO** axes labelled with units and correct orientation	1
			PDO suitable scale with plotted data occupying more than half the page in both directions	1
			PDO all points plotted correctly (points must be less than half a small square from correct position)	1
			PDO best fit straight line and small crosses	1
	(ii)		**ACE** Correct calculation of gradient and use of a gradient triangle spanning more than half of the drawn line	1
			ACE correct calculation to 2/3 sf and correct units	1
(d)		**ACE** any sensible explanation about why masses greater than 400 g is not used		1
(e)		**MMO** any sensible source of error with clear indication of reading affected		1
(f)		**MMO** any sensible suggestion to improve accuracy		1

MMO: 6, ACE: 7, PDO: 7

MMO: 12 (30%) ACE: 13 (32.5 %) PDO: 10 (25 %) P: 5 (12.5%)

	Class	Index No.
Candidate Name:		

FUHUA SECONDARY SCHOOL

Secondary Four Express

Preliminary Examination 2022

4E

Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary
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PHYSICS

6091/01

Paper 1

30 Aug 2022
0800 – 0900
1 hour

Additional Material: Optical Mark Recognition (OMR)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, class, index number on the OMR and this question booklet.

There are **forty** questions on this paper. Answer all questions. For each question, there are four possible answers **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate OMR.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done on this paper.

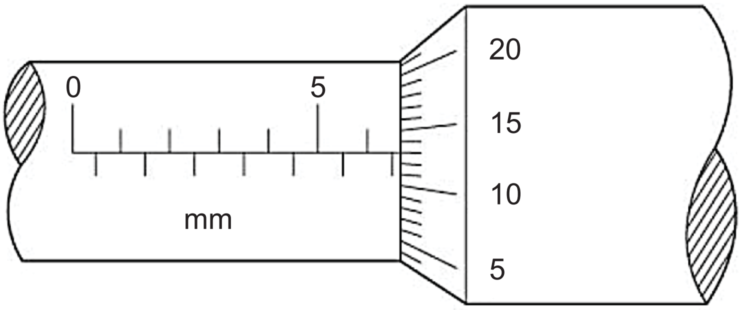
The use of an approved scientific calculator is expected, where appropriate.

PARENT'S SIGNATURE	FOR EXAMINER'S USE	
		40

Setter: Mr Raymond Loh **Vetter:** Mrs Wong Kexin

This question paper consists of 15 printed pages including this page.

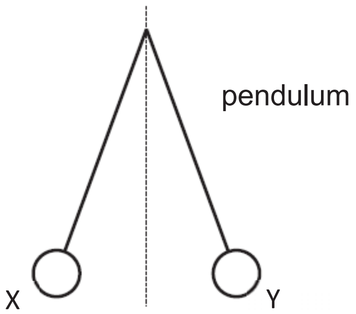
1 The diagram shows a micrometer screw gauge.



What is the reading shown?

A 5.63 mm **B** 6.50 mm **C** 6.63 mm **D** 7.13 mm

2 The diagram shows a frictionless pendulum swinging between points X and Y at a frequency of 2.0 Hz.



How long does it take for the bob to swing from X to Y?

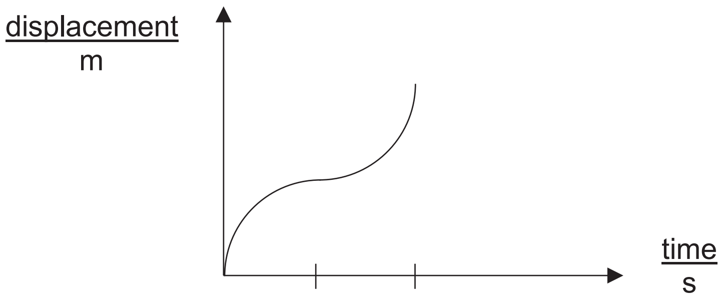
A 0.25 s **B** 0.50 s **C** 1.0 s **D** 2.0 s

3 A parachutist falling at a steady speed opens his parachute.

Which row gives the direction of the resultant force and the direction of the acceleration of the parachutist just after his parachute opens?

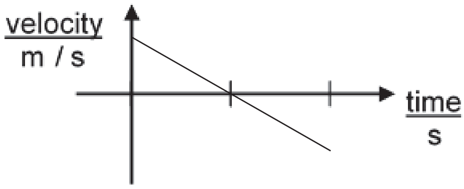
	direction of the resultant force	direction of the acceleration
A	downwards	upwards
B	downwards	downwards
C	upwards	upwards
D	upwards	downwards

4 The graph shows how the displacement of an object changes with time.

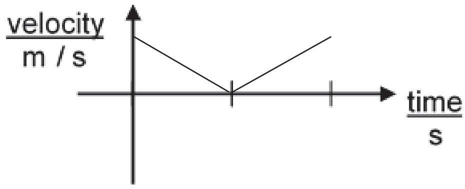


Which graph represents the velocity-time graph of the object?

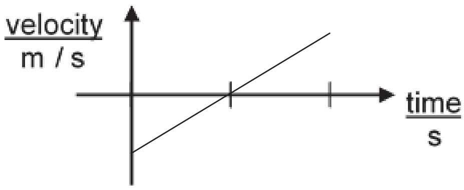
A



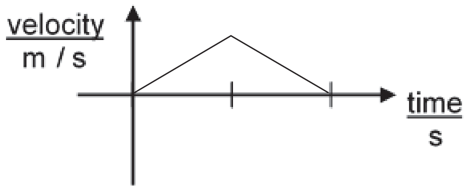
B



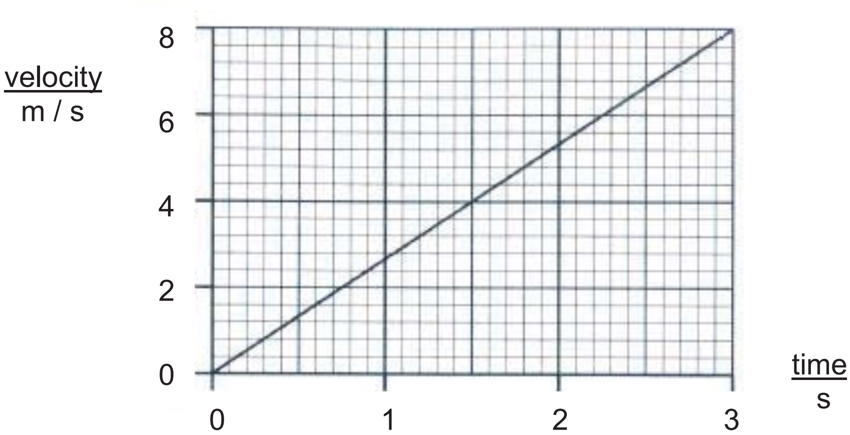
C



D



5 The graph shows how the velocity of a model car travelling on a flat surface varies with time.

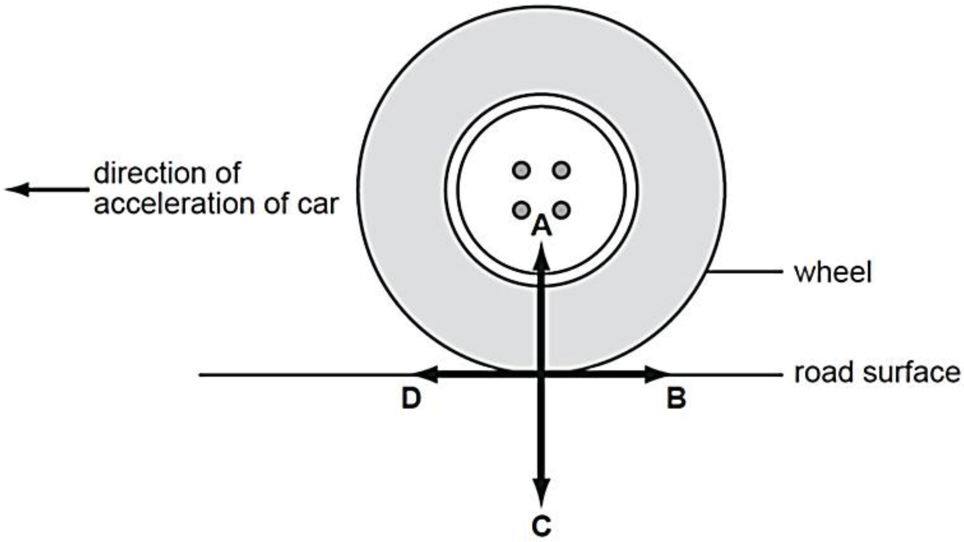


Which statement about the model car is **not** correct?

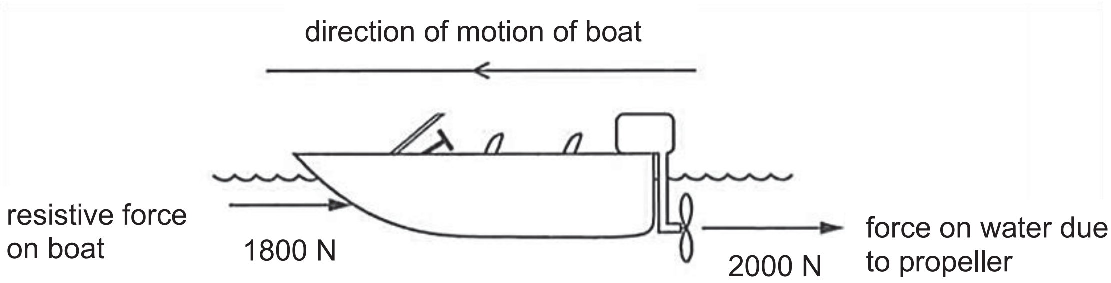
A Its acceleration is 2.7 m / s^2.
B Its distance travelled is 12 m.
C It is moving at a uniform velocity.
D It is moving in the same direction throughout the 3 s.

6 The diagram shows the wheel of a moving car. The wheel is connected to the engine. The car is accelerating along a road in the direction shown.

What is the direction of the frictional force exerted by the road surface on the wheel?



7 The propeller of a boat pushes water backwards with a force of 2000 N. The boat moves through the water against a total resistive force of 1800 N.



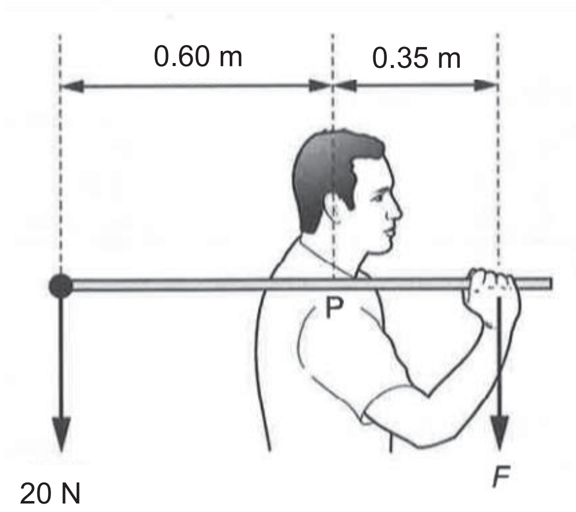
What is the magnitude of the resultant force on the boat?

A 200 N **B** 1800 N **C** 2000 N **D** 3800 N

8 Which property of an object causes the object to resist a change in the state of rest or motion of the object?

A density **B** mass **C** velocity **D** volume

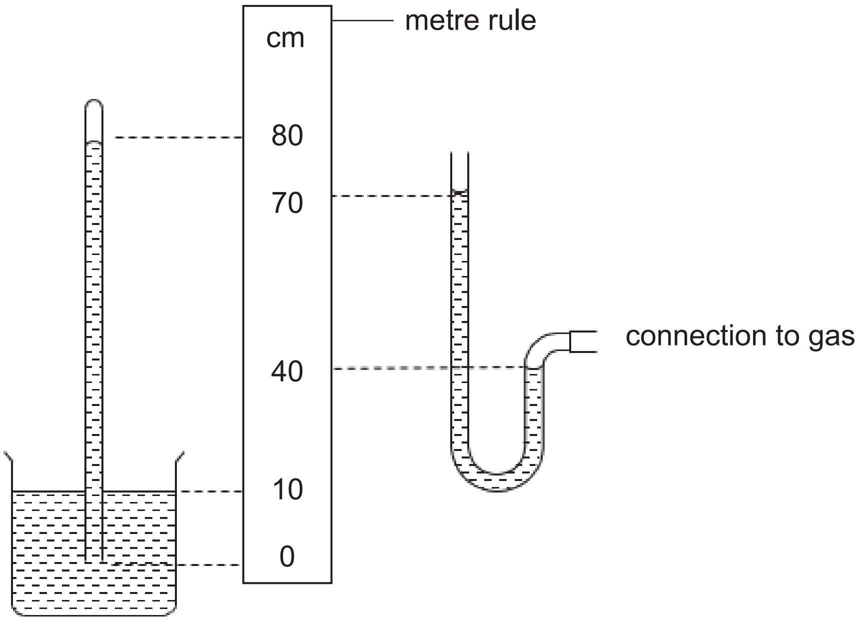
9 A man is carrying a load on the end of a uniform pole of length 1.0 m and weight 5 N. He rests the pole on his shoulder at point P which acts as a pivot. He keeps the pole in balance with a downward force *F* with his hand, as shown.



What is the force *F* applied by the man to balance the pole?

A 12.0 N **B** 17.0 N **C** 34.3 N **D** 35.7 N

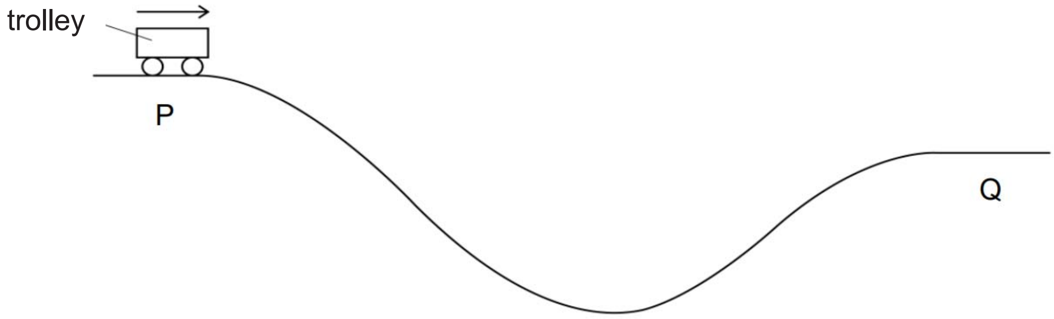
10 The diagram shows a mercury barometer and a mercury manometer placed beside each other. One end of the manometer is connected to a container filled with an unknown gas.



What is the pressure of the gas?

A 30 cm Hg **B** 60 cm Hg **C** 70 cm Hg **D** 100 cm Hg

11 A trolley of mass 20 kg moves from position P to Q along a rough track. At point Q, its gravitational potential energy is 100 J less than that at point P. Its speed at point P is 2.0 m / s. The work done against friction from point P to Q is 60 J.



What is the speed of the trolley at point Q?

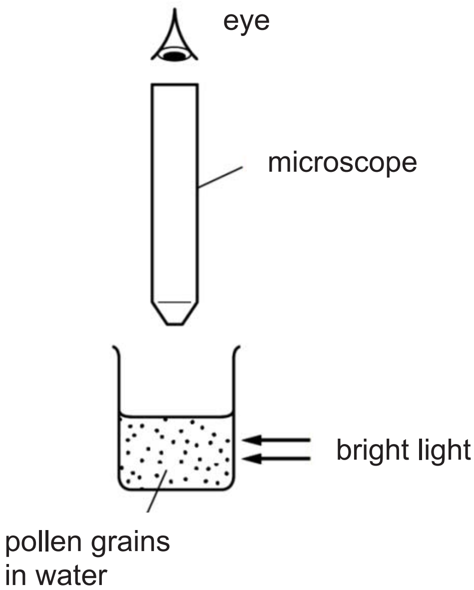
A 2.8 m / s **B** 3.2 m / s **C** 4.4 m / s **D** 5.8 m / s

12 A 1500 kg car accelerates from 10 m / s to 30 m / s in 10 s.

What is the average power output developed by the engine of the truck?

A 15 kW **B** 30 kW **C** 60 kW **D** 600 kW

13 Very small pollen grains are suspended in water. A bright light shines from the side. Through a microscope, small specks of light are seen to be moving in a random, jerky manner.



What are the moving specks of light?

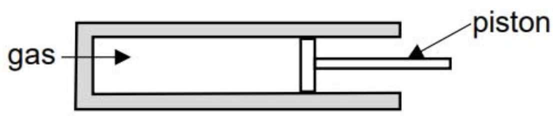
A Pollen grains being hit by other pollen grains.
B Pollen grains being hit by water molecules.
C Water molecules being hit by other water molecules.
D Water molecules being hit by pollen grains.

14 A sealed container contains nitrogen gas.

What will happen to the gas molecules when the container is heated?

A They will become denser.
B They will expand.
C They will move further apart.
D They will move more quickly.

15 The diagram shows a cylinder made of insulating material with a movable piston at one end. The piston can be pushed or pulled without the gas leaking out.



Which statement about the gas when the piston is moving is **not** correct?

A The density of the gas decreases as the piston is pulled outwards.
B The mass of the gas in the piston remains unchanged.
C The pressure of the gas decreases as the piston is pulled outwards.
D The temperature increases as the piston is pushed gently inwards.

16 When a hand is placed on a metal surface and a wooden surface at room temperature, it feels colder on the metal surface than on the wooden surface.

Which statement is the correct explanation?

A The metal surface is a better absorber of infra-red than wooden surface.
B The metal surface is a better thermal conductor than wooden surface.
C The metal surface is a better emitter of infra-red than wooden surface.
D The metal surface is at a much lower temperature than the wooden surface.

17 Which statement is true about the particles that remain in a liquid during evaporation?

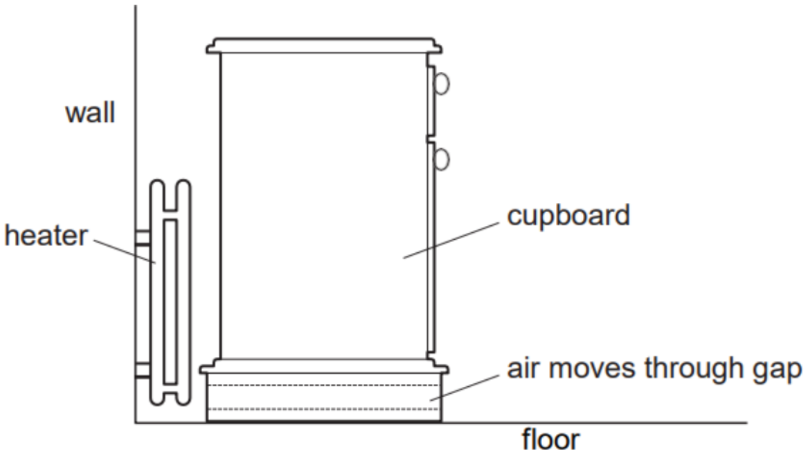
A The average size of the particles is decreasing.
B The average size of the particles is increasing.
C The average speed of the particles is decreasing.
D The average speed of the particles is increasing.

18 Two different liquids, X and Y, with the same mass and initial temperature, are heated by the same heat source. Liquid X reaches a temperature of 60°C slower than liquid Y.

Which statement is the correct explanation?

A Liquid X has a higher specific heat capacity than liquid Y.
B Liquid X has a higher specific latent heat of fusion than liquid Y.
C Liquid X has a lower specific heat capacity than liquid Y.
D Liquid X has a lower specific latent heat of fusion than liquid Y.

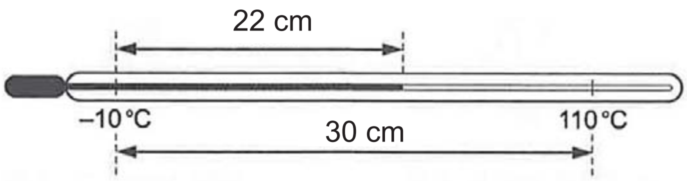
19 A cupboard is placed in front of a heater. Air can move through a gap under the cupboard.



Which of the following describes the temperature and the direction of motion of the air in the gap?

	temperature of air	direction of air
A	cool	towards the heater
B	cool	away from the heater
C	warm	towards the heater
D	warm	away from the heater

20 The diagram shows a mercury-in-glass thermometer. The distance between the –10 ºC and the 110 ºC markings is 30 cm.



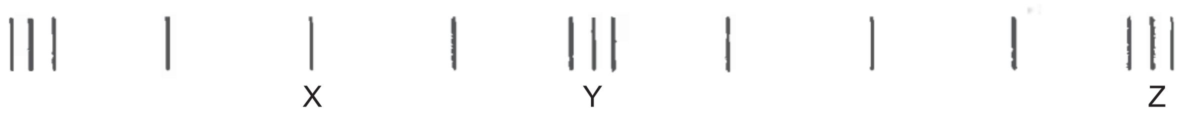
What is the temperature when the end of the mercury thread is at a distance of 22 cm from the –10 ºC mark?

A 60.0 ºC **B** 65.0 ºC **C** 78.0 ºC **D** 88.0 ºC

21 Which row shows an example of a transverse wave and a longitudinal wave?

	transverse wave	longitudinal wave
A	infra-red radiation	X-ray
B	visible light	radio wave
C	ultrasound wave	ultra-violet radiation
D	gamma ray	ultrasound wave

22 A longitudinal wave travels along a spring.
The diagram represents the position of the coils of the spring at one particular instant.

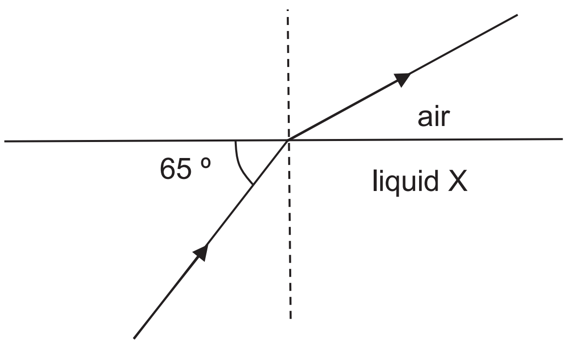


The coils vibrate from side to side. Each coil completes 4.0 oscillations in 2.0 s.

Which row shows the correct frequency and wavelength of the wave?

	frequency / Hz	wavelength / m
A	0.5	XY
B	2.0	XY
C	0.5	YZ
D	2.0	YZ

23 A ray of light is incident from below the surface of liquid X as shown in the diagram. The refractive index of liquid X is 1.2.

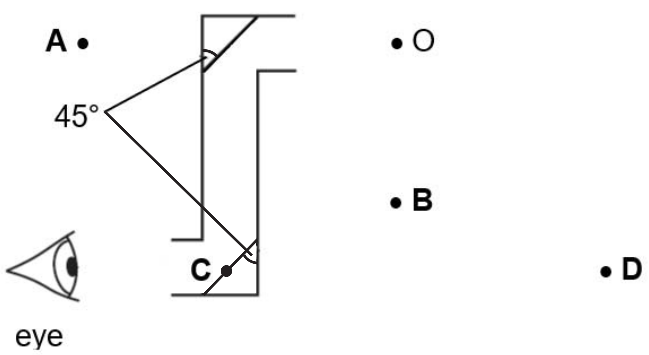


What is the angle of refraction in air?

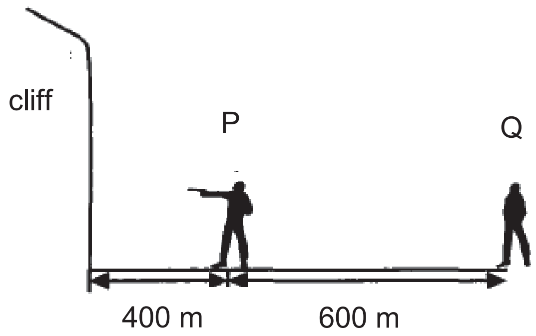
A 30 ° **B** 35 ° **C** 42 ° **D** 49 °

24 The diagram shows a child using a periscope to look at an object O on the other side of the wall. The periscope has two plane mirrors.

At which position is the image of O seen?



25 Two people, P and Q, stand in front of a vertical cliff as shown.

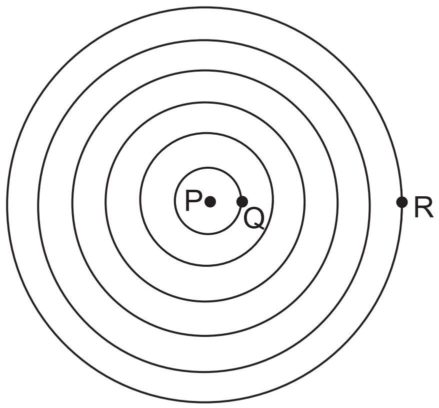


P fires one shot using a pistol and Q hears two shots.
The speed of sound in air is 340 m / s.

What is the time interval between the two shots that Q hears?

A 2.4 s **B** 2.9 s **C** 4.1 s **D** 5.0 s

26 The diagram shows the top view of some water waves produced from point P.



The waves have a speed of 0.40 m / s and take 2.0 s to travel from point Q to R.

What is the wavelength of the wave?

A 0.16 m **B** 0.20 m **C** 0.40 m **D** 0.80 m

27 Below are four statements about the uses of electromagnetic radiation.

Gamma rays are used in cancer treatment.
Infra-red waves are used in thermal imaging cameras.
Microwaves are used in satellite TV.
X-rays are used to check bone fractures.

How many of these statements is/are correct?

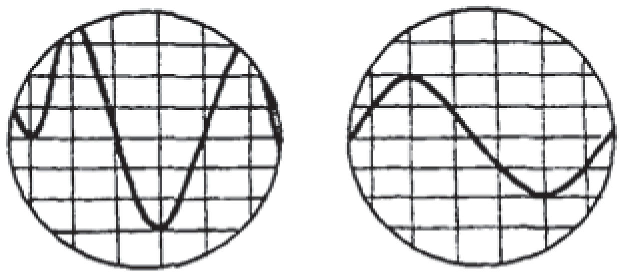
A 1 **B** 2 **C** 3 **D** 4

28 Which electromagnetic wave will **not** cause damage to living cells?

A gamma rays
B microwaves
C ultra-violet radiation
D X-rays

29 The waveforms of two notes X and Y are shown in the datalogger screens with the same scale.

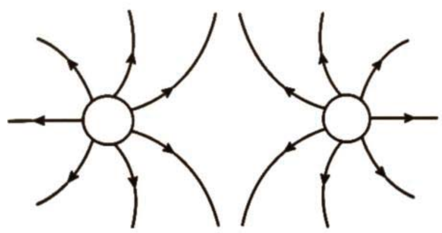
note X note Y



Which row is true about note X as compared with note Y?

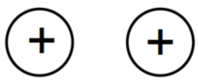
	loudness	pitch
A	louder than Y	higher than Y
B	louder than Y	lower than Y
C	not as loud as Y	lower than Y
D	not as loud as Y	higher than Y

30 The diagram shows the electric field pattern between two isolated point charges.

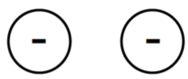


Which two point charges produce this pattern?

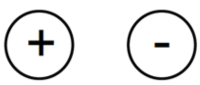
A



B



C



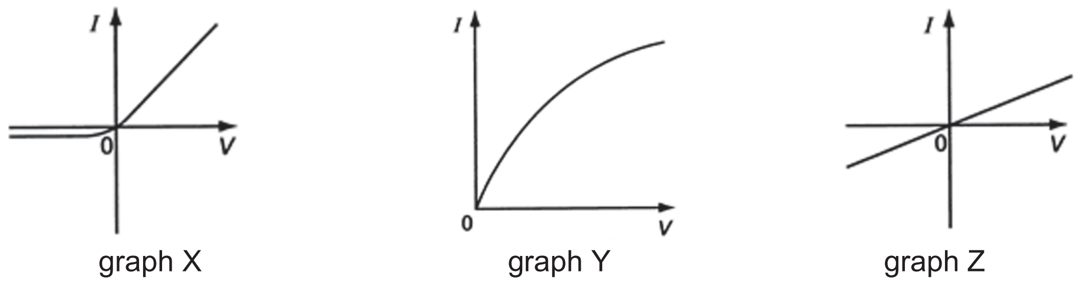
D

31 An electron is placed at a point where an electric field is acting vertically downwards. There is a force exerted on the electron due to the field.

In which direction does this force act on the electron?

A horizontally to the left
B horizontally to the right
C vertically downwards
D vertically upwards

32 Graphs X, Y and Z show how the current varies with potential difference for three electrical components.



Which electrical component does each graph represent?

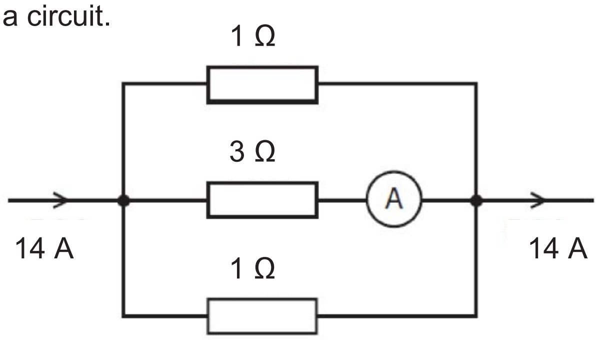
	graph X	graph Y	graph Z
A	filament lamp	semiconductor diode	metallic conductor
B	semiconductor diode	filament lamp	metallic conductor
C	metallic conductor	semiconductor diode	filament lamp
D	semiconductor diode	metallic conductor	filament lamp

33 A current of 10 A flows through an electrical component.

What is the amount of charge flowing through the electrical component in an hour?

A 0.0028 C **B** 10 C **C** 360 C **D** 36000 C

34 The diagram shows a circuit.



What is the reading of the ammeter?

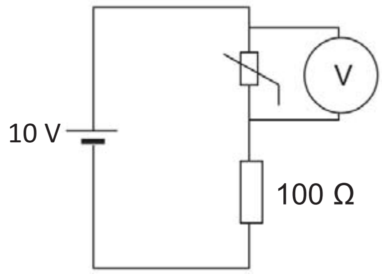
A 1 A **B** 2 A **C** 3 A **D** 4 A

35 The table shows the resistance of a light dependent resistor (LDR) and a thermistor under different conditions.

LDR	thermistor
dark: 10 kΩ bright: 100 Ω	cold: 1 kΩ hot: 100 Ω

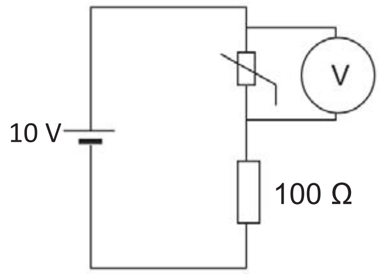
Which circuit will show the smallest voltmeter reading?

A



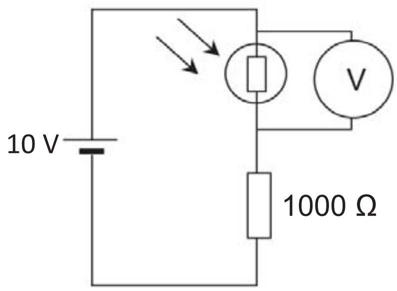
cold

B



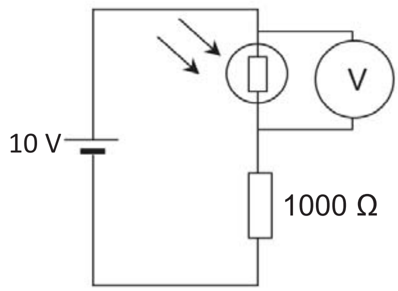
hot

C



bright

D



dark

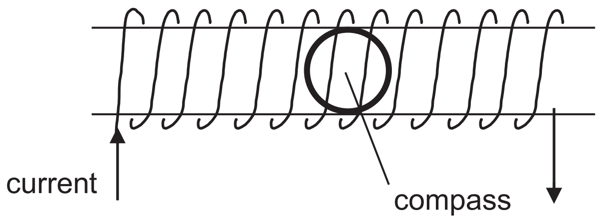
36 The diagram below shows the label on an electric iron. The iron is used for 12 hours every month. The cost of 1 kWh of electrical energy is 25 cents.

ELECTRIC IRON	
Operating Voltage	240 V
Power	2800 W
Fuse Rating	13 A

Which statement is **not** true about the electric iron?

A The energy dissipated in the iron every month is 121 MJ.
B The fuse will blow when the current flowing through the iron is above 13 A.
C The iron should use a fuse with a fuse rating of 10 A instead of 13 A.
D The user pays $8.40 every month to use the iron.

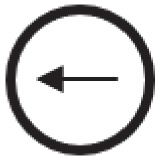
37 A compass is placed in the centre of a solenoid as shown in the diagram below.



In which direction will the compass needle point?

A

B



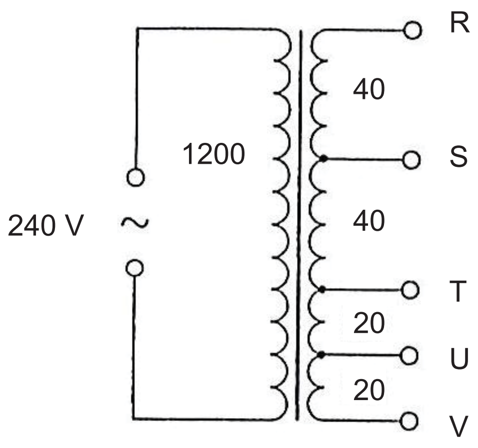
C

D

38 What is the main function of the split ring commutator in a d.c. motor?

A It allows electrical contact between the coil of wire and the battery.
B It increases the turning effect of the coil of wire.
C It reverses the direction of the current in the coil every half a revolution.
D It reverses the direction of the force on the coil every full revolution.

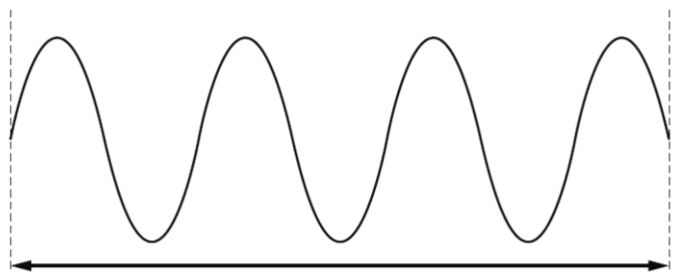
39 A transformer consists of one coil with 1200 turns and a second coil with a total of 120 turns, which can be tapped at various places.



Which pair of terminals should be connected to a 12 V, 24 W lamp for it to light up normally?

A RS **B** RT **C** ST **D** SU

40 A student uses a cathode-ray oscilloscope (c.r.o.) to measure the period of a signal. She sets the time-base of the c.r.o. to 20 ms / cm and observes the trace illustrated below. The trace has a length of 5.0 cm.



What is the period of the signal?

A 0.004 s **B** 0.029 s **C** 1.14 s **D** 28.6 s

End of Paper

	Class	Index No.
Candidate Name: ______________________		

FUHUA SECONDARY SCHOOL

Secondary Four Express

Preliminary Examination 2022

4E

PHYSICS **6091/02**

Paper 2 Theory

25 Aug 2022
1130 – 1315
1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number in the spaces provided on top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A (50 marks)
Answer **all** questions in the spaces provided.
Section B (30 marks)
Answer all questions. Question 11 has a choice of parts to answer.
Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The use of an approved scientific calculator is expected, where appropriate.

PARENT'S SIGNATURE

FOR EXAMINER'S USE		
Section A	Section B	**Total**
/50	/30	/80

Setter: Mr Raymond Loh **Vetter:** Mrs Wong Kexin,

This question paper consists of 19 printed pages including this page.

Section A

Answer **all** questions in this section.

1 Fig. 1.1 shows a box of mass 900 g resting on a rough plane inclined at an angle of 30^{o} to the horizontal. The box is about to slip down the plane.
The gravitational field strength is 10 N / kg.

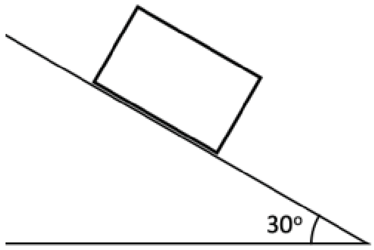


Fig. 1.1 (not to scale)

(a) On Fig. 1.1, draw the forces exerted on the box. Label them clearly. [1]

(b) Calculate the weight of the box.

weight of the box = ……………….. [1]

(c) Draw a suitable scaled diagram to determine the magnitude of the frictional force acting on the box.

frictional force = ……………….. [3]

(d) Suggest, in terms of forces, why the object does not slide down the rough plane.

…………………………………………………………………………………...

…………………………………………………………………………………... [1]

2 Fig. 2.1 shows the hydraulic braking system of a car.

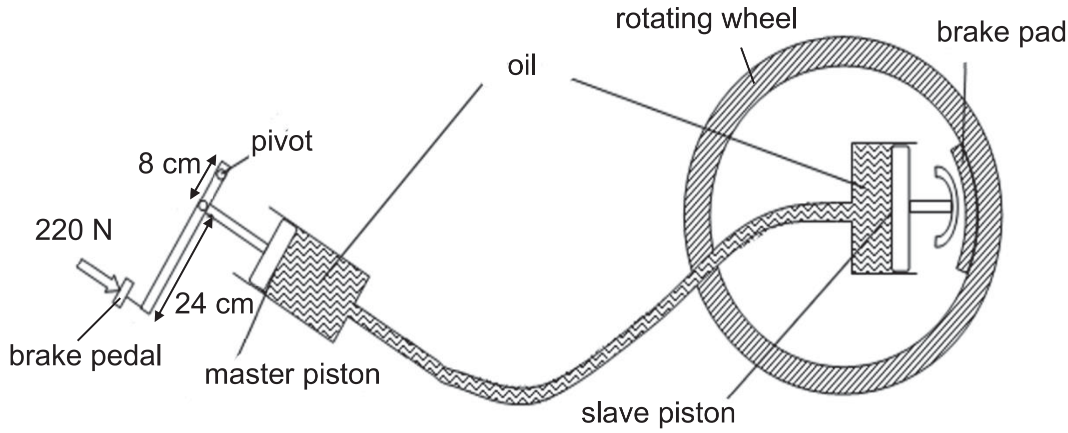


Fig. 2.1 (not to scale)

A force of 220 N is applied by the car driver on the brake pedal.
The cross-sectional area of the master piston is 1.5 cm^2.
The cross-sectional area of the slave piston is 5.0 cm^2.
The weight of both pistons is negligible.

(a) Calculate the force exerted on the master piston.

force = ……………….. [2]

(b) Hence, calculate the force that the oil exerts on the slave piston.

force = ……………….. [2]

3 Fig. 3.1 shows the path of a ball after being kicked by a boy.

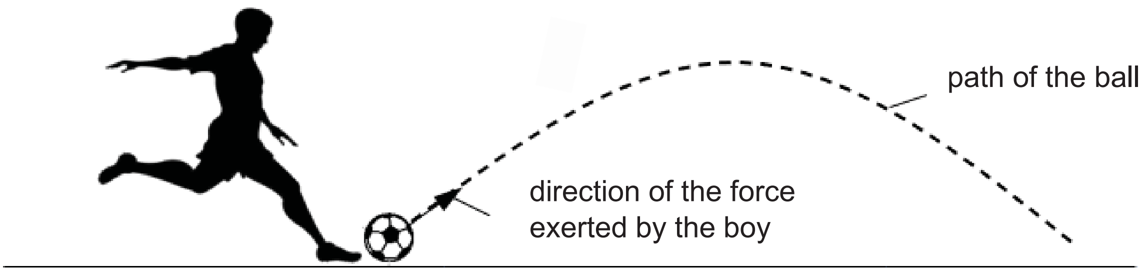


Fig. 3.1

As the boy kicks the ball, work is done.

(a) State what is meant by *work done*.

………………………………………………………………………………………

……………………………………………………………………………………… [1]

(b) The speed of the 200 g ball when it first leaves the ground is 20 m / s.
Calculate the initial kinetic energy of the ball.

initial kinetic energy = ……………….. [2]

(c) The ball reaches a maximum height of 12 m from the ground. The gravitational field strength, g, is 10 N / kg.
Calculate the gravitational potential energy gained by the ball.

gravitational potential energy gained = ……………….. [2]

(d) Hence or otherwise, determine the speed of the ball at the maximum height.

speed = ……………… [2]

4 Fig. 4.1 shows three rays emerging from the top of an object. The path of one ray through the lens has been completed in the diagram.

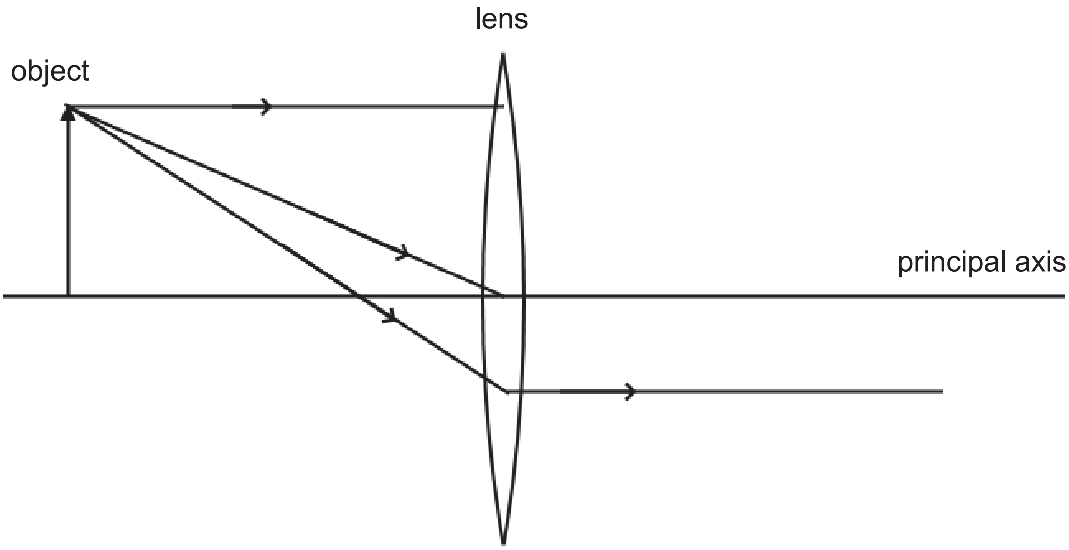


Fig. 4.1 (not to scale)

(a) Define the *focal length* of a converging lens.

…………………………………………………………………………………………...

…………………………………………………………………………………………...

…………………………………………………………………………………………... [1]

(b) On Fig. 4.1,

(i) complete the paths of the other two rays,

(ii) identify the position of the image formed and label the image as “I”,

(iii) mark the position of the principal focus and label it as “F”. [3]

(c) Fig. 4.2 shows how the distance of the image to the lens varies with the distance of the object to the lens.

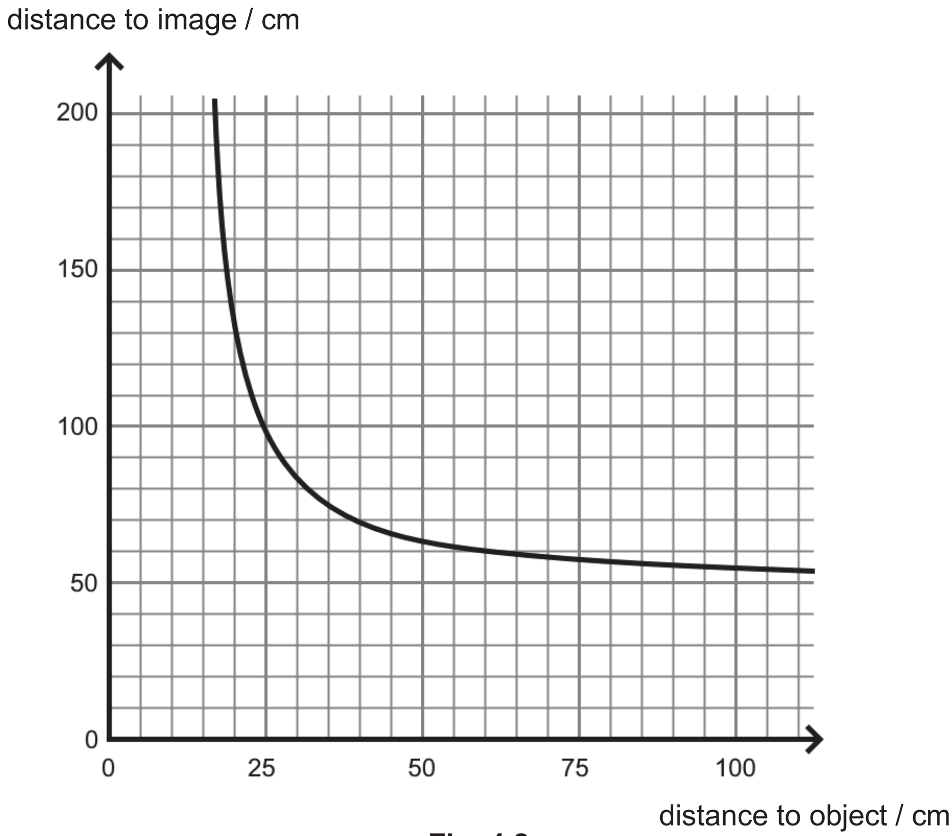


Fig. 4.2

(i) An object is placed such that its image is real and of the same size as the object.

Using the graph in Fig 4.2, determine the distance of the object to the lens.

distance of object = ……………………. [1]

(ii) Hence, determine the focal length of the lens.

focal length = ……………………. [1]

(iii) State **three** characteristics of the image formed when the object is placed at a distance less than the focal length of this lens.

……………………………………………………………………………………

…………………………………………………………………………………… [1]

5 Two small uncharged metal spheres A and B are suspended side by side by insulating strings, as shown in Fig. 5.1. The two small spheres are separated by a sheet of paper.

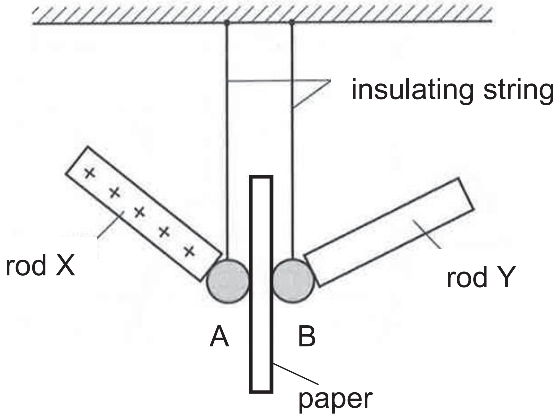


Fig. 5.1

Rod X and Y are both conductors that are held using insulators. Rod X is positively charged and touches sphere A. Rod Y is neutral and touches sphere B. After a while, rod Y is removed followed by rod X.

(a) State, if any, the charge of sphere B after the rods are removed.

…………………………………………………………………………………………… [1]

(b) Explain your answer in **(a)**.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [3]

(c) Describe and explain what will happen to both spheres when the sheet of paper is subsequently removed.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

6 Fig 6.1 shows a circuit with a battery of e.m.f. 6.0 V connected to a network of resistors and a voltmeter.

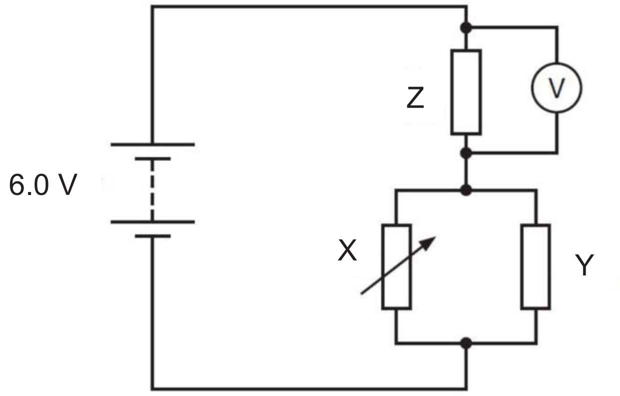


Fig. 6.1

Resistor Y has a resistance of 24 Ω and resistor Z has a resistance of 32 Ω.

(a) The resistance R_x of the variable resistor X is adjusted until the voltmeter reads 4.8 V. Calculate

(i) the current in resistor Z,

current = ……………….. [2]

(ii) the amount of charge that flows through the battery in 25 s,

charge = ……………….. [2]

(iii) the effective resistance of resistors X and Y connected in parallel,

total resistance = ……………….. [2]

(iv) the resistance R_x of resistor X.

R_x = ……………….. [2]

(b) The resistance R_x of resistor X is now decreased.
State and explain the change, if any, to the voltmeter reading.

……………………………………………………………………………………………...

……………………………………………………………………………………………...

……………………………………………………………………………………………...

……………………………………………………………………………………………... [2]

7 Fig. 7.1 shows a simple d.c. motor.

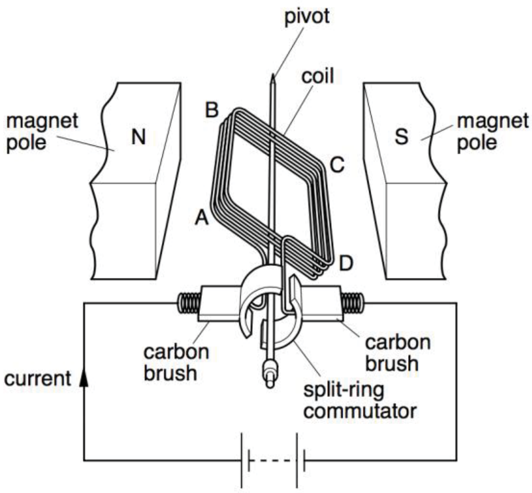


Fig. 7.1

As current flows from the external circuit into the coil, a set of forces cause the coil to rotate about the pivot.

(a) On Fig. 7.1, draw an arrow to show the direction of a force acting on the coil.
Label it as "F". [1]

(b) State the direction of rotation of the coil. Explain how you derive your answer.

……………………………………………………………………………………………...

……………………………………………………………………………………………...

……………………………………………………………………………………………...

……………………………………………………………………………………………... [3]

(c) State the position of the coil when the moment on the coil is maximum. Explain your answer.

……………………………………………………………………………………………...

……………………………………………………………………………………………...

……………………………………………………………………………………………...

……………………………………………………………………………………………... [2]

8 Fig. 8.1 shows a step-up transformer.

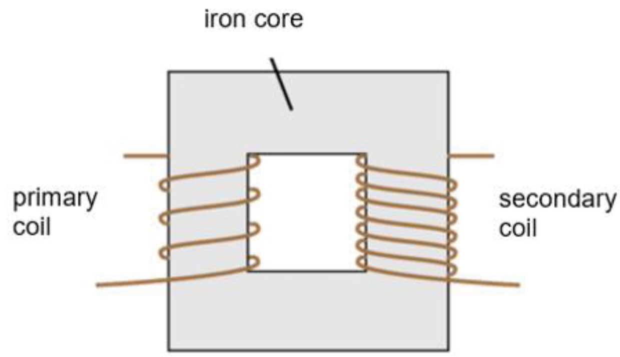


Fig. 8.1

(a) Describe the function of the iron core and why it cannot be replaced with steel.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(b) Explain why step-up transformers are used in power transmission.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

Section B

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 11**.

9 Fig. 9.1 shows a cooling system used to cool a motor car engine by circulating water through it. The radiator is a heat exchanger where the hot water transfers its thermal energy to the air.

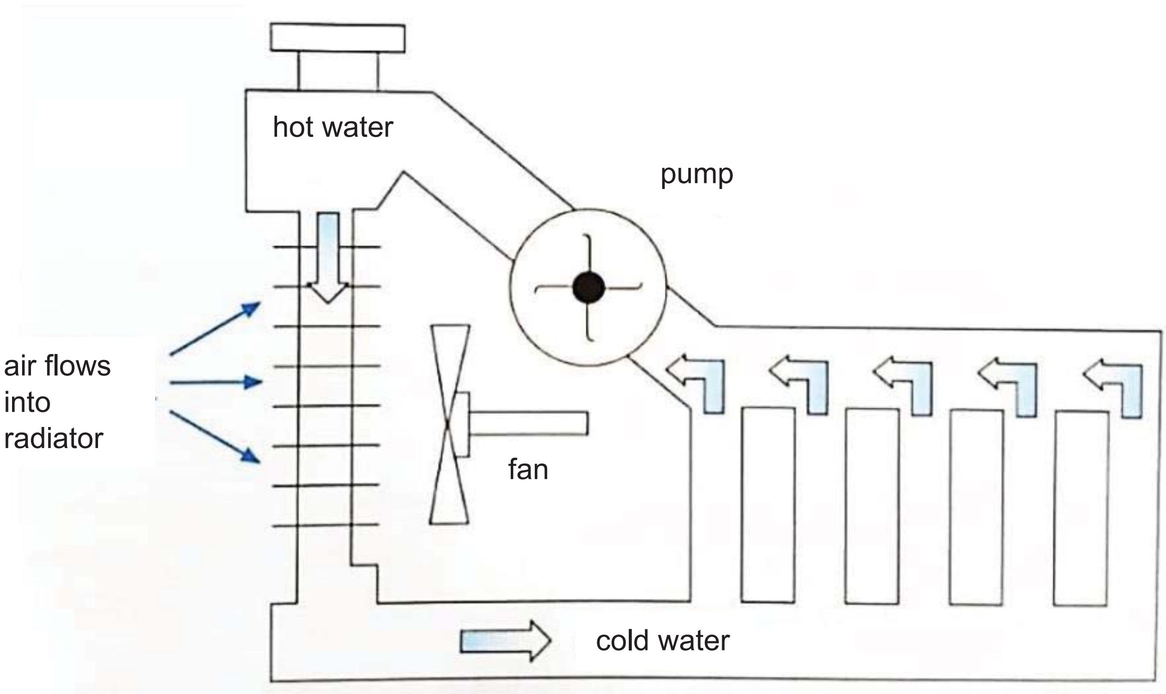


Fig. 9.1

A number of test runs are carried out to investigate the cooling system. Fig. 9.2 shows the data from one test run and the specific heat capacities of some substances.

duration of test / min	4.0
energy available from fuel used / J kg^{-1}	5.0 x 10^{7}
fuel consumed / kg	0.80
initial temperature of air / ^{o}C	20.0
initial temperature of cooling water / ^{o}C	30.0
final temperature of cooling water / ^{o}C	80.0
rate of flow of cooling water / kg s^{-1}	0.22
rate of flow of air over radiator fins / kg s^{-1}	1.25
specific heat capacity of castor oil / J kg^{-1} ^{o}C^{-1}	1800
specific heat capacity of glycerine / J kg^{-1} ^{o}C^{-1}	2430
specific heat capacity of water / J kg^{-1} ^{o}C^{-1}	4200
specific heat capacity of air / J kg^{-1} ^{o}C^{-1}	760

Fig. 9.2

Fig. 9.3 shows an expanded view of the cross-section of the radiator.

