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2022

SECONDARY 4

Express Exam Paper

Pure Physics (Set B)

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2	Bedok Green Sec	SA2
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BEATTY SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2022
SECONDARY FOUR EXPRESS

CANDIDATE NAME			
CLASS		REGISTER NUMBER	

PHYSICS **6091/01**

Paper 1 Multiple Choice **23 August 2022**

Setter: Mr Teng JB **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, class and register number on the Multiple Choice Answer Sheet 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.

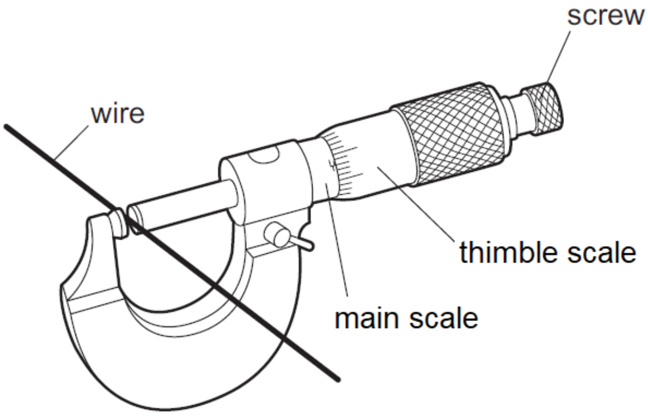
Read the instructions on the Answer Sheet very carefully.

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 and **0** blank pages.

[Turn over

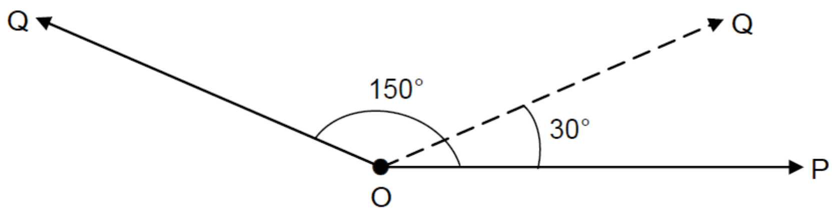
1 A micrometer is used to measure the diameter of a uniform wire.



What is done to obtain an accurate measurement?

A Make the micrometer horizontal and then use the scales to find the reading.
B Subtract the main-scale reading from the thimble-scale reading.
C Subtract the thimble-scale reading from the main-scale reading.
D Use the scales to find the reading and add or subtract any zero error.

2 Two forces P and Q act at a point O as shown below. The angle between their lines of action is varied between 30° and 150°.



If R is the resultant force acting on O, which statement about R is correct?

A R is always greater in magnitude than either P or Q.
B R is always smaller in magnitude than either P or Q.
C R is never in the same direction as either P or Q.
D R can be equal to the sum of the magnitudes of P and Q.

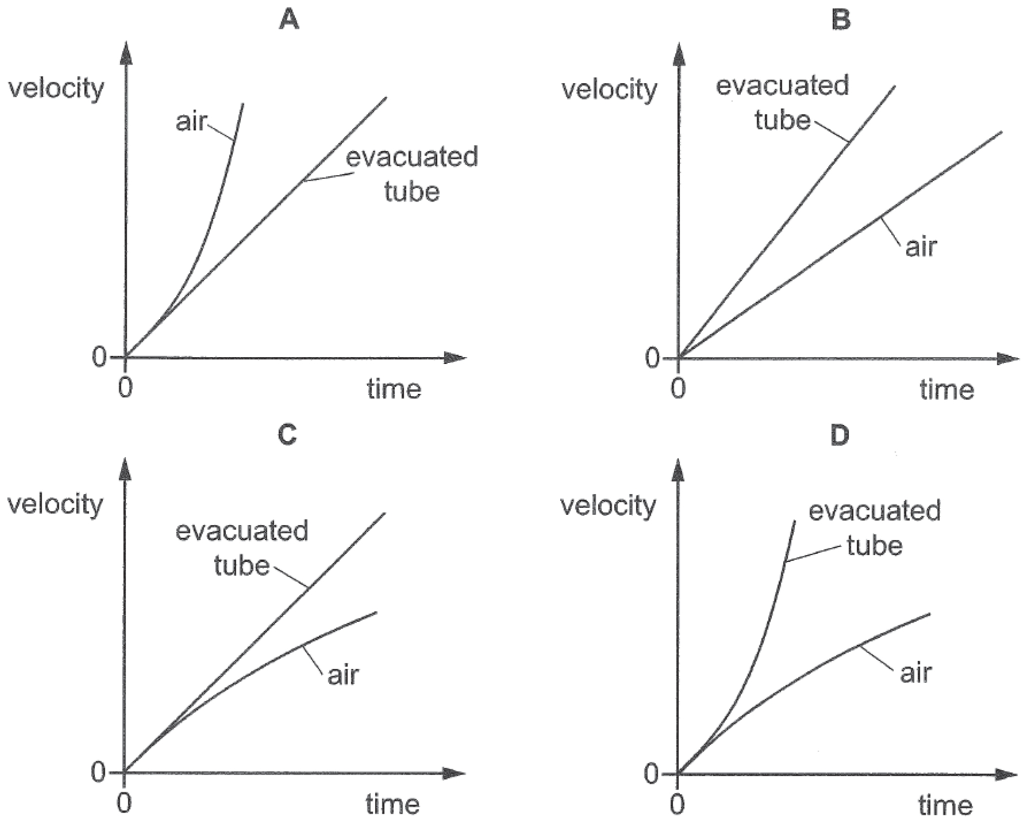
3 Which statement about the motion of an object is **not** correct?

A An object can have a constant speed but a varying velocity.
B An object can have a constant velocity but a varying speed.
C An object has no acceleration if it is moving with a uniform velocity.
D An object with zero velocity can have acceleration.

4 Two experiments were conducted to examine the change of velocity as a ball fall,

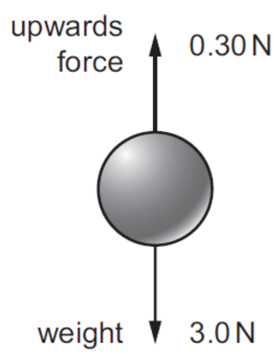
(1) through air and
(2) through an evacuated tube which has most of the air in it removed.

Which graph shows how the velocity of the ball changes with time in these cases?



5 A metal ball of weight 3.0 N is held below the surface of oil.

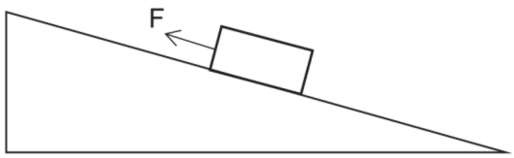
It experiences an upwards force of 0.30 N.



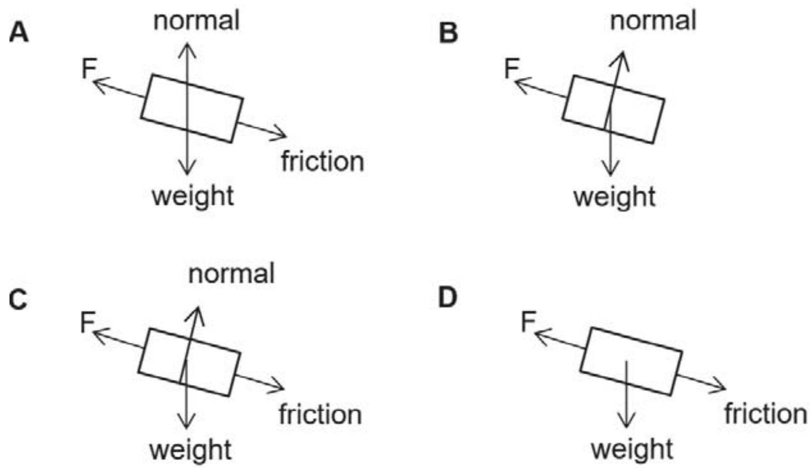
When the ball is released, what is its initial acceleration?

A 1.0 m/s^2 **B** 9.0 m/s^2 **C** 10 m/s^2 **D** 11 m/s^2

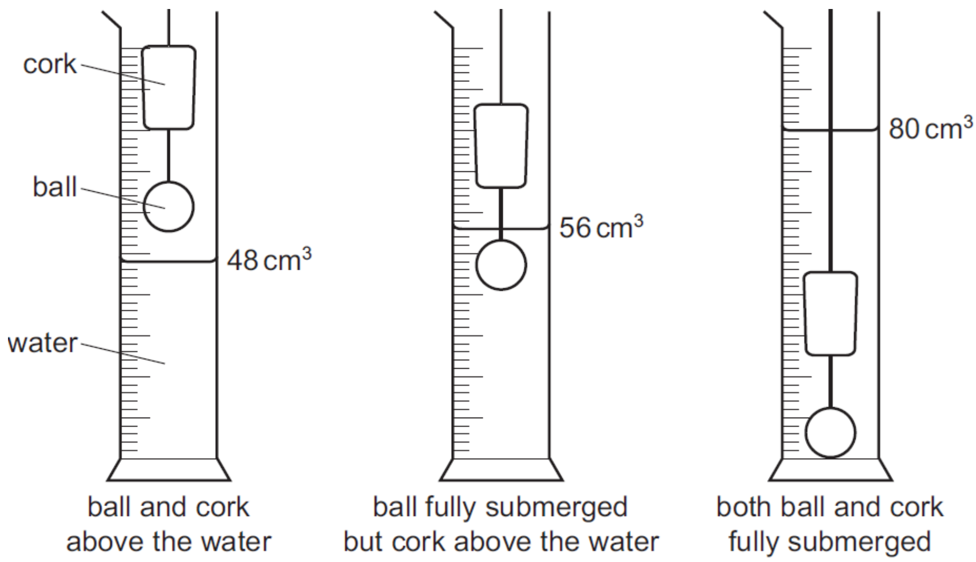
6 The diagram shows a box being moved up by a force, F, on a rough inclined plane. F is parallel to the inclined plane.



Which diagram correctly shows all the forces acting on the block?



7 A metal ball is attached to a cork and is lowered into a measuring cylinder, pulling the cork into the water, as shown.

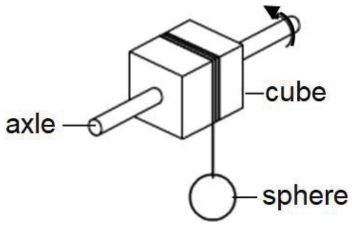


The mass of the cork is 4.8 g.

What is the density of the cork?

A 0.15 g/cm^3 **B** 0.20 g/cm^3 **C** 0.60 g/cm^3 **D** 5.0 g/cm^3

8 A cube of side 10 cm is attached to a rotating axle through the centre as shown.

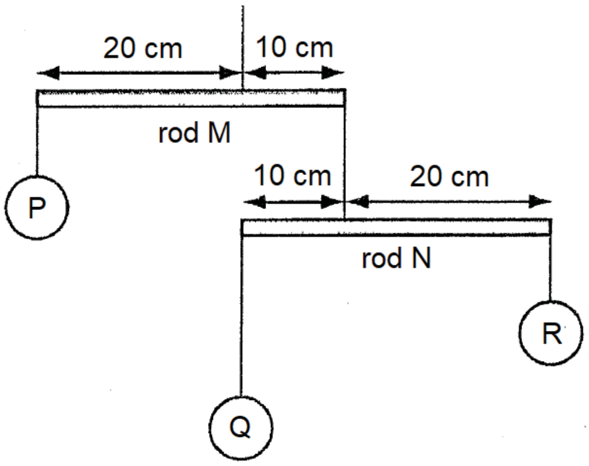


A 1.0 kg sphere is raised as the axle is rotated in an anti-clockwise direction.

What is the maximum moment due to the weight of the sphere about the centre of the axle?

A 0.50 Nm **B** 0.71 Nm **C** 1.00 Nm **D** 1.40 Nm

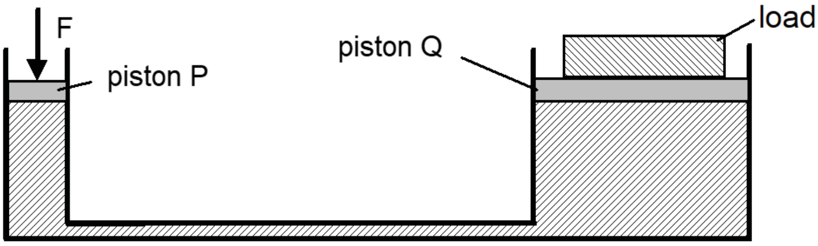
9 The diagram shows a decoration, which is made by suspending objects P, Q and R and light rods M and N. Both the rods are horizontal.



Which row gives a possible combination of the masses P, Q and R?

	mass of P / g	mass of Q / g	mass of R / g
A	10	10	10
B	15	10	10
C	15	20	10
D	20	40	20

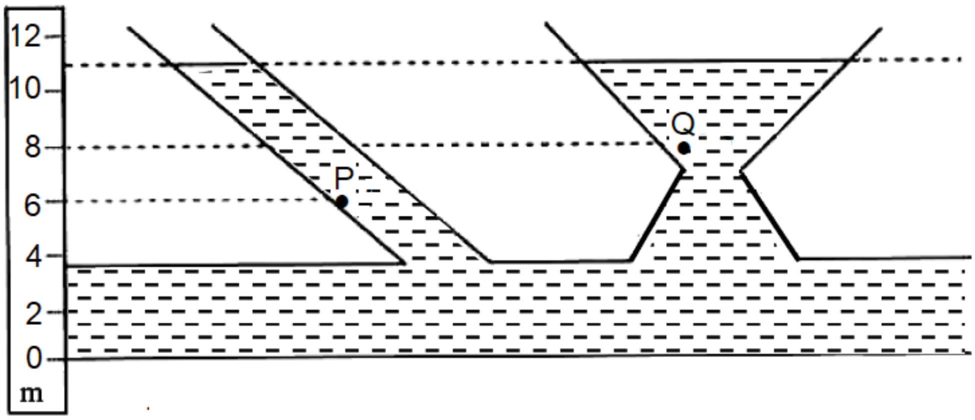
10 The diagram shows a hydraulic pump.



Which statement is true?

A The force F is equal to the weight of the load.
B The force F is greater than the weight of the load.
C The pressure on piston P is equal to the pressure on piston Q.
D The pressure on piston P is greater than the pressure on piston Q.

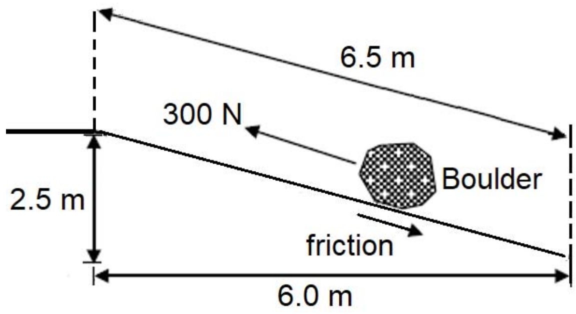
11 The diagram shows two vessels filled with oil of density 880 kg/m^3. The height of fluid in the vessels is 11 m.



What is the ratio of the liquid pressure at P to that at Q?

A 1 : 2 **B** 3 : 4 **C** 5 : 3 **D** 5 : 8

12 A boulder of weight 400 N is pushed up a slope at constant speed with a force of 300 N as shown.



What is the work done against friction in pushing the boulder up the slope?

A 950 J **B** 1000 J **C** 1800 J **D** 1950 J

13 Four different electric motors are used to lift loads vertically.

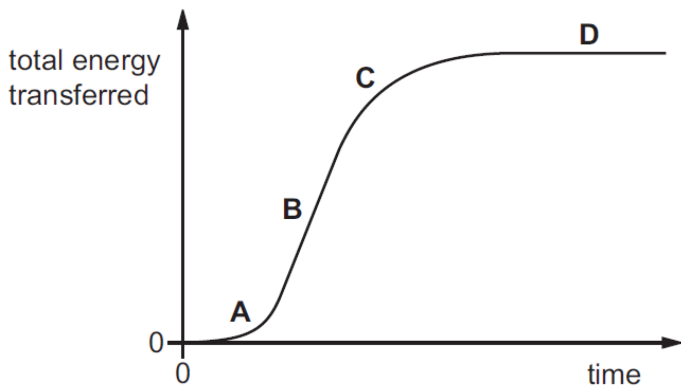
Under normal operating circumstances, the power outputs of the motors are shown in the table below.

Which electric motor has the highest efficiency?

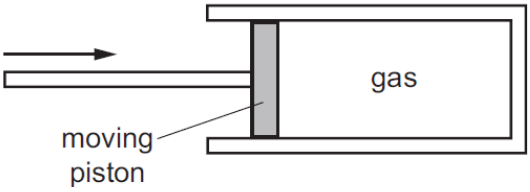
motor	power output (W)		
	sound	mechanical	heat
A	5	25	30
B	5	35	20
C	10	30	20
D	10	40	10

14 The graph shows the total energy transferred by an electric motor over a period of time.

In which region of the graph is the greatest power being developed by the motor?



15 A mass of gas is trapped inside a cylinder by a moving piston.

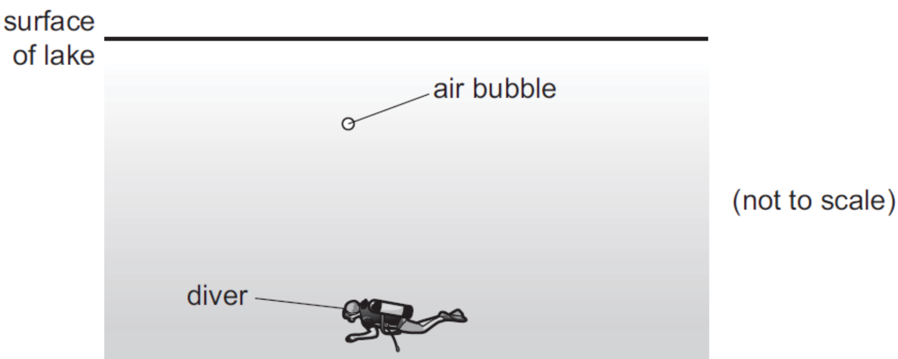


As the piston moves in, the volume of the gas decreases but the temperature stays the same.

Which row correctly explains the effect on gas pressure?

	pressure	reason
A	decreases	the molecules have less room to move in the cylinder
B	decreases	the molecules move more slowly between collisions
C	increases	the molecules collide more frequently with the piston
D	unchanged	the temperature of the gas is constant

16 The diagram shows a diver 20 m below the surface of a lake. The total pressure at this depth is 3.0×10^5 Pa.



An air bubble has a volume of 0.60 cm^3 as it leaves the diver. It rises to the surface of the lake where the pressure is 1.0×10^5 Pa. The temperature of the air in the bubble remains constant.

What is the volume of the air bubble at the surface of the lake?

A 0.20 cm^3 **B** 0.60 cm^3 **C** 1.8 cm^3 **D** 2.4 cm^3

17 Small smoke particles suspended in air are viewed through a microscope.

The smoke particles move randomly.

What can be concluded from this observation?

A The air consists of fast-moving molecules.
B The pressure of the air is increasing.
C The temperature of the air is increasing.
D There are convection currents in the air.

18 A silver cup is filled with boiling water from a kettle.

A man touches the outside surface of the cup and finds that it is extremely hot.

Which statement explains why the surface is extremely hot?

A Convection takes place in the boiling water.
B Silver is a good conductor of heat.
C The boiling water gives out latent heat.
D The shiny surface is a good emitter of infra-red radiation.

19 Which statement about ice point and steam point is true?

A Ice point is the process of pure ice melting.
B Ice point is the temperature at which pure water freezes.
C Steam point is the standard atmospheric pressure at which pure water boils.
D Steam point is the temperature at which pure water evaporates.

20 The electrical resistance of a metal varies linearly with temperature.

A wire's resistance at 0 °C and 28 °C is 25 Ω and 38 Ω respectively.

What is the resistance of the wire at 100 °C?

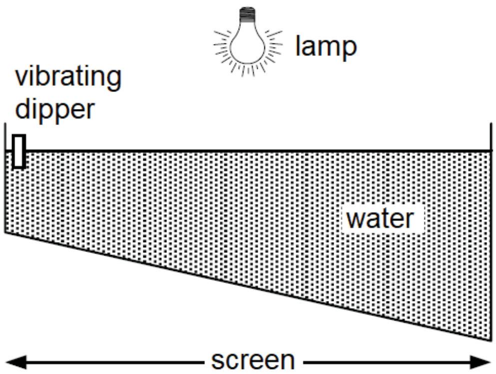
A 28 Ω **B** 46 Ω **C** 71 Ω **D** 152 Ω

21 Some of the liquid in a dish evaporates, as shown in the diagrams.

Which row best describes the energy states of the molecules?

	molecules that leave have	molecules in the liquid have greater average kinetic energy
A	high energy	before evaporation
B	high energy	after evaporation
C	low energy	before evaporation
D	low energy	after evaporation

22 The diagram shows a ripple tank with a sloping base. A vibrating dipper is used to create waves on the surface of the water.

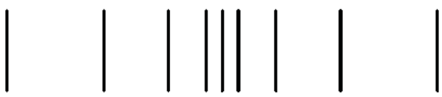


Which wave pattern can be seen on the screen below the ripple tank?

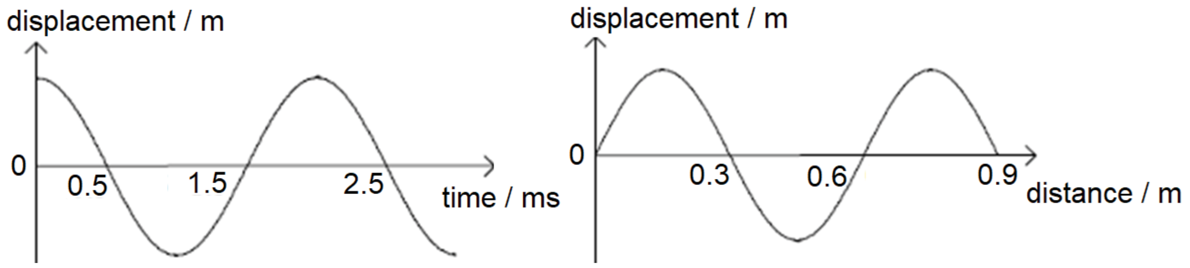
A


B


C


D


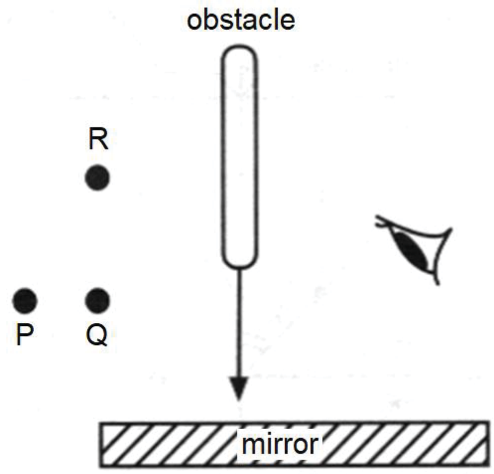
23 The two graphs shown below refer to the same wave.