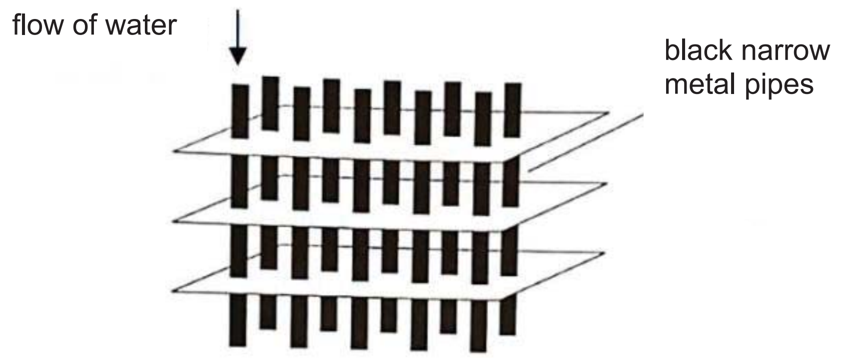


Fig. 9.3

(a) Explain why water is used as a coolant in the radiator of a motor car engine instead of the other fluids given in the table in Fig. 9.2.

…………………………………………………………………………………………...

…………………………………………………………………………………………...

…………………………………………………………………………………………...

………………………………………………………………………………………… [2]

(b) The manufacturer claims that 20% of the energy from the fuel is converted into useful mechanical energy.

(i) Calculate the amount of thermal energy removed from the hot water in the test run based on the manufacturer's claim.

energy = ……………….. [1]

(ii) Calculate the actual amount of thermal energy removed from the hot water during the test run.

energy = ……………….. [1]

(iii) Suggest a reason for the difference between the values in **(i)** and **(ii)**.

…………………………………………………………………………………

………………………………………………………………………………… [1]

(c) Using Fig. 9.3, explain the features of the radiator that allow thermal energy to be transferred easily away from the hot water which flows through the tubes.

…………………………………………………………………………………...

…………………………………………………………………………………...

…………………………………………………………………………………...

…………………………………………………………………………………...

…………………………………………………………………………………...

…………………………………………………………………………………... [3]

(d) Assuming that there is no heat loss by the cooling water as it flows from the engine to the radiator, calculate the average final temperature of air leaving the radiator in the test run.

final temperature = ……………………. [2]

10 Fig. 10.1 shows a solenoid connected to a sensitive galvanometer.

The South pole of a permanent magnet is placed next to the left end X of the solenoid.

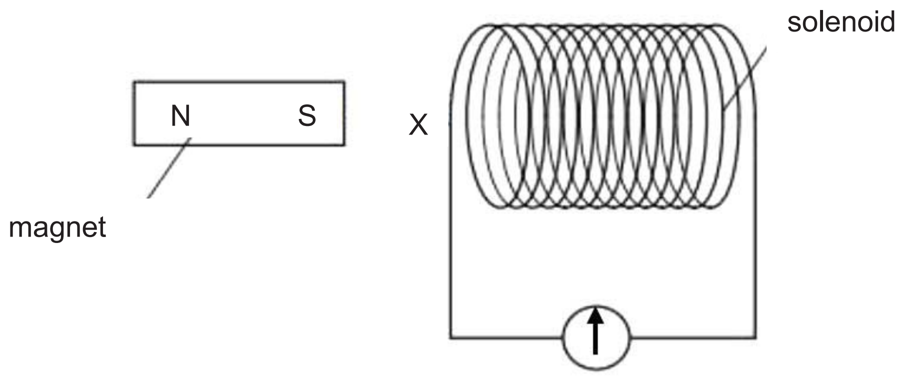


Fig. 10.1

(a) The solenoid is moved away from the magnet and the needle of the galvanometer deflects to the left.

(i) Explain why the needle of the galvanometer deflects.

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [2]

(ii) State the magnetic pole induced at the left end X of the solenoid.

…………………………………………………………………………………… [1]

(iii) State the deflection, if any, of the needle of the galvanometer when the coil is held stationary and the magnet is moved towards the coil instead. Explain your answer.

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [2]

(b) The galvanometer is replaced with a cathode ray oscilloscope (C.R.O.). The magnet is then oscillated continually towards and away from the solenoid. A trace is formed on the C.R.O. as shown in Fig. 10.2.

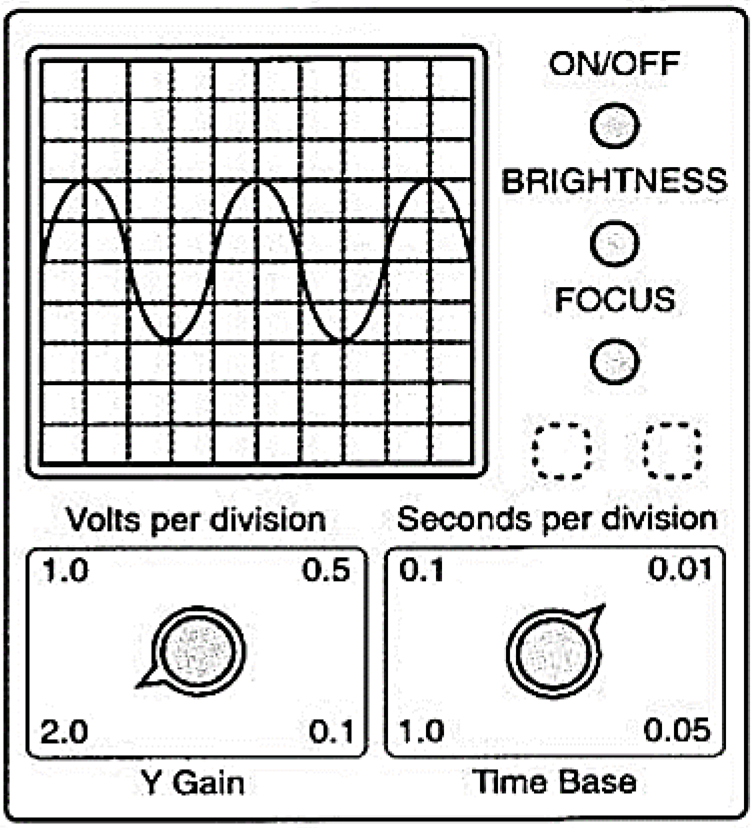


Fig. 10.2

(i) Determine the peak voltage and frequency of the trace in Fig. 10.2.

peak voltage = ……………… [1]

frequency = ……………… [2]

(ii) Describe the trace that will be formed if the time base is switched off.

………………………………………………………………………………

……………………………………………………………………………… [1]

(iii) The speed of oscillation is reduced to half of its original speed.

On the screen of the C.R.O. in Fig. 10.2, draw one cycle of the new trace. with the same settings shown. [1]

11 **Either**

Fig. 11.1 shows three different forms of long-distance communication.

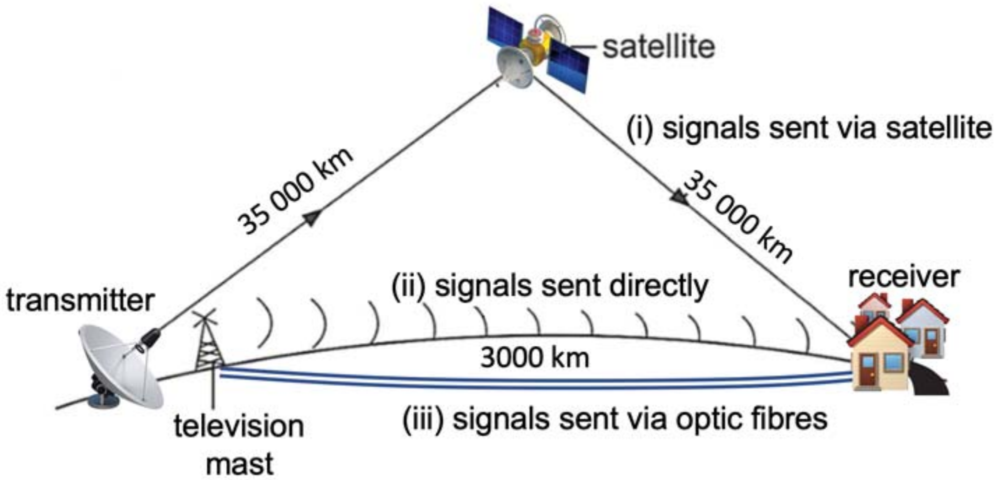


Fig. 11.1

(a) State which region of the electromagnetic spectrum is used for each form of communication.

(i)	signals sent via satellite communication	
(ii)	signals sent directly using television mast	
(iii)	signals sent via optic fibres	

[1]

(b) The speed of light in vacuum is 3.0×10^8 m / s.
The refractive index of the glass used in optic fibre is 1.5.

Calculate the speed of light in glass.

speed of light in glass = ……………….. [2]

(c) State which form of communication took the least amount of time for each signal to be transmitted and received.

Justify your answer with appropriate calculations.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

………………………………………………………………………………………… [2]

(d) The signal enters the optical fibre as shown in Fig. 11.2. The signal passes along the optical fibre.

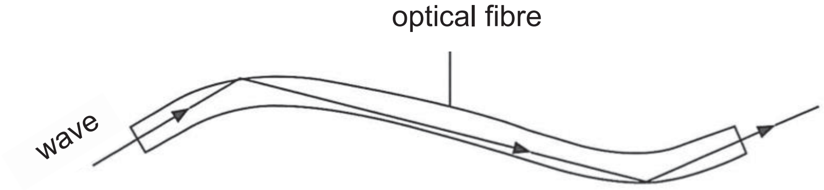


Fig. 11.2

Explain how the signal is able to pass along the optical fibre without escaping from the sides.

…………………………………………………………………………………………

…………………………………………………………………………………………

………………………………………………………………………………………… [3]

(e) Suggest why sound waves are not used as

(i) signals sent via satellite communication.

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [1]

(ii) signals sent directly using television mast.

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [1]

11 Or

(a) Fig. 11.3 shows circular wavefronts produced at the centre of a wave pool. Two plastic buoys, A and B, float on the water in the pool. Buoy A is on the crest of a wave at the instant shown.

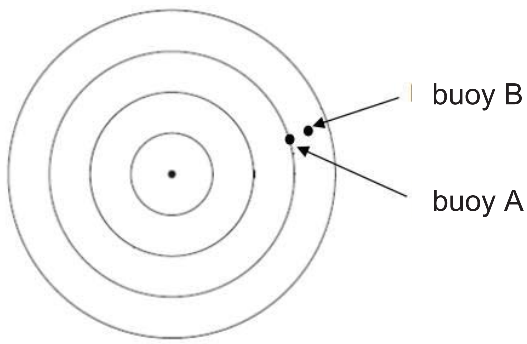


Fig. 11.3

Fig. 11.4 shows a snapshot of the displacement-distance graph of a wave at a particular instant. The wave takes 0.800 s to move from buoy A to buoy B.

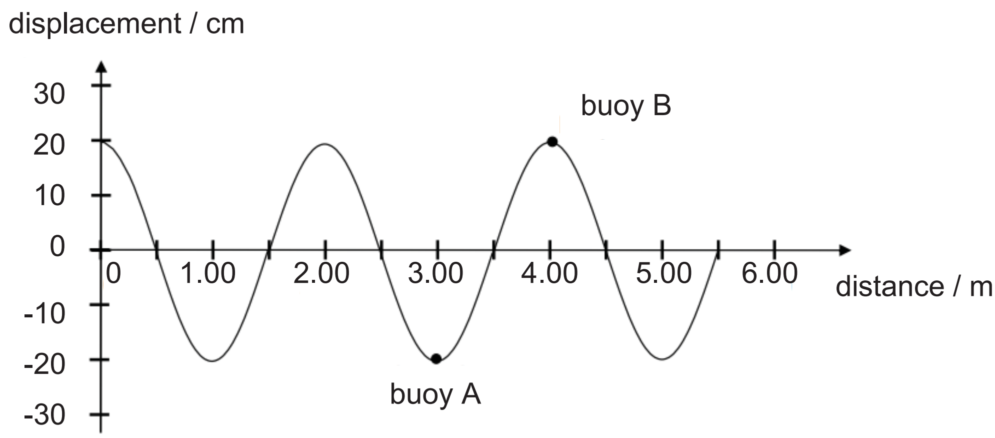


Fig. 11.4

(i) State what is meant by a *wavefront*.

…………………………………………………………………………………

………………………………………………………………………………… [1]

(ii) Calculate the frequency of the wave.

frequency = ……………….. [2]

(iii) Calculate the wavelength of the wave and the speed of the wave.

wavelength = ………………..

speed = ……………….. [2]

(iv) On Fig. 11.4, draw using arrows, the direction buoys A and B will be moving in at the next instant. [1]

(b) Sonar is used to locate schools of fish and the depth of the seabed in the sea. The sonar sends pulses of ultrasound of frequency 45 kHz from the bottom of the ship to determine the depth of the seabed. The time intervals between the pulse and the subsequent echoes are then measured to determine the depth of the schools of fish or the seabed. The speed of the ultrasound in water is known to be 1450 m / s.

(i) State one difference between the pulses of the echo and the pulses sent. Explain your answer.

………………………………………………………………………………

………………………………………………………………………………..

………………………………………………………………………………

……………………………………………………………………………… [2]

(ii) The time interval between the pulse and the echo is 150 ms.

Calculate the depth of the source of the echo.

depth = ……………….. [2]

End of Paper

Paper 1

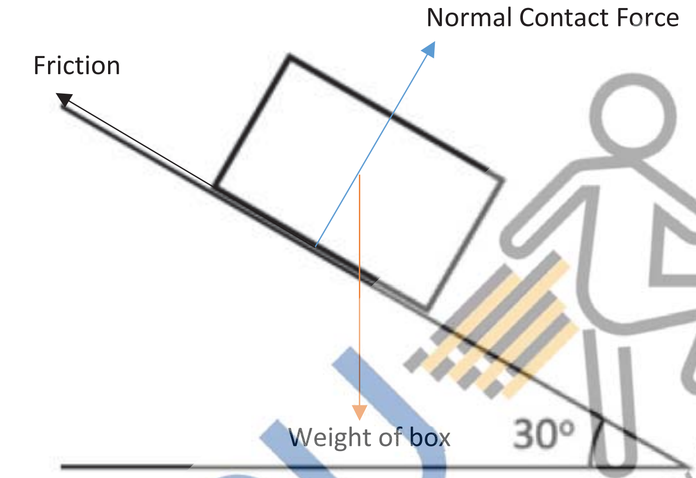
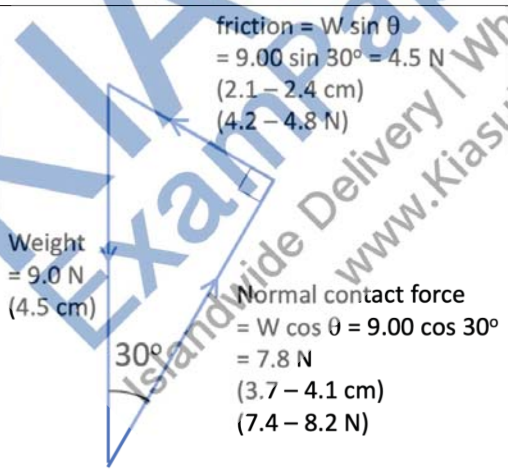
1	2	3	4	5	6	7	8	9	10
C	A	C	B	C	D	A	B	D	D

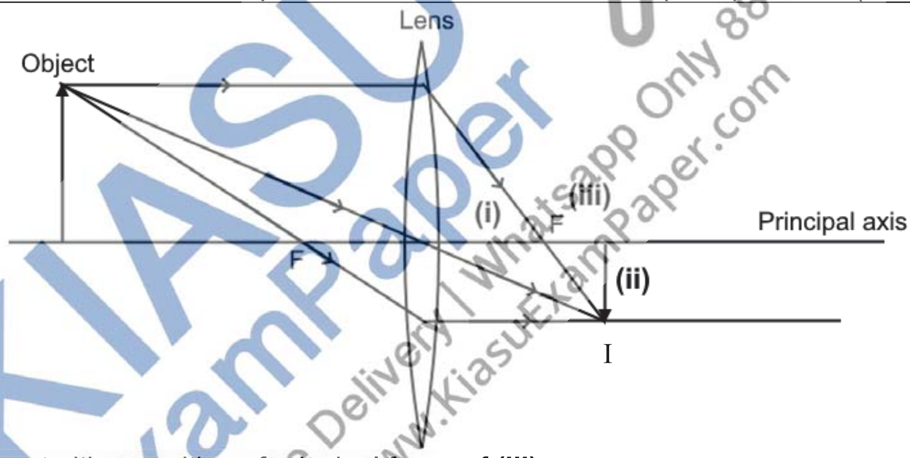
11	12	13	14	15	16	17	18	19	20
A	C	B	D	D	B	C	A	A	C

21	22	23	24	25	26	27	28	29	30
D	D	A	D	A	A	D	B	A	A

31	32	33	34	35	36	37	38	39	40
D	B	D	B	C	C	B	C	D	B

Section A

1	(a)		[1]
	(a)	W = mg = (0.900 kg)(10 N/kg) = 9.00 N (3sf) or 9.0 N (2sf)	[1]
	(b)	 1m – appropriate scale (1.0 cm to 2.0 N) 1m – correct vector diagram (right angle triangle, direction of arrows) 1m – correct magnitude of friction force Allow for e.c.f. from (a)	[1] [1] [1]
	(c)	Newton's first law. Forces are balanced. Resultant force of friction, weight and normal contact force = 0 N. (Any one)	[1]
2	(a)	moment by brake pad = moment by master piston (220)(32) = (F)(8) F = 880 N	[1] [1]

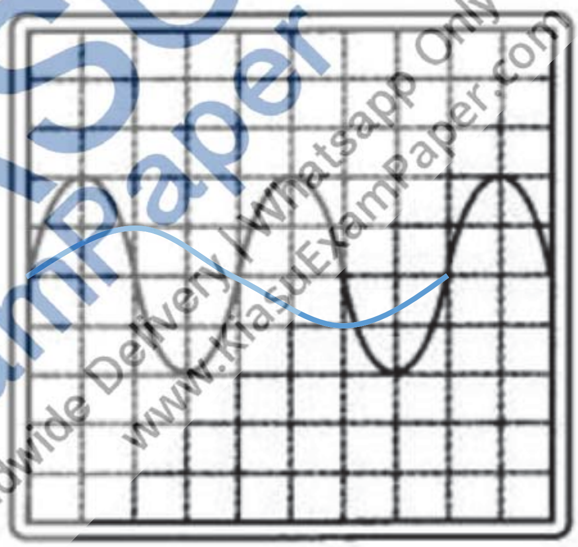
	(b)	$P_{master\ piston} = P_{slave\ piston}$ $F_1/A_1 = F_2/A_2$ $880 / 1.5 = F_2/5.0$ F_2 = 2930 N or 2900 N (allow for e.c.f.)	[1] [1]
3	(a)	The product of force applied and distance moved in the direction of the force	[1]
	(b)	KE = ½ x m x v^2 = 0.5 x 0.20 x 20^2 = 40 J	[1] [1]
	(c)	G.P.E at max height = m x g x h = 0.200 x 10 x 12 = 24 J (2sf)	[1] [1]
	(d)	At max height, KE remaining = 40 J – 24 J = 16 J (allow for e.c.f.) 0.5 x 0.200 x v^2 = 16 v = 12.6 m / s or 13 m / s	[1] [1]
4	(a)	The focal length is the **distance along the principal axis**, between the **principal focus and the optical centre** of the lens. OR Distance between the optical centre of the lens and the principal focus (focal point).	[1]
	(b)	 Accept either position of principal focus of **(iii)** Rays and arrowheads should be in solid lines	[1] [1] [1]
	(c)(i)	60.0 cm	[1]
	(ii)	2f = 60.0 cm f = 30.0 cm	[1]
	(iii)	1. Virtual 2. Upright 3. Magnified	[1]
5	(a)	Negatively charged	[1]
	(b)	The negative charges will be transferred from rod Y to sphere B.	[1]

		The negative charges are attracted by positively charged rod X as unlike charges attract.	[1]
		Hence, there is more negative charges than positive charges in sphere B upon removal of the rods. (Sphere B has a net negative charge)	[1]
	(c)	Sphere A will become positively charged (and B is negatively charged).	[1]
		They will attract each other.	[1]
		Since unlike charges attract.	[1]
6	(a)(i)	I = V/R = 4.8 / 32 = 0.15 A	[1] [1]
	(ii)	Q = I(t) = (0.15)(25) = 3.75 C or 3.8 C (allow for e.c.f.)	[1] [1]
	(iii)	Pd across parallel branch = 6.0 – 4.8 V = 1.2 V R = V/I = 1.2 / 0.15 = 8.0 Ω Alternative method: Potential Divider method [32 / (32 + R)] x 6.0 = 4.8 (32 + R) / 32 = 6.0 / 4.8 R = 8.0 Ω	[1] [1]
	(iv)	Method 1 ($1/R_1 + 1/R_2 = 1/R_{total}$) 1/R + 1/24 = 1/8 R = 12 Ω allow for e.c.f. Method 2 Current flowing through Y = 1.2 / 24 = 0.050 A Current flowing through X = 0.15 – 0.050 = 0.10 A R = V/I = 1.2 / 0.10 = 12 Ω	[1] [1] [1] [1]
	b	Overall resistance of circuit decreases, so overall current (I) increases. Voltmeter reading will increase since <u>pd across Z increases</u> (or V = RI). Alternative Answer Overall resistance of parallel branch decreases. Pd across Z will increase since Z will receive a larger proportion of the e.m.f and voltmeter reading increases. (Potential Divider)	[1] [1] [1] [1]
7	(a)	Either AB – Downward arrow Or CB – Upward arrow	[1]
	(b)	Current flows from A to B. By **Fleming's Left Hand rule**, the induced force which is perpendicular to the magnetic field and current will be **downwards**. For side, CD, current flows from C to D and the force will be **upwards**. The coil rotates in an **anticlockwise** direction.	[1] [1] [1]
	(c)	The **coil is horizontal**.	[1]

		That is when the **perpendicular distance from the centre of rotation to the line of action of the force** is **maximum**.	[1]
8	(a)	Iron is easily **magnetised and demagnetised** (or **soft magnetic material**) whereas steel **does not magnetise or demagnetise easily (**or **hard magnetic material)**. This ensures **better magnetic flux linkage** between the 2 coils if iron is used instead of steel. Any other plausible answer.	[1] [1]
	(b)	**Reduce energy loss** during transmission Since **heat loss is P = I^2R**, the **lower the current, the lower the energy loss** during transmission.	[1] [1]

Section B

9	(a)	Water is used as a coolant because of its very **high specific heat capacity**. It can **take in a large amount of thermal energy** with only a **small rise in its temperature**.	[1] [1]
	(b)(i)	Thermal energy required to be removed as claimed = (0.8 x 5.0 X 10^7) x 80% = 3.2 x 10^7 J	[1]
	(ii)	Actual amount of thermal energy removed Q = mc$\Delta\theta$ = (0.22 x 4 x 60) (4200)(80-30) = 1.1088 x 10^7 J = 1.1 x 10^7 J	[1]
	(iii)	Some thermal energy is **lost to the surroundings**, apart from it being absorbed by the cooling water.	[1]
	(c)	**Metal** pipes are used as they are **good conductors** of heat and allows heat to be **conducted faster away** from the hot water to the external wall of the pipe. The metal pipes being coloured in **black** are **good emitters of radiation** and therefore **radiates heat to the surrounding air at a higher rate**. Using **narrow** pipes **increase the surface area** to facilitate a **higher rate of emission of heat** to the surrounding air.	[1] [1] [1]
	(d)	Energy absorbed by air = 1.1088 x 10^7 J (allow for e.c.f.) (1.25 x 4 x 60)(760)(θ - 20) = 1.1088 x 10^7 J θ = 68.6 °C = 69 °C (68.6 °C also accepted)	[1] [1]
10	(a)(i)	As the coil moves away, there is a **changing magnetic field experienced by it**. Or	[1]

		There is a **changing magnetic flux linkage** between the magnet and the solenoid. According to **Faraday's Law**, there is an **induced emf** in a closed circuit, hence there is a flow of an induced current.	[1]
	(ii)	North-pole	[1]
	(iii)	Deflect right; According to Lenz's Law**, the direction of the induced e.m.f. opposes the change producing it.** Hence, the induced current flows in opposite direction as compared with the original motion.	[1] [1]
	(b)(i)	4.0 V ; T = 0.04 s f = 1 / 0.04 = 25 Hz	[1] [1] [1]
	(ii)	**Vertical line** across **4 divisions**	[1]
	(iii)	1 division above and 1 division below the x-axis 8 divisions along the x-axis 	[1]
11E	(a)	(i) microwaves (satellite communication) (ii) radio waves (television broadcast) (iii) visible light (optic fibre communication)	[1]
	(b)	n = $\frac{c}{v}$ 1.5 = $\frac{3.0 \times 10^8\ m/s}{v}$ v = 2.0 x 10^8 m/s	 [1] [1]

	(c)	Signal with least time = (ii) radio communication time = $\frac{distance}{speed}$ Time taken for (i) satellite communication = $\frac{2 \times 35\,000\,000\ m}{3.0 \times 10^8\ m/s}$ = 0.23 s (2sf) Time taken for (ii) radio communication = $\frac{3\,000\,000\ m}{3.0 \times 10^8\ m/s}$ = 0.010 s (2sf) Time taken for (iii) optic fibre = $\frac{3\,000\,000\ m}{2.0 \times 10^8\ m/s}$ = 0.015 s (2sf)	[1] [1]
	(d)	Signal / wave / light experiences total internal reflection. Angle of incidence is greater than critical angle. Light is traveling from optically denser medium (glass) to optically less dense medium (air).	[1] [1] [1]
	(e)	(i) Sound waves cannot be transmitted in vacuum. Sound waves require a medium for propagation. (ii) speed of sound in air = 330 m/s. This much slower speed of sound would mean a very long time between transmitting the signal and receiving the signal. (time = $\frac{3\,000\,000\ m}{330\ m/s}$ = 9090 s = 2.5 hours)	[1] [1]
11 O	(a)(i)	The imaginary line drawn by joining all adjacent points of a wave that are on the same phase.	[1]
	(a)(i)	T = 2 x 0.80 s = 1.60 s f = 1/T = 1/1.60 = 0.625 Hz	[1] [1]
	(a) (iii)	wavelength = 2.0 m speed = 2.0 x 0.625 = 1.25 m / s or 1.3 m / s (allow for e.c.f.)	[1] [1]
	(a) (iv)	Arrows correctly drawn A – up, B – down	[1]
	(b)(i)	Echo smaller in amplitude – some energy absorbed by the surrounding Echo may be diffused – the seabed may be uneven.	[1] [1]
	(ii)	2 x d = 1450 x 0.150 d = 109 m (2 or 3 sf)	[1] [1]

Class | Register No.

Candidate Name____

PEIRCE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2022
SECONDARY 4 EXPRESS

PHYSICS **6091/01**
Paper 1 Multiple Choice **31 Aug 2022**
1 hour

Additional Material:
Multiple Choice Answer Sheet

INSTRUCTIONS TO CANDIDATES
Write in soft pencil.
Do not use paper clips, highlighters, glue or correction fluid.
Write your name, class and register number on the Multiple Choice Answer Sheet in the spaces provided.

There are **forty** questions in this paper. Answer **ALL** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Multiple Choice Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this paper.
The use of an approved scientific calculator is expected, where appropriate.

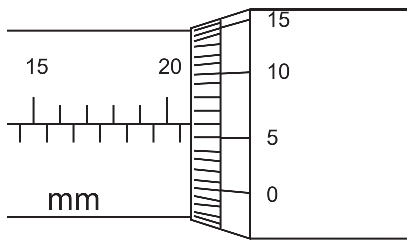
This paper consists of **16** printed pages and **0** blank page.
Setter: Mr Kan Cheng Mun

1 Which pair consists of two vector quantities?

A acceleration and weight **B** density and velocity

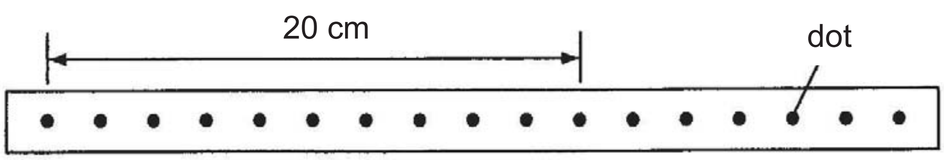
C pressure and kinetic energy **D** work done and force

2 What is the the micrometer reading in the diagram below?



A 20.6 mm **B** 20.56 mm **C** 25.06 mm **D** 25.6 mm

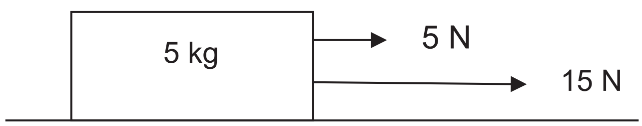
3 The diagram shows a strip of paper tape that has been pulled under a vibrating arm by an object moving at constant speed. The arm is vibrating regularly, making 50 dots per second.



What was the speed of the object?

A 2.0 cm/s **B** 5.0 cm/s **C** 100 cm/s **D** 200 cm/s

4 Two forces of 15 N and 5 N to the right are applied to a block of mass 5 kg as shown below.



Smooth surface

What is the resultant acceleration?

A 3.0 m s^{-2} **B** 3.0 m s^{-1} **C** 4.0 m s^{-2} **D** 4.0 m s^{-1}

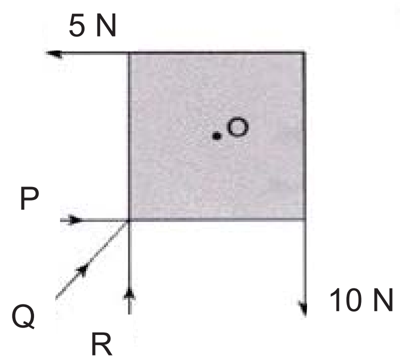
5 Which of the following **cannot** be the magnitude of the resultant when forces of magnitude 3 N and 4 N are combined?

A 1 N **B** 3 N **C** 7 N **D** 8 N

6 An irregular shaped object of copper with density 8.96 g cm^{-3} is lowered into a displacement can filled with water of density 1 g cm^{-3}, until the copper object is completed immersed. The mass of the water which overflowed is 180 g.
What is the mass of the copper object?

A 20.1 g **B** 180 g **C** 1.61 kg **D** 1.94 kg

7 Two forces of 5 N and 10 N act on a square wooden plane which is pivoted at the centre **O** as shown.

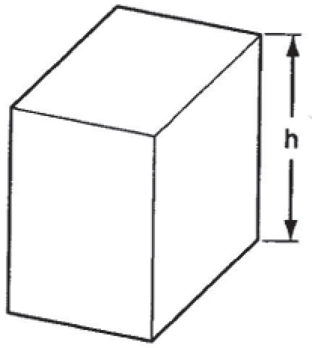


Which of the following conditions can keep the square plane in equilibrium?

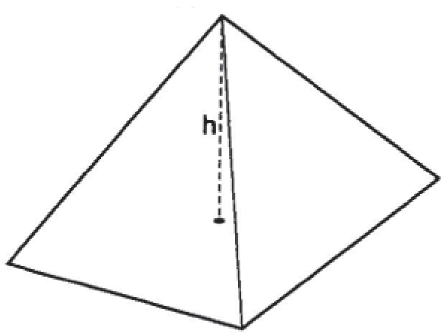
	Direction	Force
A	P	5 N
B	P	10 N
C	Q	10 N
D	R	5 N

8 Which shape is the most stable, assuming they have the same mass and height?

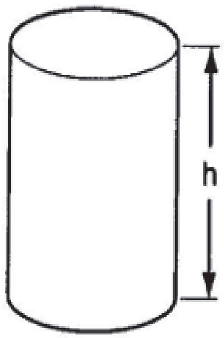
A cube



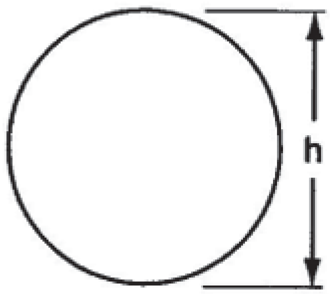
B pyramid



C cylinder



D sphere



9 Object P has a mass of m and is moving with a speed of v.

Object Q has a mass of 2 m and is moving with a speed of $\frac{1}{2}v$.

How do the kinetic energies of P and Q compare?

A The kinetic energy of Q is one half the kinetic energy of P.

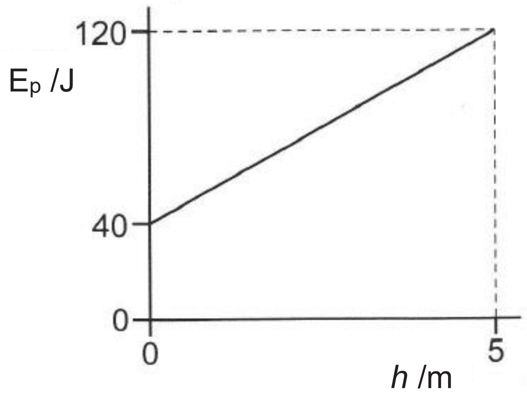
B The kinetic energy of Q is the same as that of P.

C The kinetic energy of Q is twice the kinetic energy of P.

D The kinetic energy of Q is four times the kinetic energy of P.

10 The gravitational potential energy E_p of a mass varies with height *h* as shown.

The gravitational field strength is 10 N / kg.



What mass is being lifted?

A 1.6 kg **B** 2.4 kg **C** 8.2 kg **D** 16 kg

11 Which would be the **least** likely to sink into soft ground?

A A loaded lorry with four wheels.
B A loaded lorry with six wheels.
C An empty lorry with four wheels.
D An empty lorry with six wheels.

12 The lengths of mercury thread in the steam of a mercury thermometer are given in three situations.

Length in melting ice = 20 mm

Length in steam above boiling water = 170 mm

Length in liquid X = 50 mm

What is the temperature of liquid X?

A 20 ºC **B** 25 ºC **C** 30 ºC **D** 33.3 ºC

13 Physical properties of materials are used in the measurement of temperature.

Which physical property is **not** suitable for this purpose?

A expansion of a liquid

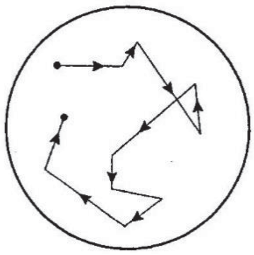
B mass of a liquid

C resistance of a metal

D volume of a liquid

14 Smoke particles in a transparent box are observed using a microscope.

A small point of light is seen to move around as shown.



What does this experiment demonstrate about air molecules?

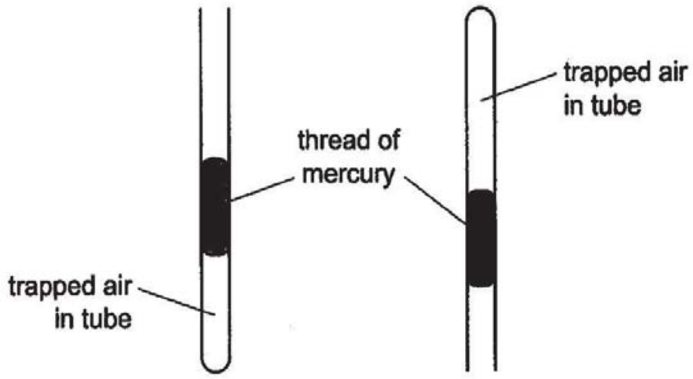
A They are in continuous random motion.

B They can be seen through a microscope.

C They move more quickly when they are heated.

D They move because of collisions with smoke particles.

15 A thin tube contains a thread of mercury which traps air at the end of the tube. The other end of the tube is open to the atmosphere.



When the tube is turned upside down, the volume of the trapped air increases.

Which statement explains this?

A The pressure of the trapped air is reduced.
B The atmosphere pushes less when it acts upwards on the mercury.
C The air gets hotter when the tube is turned upside down.
D The trapped air molecules hit the mercury harder when travelling downwards.

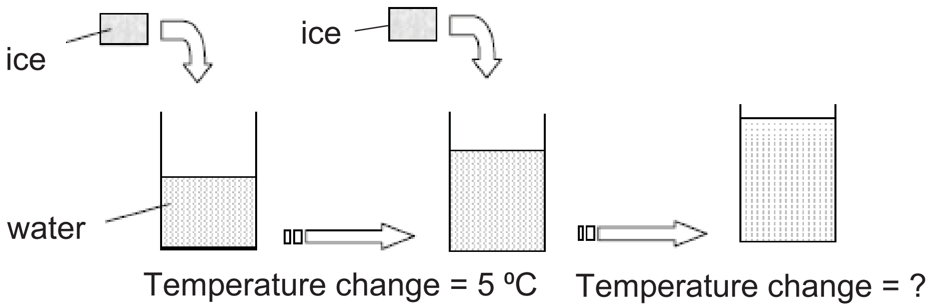
16 In cold countries, animals usually grow thicker layers of fur in winter to keep them warm. What is the **best** explanation of why this extra fur keeps them warm?

A It is a good conductor of heat.
B It is a poor conductor of heat.
C It traps more air, which is a good conductor of heat.
D It traps more air, which is a poor conductor of heat.

17 In a vacuum flask, which methods of heat transfer are prevented by the vacuum?

A conduction and convection only
B convection only
C conduction only
D conduction, convection and radiation

18 When a lump of ice was added to a beaker of warm water, the resulting water temperature was 5 ^{0}C less than the initial temperature of the warm water at the instant when all the ice had melted.



If another identical lump of ice at the same initial temperature is added to the same beaker, the temperature will ………………………………

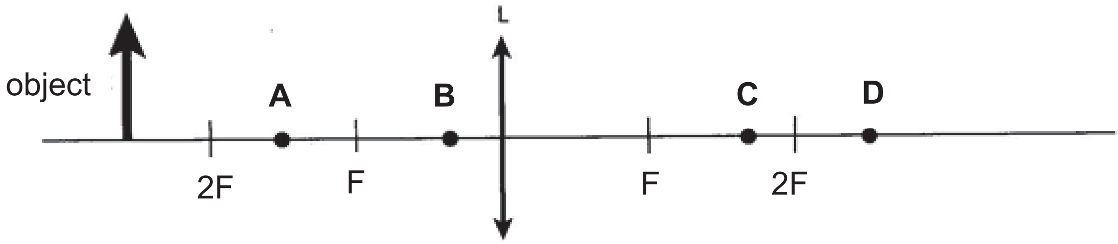
A decrease by another 5 ^{0}C

B will not change at all

C decrease by more than 5 ^{0}C

D decrease by less than 5 ^{0}C

19 The diagram shows an object placed in front of a thin converging lens L.
If F is the focal point, at which point is the base of the image formed?



20 What is meant by the term wavefront?

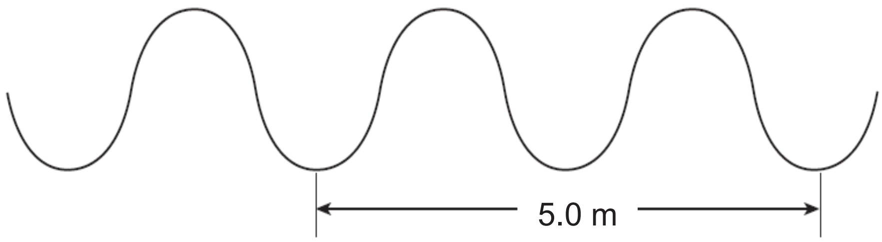
A a line joining points along the peak of a wave

B a line joining the trough and the peak of a wave

C the distance between successive peaks of a wave

D the distance between the trough and the peak of a wave

21 The periodic wave in the diagram below has a frequency of 40 Hz.



What is the speed of the wave?

A 8 m s^{-1} **B** 16 m s^{-1}

C 100 m s^{-1} **D** 200 m s^{-1}

22 Which of the following groups of electromagnetic waves is in the order of **increasing** frequency?

A	Gamma ray	→	Ultra-violet	→	Radio wave
B	Gamma ray	→	Visible light	→	Ultra-violet
C	Microwave	→	Ultra-violet	→	X-ray
D	Visible light	→	Infra-red	→	X-ray

23 Below are four statements about the uses of electromagnetic radiation.

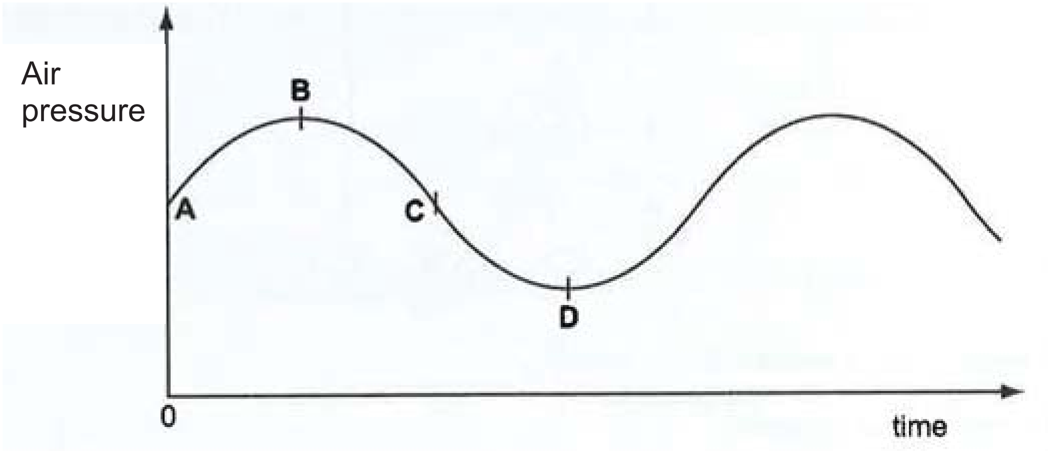
1. Gamma rays are used in medical treatment.
2. Ultra-violet rays are used in sunbeds.
3. Microwaves are used in satellite television.
4. X-rays are used in Global Positioning System (GPS).

How many of these statements are **correct**?

A 1 **B** 2 **C** 3 **D** 4

24 The graph shows how the air pressure varies for a sound wave.

Which point represents a compression?



25 Two notes of the same loudness but different pitches are played on a musical instrument.

The two sound waves produced will have ……………………..

A the same amplitude and different speeds.

B the same amplitude and different frequencies.

C different amplitudes and same speed.

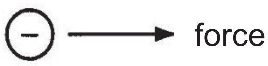
D different amplitudes and same frequency.

26 When a plastic rod is charged positively by friction, ...

A it gains electrons **B** it loses electrons

C it gains protons **D** it loses protons

27 A stationary negative charge in an electric field experiences an electric force in the direction shown.

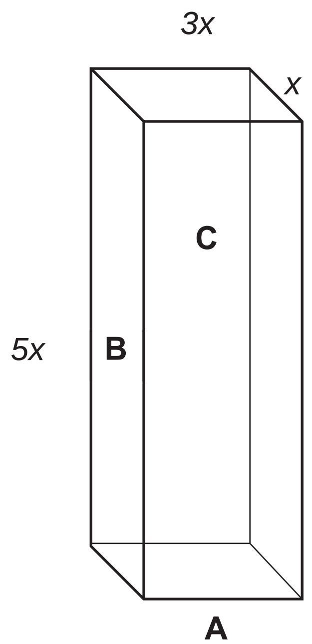


What is the direction of the electric field?

A vertically downwards **B** vertically upwards

C horizontally to the left **D** horizontally to the right

28 The diagram shows a rectangular block with dimensions *x*, *3x* and *5x*.



Electrical contact can be made to the block between opposite pairs of faces.
For example, between the face labelled **A**, the top and bottom surfaces are connected.
Between which two faces would the minimum electrical resistance be obtained?

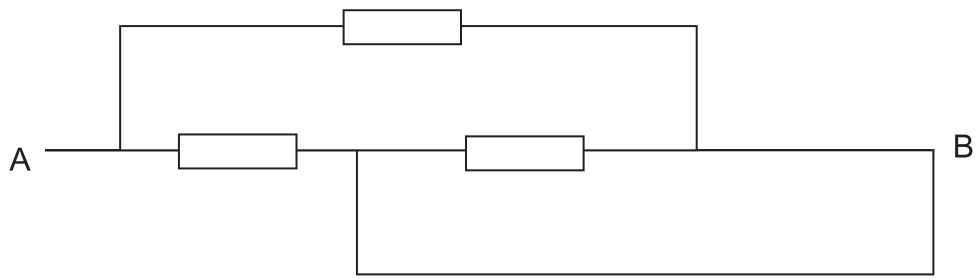
A the resistance is the same, whichever pair of faces is used

B the faces labelled **A**

C the faces labelled **B**

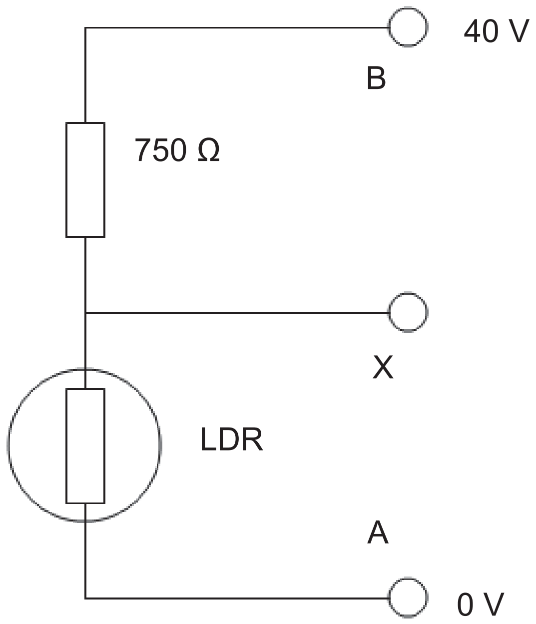
D the faces labelled **C**

29 Three resistors, each of resistance R, are arranged in the circuit below. What is effective resistance between point A and B?



A $\frac{1}{3}$ R **B** $\frac{1}{2}$ R **C** 2 R **D** 3 R

30 The diagram shows a potential divider formed using a light dependent resistor (LDR) and a 750 Ω resistor. The ends A and B of the potential divider are maintained at 0 V and +40 V respectively. The resistance of the LDR is 2000 Ω in darkness and 200 Ω in bright light.



What range of potential difference can be obtained between B and X?

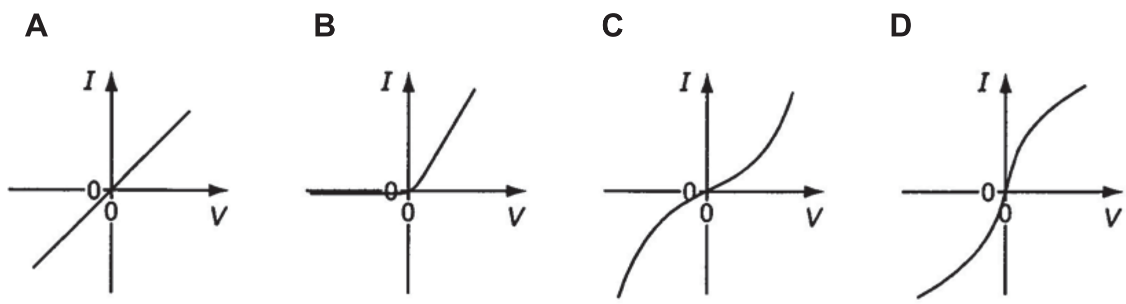
A 0 V to 8.4 V

B 0 V to 29 V

C 8.4 V to 29 V

D 11 V to 32 V

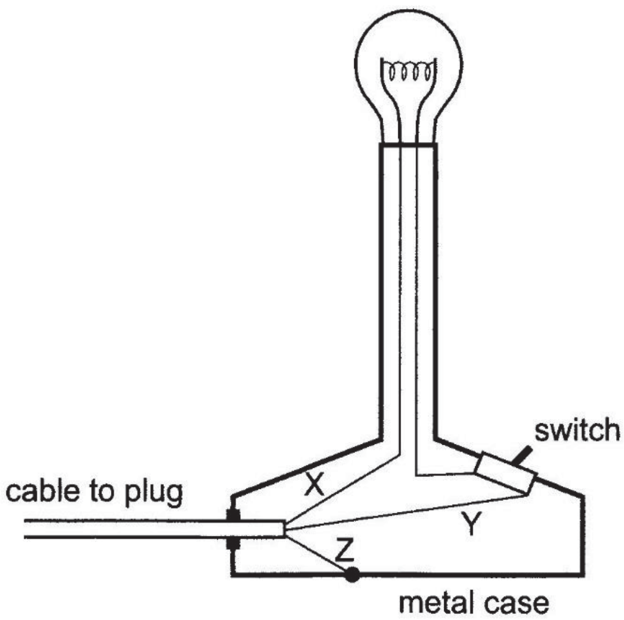
31 Which graph shows the I/V characteristic for a semiconductor diode?



32 The diagram shows the wiring of a mains electric lamp.

The lamp has a metal case and a switch.

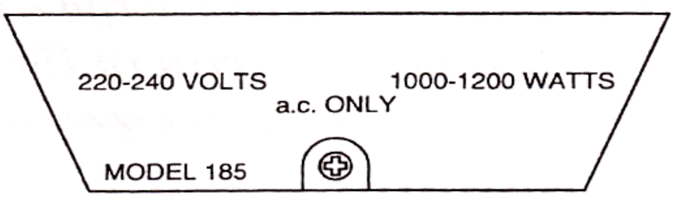
There are three wires X, Y and Z in the mains cable connected to the plug.



Which of the following is the correct wiring of the wires?

	wire X	wire Y	wire Z
A	live	earth	neutral
B	live	neutral	earth
C	neutral	earth	live
D	neutral	live	earth

33 The diagram below shows the information given on an electric iron.



If electricity costs 25 cents per kWh, what is the cost of using this iron at maximum power for 10 hours?

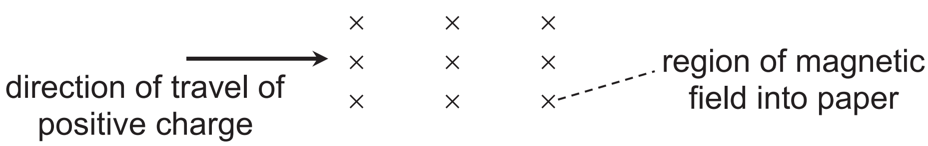
A $2.50 **B** $3.00

C $250 **D** $300

34 Which of the following gives the **wrong** choice of metal for their use?

	uses	choice of metal
A	A bar magnet	Steel
B	The core of an electromagnetic magnet	Iron
C	A magnetic shield	Steel
D	A compass needle	Steel

35 The diagram below shows a positive charge travelling horizontally into a region of uniform magnetic field.



What is the direction of deflection of the positive charge when it is in the region of the magnetic field?