What is the speed of the wave?

A 0.30 m/s **B** 1.2 m/s **C** 150 m/s **D** 300 m/s

24 Three objects P, Q and R are viewed through a plane mirror as shown in the diagram.

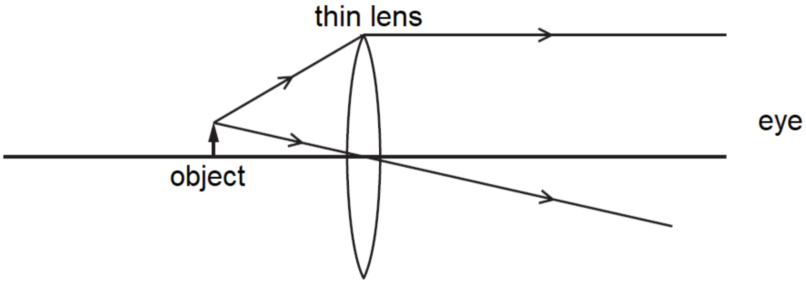


When an obstacle is moved towards the mirror, which object disappears first and which object disappears last in the mirror?

	disappears first	disappears last
A	P	Q
B	P	R
C	R	Q
D	R	P

25 An object is viewed through a converging lens.

The diagram shows the paths of two rays from the top of the object to an eye.



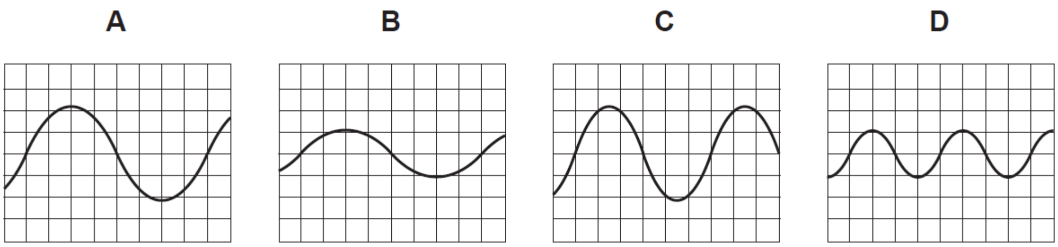
How does the image compare with the object?

A It is larger and inverted.
B It is larger and upright.
C It is smaller and inverted.
D It is smaller and upright.

26 The diagrams show oscilloscope traces of sounds picked up by microphones.

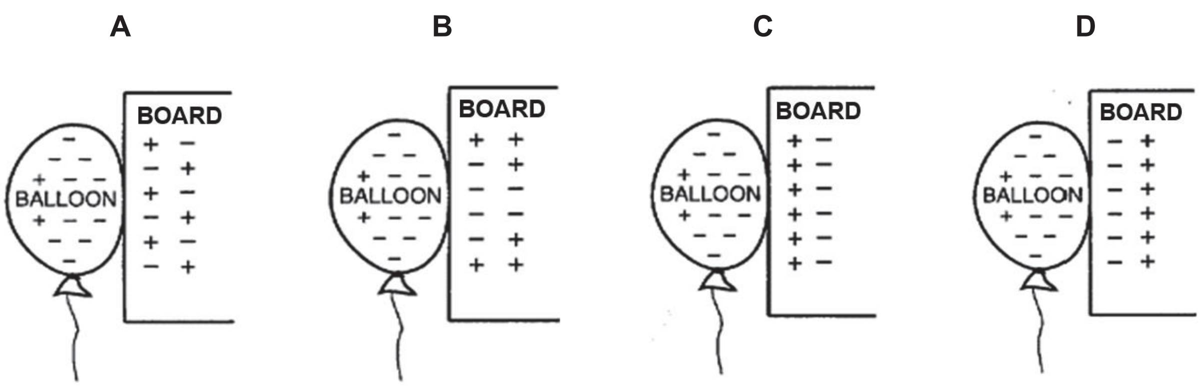
The oscilloscope controls are set in the same position for all the traces.

Which trace shows the sound that is both loud and low-pitched?

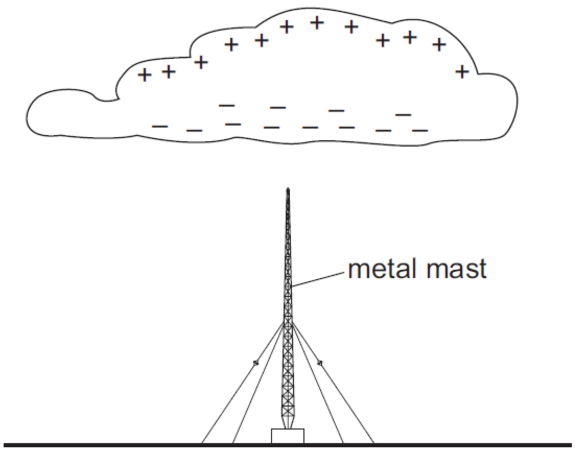


27 An inflated balloon which has been rubbed against a person's hair remains attracted to a neutral metallic board after touching it.

Which diagram best represents the charge distribution on the balloon and metallic board?



28 The base of a cloud is negatively charged.



The cloud is over a metal mast as shown.

Which row describes the charge induced at the top of the mast and how it is produced?

	charge at the top of the mast	charge at the top of mast is produced by
A	negative	electrons moving to the top of the mast
B	negative	protons moving to the bottom of the mast
C	positive	electrons moving to the bottom of the mast
D	positive	protons moving to the top of the mast

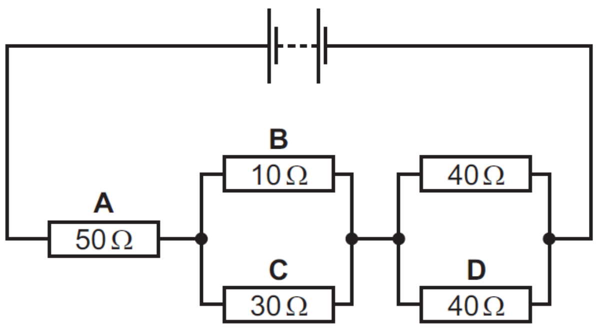
29 During a single lightning flash, 20 C of charge travels between a cloud and the earth in 0.020 s, across an average potential difference of 2.0×10^7 V.

How much energy is converted during the flash?

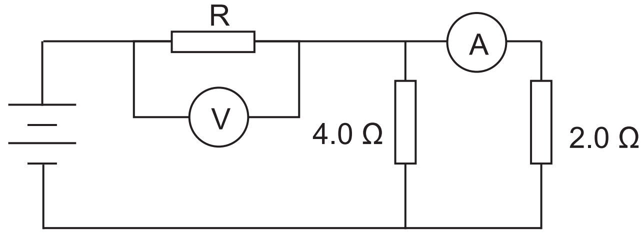
A 1.0×10^{-6} J **B** 1.0×10^6 J **C** 4.0×10^8 J **D** 2.0×10^{10} J

30 The diagram shows a circuit containing five resistors connected to a battery.

In which resistor is the current the smallest?



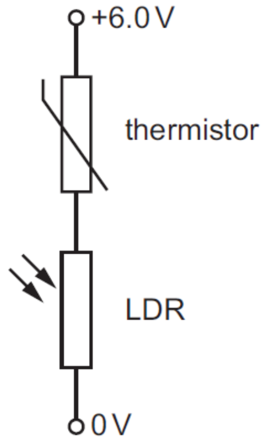
31 In the circuit below, the ammeter reads 0.40 A and the voltmeter reads 4.5 V.



What is the current flowing through resistor R?

A 0.40 A **B** 0.60 A **C** 0.80 A **D** 1.2 A

32 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.

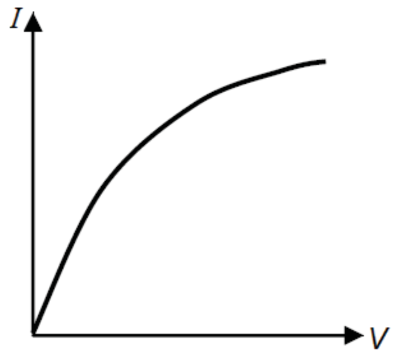


The thermistor has a resistance of 6000 Ω in a cold room and 1000 Ω in a warm room. The LDR has a resistance of 2000 Ω in dim light and 500 Ω in bright light.

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

33 The graph shows the I-V characteristics of a certain conductor.



Which statement about this conductor is true?

A Its current decreases when the potential difference across it increases.
B Its resistance decreases when the current flowing through it increases.
C Its resistance increases when the current flowing through it increases.
D Its resistance remains constant when the current flowing through it increases.

34 A combined bathroom unit of a heater and a lamp is controlled by one switch. The unit contains a 2.0 kW heater and a 100 W lamp.

In one week, the lamp uses 2.0 kWh of electrical energy.

How much energy is used by the heater alone?

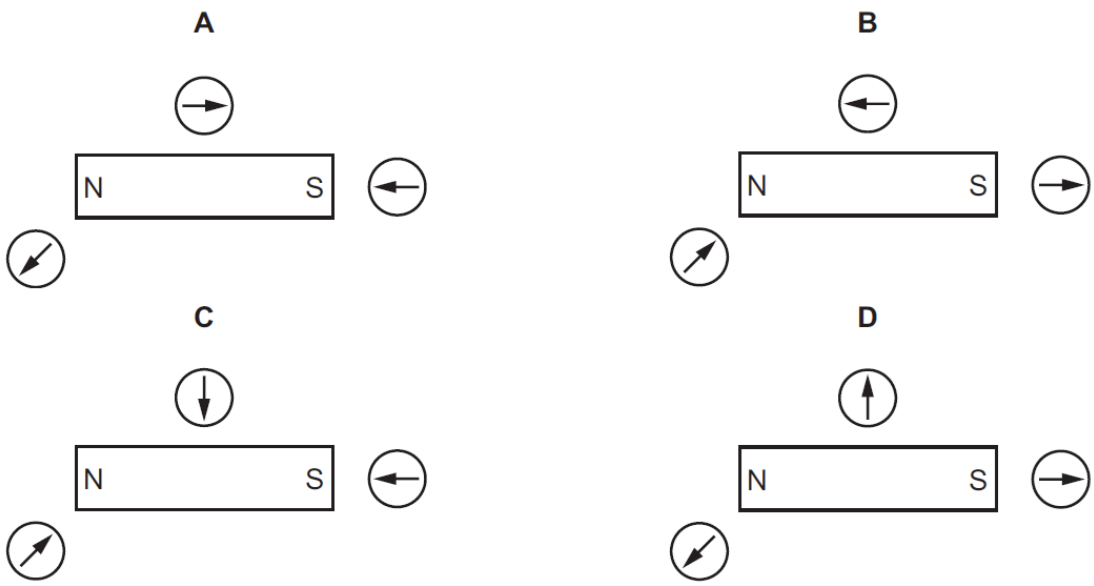
A 0.10 kWh **B** 4.0 kWh **C** 20 kWh **D** 40 kWh

35 Which statement describes an example of induced magnetism?

A A bar magnet loses its magnetism if it is repeated dropped on the floor.
B A piece of soft iron is attracted to a bar magnet.
C A solenoid magnetizes a piece of soft iron inside it as the d.c. supply is switched on.
D Two like poles of magnets repel each other.

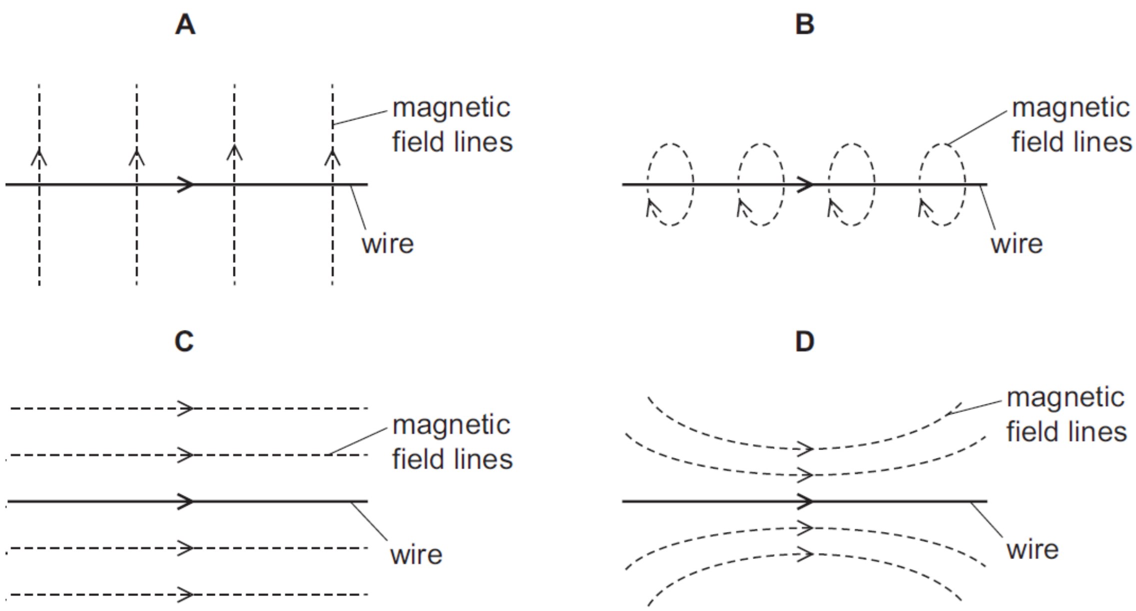
36 A student uses three small plotting compasses to investigate the magnetic field around a bar magnet.

Which diagram shows the directions in which the compass needles point?

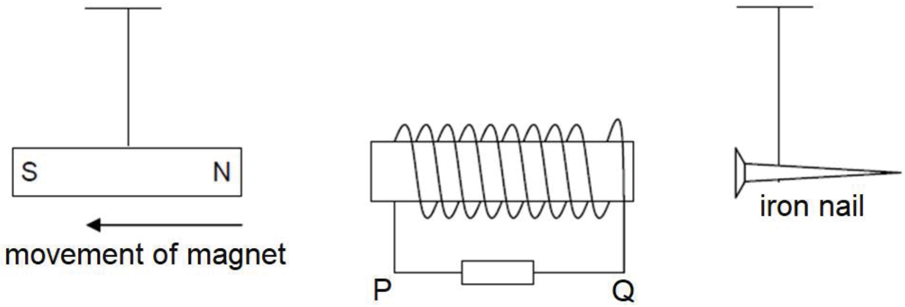


37 The diagrams show a current-carrying wire with an arrow in the direction of the current.

Which diagram shows the magnetic field produced by the current?



38 A solenoid is placed in between a magnet and an iron nail that are freely suspended from the ceiling, as shown in the diagram. The magnet is then moved away from the solenoid.

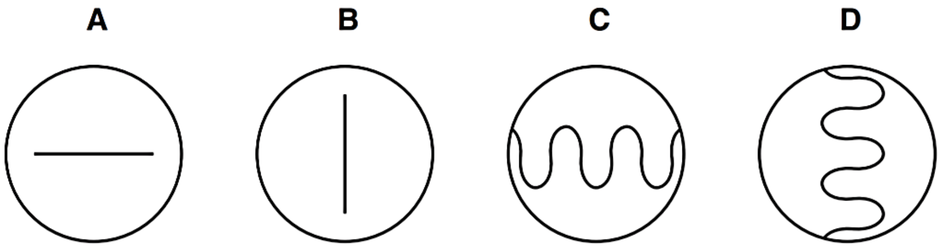


What is the direction of the current flowing through wire PQ and the direction that the iron nail moves when the magnet is moved away from the solenoid?

	direction of current on PQ	direction of movement of iron nail
A	from Q to P	towards solenoid
B	from Q to P	away from solenoid
C	from P to Q	towards solenoid
D	from P to Q	away from solenoid

39 An alternating potential difference is applied to the Y-plates of a cathode-ray oscilloscope. The time-base is turned off.

Which pattern appears on the cathode-ray oscilloscope screen?



40 A teacher builds the circuit as shown.

The identical lamps X and Y are connected to a low voltage a.c. power supply by high resistance transmission wires. The lamps are switched on.

Lamp X is then switched off.

What happens to the voltage and power supplied to lamp Y?

	the voltage supplied to lamp Y	the power supplied to lamp Y
A	decreases	decreases
B	decreases	stays the same
C	increases	increases
D	increases	stays the same

BEATTY SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2022
SECONDARY FOUR EXPRESS

CANDIDATE NAME			
CLASS		REGISTER NUMBER	

PHYSICS

6091/02

Paper 2 Theory

Setter: Mr Teng JB

30 August 2022

1 hour 45 minutes

Candidates answer on the Question Paper.
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.
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 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	
A	50
B…..	10
B…..	10
B…..	10
Total	80

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Section A

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

1 Fig. 1.1 shows the distance-time graph for a train journey.

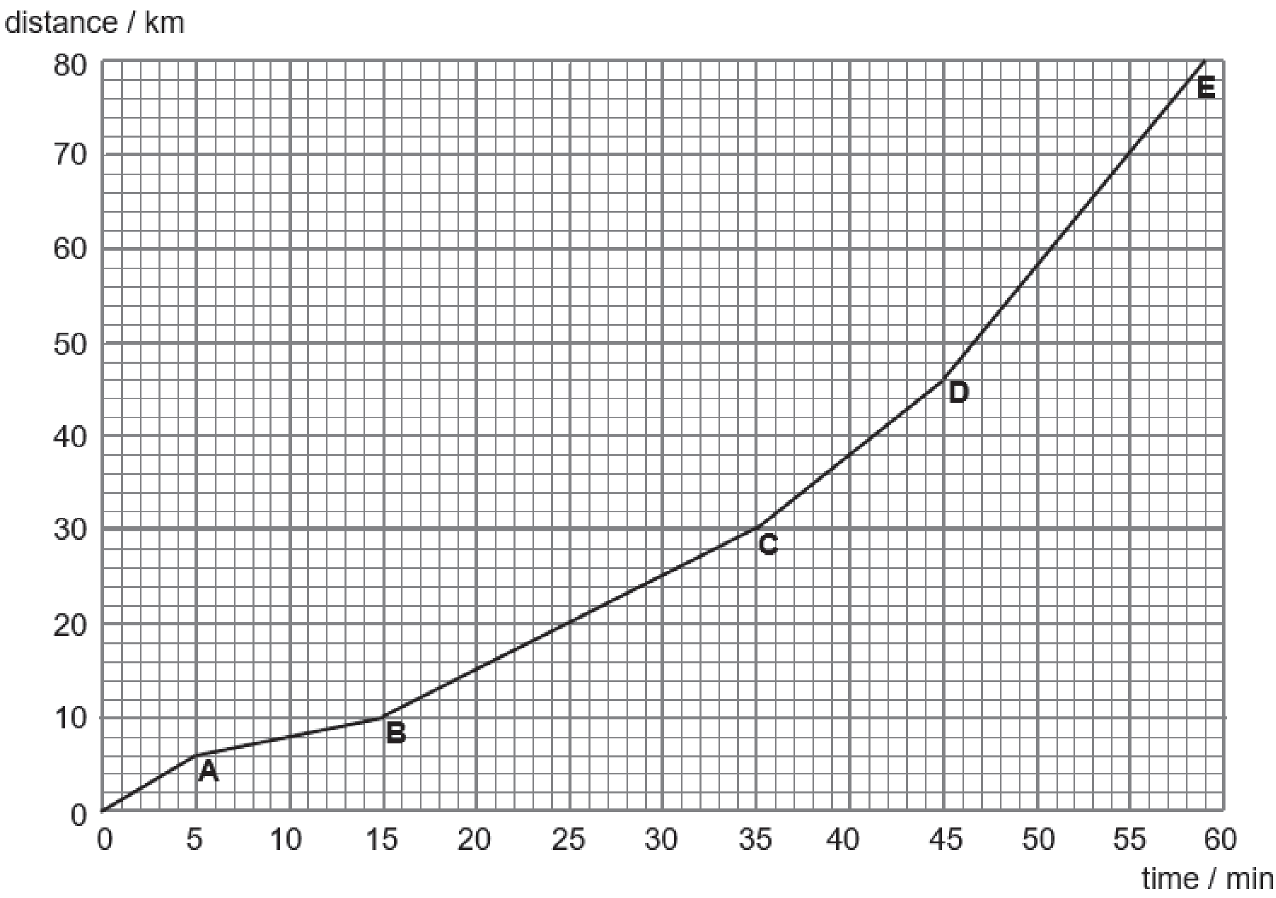


Fig. 1.1

The train travels on a straight horizontal track and passes, without stopping, through stations **A**, **B**, **C**, **D** and **E**, as shown in Fig. 1.1.

(a) Using Fig. 1.1,

(i) determine the distance between stations **B** and **D**,

distance = …………………… [1]

(ii) state between which two stations does the train have its lowest average speed,

between station ………… and station ………… [1]

(iii) calculate the average speed, in km/h, for the journey between **A** and **E**.

average speed = …………………… km/h [2]

(b) After leaving station **E**, the train moves along the straight horizontal track with a constant speed of 40 m/s. The total force opposing the motion due to friction and air resistance is 7.2×10^4 N.

(i) By considering the work done by the train's engine in 1.0 s, calculate its output power.

power = …………………… [2]

(ii) After some time, the train begins to travel up a slope.

Explain why the power of the train's engine must be increased to maintain the speed of 40 m/s.

……………………………………………………………………………………………

……………………………………………………………………………………………

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

2 During the launch of a rocket, hot exhaust gas is produced in the engine. The hot exhaust gas flows through the rocket and accelerates to the rear of the rocket as shown in Fig. 2.1.

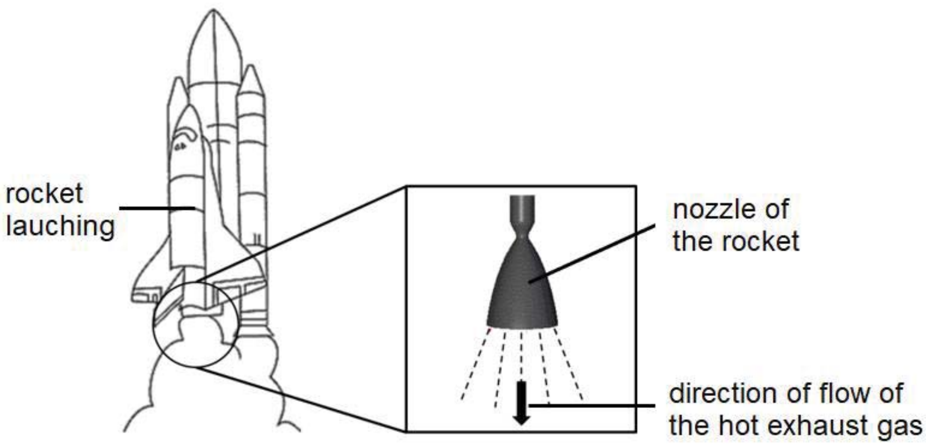


Fig. 2.1

The total mass of the rocket is 1.5×10^6 kg and the rocket engine initially provides a thrust of 6.0×10^7 N. Assume the gravitational field strength g to be 10 N/kg.

(a) Calculate the initial acceleration of the rocket as it is about to take off from the ground.

acceleration = ……………………… [2]

(b) Using Newton's third law, explain how the hot exhaust gas lifts the rocket above the surface of Earth.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

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

(c) In the early stages of the flight within the atmosphere of Earth, the acceleration of the rocket increases rapidly from the initial acceleration, even though the engine thrust remains roughly constant.

Suggest a reason for this.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

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

3 Fig. 3.1 shows a uniform rod of wood suspended from a pivot.

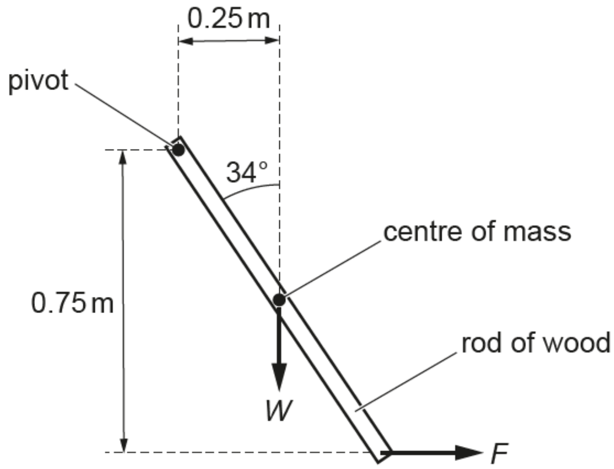


Fig. 3.1

The rod is held stationary by a horizontal force *F* acting as shown.

The mass of the rod is 0.080 kg and the gravitational field strength *g* is 10 N/kg.

Calculate

(a) the moment of *W* about the pivot,

moment of *W* = …………………… [3]

(b) the force *F*.

force *F* = …………………… [1]

(c) The angle between the rod and the vertical is increased.

Explain whether the force *F* needed to hold the rod stationary must be increased, decreased or remained the same.

…………………………………………………………………………………………

…………………………………………………………………………………………

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

4 Fig. 4.1 shows a tube full of mercury placed upside down in a dish of mercury. Initially a small piece of glass closes the open end of the tube.

The piece of glass is removed and the level of mercury in the inverted tube falls, as shown in Fig. 4.2.

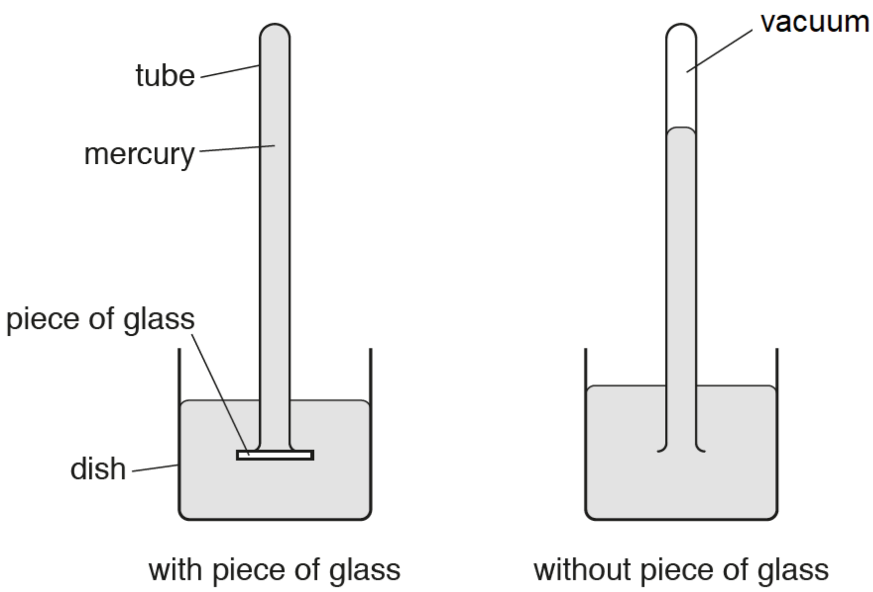


Fig. 4.1 **Fig. 4.2**

(a) Explain why the level of mercury in the tube falls.

....

....

....

.... [2]

(b) Describe how the tube of mercury in Fig. 4.2 is used to determine a value for the atmospheric pressure in pascals (Pa). You may draw on Fig. 4.2 if you wish.

....

....

....

....

.... [3]

5 An object is placed in front of a thin converging lens and a real image is formed on the opposite side of the lens. The object distance is varied and the image distance is measured.

Fig. 5.1 shows how the image distance varies with the object distance.

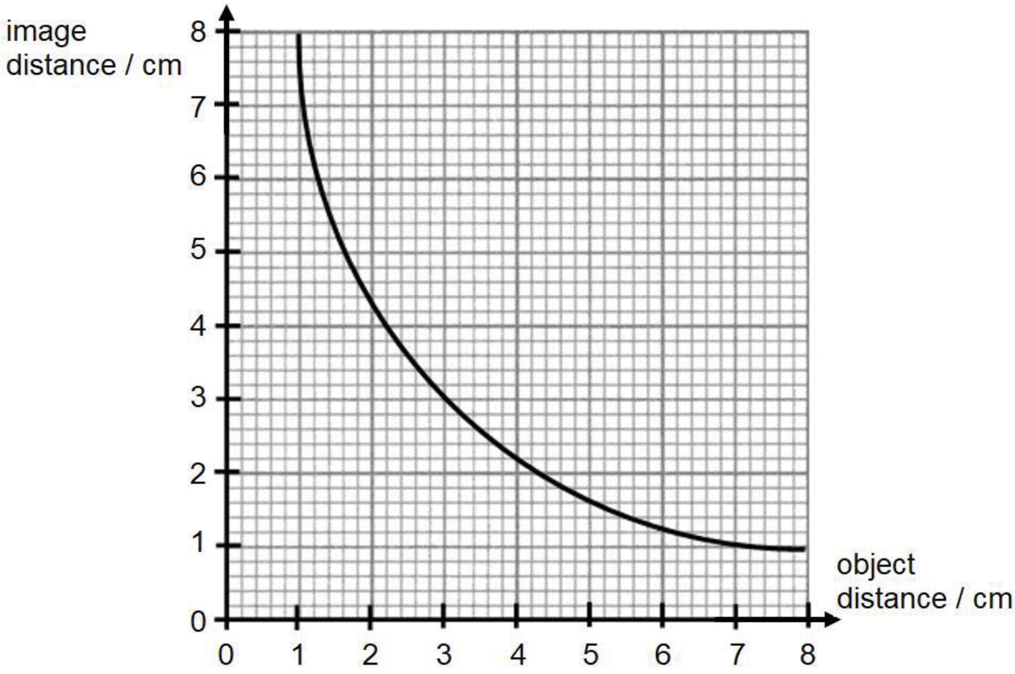


Fig. 5.1

(a) Determine the focal length of the converging lens from Fig. 5.1.

focal length = ……………………… [1]

(b) Fig. 5.2 shows an incomplete full-scale ray diagram.

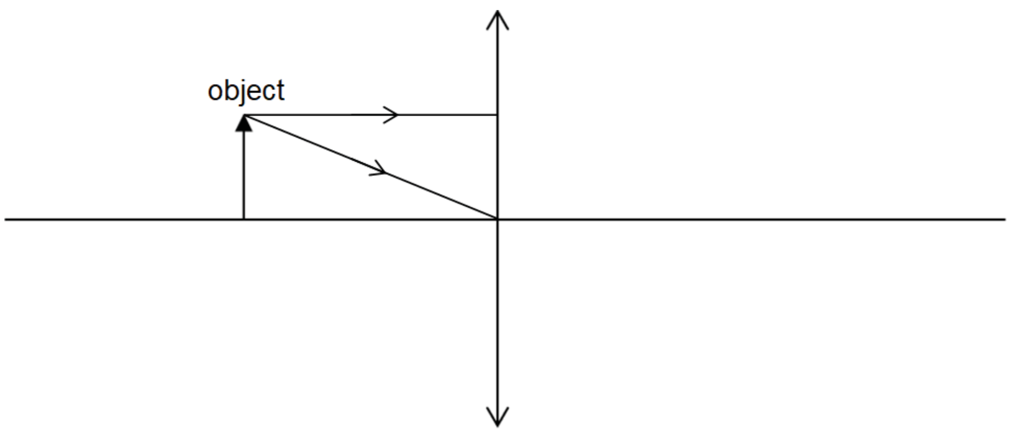


Fig. 5.2

Using your answer in **(a)**, complete Fig. 5.2 for the object by

(i) continuing the two rays,

(ii) drawing the image formed,

(iii) and marking the position of the focal point F.

[3]

6 A car is fitted with a parking system that warns the driver as to how close objects are behind the car.

Equipment on the rear bumper of the car transmits sound waves through the air towards the wall and receives the reflected waves, as shown in Fig. 6.1.

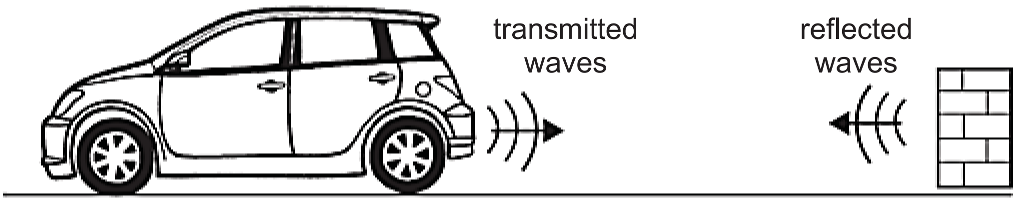


Fig. 6.1

(a) Describe how the sound waves travel through the air from the car to the wall.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

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

(b) For the parking system to work properly, the object must not be too near or too far from the rear bumper.

A sensor in the parking system detects the time delay between the transmitted sound wave and the reflected wave. The sensor can only detect time delay between 3.0 ms to 10 ms.

Calculate the minimum distance an object can be from the rear bumper. Take the speed of sound in air to be 340 m/s.

distance = ……………………… [3]

7 Fig. 7.1 shows an electrostatic generator used to produce sparks.

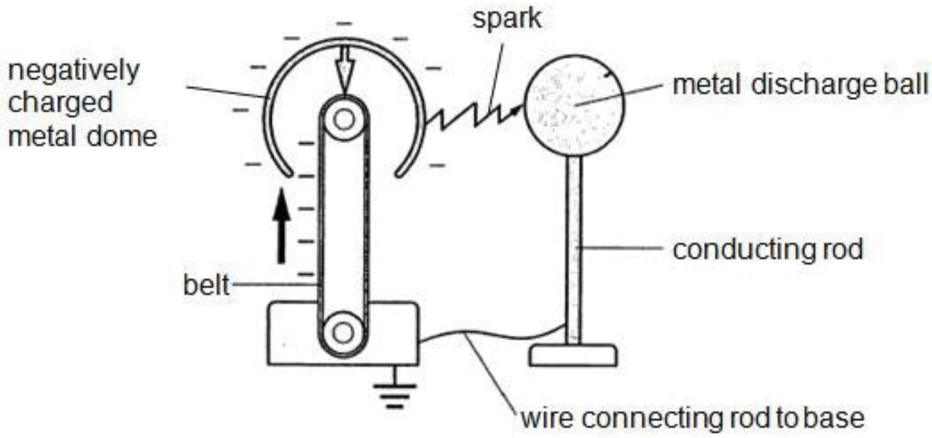


Fig. 7.1

The moving belt carries negative charges to the dome. Before a spark is produced, the discharge ball becomes positively charged.

(a) Describe and explain the movement of negative charges in the discharge ball as the ball becomes positively charged.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

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

(b) On Fig. 7.1, use a cross (X) to mark the point where there are the most positive charges on the discharge ball. [1]

(c) When there are enough negative charges on the dome, a spark jumps between the dome and the discharge ball. A charge of 1.6 μC flows in a time of 0.0012 s.

Calculate the spark current.

current = ……………………… [2]

8 Two identical metal rods X and Y are connected to a resistor R and a d.c power supply. Each rod passes through a hole in a card, which is horizontal, as shown in Fig. 8.1.

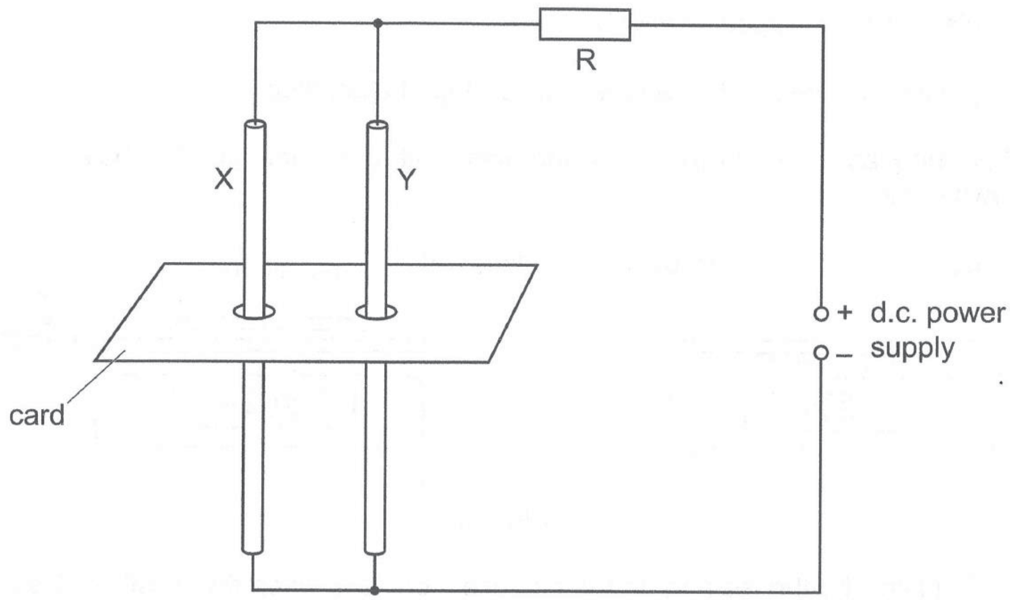


Fig. 8.1

There is an electric current flowing downwards in each rod.

(a) Fig. 8.2 shows the view, from above, of the card. The two circles are the holes in the card.

On Fig. 8.2, draw the pattern of the magnetic field around, and between, the two holes. Mark the direction of the magnetic field line on your pattern. [2]

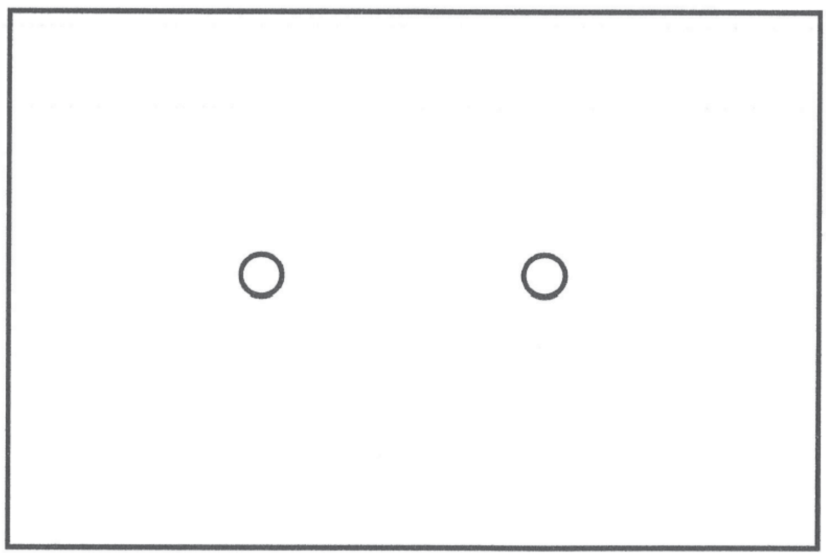


Fig. 8.2

(b) The d.c power supply has a voltage of 9.0 V and the resistance of R is 10 Ω. The current flowing through R is 0.50 A.

Calculate

(i) the effective resistance of the circuit,

effective resistance = …………………… [2]

(ii) the resistance of one metal rod.

resistance = …………………… [2]

9 A washing machine is working normally with the motor switched on. The washing machine is connected to the mains supply by a cable.

Under normal operating condition, the current in the live wire in the cable is 13 A.

(a) State the size of the current in

(i) the neutral wire,

current = …………………… [1]

(ii) the earth wire.

current = …………………… [1]

(b) The insulation on the mains cable is now damaged and, as the washing machine vibrates, the live wire touches the metal casing.

Explain how the earth wire and the fuse can together prevent a user from getting electric shock.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………… [3]

Section B

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 12**.

10 Fig. 10.1 shows a flowmeter that measures the volume of oil passing through a pipe.

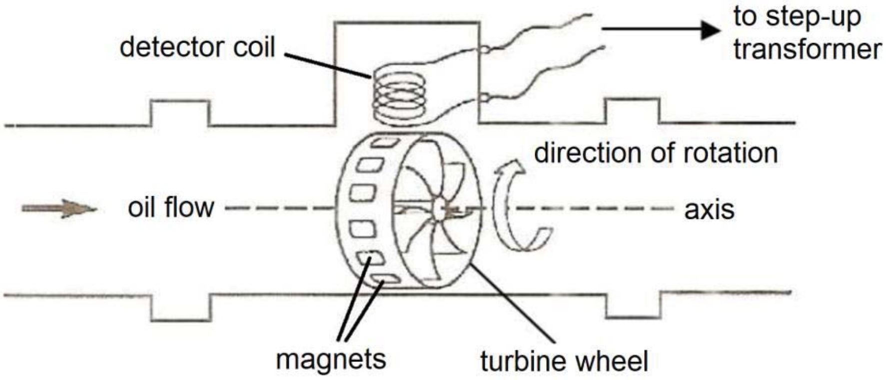


Fig. 10.1

Twenty identical magnets are spaced equally around the turbine wheel. As oil flows, the turbine wheel rotates around the axis as shown and an electromotive force (e.m.f) is generated across the detector coil.

The detector coil is connected to the primary coil of a step-up transformer, as shown in Fig. 10.2, to amplify the voltage signal. The signal is then displayed on a cathode ray oscilloscope (c.r.o).

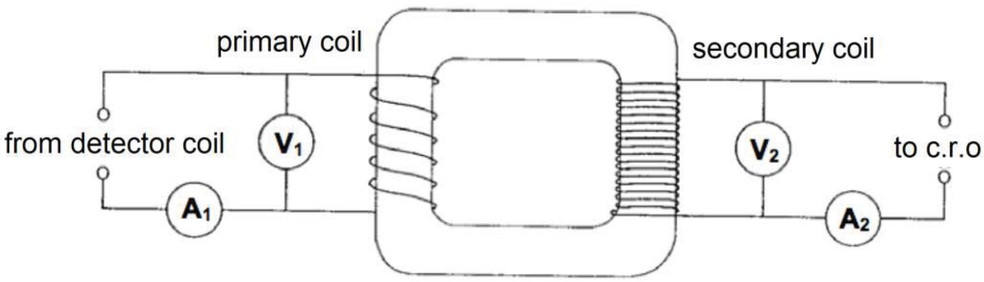


Fig. 10.2

Table 10.1 shows the data for two different oil flowrates. Some values are missing from the table.

Table 10.1

Oil flowrate (cm^3/s)	Time taken for turbine to complete one spin (s)	Transformer readings			
		A_1 (A)	V_1 (V)	A_2 (A)	V_2 (V)
10	2.0	4.0	6.0	1.6	12.0
20	1.0	4.0		1.6	

(a) Explain why an alternating e.m.f is induced in the detector coil.

………

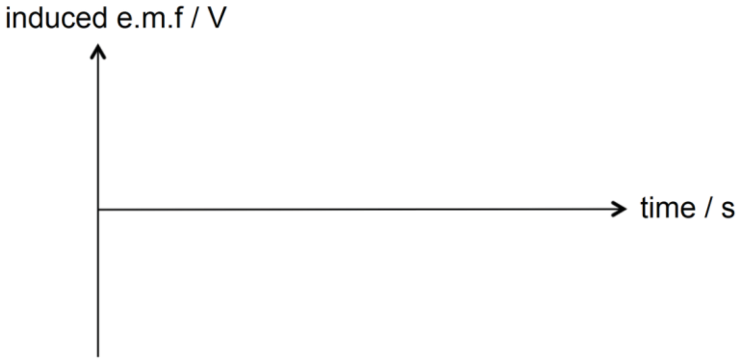
………

………

………

…………………………………………………………………………………………………… [3]

(b) **(i)** Using information in Table 10.1, draw a graph to show how the induced e.m.f in the primary coil varies with time when a magnet moves past the detector coil at a flowrate of 10 cm^3/s. Label the necessary values clearly on the graph. [2]



(ii) State how the graph for a flowrate of 20 cm^3/s differs from your answer in **(b)(i)**.

……………………………………………………………………………………………

……………………………………………………………………………………………

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

(c) Calculate the turns ratio of the transformer.

ratio = ……………………… [2]

(d) Hence or otherwise, determine the missing values of V_1 and V_2 in Table 10.1.

V_1 = ………………………

V_2 = ……………………… [1]

11 A small electrical heater placed at the bottom of a beaker is used to heat water.

Fig. 11.1 shows how the temperature varies for 30 minutes after the heater is turned on.