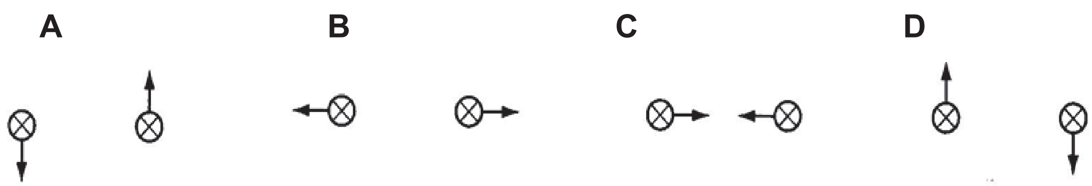
A upwards **B** downwards

C into the plane **D** out of the plane

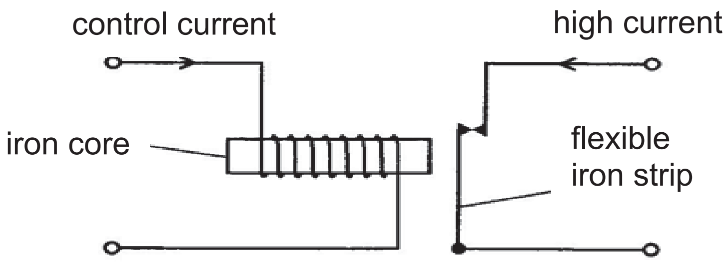
36 Each diagram is a cross-section through two parallel current-carrying conductors.

In both conductors, the current direction is **into** the plane of the paper.

Which diagram shows the forces on the two conductors?



37 In the circuit shown, a control current is used to switch off a high current.



When the control current is switched on, the high current does not switch off.

Which of the following changes is **mostly likely** to switch off the high current?

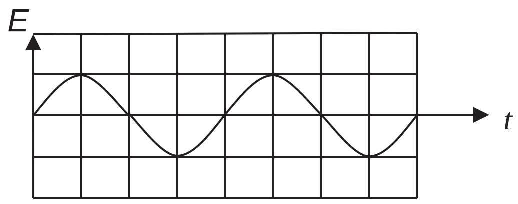
A moving the strip further away from the iron core

B reducing the number of turns around the iron core

C replacing the iron core by a steel core

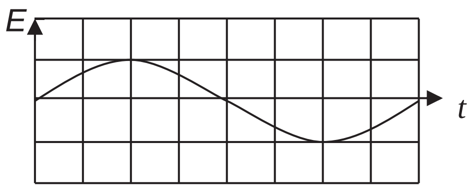
D using a larger control current

38 When a coil is rotated in a magnetic field, the induced e.m.f. E varies with time.

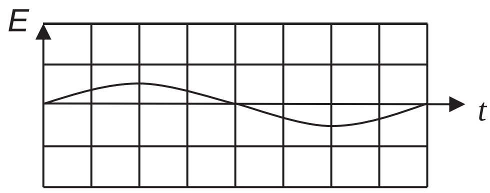


Which of the following graphs, drawn to the same scale, would be obtained if the speed of rotation of the coil is halved?

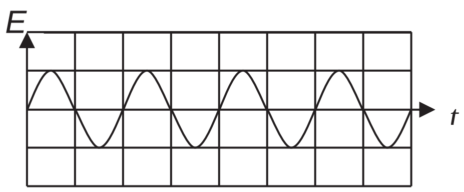
A



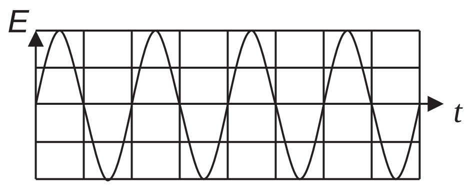
B



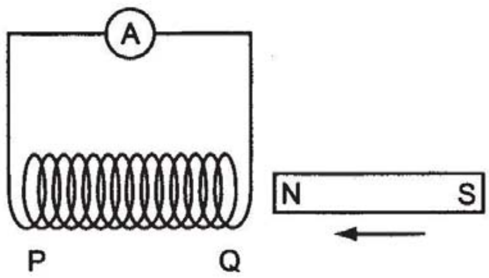
C



D



39 A student pushes the N-pole of a bar magnet into end Q of a long solenoid and observes a deflection to the right on the centre-zero ammeter.



What produces a deflection in the same direction?

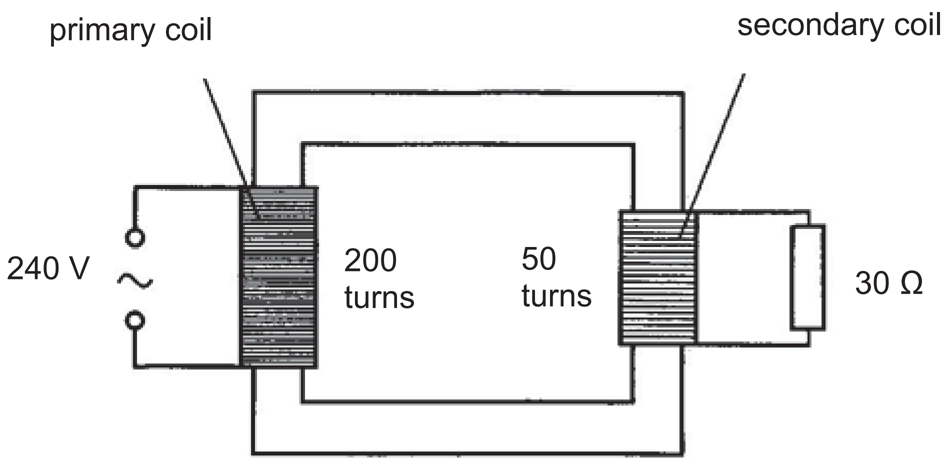
A pulling the N-pole out of end Q

B pulling the S-pole out of end P

C pushing the N-pole into end P

D pushing the S-pole into end P

40 The secondary coil of an ideal transformer is connected to a 30 Ω resistor as shown.



What is the current in the **primary** coil?

A 0.5 A **B** 0.6 A **C** 2.0 A **D** 60 A

	Class	Register No.
Candidate Name________________________________		

PEIRCE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2022
SECONDARY 4 EXPRESS

PHYSICS **6091/02**
Paper 2 (Theory) **29 Aug 2022**
1 hour 45 minutes

Additional Material: Nil
Candidates answer on the Question Paper.

INSTRUCTIONS TO CANDIDATES
Write your name, class and register number in the spaces provided at the top of this page.
Write in dark blue or black pen. You may use a soft pencil for any diagrams, graphs or rough working. Do not use staples, paper clips, glue or correction fluid.

Section A [50 marks]
Answer **all** questions.

Section B [30 marks]
Answer **all** questions. Question 11 has a choice of parts to answer.

Candidates are reminded that all quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

PARENT'S SIGNATURE

For Examiner's Use	
Section A	
Section B	
Total	80

This paper consists of **19** printed pages and **1** blank page.
Setter: Mr Kan Cheng Mun

Section A [50 marks]

Answer **all** questions in the spaces provided.

1 Fig 1.1 below shows how a hanging picture frame is supported by two strings that hang from a ceiling.

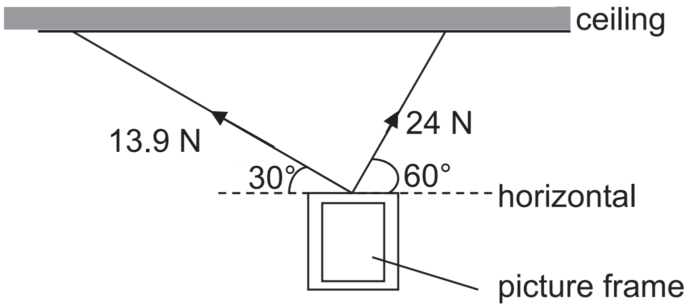


Fig 1.1

The tensions in the strings are 13.9 N and 24 N respectively.

(a) With a suitable scale, draw a labelled vector diagram to show the resultant of the two tensions. Determine the magnitude and the direction of the resultant force.

Scale: …………….. : ………………….

magnitude of resultant force = ……………….

direction = ……………………………… [4]

(b) Hence, determine the mass of the picture frame. The gravitational field strength is 10 N / kg.

mass = ……………..... [2]

2 A designer plans to use some hollow aluminium balls as decorative pieces that float in a pond.

Fig 2.1 shows the cross section of one of these balls. The outer radius of the ball is 10.0 cm. The inner radius is *r*. The designer has to decide the thickness *t* of the aluminium so that the balls can float in water.

The density of water = 1.0 g / cm^3, and volume of sphere = $\frac{4}{3}\pi r^3$

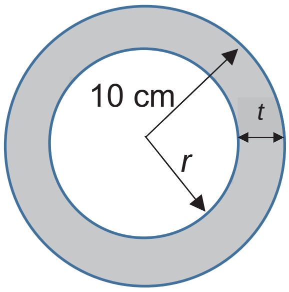


Fig 2.1

(a) State the maximum density and hence calculate the maximum mass of the ball for it to remain afloat in water. It is assumed the air in the ball has negligible mass.

maximum density of aluminum ball = ………………

mass of aluminum ball = ……………...…… [3]

(b) The density of aluminium is 2.7 g / cm^3. Calculate the maximum volume of aluminium in the ball for it to remain afloat in water.

maximum volume = ……….………..……… [1]

(c) By considering the volume of air in the ball and the inner radius *r*, calculate the maximum thickness *t* of the aluminium for the ball to remain afloat.

maximum *t* = ………… [2]

3 **(a)** State the principle of moments.

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………….. [2]

(b) A 15000 N raft is supported by two ropes as shown in Fig. 3.1. Point A indicates the centre of gravity of the raft. The two ropes are 2.0 m apart.

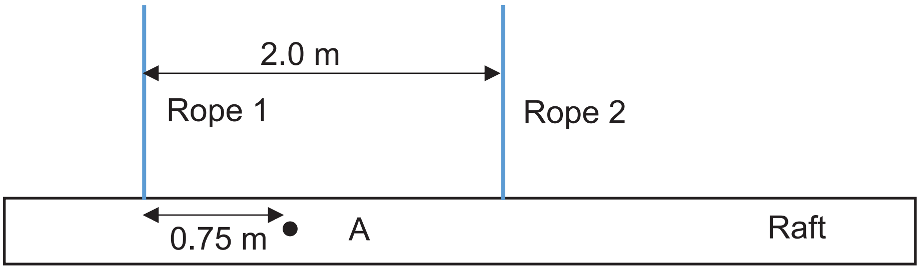


Fig 3.1

(i) The position of the center of gravity is not at its midpoint. Suggest what this implies about the distribution of the mass in the raft.

……………………………………………………………………………

………………………………………………………………………..… [1]

(ii) By choosing the appropriate pivot or otherwise, calculate the tensions in both ropes.

tension in rope 1 = ……………………...

tension in rope 2 = …………………..… [3]

4 Fig 4.1 shows a fixed mass of air trapped in a cylinder with a piston that is fixed by a pin.

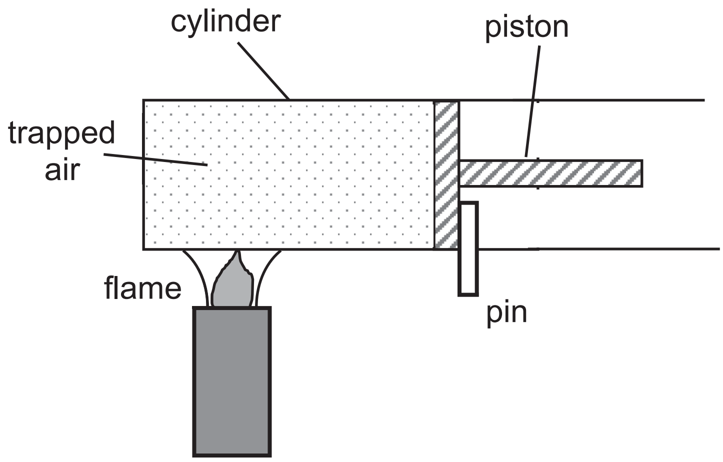


Fig 4.1

(a) State and explain, using kinetic model, what happens to the pressure of the trapped air when the cylinder is heated.

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [3]

(b) The pin is removed, and the piston is allowed to move after the air is heated. State and explain, what would happen to the:

1. piston

………………………………………………………………………………

……………………………………………………………………………….. [1]

2. final pressure of the trapped air in the cylinder.

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………….… [2]

5 **(a)** Use the kinetic theory of matter to explain why melting requires energy but there is no change in temperature.

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………….. [2]

(b) A block of ice at 0 ºC has a hollow in its top surface as shown in Fig 5.1.

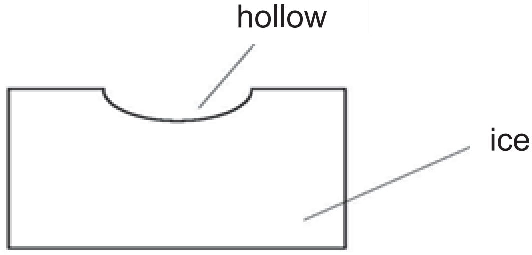


Fig 5.1

A mass of 0.16 kg of water at 100 °C is poured into the hollow. The water has specific heat capacity 4.20 kJ kg^{-1} K^{-1}. Some of the ice melts and the final mass of water in the hollow is 0.365 kg.

(i) Assuming there is no heat gain from the surrounding, state the temperature of the final mass of water in the hollow.

temperature = ………...……. [1]

(ii) Calculate the specific latent heat of fusion for the ice.

specific latent of fusion of ice = …….…………… [2]

(iii) In practice, thermal energy is gained from the surrounding. Suggest a way to reduce thermal energy gained from surrounding, state the method of heat transfer that was reduced. [2]

method of heat transfer	suggestion to reduce thermal energy gained

6 Bats emit ultrasound waves of high frequency and receive the reflected waves (echoes) to locate objects ahead. This process is called echolocation, which is illustrated in Fig. 6.1.

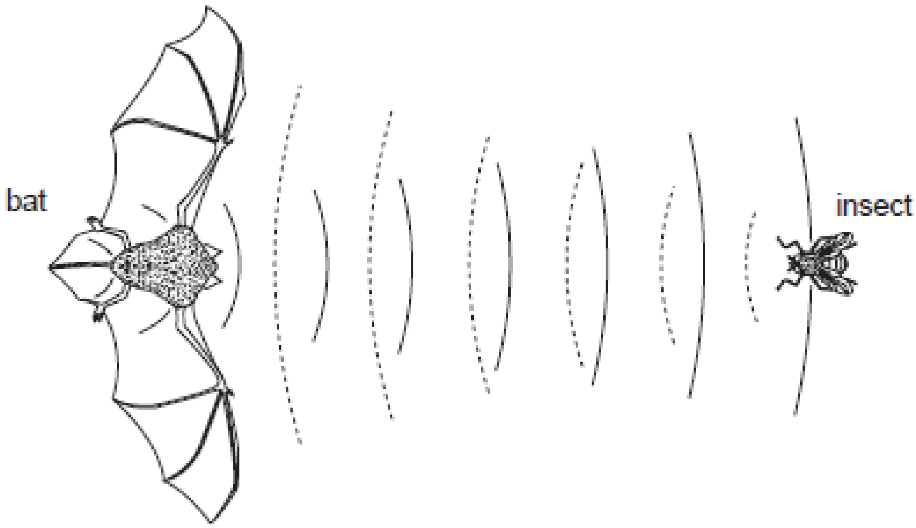


Fig 6.1

(a) Sound waves are longitudinal in nature. Describe what is meant by a longitudinal wave.

…………………………………………………………………………………………

…………………………………………………………………………………………

………………………………………………………………………………….. [1]

(b) Bats uses ultrasound of frequency range of 20 kHz to 80 kHz. These sound waves travel at 340 m s^{-1}.

Calculate the range of wavelengths for this frequency range.

range of wavelengths = ………………. to ……………….... [3]

(c) In a particular hunt by the bat, there is a time delay of 0.1 s between the emission of the sound wave and the arrival of the echo from the insect.

Calculate the distance between the bat and the insect.

distance between the bat and insect = …………………… [2]

7 Fig.7.1 shows a magnet, two compasses and two nails.

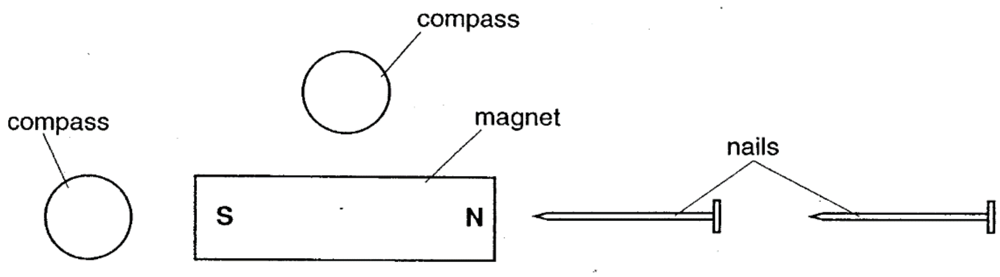


Fig.7.1

(a) On Fig.7.1, draw an arrow in each compass to show the direction of the magnetic field of the magnet at the two positions. [2]

(b) The magnet causes the nails to become magnetized by induction. Both ends of each nail become magnetic poles.

On Fig.7.1, mark a **N** or a **S** at both ends of each nail to show the magnetic poles. [2]

(c) When the magnet is removed, the nails are still magnetized. Describe how to test whether the nails are still magnetized when they are away from the magnet.

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………. [2]

(d) Describe how the nails can be demagnetized.

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………. [1]

8 Fig.8.1 shows two coils of copper wire wound on a soft-iron rod. Each coil can slide easily on the rod. Coil P is connected in series to a battery and a switch S. Coil Q is connected to a sensitive centre-zero meter. As S is closed, a deflection is seen on the meter.

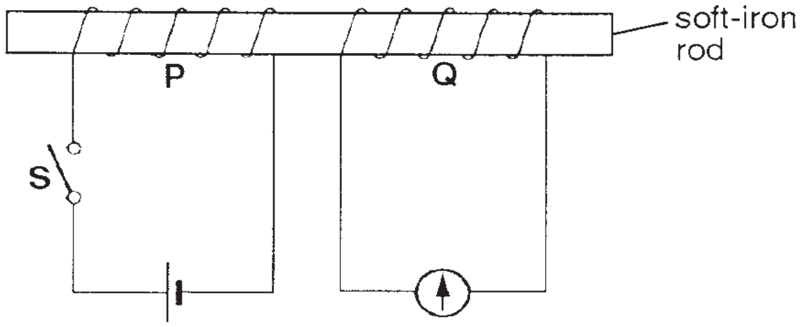


Fig.8.1

(a) Explain briefly why there is a deflection on the meter.

....

....

....

.... [2]

(b) State and explain what you would expect to observe as S is opened.

....

....

....

.... [2]

(c) State and explain the effect on the deflection in **(a)** if the soft-iron rod was replaced with a wooden rod.

....

....

....

.... [2]

Section B (30 marks)

Answer **all** the questions from this section. Question 11 has a choice of parts to answer.

9 A thin copper wire has a radius of 0.09 mm and is 96 m long. The resistivity of copper is 1.7×10^{-8} Ω m.

(a) Show that the resistance of the copper wire is 64.1 Ω. [2]

(b) When the wire hangs vertically, suspended from one end, it stretches slightly under its weight.

(i) State and explain whether the cross-sectional area of the wire would increase or decrease when it stretches.

…………………………………………………………………………

…………………………………………………………………………

…………………………………………………………………………

………………………………………………………………………... [2]

(ii) Hence, or otherwise, state and explain what happens to the resistance of the wire.

…………………………………………………………………………

…………………………………………………………………………

…………………………………………………………………………

………………………………………………………………………... [2]

(c) A cable of length 96 m consists of 16 strands of this wires bundled together. Calculate the resistance of this cable.

resistance = …………………. [2]

(d) The current in the cable in **(c)** is 2.5 A. Determine the power dissipated in the cable due to Joule heating.

power dissipated = ……..………….. [2]

10 **(a)** Fig 10.1 shows a rigid conducting wire loop connected to a 6.0 V battery through a 6.0 V, 3.0 W lamp. The circuit is standing on a top-pan balance. A uniform horizontal magnetic field strength 0.05 T acts at right angles to the straight top part of the conducting wire in the direction indicated in the diagram, i.e. into the paper. This magnetic field extends over the shaded area. The reading of the balance is 15.67 g

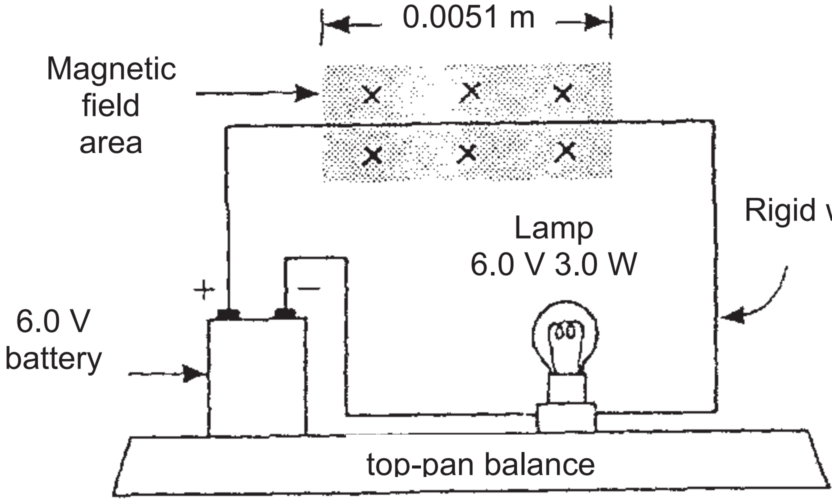


Fig. 10.1

Given that the force on the current-carrying wire , *F*, is by

F = B I L where B = magnetic field strength in Tesla (T)

I = current in Ampere (A)

L = length of wire in magnetic field in metre (m)

(i) Compute the magnitude and direction of the force exerted on the conducting wire by the magnetic field.

direction of the force = ………………...

magnitude of the force = …………... [4]

(ii) The direction of the magnetic field in Fig 10.1 was reversed to out of the paper. State and explain, without any calculation, how the reading on the balance would change.

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

……………………………………………………………………………….. [2]

(b) James uses a pair of wireless earbuds to listen to music. These earbuds use ultra-high frequency radiowaves to receive the music from his mobile phone.

(i) The radiowaves that the earbuds use has a wavelength of 125 cm. Calculate the frequency of the radiowaves.

frequency = ……………………..[2]

(ii) James accidentally brought his earbuds to swim.
State and explain what happens to the **frequency** and **wavelength** of the radiowaves as they enter the water from air.

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

……………………………………………………………………………….. [2]

11 Either

(a) State what is meant by acceleration.

…………………………………………………………………………………………

…………………………………………………………………………………………[1]

(b) Fig. 11.1 below shows the top view of a train consisting of an engine pulling a cargo carriage and 2 passenger carriages. The mass of the engine, cargo carriage and each of the passenger carriages are 3500 kg, 7500 kg and 4500 kg respectively. The frictional force of the track acting on the engine, cargo carriage and each of the passenger carriages are 2.0 kN, 4.0 kN and 3.0 kN respectively.

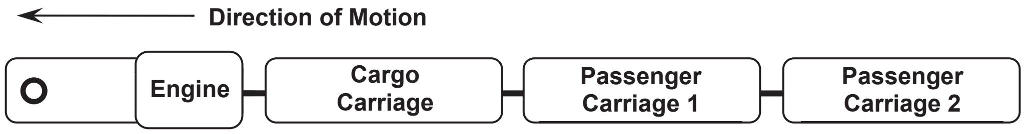


Fig 11.1

(i) The train accelerates uniformly from rest to 30 m s^{-1} in 40 s. calculate the acceleration of the train.

acceleration = ………………. [1]

(ii) Compute the resultant force of the train.

resultant force = ……………… [2]

(iii) Determine the driving force required by the engine, assuming that the air resistance on the train is negligible.

driving force = ………………. [2]

(iv) Show, with clear workings, that the distance moved during this acceleration is 600 m. [2]

(v) Hence, or otherwise, compute the power of the engine during this period of acceleration.

power = …..…………… [2]

11 **OR**

(a) State the two conditions required for light traveling in a medium to experience total internal reflection.

1…………………………………………………………………………………..…….

……………………………………………………………………………………………

2………………………………………………………………………………..…………

…………………………………………………………………………...……… [2]

(b) Fig 11.2 (not drawn to scale) below is a semi-circular glass block, centre **C**, and with a refractive index of 1.5.

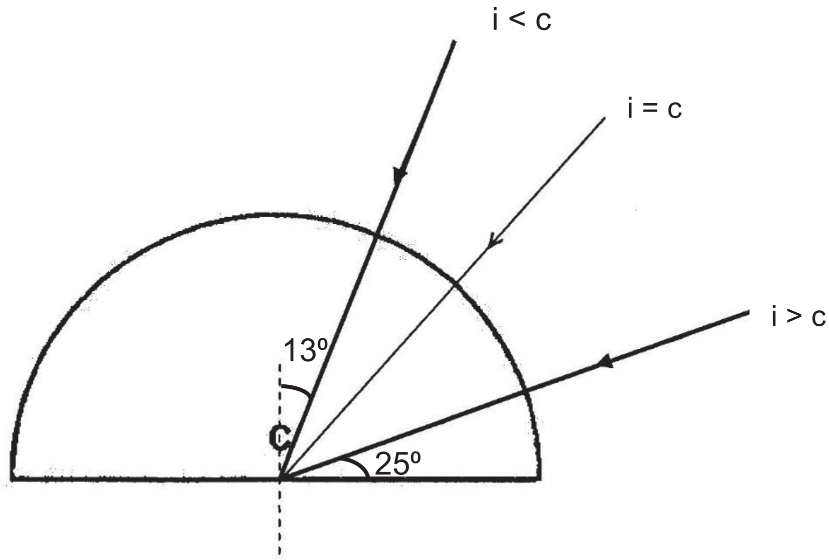


Fig 11.2

(i) Calculate the critical angle c of the glass block.

critical angle, c = ………………….. [2]

(ii) Three rays are incident perpendicularly on the glass block as shown in Fig 11.2.
By making appropriate calculations, show the workings and label how the rays interacted after point C at the plane surface for: [5]

1. i < c. Label the angle from normal at C as M.

2. i = c. Label the angle from normal at C as N.

3. i > c. Label the angle from normal at C as L.

State the values of the angles of M, N and L.

(c) State a real-life application where total internal reflection was used.

………………………………………………………………………..…………… [1]

END OF PAPER

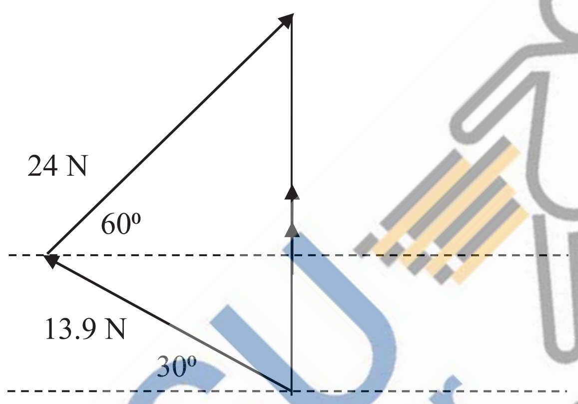
2022 Prelim Sec 4 Physics (5059/01)

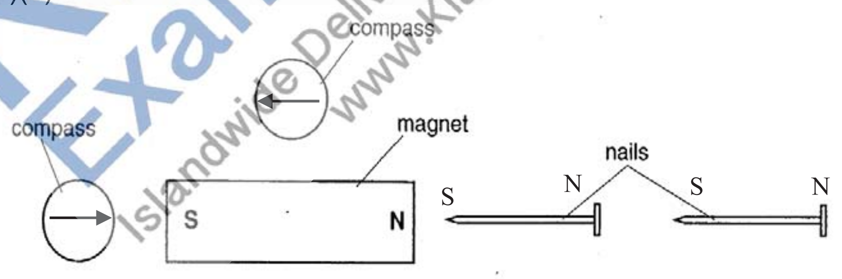
Answer Key

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
A	B	C	C	D	C	A	B	A	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
D	A	B	A	A	D	A	D	C	A
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
C	C	C	B	B	B	C	D	B	D
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
B	D	B	C	A	C	D	B	D	A

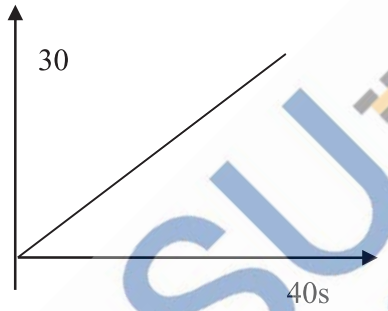
A -10
B – 10
C – 11
D - 9

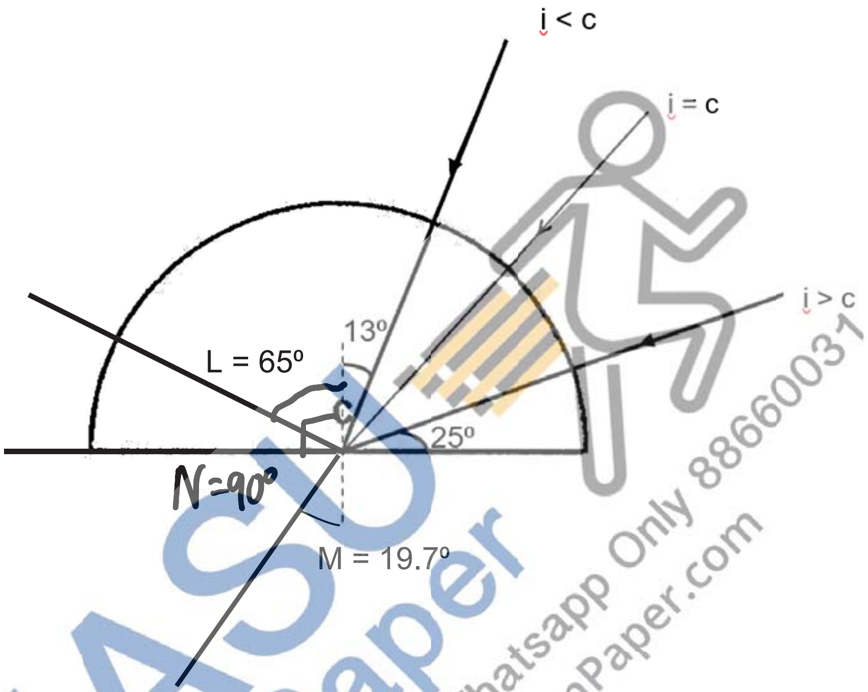
2022 Prelim
4E Physics (6091/2)
Marking Scheme

Section A (50 marks)		
Qn	**Answers**	**Marks**
1	(a) Correct scale [1]  correct scaled drawing with correct arrows (resultant force with 2 arrows) magnitude of resultant force = 27.7 N ± 3 N upward direction	B1 B1 A1 A1
	(b) W = mg 27.7 = m x 10 m = 2.77 kg	M1 A1
2	(a) maximum density of aluminum ball= 1 g/cm^3 Volume of aluminum ball = 4/3 π r^3 = 4/3 x π x 10^3 = 4188 cm^3 mass of aluminum ball = ρ x V = 1 x 4188 = 4190 g	A1 M1 A1
	(b) V = m/ρ $= \frac{4188}{2.7}$ = 1550 cm^3	A1
	(c) volume of air = 4188 -1551 = 2636 cm^3 = 4/3 x π x r^3 radius of air = 8.57 cm t = 10 – 8.57 = 1.43 cm	M1 A1
3	(a) The **principle of moments** states that when a body is in **equilibrium**, the sum of clockwise moments about a pivot is equal to the sum of anticlockwise moment about the **same** pivot.	B1 B1

	b(i) It is not uniformly distributed	B1
	(ii) taking pivot around Rope 1, CW M = AC M $0.75 \times 15000 = 2 \times T_2$ $T_2 = 5625 = 5630$ N $T_1 + T_2 = 15000$ $T_1 = 15000 - T_2 = 9380$ N	 M1 A1 A1
4	(a) As the air is heated up, the average kinetic energy of the air molecules increases. The frequency **and** the force of collision of the air molecules on the walls increases. With Pressure = Force / area, with a higher force over the same volume/surface area, the pressure increases.	B1 B1 B1
	(b) i. The air will expand, and so the piston will move to the right.	B1
	ii. the trapped air will expand until its pressure drops to be the same pressure as the atmospheric pressure	B1 B1
5	(a) melting requires energy to break the intermolecular forces of the solid to liquid. Melting does not increase the kinetic energy of the molecules so the temperature remains constant.	B1 B1
	(b)i. 0 ºC ii. heat loss by 100 ºC water to 0 ºC = heat gained by melting of ice 0.16×4.2 kJ $\times 100 = (0.365 - 0.16) \times l$ $l =$ 328 kJ/kg	A1 M1 A1
	iii) Conduction – put the ice in a poor conductor/ insulator container Convection – cover the told of the ice with a lid Radiation – use a shiny and bright material as a container Note: Mode of transfer of energy must coincide with the suggestion.	B2
6	(a) Longitudinal waves are waves that travel parallel to particle vibration.	B1
	(b) $v = f\lambda$ $340 = 20\,000 \times \lambda$ $340 = 80\,000 \times \lambda$ $\lambda = 0.017$ m $\lambda = 0.00425$	 M1 A2
	(c) $v = d / t$ $340 = d / 0.1$ $d = 34$ distance between bat and insect = 34/2 = 17 m	 M1 A1
7	(a)(b)  [1] for each correct arrow [1] for each correct pair of N-S	B2 B2
	(c) Test the nails with another magnet, using two sides of the magnet. The nails are **only** magnetized, when it is repelled by another magnet.	B1 B1

	Cannot accept: Placing near another metal and the nail is attracted to it (the test metal could be magnetized). Accept: place near a compass, and see deflection (d) heating, hammering or using a coil with a Alternating current	B1
8	(a) when the switch is turned on, coil P creates a magnetic field that could be experienced by coil Q. By Faraday's Law, Q experienced a change in magnetic flux, it would induce a current in Q	B1 B1
	(b) As S is opened, the magnetic field in coil P is destroyed. As coil Q experience a change in magnetic flux (from magnetic field to none), it would induce a current in Q. (opposite in direction to (a))	B1 B1
	(c) As wood is not a soft magnetic material, the magnetic flux/field experienced by coil Q will be lower. The current induced would also be lower.	B1 B1
Qn		**Marks**
9	(a) $A = \pi r^2 = 3.142 \times (9 \times 10^{-5})^2 = 2.545 \times 10^{-8}$ m^2 $R = \rho\frac{L}{A} = 1.7 \times 10^{-8} \times \frac{96}{2.545 \times 10^{-8}}$ $= 64.1\ \Omega$ (shown)	M1 M1
	(b)(i) V = A x l For the same volume, as length increases, The cross-sectional area of the wire decreases.	B1 B1
	ii, with the length increasing and cross-sectional area decreasing, by $R = \rho\frac{L}{A}$, the resistance of the wire will increase	B1 B1
	(c) with 16 wires bundled together, it is as if it is 16 resistors parallel to each other. Hence, the effective resistance, $\frac{1}{Reff} = \frac{1}{R} \times 16$ $Reff = \frac{R}{16} = 4.01\ \Omega$ Accept: the effective area increases by 16 times, and so the resistance $\frac{R}{16}$.	M1 A1
	(d) $P = I^2 R = 2.5^2 \times 4.01$ $= 25.1$ W	M1 A1
10	ai) upward force (by Fleming left hand rule P = VI → 3 = 6 x I → I = 0.5 A F = BIL = 0.05 x 0.5 x 0.0051 F_{mag} = 0.0001275 N = 0.000128 N ii) When the magnetic field is reversed, it would exert a downward force, and so it would cause the reading on the balance to be higher. Allow ecf	B1 M1 B1 A1 B1 B1
	bi) $v = f\lambda$ $3 \times 10^8 = f \times \frac{125}{100}$ $f = 2.4 \times 10^8$ Hz	M1 A1

	ii) When radiowaves enter water from air, the frequency remains the same. The speed of the wave reduces in speed while in water. With $v = f\lambda$, hence, the wavelength decreases.	B1 B1
11Ei	a) Acceleration is the rate of change in velocity per unit time	B1
	bi) $a = \frac{30-0}{40} = 0.75\ \text{m s}^{-2}$ ii) Total mass = 3500 + 7500 + (4500 x 2) = 20 000kg F = ma = 20 000 x 0.75 = 15 kN iii) Fnet = Driving force – Frictional forces 15 kN = Driving force – (2 + 4 + 3 + 3) kN Driving force = 27 kN	A1 M1 A1 M1 A1
	iv) using graph of speed time graph  Area = ½ x 30 x 40 = 600 m Accept: since acceleration is constant, average speed is 30/2 = 15 m/s Therefore, distance = average speed x 40s = 600 m	M1 M1
	v) Power = $\frac{\text{Work Done}}{\text{Time}} = \frac{\text{Force x Distance}}{\text{Time}}$ $= \frac{27\ 000 \times 600}{40}$ = 405 kW	M1 A1
11Or	a) 1. The angle of incidence must be greater than the critical angle 2. Light travels from an optically denser medium to an optically less dense medium	B1 B1
	bi) $n = \frac{1}{\sin c}$ $1.5 = \frac{1}{\sin c}$ $c = \sin^{-1}(\frac{1}{1.5}) = 41.81^{o}$	M1 A1
	ii) 1. With i < c, the ray undergoes refraction. $n_i \sin i = n_r \sin r$ 1.5 sin 13 = 1 sin r r = 19.7°	M1

	2. with i = c, the ray should refract exactly at 90º, (show on diagram) 3. with i > c, the ray should undergo total internal reflection, when angle of incidence = (90 – 25) = 65º, and so the angle of reflection is 65º  [1] for each correctly labelled angle on Fig	M1 A3
	(c) **Transmission of data** using optical fibres.	B1

Note:

- 3SF for final answer – For each mistake, deduct 1 mark up to a maximum of 3 marks per paper.
  (For exact value, need not write answer to 3 SF.)

- No unit written for final answer - For each mistake, deduct 1 mark up to a maximum of 3 marks per paper.

- Don't give ½ mark.

Setter: Mr Kan Cheng Mun

THE END

NAME:	CLASS:	INDEX NO:

QUEENSWAY SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2022

SECONDARY 4 EXPRESS

Parent's Signature:

PHYSICS **6091/01**

Paper 1 Multiple Choice **15 September 2022**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name and index number on the Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

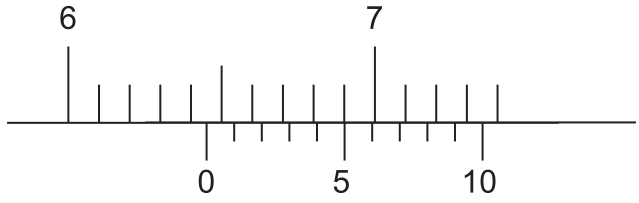
Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **20** printed pages.

Setters: Mrs Pang FH, Ms Tan YN **[Turn over**

1 The diagram shows a vernier calipers scale.



Which reading is shown?

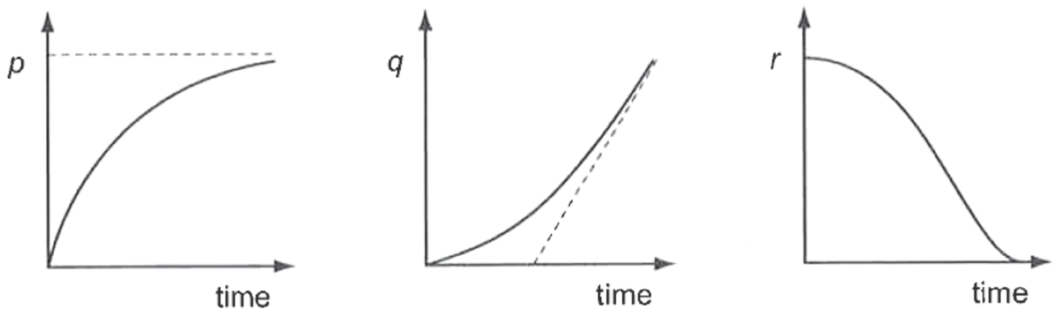
A 6.40 cm
B 6.45 cm
C 6.50 cm
D 7.35 cm

2 A motorcyclist accelerates from rest at 2.0 m s^{-2} along a level road until he reaches and maintains a steady speed of 40 m s^{-1}.

How much time will elapse before the motorcyclist covers a distance of 1.0 km from his starting point?

A 20 s
B 25 s
C 35 s
D 50 s

3 A stone is released from rest at a great height in air and falls vertically. Each of the three graphs represents the variation with time of one of the three variables *p*, *q* or *r*.

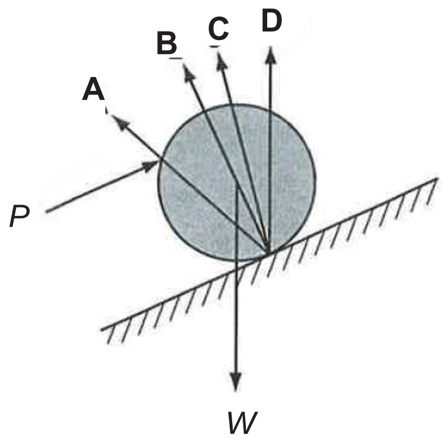


Which row correctly identifies the three variables *p*, *q* and *r*?

	p	*q*	*r*
A	velocity	displacement	acceleration
B	velocity	acceleration	displacement
C	displacement	velocity	acceleration
D	acceleration	displacement	velocity

4 A force P is required to hold a barrel of weight W at rest on a ramp. Friction between the barrel and the ramp stops the barrel from slipping.

Which arrow represents the resultant force the ramp exerts on the barrel?

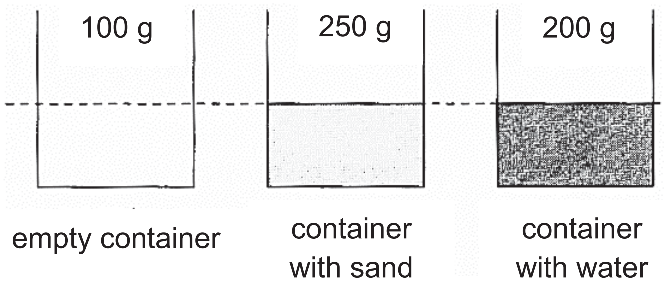


5 When a block of wood of mass 1 kg is pushed with a force of 5 N along the horizontal flat surface of a bench, the block moves with a constant speed of 2 m s^{-1}.

When the block is pushed along the same bench with a force of 10 N, it moves with a constant

A speed of 4 m s^{-1}.
B speed of 5 m s^{-1}.
C acceleration of 4 m s^{-2}.
D acceleration of 5 m s^{-2}.

6 The diagrams show three containers. One container is empty and the other two contain sand and water respectively. The density of water is known to be 1.0 g cm^{-3}.



What is the density of the sand?

A 1.25 g cm^{-3}
B 1.50 g cm^{-3}
C 2.00 g cm^{-3}
D 2.40 g cm^{-3}

7 The weights of two objects measured on two different planets are listed below.

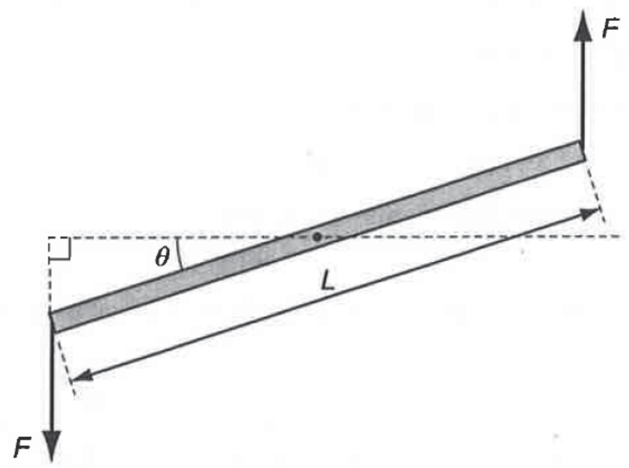
Weight of object M on Mercury = 2000 N
Weight of object J on Jupiter = 6000 N

The gravitational field strength of Mercury and Jupiter are 3.8 N kg^{-1} and 25.4 N kg^{-1} respectively.

Which of the following statements describing the mass and/or weight of the objects is correct?

A Object M has a smaller mass than object J because object M has a smaller weight than object J.
B Object M has a smaller mass than object J because the gravitational field strength of Mercury is smaller than that of Jupiter.
C Object M has a smaller weight than object J because the gravitational field strength of Mercury is smaller than that of Jupiter.
D Object M has a mass one-third of the mass of object J because the weight of object M is one-third of the weight of object J.

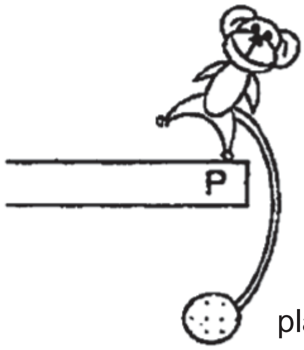
8 The diagram shows two equal and opposite forces applied to the ends of a pivoted bar of length L.



What is the magnitude of the moment exerted by these forces on the bar?

A FL
B $FL\sin\theta$
C $FL\cos\theta$
D $2FL\cos\theta$

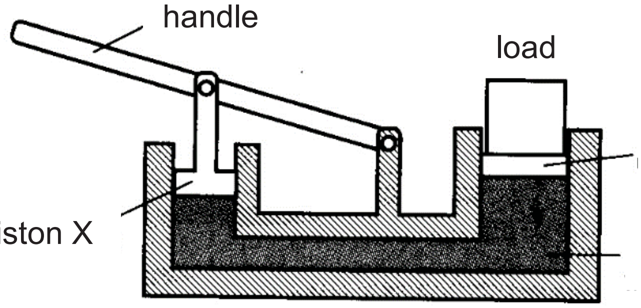
9 The diagram shows a toy monkey with a lump of plasticine placed at the end of its tail. When displaced about point P, it oscillates and eventually comes to rest at this same position.



How does the plasticine help the toy in maintaining its state of equilibrium?

A It increases the weight of the toy.
B It moves the centre of gravity to be directly above P.
C It moves the centre of gravity to be directly below P.
D It moves the centre of gravity to be exactly at P.

10 The diagram shows a simple hydraulic jack.

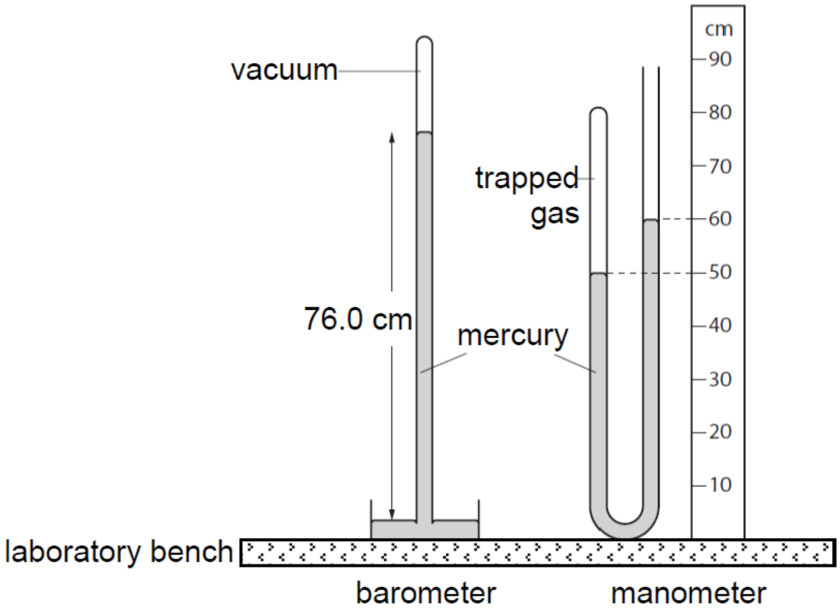


The base areas of both pistons X and Y in contact with the hydraulic fluid are circular in shape.

Which of the following changes should be made in order for heavier loads to be lifted?

	radius of piston X	radius of piston Y
A	halved	doubled
B	doubled	halved
C	doubled	remains the same
D	remains the same	halved

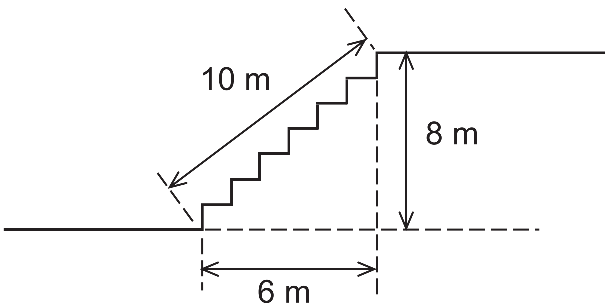
11 A mercury barometer and a mercury manometer are placed side by side on a laboratory bench.



What is the pressure of the trapped gas?

A 10 cm Hg
B 50 cm Hg
C 66 cm Hg
D 86 cm Hg

12 A boy weighing 800 N runs up a flight of stairs.

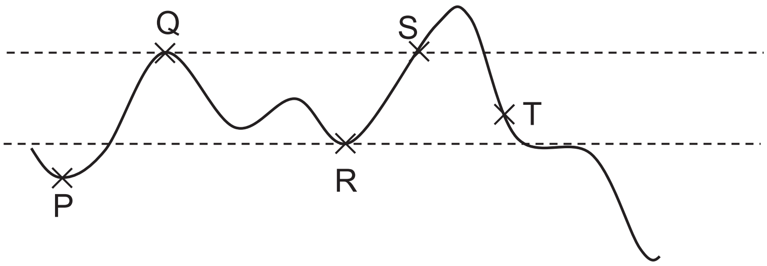


How long does he take to run up the flight of stairs with an average power of 400 W?

A 12 s
B 16 s
C 20 s
D 32 s

13 A marble is allowed to roll along an undulating plane from left to right. It is in motion at P and at rest at Q.

Neglect air resistance and assume the plane is smooth.



Which of the following statement(s) is/are correct?

I The marble has zero gravitational potential energy at P.
II The speed of the marble at R is less than that at P.
III The marble will only roll up to S and return.

A I only
B I and II only
C II and III only
D I, II and III

14 In a Brownian motion experiment involving smoke particles in air, larger smoke particles are seen to be less agitated in their motion as compared to the smaller smoke particles.

Which statement(s) explain(s) the motion of the larger smoke particles?

I The larger smoke particles have greater weight than the smaller smoke particles.
II The larger smoke particles have greater density than the air molecules.
III There is less bombardment by air molecules on the larger smoke particles.

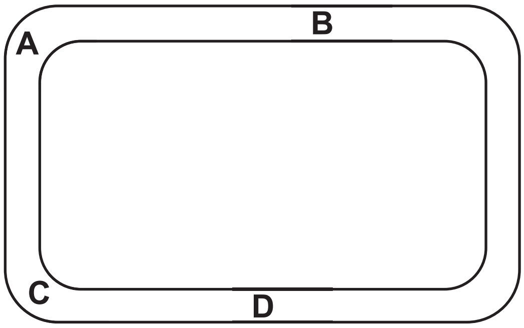
A I only
B III only
C I, II and III
D None of the statements

15 A fixed mass of gas is cooled down while its pressure is kept constant.

How do the properties of the molecules of the gas change?

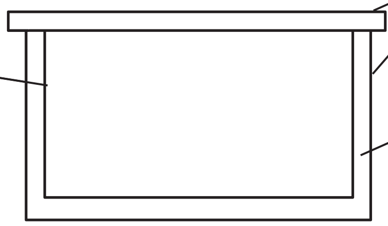
	average speed	frequency of collisions with walls	average distance apart
A	decreases	decreases	decreases
B	decreases	increases	decreases
C	decreases	increases	unchanged
D	unchanged	decreases	increases

16 A heating element is to be positioned in a narrow sealed tube of liquid.



Which would be the best position, **A**, **B**, **C** or **D**, to place the heating element in order to obtain the best circulation of the liquid throughout the tube?

17 The diagram shows the cross-section of a plastic container that a manufacturing company has created.



The company claims that the container can keep food warm or cold for a duration that surpasses other brands of containers. It offers the following explanations to justify its claims.

I The plastic cover will reduce heat gain or heat loss through conduction as plastic is a poor conductor of thermal energy.
II The vacuum between the interior and exterior walls of the container will reduce heat gain or heat loss through conduction, convection and radiation.
III The silvered inner walls will reflect hotness or coldness back to the food as silver surfaces are good reflectors.

Which of the above explanation(s) is/are correct?

A I only
B I and II only
C I and III only
D II and III only

18 One of the steps required to calibrate a thermometer is the selection and determination of the two fixed points.

Which of the following statement(s) about the fixed points is/are correct?

I The fixed points must be easily obtainable and reproducible.
II The fixed points should be based on the physical property of the substance of the thermometer.
III The lower fixed point is the melting point of a substance and the upper fixed point is the boiling point of the substance.

A I only
B I and II only
C II and III only
D I, II and III

19 When one junction of a thermocouple is placed in pure melting ice at 0 °C and the other junction in steam at 100 °C, the e.m.f. is 8.0 mV. The cold junction is then removed from the melting ice and placed in a liquid at constant temperature. The e.m.f. is now 2.0 mV.

What is the temperature of the liquid?

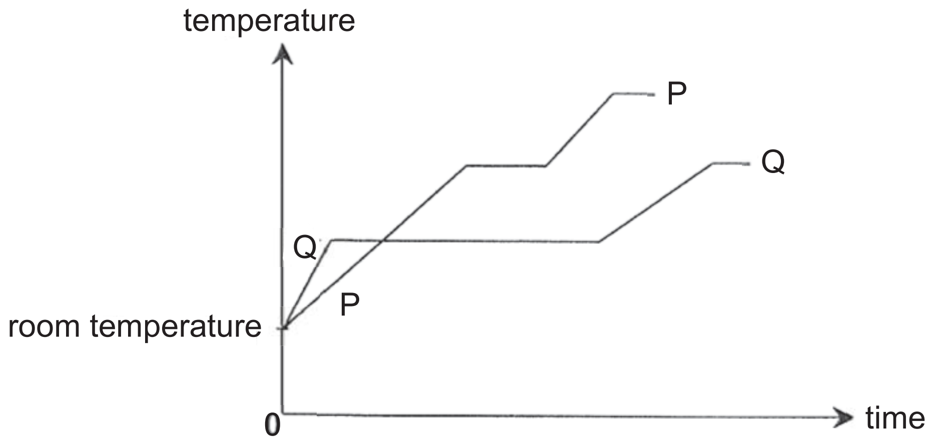
A 20 °C
B 25 °C
C 55 °C
D 75 °C

20 The characteristic of certain cooking pots is that when they are removed from the source of heat, the contents in the pots may continue to boil for some time.

What may be the reason for this?

A The material of the pot has high specific heat capacity.
B The material of the pot has low specific heat capacity.
C The pot is made of a very poor conductor of thermal energy.
D The pot is made of a poor radiator of thermal energy.

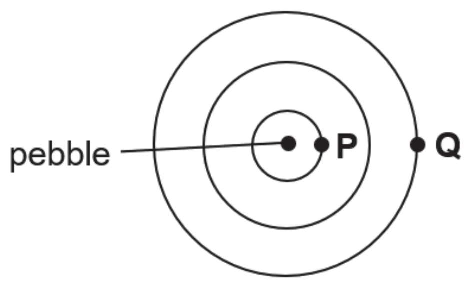
21 The graph shows the variation in temperature with time of two equal masses of substances P and Q, when they are separately heated by identical heaters.



Which of the following deductions is correct?

A The boiling point of P is lower than Q.
B The specific latent heat of fusion of P is larger than that of Q.
C The specific heat capacity of P in the solid state is smaller than that of Q.
D Less energy is required to raise the temperature of P from room temperature to its boiling point than Q.

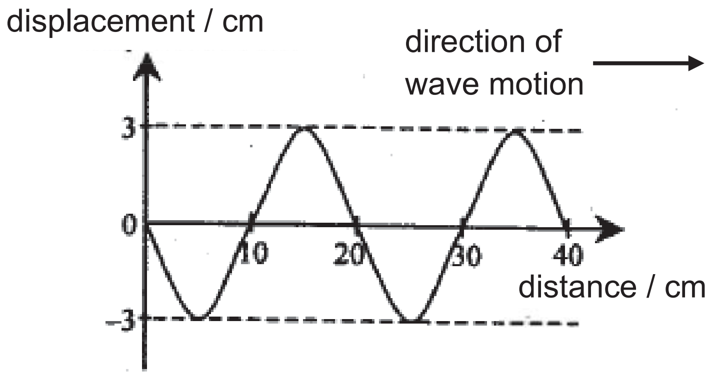
22 A pebble is dropped into still water and circular wavefronts are seen to travel outwards with a speed of v.



If the wavelength is λ , what is the time taken for the wave to travel from P to Q?

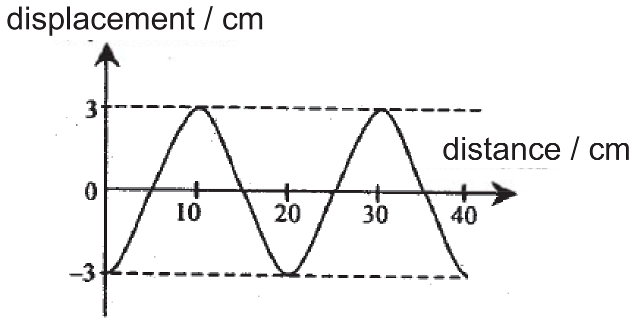
A $\lambda / 2v$
B λ / v
C $2\lambda / v$
D $3\lambda / 2v$

23 A transverse wave travels along a string with a speed of 0.5 m s^{-1}. The graph shows the shape of the string at a certain instant.

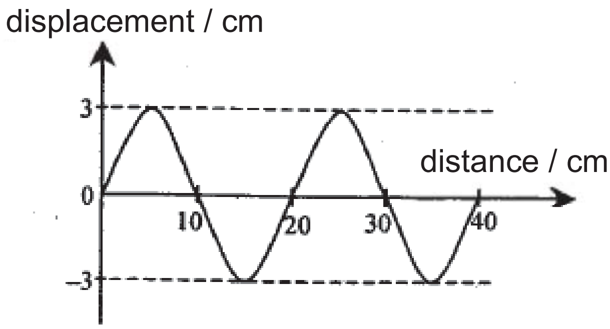


Which of the following graphs shows the shape of the string 0.7 s later?

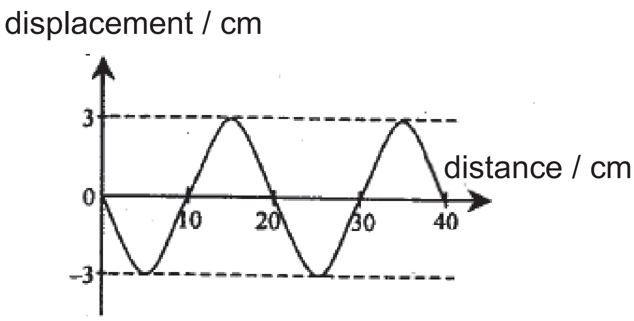
A



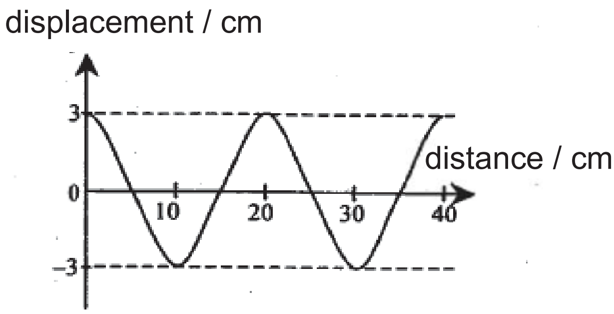
B



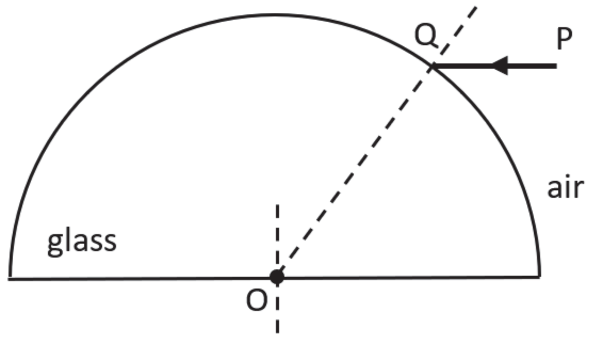
C



D

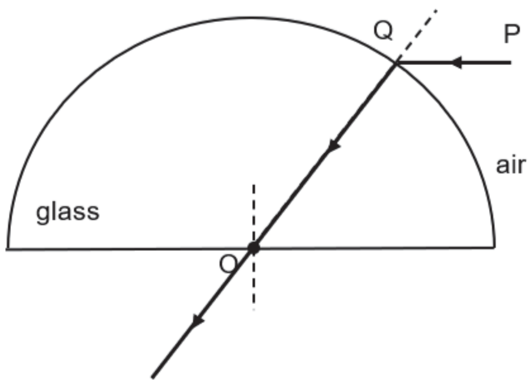


24 A ray of light in air is incident on a semi-circular block of glass at point Q. OQ is the radius of the semicircle.

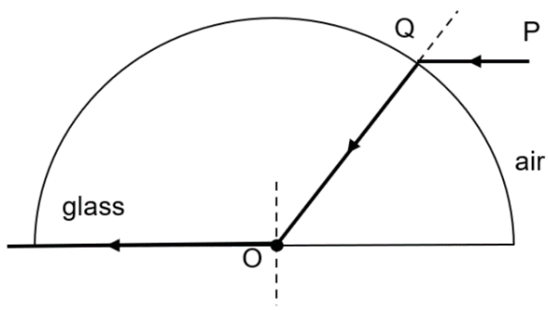


Which of the following ray diagrams shows how the ray will pass through the block and into the air again?

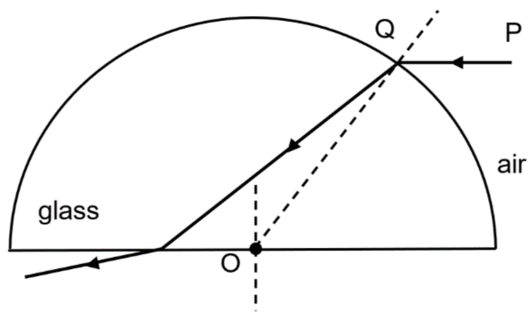
A



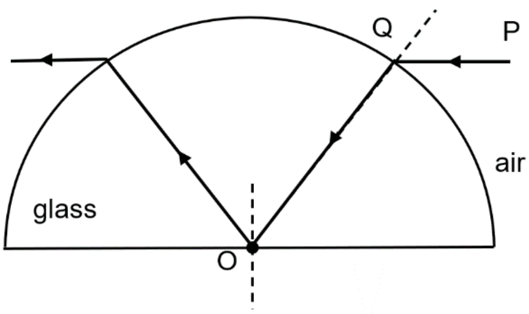
B



C



D



25 The human eye has a converging lens system that produces an image at the back of the eye.

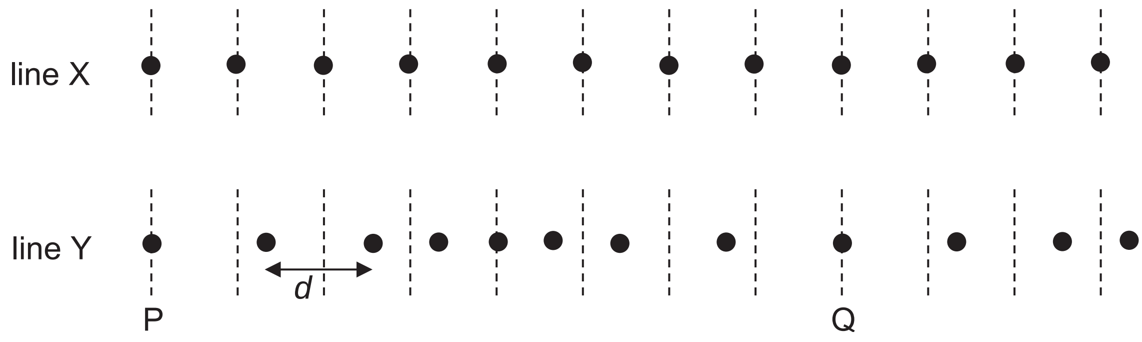
If the eye views a distant object, which type of image is produced?

A real, inverted, diminished
B real, upright, same size
C virtual, upright, diminished
D virtual, upright, same size

26 Which of the following is true about gamma rays?

A Gamma rays travel at the highest speed in any medium.
B Only gamma rays are used to kill cancer cells in radiation therapy.
C Gamma rays are the most energetic in the electromagnetic spectrum.
D Gamma rays are the only electromagnetic waves that have ionising effect.

27 The diagram shows a sound wave passing through a medium. The dots on line X represent the equilibrium positions of the air molecules and the dots on line Y represent the positions of the same air molecules at a particular time.

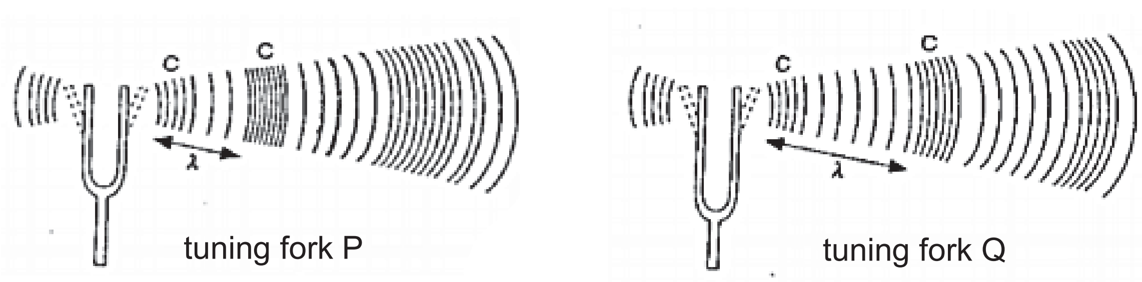


Which of the following statement(s) is/are correct?

I Molecule Q is always at rest.
II The distance between molecules P and Q is the wavelength of the sound wave.
III *d* is the amplitude of the wave.

A II only
B I and II only
C I and III only
D I, II and III

28 Tuning forks with prongs of different lengths produce sounds of different pitch.



Which of the following describes the characteristics of the sound produced?

A The sound produced by Q has a longer wavelength and so has a higher pitch.
B The sound produced by P has a shorter wavelength and so has a higher pitch.
C Q has longer prongs and so the sound it produces has a higher pitch.
D The sound produced by P has closer regions of compressions and so has a lower pitch.

29 An electroscope is used to determine the presence of charges. Plate A is fixed in position but plate B can swing freely about pivot P. Diagram 1 shows that initially, the electroscope is charged positively. Both plates A and B are not touching each other.

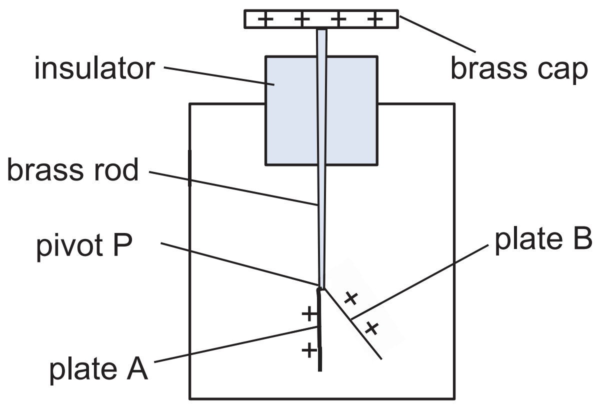


Diagram 1

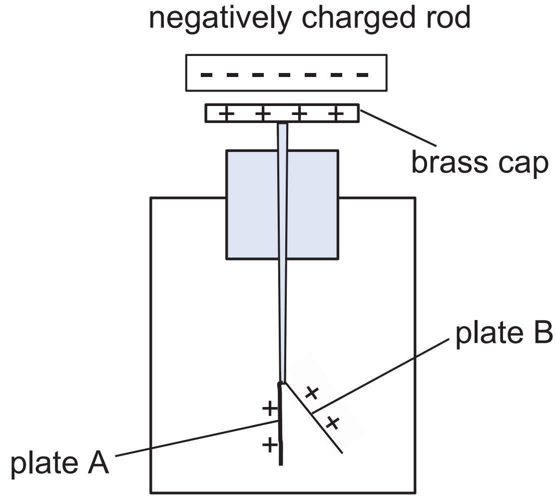


Diagram 2

A negatively charged rod is then placed near the brass cap of the electroscope, as shown in Diagram 2.

Which of the following explains what happens to plate B?

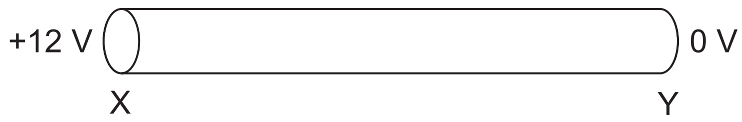
A Plate B swings further away from plate A because more positive charges are repelled downwards from the cap, causing both plates to be more positively charged.

B Plate B swings further away from plate A because negative charges are repelled downwards from the cap, causing both plates to become negatively charged.

C Plate B swings less from plate A because negative charges are repelled downwards from the cap, causing both plates to be less positively charged.

D Plate B swings less from plate A because positive charges are attracted upwards to the cap, causing both plates to be less positively charged.

30 A conductor XY has a potential difference of 12 V between its ends. There is a current of 3 A in XY.



Which statement is correct?

A The charge flowing each second in the conductor is 12 C.
B Electrons flow from X to Y.
C The power dissipated in the conductor is 36 W.
D The resistance of the conductor is 3 Ω.

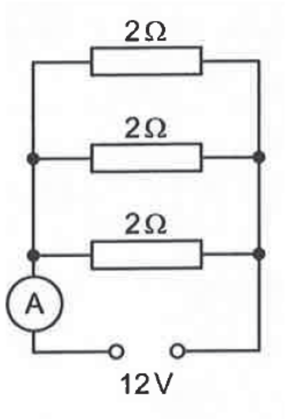
31 The resistance of a piece of wire, of length 1 m and diameter 0.3 mm, is *R*.

Another piece of wire, made of the same metal, is 2 m longer than the first wire. Its diameter is 50% that of the first wire.

What is the resistance of the second piece of wire?

A 4*R*
B 6*R*
C 8*R*
D 12*R*

32 The diagram shows a circuit containing a 12 V source and three resistors each of resistance 2 Ω. An ammeter measures the current leaving the source.



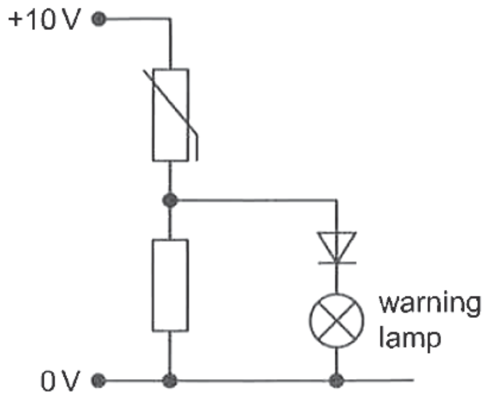
How will the ammeter reading change, if the connection to one of the resistors is broken?

A decreases by 6 A
B decreases by 1 A
C increases by 1 A
D increases by 6 A

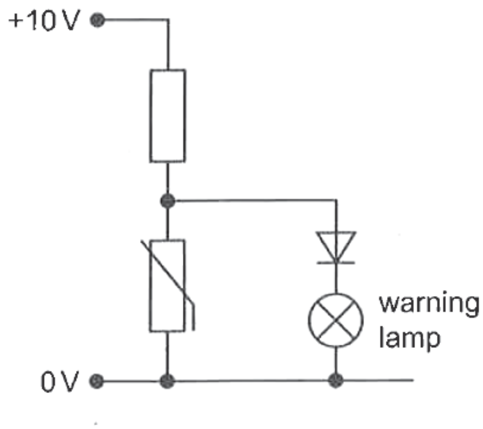
33 A circuit is needed to switch on a warning lamp when the temperature of a thermistor is too high.

Which circuit is suitable?

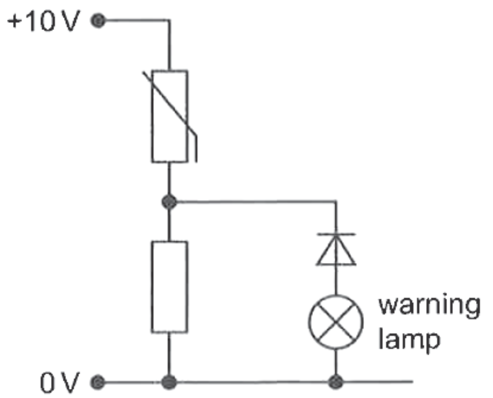
A



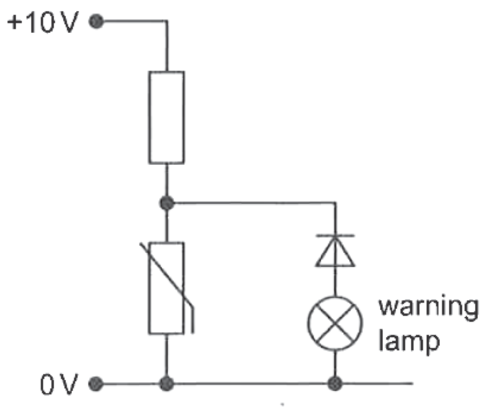
B



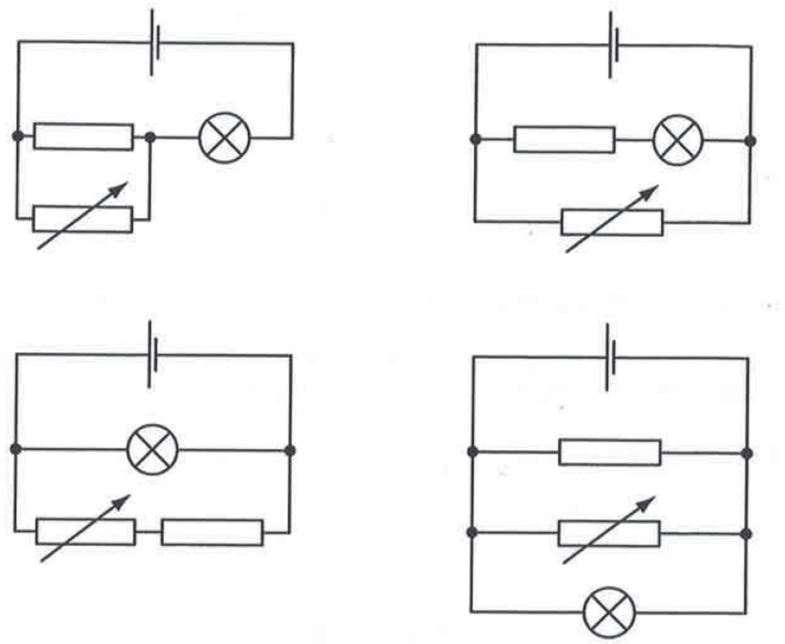
C



D



34 A fixed resistor, a variable resistor, a filament lamp and a cell are arranged in four different circuits.



In how many of these circuits will the brightness of the lamp be changed by adjusting the resistance of the variable resistor?

A 1
B 2
C 3
D 4

35 A plug for a lamp contains a fuse with a 3.0 A rating.

Which statement is **incorrect**?

A The fuse breaks the circuit if the current exceeds 3.0 A.
B The fuse contains a thin wire.
C The fuse is connected to the live pin of the plug.
D The fuse can be reset like a circuit breaker after it blows.

36 Diagram 1 shows a compass needle pointing north when there is no other magnet around. It is then placed at a point P near to a magnet surrounded by a soft iron ring as shown in Diagram 2.

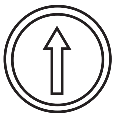


Diagram 1

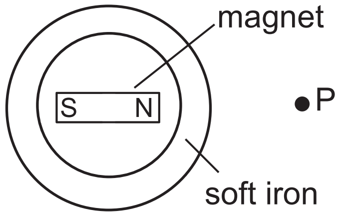
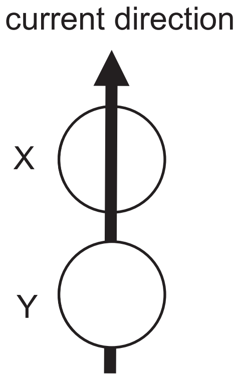


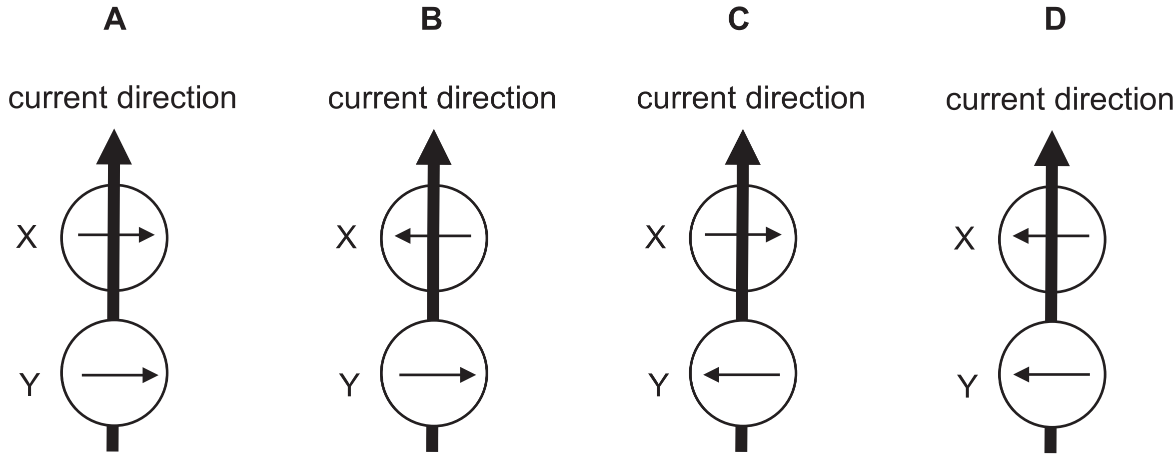
Diagram 2

Which of the following diagrams shows the possible orientation of the compass needle?

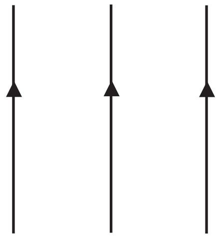
37 Plotting compasses X and Y are placed below and on top of a current-carrying wire respectively, as shown in the diagram.



Which of the following shows the possible directions of the compass needles?



38 Three vertical conducting wires have the same amount of current flowing through them in the direction shown.



Given that the distances between the wires are the same, what is the direction of the resultant electromagnetic force acting on the middle wire?

A to the left
B to the right
C perpendicular to the plane of the paper
D resultant electromagnetic force is zero

39 Diagram 1 shows the oscilloscope trace produced by an input of maximum voltage 2 V and frequency 50 Hz.

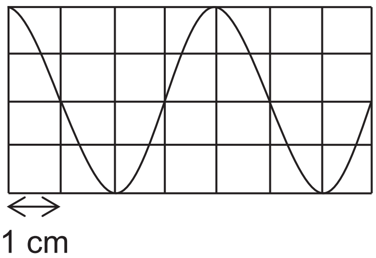


Diagram 1

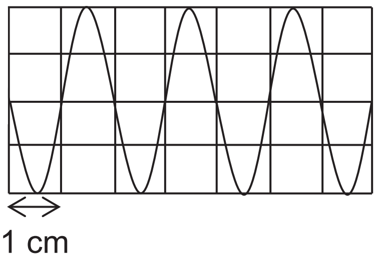


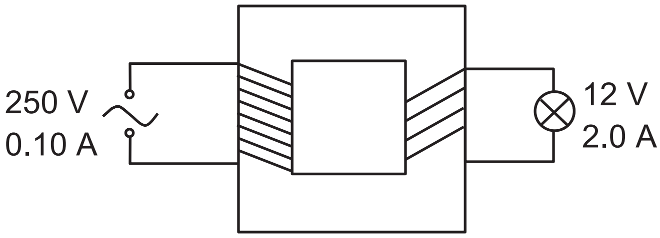
Diagram 2

With no changes in the oscilloscope setup, what are the new values of maximum voltage and frequency as shown in Diagram 2?

A 1 V and 50 Hz
B 2 V and 25 Hz
C 2 V and 100 Hz
D 4 V and 100 Hz

40 A transformer is used to operate a 12 V lamp from a 250 V mains supply. The mains current is 0.10 A and the current flowing through the lamp is 2.0 A.

What is the efficiency of the transformer?



A 4.8 %
B 5.0 %
C 96 %
D 104 %

END OF PAPER

NAME:	CLASS:	INDEX NO:

QUEENSWAY SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2022

SECONDARY 4 EXPRESS

Parent's Signature:

PHYSICS **6091/02**

Paper 2 Theory

14 September 2022

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and index number on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A:
Answer **all** questions.

Section B:
Answer **all** questions. Question 13 has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

The number of marks is given in brackets [ ] at the end of each question or part question.

	For Examiner's Use	
	Section A	/50
	Q11	/10
	Q12	/10
E / O	Q13	/10
	TOTAL	/80

This document consists of **23** printed pages.

Setters: Mrs Pang FH, Ms Tan YN

[Turn over

SECTION A

Answer **all** the questions in this section.

1 Fig. 1.1 shows a man of mass 90 kg standing on a weighing scale in a lift.

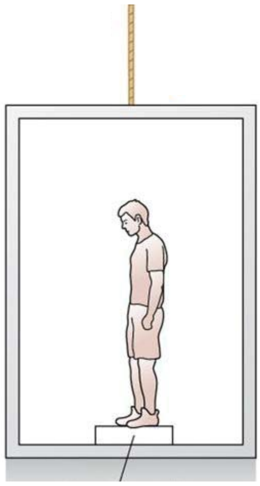


Fig. 1.1

The gravitational field strength is 10 N kg^{-1}.

(a) **(i)** On Fig. 1.1, draw and label the two forces acting on the man. [1]

(ii) Explain why the forces in **(a)(i)** are **not** an action-reaction pair.

....

....

.... [2]

(b) The lift is moving upwards at a velocity of 1.8 m s^{-1}. It then comes to a stop in a time of 0.50 s.

Determine the scale reading (in Newton) during this deceleration.

scale reading = ...[2]

2 Fig. 2.1 shows a desk lamp with the dimensions shown. The base of the lamp is circular and has a radius of 10 cm. The total weight of the light bulb and shade is 5.0 N and each of the uniform arms has weight 1.5 N.

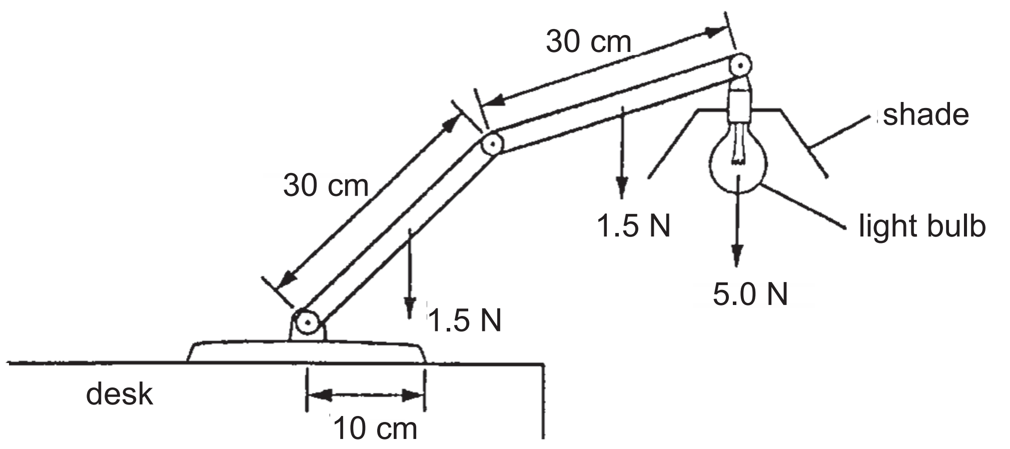


Fig. 2.1

The lamp must be constructed so that it does not topple over when fully extended as shown in Fig. 2.2. The base must be heavy enough so that the lamp will not rotate about a point X.

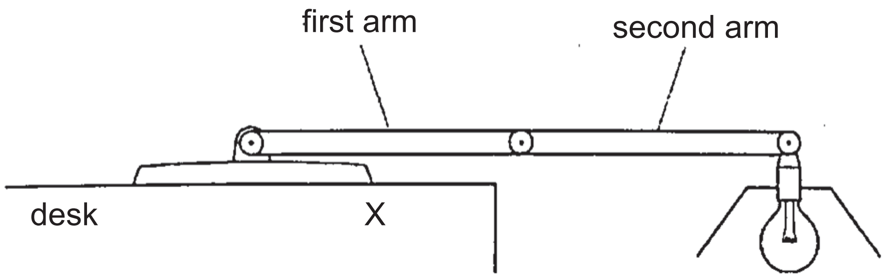


Fig. 2.2

(a) By taking moments about X, calculate the minimum weight of the base required to prevent toppling.

weight = ...[2]

(b) Explain why the lamp tends to topple over when fully extended as shown in Fig. 2.2, rather than when partially extended as shown in Fig. 2.1.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………… [2]

(c) State and explain one change that could be made to the base to increase the stability of the lamp. The weight of the base is to remain constant.

…………………………………………………………………………………………………

………………………………………………………………………………………… [1]

3 Fig. 3.1 shows a manometer that is connected to two separate containers containing pressurised gases X and Y. The pressure of both gases is much greater than the atmospheric pressure. There are two immiscible liquids A and B in the manometer, of densities 5.2 g cm^{-3} and 2.8 g cm^{-3} respectively.

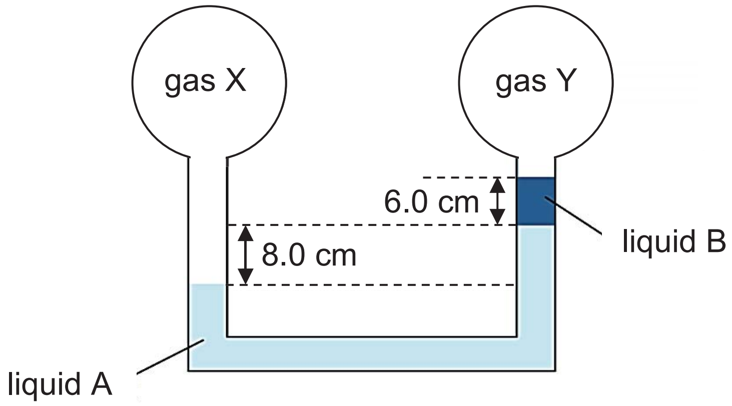


Fig. 3.1

The gravitational field strength is 10 N kg^{-1}.

(a) Explain which gas has a larger pressure.

....

.... [1]

(b) Calculate the pressure difference due to the gases.

pressure difference = ...[3]

(c) There is a crack in the container containing gas X.

State and explain what will happen to the liquid levels in the manometer.

....

....

....

.... [2]

4 An archer pulls the string of his bow and it stretches by a horizontal distance of 40 cm, as shown in Fig. 4.1. As he releases the string, an average force of 150 N acts on the arrow before it loses contact with the string.

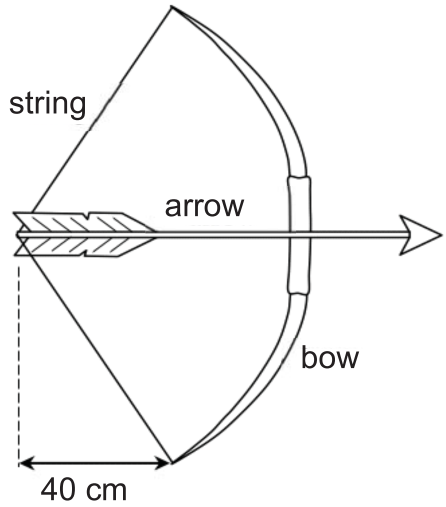


Fig. 4.1

(a) State the main energy change that occurs as he releases the string.

.... [1]

(b) Calculate the average work done on the arrow.

work done = ...[1]

(c) **(i)** The arrow has a mass of 100 g.
Calculate the speed of the arrow as it loses contact with the string.

speed = ...[2]

(ii) State two ways in which the speed in **(c)(i)** may be increased.

....

.... [2]

5 A tyre that is originally completely deflated is inflated by using a pump.

(a) Describe, using the concept of pressure, how the pump pushes the air into the tyre.

....

....

.... [1]

(b) Explain, using the kinetic model of matter,

(i) how the atmosphere exerts a pressure on the outside of the inflated tyre,

....

....

....

.... [2]

(ii) why the air inside the tyre exerts a greater pressure on the tyre than the air outside.

....

....

....

.... [2]

6 Fig. 6.1 shows the positions of a travelling wave at time t = 0 s and t = 4 s. P is a particle on the wave.

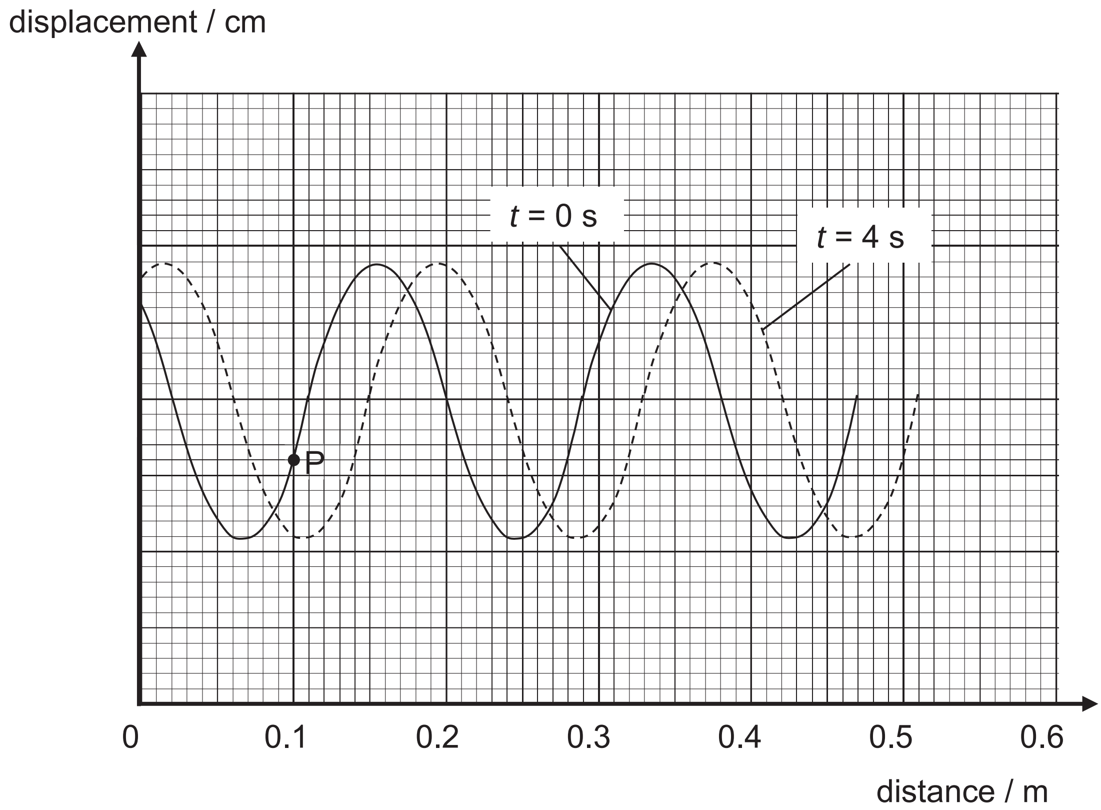


Fig. 6.1

(a) Describe the movement of P for one complete cycle, starting from t = 0 s.

....

....

....

.... [2]

(b) Determine the speed of the wave.

speed = ... [2]

7 Fig. 7.1 shows a narrow road with a plane mirror mounted at the corner of a 90° bend. Point C represents a car and point M represents a man. The image of the car seen by the man at M in the mirror is indicated by the point I.

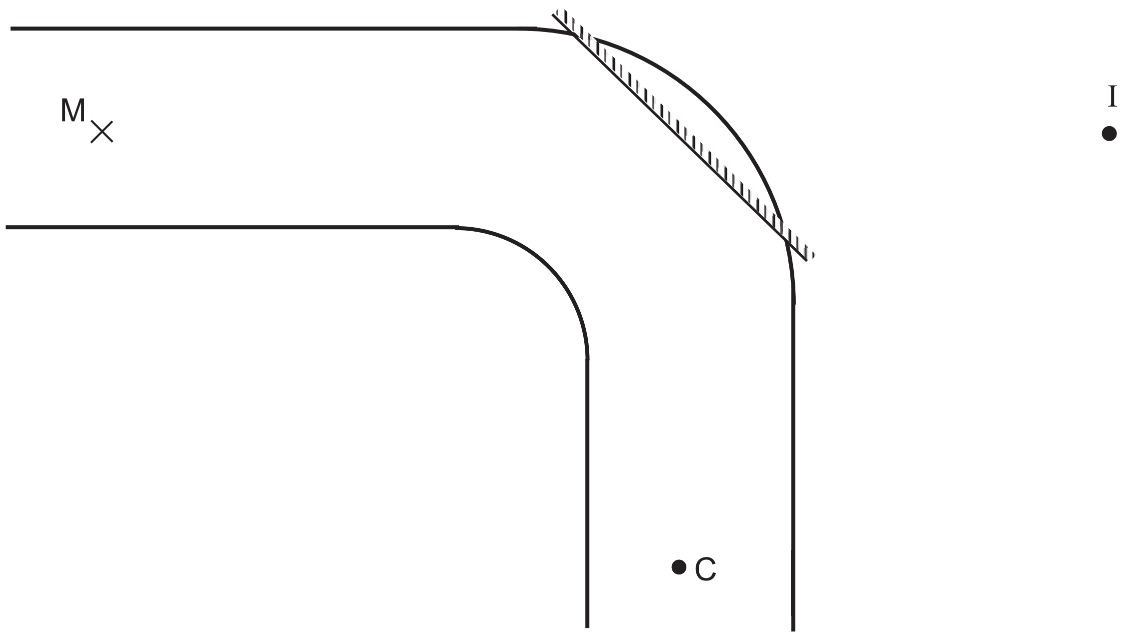


Fig. 7.1

(a) State one characteristic of the image of the car.

.... [1]

(b) Complete the following on Fig. 7.1.

(i) Draw a ray of light from C, reflected by the mirror, to the man at M. Mark and label the angle of incidence *i* and the angle of reflection *r*. [2]

(ii) Mark the position of the image of the man at M as seen by the driver of the car at C. Label this position M'. [1]

(iii) The car is travelling towards the bend. Draw an arrow at I to show the direction in which the image of the car I appears to be travelling to the man at M. [1]

8 Fig. 8.1 shows two horizontal metal plates connected to a high voltage power supply. A charged styrofoam ball is placed between the plates and is observed to be floating above the bottom plate.

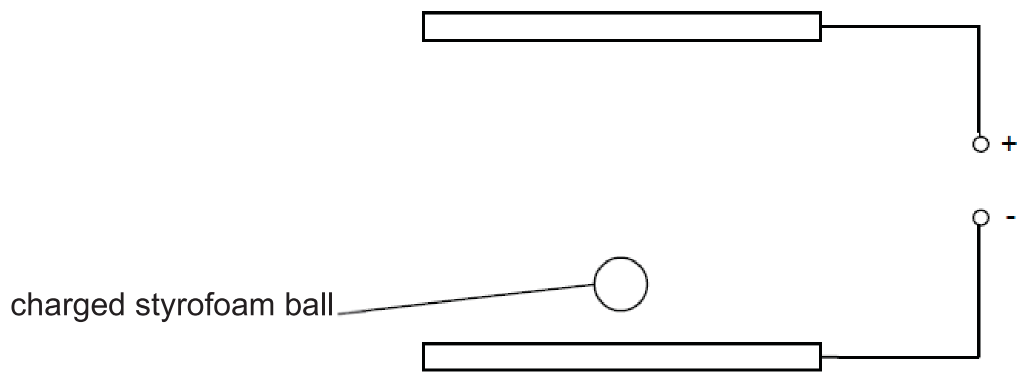


Fig. 8.1

(a) On Fig. 8.1, draw the electric field lines between the two plates. (Ignore the effect of the field lines of the charged styrofoam ball.) [1]

(b) Explain why the styrofoam ball is able to float just above the bottom plate.

....

....

.... [2]

9 A lamp is marked 240 V, 60 W.

(a) Calculate the charge that flows through the lamp in 2 hours, when it is operating at normal brightness.

charge = ...[2]

(b) Calculate the cost of switching on the lamp for 2 hours, given that the cost of electricity is \$0.25 per kWh.

cost = ...[2]

(c) In practice, the filament in the lamp gets hot and its resistance changes.

Suggest how this affects the current in the lamp and its brightness.

…………………………………………………………………………………………………….

…………………………………………………………………………………………………. [1]

10 Fig. 10.1 shows a bar magnet hanging from one end of a spring. Its N pole is just inside a vertical coil whose ends are connected to a centre-zero galvanometer.

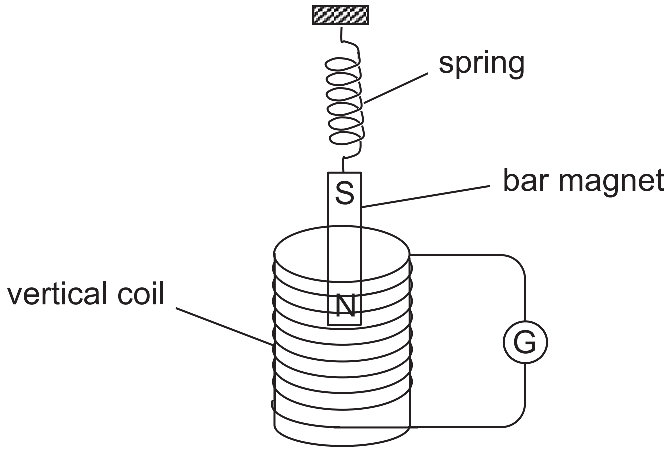


Fig. 10.1

The magnet is pulled down and released, such that the S pole stays well above the coil and only the N pole moves in and out of the coil.

(a) The galvanometer shows deflection as the magnet moves. Explain why.

....

....

....

.... [2]

(b) On the axes in Fig. 10.2, sketch a graph of the readings on the galvanometer for 5 complete oscillations of the magnet.

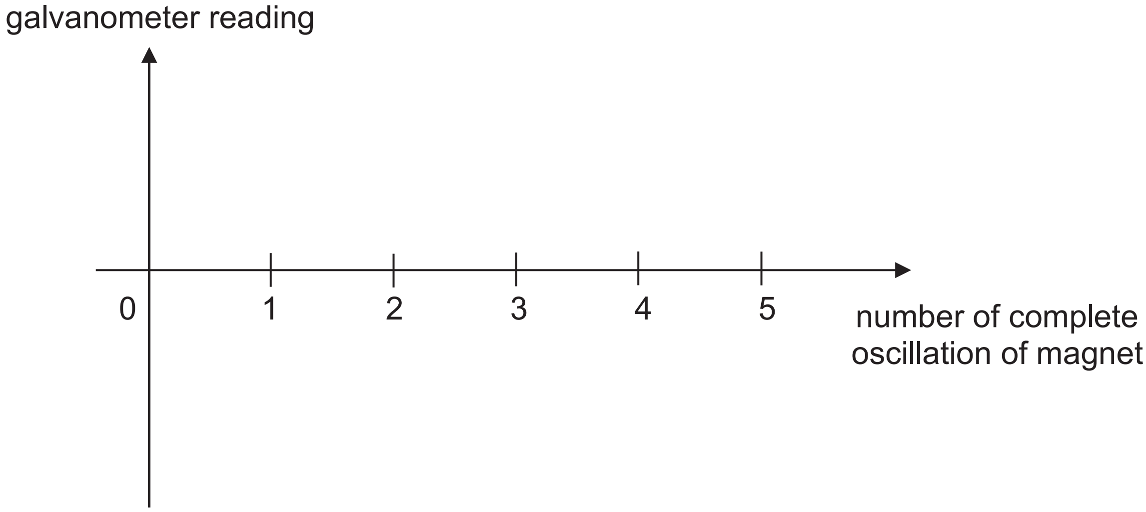


Fig. 10.2

[2]

(c) Suggest two ways to increase the galvanometer reading.

……………………………………………………………………………………………….

……………………………………………………………………………………………… [2]

SECTION B

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 13**.

11 Fig. 11.1 shows a section of the solar heating system which helps to provide water for a house. It consists of a solar collector placed outside on a roof. Water pipes are connected to the solar collector.

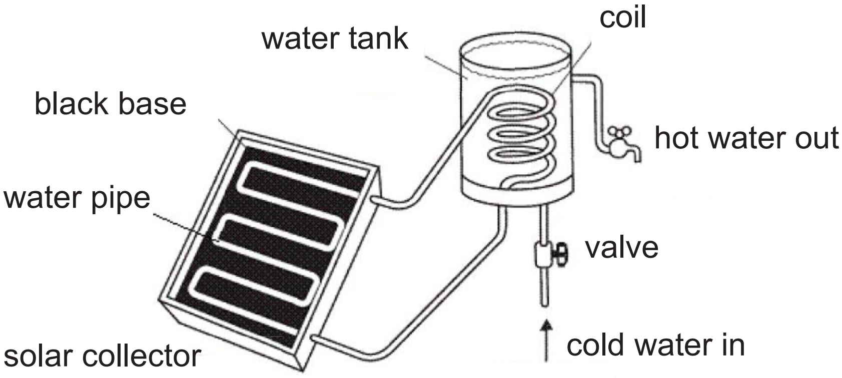


Fig. 11.1

It is found that tilting the solar collector at different angles affects the amount of energy received during different months of the year.

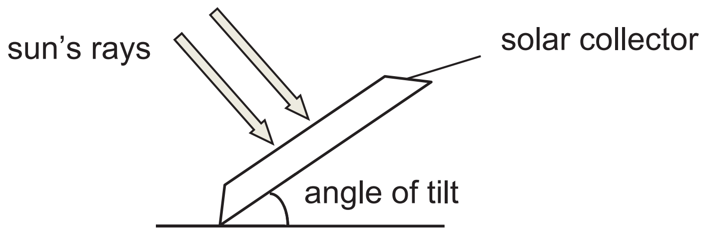


Fig. 11.2

Table 11.1 shows the results of the amount of energy in megajoules received by a 1 m^2 solar collector at different angles of tilt between the months of April and September.

Table 11.1 (Energy received in megajoules by a 1 m^2 solar collector)

	angle of tilt									
month	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
April	20.5	22.3	23.8	24.9	24.8	24.1	22.7	20.5	18.4	15.1
May	26.3	27.7	28.4	28.8	27.4	25.2	23.0	19.8	16.6	13.0
June	28.4	28.8	29.2	29.2	27.4	25.2	22.3	19.1	15.1	11.2
July	28.1	28.4	28.8	29.2	27.4	25.6	23.0	20.2	16.2	12.2
August	23.0	24.8	25.6	25.9	26.3	24.8	22.7	20.5	17.3	13.7
September	16.2	18.7	20.5	21.6	22.3	22.7	21.6	19.0	15.0	10.9

(a) State and explain two features of the solar collector that allow the heating of water in the water pipes to be more efficient.

....

....

....

.... [2]

(b) For the range of angles of tilt in Table 11.1, state, for the months from April to July,

(i) a similarity in the amount of energy received,

....

.... [1]

(ii) a difference in the amount of energy received.

....

.... [1]

(c) Determine, by calculation, whether it would be better to tilt the solar collector at an angle of 30° or 40°, between the months of June and September, in order to obtain the greatest amount of total energy.

.... [2]

(d) The amount of energy received in September seems very different from the other months. Suggest a reason for this.

....

.... [1]

(e) Fig. 11.3 shows a graph of the power generated by the solar collector on a particular day.

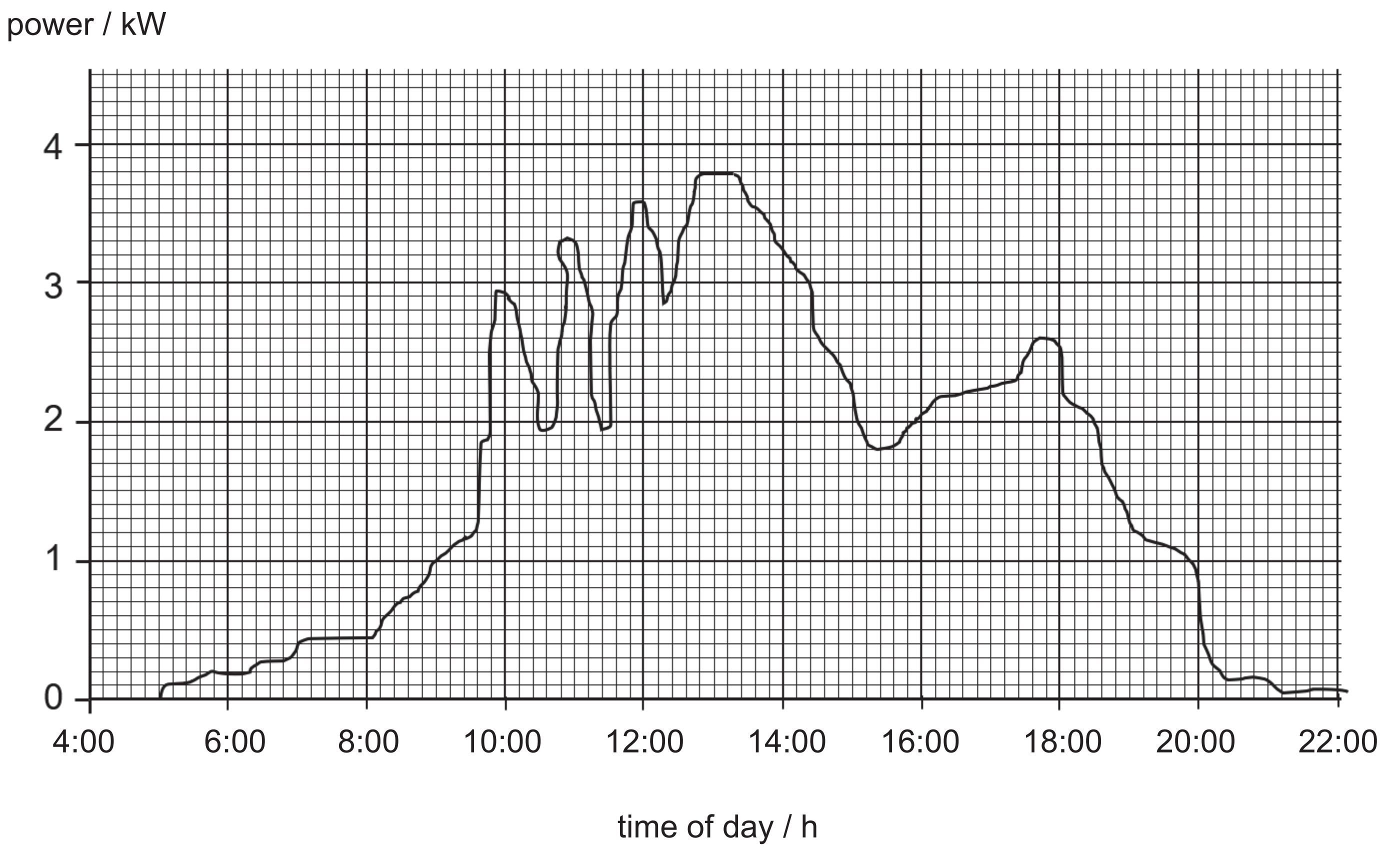


Fig. 11.3

(i) Suggest a reason for the irregular shape of the graph.