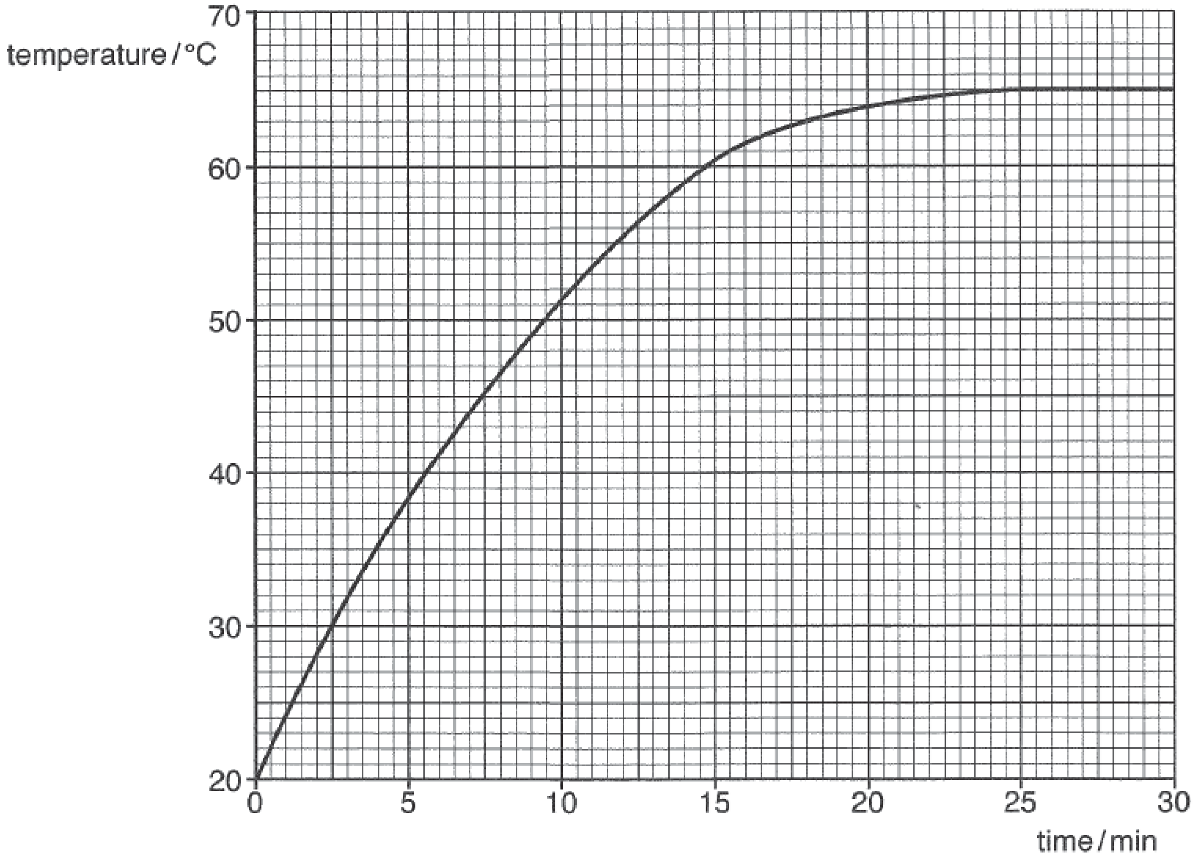


Fig. 11.1

(a) **(i)** Describe how heat is distributed throughout the water inside the beaker.

....

....

....

....

.... [3]

(ii) State how the motion and arrangement of the water molecules changes when the temperature increases.

....

....

.... [2]

(b) **(i)** Using Fig. 11.1, determine the initial rate of rise in temperature, giving your answer in °C/min.

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 water in the beaker is 125 g. The specific heat capacity of water in 4.2 J/(g°C).

Using your answer in **(b)(i)**, calculate the energy supplied to the water per minute.

energy supplied per minute = …………………… [2]

(c) 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 EITHER

(a) The arrangement shown in Fig. 12.1 is used to measure the length of the day (i.e. the length of time during which the daylight is above a certain brightness).

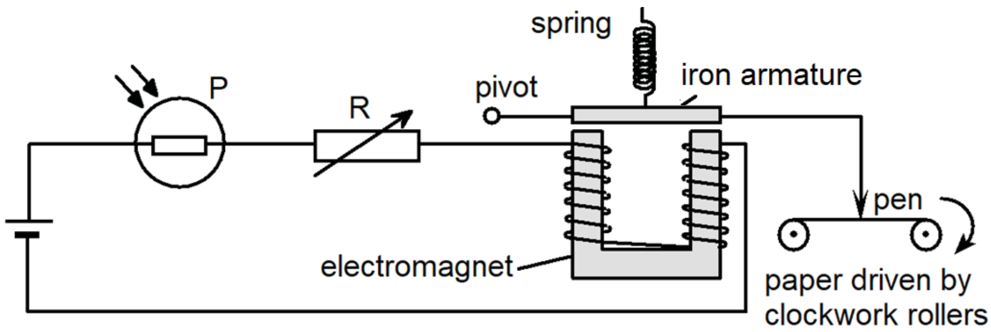


Fig. 12.1

A trace is drawn on the paper that is moved continuously using rollers.

(i) Name the device P (in full).

.... [1]

(ii) Explain why the pen will begin to draw a trace on the paper when light starts to fall on P.

....

....

....

....

.... [4]

(b) Fig. 12.2 shows a rigid rectangular coil ABCD mounted on the axle XY which is perpendicular to the axis of the solenoid on its right. The coil is connected through slip rings and brushes to a battery in a circuit.

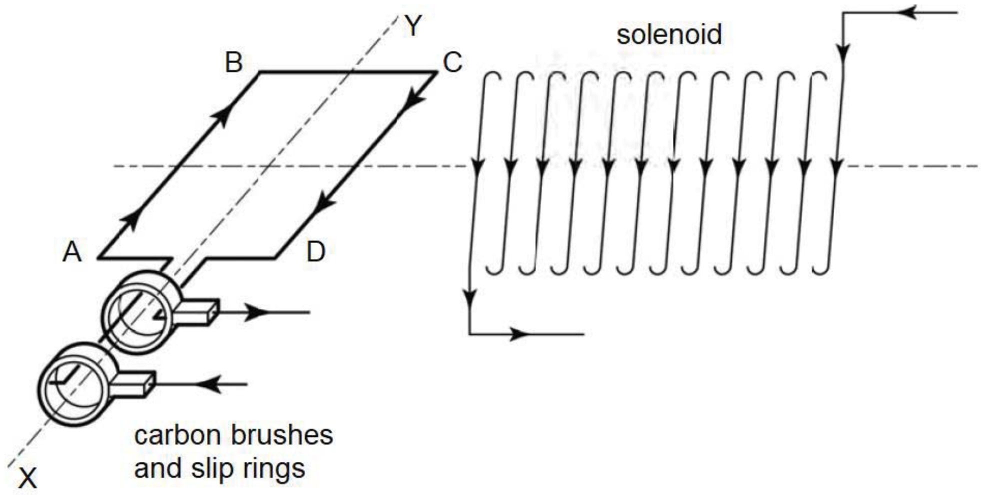


Fig. 12.2

(i) On Fig. 12.2, label the magnetic poles of the solenoid. [1]

(ii) Explain why the coil begins to rotate when current flows through the solenoid in the direction shown.

……………………………………………………………………………………………

……………………………………………………………………………………………

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

(iii) Explain why continuous rotation of the coil in one direction does not take place.

……………………………………………………………………………………………

……………………………………………………………………………………………

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

12 OR

Fig. 12.3 illustrates three ways in which different electromagnetic waves may be used to send television signals into a home.

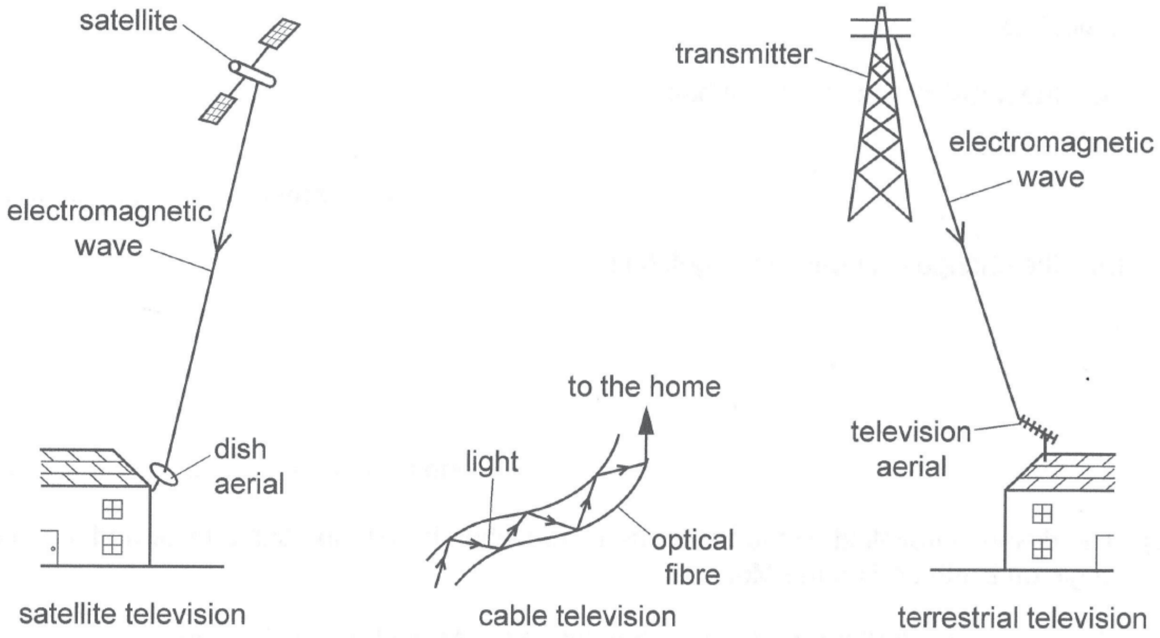


Fig. 12.3

In satellite television, electromagnetic waves travel from a satellite to a dish aerial on the wall of the home.

In cable television, light travel through optical fibres into the home. Optical fibres are made of glass.

In terrestrial television, electromagnetic waves travel from a transmitter on Earth to an aerial in the home.

(a) State the region of the electromagnetic waves used in each of these systems.

satellite: ……………………………………………………………………………………………

terrestrial: …………………………………………………………………………………………

[1]

(b) The electromagnetic waves used in the satellite has a wavelength of 6.6 cm.

Calculate the frequency of the waves used.

frequency = …………………… [2]

(c) Fig. 12.4 shows an optical fibre used in cable television.

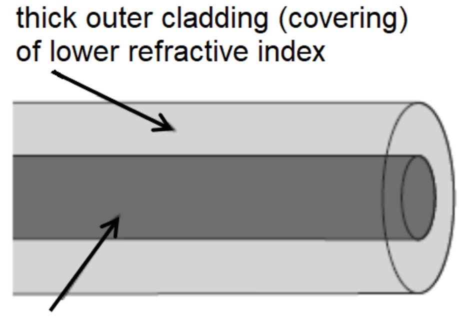


Fig. 12.4

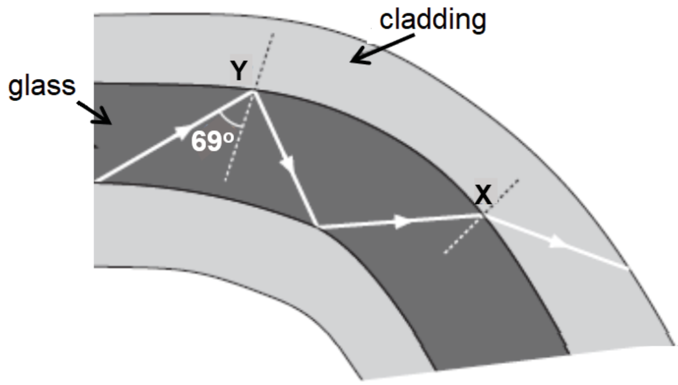


Fig. 12.5

As thin as a human hair, an optical fibre has a central core made up of glass, with a thick outer cladding as its covering.

If the optical fibre is kept mainly straight, light can travel great distances without losing much energy.

When the fibre is bent too much, the light can escape from the glass as shown at the point X in Fig. 12.5.

The angle of incidence θ and refractive index η of a medium are related by the following

$$\frac{\sin\theta_A}{\sin\theta_B} = \frac{\eta_B}{\eta_A} = constant$$

where A and B are two different medium.

Some information about the cladding and glass are as follows:

Refractive index of cladding = 1.51
Refractive index of glass = 1.69
Angle of refraction in cladding at X = 52.7°
Angle of incidence in glass at X = 45.2°

(i) Define the term *critical angle*.

……………………………………………………………………………………………………

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

(ii) Using the given equation and information, calculate the critical angle of the glass and cladding boundary.

critical angle = …………………… [2]

(iii) Hence, explain why the change in direction at point X cannot occur at point Y in Fig. 12.5.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

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

(d) Sound waves are also used to transfer information. Unlike electromagnetic waves, they are longitudinal waves that cannot travel without a medium.

State **two** other differences between sound waves and electromagnetic waves.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

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

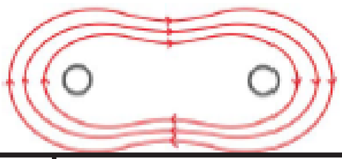
Beatty Sec 4E Physics (6091) Paper 1 and Paper 2
Preliminary Examination 2022
MARKING SCHEME

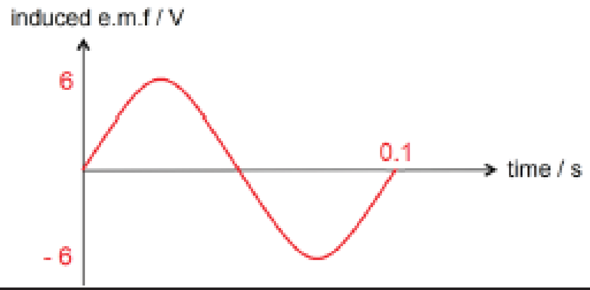
Paper 1 [40 marks]																			
1	D	2	C	3	B	4	C	5	B	6	C	7	B	8	B	9	C	10	C
11	C	12	A	13	D	14	B	15	C	16	C	17	A	18	B	19	B	20	C
21	A	22	A	23	D	24	C	25	B	26	A	27	C	28	C	29	C	30	C
31	B	32	C	33	C	34	D	35	B	36	A	37	B	38	A	39	B	40	C

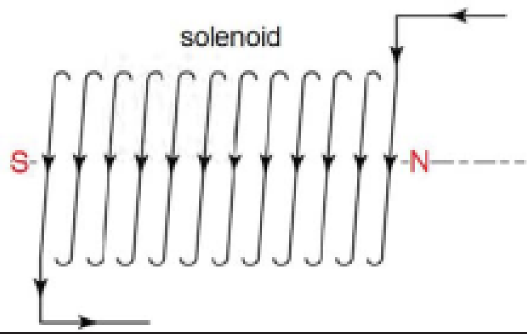
Minus 1 for missing/wrong unit and minus 1 for wrong s.f or fractions [Max minus 2 for whole paper]

Section A					
Qn no.			**Answer**	**Mark**	**Comment**
1	(a)	(i)	46 – 10 = 36 km (Award without working)	1	
		(ii)	Station A to Station B	1	
		(iii)	Average speed = Total distance / Total time = (80 – 6) / [(59 – 5) / 60] ≈ 82 km/h (2 s.f)	 1 1	
	(b)	(i)	P = WD / t = (F × D) / t = F × v = $(7.2 \times 10^4)(40)$ = 2.88×10^6 W	 1 1	
		(ii)	• Gravitational potential energy increase when train moves up the slope. (Backward force acts on the train as it moves up the slope causing deceleration) • More work has to be done by engine in the same amount of time. (More energy has to be supplied by engine in the same amount of time.) (Reject: Work done against gravitational potential energy)	1 1	
2	(a)		$F_R = (6.0 \times 10^7) - (1.5 \times 10^7) = 4.5 \times 10^7$ N $a = F_R / m = (4.5 \times 10^7) / (1.5 \times 10^6) = 30$ m/s² (2 s.f)	1 1	
	(b)		• The rocket exerts a downward force on the hot exhaust gas. • An equal and opposite upward force is exerted by the hot exhaust gas on the rocket.	1 1	
	(c)		• As rocket moves, fuel is consumed and this decreases the mass of the rocket. • Since $F_R = ma$, the decrease in mass leads to an increase in acceleration. OR • As rocket moves higher, there is lesser air resistance as air is less dense at higher altitude. • Since F_R = engine thrust – resistive forces, the resultant force increases. (ignore mass remains constant) OR • Gravitational field strength decreases when rocket is further away from the earth and thus weight decrease. • Since F_R = engine thrust – resistive forces, the resultant force increases. (ignore mass remains constant)	1 1	

3	(a)	W = mg = (0.080)(10) = 0.80 N M = F × perp d = (0.80)(0.25) = 0.20 Nm (Ignore error in weight calculation in awarding marks for moments)	1 1 1	
	(b)	F = M / perp d = 0.20 / 0.75 ≈ 0.27 N (2 s.f) (allow ECF from 3a)	1	
	(c)	• Perpendicular distance between pivot and line of action of *F* decreases (Perpendicular distance between pivot and line of action of *W* increases). • Increased force *F* is required for a greater moment. (Reject: increased force so that sum of clockwise moments is equal to sum of anticlockwise moments.	1 1	
4	(a)	• Pressure due to mercury in tube is greater than pressure due to atmosphere (and small height of mercury). • Resultant force act downwards and mercury flows out of tube. / Mercury level in tube decreases to reduce pressure inside tube until it is equal to atmospheric pressure.	1 1	
	(b)	• The vertical height of mercury column • above the mercury level in dish is measured. • Use *p* = *hρg* to calculate the pressure with *h* in metres. (Label of height on diagram to compensate missing points of either "vertical height" or "above mercury level in dish"	1 1 1	
5	(a)	From graph, 2F = 3 cm Focal length = 3 / 2 = 1.5 cm	 1	
	(b)	(i) Ray passing through optical centre without bending and ray passing parallel to principal axis will pass through focal point (measured 1.5 cm from lens) (Allow ECF from 5a) (ii) Correct drawing and position of image (iii) Correct focal point marked with F 	1 1 1	
6	(a)	• Air particles vibrates longitudinally / back and forth / parallel to direction of wave motion • to form alternating series of compressions and rarefactions in the air.	1 1	
	(b)	3.0 ms = 0.0030 s v = 2d / t 340 = 2d / 0.0030 d = 0.51 m (2 s.f) (Ignore error in timing in awarding marks for distance)	1 1 1	
7	(a)	• The negative charges in the ball will be repelled by the negative charges in the dome towards the right (or bottom of rod). • The negative charges will then travel down the conducting rod towards earth from the wire.	1 1	

Qn no.			Answer	Mark	Comment
	(b)		Cross marked at left most point of sphere	1	
	(c)		$I = Q / t$ $= (1.6 \times 10^{-6}) / 0.0012$ $= 1.3 \times 10^{-3}$ A (2 s.f) (Allow ECF for error in conversion)	 1 1	
8	(a)		• Clockwise direction • Pattern (No field line between wires, spacing between field lines) 	1 1	
	(b)	(i)	$R_{eff} = V / I$ $= 9.0 / 0.50$ $= 18\ \Omega$ (2 s.f)	 1 1	
		(ii)	$V_{rod} = V_{emf} - V_R = 9.0 - (0.50)(10) = 4.0$ V $R_{rod} = 4.0 / (0.50 / 2) = 16\ \Omega$ OR $R_{eff} = 10 + [1 / R + 1 / R]^{-1}$ $18 - 10 = R / 2$ $R = (8.0)(2) = 16\ \Omega$	1 1	
9	(a)	(i)	13 A	1	
		(ii)	0 A	1	
	(b)		• When the live wire touches the metal casing, the earth wire provides a low resistance path for current to flow from the casing to the ground. • A large current flow to the ground that exceeds the fuse rating. • The fuse melts and disconnect washing machine from live terminal.	1 1 1	

Section B					
Qn no.			Answer	Mark	Comment
10	(a)		• As the turbine wheel turns and a magnet approaches the coil, the change in magnetic flux linking the coil generates an induced e.m.f. in the coil. • As the same magnet leaves the coil, it generates an induced e.m.f. of the opposite polarity. • The cycle repeats with each approaching magnet, inducing an alternating e.m.f. in the detector coil.	1 1 1	
	(b)	(i)	Shape of graph with two halves Labelled values for e.m.f and period (period = 2 sec / 20 magnets = 0.1 s) 	1 1	

		(ii)	• Double induced e.m.f • Half period or double frequency	1 1	
	(c)	$V_s / V_p = N_s / N_p$ $N_s / N_p = 12 / 6$ $= 2$ or $(2 : 1)$		1 1	
	(d)	$V_1 = 12$ V and $V_2 = 24$ V (Both correct to award mark) (allow ECF from 10c)		1	
11	(a)	(i)	• Heated water expands become less dense and rises. • Cooler denser water sinks to the bottom to the heater and is heated. • The process repeats and convection current is setup.	1 1 1	
		(ii)	• The molecules slide over each other within the liquid at a faster speed. • The molecules are slightly further apart.	1 1	
	(b)	(i)	Initial rate of rise = (24 – 20) / 1 = 4 °C/min (Accept range from 3.6 to 4.2)	1	
		(ii)	Energy supplied per min = $mc\Delta\theta$ = 125 × 4.2 × 4 = 2100 J/min (Allow ECF from 11bi)	1 1	
	(c)	• The rate of heat gained by the water from the heater is equal to the rate of heat lost by the water to the surroundings. • The average internal kinetic energy of the water molecules does not increase and therefore the temperature of the water remains constant. (Reject: Reach thermal equilibrium causing no temperature change)		1 1	
12	EITHER				
	(a)	(i)	Light dependent resistor	1	
		(ii)	• Resistance of P decreases when light intensity increases. • Current flow in the circuit increases (p.d across electromagnet increases) • and magnetic field strength of electromagnet increases. • Iron armature undergoes magnetic induction and is attracted to the electromagnet. The pen is pulled and draws a trace on the paper. (Reject: magnetically induced, induced magnetically)	1 1 1 1	
	(b)	(i)	Close to coil: S, Away from coil: N  	1	

		(ii)	• The magnetic field of the current-carrying rectangular coil interacts with the magnetic field of the solenoid. • CD experiences an upward force and AB experiences a downward force to give a turning effect that rotates the coil.	1 1	
		(iii)	• When the coil rotates through 180°, the forces acting on either side of the coil reverses, causing the moment acting on the coil about XY to reverse direction. • Hence the coil will rotate back to its starting position.	1 1	
12	OR				
	(a)	Satellite: Microwaves Terrestrial: Radio waves (Both correct to award mark)		1	
	(b)	$v = f\lambda$ $f = v / \lambda = (3.0 \times 10^8) / (0.066)$ $= 4.5 \times 10^9$ Hz		 1 1	
	(c)	(i)	The angle of incidence in the optically denser medium for which the angle of refraction in the optically less dense medium is 90°.	1	
		(ii)	$\sin 90° / \sin C = 1.69 / 1.51$ $C = 63.3°$	1 1	
		(iii)	• Light travels from the optically denser glass to the optically less dense cladding at both X and Y. • However, at Y the angle of incidence is 69° which is larger than the critical angle of 63.3° and total internal reflection takes place (at X the angle of incidence is 45.2° which is smaller than the critical angle of 63.3° so refraction takes place)	1 1	
	(d)	Any two from: • The speed of sound waves is much slower than electromagnetic waves. • The speed of sound increases when entering a denser medium whereas the speed of electromagnetic waves decreases when entering an optically denser medium. • Magnetic field (or electric field) is generated when electromagnetic waves travel but not for sound waves.		2	

Name:	Register Number:	Class:

4E

BEDOK GREEN SECONDARY SCHOOL

4E

Preliminary Examination 2022

PHYSICS **6091/1**

Paper 1

31 August 2022

Additional Materials: Multiple Choice Answer Sheet

1 hour

READ THESE INSTRUCTIONS FIRST

Write your name, register number and class on all the work you hand in.
Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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 optical mark sheet.