....

.... [1]

(ii) In the solar heating system, the water tank holds 30 kg of water. Calculate the maximum change in temperature of the water in the water tank between 12.55 pm and 1.05 pm. (Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$)

temperature change = ...[2]

12 Fig. 12.1 shows a simple motor that can be used to turn a fan.

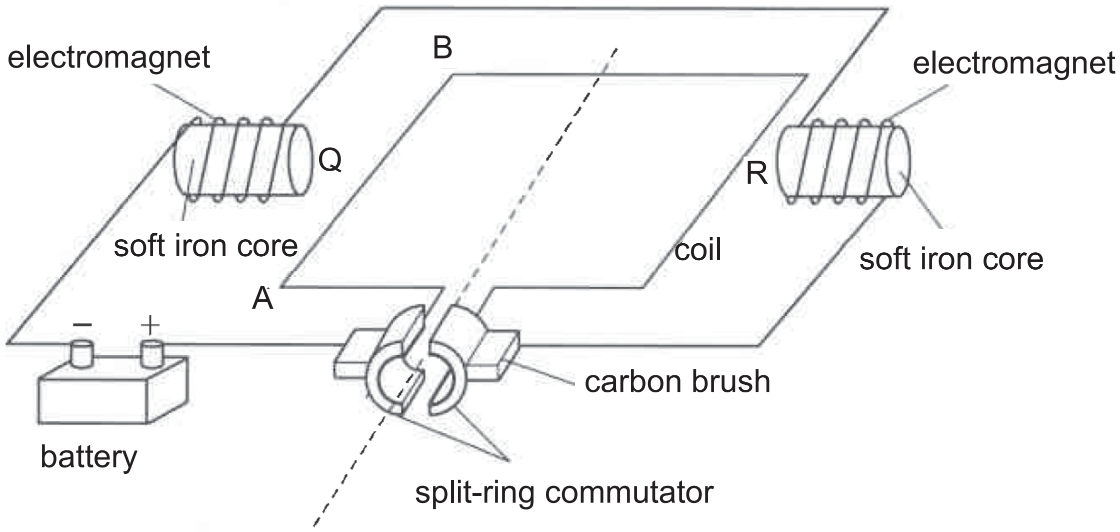


Fig. 12.1

(a) (i) State the polarity of Q and R.

.... [1]

(ii) State the purpose of the soft iron core.

....

.... [1]

(b) (i) On Fig. 12.1, draw an arrow on wire AB to show the direction of the force acting on the wire. [1]

(ii) Explain why the wire experiences a force in the direction shown in **(b)(i)**.

....

....

....

.... [2]

(iii) State two ways to increase the magnitude of the force on AB.

....

....

.... [2]

(iv) Suggest one way to change the direction of rotation of the coil.

....

.... [1]

(c) As the coil rotates by 180°, explain what happens to the

(i) current in AB,

....

.... [1]

(ii) force on AB.

....

.... [1]

13 EITHER

A student stands near the edge of a cliff. He throws a ball upwards with a velocity u, at a height h from the top of the cliff, as shown in Fig. 13.1. The ball rises vertically a short distance and then falls.

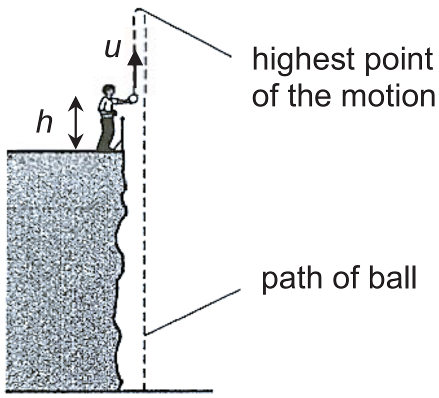


Fig. 13.1

(a) Fig. 13.2 shows the displacement-time graph and Fig. 13.3 shows part of the velocity-time graph for the first 1.0 s of the motion. Air resistance is very small in the first 1.0 s of the motion.

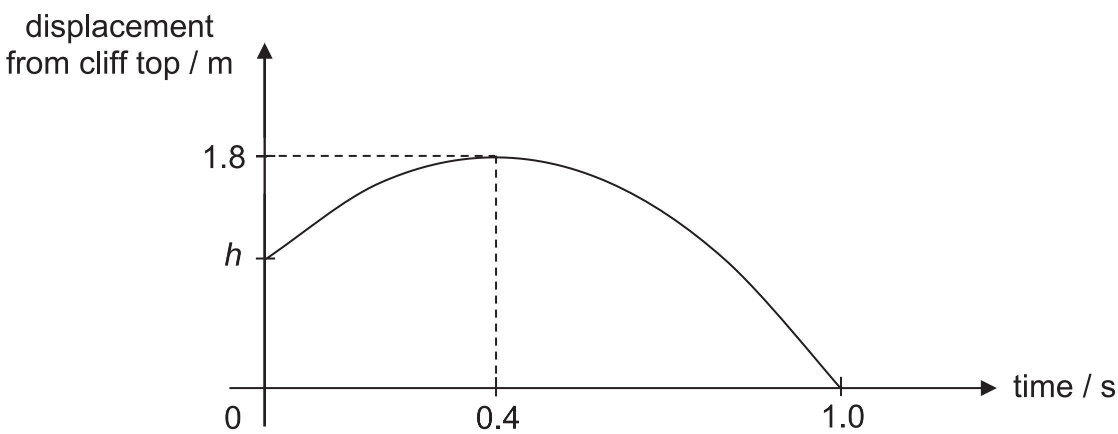


Fig. 13.2

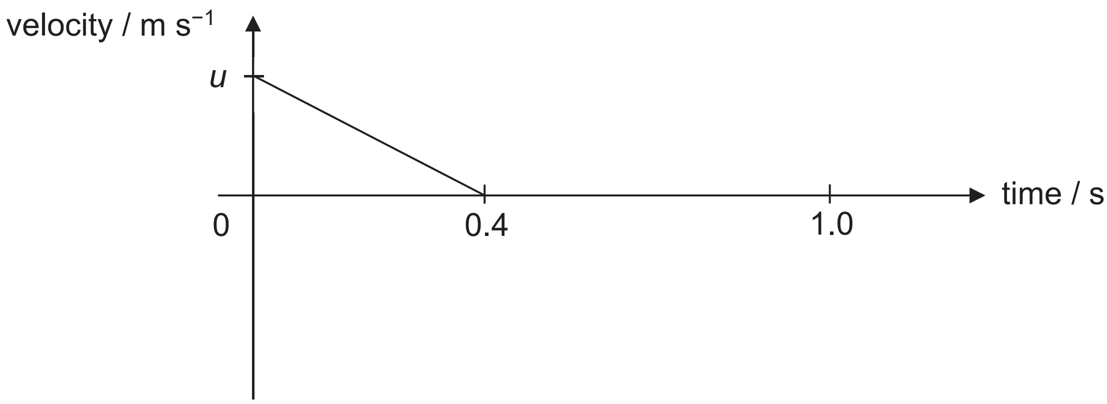


Fig. 13.3

Using Fig. 13.2, explain why the velocity is zero at 0.4 s.

....

.... [1]

(b) **(i)** On Fig. 13.3, complete the velocity-time graph for the first 1.0 s of the motion. [1]

(ii) Explain your answer to **(b)(i)**.

....

....

.... [1]

(c) **(i)** Using Fig. 13.3, determine the velocity *u*.

u = ...[2]

(ii) Hence, determine the height *h*.

h = ...[3]

(d) The ball continues to fall. The effect of air resistance becomes significant and the ball eventually falls at terminal velocity.

Describe the velocity and acceleration of the ball as it falls at terminal velocity.

....

.... [2]

OR

Fig. 13.4 shows the I / V characteristic graph of a diode.

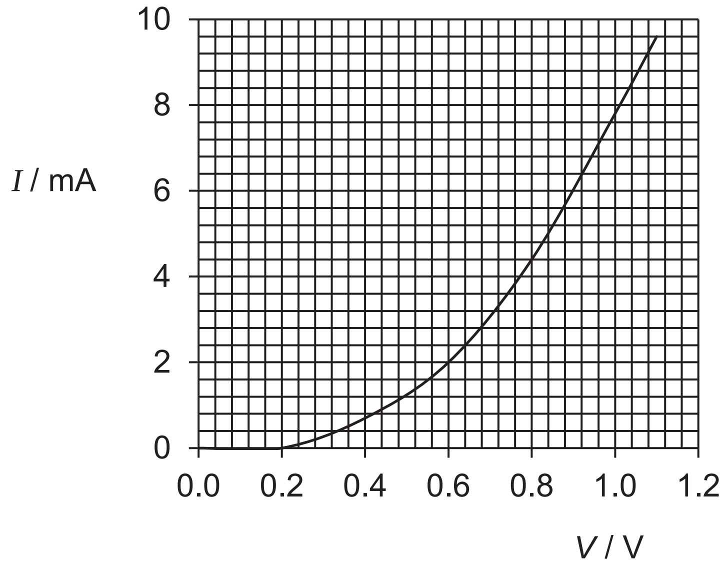


Fig. 13.4

(a) **(i)** Describe how the current and the resistance of the diode change as the voltage is increased from 0 to 1.0 V.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………[2]

(ii) Determine the resistance of the diode at 0.8 V.

resistance = ...[2]

(b) **(i)** To obtain the I / V characteristic graph, a student connects the diode to a circuit containing a 1.5 V cell and a variable resistor X, as shown in Fig. 13.5. The maximum resistance of X is 100 Ω.

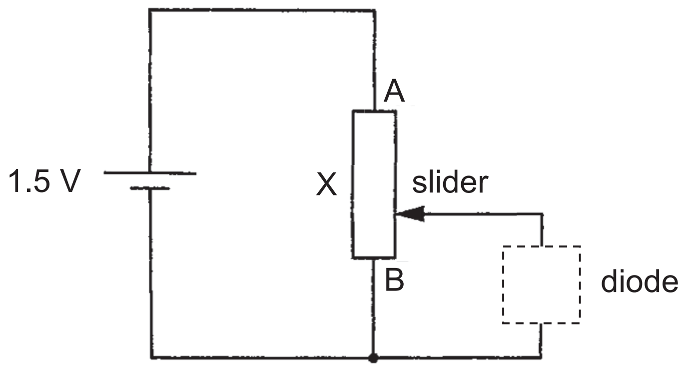


Fig. 13.5

On Fig. 13.5, complete the circuit by drawing the following electrical components:

- a diode (inside the dotted box)
- an ammeter
- a voltmeter

[2]

(ii) Explain how this circuit can be used to obtain the I / V characteristic graph of the diode.

....

....

.... [2]

(c) Using the same apparatus in **(b)**, another student sets up a circuit as shown in Fig. 13.6 instead.

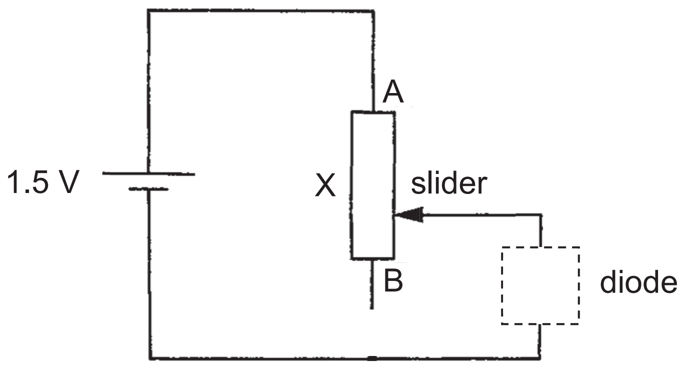


Fig. 13.6

State and explain why the circuit shown in Fig. 13.6 is inappropriate for determining the I / V characteristic graph of the diode.

....

....

.... [2]

END OF PAPER

Solutions to 2022 4E Physics Prelim Exam

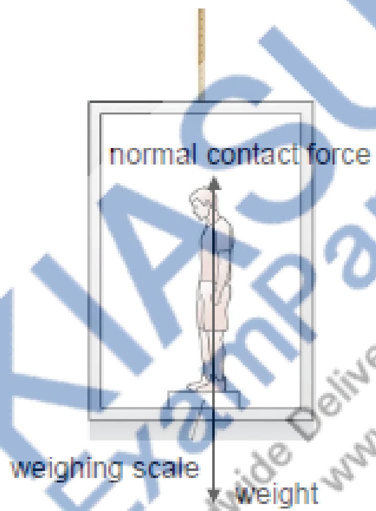
Paper 1

Multiple Choice Questions [40 marks]

1	B	11	D	21	D	31	D
2	C	12	B	22	C	32	A
3	A	13	C	23	A	33	A
4	C	14	D	24	C	34	A
5	D	15	B	25	A	35	D
6	B	16	C	26	C	36	B
7	C	17	A	27	A	37	B
8	C	18	B	28	B	38	D
9	C	19	D	29	C	39	C
10	A	20	A	30	C	40	C

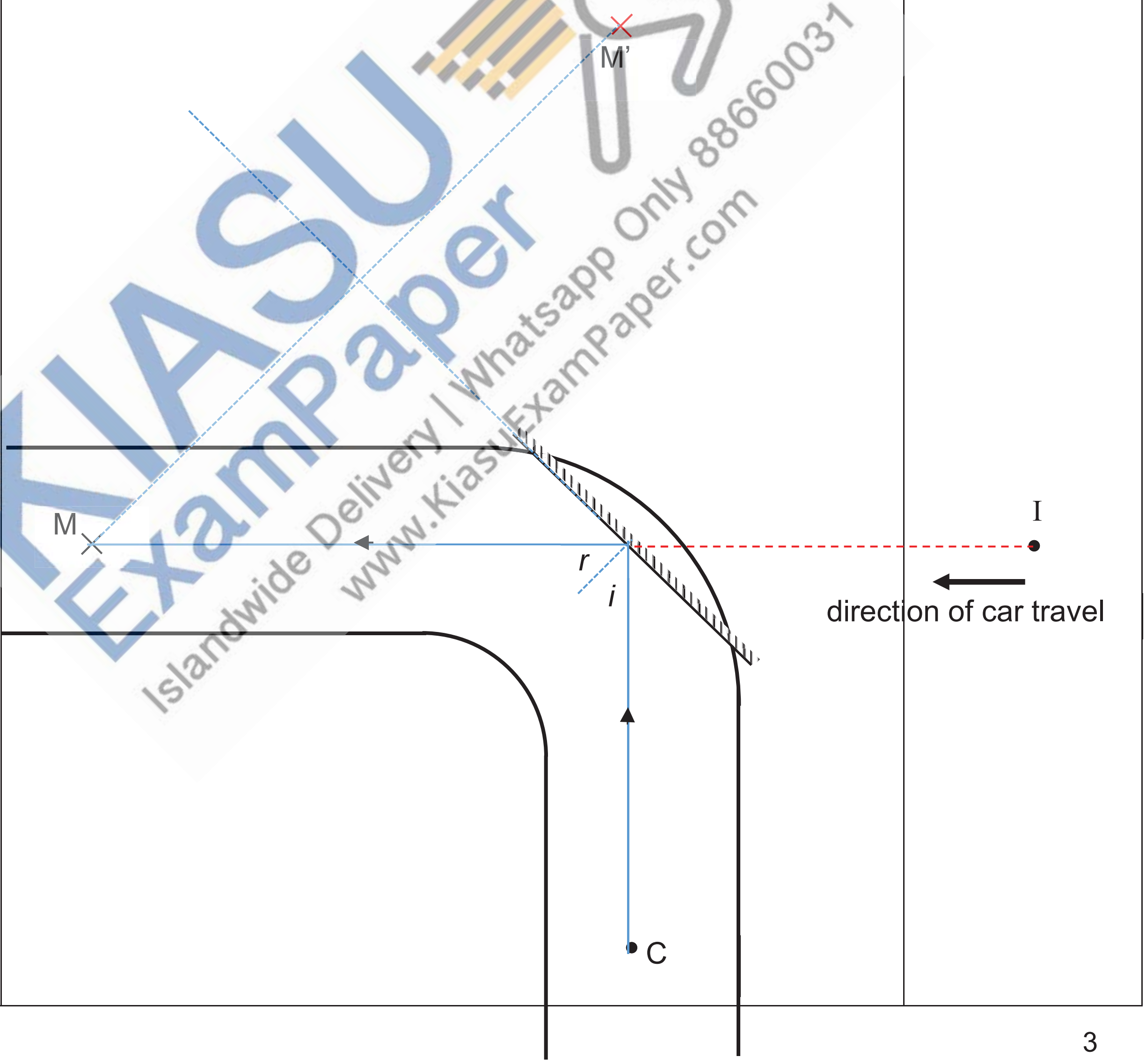
Paper 2

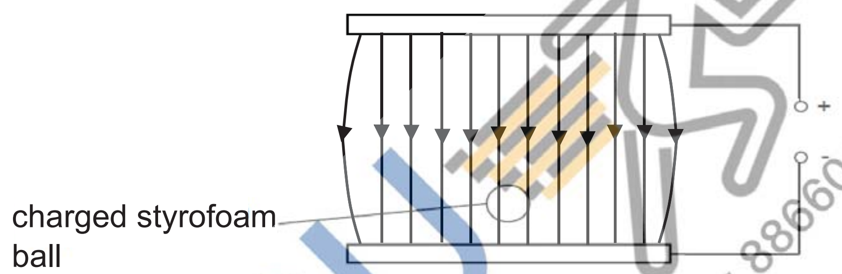
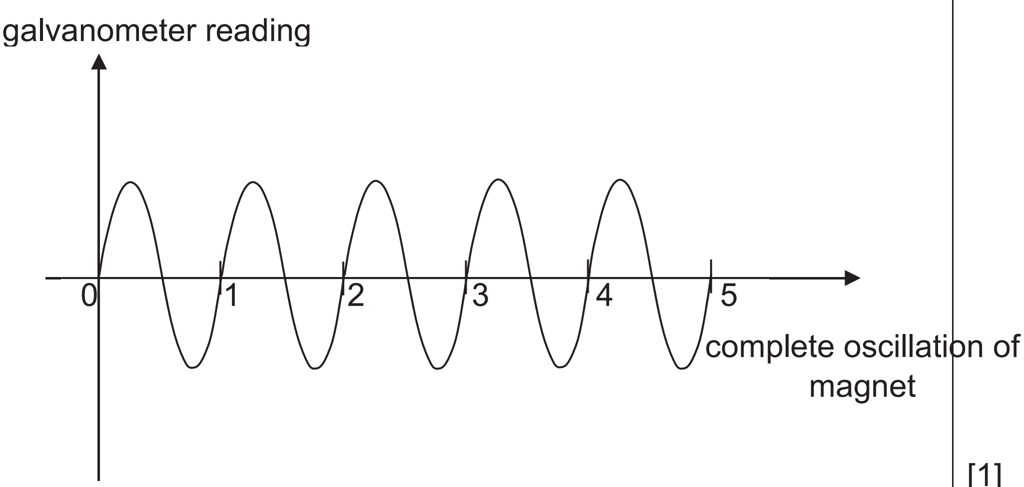
Section A: Structured Questions [50 marks]

Qn	Solution	Mark
1(a)(i)		[1]
1(a)(ii)	They are not of the same nature and they both act on the same body (man).	[2]
1(b)	$a = \frac{0 - 1.8}{0.50}$ $a = -3.6 \text{ m s}^{-2}$ $W - N = ma$ $(90 \times 10) - N = 90 \times 3.6$ $N = 576 \text{ N}$	[1] [1]

1

2(a)	Total anticlockwise moments = total clockwise moments $W \times 10 = (1.5 \times 5) + (1.5 \times 35) + (5.0 \times 50)$ $W = 31$ N	[1] [1]
2(b)	The perpendicular distances from the lines of action of the components of the weights to the pivot are maximum, creating the maximum clockwise moments about X.	[1] [1]
2(c)	The area of the base could be increased. This decreases the clockwise moment about the new point X, and increases the anticlockwise moment as well.	[1] any acceptable explanation to increase in stability
3(a)	Gas X has a larger pressure because the liquid level is lower than that exerted by gas Y.	[1]
3(b)	pressure difference = pressure difference due to the liquid levels $= (0.080 \times 5200 \times 10) + (0.060 \times 2800 \times 10)$ $= 5840$ Pa	[1] pressure due to liquid A [1] pressure due to liquid B [1] concept and answer
3(c)	Gas X will escape from the container, decreasing its pressure within the container. The liquid level on the left will increase, while the liquid level on the right will decrease.	[1] [1]
4(a)	Elastic potential energy of the string to kinetic energy of the arrow.	[1]
4(b)	Work Done = F x . d = 150 x . 0.4 = 60 J	[1]
4(c)(i)	½ m v² = 60 ½ x . 0.100 x . v² = 60 ECF for energy v = 34.6 m / s (accept 3 sf)	[1] [1]
4(c)(ii)	Pull the string a longer horizontal distance back. Use a lighter arrow.	[1] [1]
5(a)	When the pump is pushed down, the volume inside the pump decreases, and the pressure of the air in the pump increases. This air pressure in the pump is higher than the air pressure in the tyre and so the air is pushed into the tyre.	[1]
5(b)(i)	The air molecules outside the tyre are continuously bombarding the walls of the tyre. This bombardment produces a force per unit area and hence an atmospheric pressure on the tyre.	[1] [1]

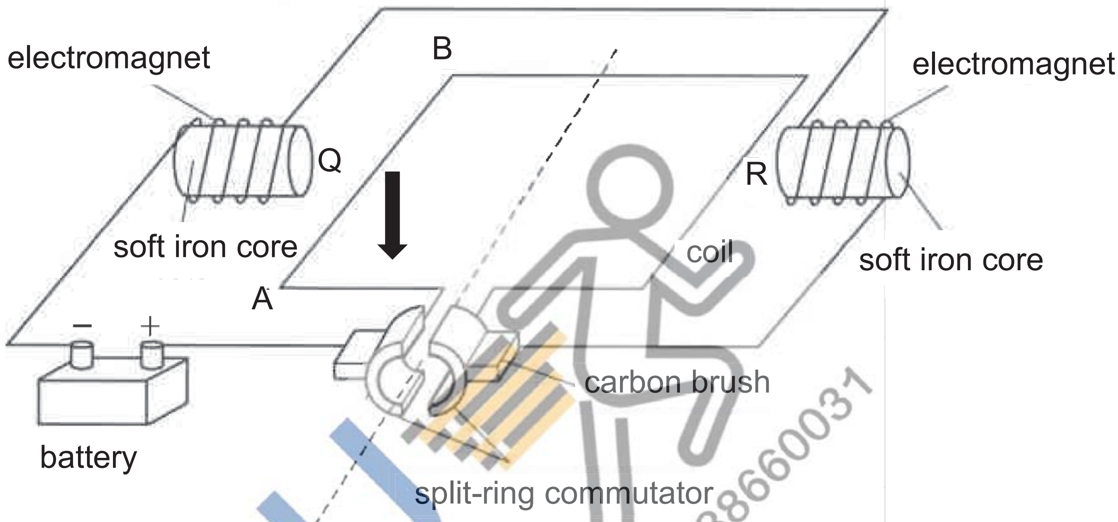
5(b)(ii)	The tyre contains more air molecules per unit volume than outside. Thus, molecular collisions with the wall are more frequent, resulting in the air inside the tyre exerting a greater pressure in the tyre.	[1] [1]
6(a)	Particle P will move downwards and reach the maximum negative displacement. It then moves upwards passing the equilibrium position and reach the maximum positive displacement. After which it moves downwards passing the equilibrium position again and back to its starting point.	[1] [1]
6(b)	wavelength, λ = **0.18 m** **(0.1/10 × 18)** $\frac{4}{18}$ of a wave takes 4 s therefore, f = $\frac{4}{18} \div 4 = \frac{1}{18}$ Hz v = fλ = $\frac{1}{18}$ x 0.18 = **0.010 ms^{-1}**	[1] [1]
7(a)	1. Virtual 2. Upright 3. Laterally inverted 4. As far behind the mirror as the object is in front 5. Same size	[1] any one
7(b)		

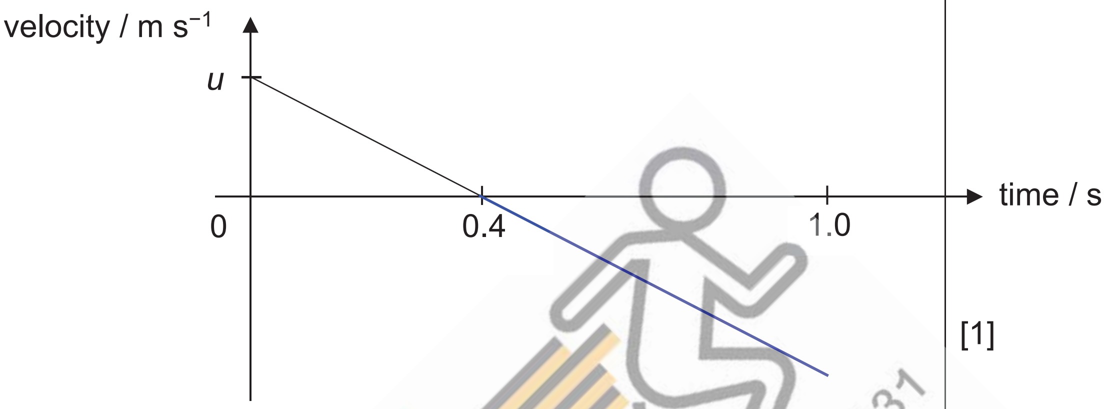
	Correct ray drawn with arrows, label *i* and *r* Correct position of M' (equal perpendicular distance from mirror as M) Correct direction of car travel	[2] [1] [1]
8(a)	Correct direction and shape of electric field 	[1]
8(b)	The ball is negatively charged. Upward electric force balances its downward weight	[1] [1]
9(a)	$V = \frac{W}{Q}$ $240 = \frac{60 \times 2 \times 3600}{Q}$ $Q = 1800\ \text{C}$	 [1] [1]
9(b)	$\text{cost} = \frac{60}{1000} \times 2 \times \$0.25$ = \$0.03	[1] [1]
9(c)	The resistance of the lamp increases. Hence, the current decreases and the brightness decreases as well.	[1]
10(a)	When the magnet moves, its lines of magnetic flux are being cut by the coil, and so a current is induced in the coil which causes the deflection of the pointer of the galvanometer.	[1] [1]
10(b)	 [1] correct shape, starting at zero [1] 1 complete cycle for one oscillation of the magnet	[1] [1]

10(c)	1. Use a stronger magnet 2. Use a coil with more turns per unit length 3. Insert the magnet in and out of the coil at a faster rate	[1] [1] Any two ways

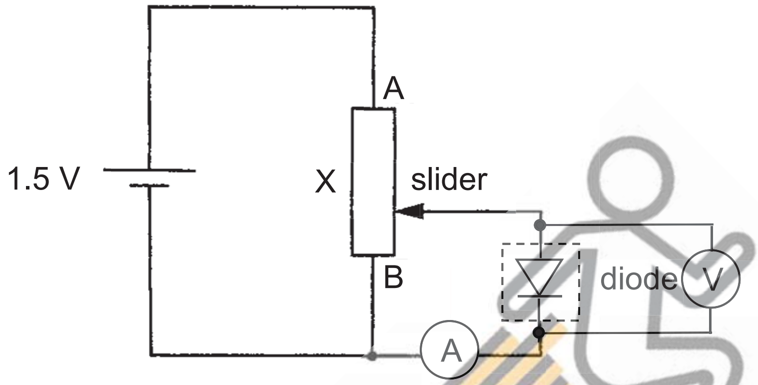
Section B: Structured Questions [30 marks]

Qn	Solution	Mark
11(a)	The base of the solar collector is painted black. Black is a good absorber of infra-red radiation and is able to absorb radiation from the Sun to heat up the water pipes. The water pipes have a loop design. The loops increase the surface area of absorption of radiation to heat up the water pipes.	[1] [1]
11(b)(i)	1. The amount of energy received increases with the angle of tilt from 0° to 30° and decreases from 30° to 90°. 2. At angle of tilt of 90°, the energy received is less than 16 MJ (the lowest in all the 4 months) 3. At angle of tilt of 30°, the energy received is the highest in all the months April to July	[1] any one reasonable similarity
11(b)(ii)	1. At angle of tilt of 0°, the energy received is much higher of more than 25 MJ for May to July but not April 2. For every 10° increase in the angle of tilt, the amount of increase or decrease in energy received is not the same for each month.	[1] any one reasonable difference
11(c)	At 30°, the sum of energy received from June to Sept is 29.2 + 29.2 + 25.9 + 21.6 = 105.9 MJ At 40°, the sum of energy received from June to Sept is 27.4 + 27.4 + 26.3 + 22.3 = 103.4 MJ Hence 30° is a better tilt angle as the collector will receive the most energy	[1] [1]
11(d)	It could be a cloudy / rainy month with not much solar energy received.	[1] accept any reasonable answer
11(e)(i)	The amount of solar energy received depends on the weather (amount of daylight), any clouds cover above the collector	[1]
11(e)(ii)	Energy output of the solar collector = 3.8 kW × 10 min × 60 = 2.28 MJ Energy output = $mc\Delta\theta$ $2.28 \times 10^6 = 30 \times 4200 \times \Delta\theta$ $\Delta\theta$ = 18.1°C	[1] [1]
12(a)(i)	Q is north pole and R is south pole	[1] for both correct
12(a)(ii)	The soft iron core will concentrate the magnetic field lines and increase the magnetic field strength of the solenoid.	[1]

12(b)(i)	 Correct downwards direction	[1]
12(b)(ii)	There is a combined magnetic field between that due to the two electromagnets and that due to the current carrying conductor AB. The resultant magnetic field above AB is stronger and the resultant magnetic field below AB is weaker. The difference between the magnetic field strength around the wire AB causes a net force to act on the wire downwards.	[1] [1]
12(b)(iii)	Increase the strength of the magnetic field by the electromagnets (increase the number of turns per unit length), and increase the current flowing through the wire AB (increase the voltage of the battery).	[1] [1]
12(b)(iv)	Switch the polarity of the magnets by reversing windings on the solenoid (Not acceptable - switching the polarity of the battery)	[1]
12(c)(i)	The split-ring commutator changes its contact position with the carbon brushes and so reverses the direction of the current flowing in AB.	[1]
12(c)(ii)	With the direction of the current flowing in AB reversed, the force acting on AB is reversed.	[1]
EITHER		
13(a)	The gradient of the displacement-time graph at 0.4 s is zero, which shows that the velocity is zero.	[1]

13(b)(i)		[1]
13(b)(ii)	The acceleration remains constant as the ball continues to fall with negative velocity.	[1] any reasonable answer
13(c)(i)	gradient $= -10$ $\frac{u-0}{0-0.4} = -10$ $u = 4.0 \text{ m s}^{-1}$	[1] [1]
13(c)(ii)	distance moved upwards = area under graph from 0 s to 0.4 s $= \frac{1}{2} \times 0.4 \times 4.0$ $= 0.80 \text{ m}$ $h = 1.8 - 0.80$ $h = 1.0 \text{ m}$	[1] [1] [1]
13(d)	The velocity remains constant and the acceleration is zero.	[2]
OR		
13(a)(i)	From 0 to 0.2 V, the current is zero and so the resistance of the diode is infinite. From 0.2 V to 1.0 V, the current increases at an increasing rate (with respect to p.d.) and the resistance of the diode decreases.	[1] [1]
13(a)(ii)	$R = \frac{0.8}{4.4 \times 10^{-3}}$ $R \approx 182 \ \Omega$	[1] [1]

7

13(b)(i)		[1] diode [1] ammeter and voltmeter
13(b)(ii)	When the slider is placed at B, the p.d. across the diode is zero and the current flowing through it can be measured. As the slider is moved towards A, the p.d. across the diode increases to 1.5 V and the corresponding current values can be measured.	[1] [1]
13(c)	The resistance of the variable resistor X is too small. As the slider moves towards B, there could be no common value of current flowing through both X and the diode.	[1] [1] Accept any other reasonable answer.

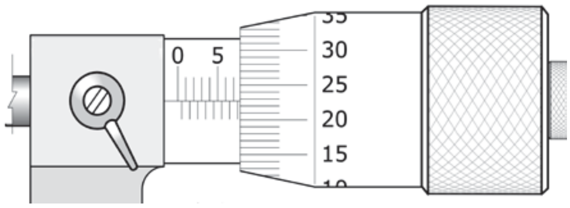
Answer all questions on the optical mark sheet.

1 The light year is defined as the distance light travels in 1 year. There are 365 days in 1 year.

Which of the following is the nearest estimate of 1 light year?

A 100 Gm **B** 1 000 Gm **C** 10 000 Gm **D** 10 000 000 Gm

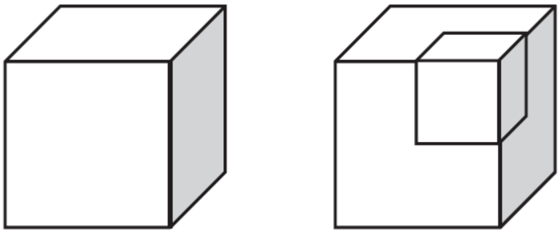
2 The diagram below shows the reading on a micrometer screw gauge.



What is the reading on the micrometer screw gauge?

A 7.22 mm **B** 7.72 mm **C** 7.22 cm **D** 7.72 cm

3 A cube of mass 5.0 kg with sides 0.20 m long has a cube of sides 0.10 m cut from its corner as shown.



What is the density of the remaining section of the cube?

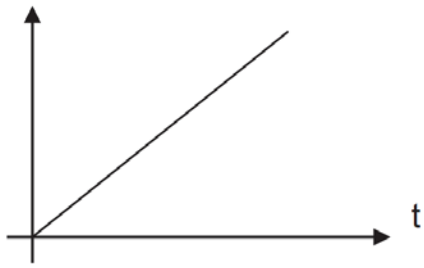
A 25 kg/m^3 **B** 547 kg/m^3 **C** 625 kg/m^3 **D** 714 kg/m^3

4 A bullet is fired towards a nearby tree trunk with a speed of 200 m/s. The bullet is found at a depth of 0.05 m in the tree trunk.

What is the time taken by the tree to stop the bullet in its trunk?

A 5×10^{-2} s **B** 5×10^{-3} s **C** 5×10^{-4} s **D** 5×10^{-5} s

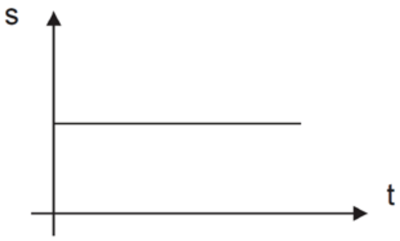
5 The following graph shows the velocity-time graph of a body.



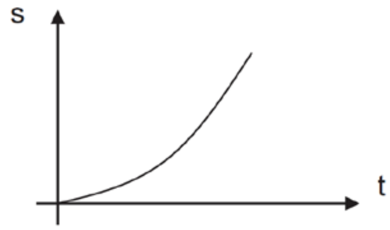
Which of the following graphs shows the correct displacement-time graph of the body?

A

A

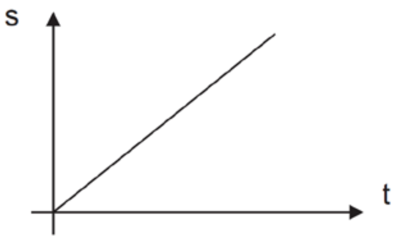


B

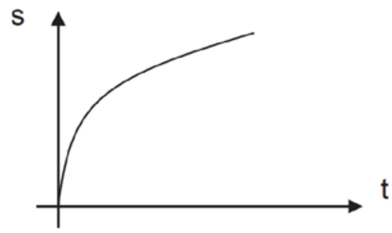


C

B



D



6 A ball rolling across a field will slow down and eventually stop because

A inertia will cause all objects to remain in a state of rest.

B there is no net force acting on the ball.

C there is a force that acts in the direction opposite its motion.

D the ball has no energy since there is no work done on the ball.

7 A 2000 kg car travelling at a constant velocity of 25 m/s encounters a total resistive force of 50 kN. You may assume that there are no other horizontal forces acting on the car.

Which of these relationships describes the driving force *F* provided by the engine?

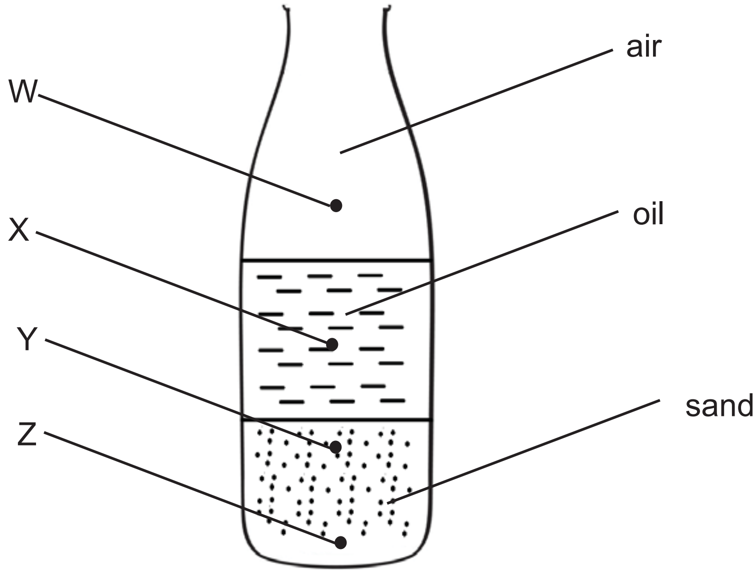
A $F = 0$ N **B** $F < 50$ kN **C** $F = 50$ kN **D** $F > 50$ kN

8 A pellet of mass 50 mg is fired vertically upwards and reaches a height of 1000 m.
The gravitational field strength *g* is 10 N/kg.

What is the total energy at the highest point?

A 0 J **B** 0.5 J **C** 500 J **D** 500 000 J

9 The diagram shows a bottle containing air, oil and sand.



More sand is added to the bottle. This affects the position of the centre of gravity of the bottle and its contents.

How might the centre of gravity move?

A from X towards W

B from W towards X

C from Y towards X

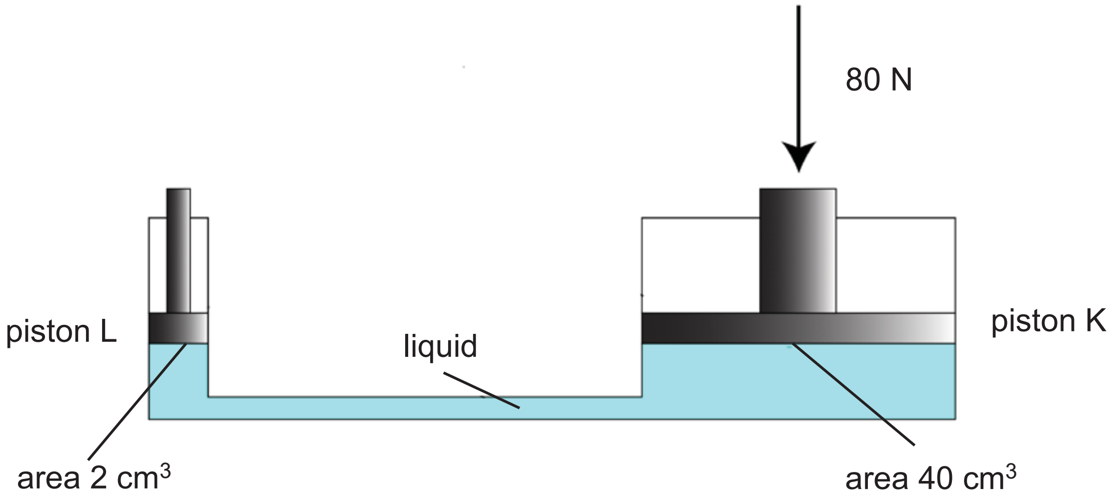
D from Y towards Z

10 A rectangular box of dimensions 4.0 m by 2.0 m by 3.0 m weighs 50 N.

What is the minimum pressure it can exert on the surface it rests on?

A 2.1 Pa **B** 4.2 Pa **C** 6.3 Pa **D** 8.3 Pa

11 The diagram shows the cross-section of a hydraulic jack. Piston K is supporting a weight of 80 N. The liquid in the hydraulic jack is not compressible.



Which of the following statements is correct?

A The force at piston L is 1600 N.

B Piston K will move a longer distance than piston L.

C The pressure at piston K and piston L is the same.

D The pressure at piston K is lower than at piston L.

12 A man lies on a bed of needles. The number of needles is doubled.

What row describes the change on force on the man and the pressure at the contact?

	force on man	pressure at contact
A	doubled	remains the same
B	remains the same	halved
C	doubled	doubled
D	remains the same	remains the same

[Turn Over

13 Illuminated smoke particles, suspended in air, are viewed through a microscope. They appear to move randomly.

Which of the following best describes the conversion or transfer of energy that takes place?

A kinetic energy of air molecules → kinetic energy of smoke particles

B potential energy of air molecules → kinetic energy of smoke particles

C heat energy from source → kinetic energy of smoke particles

D light energy from source → kinetic energy of smoke particles

14 Which of the following statements is true when the temperature of a solid is raised?

A The mass of the solid increases as the volume increases

B The molecules expand and the solid occupies a greater volume.

C The molecules in the solid start to slide past each other at a greater speed.

D Heat travels to all parts of the solid in the form of kinetic energy of the molecules.

15 A gas in the process of condensation.

Which of the following statements best describes what happen to the gas?

A It will take in heat in order to break the intermolecular forces.

B It will give off heat because intermolecular forces are forming.

C It will give off heat because its molecules are losing kinetic energy.

D It will not give off or take in any heat because there is no change in temperature.

16 Blowing across the surface of a bowl of hot soup will cause it to cool.

Which of the following statements best explains this observation?

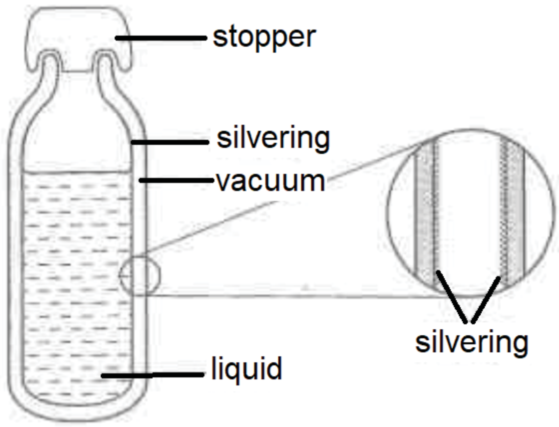
A Convection cannot occur without blowing.

B Blowing across the surface allows more evaporation to take place.

C Blowing across the surface increases the surface area for radiation.

D Still air is a poor conductor of heat but moving air is good conductor of heat.

17 The diagram shows a vacuum flask and an enlarged view of a section through the flask wall.



Which of the following best explains why the silvering is needed in reducing heat loss of the liquid in the flask?

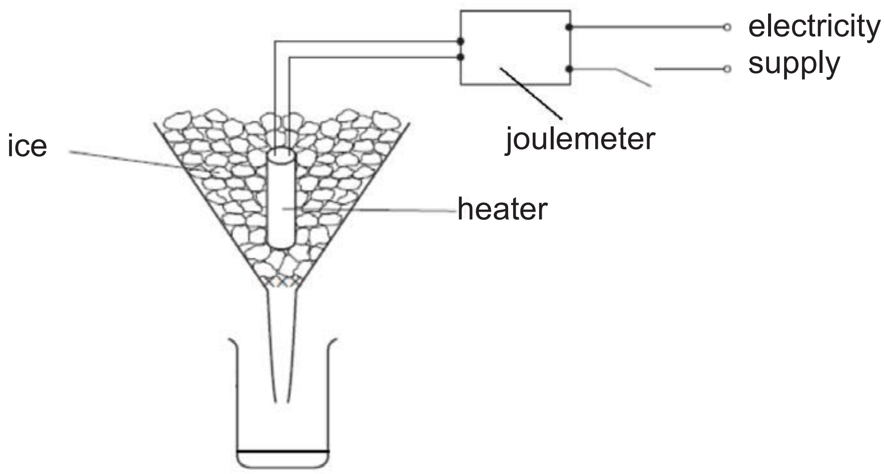
A silver surfaces are poor absorbers of radiation

B silver surfaces are good absorbers of radiation

C silver surfaces are poor emitters of radiation

D silver surfaces are good emitters of radiation

18 In the experiment shown below, the amount of electrical energy used to melt some ice is measured using a joulemeter.



What is needed to find the specific latent heat of fusion?

A the final temperature of water

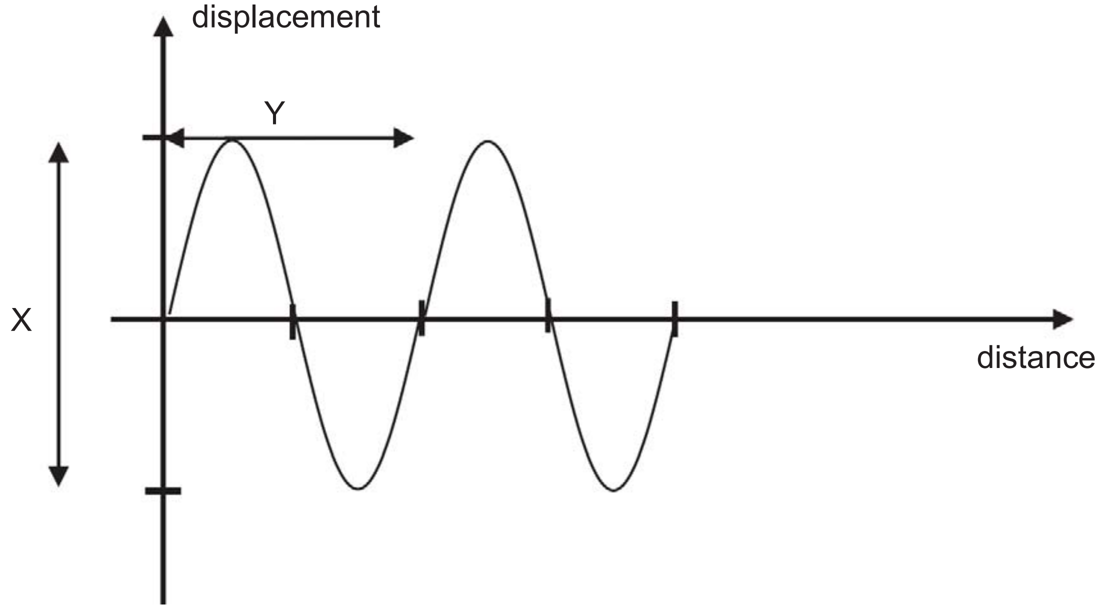
B the temperature change of ice

C the voltage of the electricity supply

D the mass of water produced by the melting ice

 [Turn Over

19 The diagram shows a graph of wave motion.



What information can you deduce from the graph?

A The amplitude of the wave is X.

B The amplitude of the wave is X/2.

C The period of the wave is Y.

D The period of the wave is Y/2.

20 A wave moves across the surface of the water in a ripple tank. In 1.0 minute, a wavefront moves 12 wavelengths.

What is the frequency of the wave?

A 0.20 Hz **B** 2.5 Hz **C** 5.0 Hz **D** 12 Hz

21 The critical angle of a medium is 45^{o}.

What is the refractive index of the medium?

A 0.71 **B** 1.00 **C** 1.33 **D** 1.41

22 An object is placed 12 cm from a lens of focal length 8 cm.

Which of the following best describes the property of the image?

A real, inverted, diminished

B real, inverted, magnified

C real, upright, magnified

D virtual, upright, diminished

23 The refractive index of water is 1.33.

What is the speed of light in water?

A 7.5×10^7 m/s **B** 2.25×10^8 m/s **C** 3.00×10^8 m/s **D** 4.00×10^8 m/s

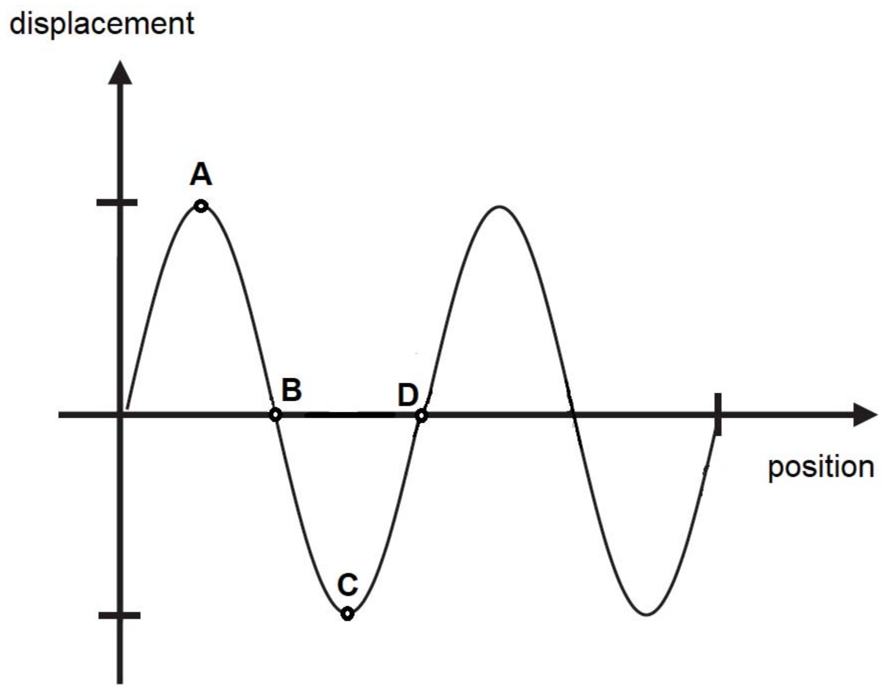
24 A boy shouts on a mountain and hears the echo from the nearest neighbouring mountain after 2.0 s. The speed of sound in air is 300 m/s.

How far is the neighbouring mountain from the boy?

A 75 m **B** 150 m **C** 300 m **D** 600 m

25 The diagram shows a graph which describes a longitudinal wave, with right defined as the positive direction.

Which is a center of compression?



 [Turn Over

26 Which of the following observation/s shows that an unknown material X is a magnet?

I A current carrying wire is wound around X deflected a compass needle.

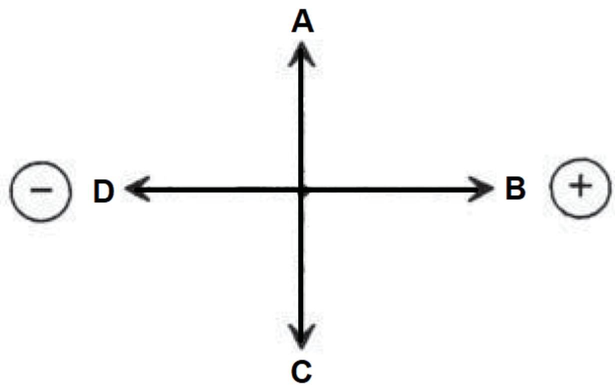
II A North pole of a permanent magnet will attract X.

III A South pole of a permanent magnet will repel X.

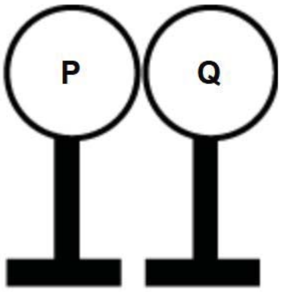
A **I** and **III** only **B** **II** and **III** only **C** **I** and **II** only **D** **III** only

27 The diagram shows two charges placed near to each other.

In which direction will the electric field act?



28 The diagram shows two insulated metal spheres P and Q touching each other. The following steps are carried out in succession on both spheres.



Step 1: Bring a positively charged rod near to sphere P on the left.

Step 2: Earth sphere Q momentarily.

Step 3: Separate sphere P and Q.

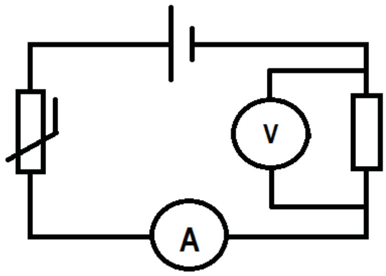
Step 4: Remove the positively charged rod.

What are the final charges on sphere P and Q?

	charge on sphere P	charge on sphere Q
A	positive	positive
B	positive	neutral
C	negative	neutral
D	negative	negative

[Turn Over

29 A resistor and a thermistor are connected in series with a cell, as shown.

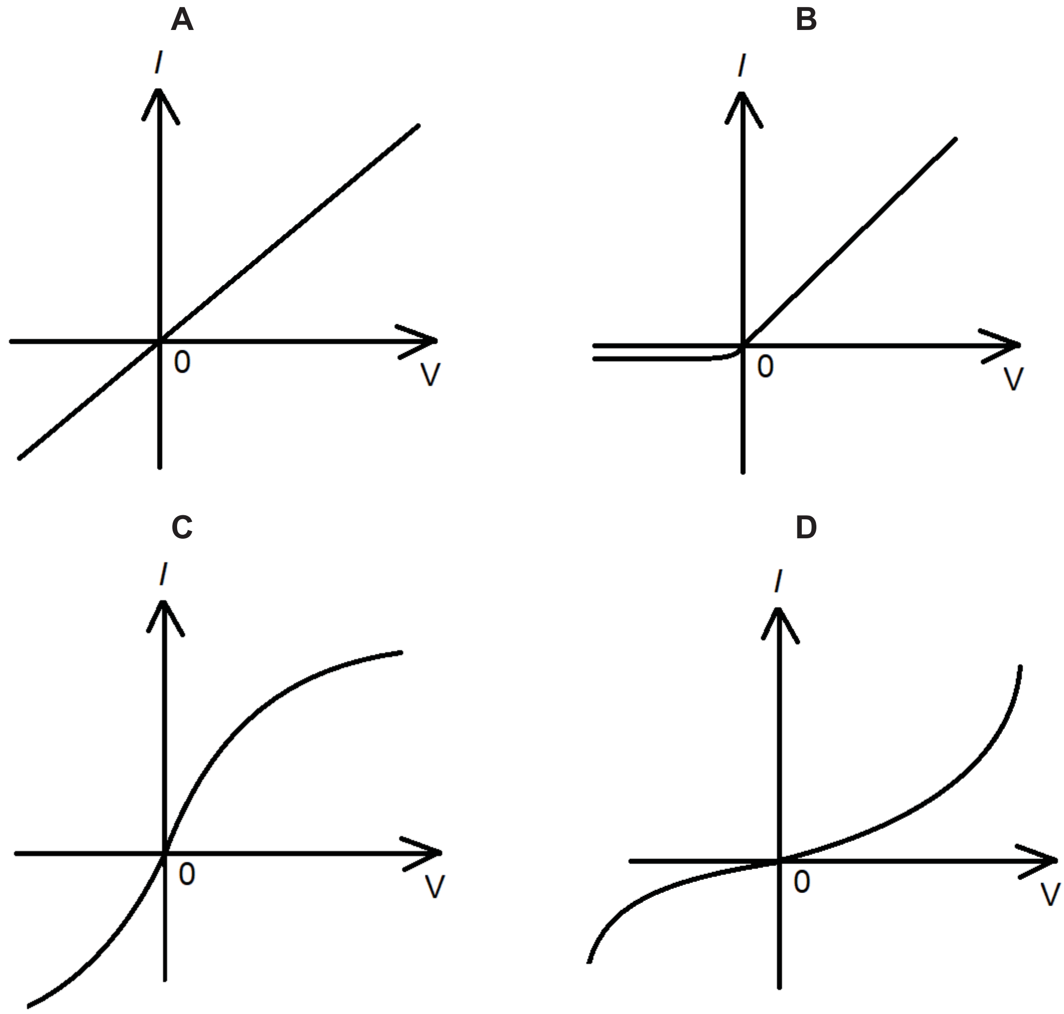


The thermistor is exposed to high temperature, the readings on both ammeter and voltmeter change.

How do they change?

	reading on ammeter	reading on voltmeter
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

30 Which graph shows the *I* / V characteristics for a semiconductor diode?



31 A wire has resistance R. Another wire has a length that is half as long with twice the diameter of the original wire. Both wires are made of the same material.

What is the resistance of the new wire?

A (R / 8) **B** (R / 4) **C** R **D** 2R

32 A battery moves a charge of 60 C around a circuit in a time of 15 s.

What is the current in the circuit?

A 900 A **B** 240 A **C** 4.0 A **D** 0.25 A

33 A heater is marked 240 V, 1.2 kW.

Which fuse rating is suitable for the heater?

A 5 A **B** 7 A **C** 12 A **D** 20 A

34 The cost of a unit (kWh) of electricity is 24 cents.

What is the cost, to the nearest cent, to turn on a 0.5 kW computer for 30 minutes?

A \$ 0.06 **B** \$ 3.60 **C** \$ 21.60 **D** \$ 60.00

35 A current of 4 A flows in the live wire of a socket when the appliance is functioning normally.

Which of the following statements is true?

A A current of 4 A flows in the neutral wire.

B A current of 4 A flows in the earth wire.

C A current of less than 4 A flows in the neutral wire.

D A current of less than 4 A flows in the earth wire.

36 The electric light switch for a bathroom is sometimes fitted on wall outside the bathroom.

Why is this safer than fitting the switch on the wall inside the bathroom?

A The heat from the light affects the switch.

B The switch is less likely to be damaged outside the bathroom.

C The warm air in the bathroom causes the switch to overheat.

D The person in the bathroom may be electrocuted if the user touches the switch with wet hands.

37 Which of the following statement best expains why a magnet will attract a piece of soft iron?

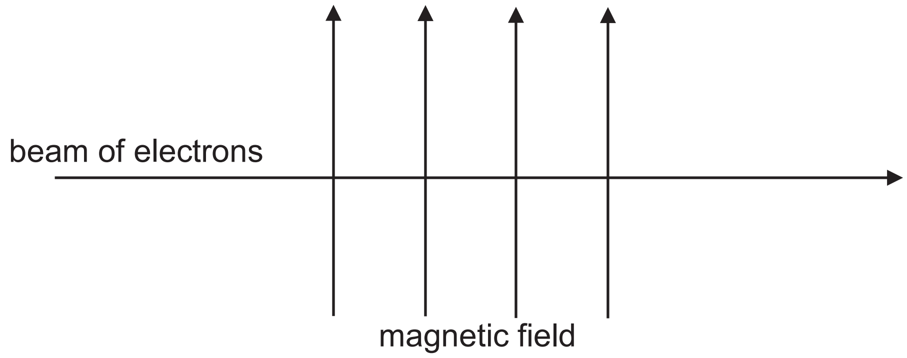
A The piece of soft iron becomes an induced magnet.

B The piece of soft iron becomes a temporary magnet.

C The piece of soft iron becomes a permanent magnet.

D An induced current will flow in the piece of soft iron.

38 The diagram shows the direction of a beam of electrons passing through a magnetic field.



In which direction will the beam of electrons deflect?

A into the page

B out of the page

C up towards the top of the page

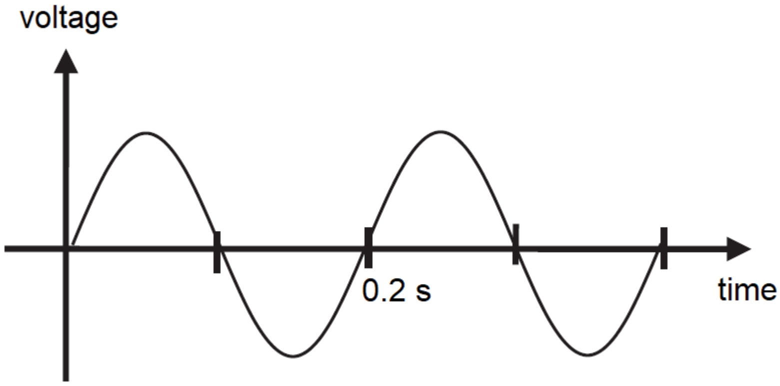
D down towards the bottom of the page

39 An a.c. input of 240 V is connected to the primary coil of an ideal transformer. The output current is 6 A.

Which of the following is a possible combination of the input current and output voltage?

	input current	output voltage
A	12 A	120 V
B	480 A	24 V
C	1 A	40 V
D	0 A	0 V

40 An ac generator produces an output voltage as shown in the diagram.



Which of the following best describes the changes if the generator is turned twice as fast?

	output voltage	period
A	doubles	doubles
B	halves	doubles
C	doubles	halves
D	unchanged	doubles

END OF PAPER

For examiner's use

SECTION A [50 marks]

Answer **all** questions in this section.

1 A car describes a linear motion represented by the graph shown in Fig.1.1.

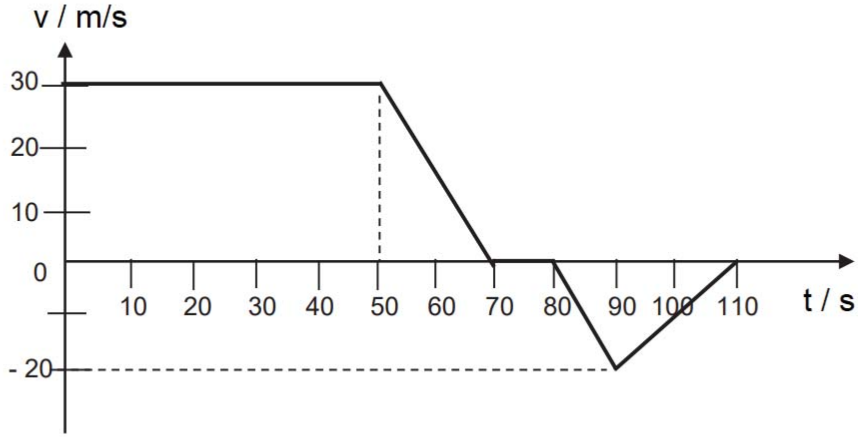


Fig. 1.1

(a) **(i)** Describe the motion of the car from t = 50 s to 90 s.

………………………………………………………………………..

………………………………………………………………………..

………………………………………………………………………..

……………………………………………………………………….. [2]

(ii) Calculate the deceleration of the car from t = 50 to 70 s.

deceleration = …………… [2]

(b) Calculate the total displacement of the car for the whole journey.

total displacement = …………… [2]

 [Turn Over

For examiner's use

(c) On Fig. 1.2, sketch the displacement-time graph for the car's motion from t = 0 s to t = 80 s. Indicate all relevant values on the graph.

Fig. 1.2

[2]

2 A uniform rod PQ of length 80.0 cm and weight 2.0 N is placed on the pivot as shown in Fig. 2.1 below. A spring balance is attached to the other end of the rod. A load of 8.0 N is placed 20.0 cm from the spring balance.

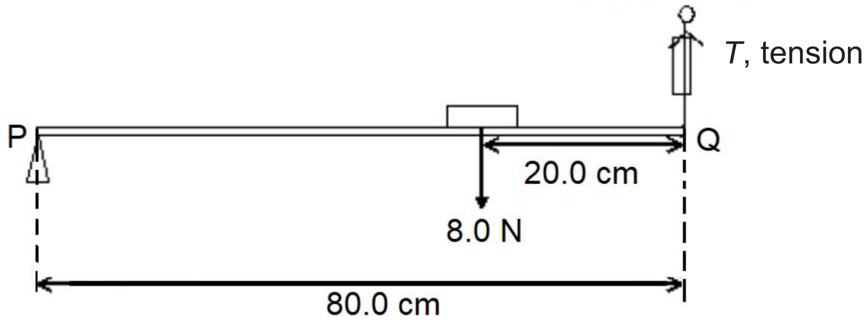


Fig. 2.1

(a) **(i)** Calculate *T*, the tension on the spring balance in order for the rod to balance horizontally.

tension, T = …………………. [2]

[Turn Over

(ii) Calculate the magnitude of the reaction force on the pivot and state the direction of the force.

direction : ……………………………

magnitude of force = …………………. [2]

(b) The 8.0 N weight is pushed horizontally towards point P. The rod remains horizontal throughout.

State and explain the change in the magnitude of T.

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

…………………………………………………………………………… [2]

3 Fig. 3.1 shows a 0.50 kg ball sliding down a rough incline from position A which is 7.5 m above the ground with an initial speed of v_o m/s. Friction along the incline produces 10.7 J of heat energy. The ball leaves the incline at position B moving vertically upward and reaches a height of 13.0 m above the floor at position C.

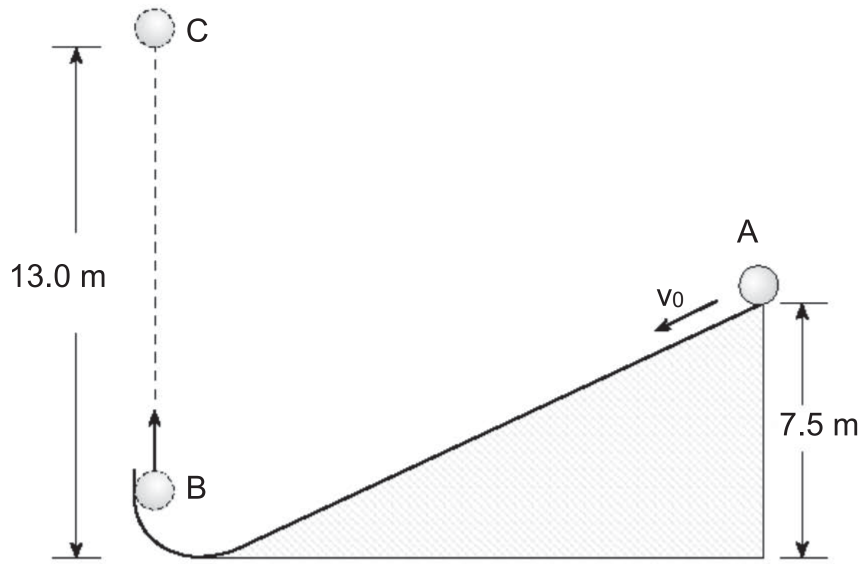


Fig. 3.1

For examiner's use

(a) State the principle of conservation of energy.

....

.... [1]

(b) **(i)** Calculate the gravitational potential energy of the ball at position C.

gravitational potential energy = ... [2]

(ii) Calculate the initial speed v_0, at position A.

v_0 = ... [2]

(c) State one assumption for your calculations in **(b)(ii)**.

....

.... [1]

4 Fig.4.1 shows the top view of a fish tank. A light ray from the fish exits from the water into air as shown.

The diagram is drawn to scale.

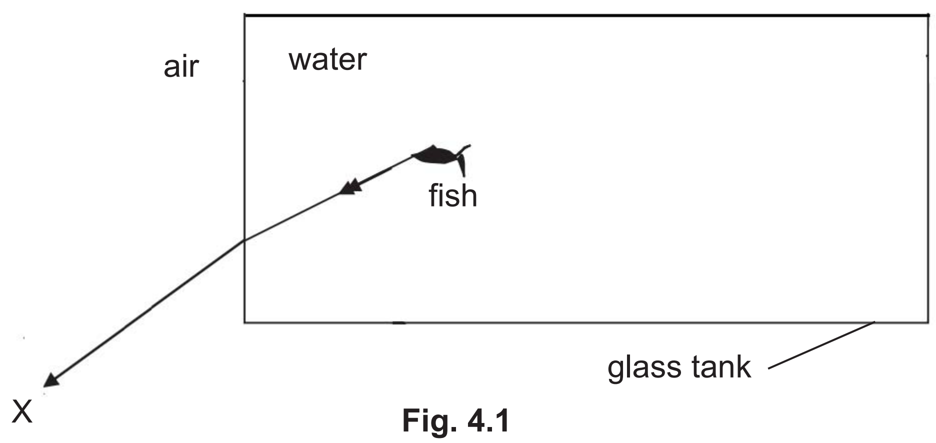


Fig. 4.1

For examiner's use

(a) **(i)** On Fig.4.1 measure the angle of incidence, *i* and the angle of refraction, *r* .

i = ……………….….

r = ………………..…… [1]

(ii) Calculate the refractive index of the water in the tank.

refractive index = …………………. [2]

(b) Explain why it is possible to see two images of the fish at position X.

………………………………………………………………………………………

……………………………………………………………………………………… [1]

5 Explain, in terms of the air molecules, how the air inside a car tyre exerts a pressure on the walls of the tyre.

………………………………………………………………………………………...

……………………………………………………………………………………..

……………………………………………………………………………………..

…………………………………………………………………………………….. [2]

For examiner's use

6 Fig. 6.1 shows a charged light perspex ball placed near a positively charged metal dome in a Van de Graaf generator. The ball swings away from the positively charged metal dome and remains stationary at X.

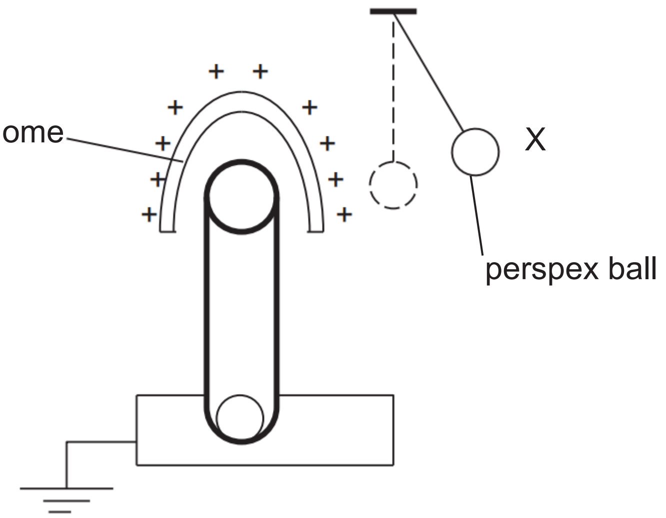


Fig. 6.1

(a) Explain why the perspex ball moves away from the metal dome.

....

....

....

.... [2]

(b) The perspex ball has a weight of 0.05 N.

Fig. 6.2 shows the instant where the ball is stationary at X. There is a horizontal electric force of 0.15 N acting to the right, tension *T* along the string and the weight of the ball.

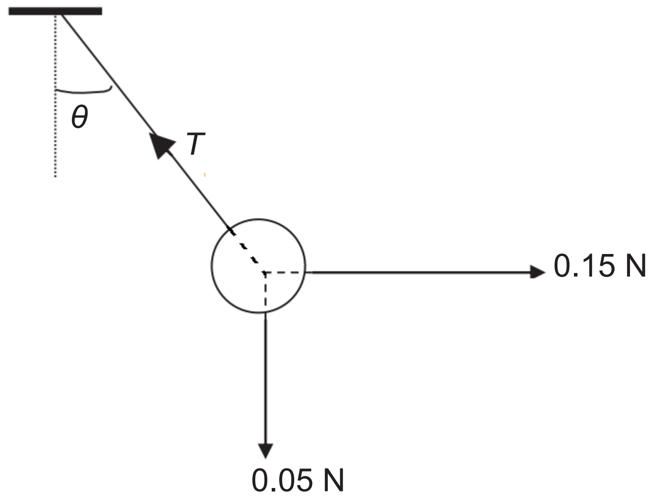


Fig. 6.2

By using a scale drawing, determine the tension *T* and the angle *θ* that the string makes with the vertical.

The gravitational field strength *g* is 10 N / kg.

T = ………………………..

θ = ……………………….. [4]

 [Turn Over

For examiner's use

7 **(a)** Fig. 7.1 shows an electric circuit powered by a 12.0 V battery of negligible internal resistance.

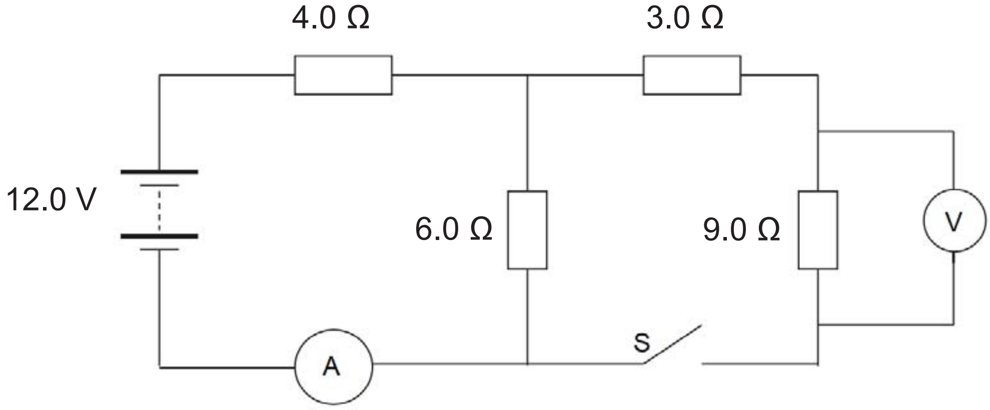


Fig. 7.1

When switch S is closed, calculate

(i) the total resistance of the circuit,

total resistance = …………………. [2]

(ii) the current flowing through the ammeter.

current = …………………. [2]

(b) Switch S is then opened.
State the effect on the reading of the ammeter when the switch is opened.

………………………………………………………………………………

……………………………………………………………………………… [1]

[Turn Over

(c) Fig. 7.2 shows the same power source connected to a potential divider consisting of an LDR and a resistor instead.
An LDR (light-emitting diode) is an input transducer whose resistance can change according to the amount of light falling on it.

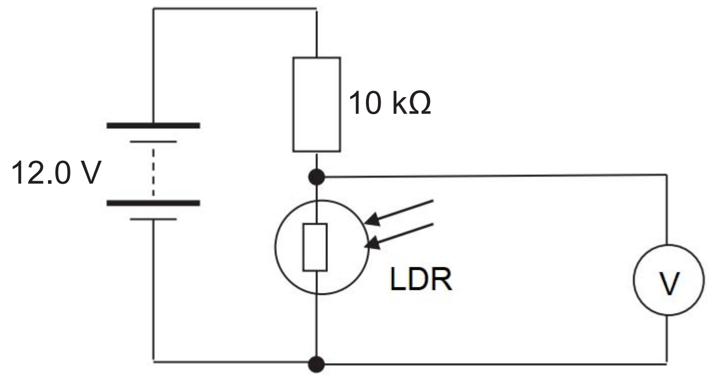


Fig. 7.2

(i) Explain the term 'input transducer'.

……………………………………………………………………………

…………………………………………………………………………… [1]

(ii) Calculate the resistance of the LDR when the voltmeter reads 2.0 V.

resistance = ………………… [2]

 [Turn Over

For examiner's use

8 A student makes a simple d.c motor as shown in Fig. 8.1 using some common materials connected to a 6.0 V battery.

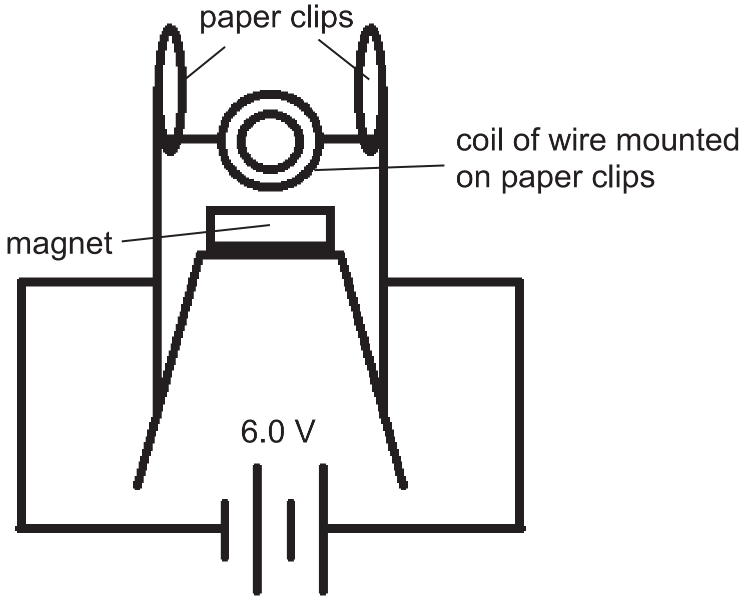


Fig. 8.1

The ends of the coil are placed on large paper clips inserted into the cup. When the power source is turned on, the coil is given a slight push and the coil begins to spin.

(a) **(i)** Explain why the coil is given a slight push.

....

.... [1]

(ii) Explain why the coil starts to rotate.

....

....

....

....

.... [2]

(b) If a stronger power source is used, state its effect on the rotation of the coil.

....

.... [1]

[Turn Over

For examiner's use

9 Fig. 9.1 shows the structure of a transformer which is used in the transmission of electrical power through the cables.

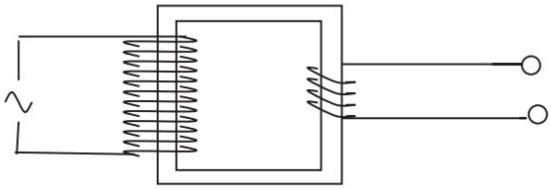


Fig. 9.1

coil	number of turns
J	50
K	100
L	1 000
M	1 500

Table 9.2

An engineer is assigned to build a step-down transformer for stepping down the voltage from 3.3 kV to 220 V in the substation of a housing estate. He has the choice of using four types of coils with different number of turns as shown in Table 9.2 above.

(a) Based on Table 9.2, select the most suitable pair of coils for making the primary coil and secondary coil of the transformer.

Explain your choice.

....

....

....

.... [2]

(b) Assume that the transformer is 75 % efficient and the power output is 15 kW, calculate the current flowing in the primary coil.

resistance = ... [2]

(c) State and explain one feature that can improve the efficiency of this transformer.

....

....

....

.... [2]

[Turn Over

For examiner's use

SECTION B [30 marks]

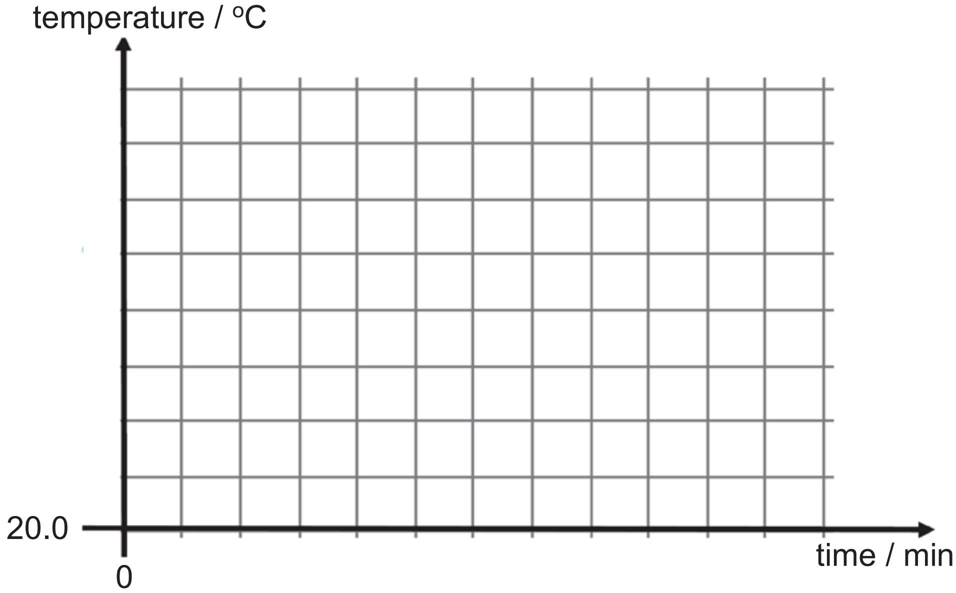
Answer **all** questions from this section.
Answer only one of the two alternative questions in **Question 12.**

10 (a) A heater was used to melt a pure substance X from its solid state until it reaches the gaseous state. Substance X was heated uniformly throughout the entire process. Fig. 10.1 shows the temperature of X taken in intervals of 2 minutes.
You may assume that the heat supplied was constant and no heat was lost during the heating process.

time / min	temperature / ^{o} C
0	25.0
2	35.0
4	45.0
6	45.0
8	45.0
10	60.0
12	75.0
14	90.0
16	90.0
18	90.0
20	90.0

Fig. 10.1

(i) On Fig. 10.2, draw the heating curve of pure substance X in the grid lines provided.



[1]

Fig. 10.2

[Turn Over

For examiner's use

(ii) Using the data from Fig. 10.1, determine the melting point and boiling point of substance X.

mass of substance X = 2 kg
power of heater used = 1 000 W

melting point = ………………….

boiling point = …………………… [1]

(iii) Calculate the specific heat capacity of the solid X.

specific heat capacity = ………..……. J / kg^{o}C [3]

(b) Fig. 10.3 below shows the cooling curve graphs of two pure liquids, Y and Z, of the same mass.

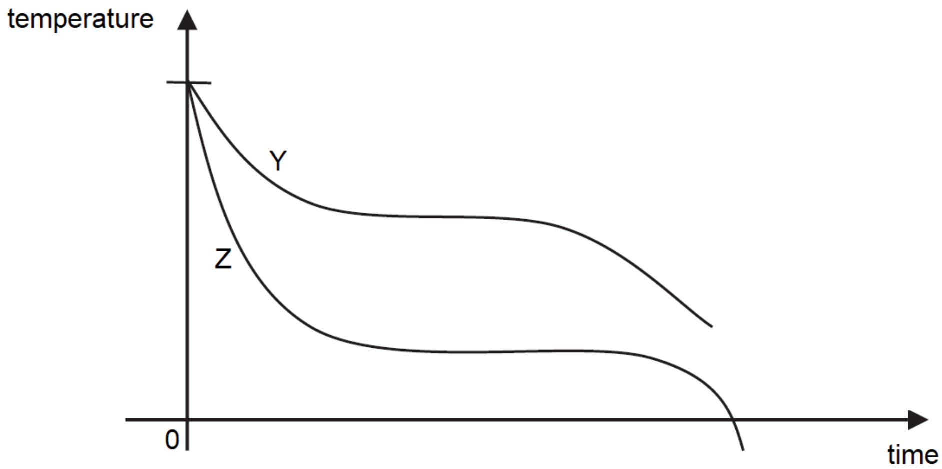


Fig. 10.3

(i) State why both liquids are losing thermal energy throughout the experiment.

……………………………………………………………………… [1]

(ii) Which substance (Y or Z) has a greater specific heat capacity in the liquid state?

Explain your answer clearly.

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

…………………………………………………………………………… [2]

(iii) Which substance (Y or Z) has a greater specific latent heat of fusion?

Explain your answer clearly.

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

…………………………………………………………………………… [2]

[Turn Over

For examiner's use

11 Fig. 11.1 shows the hydraulic braking system for a car from the brake pedal to the braking discs of the wheel.

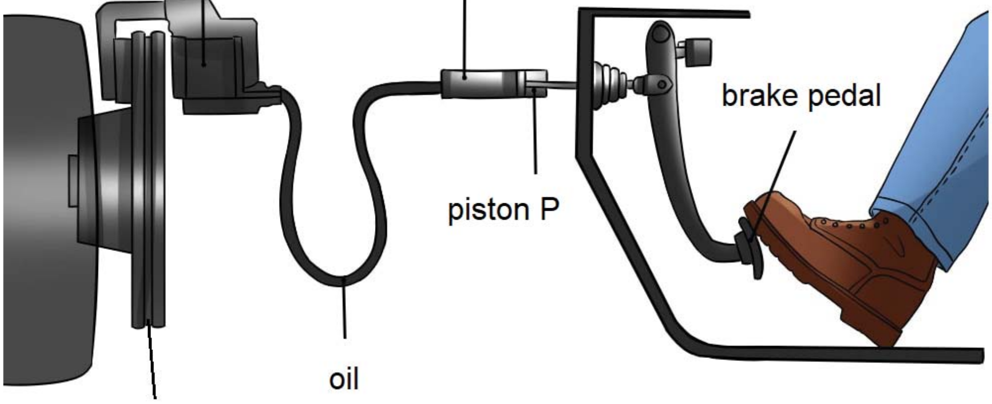


Fig. 11.1

A force is applied downwards on the brake pedal in order to slow down the wheels of the car.

(a) Using Fig. 11.1, explain clearly how a force applied on piston P can create a larger force to slow down the wheels of the car.

....

....

....

.... [2]

(b) The surface area of piston P in contact with the brake fluid at the master cylinder is 5.0×10^{-4} m^2 and the area of piston Q of the slave cylinder is 7.5×10^{-3} m^2.

(i) Explain why the area of piston P is smaller than piston Q.

....

.... [1]

(ii) Calculate the force exerted on Piston Q when a force of 120 N is exerted on the brake pedal.

force = ………………… [2]

(c) In order to ensure that the braking system functions properly, air cannot be trapped in the oil.

Explain clearly how trapped air in the oil can affect the performance of the hydraulic braking system.

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

……………………………………………………………………………… [2]

(d) When the road is wet, a sudden hard braking when the car is moving at a high speed can cause the wheels to stop rotating instantly and the car will skid.

(i) Explain why a fast moving car skids on the wet road when the brake is suddenly pressed very hard and the wheels stop rotating.

…………………………………………………………………………

…………………………………………………………………………

…………………………………………………………………………

………………………………………………………………………… [2]

(ii) To reduce the possibility of a car skidding on a wet surface, the wheels of the car have specially designed threads as shown in Fig.11.2. Suggest how these threads are able to reduce the chances of the car skidding on a wet surface.

Fig. 11.2

………………………………………………………………………………

……………………………………………………………………………… [1]

 [Turn Over

For examiner's use

EITHER

12 (a) Fig. 12.1 shows an object AB near a thin converging lens. The principal foci of the lens are at F and F'.

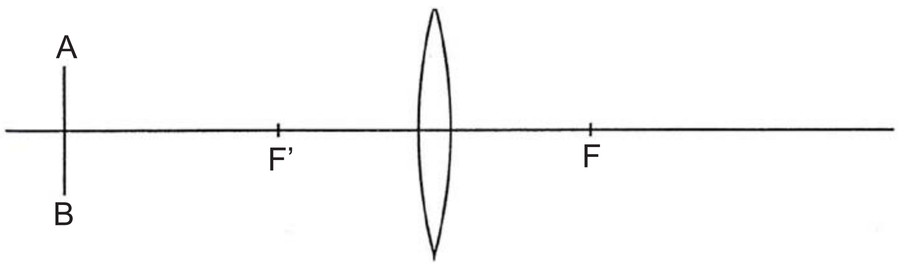


Fig. 12.1

(i) By means of an accurate drawing, draw rays to find the positions of the images of the points A and B. [2]

(ii) If object AB is gradually brought closer to the converging lens until a distance less than one focal length, describe clearly the changes to the image of AB.

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

…………………………………………………………………………… [2]

(b) Fig. 12.2 shows a scaled drawing of an object PQ and its image P'Q' after passing through a thin converging lens. P'Q' is a virtual image.

With the aid of drawing light rays on the diagram, find the focal length of the converging lens.

Fig. 12.2

[2]

focal length = ………………

For examiner's use

(c) Light rays passing into an eyeball undergo two refractions; once as they pass through the cornea and another as they pass through the lens of the eye. Fig.12.3 shows how light rays pass through the eyeball and the image of an object is formed in front of the retina for an individual with short-sightedness.

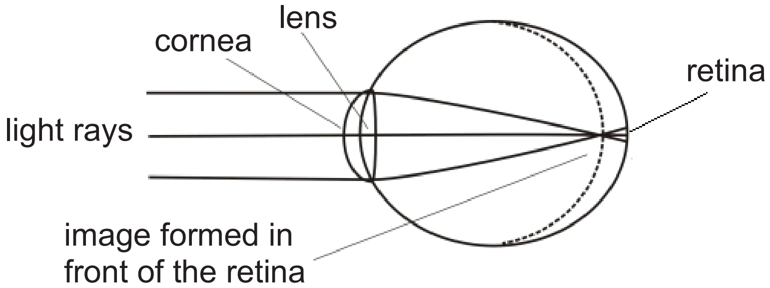


Fig. 12.3

(i) One way to correct short-sightedness is to use a pair of spectacles. Which type of spectacle lens (converging or diverging) would be suitable to correct short-sightedness?

Explain your answer clearly.

……………………………………………………………………

……………………………………………………………………

……………………………………………………………………

…………………………………………………………………… [2]

(ii) Another method to correct short-sightedness is by performing a 'lasik surgery' which removes a small portion of tissue in the cornea to make the cornea less rounded.

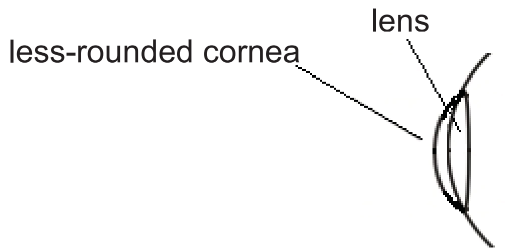


Fig. 12.4

Suggest how the less-rounded cornea in front of the eye's lens can help to correct short-sightedness.

……………………………………………………………………

……………………………………………………………………

……………………………………………………………………

…………………………………………………………………… [2]

[Turn Over

For examiner's use

OR

12 **(a)** Fig. 12.4 shows a solenoid with an alternating current (a.c) supply coiled around a soft iron core. An aluminium ring is placed through the soft iron and rests on the solenoid. When the a.c supply is turned on, the ring 'floats' above the solenoid as shown in Fig. 12.5.

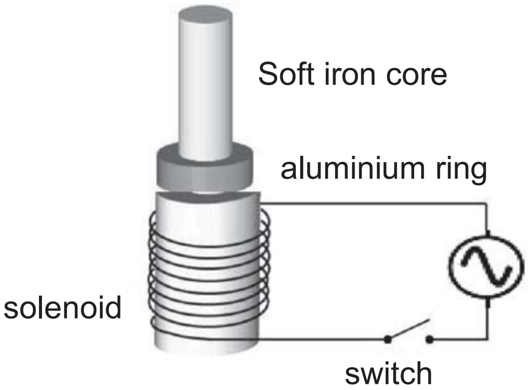


Fig. 12.4

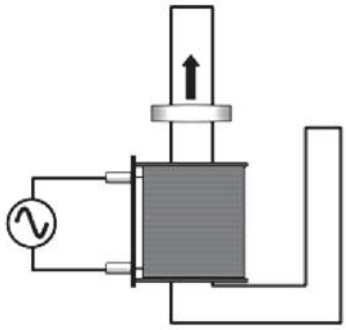


Fig. 12.5

(i) Explain clearly why the aluminium ring 'floats' when the a.c supply is turned on.

....

....

....

....

....

.... [3]

(ii) If the a.c supply is now replaced by a d.c supply, state what will be observed after the supply is turned on.

....

....

....

.... [1]

(iii) The solenoid has an a.c supply but the aluminium ring is replaced with a 'C'-shaped ring instead as shown in Fig. 12.6. When the supply is turned on, the C-shaped ring does not 'float' upwards but continued to remain at rest on the solenoid instead.

Fig. 12.6

Explain why this happens.

………………………………………………………………………

………………………………………………………………………

………………………………………………………………………

……………………………………………………………………… [2]

(b) Fig.12.7 shows a simple a.c generator which has a frequency of 60 Hz and peak voltage 12 V.

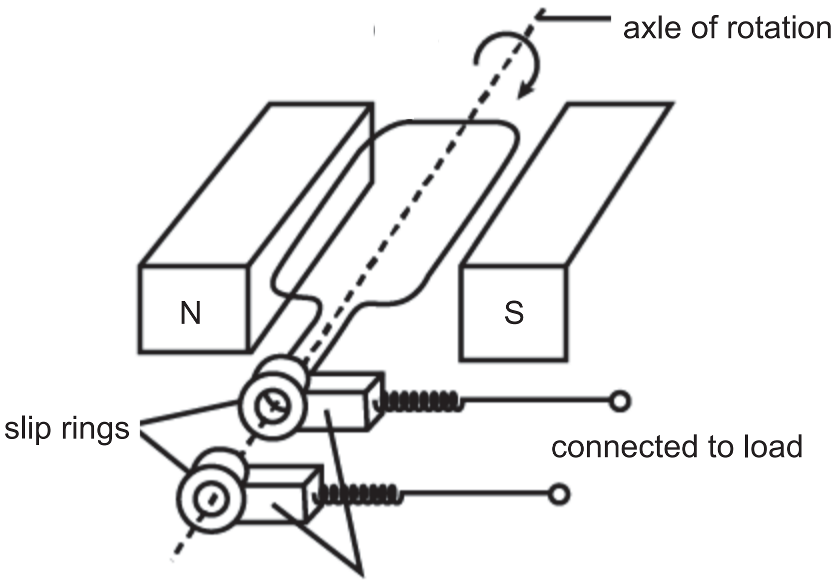
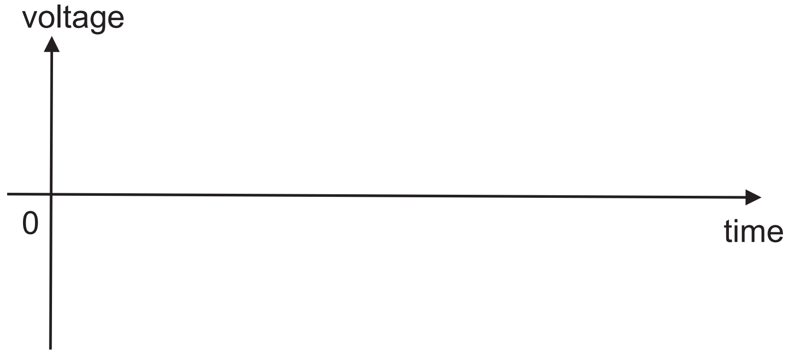


Fig. 12.7

For examiner's use

(i) Sketch the graph of the voltage produced against time for two complete cycles below. The position of the coil at time = 0 s is as shown in Fig. 12.7.



[2]

(ii) If the speed of rotation of the coil is reduced, sketch the new graph of the voltage produced on the same axis above.

Label this new graph with **(ii)**.

[1]

(iii) Explain the difference in amplitude between the graphs for **b(i)** and **b(ii)**.

....

....

....

.... [1]

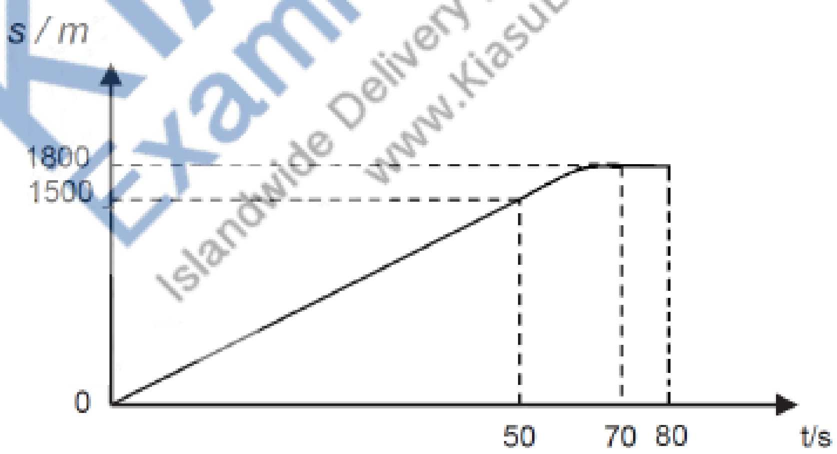
END OF PAPER

MARKING SCHEME 4E Pure Physics PRELIMS 2022

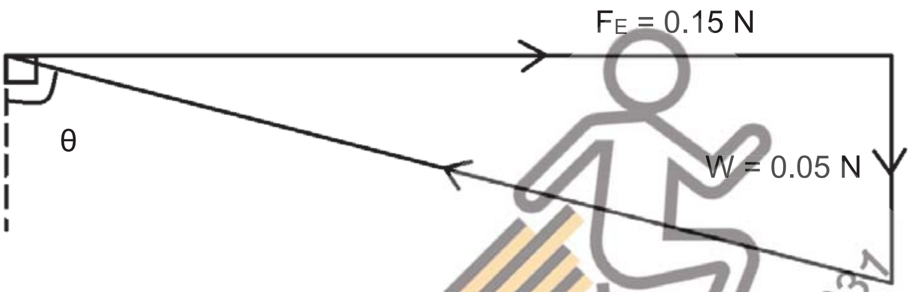
Paper 1 (40 marks)

1	D	6	C	11	C	16	B	21	D	26	D	31	A	36	D
2	B	7	C	12	B	17	C	22	B	27	D	32	C	37	A
3	C	8	B	13	A	18	D	23	B	28	C	33	B	38	A
4	C	9	C	14	D	19	B	24	C	29	D	34	A	39	C
5	B	10	B	15	B	20	A	25	B	30	B	35	A	40	C

Paper 2 Section A (50 marks)

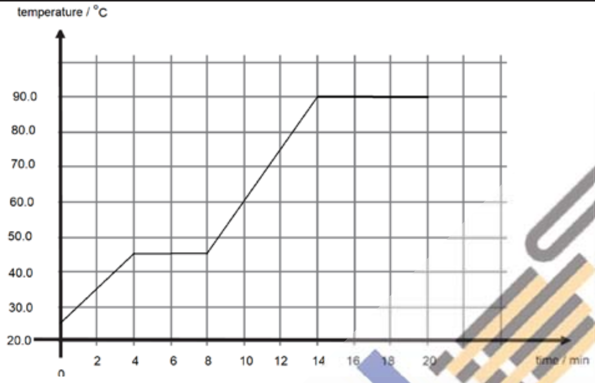
Qn	Answer	Sub marks	Total marks
1ai	The car decelerates uniformly to stop from t = 50 s to 70 s, and remain stationary / at rest for a further 10 s, It reverses / change direction and accelerates uniformly	1 m 1 m	2 m
1aii	a = (v – u) / t = (0 – 30) / 20 = - 1.5 m/s^2 deceleration = 1.5 m/s^2	 1 m 1 m	2 m
1b	Total displacement = distance moved (first 70s) – distance moved (t =80s to 110s) = ½ (50 + 70) x 30 – (½ x 30 x 20) = 1500 m	 1 m 1 m	2 m
1c	 Correct shape of graph Correct values on both x and y axis	1 m 1 m	2 m
2ai	Using principle of moments about P		2 m

	Total anticlockwise moment = Total clockwise moment T x 80 = (2 x 40) + (8 x 60) T = 7.0 N	 **1 m** **1 m**	
2aii	Let the reaction force at the pivot be R. Since net force = 0 (not moving / at balance) T + R = 2 + 8 7 + R = 10 R = 3 N Direction of R is upwards.	 **1 m** **1 m**	**2 m**
2b	Magnitude (size) of the spring balance reading decreases. The total clockwise moment has decreased as the clockwise moment by the 8 N weight about P has decreased with the reduction in the distance. To maintain equilibrium, the anticlockwise moment by spring must also decrease proportionately. As moment = force x perpendicular distance (and the distance is constant), the spring force must decrease to compensate the reduction in the moment.	**1 m** **1 m**	**2 m**
3a	Total energy is always conserved (remain unchanged) Energy cannot be created or destroyed; They can only be converted from one form to another.	 **1 m**	**1 m**
3bi	GPE = mgh = 0.5 x 10 x 13 = 65 J	 **1 m** **1 m**	**2 m**
3bii	Assume no energy is loss and total energy is conserved, $GPE_C + W_{friction}$ = total energy at A 65 + 10.7 = ½ (0.5) (v_0^2) +(0.5 x 10 x 7.5) v_0 = 12.4 m/s	 **1 m** **1 m**	**2 m**
3c	There is no work done against air resistance as the ball moves up to position C.	**1 m**	**1 m**
4ai	*i* ° = 26° *r* ° = 35°	 **1 m**	**1 m**
4aii	n = sin i / sin r = sin 35° / sin 26° (+/- 1°) = 1.31 (1.28 to 1.39)	 **1 m** **1 m**	**2 m**
4b	Light can also be refracted from the longer side of the fish tank giving another image of the fish.	**1 m**	**2 m**

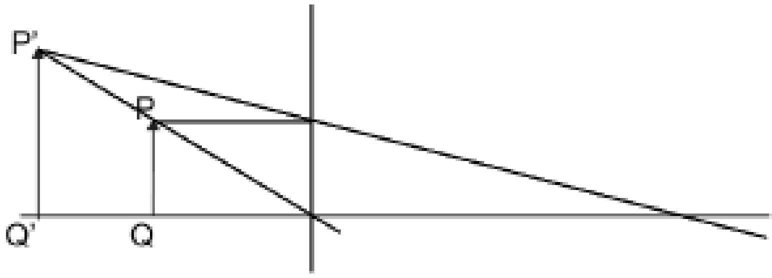
5	Air molecules moving randomly and bombarding / colliding with the tyre walls. This exerts a force on the wall's surface which produces a pressure.	**1 m** **1 m**	**2 m**
6a	Perspex ball is positive charged. As like charges repel, the Perspex ball moves away from the charged metal dome.	**1 m** **1 m**	**2 m**
6b	 Diagram drawn to scale Arrows drawn and values labelled correctly θ = 72° T = 0.16 N	**1 m** **1 m** **1 m** **1 m**	**4 m**
7ai	$\frac{1}{R_T} = 4+(\frac{1}{6}+\frac{1}{3+9})^{-1}$ R_T = 8 Ω	**1 m** **1 m**	**2 m**
7aii	I = V / R = 12 / 8 = 1.5 A	**1 m** **1 m**	**2 m**
7b	The ammeter reading decreases.	**1 m**	**1 m**
7ci	A device that converts other form of energy(s) to electrical energy.	**1 m**	**1 m**
7cii	R_{LDR} / 10 = 2 V / 10 V R_{LDR} = 2.0 kΩ	**1 m** **1 m**	**2 m**
8ai	To overcome inertia of the coil so that it can start to turn / enable the conducting (enameled) part of the wire to be in contact with paper clip to allow current to pass into the coil.	**1 m**	**1 m**
8aii	When electric current flows into the coil via the paper clip say from it sets up a magnetic field around the coil which interact with the magnetic field of the permanent magnet below.	**1 m**	**2 m**

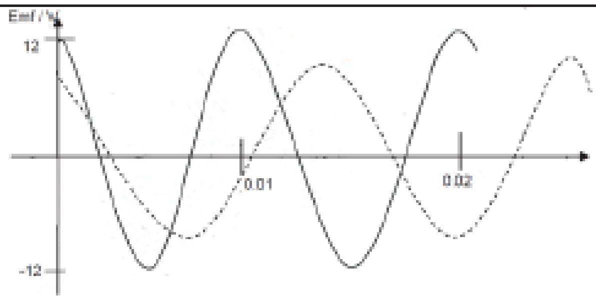
	This produces a force pushing the bottom coil near the bottom tape which turns the coil. This causes the conducting enameled copper wire to rotate.	1 m	
8b	The coil will rotate faster.	1 m	1 m
9a	Comparing the voltages of primary coil to secondary coil: Step down ratio = 3 300 : 220 = 15 : 1 Hence the coils must be step down to the same ratio of 15 : 1 Comparing the turn ratio i.e Coil M : Coil K = 1 500 : 100 = 15 : 1	1 m 1 m	2 m
9b	Input power = 100 / 75 x 15 kW = 20 kW I = P / V = 20 000 / 3 300 = 6.1 A	1 m 1 m	2 m
9c	Feature Explaination (Any one) Laminating the iron core reduces the power loss due to heat produced by induced current in the core itself. Using low resistance (primary and secondary) coils will minimize the amount of heat produced in the coils. To increase the magnetic flux linkage between the primary and secondary coils by using a soft magnetic material (iron core) to link	1 m 1 m	2 m

SECTION B (30 marks)

QN	Answer	Sub-marks	Marks
10ai	 All plots are correct.	**1 m**	**1 m**
10aii	melting point = 45 °C boiling point = 90 °C	**1 m**	**1 m**
10aiii	Heat supplied by heater = P x t = 1000 x 4 x 60 = 240 000 J Heat supplied by heater = Energy gained by solid X 240 000 = mc ΔT 240 000 = 2 c (45 – 25) c = 6000 J/kg °C	**1 m** **1 m** **1 m**	**3 m**
10bi	The room temperature is lower than the liquids, thermal energy flows from liquids to the surroundings.	**1 m**	**1 m**
10bii	Substance Y When subjected to the same cooling condition, the fall in temperature for substance Y is slower than substance Z. This indicates that a higher amount of energy needs to be lost by substance Y compared to Z for the same amount of fall in temperature.	**1 m** **1 m**	**2 m**
10biii	Substance Z For the same mass, same period of time, Substance Z takes a longer time to change state indicating that higher amount of latent heat needs to be lost by Z compared to Y to change from liquid to solid state.	**1 m** **1 m**	**2 m**

11a	A force exerted on the brake pedal acts on the surface area of Piston P in contact with the oil in the master cylinder to create a pressure This pressure in the oil is transmitted to all parts of the oil Since oil is incompressible, this creates a force to slow down the wheels of the car.	**1 m** **1 m**	**2 m**
11bi	Since the pressure acting in the liquid is the same throughout, A small area at Piston P would require a smaller force exerted to produce a larger force at Piston Q.	 **1 m**	**1 m**
11bii	Force exerted on piston Q = $(F_P \times A_Q)/A_P$ = $(120 \times 7.5 \times 10^{-3})/ 5.0 \times 10^{-4}$ = 1800 N	 **1 m** **1 m**	**2 m**
11c	Since air is compressible, pressure exerted at the master cylinder will not be fully transmitted to the disc brakes resulting in an insufficient force to stop the revolution.	**1 m** **1 m**	**2 m**
11di	On a wet road, there is less friction between the wheels and the road. When wheels suddenly stops turning, the forward force is greater than the frictional force between the road and wheels causing the car to skid.	**1 m** **1 m**	**2 m**
11dii	The threads allows water the flow through them, increasing the friction between the car and the road surface to prevent skidding.	**1 m**	**1 m**
Either 12ai	 Correct pair of rays from A to A' Correct pair of rays from A to A'	 **1 m** **1 m**	**1 m**
12aii	As the object is brought nearer to the lens towards one focal length distance, image becomes magnified but remain inverted and real When the object is less that one focal length distance from the lens, the image becomes magnified, upright and virtual.	 **1 m** **1 m**	**2 m**

12b	 Correct line passing through top of object and image to locate position of lens, Correct line from object to lens, combined with line Focal length between 4.7 to 5.1 cm	1 m 1 m	2 m
12ci	Diverging lens. Diverging lens will spread the incoming rays before it reaches the lens The more diverged rays entering the lens will be focused at a further distance in the eye onto the retina	1 m 1 m	2 m
12cii	When rays enter the less rounded cornea, it undergoes lesser refraction/less converging This causes the lesser refracted rays to be focused at a further distance in the eye after passing through the lens.	1 m 1 m	2 m
OR 12ai	When the supply is turned on, a changing magnetic field is produced around the solenoid The changing magnetic flux/magnetic field lines cutting the aluminium ring induces an emf on the ring By Lenz's law, the induced emf on the ring is such that the magnetic field induced around the aluminum ring opposes the magnetic field of the solenoid that produced it Like poles will exist between the aluminium ring and the solenoid And repel the ring upwards since like poles repel	1 m 1 m 1 m	3 m
12aii	The ring will move upwards momentarily and subsequently falls back down and rest on top of the solenoid.	1 m	1 m
12aiii	The C-shaped ring does not allow current to pass around the aluminium continuously. This does not allow any induced current, magnetic force/field to be produced around the C-shaped ring. Hence the ring will remain at rest on the top part of the solenoid.	1 m 1 m	2 m

12bi	 Solid line: max emf 12 V, min emf 12 V. period = 0.01 s	 **1 m** **1 m**	**2 m**
12bii	Dotted line in diagram above Smaller peaks, longer peroid	**1 m**	**1 m**
12biii	A lower speed of rotation results in smaller voltage produced as the rate of magnetic flux is reduced.	**1 m**	**1 m**

YUYING SECONDARY SCHOOL
PRELIMINARY EXAMINATION
Secondary 4 Express

NAME			
CLASS		**REG. NO**	

PHYSICS **6091/1**

Paper 1 Multiple Choice **31 August 2022**

1 hour

Setter: Mr Soh Wei Yong

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on this question booklet and the separate Answer Sheet.
Do not use staples, paper clips, highlighters, glue or correction fluid.