Read the instructions on the Multiple Choice Answer Sheet very carefully.

Each correct answer will score one mark.
Any rough working should be done in this booklet.

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

[Turn Over

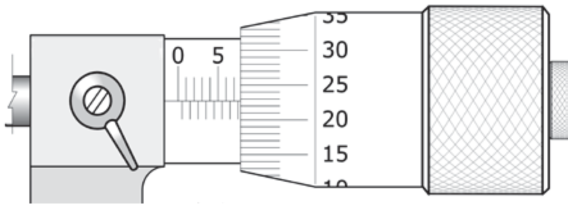
Answer all questions on the optical mark sheet.

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

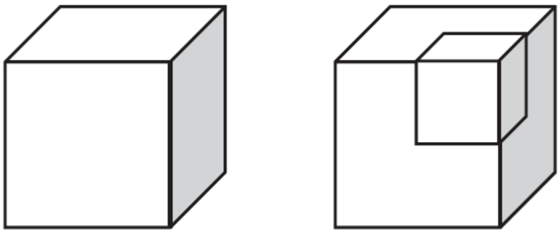
2 The diagram below shows the reading on a micrometer screw gauge.



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?

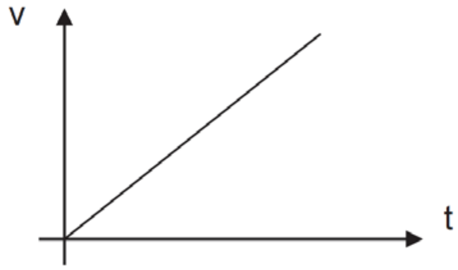
A 25 kg/m^3 **B** 547 kg/m^3 **C** 625 kg/m^3 **D** 714 kg/m^3

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

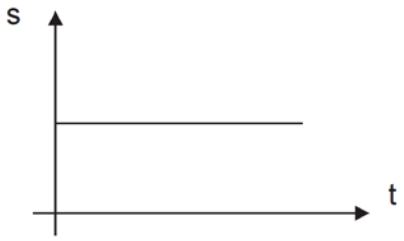
5 The following graph shows the velocity-time graph of a body.



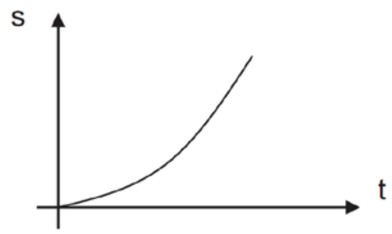
Which of the following graphs shows the correct displacement-time graph of the body?

A

A

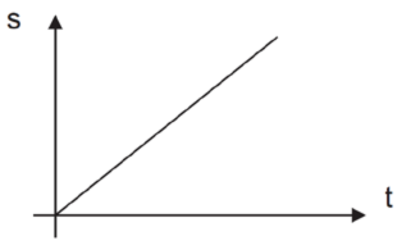


B

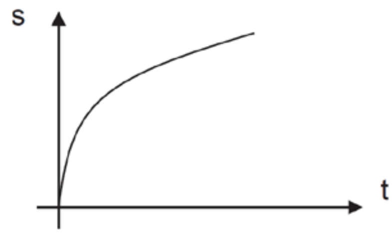


C

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

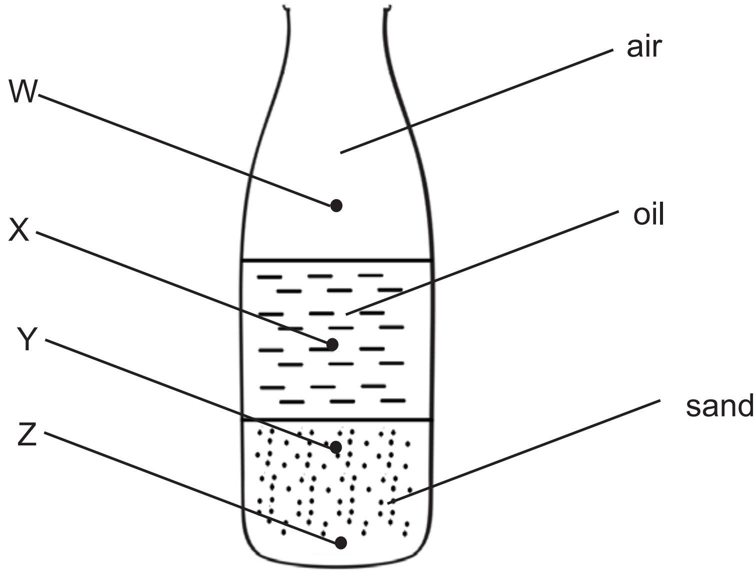
 [Turn Over

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

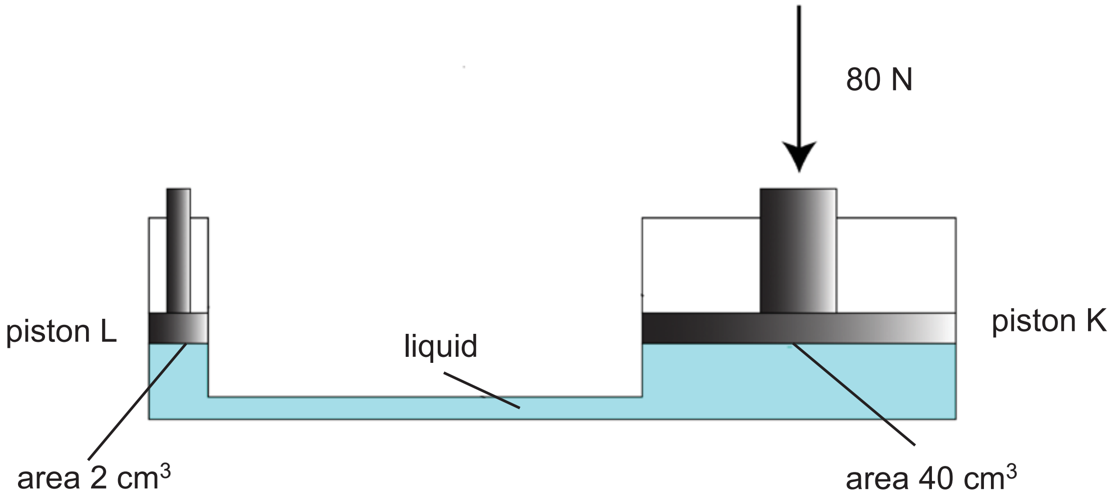
10 A rectangular box of dimensions 4.0 m by 2.0 m by 3.0 m weighs 50 N.

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

 [Turn Over

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.

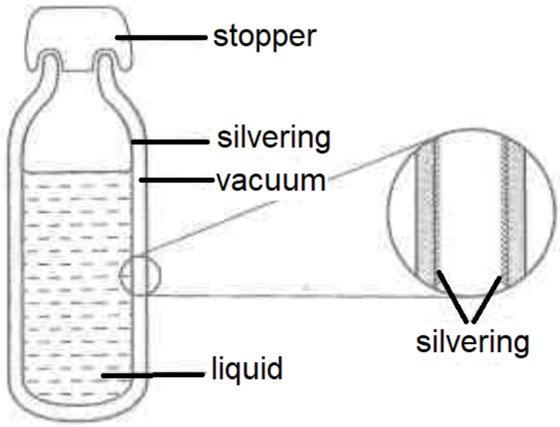
B Blowing across the surface allows more evaporation to take place.

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.

[Turn Over

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?

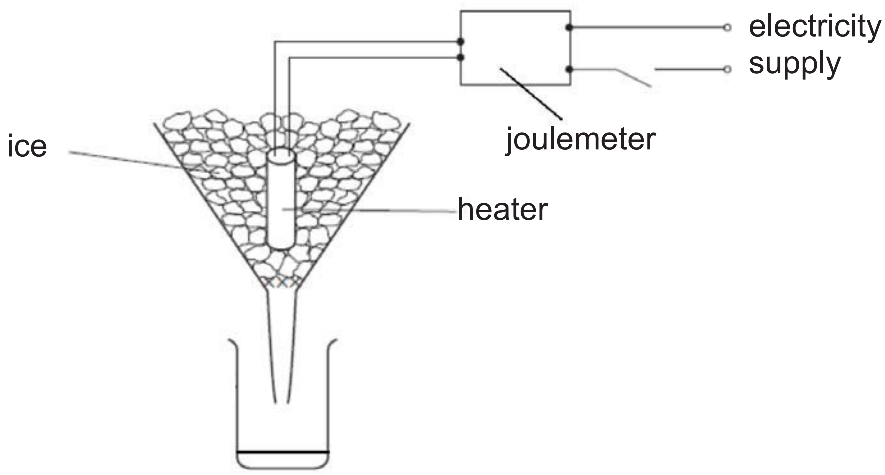
A silver surfaces are poor absorbers of radiation

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

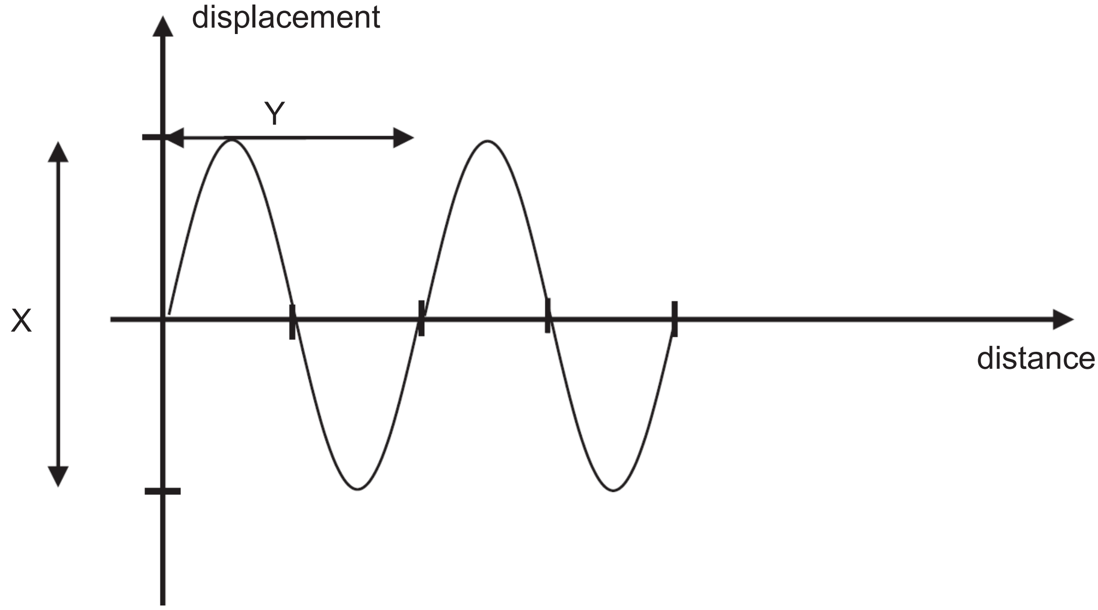
B the temperature change of ice

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

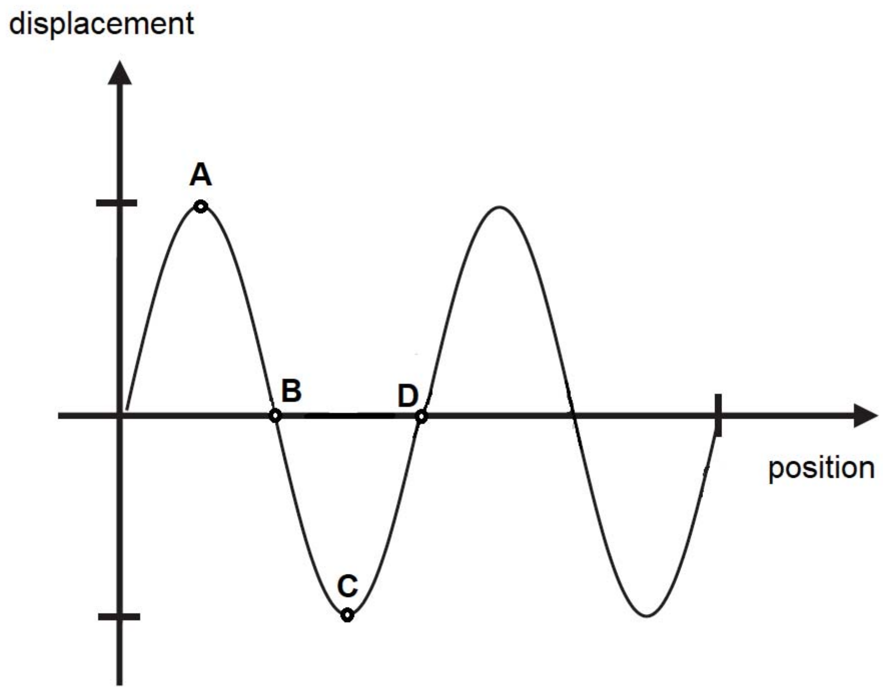
24 A boy shouts on a mountain and hears the echo from the nearest neighbouring mountain after 2.0 s. The speed of sound in air is 300 m/s.

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?



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.

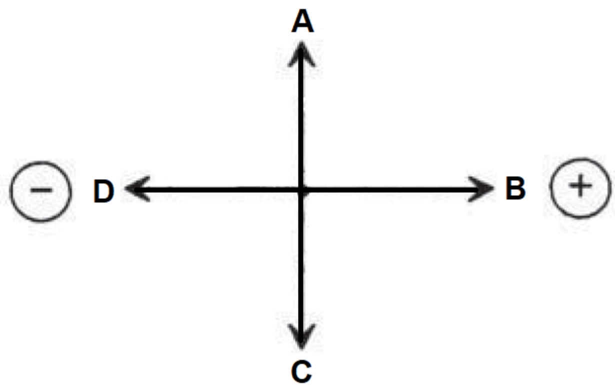
II A North pole of a permanent magnet will attract X.

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

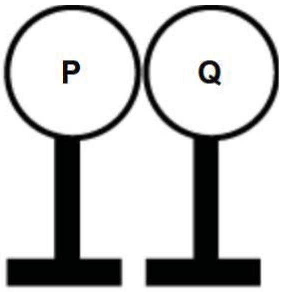
27 The diagram shows two charges placed near to each other.

In which direction will the electric field act?



[Turn Over

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.

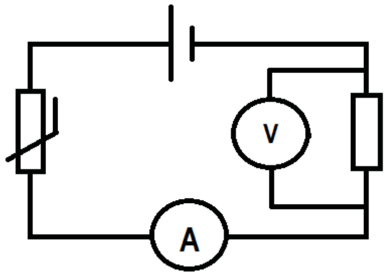
Step 3: Separate sphere P and Q.

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

29 A resistor and a thermistor are connected in series with a cell, as shown.



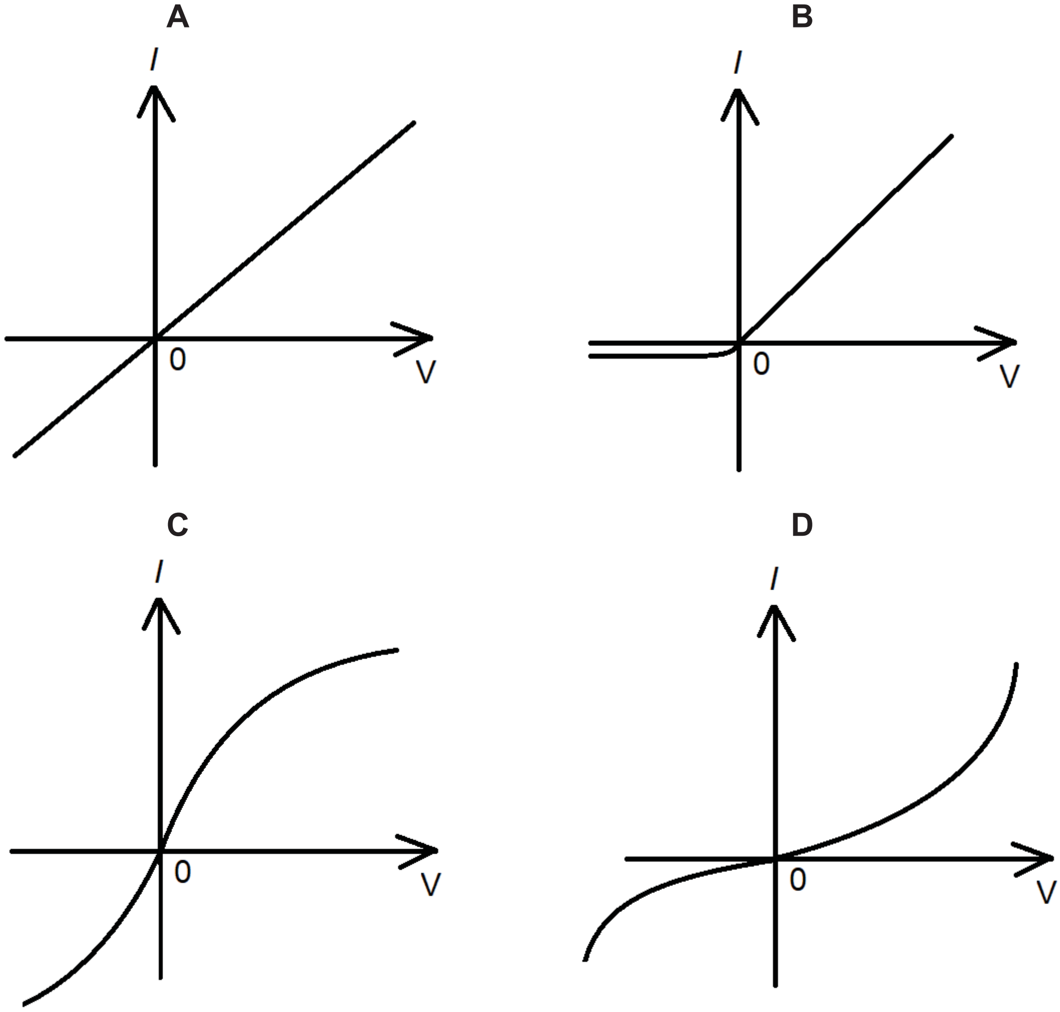
The thermistor is exposed to high temperature, the readings on both ammeter and voltmeter change.

How do they change?

	reading on ammeter	reading on voltmeter
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

 [Turn Over

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

[Turn Over

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.

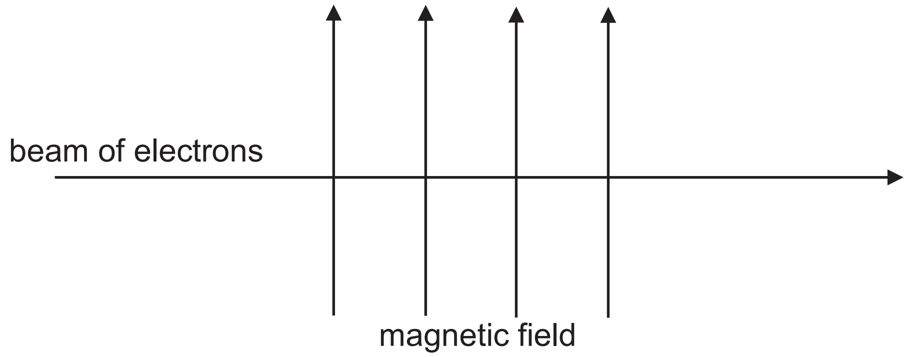
B The piece of soft iron becomes a temporary magnet.

C The piece of soft iron becomes a permanent magnet.

D An induced current will flow in the piece of soft iron.

[Turn Over

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

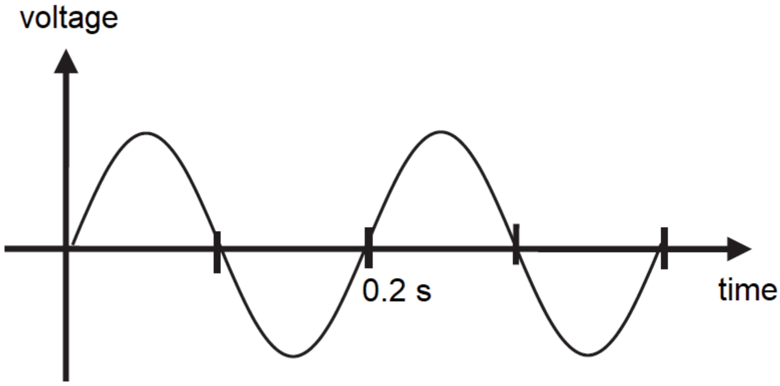
D down towards the bottom of the page

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

Name:	Register Number:	Class:

4E BEDOK GREEN SECONDARY SCHOOL 4E

Preliminary Examination 2022

PHYSICS **6091/2**

Paper 2 25 August 2022

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

1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your class, register number and name 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 in the spaces provided on the Question Paper.

Section **B**
Answer **all** questions in the spaces provided on the Question Paper.
Question 11 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 any separate answer paper securely to the Answer Booklet.
The number of marks is given in brackets [ ] at the end of each question or part question.

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

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

[Turn Over

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.