There are **forty** questions on this paper. Answer **all** questions.
For each question there are four possible answers **A, B, C** and **D**.
Choose the one you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved calculator is expected, where appropriate.

For Examiner's Use	
Total	40

This document consists of **20** printed pages.

1. A student uses a micrometer screw gauge to measure the diameter of a ball bearing. Diagram 1 shows the zero error of the gauge and diagram 2 shows the measurement of the diameter before it is corrected.

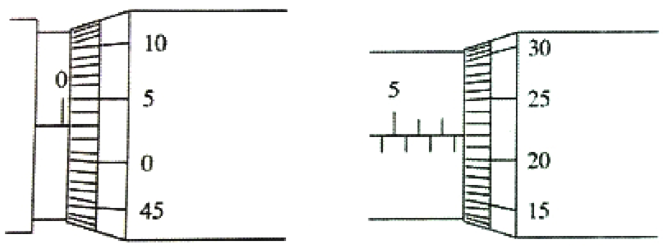


diagram 1 diagram 2

What is the true diameter of the ball bearing?

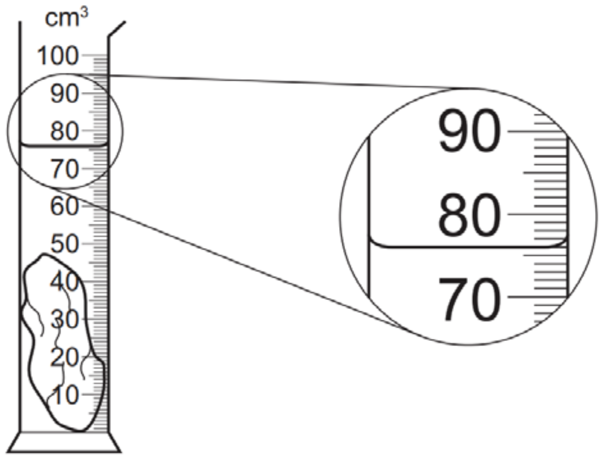
A 7.19 mm B 7.69 mm C 7.72 mm D 7.75 mm

2. An object in a space probe above the Earth weighs 3.5N.
The gravitational field strength at the height of the space probe is 7.0N/ kg.
The gravitational field strength on the Earth's surface is 10N/ kg.

What are the mass and the weight of the object on the Earth's surface?

	mass / kg	weight / N
A	0.50	3.5
B	0.50	5.0
C	2.0	3.5
D	2.0	20

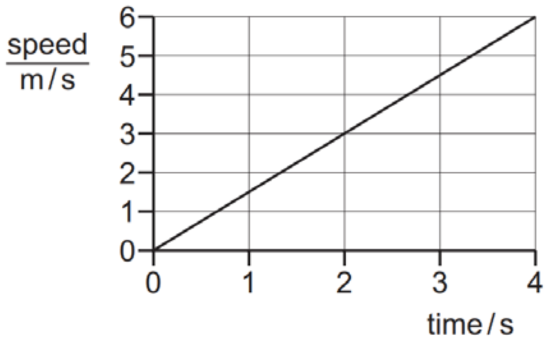
3. A measuring cylinder contains 40 cm^3 of water. A stone of mass 94 g is lowered into the water so that it is fully submerged as shown.



What is the density of the stone?

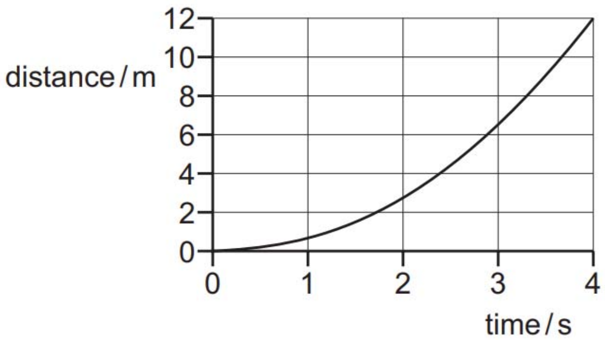
A 1.1 g/cm^3 B 1.2 g/cm^3 C 2.1 g/cm^3 D 2.6 g/cm^3

4. The graph shows how the speed of a car varies with time at the start of a journey.

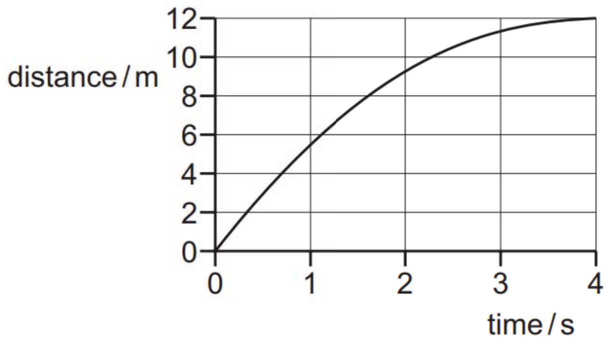


Which distance–time graph represents the motion of the car over the same time period?

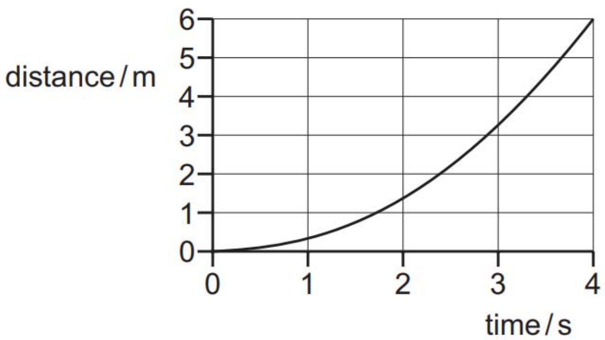
A



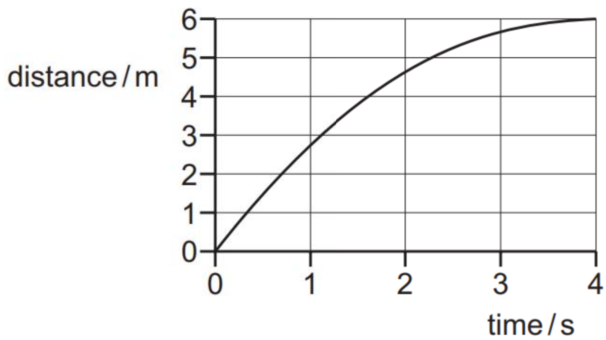
B



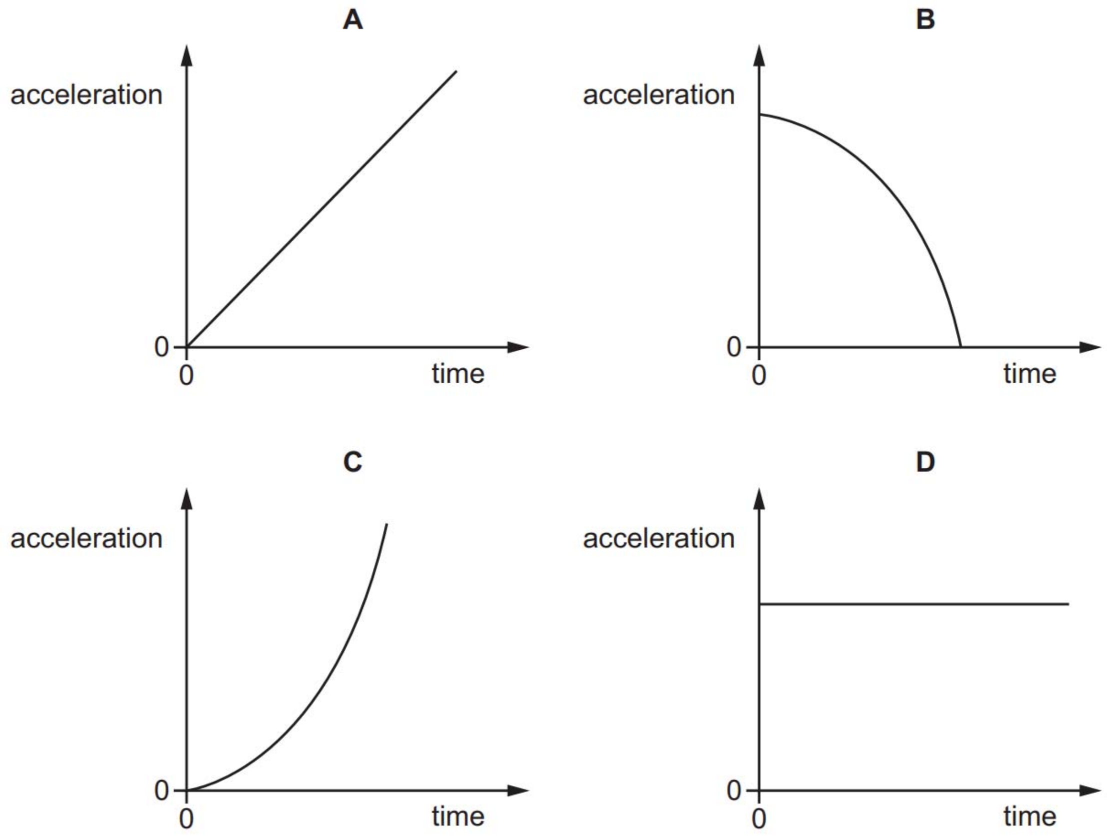
C



D

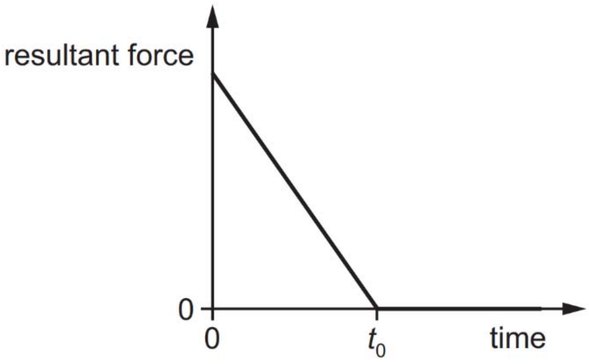


5. A stone falls freely from the top of a cliff. Air resistance may be ignored.
Which graph shows how the acceleration of the stone varies with time as it falls?



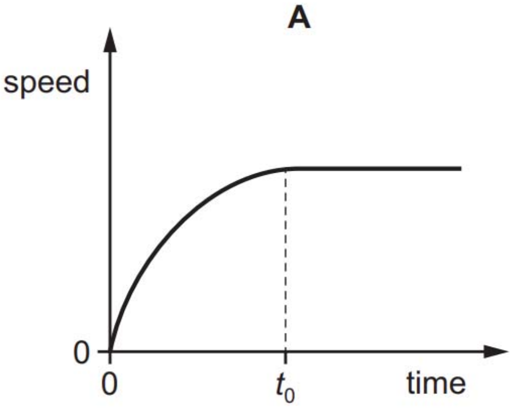
6. A resultant force acts on an object and causes it to move in a straight line.

The graph shows how the resultant force varies with time.

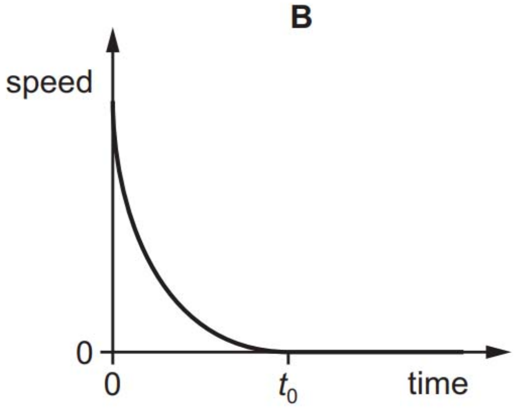


Which graph is the speed-time graph for the object?

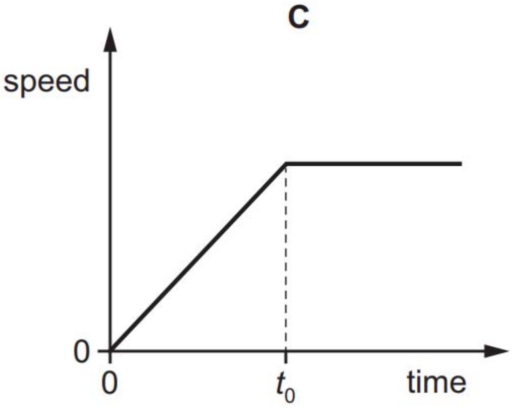
A



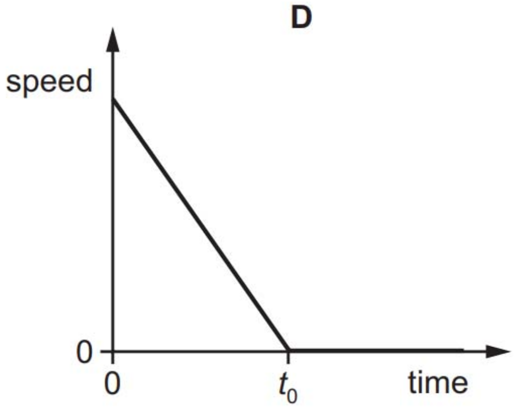
B



C

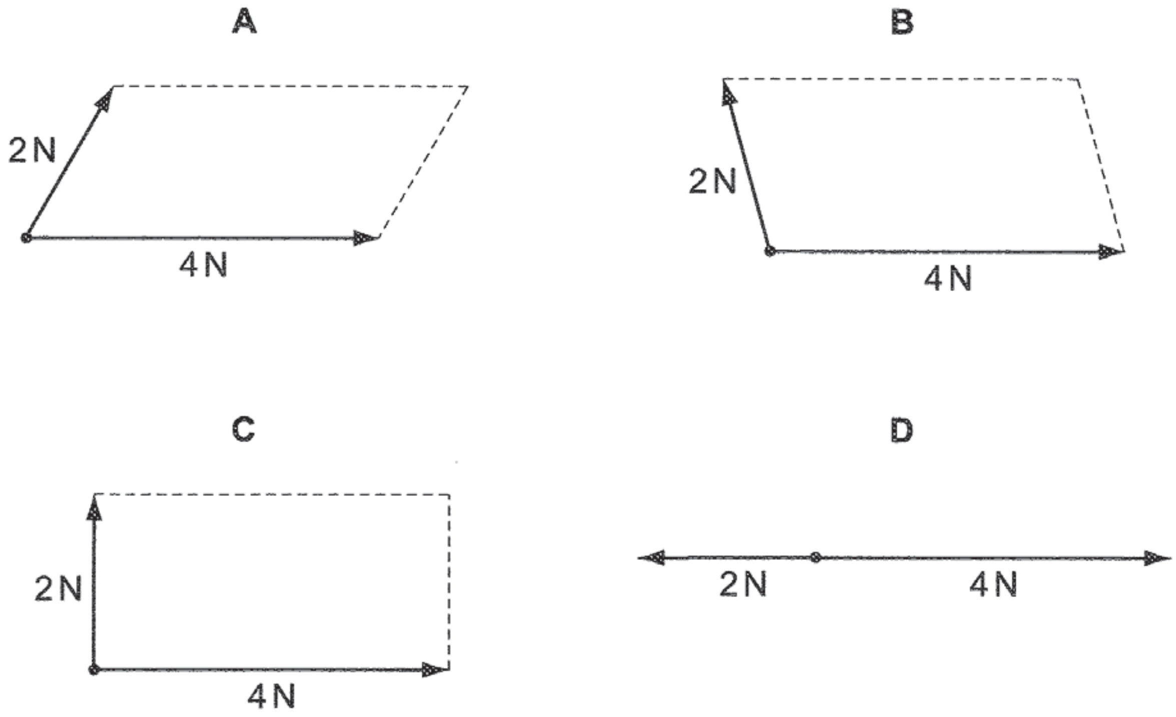


D

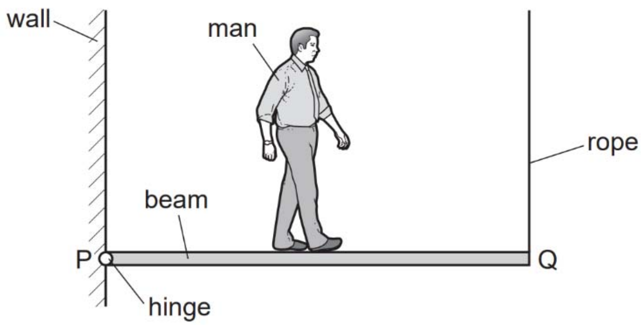


7. Forces of 4 N and 2 N act at a point.

Which scale diagram shows the forces that have a resultant of 4 N?



8. The diagram shows a wooden beam PQ, of negligible weight, which is attached to a wall by a hinge at P and kept in a horizontal position by a vertical rope attached at Q. The beam is 3.0 m in length.
A man of weight 800 N walks along the beam from P to Q.



What is the distance of the man from P when the tension in the rope at Q becomes equal to 500N?

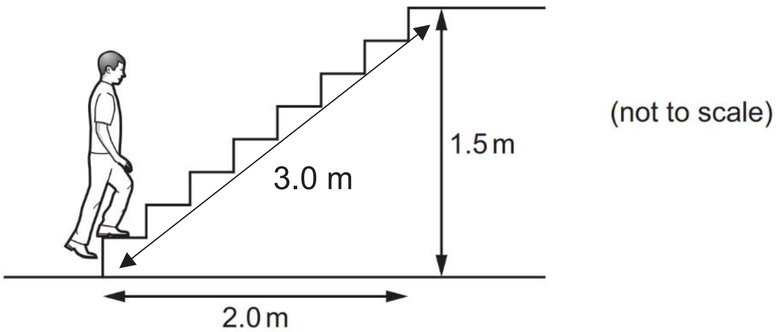
A 0.53 m B 1.1 m C 1.9 m D 2.5 m

9. A ball is dropped onto a floor. Its speed just before hitting the floor is 3.0 m/s.

Ignore any effects due to air resistance.
Which change would result in a speed of 6.0 m/s just before hitting the floor?

A Drop the ball from double the height above the floor.
B Drop the ball from four times the height above the floor.
C Use a ball with double the mass.
D Use a ball with four times the mass.

10. A student of mass 60 kg climbs some steps. He travels a horizontal distance of 2.0 m and a vertical distance of 1.5 m. The gravitational field strength g is 10N/kg.



What is the work done against gravity as the student climbs up the stairs?

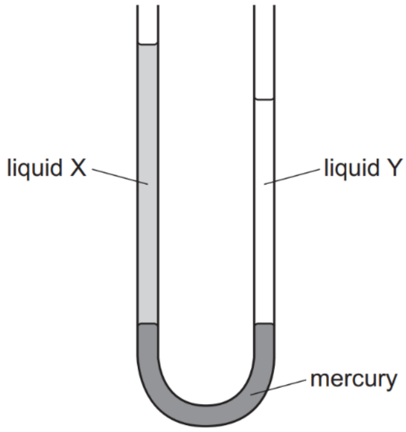
A 90J
B 120J
C 900J
D 1800J

11. A horizontal metal plate of area 0.50 m^2 lies at the bottom of a lake at a depth of 40 m.
The density of water is 1000 kg/m^3 and the gravitational field strength g is 10 N/ kg.

What is the downward force acting on the plate due to the water?

A 20 kN
B 80 kN
C 200 kN
D 800 kN

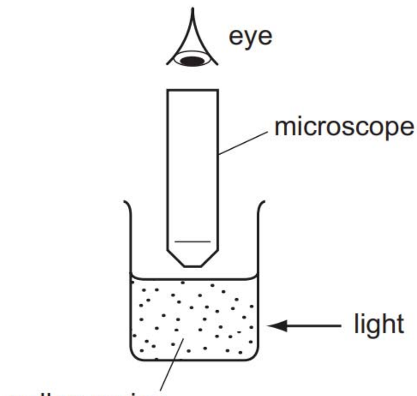
12. The diagram shows a U-tube manometer containing three liquids: mercury, liquid X and liquid Y. Neither liquid X or liquid Y mixes with mercury.



Which row compares the pressure exerted by liquid X and by liquid Y on the mercury, and the density of liquid X and the density of liquid Y?

	pressure exerted by X and by Y on the mercury	densities of X and Y
A	pressure of X is greater than Y	density of X is greater than Y
B	pressure of Y is greater than X	density of Y is greater than X
C	pressure of X and of Y is the same	density of X is greater than Y
D	pressure of X and of Y is the same	density of Y is greater than X

13. Very small pollen grains are suspended in a beaker of water. A bright light shines from the side. Small, bright dots of light are seen through a microscope. The dots move in rapidly changing, random directions.



What are the bright dots?

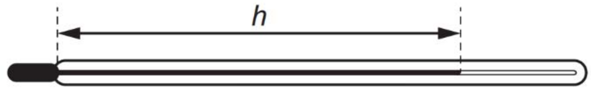
A pollen grains being hit by other pollen grains
B pollen grains being hit by water molecules
C water molecules being hit by other water molecules
D water molecules being hit by pollen grains

14. A liquid at room temperature is put on a metal surface which is also at room temperature.
A student blows gently across the liquid and its temperature decreases.

What causes the liquid to become cooler?

A Bubbles of water vapour form in the liquid and go into the air.
B The moving air reduces the kinetic energy of all the particles in the liquid.
C Thermal energy flows from the liquid into the metal.
D The more energetic particles in the liquid escape into the air.

15. The mercury-in-glass thermometer shown has a linear scale.

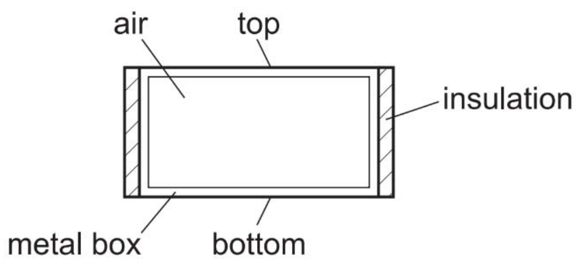


At a temperature of 100°C, h has a value of 28 cm.
At 80 °C, h has a value of 24 cm.

What is the value of h when the temperature is 0 °C?

A 0.0 cm B 2.8 cm C 4.0 cm D 8.0 cm

16. A sealed metal box contains a fixed mass of air. The sides of the box are insulated.



A scientist investigates the thermal conductivity of air. She measures how quickly thermal energy passes between the top and bottom of the box.
Which row gives the correct procedure and conclusion?

	procedure	conclusion
A	heat bottom surface	air is a good thermal conductor
B	heat bottom surface	air is a poor thermal conductor
C	heat top surface	air is a good thermal conductor
D	heat top surface	air is a poor thermal conductor

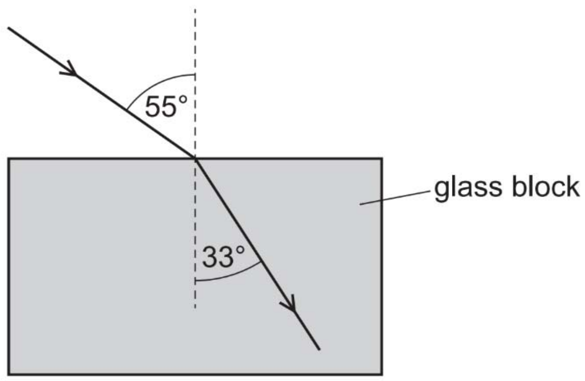
17. The water from two buckets is mixed together. One bucket contains 5 kg of water at 20 °C and the other contains 1 kg of water at 80 °C.

What is the final temperature of the mixture, assuming no heat is lost to the surroundings?

A 30 °C B 50 °C C 60 °C D 70 °C

18. Light travelling at a speed of 3.0×10^8 m/s strikes the surface of a glass block and undergoes refraction as it enters the block.

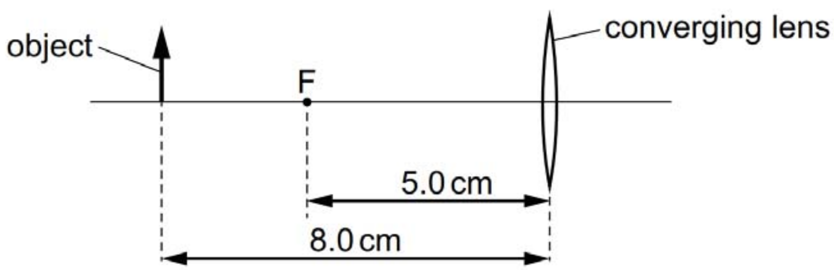
The diagram shows a ray of this light before and after it enters the block.



What is the speed of light in the glass?

A 1.8×10^8 m/s
B 2.0×10^8 m/s
C 4.5×10^8 m/s
D 5.0×10^8 m/s

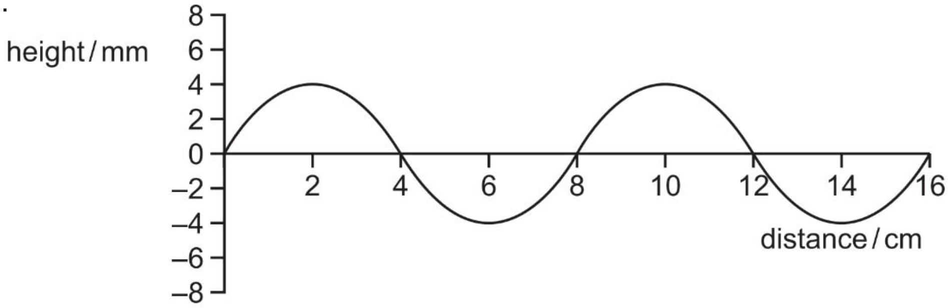
19. An object is placed 8.0cm from a thin converging lens of focal length 5.0cm.



Which statement about the image formed by the lens is correct?

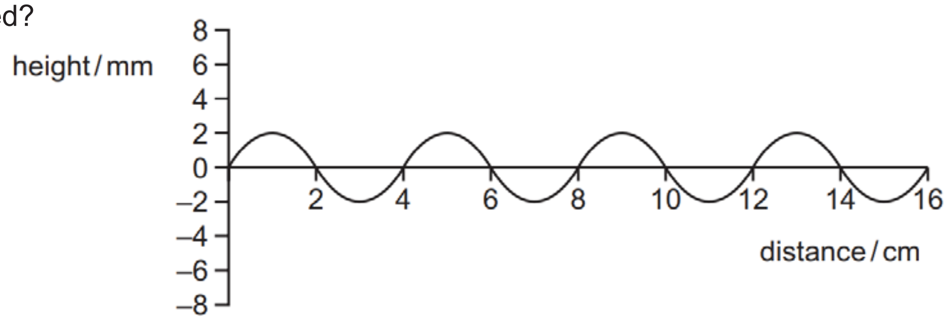
A The image is diminished, real and inverted.
B The image is magnified, real and inverted.
C The image is same size, real and inverted.
D The image is magnified, virtual and upright.

20. The graph shows how the height of a water wave varies with distance along the wave.

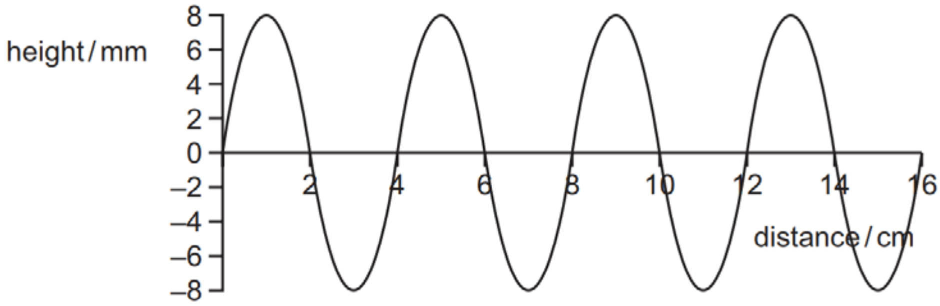


Which graph shows a wave with twice the amplitude, half the frequency, and the same speed?

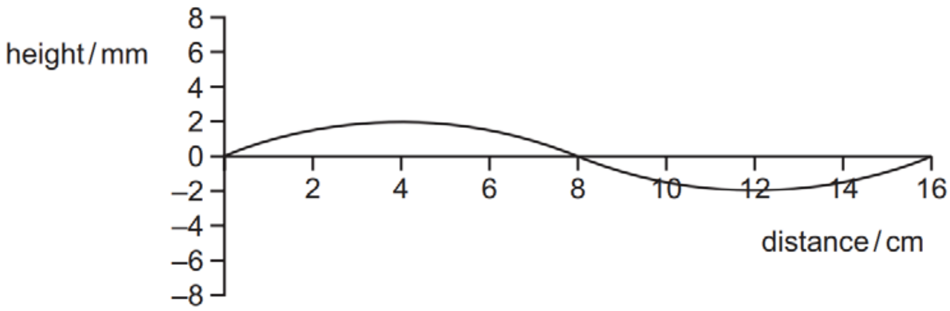
A



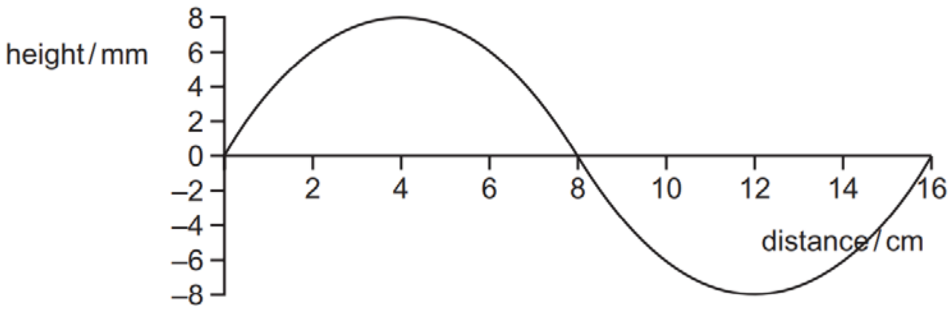
B



C



D



21. A wave of frequency 6600 Hz travels 1320 m in 4.0 s.

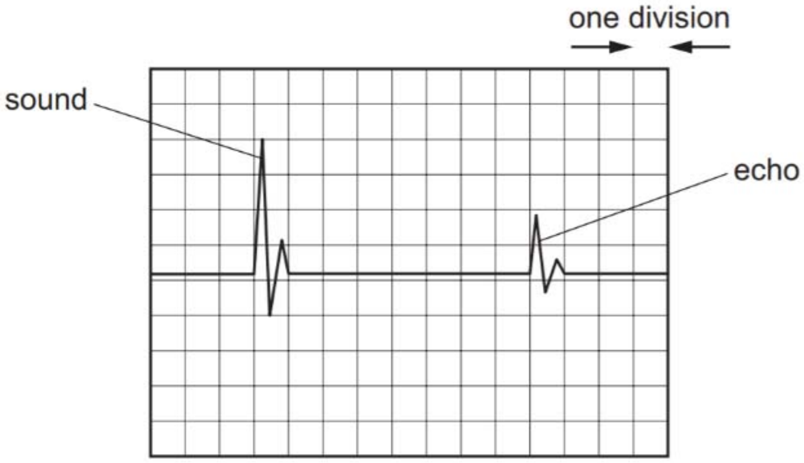
What is the wavelength?

A 0.050 m B 0.80 m C 1.3 m D 20 m

22. A loudspeaker and a microphone are placed in front of a wall.

The loudspeaker makes a sound which is detected by the microphone.

The microphone is connected to an oscilloscope which is set so that each division on the screen represents 0.01 s. The microphone detects the original sound and the echo



display on oscilloscope

The speed of sound in air is 300 m / s.

What is the distance between the loudspeaker and the wall?

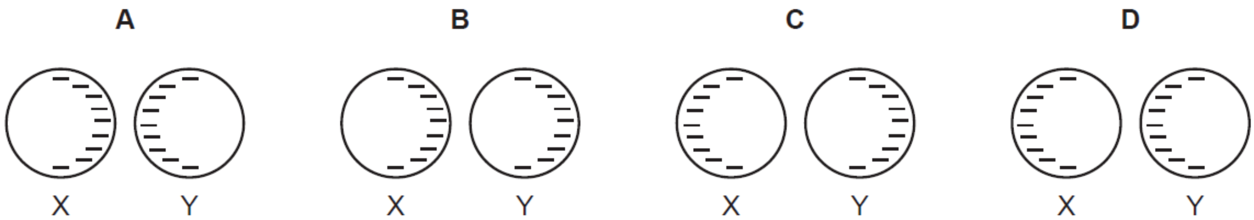
A 6.0 m B 12 m C 24 m D 48 m

23. The Sun emits infrared radiation and light. Light from the Sun reaches the Earth in 8 minutes.
Which row gives correct information about the infrared radiation?

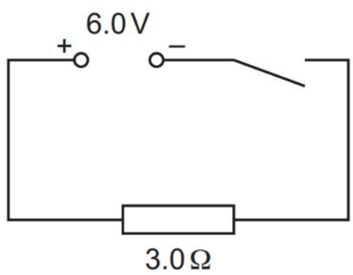
	wavelength of infrared radiation	time taken for infrared radiation to reach the Earth
A	longer than wavelength of light	8 minutes
B	longer than wavelength of light	much less than 8 minutes
C	shorter than wavelength of light	8 minutes
D	shorter than wavelength of light	much more than 8 minutes

24. Two metal spheres X and Y are on insulating bases. Both spheres are negatively charged.

Sphere X is moved towards sphere Y until they almost touch.
Which diagram shows the final pattern of charges?



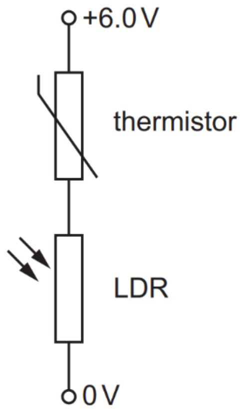
25. The circuit shown is switched on for 1.0 minute.



How much charge passes through the 3.0 Ω resistor?

A 2.0 C   B 12 C   C 120 C   D 720 C

26. A thermistor and a light-dependent resistor (LDR) are connected in series. A potential difference (p.d.) of 6.0 V is applied across them as shown.



The thermistor has a resistance of 6000 Ω in a cold room and 1000 Ω in a warm room. The LDR has a resistance of 2000 Ω in dim light and 500 Ω in bright light.

When is the p.d. across the LDR equal to 2.0 V?

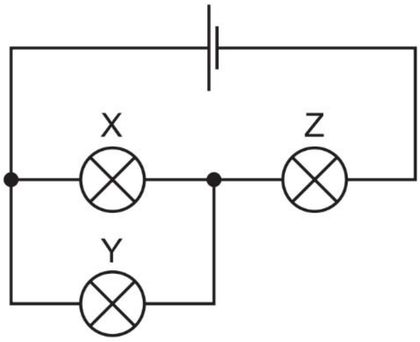
A in a cold room with bright light
B in a cold room with dim light
C in a warm room with bright light
D in a warm room with dim light

27. A copper wire has a resistance of 2.0 Ω.
A second copper wire is twice as long as the first wire, and its diameter is twice the diameter of the first wire.

What is the resistance of the second wire?

A 1.0 Ω   B 2.0 Ω   C 8.0 Ω   D 16.0 Ω

28. The circuit diagram shows a cell connected to three identical lamps X, Y and Z. All the lamps are lit.



Lamp Y is removed by unscrewing it from its holder.

What happens to lamp Z?

A It goes out completely.
B It becomes dimmer but stays lit.
C It stays the same brightness.
D It becomes brighter.

29. A desk lamp should have a 3 A fuse fitted, but a 13 A fuse has been fitted by mistake. The lamp is not faulty.

The lamp is switched on. What happens?

A The fuse blows.
B The fuse does not blow but the lamp does not light.
C The lamp draws too much current and the supply cables could melt.
D The lamp works normally.

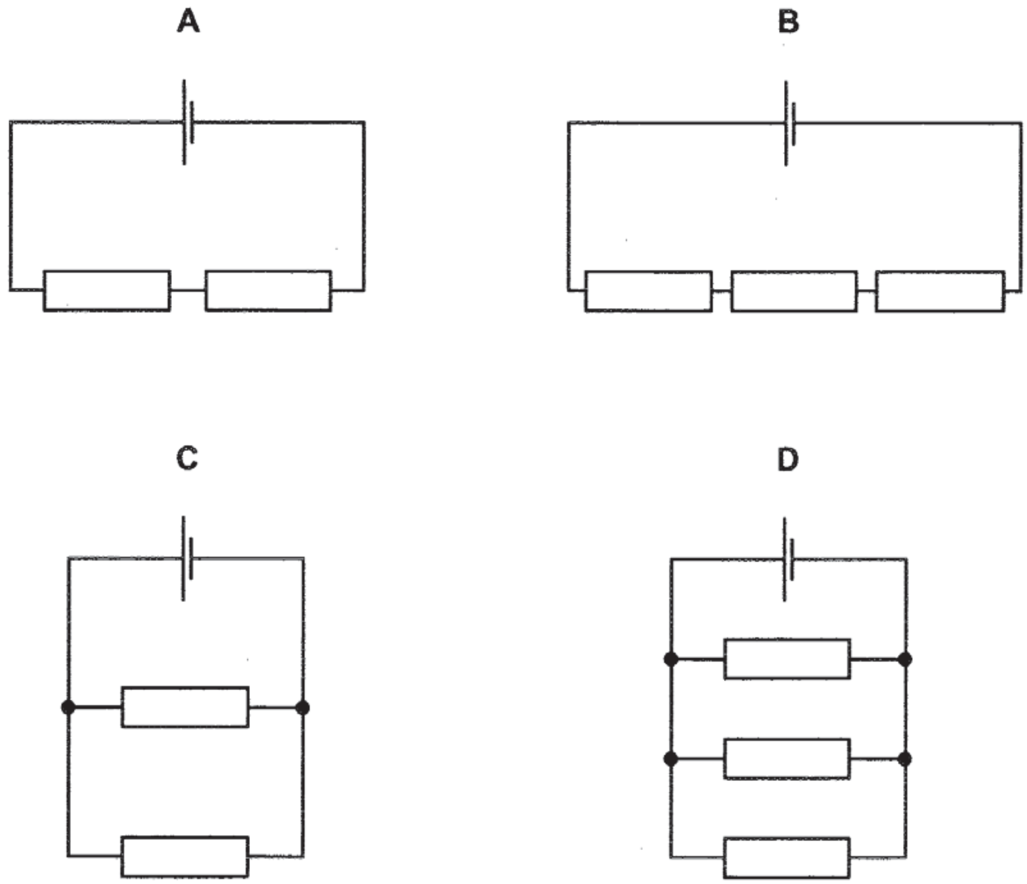
30. A microwave oven uses 6.0 A of current when plugged into a 240 V mains supply. It is used for two minutes each day and electricity costs \$0.24 per kWh.

What is the cost of using it for a year (365 days)?

A \$4.20
B \$11.50
C \$420
D \$691

31. The circuits show a cell joined to different combinations of identical resistors.

In which circuit is electrical energy transformed at the greatest rate ?



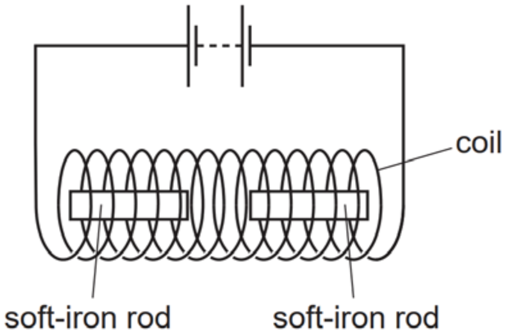
32. An old and expensive steel watch becomes magnetised.

The owner wants to use the watch again. He must demagnetise the watch.

What is the **best** method to do this?

A Insert the watch in a solenoid that carries alternating current and then slowly remove it.
B Insert the watch in a solenoid that carries direct current and then slowly remove it.
C Pass alternating current through the watch.
D Pass direct current through the watch.

33. Two soft-iron rods are placed end to end inside a coil which is connected to a battery.



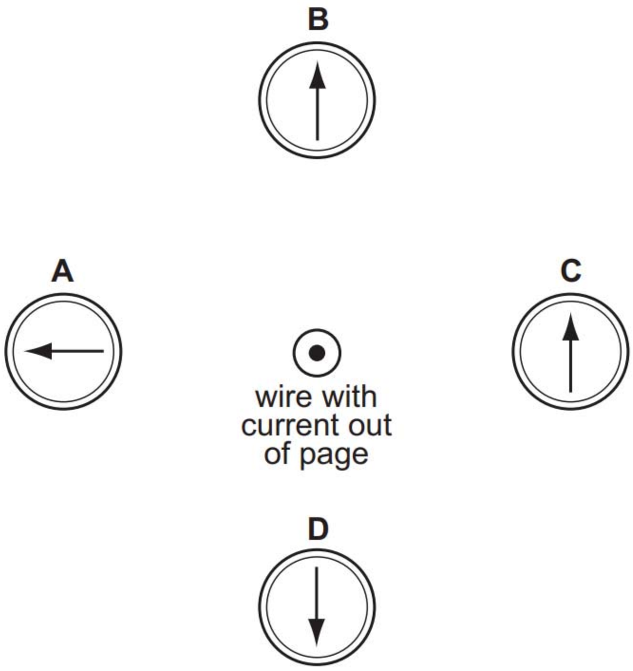
The connections from the battery to the coil are now reversed.

What happens to the soft-iron rods in each case?

	battery connections as shown	battery connections reversed
A	rods attract	rods attract
B	rods attract	rods repel
C	rods repel	rods attract
D	rods repel	rods repel

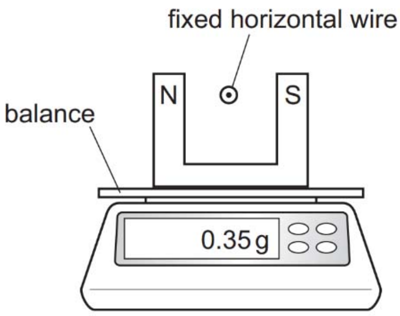
34. A wire perpendicular to the page carries an electric current in a direction out of the page. There are four compasses near the wire.

Which compass shows the direction of the magnetic field caused by the current?

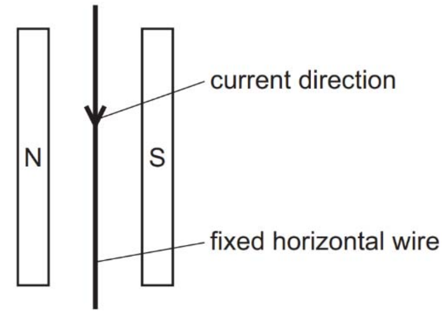


35. The diagrams show a horizontal wire in a magnetic field.
The horizontal wire is firmly held at each end (not shown) and cannot move.
The magnets and holder are on a balance.

When there is no current in the wire, the reading on the balance is 0.35 g.



view from side



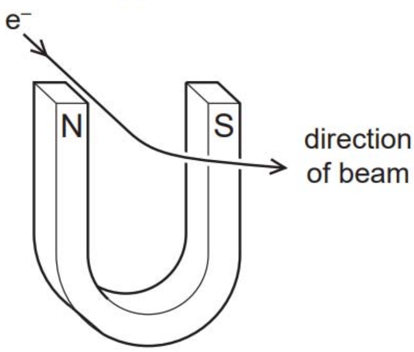
view from above

There is a d.c. current in the wire, as shown.
What happens to the reading on the balance?

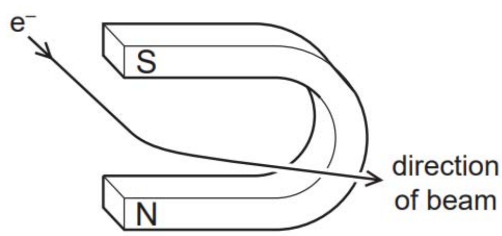
A smaller than 0.35 g
B no change
C changing from smaller to larger than 0.35 g repeatedly
D larger than 0.35 g

36. A beam of electrons is passed through the magnetic field of a magnet. How must the magnet be positioned to deflect the beam in the direction shown?

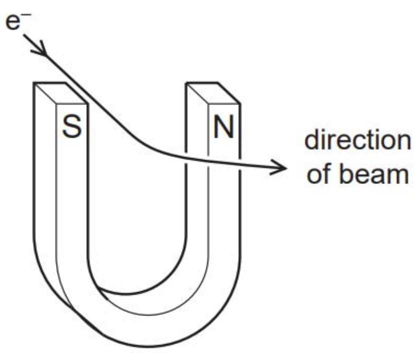
A



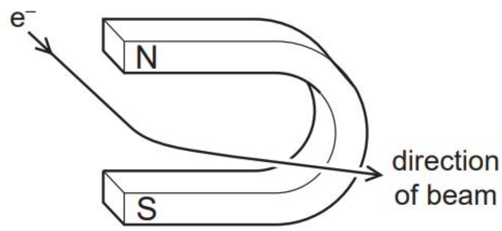
B



C



D



37. Diagram 1 shows a coil of wire P between the poles of a magnet. The ends of coil P are connected to a battery by slip rings.

Diagram 2 shows a coil of wire Q between the poles of a different magnet. The ends of coil Q are connected to a battery by a split-ring commutator.

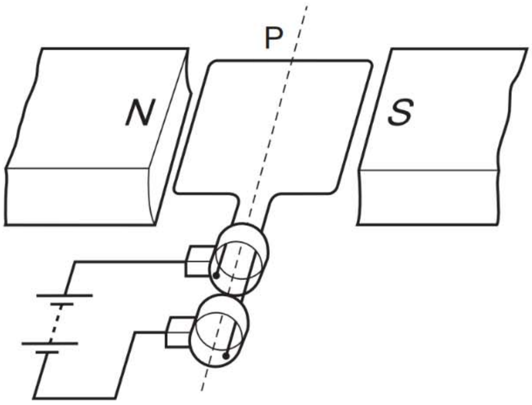


diagram 1

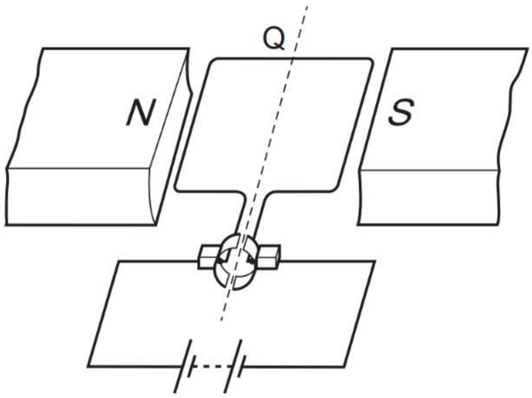
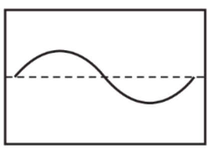


diagram 2

What happens to coils P and Q?

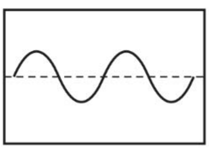
	coil P	coil Q
A	continuously turns anticlockwise	makes one quarter turn anticlockwise then stops
B	continuously turns clockwise	makes one quarter turn clockwise then stops
C	makes one quarter turn anticlockwise then stops	continuously turns anticlockwise
D	makes one quarter turn clockwise then stops	continuously turns clockwise

38. The coil of an a.c. generator is rotated and the output is displayed on the screen of a cathode-ray oscilloscope (c.r.o.).
The diagram shows the trace on the screen.

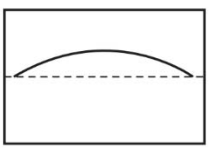


Which trace appears on the screen when the speed of rotation of the coil is doubled but the settings on the c.r.o. are unaltered?

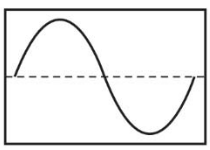
A



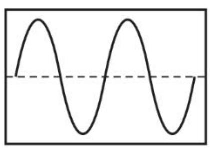
B



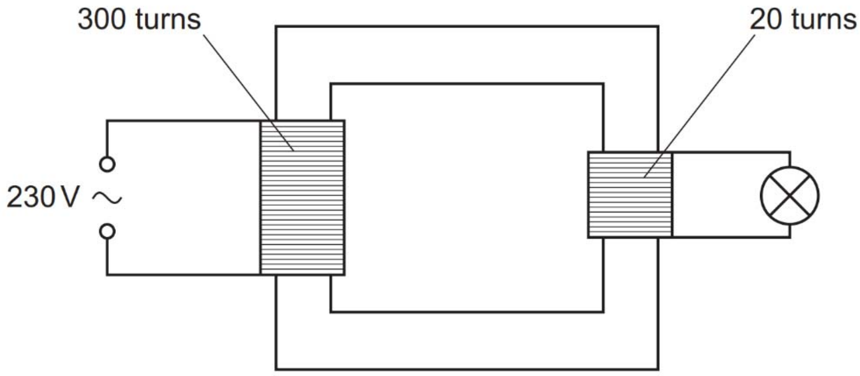
C



D



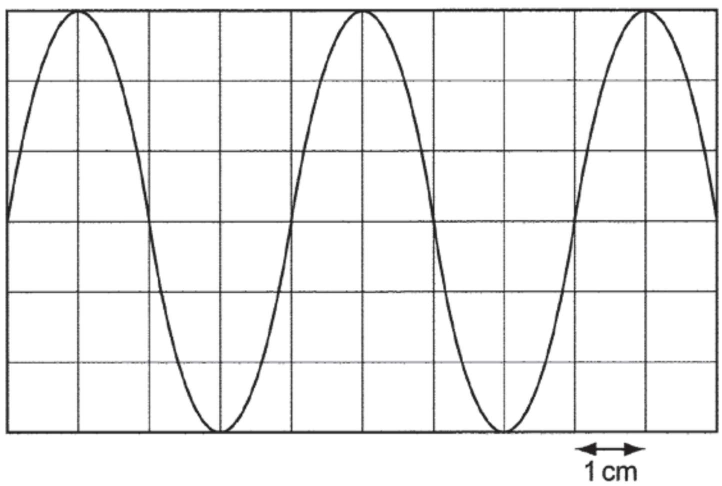
39. A student uses a transformer to light a filament lamp using a 230 V a.c. supply. The lamp has a maximum voltage rating of 6.0 V.



What happens when the circuit is switched on?

A The lamp does not light at all.
B The lamp lights dimly.
C The lamp lights at normal brightness.
D The lamp lights up brightly and then goes out.