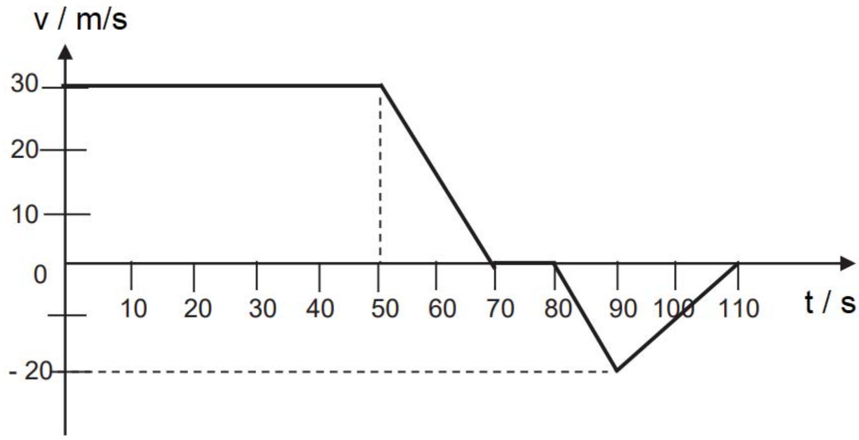


Fig. 1.1

(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.

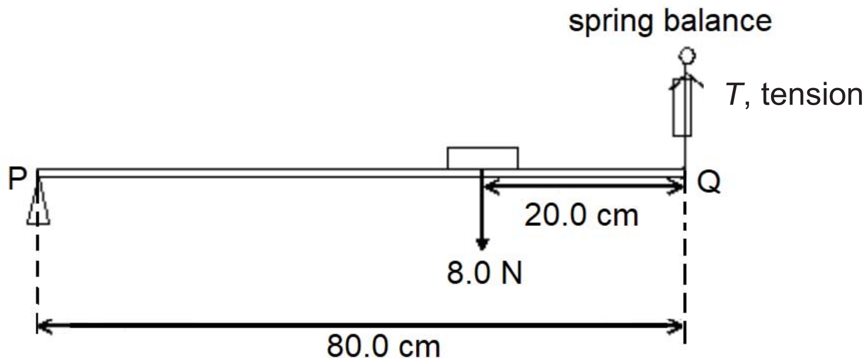


Fig. 2.1

(a) **(i)** Calculate *T*, the tension on the spring balance in order for the rod to balance horizontally.

tension, T = …………………… [2]

[Turn Over

For examiner's use

(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_0 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.

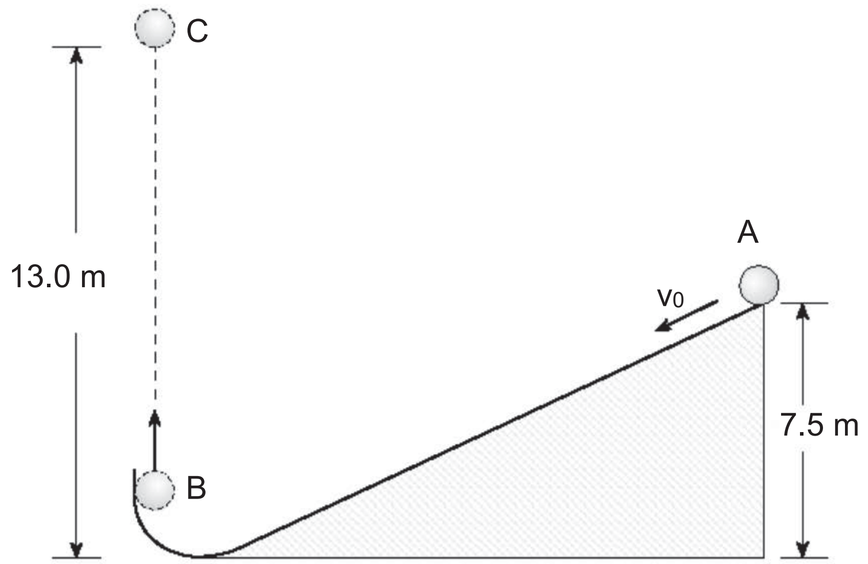


Fig. 3.1

 [Turn Over

(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.

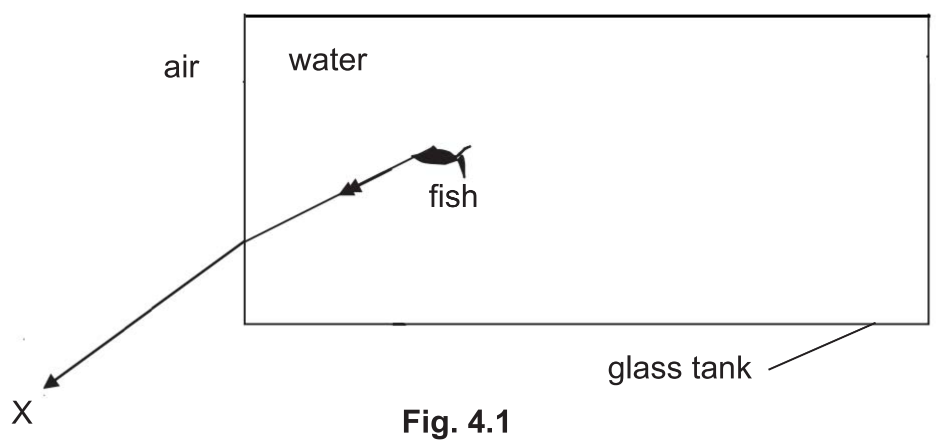


Fig. 4.1

 [Turn Over

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]

[Turn Over

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.

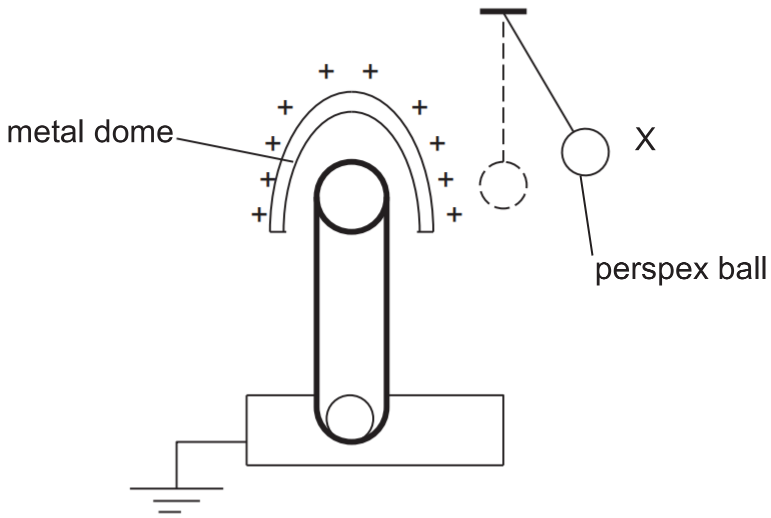


Fig. 6.1

(a) Explain why the perspex ball moves away from the metal dome.

....

....

....

.... [2]

For examiner's use

(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.

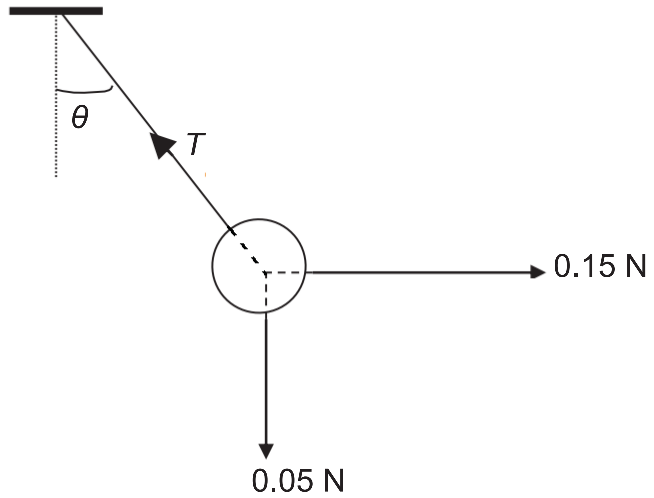


Fig. 6.2

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]

For examiner's use

7 **(a)** Fig. 7.1 shows an electric circuit powered by a 12.0 V battery of negligible internal resistance.

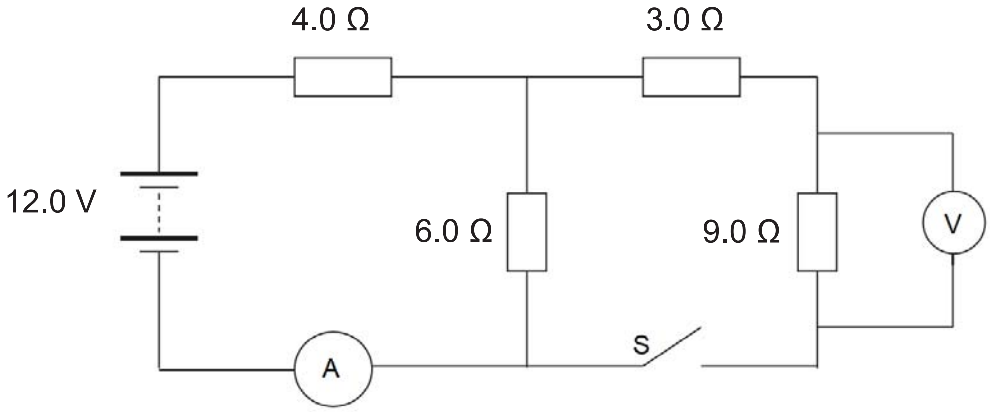


Fig. 7.1

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]

(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.

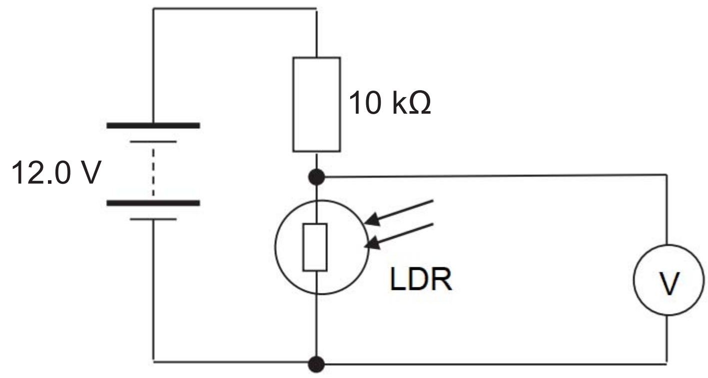


Fig. 7.2

(i) Explain the term 'input transducer'.

………………………………………………………………………….

…………………………………………………………………………. [1]

(ii) Calculate the resistance of the LDR when the voltmeter reads 2.0 V.

resistance = …………………. [2]

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.

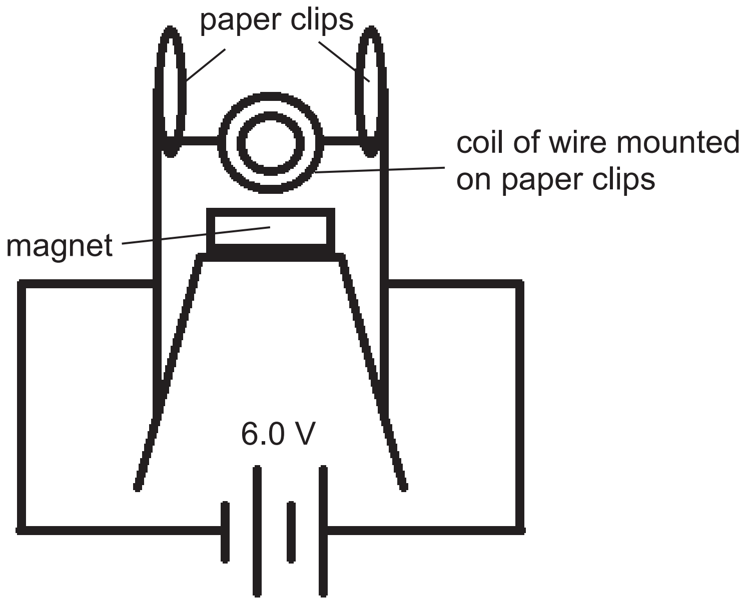


Fig. 8.1

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.

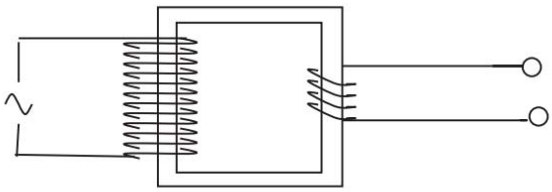


Fig. 9.1

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]

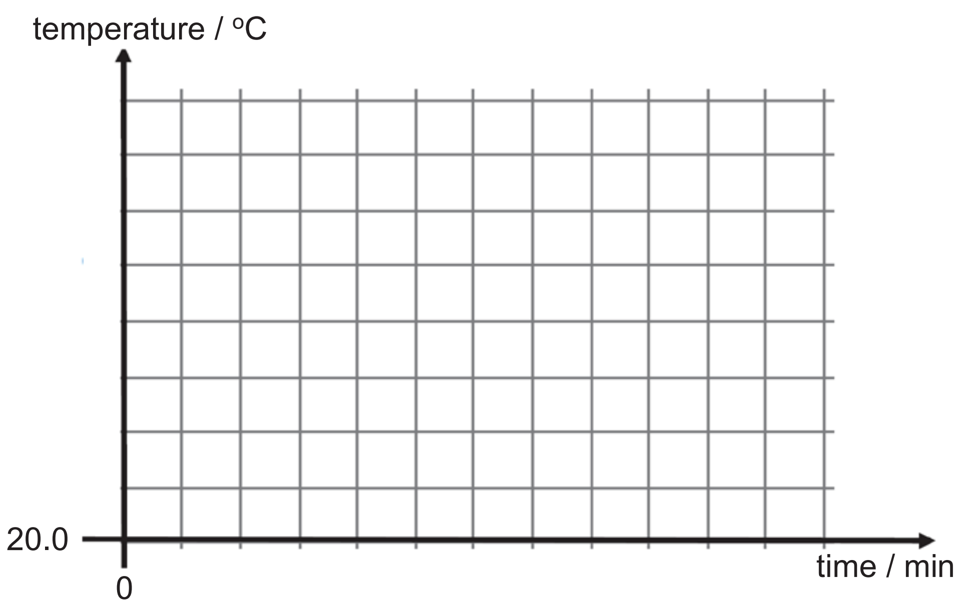
Answer **all** questions from this section.
Answer only one of the two alternative questions in **Question 12.**

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

(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°C [3]

(b) Fig. 10.3 below shows the cooling curve graphs of two pure liquids, Y and Z, of the same mass.

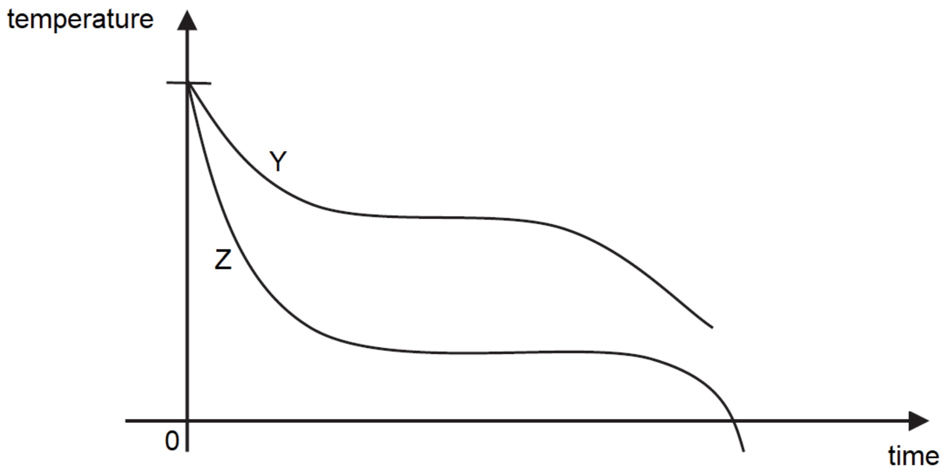


Fig. 10.3

(i) State why both liquids are losing thermal energy throughout the experiment.

……………………………………………………………………… [1]

For examiner's use

(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.

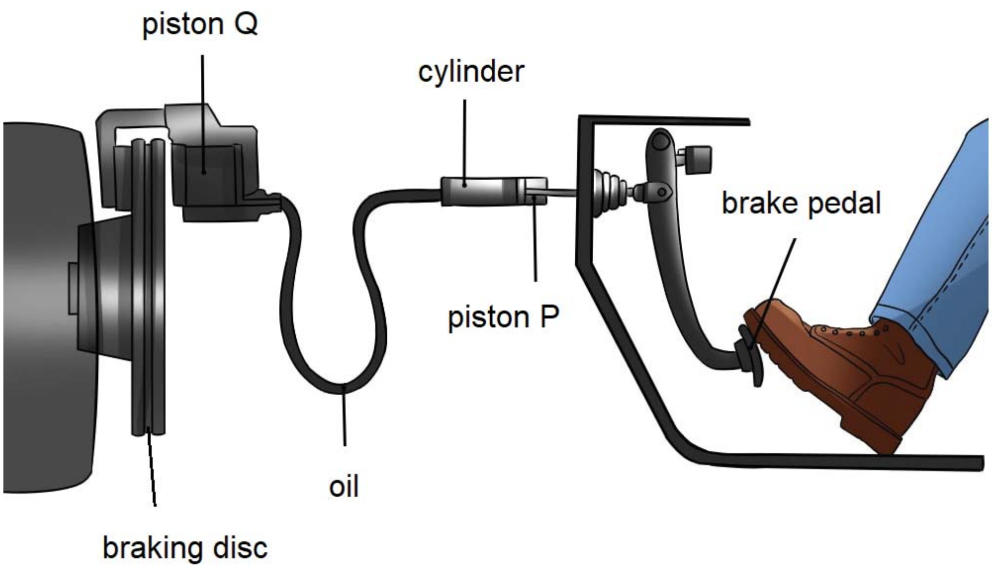


Fig. 11.1

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]

[Turn Over

(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]

For examiner's use

(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]

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'.

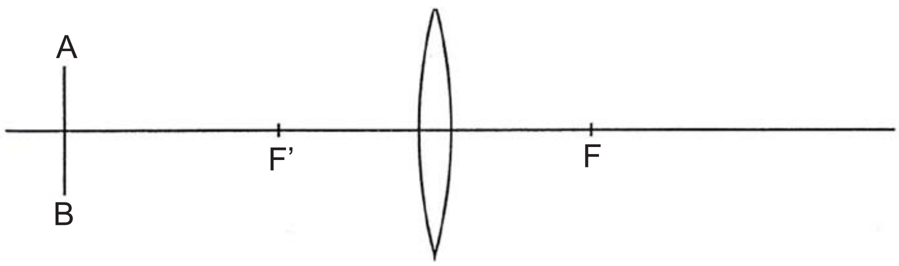


Fig. 12.1

(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 = ………………

[Turn Over

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.

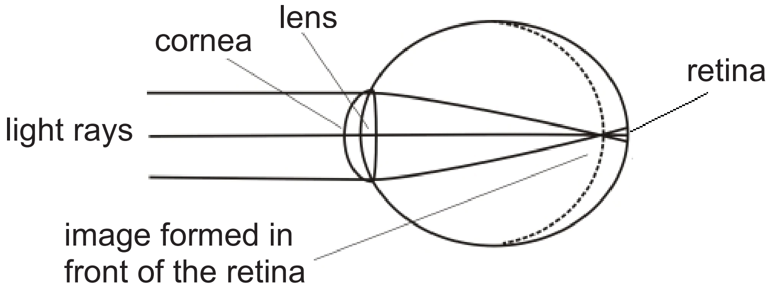


Fig. 12.3

(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.

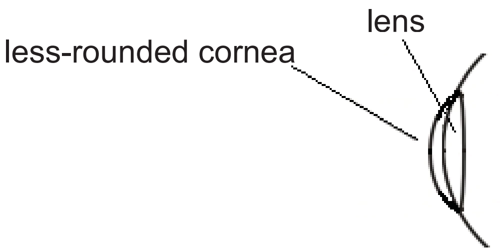


Fig. 12.4

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.

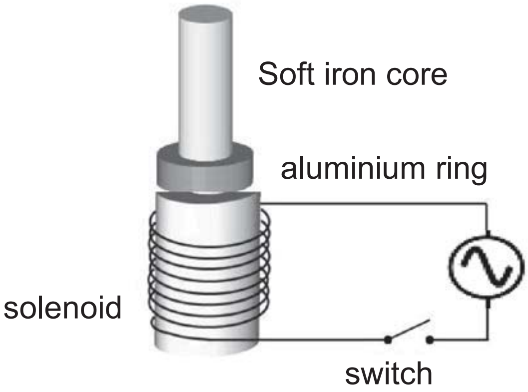


Fig. 12.4

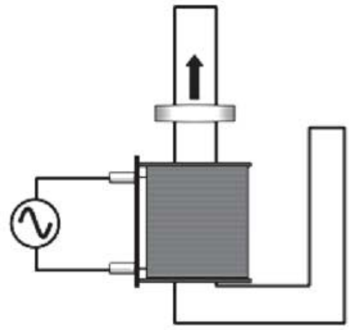


Fig. 12.5

(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.

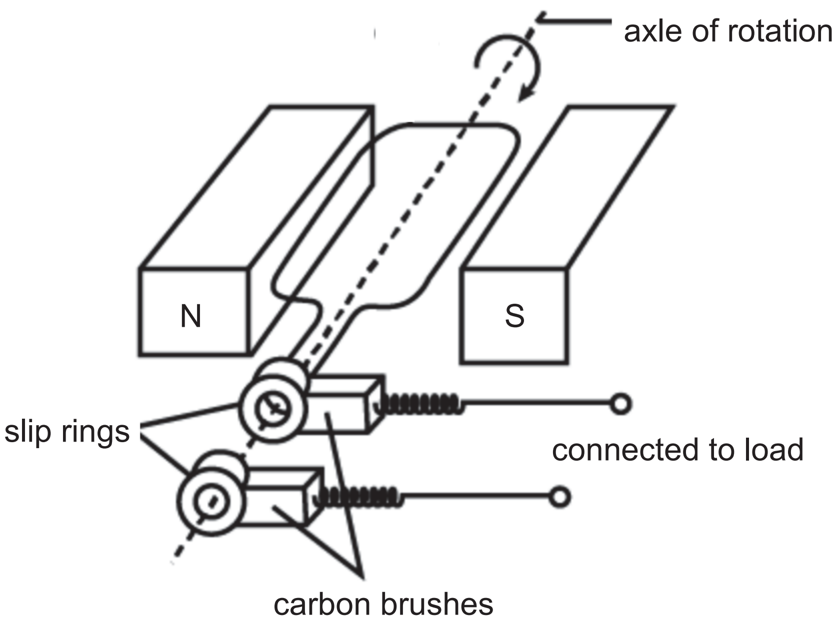
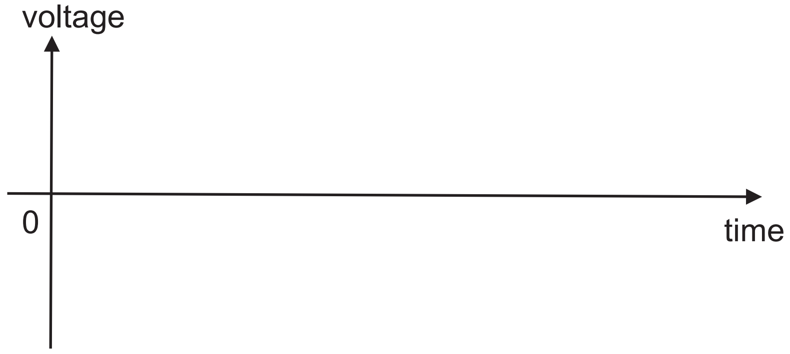


Fig. 12.7

(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]

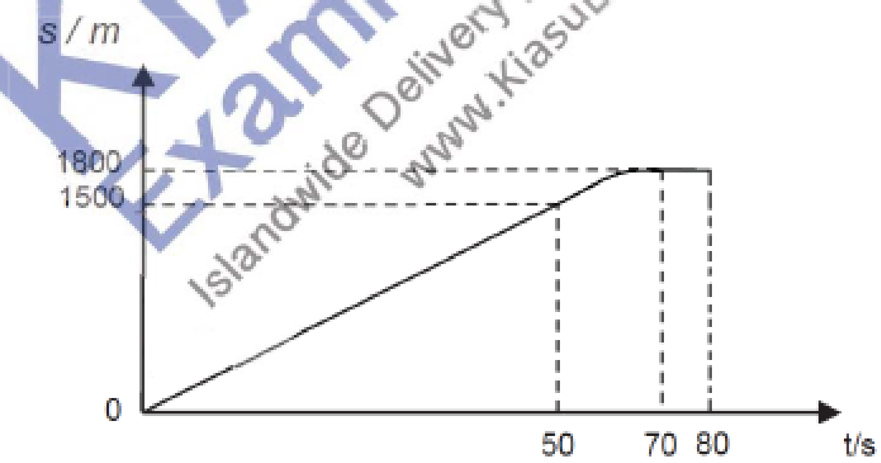
END OF PAPER

MARKING SCHEME 4E Pure Physics PRELIMS 2022

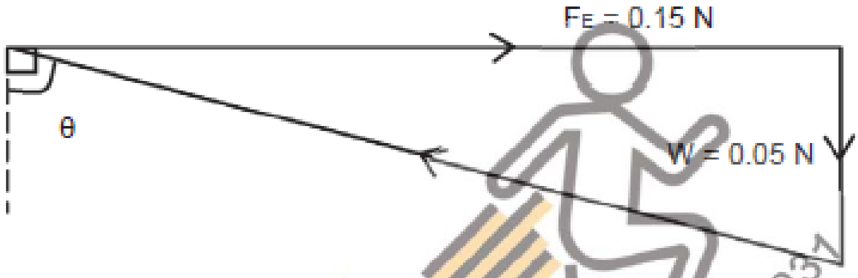
Paper 1 (40 marks)

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	C	13	A	18	D	23	B	28	C	33	B	38	A
4	C	9	D	14	D	19	B	24	C	29	D	34	A	39	C
5	B	10	B	15	B	20	A	25	D	30	B	35	A	40	C

Paper 2 Section A (50 marks)

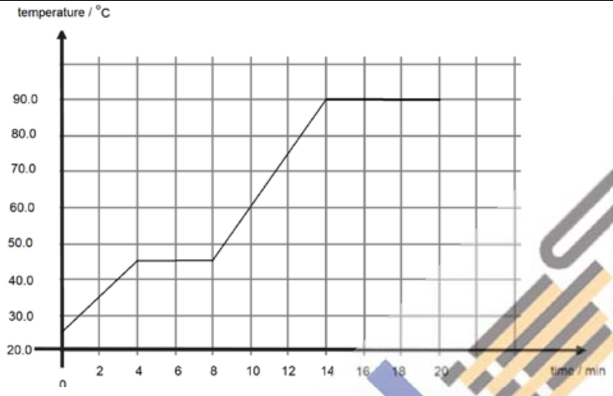
Qn	Answer	Sub marks	Total marks
1ai	The car decelerates uniformly to stop from t = 50 s to 70 s, and remain stationary / at rest for a further 10 s. It reverses / change direction and accelerates uniformly	1 m 1 m	2 m
1aii	a = (v – u) / t = (0 – 30) / 20 = - 1.5 m/s^2 deceleration = 1.5 m/s^2	 1 m 1 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

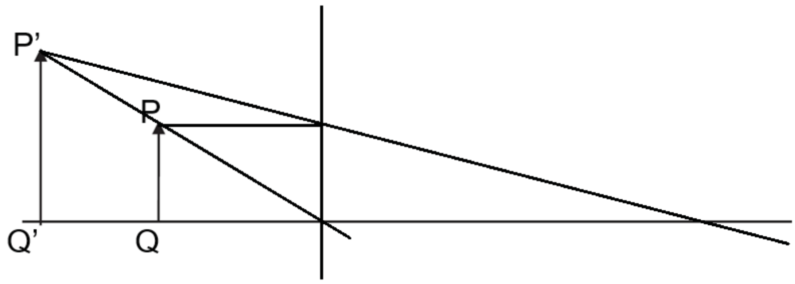
5	Air molecules moving randomly and bombarding / colliding with the tyre walls. This exerts a force on the wall's surface which produces a pressure.	1 m 1 m	2 m
6a	Perspex ball is positive charged. As like charges repel, the Perspex ball moves away from the charged metal dome.	1 m 1 m	2 m
6b	 Diagram 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

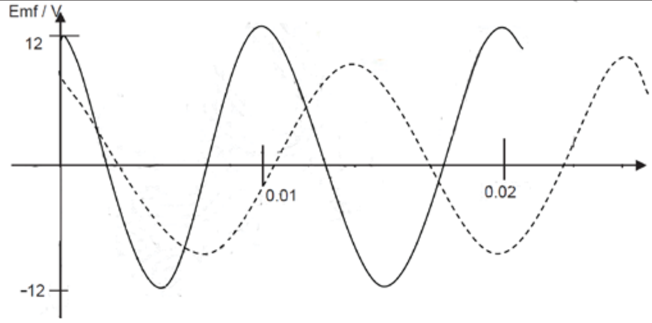
	This produces a force pushing the bottom coil near the bottom tape which turns the coil. This causes the conducting enameled copper wire to rotate.	**1 m**	
8b	The coil will rotate faster.	**1 m**	**1 m**
9a	Comparing the voltages of primary coil to secondary coil: Step down ratio = 3 300 : 220 = 15 : 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**

Name: ____________________________ ( ) Class: ______________

PRELIMINARY EXAMINATION
GENERAL CERTIFICATE OF EDUCATION ORDINARY LEVEL

PHYSICS 6091/01

Paper 1 Multiple Choice

30 August 2022

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, index number and class 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 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 on this booklet.
The use of an approved scientific calculator is expected, where appropriate.

圣尼各拉女校
CHIJ ST NICHOLAS GIRLS' SCHOOL
Girls of Grace · Women of Strength · Leaders with Heart

[Turn over

1 Which of the following has the same value as 5.0×10^{7} μm?

A 5.0×10^{8} nm
B 5.0×10^{-4} mm
C 5.0×10^{3} cm
D 5.0×10^{-1} m

2 A micrometer screw gauge is used to measure the thickness of a sheet of glass. Diagram 1 shows the reading on the micrometer when the jaws are closed with nothing between the jaws.
Diagram 2 shows the reading on the micrometer when the jaws are closed around the glass sheet.

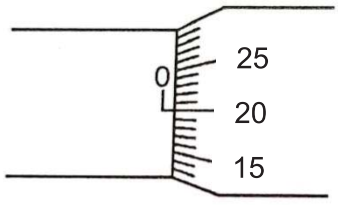


diagram 1

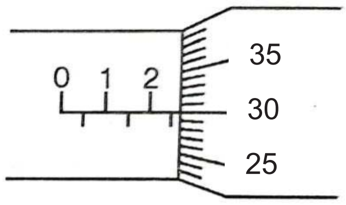
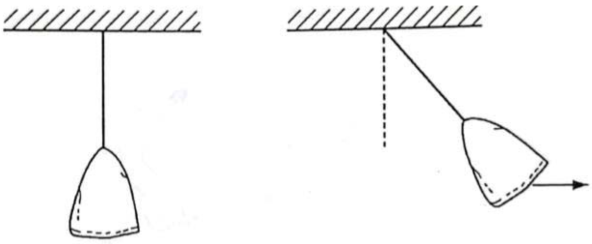


diagram 2

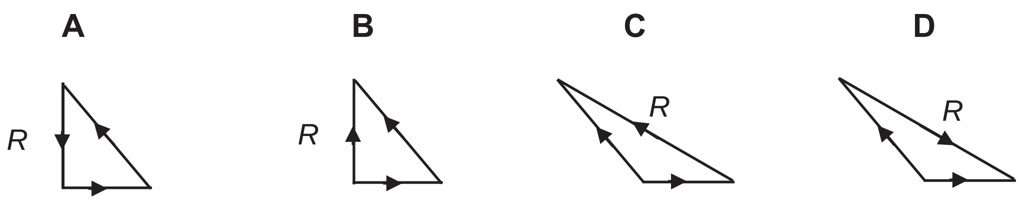
What is the thickness of the glass sheet?

A 2.10 mm
B 2.35 mm
C 2.60 mm
D 2.85 mm

3 A heavy rack is suspended from a ceiling by a rope. The sack is then pulled to one side and held stationary.



Which vector diagram shows the resultant force *R* of the pulling force and tension?



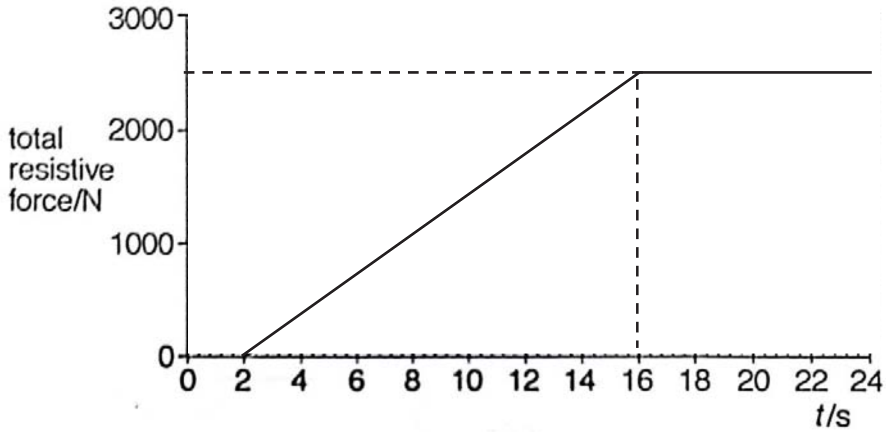
4 A block of wood of mass 2.0 kg is pushed along the horizontal flat surface of a bench with a force of 4.0 N. It moves at constant speed.

When the pushing force is increased to 12 N, what is the acceleration of the block?

A 0 m/s^2
B 4.0 m/s^2
C 6.0 m/s^2
D 8.0 m/s^2

5 The graph shows the total resistive force that acts on a car of mass 830 kg over a period of time.

The car is at rest at t = 0 s. A constant driving force of 2500 N acts on the car from t = 2 s to t = 24 s.



Which statement is **incorrect**?

A The acceleration of the car is 3.0 m/s^2 at t = 2 s.
B The acceleration of the car is zero after t = 16 s.
C The car is stationary from t = 0 s to t = 2 s.
D The resultant force acting on the car increases from t = 2 s to t = 16 s.

6 Which of the following correctly describes an action-reaction pair of forces?

A The backward force acting on water by propeller and the resistive force acting on the boat.
B The reaction force on a book resting on a table and the weight of the book.
C A runner pushes backward on the ground and the ground pushes forwards on runner.
D The pulling force acting on a trolley and the frictional force acting on the trolley.

7 A rocket is travelling vertically upwards. Three vertical forces act on it. The thrust acts upwards and is equal to 100 000 N. The weight of the rocket is equal to 80 000 N.

What is the magnitude and direction of the drag force acting on the rocket when it is travelling upwards at constant speed?

	magnitude	direction
A	20 000 N	downwards
B	20 000 N	upwards
C	160 000 N	downwards
D	160 000 N	upwards

8 Two stones of different masses fall from rest at the same time from a table. Air resistance is ignored.

What will happen and why?

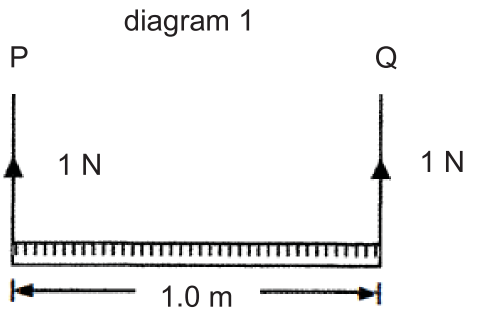
	What will happen	why
A	Both stones hit the floor at the same time.	The acceleration is constant.
B	Both stones hit the floor at the same time.	The speed is constant.
C	The heavier stone hits the floor first.	Acceleration increases with weight
D	The heavier stone hits the floor first.	Speed increases with weight

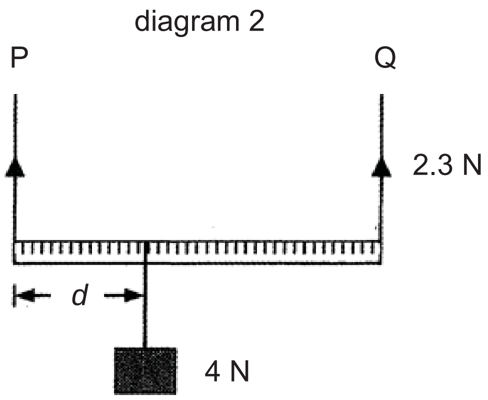
9 A rock has a weight of 19 N on Mars. The rock is then taken back to Earth. The gravitational field strength of Mars is 3.7 N/kg and the gravitational field strength of Earth is 9.8 N/kg. The mass is unchanged when transported.

What is the mass and weight of the rock on Earth?

	mass on Earth / kg	weight on Earth / N
A	1.9	50
B	1.9	19
C	5.1	19
D	5.1	50

10 A uniform metre rule is supported by vertical wires P and Q and remains horizontal as shown in diagram 1. The tension in each wire is 1 N. When a weight of 4 N is hung from the metre rule at the position as shown in diagram 2, the tension in Q becomes 2.3 N while the metre rule remains horizontal.

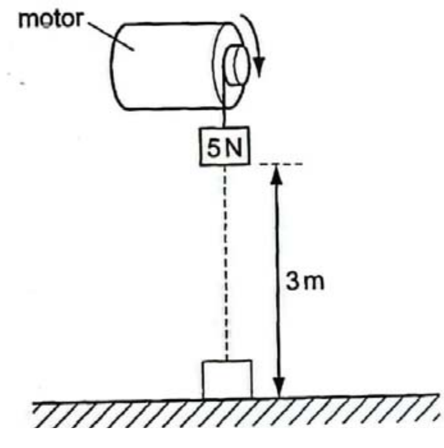




What is the distance *d* of the weight 4 N from end P?

A 32.5 cm
B 57.5 cm
C 67.5 cm
D Cannot be found as tension in P is unknown

11 An electric motor is used to lift a 5 N load through 3 m as shown.



The amount of energy wasted is 10 J.

What is the efficiency of the motor?

A 15 %
B 40 %
C 60 %
D 67 %

12 Some students climb a flight of stairs in school, and each student is timed. Their weights and times are recorded in the table.

Which student develops the most power?

	weight/ N	time/s
A	400	10
B	450	12
C	490	15
D	540	16

13 In an experiment, smoke particles are suspended in air and viewed through a microscope. The smoke particles undergo jerky random motion.

Which statement is correct?

A Air particles have large mass compared to smoke particles and they move in one direction only.

B Air particles have large mass compared to smoke particles and they move in random directions.

C Air particles move at high speed compared to smoke particles and they move in one direction only.

D Air particles move at high speed compared to smoke particle and they move in random directions.

14 Which row shows physical properties that may both be used to define temperature scales?

A e.m.f at the junction of two different metals and volume of a liquid column
B mass of a solid object and resistance of a metal wire
C mass of a solid object and volume of a liquid column
D volume of a liquid column and weight of trapped gas

15 A student measures the resistance of a metal wire at the ice point and steam point. She records the results.

temperature	resistance / Ω
ice point	15.0
steam point	20.0

What is the temperature when the resistance of the wire is 22.0 Ω?

A 40 °C
B 60 °C
C 120 °C
D 140 °C

16 Which process(es) of thermal energy transfer require a medium?

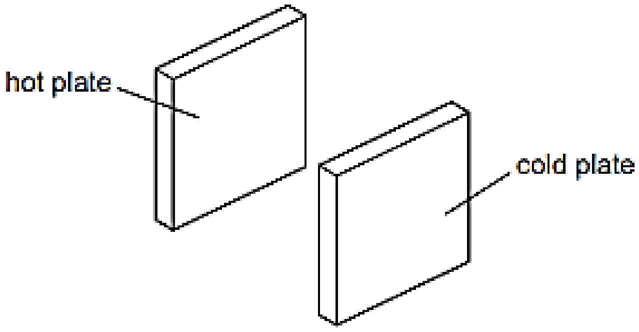
A conduction and convection
B conduction only
C convection and radiation
D radiation only

17 A student is comparing the design of a refrigerator and an oven. The cooling unit of the refrigerator and the heater of an oven can be fitted either at the top or at the bottom.

Which row shows the best position for the cooling unit and heater?

	cooling unit	heater
A	bottom	bottom
B	bottom	top
C	top	bottom
D	top	top

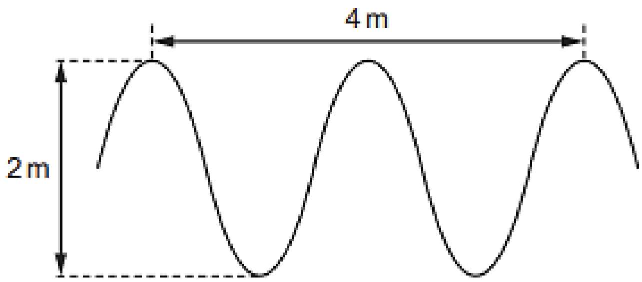
18 A hot metal plate is placed near to a cold metal plate.



Which row shows the colour for the hot plate and for cold plate that causes the temperature of cold plate to increase most slowly?

	hot plate	cold plate
A	dull black	dull black
B	dull black	shiny white
C	shiny white	dull black
D	shiny white	shiny white

19 The diagram represents a rope wave.



Which row shows the amplitude and wavelength of the wave?

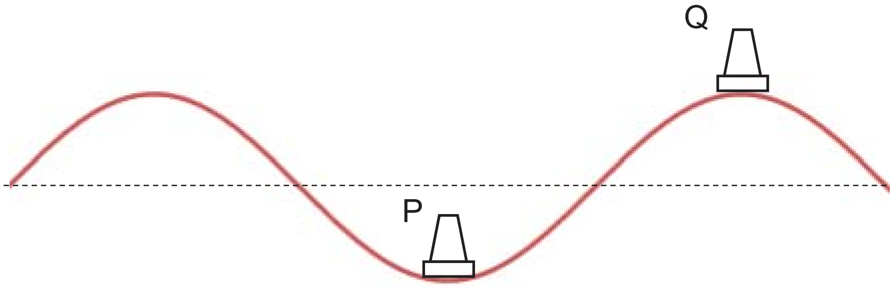
	amplitude / m	wavelength / m
A	1	2
B	1	4
C	2	2
D	2	4

20 A water wave moves from deep water to shallow water. Its speed decreases in shallow water.

Which statement correctly describes the frequency and wavelength of the wave in the shallow water?

A Both frequency and wavelength decrease.
B Both frequency and wavelength remain unchanged.
C Frequency decreases while wavelength remains unchanged.
D Frequency remains unchanged while wavelength decreases.

21 The diagram shows two buoys P and Q sitting on a pond. A wave moves across the pond from left to right.

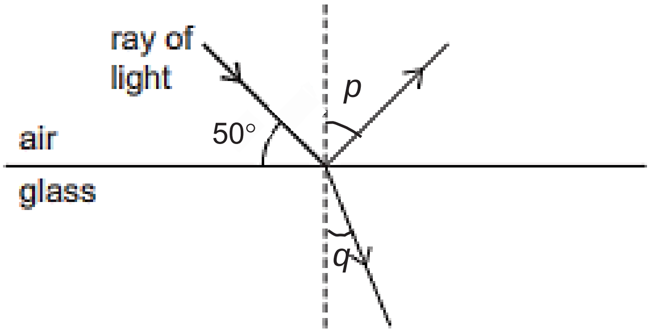


At the moment shown, buoy Q is at the crest and buoy P is at the trough.

Which row describes the movement of the buoys during the next cycle of the wave?

	P	Q
A	not moving	not moving
B	only rises	only falls
C	rises and falls	falls and rises
D	towards the right	towards the right

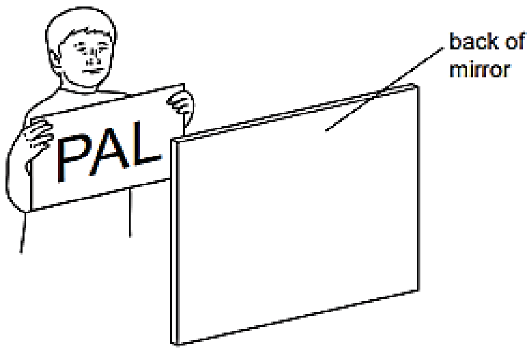
22 The diagram shows a ray of light in air incident on a glass block of refractive index 1.5. Some of the light is refracted, and some of the light is reflected. Two angles *p* and *q* are marked on the diagram.