40. An alternating supply with a period of 0.020 s is connected to a cathode-ray oscilloscope (c.r.o.).



What is the time-base setting of the c.r.o. ?

A 0.2 ms/cm B 0.5 ms/cm C 2 ms/cm D 5 ms/cm

END OF PAPER

YUYING SECONDARY SCHOOL
PRELIMINARY EXAMINATION
Secondary 4 Express

NAME			
CLASS		**REG. NO**	

PHYSICS **6091/2**

Paper 2 **29 August 2022**

1 hour 45 minutes

Candidates answer on the Question Paper. **Setter: Mr Soh Wei Yong**
No additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided on the Question Paper.

Section B
Answer all **three** questions. The last question is in the form either/or and only one of the alternatives should be attempted.
Write your answers in the spaces provided on the Question Paper.
Write your answers on the writing papers provided.

The use of an approved calculator is expected, where appropriate.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Total	**80**

This document consists of **27** printed pages.

Section A

Answer **all** the questions in this section in the spaces provided.
The total mark for this section is 50.

1. Fig. 1.1 is a distance-time graph showing the motion of an object.

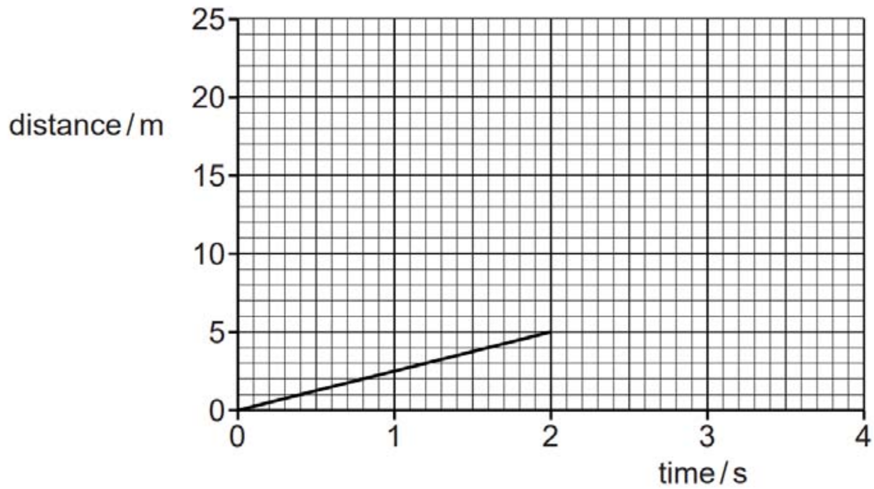


Fig. 1.1

(a) (i) Describe the motion shown for the first 2 s, calculating any relevant quantity. [1]

____

____

(ii) After 2 s the object accelerates. On Fig. 1.1, sketch a possible shape of the graph for the next 2 s. [1]

(b) Describe how a distance-time graph shows an object that is stationary. [1]

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(c) Fig. 1.2 shows the axes for a speed-time graph.

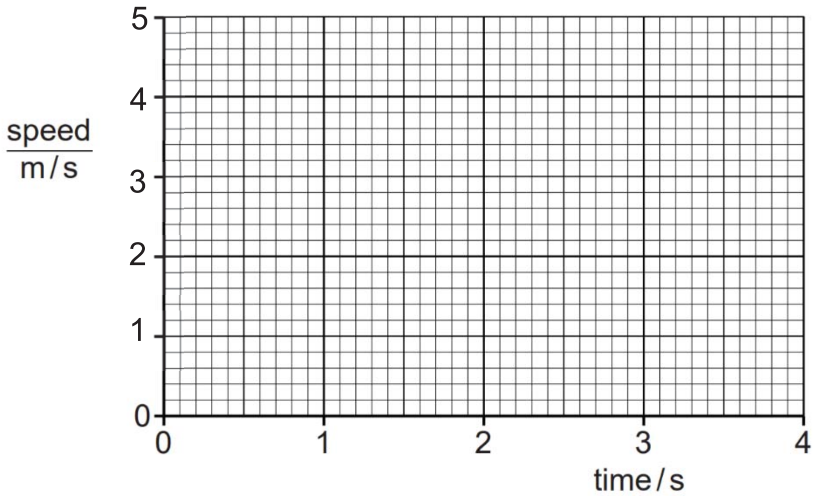

Fig. 1.2

On Fig. 1.2, draw

(i) the graph of the motion for the first 2 s as shown in Fig. 1.1, [1]

(ii) an extension of the graph for the next 2 s, showing the object accelerating at a constant rate 1.0 m/s^2. [1]

2. The rocket shown in Fig. 2.1 is about to be launched.

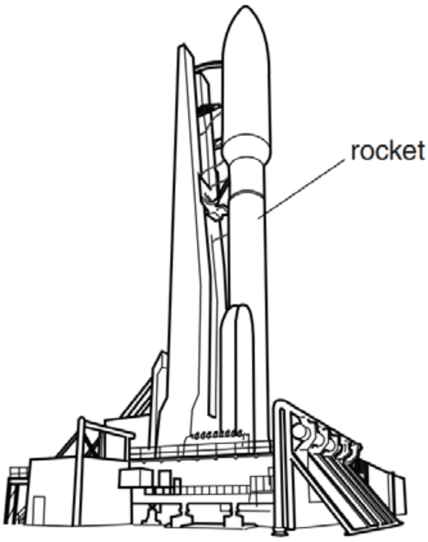

Fig. 2.1

The total mass of the rocket and its full load of fuel is 2.8×10^6 kg. The constant force provided by the rocket's motors is 3.2×10^7 N.

The gravitational field strength, g near the surface of the Earth is 10 N/kg.

(a) Calculate the vertical acceleration of the rocket immediately after lift-off. [2]

(b) Suggest one reason why the acceleration of the rocket increases as it rises above the Earth's surface. [1]

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(c) As the rocket burns fuel, it ejects hot gas downwards.

Explain how Newton's third law of motion applies to the force on the rocket. [2]

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3. A microphone in a recording studio has a mass of 0.55 kg. The gravitational field strength, g is 10 N/kg.

The microphone is suspended from the ceiling by a cord attached to a small ring. Fig. 3.1 shows the microphone pulled to one side and kept stationary by a horizontal thread.

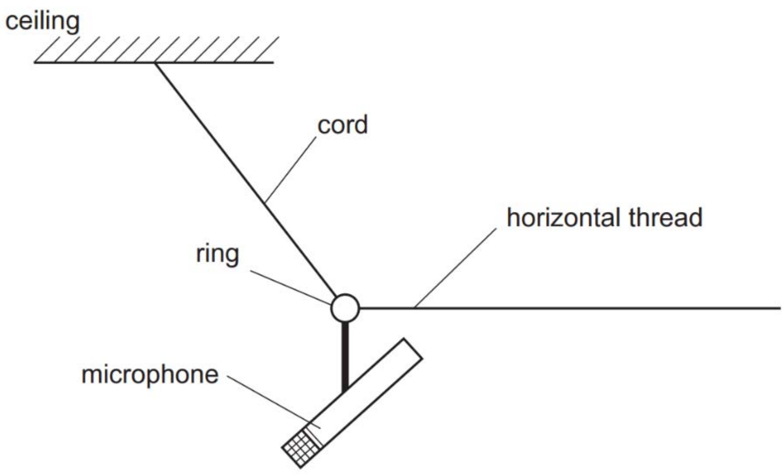

Fig. 3.1 (not to scale)

The tension T in the cord is 8.0 N.

Use a scaled vector diagram to determine the size of the force exerted by the horizontal thread on the ring. State your scale clearly. [3]

scale : ________________________

size of force by horizontal thread: ______________________

4. When the lid of a freezer is opened, it pivots about the hinge at the back of the freezer. The handle is at the front.
Fig. 4.1 is a side view of the freezer.

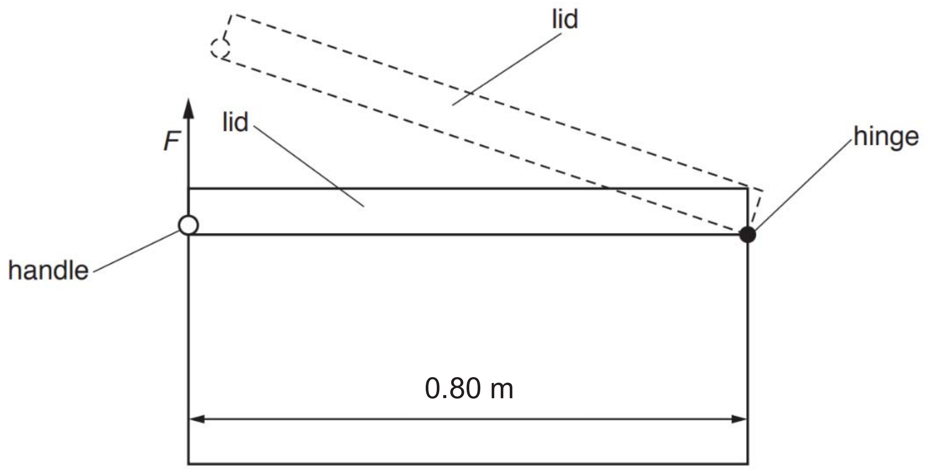

Fig. 4.1

The handle is 0.80 m from the hinge. The lid has a mass of 2.0 kg. The lid is non-uniform and its centre of gravity is at a distance of 0.45 m from the handle.

The gravitational field strength g is 10 N kg.

(a) The lid is closed. To open the lid, a force F is applied to the handle as shown in Fig. 4.1.

Determine the size of force, F required to open the lid. [2]

(b) The direction of F is vertically upwards and F is the smallest possible force that opens the lid.

A force on the handle in any other direction must be larger than F in order to open the lid. Explain why. [1]

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5. Fig. 5.1 shows a container of gas connected to a manometer. The tube in the manometer has a constant cross-sectional area.

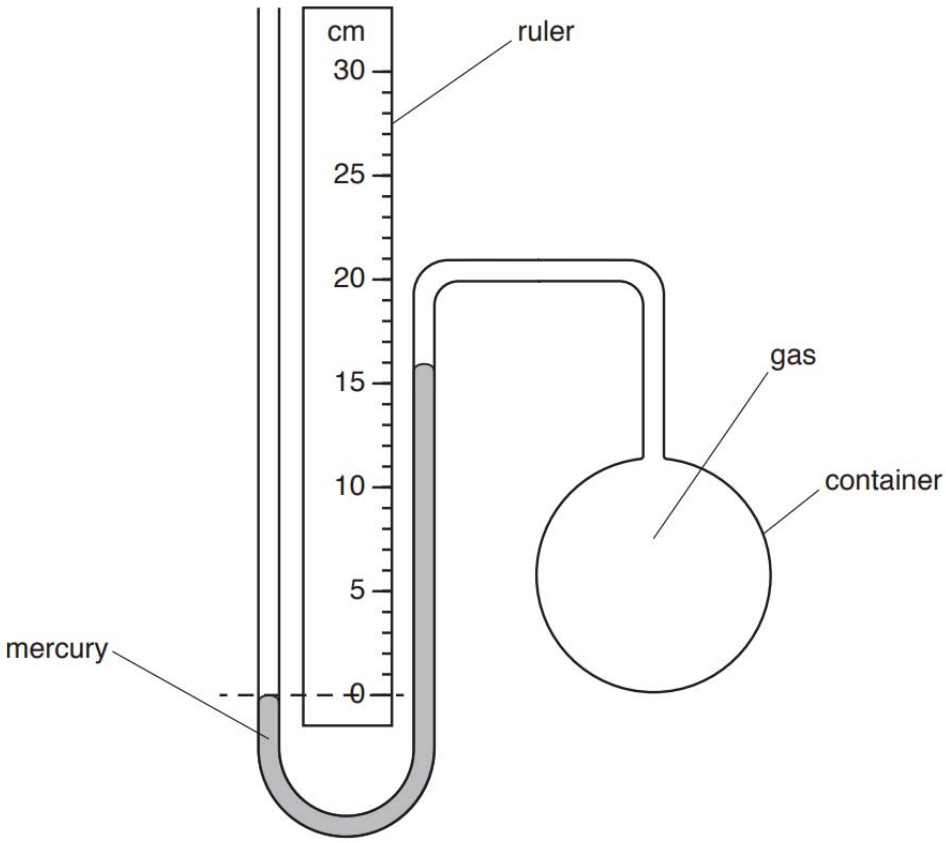

Fig. 5.1

The density of mercury is 1.4×10^4 kg/m^3. The gravitational field strength g is 10 N/kg. The pressure of the atmosphere is 76 cm Hg.

(a) Calculate the pressure of the gas **(in Pa)** in the container. [2]

(b) In Fig. 5.1, the mercury level on the left-hand side of the manometer is lower than on the right-hand side.
The gas inside the container is heated. This causes the mercury levels on both sides to become the same.

(i) Determine the mercury level, as shown on the ruler, when this happens. [1]

___

(ii) Explain, in terms of the gas molecules, what causes the level of mercury to become the same. [2]

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6. Fig. 6.1 shows a kettle containing water placed on the burner of a gas cooker.

Fig. 6.1

The gas burner is lit at time t = 0.
At t = 250 s the temperature of the water is 100 °C, the boiling point of water.

(a) Fig. 6.2 shows how the temperature of the water changes with time t.

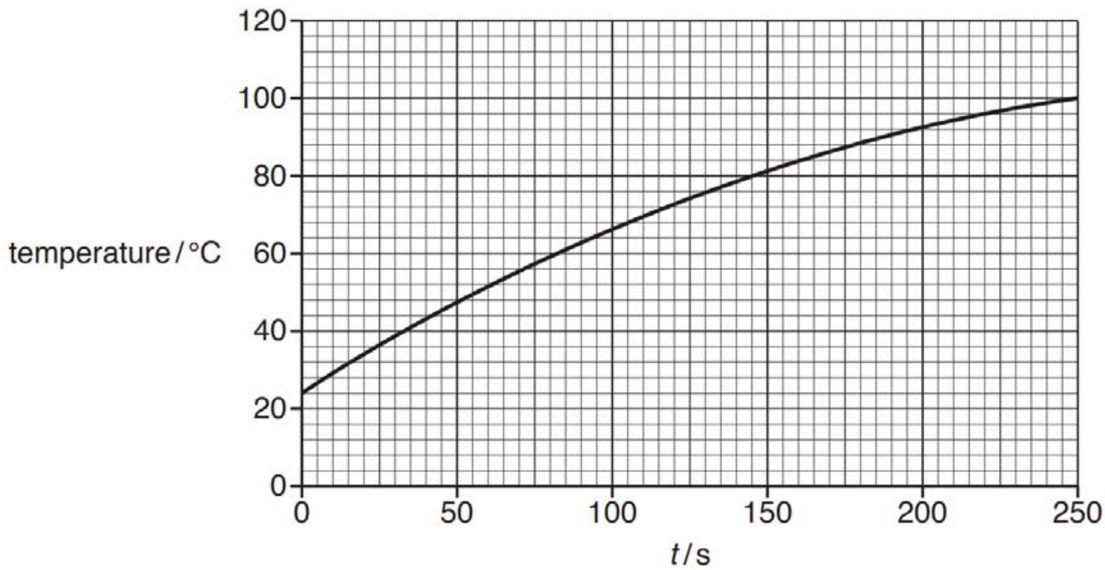

Fig. 6.2

(i) The kettle contains 1.5 kg of water which has a specific heat capacity of 4200 J/(kg °C).
Using Fig. 6.2, determine the increase in the internal energy of the water between t = 0 and t = 250 s. [2]

(ii) Thermal energy (heat) is transferred to the water at a constant rate but the temperature of the water increases at a rate that is not constant, as shown in Fig. 6.2.

Explain why the temperature increases in this way. [1]

(b) When the temperature reaches 100 °C, the kettle is left on the burner. Thermal energy is still supplied to the water. The water boils as the molecules form bubbles and rise to the surface.

Explain, in terms of the molecules, why it is necessary to supply thermal energy in order to keep the water boiling. [2]

7. Figs. 7.1 and 7.2 show a semi-circular glass block as rays of blue light are directed into the block at different angles. The rays are directed towards the centre C of the semi-circle so that no refraction occurs as the rays enter the block.

(a) At the angle shown in Fig. 7.1, no refracted ray emerges from the block at C.

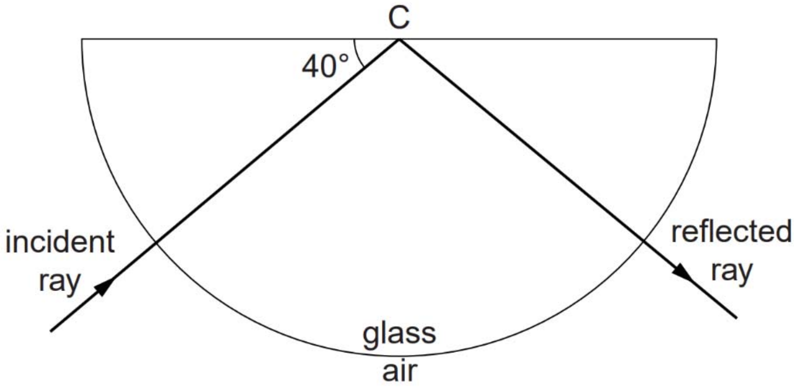

Fig. 7.1

(i) Determine the angle of incidence at C. [1]

(ii) State and explain the type of phenomenon occurring at C. [2]

(b)

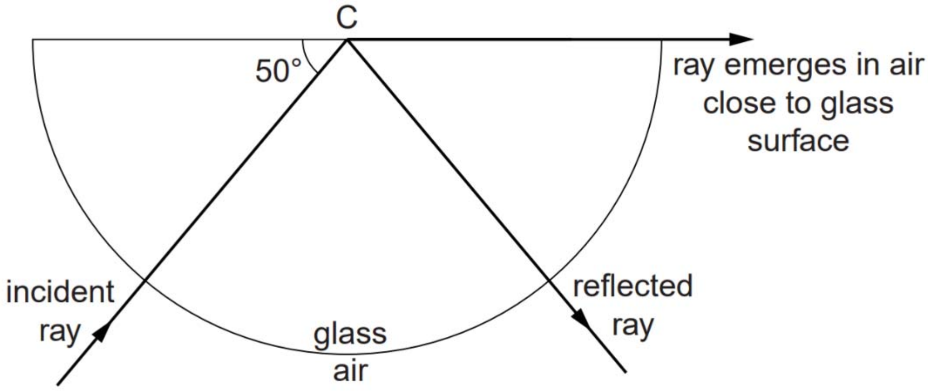

Fig. 7.2

Calculate the refractive index of the glass. [2]

(c) The experiment in **(b)** is now repeated with red light. The refractive index of red light in the glass block is smaller than the refractive index of blue light.

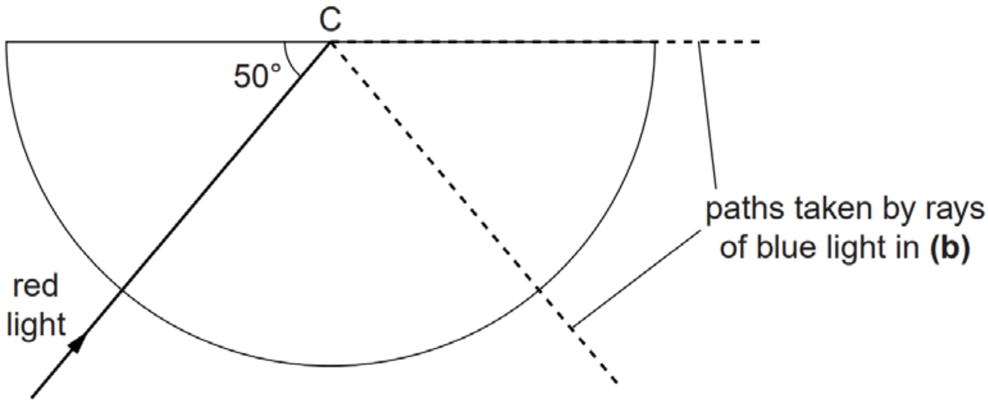

Fig. 7.3

On Fig. 7.3, draw and label the paths of the reflected and refracted rays of red light. The dashed lines show the paths taken by the blue light in **(b)**. [2]

8. Fig. 8.1 shows the position of a man working in a rock quarry. A single explosion is used to break part of one rock face.

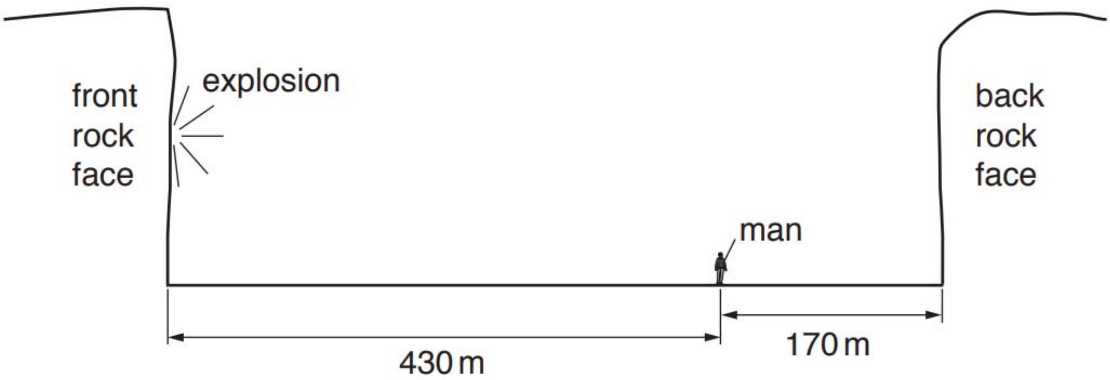

Fig. 8.1

(a) The man hears a second bang shortly after the first bang.

State and explain how the second bang compares with the first bang in terms of its amplitude and wavelength. [3]

(i) amplitude: ______________________________

____

(ii) wavelength: ______________________________

____

____

(b) The man stands 170 m from the back rock face. The time between hearing the first bang and hearing the second bang is 1.0 s.

Use the information in Fig. 8.1 to determine the speed of sound in the quarry. [2]

9. Fig. 9.1 shows a wire PQ placed between the poles of a magnet. There is a current in wire PQ.

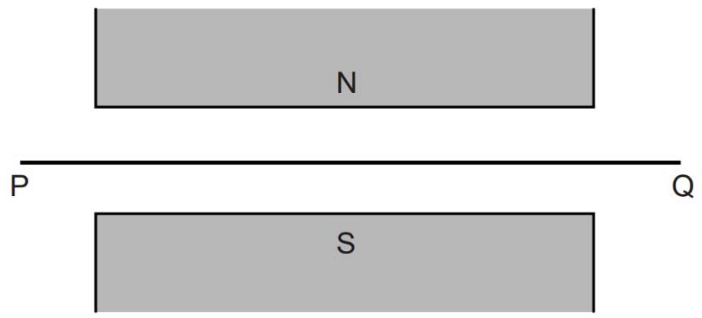

Fig. 9.1

(a) The force on PQ is into the paper.
Draw an arrow on PQ to show the direction of the current. [1]

(b) Explain the method you used to determine the direction of the current in part **(a)**. [2]

10. A straight length of copper wire lies horizontally between the poles of a U-shaped magnet.

Fig. 10.1 shows the two ends of the wire connected to a very sensitive, centre-zero ammeter.

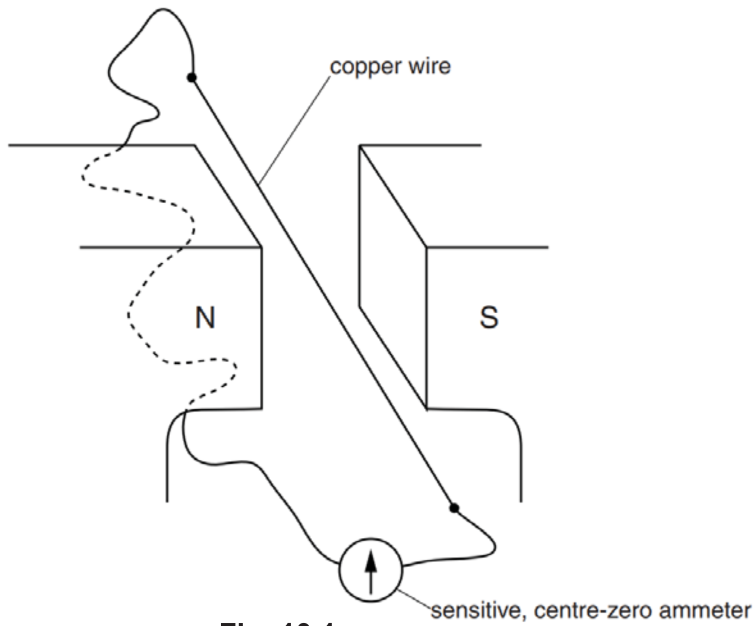

Fig. 10.1

The copper wire is moved upwards slowly between the two magnetic poles. The needle on the ammeter deflects to the right.

(a) Explain why the needle on the ammeter deflects. [2]

____

____

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____

(b) The wire is moved downwards very quickly between the two magnetic poles. State what happens to the needle on the ammeter. [1]

____

(c) State and explain what happens to the needle on the ammeter when the copper wire is moved horizontally between the two poles. [2]

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11. Fig. 11.1 shows a laptop and a charger. The charger contains a step-down transformer.

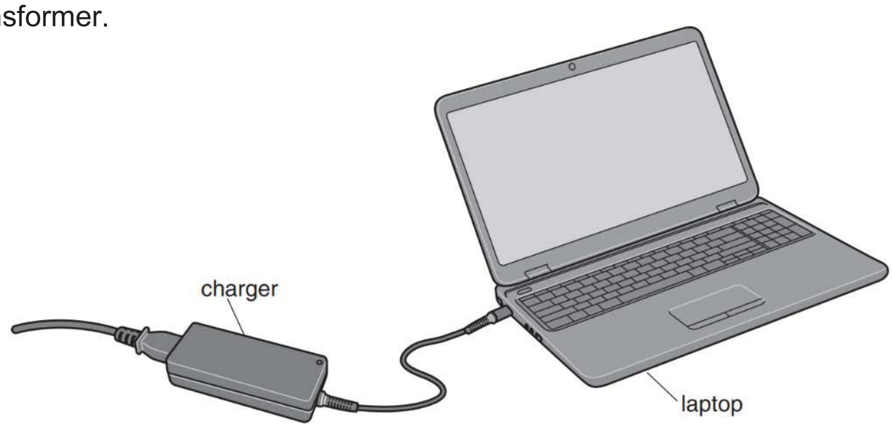

Fig. 11.1

(a) (i) Explain the function of a step-down transformer. [1]

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____

____

(ii) The transformer has an input voltage of 240V and an output voltage of 12V. There are 10 000 turns on the input coil. Calculate the number of turns on the output coil. [1]

(b) Electricity is transmitted at high voltages.
State two advantages of transmitting electricity in this way. [2]

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Section B

Answer **all** the questions in this section in the spaces provided.
The last question is in the form either/or and only **one** of the alternatives should be attempted.
The total mark for this section is 30.

12. A length of fuse wire is cut into two pieces X and Y. Each piece of wire is clamped, in turn, between two metal clips, as shown in Fig. 12.1.

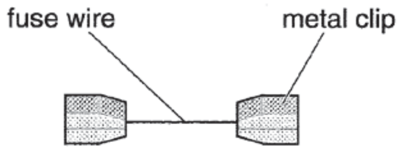

Fig. 12.1

The length of wire between the clips is 1.5 cm for wire X and 0.4 cm for wire Y.

(a) The potential difference (p.d.) across each wire is slowly increased. The p.d. is measured at various values of current until the wire melts. Fig. 12.2 shows the readings obtained.

	wire X	wire Y
current / A	p.d. / V	p.d. / V
0	0	0
0.5	0.15	0.04
1.0	0.30	0.08
1.5	0.49	0.14
2.0	0.77	0.23
2.5	1.19	0.37
3.0	1.99	0.70
3.5	2.98	1.10
3.8	melts	1.50
4.0		melts

Fig. 12.2

(i) Using data from Fig. 12.2, describe the relationship between the current in X and the p.d. across X [2]

1. for low currents, ______________________________________

____

____

2. for high currents, ______________________________________

____

____

(ii) The data in Fig. 12.2 provide some evidence of a relationship between the length of the wire and the current that causes it to melt.
State this possible relationship. [1]

____

____

(iii) With the same current, the p.d. across the two wires is different.
Explain why. [2]

____

____

____

(b) The experiment is repeated with a strong wind blowing over the wires.
Fig. 12.3 shows the new readings obtained at low currents.

	wire X	wire Y
current / A	p.d. / V	p.d. / V
0.5	0.14	0.03
1.0	0.28	0.06

Fig. 12.3

(i) Suggest a reason why the values of the p.d. at the same current are lower in Fig. 12.3 than in Fig. 12.2. [1]

____

____

(ii) Suggest one other difference that is seen when readings at values of current greater than 1.0 A are compared to those in Fig. 12.2. [1]

____

____

(c) Just before each wire melts, the middle of the wire in Fig. 12.1 becomes red hot.

(i) Describe **two** ways in which thermal energy (heat) is lost from the middle of the wire. [2]

(ii) Explain why the ends of the wire are colder than the middle. [1]

13. A student sets up the circuit shown in Fig. 13.1 in a laboratory at room temperature.

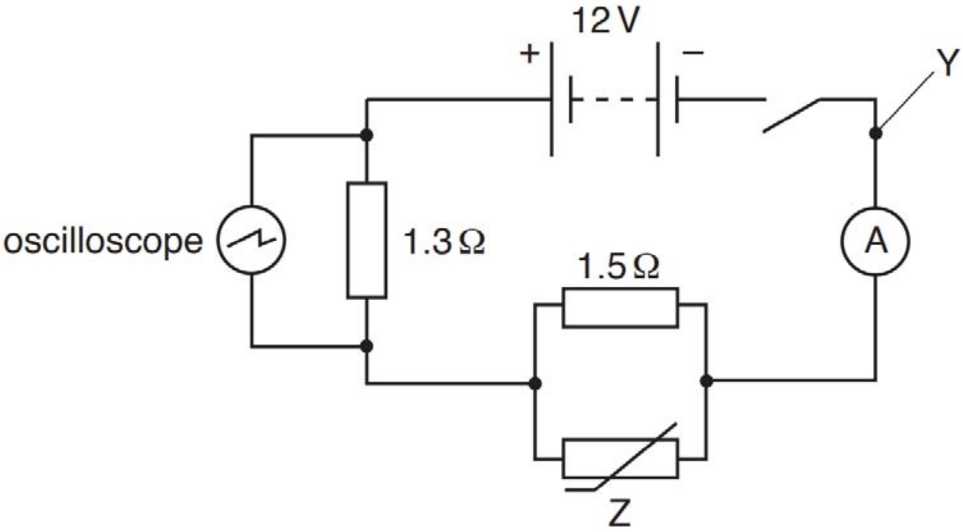

Fig. 13.1

The electromotive force (e.m.f.) of the battery is 12 V.

The switch is closed.

(a) The connecting wires in the circuit are made from copper covered by insulating plastic.

State the name of the particles that flow in the copper and state the direction in which they are flowing at point Y in the circuit. [1]

____

(b) At room temperature, the resistance of component Z is 6.0 Ω.

(i) State the name of component Z. [1]

____

(ii) Calculate the current measured by the ammeter. [2]

(iii) Calculate the potential difference (p.d.) across the 1.3 Ω resistor. [1]

(c) Fig. 13.2 shows the screen of the oscilloscope.

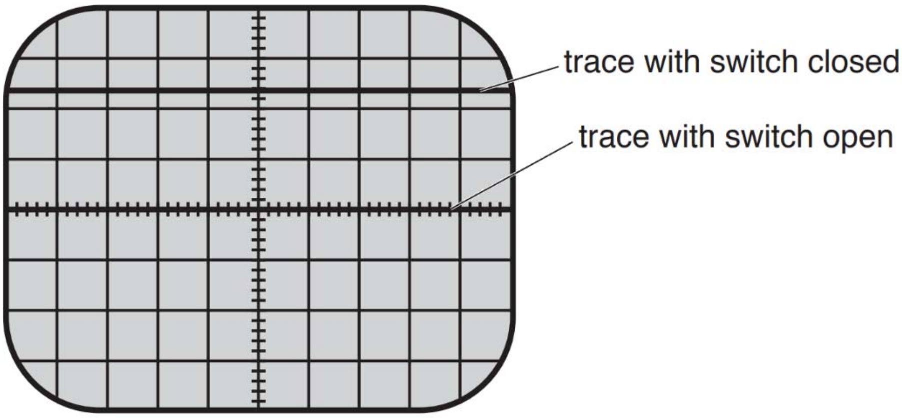

Fig. 13.2

Before the switch is closed, the trace is a horizontal line across the middle of the screen, as shown in Fig. 13.2.

When the switch is closed, the trace remains horizontal and moves up the screen.

(i) Use your answer in (b) (iii) to determine the Y-gain in V/div of the oscilloscope shown in Fig. 13.2 when the switch is closed. [2]

(ii) Component Z is heated.
State and explain what is observed on the oscilloscope screen as the temperature of Z increases. [3]

EITHER

14. Fig. 14.1 shows a large container ship travelling at constant speed in a straight line.

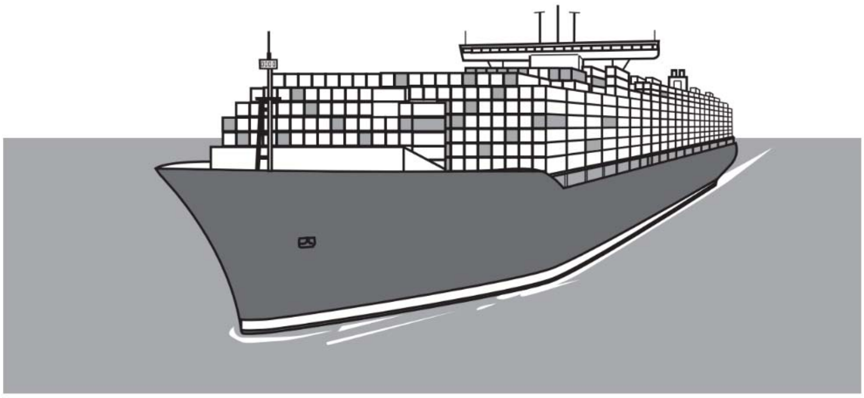

Fig. 14.1

The resistive force acting on the ship is 2.8×10^6 N.

(a) The ship is travelling at constant speed of 9.7 m/s.

(i) Calculate the work done against the resistive force on the ship in 2.0 s. [2]

(ii) The engines are powered by oil.
State the energy transfer that is taking place when the ship is travelling at constant speed. [1]

(iii) State the size of the forward force produced by the engines. [1]

(b) The mass of the ship is 2.2×10^8 kg.
The engines are switched off and the resistive force causes the ship to decelerate.

(i) Calculate the initial deceleration of the ship. [1]

(ii) As the speed of the ship decreases, its deceleration changes.
Suggest and explain how the deceleration changes. [2]

(iii) On Fig. 14.2, sketch a possible speed-time graph for the ship as it decelerates to rest. [1]

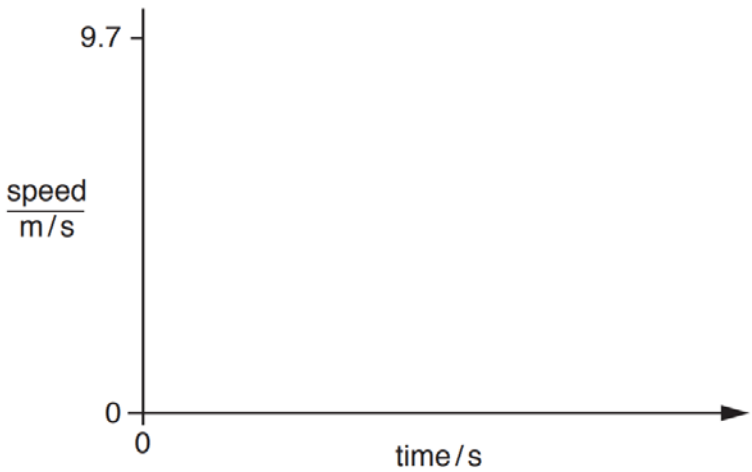

Fig. 14.2

(c) When the ship is travelling at a different speed, energy is being supplied to the engines at a rate of 33 MJ/s. The efficiency of the engines is 36%.

(i) State a relationship that defines efficiency. [1]

(ii) Calculate the rate at which energy is wasted in the engines. [1]

OR

14. (a) Fig. 14.1 shows a thunder cloud with a flat, positively charged base. It passes over a tall tree growing in a region of flat, open land.

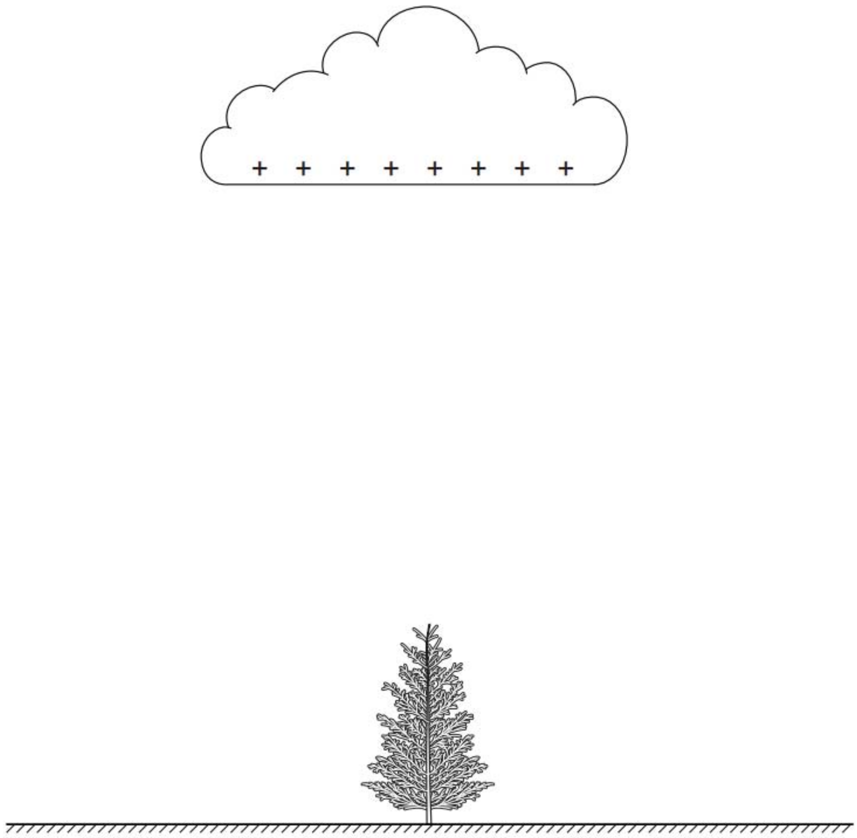

Fig. 14.1 (not to scale)

(i) On Fig. 14.1, mark the charge on the tree. [1]

(ii) Explain how the tree becomes charged. [2]

____

____

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____

(iii) A lightning strike occurs and, in 2.0×10^{-4} s, a charge of 560 C passes from the cloud to the tree.
The size of the charge on an electron is 1.6×10^{-19} C.

Calculate the number of electrons that pass between the tree and the cloud. [1]

(iv) Calculate the average current in the lightning strike. [1]

(b) Two flat metal plates are positioned horizontally, one above the other.
Fig. 14.2 shows the positive terminal of a high-voltage supply unit connected to the bottom plate and the negative terminal connected to the top plate.

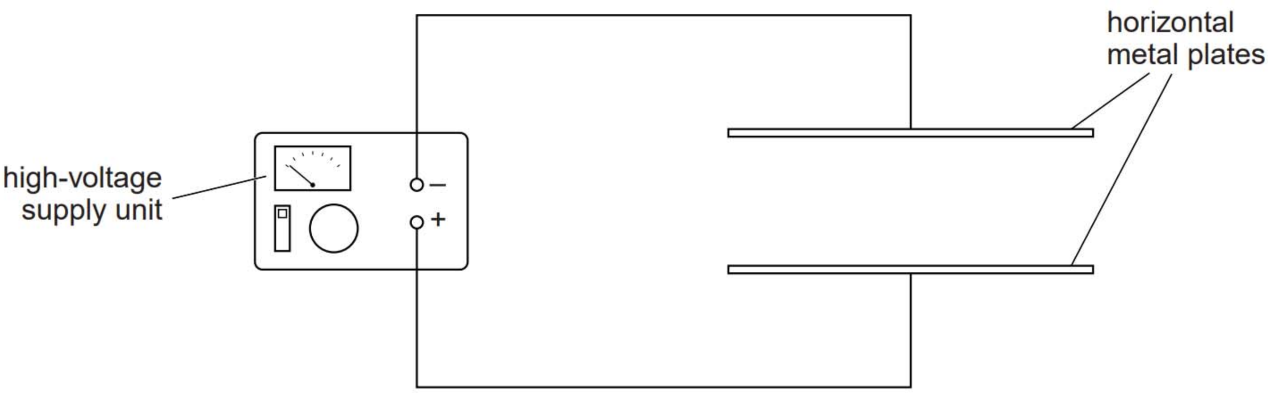


Fig. 14.2

The high-voltage supply is switched on.

(i) On Fig. 14.2, draw the shape and the direction of the electric field produced between the 2 metal plates. [1]

(ii) Explain why a small, charged oil droplet placed between the two metal plates accelerates upwards. [3]

(iii) The oil droplet touches the top metal plate. State and explain what happens to the charge on the oil droplet. [1]

END OF PAPER

PHYSICS 6091
PRELI EXAMINATION 2022
MARKING SCHEME

Sec. 4E

Paper 1 [40 marks]

1 B	6 A	11 C	16 D	21 A	26 C	31 D	36 B
2 B	7 B	12 D	17 A	22 B	27 A	32 A	37 C
3 D	8 C	13 B	18 B	23 A	28 B	33 A	38 D
4 A	9 B	14 D	19 B	24 C	29 D	34 C	39 D
5 D	10 C	15 D	20 D	25 C	30 A	35 A	40 D

Paper 2

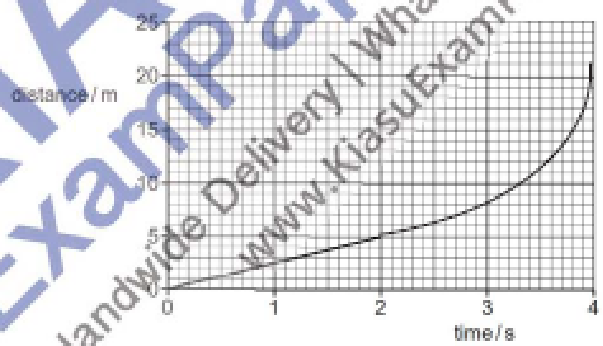
-1/2 for wrong unit used in each part question.
Final numerical answer should be given to a maximum of 3 significant figures, otherwise minus of 1/2 mark.
The total mark deducted for each part question should not exceed the mark allotted.

Section A [50 marks]

Answer **all** *the questions in the spaces provided.*

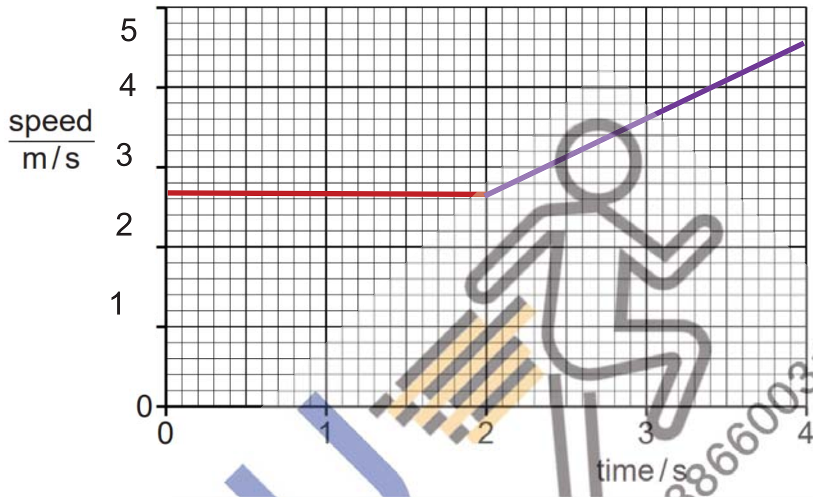
1. (a) (i) constant speed [1/2] of 2.5 m/s [1/2]

(ii)



Any graph with increasing gradient [1]

(b) distance is constant//zero gradient//horizontal line [1]

(c) 

(i) 1 mark, allow for e.c.f from (a) (i)
(ii) 1 mark for correct line

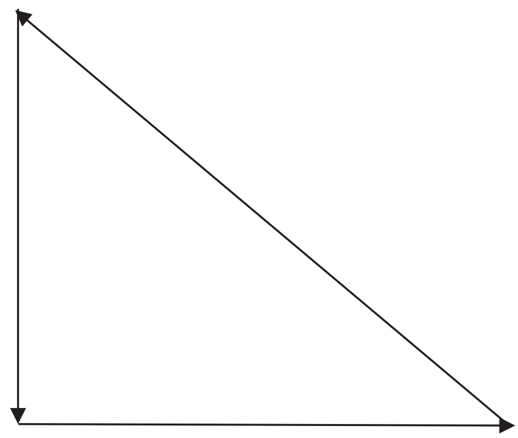
2. (a) Upthrust – weight = ma

$3.2 \times 10^7 - (2.8 \times 10^6)(10) = (2.8 \times 10^6)$ a [1]
a = 1.43 m/s^2 [1]

(b) **mass of rocket decreases** due to burning of fuel
OR **air resistance will decrease** due to smaller air density at greater height
Either answer will be 1 mark

(c) The rocket will exert a downward force on the hot gas, at the same time the **hot gas will exerts an upward force** [1] on the rocket that is **equal in magnitude.[1]**

3.



Correct triangle/vector diagram: [2]
Answer [1]

4. (a) clockwise moment = anticlockwise moment
(F x 0.8) = (20 x 0.35) [1]
F = 8.75 N [1]

(b) **The perpendicular distance** from pivot for any other direction will be **smaller than 0.8 m.** **[1]**

5. (a) Gas pressure = (76-16) cm Hg = 60 cm Hg
= (0.6)(14 000)(10) [1]
= 84 000 Pa [1]

(b) (i) 8 cm [1]

(ii) speed/K.E of the gas molecules increase [1/2]
Gas molecules will collide against the mercury will greater force or pressure of gas will increase [1/2]
The gas at higher pressure will push the mercury until it is equal to atmospheric pressure or no pressure difference [1]

6. (a) (i) Increase in internal energy = (1.5)(4200)(100-24) [1]
= 478 800 J [1]

(ii) **greater heat is lost (to the surroundings) at higher temperature** or **evaporation at higher temperatures is greater** **[1]**

(b) molecules separate / are pulled apart / are far apart / break bonds / overcome forces of attraction [1]
work done separating the molecules or molecules gain PE [1]

7. (a) (i) angle of incidence = 50° [1]

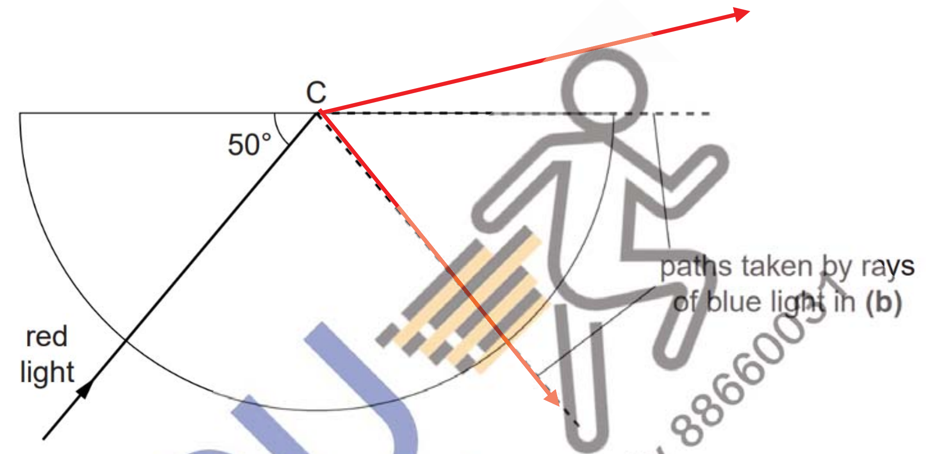
(ii) Total internal reflection [1]
Angle of incidence is greater than the critical angle [1]

(b) refractive index, $\eta = \frac{1}{\text{isnc}}$

$= \frac{1}{sin40}$ [1]

$= 1.34$ [1]

(c)



1 mark for refracted ray into air
1 mark for weak reflected ray

8. (a) State and explain how the second bang compares with the first bang in terms of its amplitude and wavelength. [3]

(i) amplitude: **lower [1/2]** as second bang has **lower energy level [1]**

(ii) wavelength: **same [1/2]** as the **speed & frequency is the same as the first bang. [1]**

(b) speed of sound = $\frac{difference\ in\ distance}{time\ interval}$

$= \frac{(2 \times 170)}{1}$ [1]

= 340 m/s [1]

9. (a) direction of current is right/PQ [1]

(b) Flemming left hand rule with labelled [1] drawing/diagram [1]

10. (a) Moving the wire upward will result **<u>changing in the magnetic field linking the wire/cutting of the magnetic lines of force</u>**, by Faraday Law, an e.m.f and current will be induced in the wire.

(b) **greater deflection** to the **left** [1]

(c) **No deflection** [1] as there is **no cutting of magnetic field line** [1] of forces by the conductor.

11. (a) (i) To make the **output voltage lower** than the input voltage. [1]

(ii)

$$\frac{N_s}{N_p} = \frac{V_s}{V_p}$$

$$\frac{N_s}{10\,000} = \frac{12}{240}$$

N_s = 500 turns [1]

(iii) The electricity is transmitted at very high voltage so that the **transmission current** will be **much smaller** since **P = VI**.
The smaller current will mean **lesser power/energy loss along the cables** that results from the **heating effect of the current.**

If current is lowered, **thinner cables** can be used, which will result in cost savings.

Section B [30 marks]

12. (a) (i) low currents: current in X **is linearly related** to p.d. across X **OR directly proportional** **[1]**

high currents: when current increases, p.d across **increases at increasing rate.** **[1]**

(ii) the shorter the wire, the larger the current required melt it [1]

OR the longer the wire, the smaller the current required melt it

(iii) They have **different resistance [1]** as **length affect resistance** **[1]**

(b) (i) The wires has **smaller resistance** [1/2] due to **lower temperature** [1/2]

(ii) The **current** that cause the wire **to melt will be higher.** [1]

(c) (i) By conduction as the wire is a good conductor of heat. [1]
By radiation in form of infra-red waves. [1]

(ii) As heat is conducted away by the metal clip. [1]

13. (a) electrons [1/2] ,

towards the positive terminal of the battery [1/2]
towards the ammeter or
away from the negative terminal

(b) (i) thermistor [1]

Total resistance, $R_T = \left(\frac{1}{6} + \frac{1}{1.5}\right)^{-1} + 1.3$
$= 2.5\ \Omega$ [1]

(ii) Current = 12/2.5
= 4.8 A [1]

p.d. across 1.3 Ω resistor = 1.3 x 4.8 = 6.24 V [1]

allow for e.c.f

(c) (i) Y-gain = 6.24/2.4 [1]
= 2.60 V/div [1]

(ii) resistance of Z / thermistor decreases [1]
resistance of parallel combination decreases or total resistance (of circuit) decreases or current increases
voltage (across 1.3 Ω) increases [1]
trace moves towards top of screen / upwards **[1]**

Either

14. (a) (i) W.D = force x dist

$= 2.8 \times 10^6 \times 9.7 \times 2$ [1]
= 5 432 0000 J [1]

(ii) chemical potential energy to thermal energy/internal energy [1]

(iii) forward force = 2.8×10^6 N [1]

(b) (i) F = ma
$a = -2.8 \times 10^6 / 2.2 \times 10^8$

$= -0.013\ m/s^2$

Initial deceleration = **$0.013\ m/s^2$** [1]

(ii) deceleration decrease [1]
As resultant force decrease/resistive force decrease [1]

(iii) curve with decreasing gradient [1]
Allow for e.c.f

(c) (i) The efficiency of a system is defined as the ratio of useful energy/power output to the energy/power input. [1]

(ii) Power wasted in the engines = 0.64 x 33 MJ/s
= 21.1 W or 21.1 MJ/s [1]

OR

14. (a) (i) negative charge on tree. [1]

(ii) tree gain electrons [1] from earth [1]

(iii) Number of electrons $= 560\ C / 1.6 \times 10^{-19}\ C$

$= 3.5 \times 10^{21}$ [1]

(iii) average current $= 560 / 2.0 \times 10^{-4}$
$= 2800000\ A$ [1]

(b) (i) parallel and equal spacing with upward direction [1]

(ii) oil droplet positively charged [1]
attraction/force on (droplet) and in direction of field/upwards [1]
force greater than weight (of droplet) or resultant force upward [1]

(iii) (droplet becomes) negative OR
(droplet) gains electrons [1]

********* END OF PAPER **********