What are the angles of *p* and *q*?

	p / °	*q* / °
A	40	25
B	40	27
C	50	31
D	50	33

23 A student holds a piece of paper in front of a plane mirror. The paper has the word ‘PAL’ written on it.



What is the image as seen by the student?

A

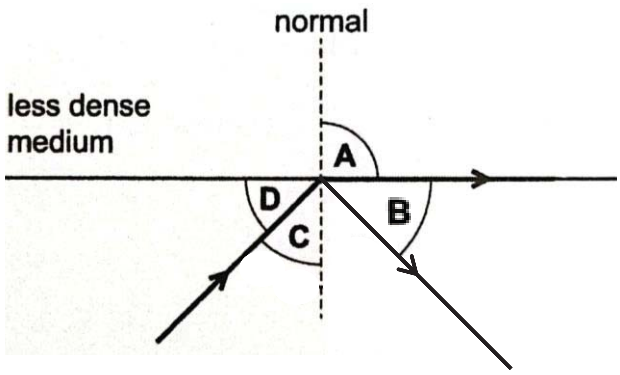
B

C

D

24 Light travels from one medium to a less dense medium. Most of the light is reflected but some is refracted along the boundary between the media as shown.

Which angle is the critical angle?



25 Which row shows regions of the electromagnetic spectrum in order of increasing frequency?

A X-ray $\rightarrow$ ultraviolet $\rightarrow$ visible light $\rightarrow$ infrared
B X-ray $\rightarrow$ infrared $\rightarrow$ visible light $\rightarrow$ ultraviolet
C infrared $\rightarrow$ visible light $\rightarrow$ ultraviolet $\rightarrow$ X-ray
D ultraviolet $\rightarrow$ visible light $\rightarrow$ infrared $\rightarrow$ X -ray

26 The three types of ultraviolet radiation are classified according to their wavelength.

UVA	315 – 400 nm
UVB	280 – 315 nm
UVC	100 – 280 nm

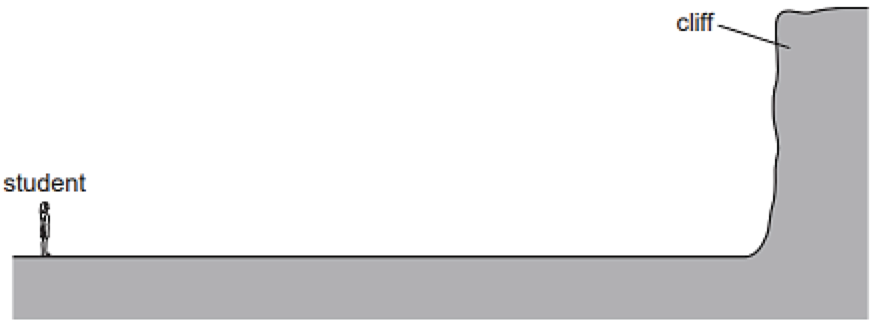
What is the largest frequency of the three types of radiation?

A 7.5×10^{10} Hz
B 3.0×10^{12} Hz
C 7.5×10^{14} Hz
D 3.0×10^{15} Hz

27 Which statement about ultrasound is **incorrect**?

A Ultrasound can travel through vacuum.
B Ultrasound has a frequency larger than 20 kHz.
C Ultrasound is used for prenatal imaging.
D Ultrasound is a type of longitudinal wave.

28 A student wishes to determine the speed of sound in air. She plans to measure the time from making a sound to hearing the echo from a cliff.

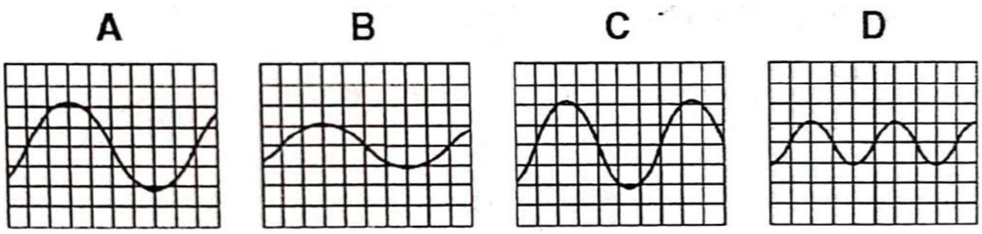


What type of sound and which distance should she use for her experiment?

	type of sound	distance to use
A	continuous sound	distance to cliff ÷ 2
B	continuous sound	distance to cliff × 2
C	short, sharp sound	distance to cliff ÷ 2
D	short, sharp sound	distance to cliff × 2

29 The diagrams show oscilloscope traces of sounds picked up by microphones. The controls settings are the same for all the traces.

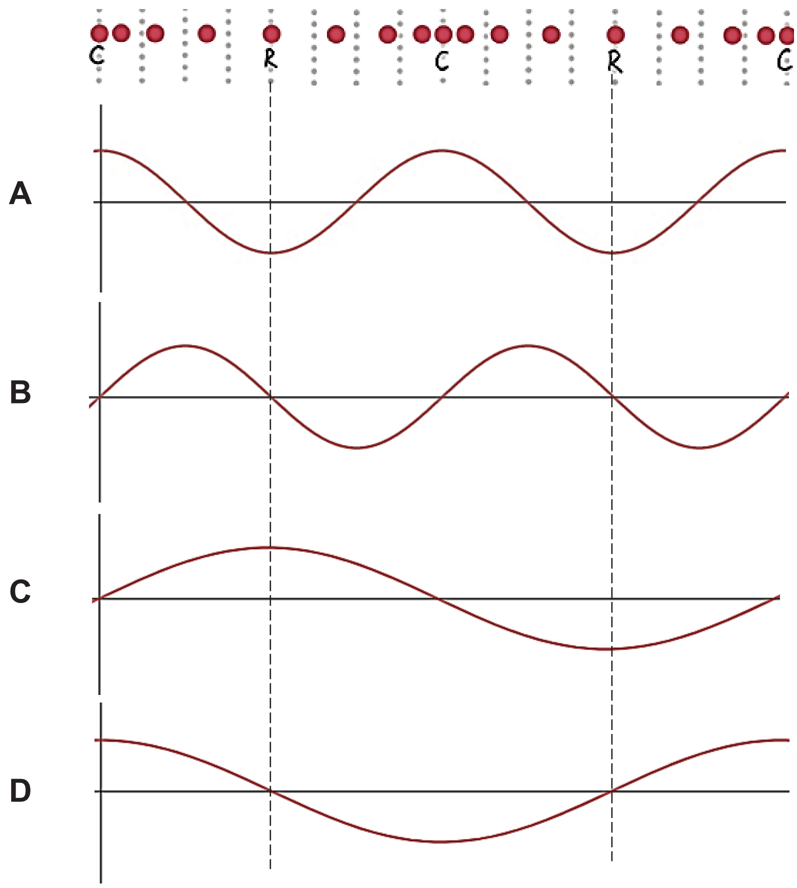
Which trace shows the sound that is the loudest and has the lowest pitch?



30 The diagram shows the positions of air particles in a longitudinal wave. The positions of compression and rarefactions are marked with "C" and "R" respectively.

Four students A, B, C, and D attempt to sketch a displacement-time graph of the wave.

Which student's graph is correct?



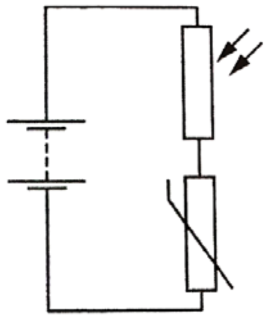
31 Wire X has a resistance of 12 Ω.

Wire Y is made of the same material as X but is half the length of X and has twice the diameter of X.

What is the resistance of wire Y?

A 1.5 Ω
B 3.0 Ω
C 6.0 Ω
D 12 Ω

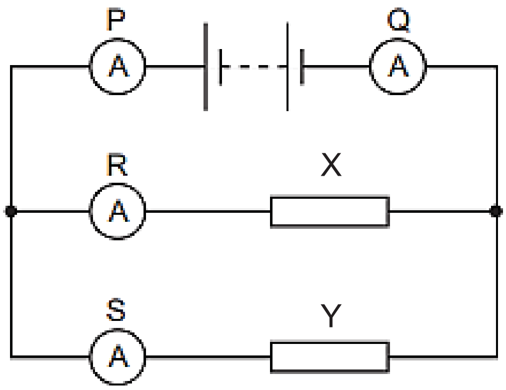
32 A light-dependent resistor (LDR) and a thermistor are connected in series with a battery.



Which conditions cause the potential difference across the LDR to be the largest?

A bright and cold
B bright and hot
C dark and cold
D dark and hot

33 The diagram shows four ammeters P, Q, R and S used to measure the current in different parts of the circuit. Resistor X has a larger resistance than resistor Y.



Which two ammeters read the largest current?

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

34 A voltmeter is used to measure the potential difference across a resistor.

What is the position and the resistance of the voltmeter in the circuit?

	position	resistance
A	in parallel to the resistor	very high
B	in parallel to the resistor	very low
C	in series with the resistor	very high
D	in series with the resistor	very low

35 A household uses four 60 W lamps. The cost of 1 kWh of electrical energy is $0.30.

What is the cost per day of using the lamps for 10 hours?

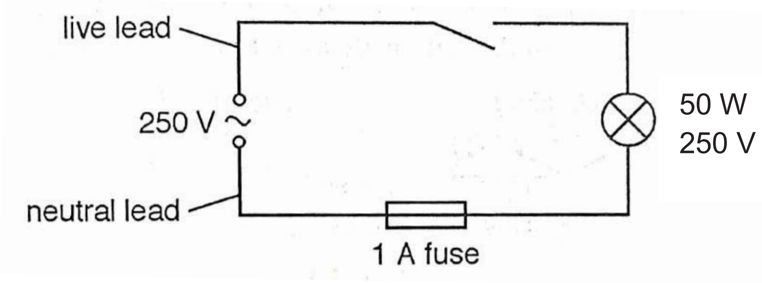
A $0.20
B $0.72
C $12.00
D $72.00

36 An electric kettle has a metal casing. The cable contains a wire that is connected to the earth pin of the plug.

Which danger can be prevented by this wire?

A the cable and the kettle becoming too hot
B the casing of the kettle becoming live
C the casing of the kettle becoming wet on the outside
D the casing of the kettle overheating

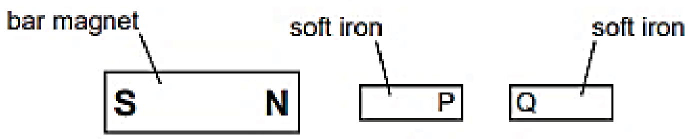
37 A student suggests setting up the circuit as shown. The lamp has a plastic casing.



Why is this circuit unsafe for use?

A The fuse rating is too small.
B The fuse is connected in the wrong lead.
C The switch is connected in the wrong lead.
D There is no earth lead connected to the lamp.

38 Two bars of soft iron are placed near a bar magnet.



Which row states and explains the behaviour P and Q of the soft iron bars?

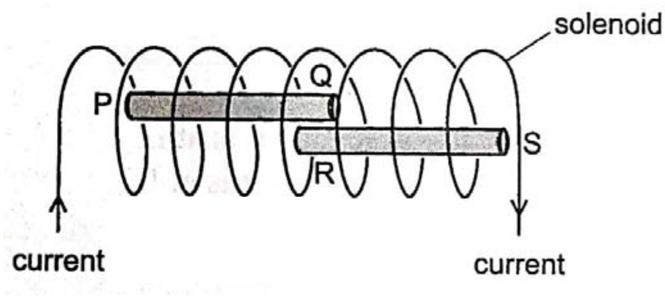
	P and Q	reason
A	attract	P and Q are like poles
B	attract	P and Q are unlike poles
C	repel	P and Q are like poles
D	repel	P and Q are unlike poles

39 How many of the following methods can be used to demagnetise a piece of steel?

heating it until it is red hot
pulling it from a coil that is carrying an alternating current
placing it in an east-west direction and hammering it
putting it in a coil which is carrying a direct current

A 1
B 2
C 3
D 4

40 Two pieces of soft iron PQ and RS are placed inside a solenoid. They become magnetised by the current in the solenoid.



Which poles are found at P, Q, R, S?

	at P	at Q	at R	at S
A	N pole	N pole	S pole	S pole
B	N pole	S pole	N pole	S pole
C	S pole	N pole	N pole	S pole
D	S pole	S pole	N pole	N pole

END OF PAPER

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Name ______________________________ (   )   Class ______________

PRELIMINARY EXAMINATION
GENERAL CERTIFICATE OF EDUCATION ORDINARY LEVEL

PHYSICS — 6091/02

Paper 2 Theory

24 August 2022

1 hour 45 minutes

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 a soft pencil for any diagrams or graphs.
Do not use highlighters, correction fluid or correction tape.

Section A
Answer **all** questions.

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

Students are reminded that **all** quantitative answers should include appropriate units.
The use of 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 Marks)	
Section B (30 Marks)	
Total (80 Marks)	

This document consists of **22** printed pages.

圣尼各拉女校
CHIJ ST NICHOLAS GIRLS' SCHOOL
Girls of Grace · Women of Strength · Leaders with Heart

[Turn over]

1 Fig. 1.1 shows a water wheel used in a farm. Water entering at the top turns the wheel about the hub.

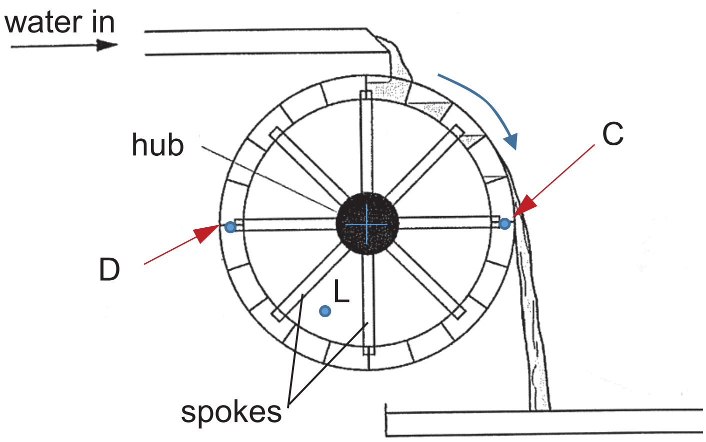


Fig. 1.1

Point C on the wheel moves in a circular path at a constant speed of 2.5 m/s.

(a) **(i)** State the change in speed of point C as it moves to position D,

change in speed =………………….. [1]

(ii) Determine the magnitude of the change in velocity of point C as it moves to position D,

change in velocity =…………………. [1]

(b) The farmer installs a laser counter at L to track the rotation of the wheel. The counter records the time interval between two spokes as the wheel rotates, as shown in Fig. 1.2.

time / s
1.48
1.51
1.50
1.49
1.52

Fig. 1.2

Determine the frequency of rotation of the wheel.

frequency of rotation = ……………………… [2]

2 A bob of mass 0.500 kg falls from rest at a given height and strikes a pond.

Fig. 2.1 shows the variation of velocity of the bob with time during its motion. The bob reaches the bottom of pond at R. The gravitational field strength of Earth is 10 N/kg and air resistance is assumed to be negligible.

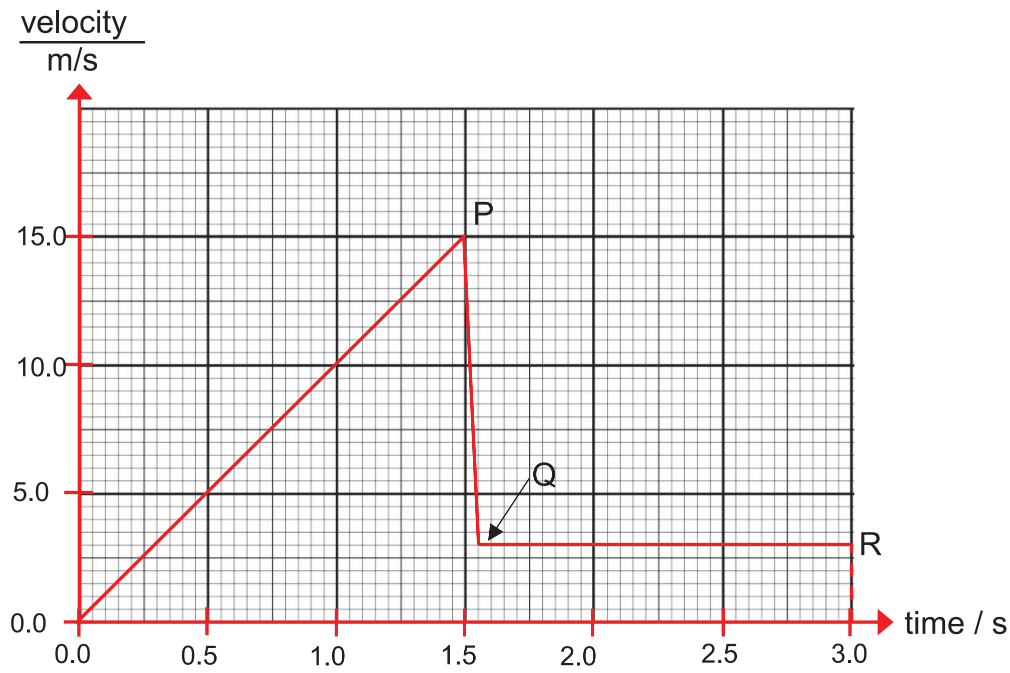


Fig. 2.1

(a) Determine the acceleration of the bob for the first 1.5 s of its descent.

acceleration = ……………… [1]

(b) Explain how a student can use Fig. 2.1 to estimate the depth of the pond.

……………………………………………………………………………

…………………………………………………………………………… [1]

(c) On Fig. 2.2, sketch a graph to show the displacement of the bob with time for t = 0.0 s to t = 3.0 s. Displacement is measured from the point the bob starts to fall. [2]

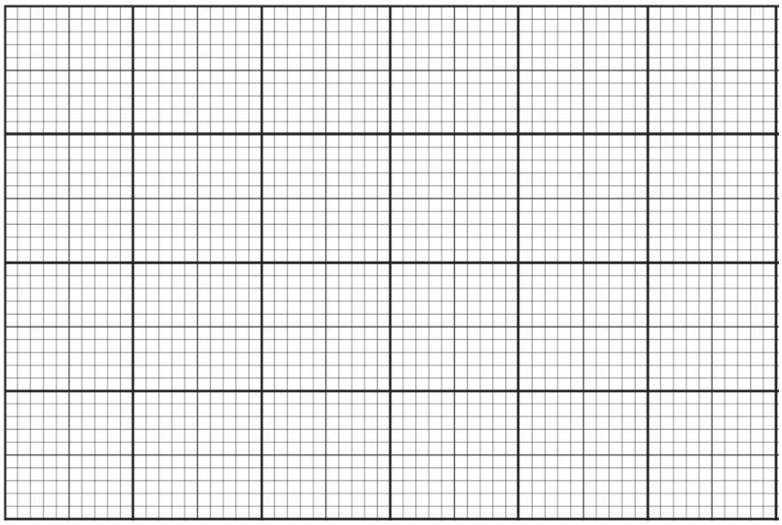


Fig. 2.2

(d) Describe the energy changes of the bob from position P to Q.

……………………………………………………………………………………

…………………………………………………………………………………… [1]

(e) Fig. 2.3 shows the bob when it is at a position between PQ.

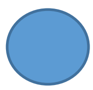


Fig. 2.3

Draw and label on Fig. 2.3 all the forces acting on it. [2]

3 An object made up of a pencil and penknife is used in a balancing trick as shown in Fig 3.1.

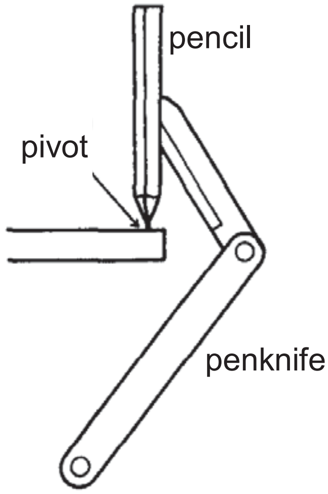


Fig. 3.1

(a) State what is meant by *centre of gravity* of an object.

……………………………………………………………………………………

…………………………………………………………………………………… [1]

(b) Mark a possible position for the centre of gravity for the object with 'X' on Fig 3.1. [1]

(c) Explain why the object is in stable equilibrium.

……………………………………………………………………………………

…………………………………………………………………………………… [1]

(d) A student removes the penknife. She tries to balance the pencil alone. State and explain what will happen to the pencil.

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [2]

4 Fig. 4.1 shows a water manometer used to measure the pressure inside a gas pipe.

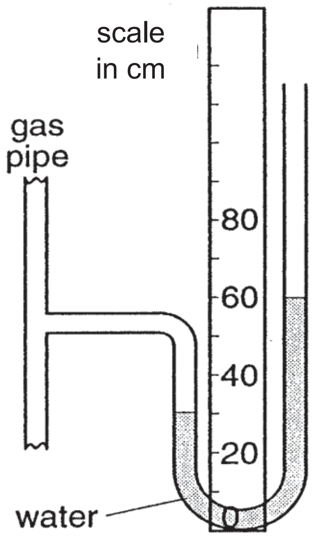


Fig. 4.1

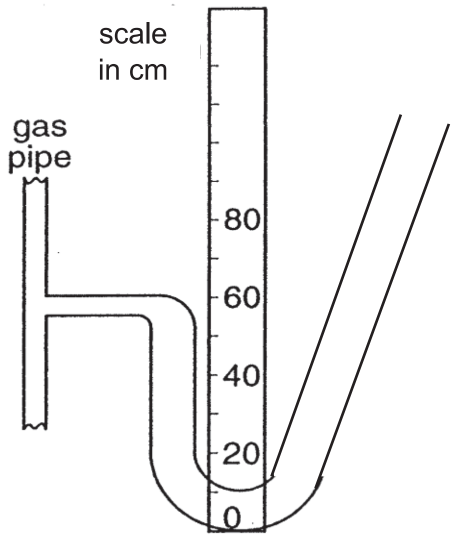


Fig. 4.2

(a) Explain how the manometer in Fig 4.1 shows that the pressure inside the gas pipe is greater than the atmospheric pressure.

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

………………………………………………………………………………… [2]

(b) Calculate the pressure of the gas inside the pipe, given that the density of water is 1000 kg/m^3, the gravitational field strength is 10 N/kg and the atmospheric pressure is 1.0×10^5 Pa.

pressure = ………………… [2]

(c) The manometer shown in Fig. 4.2 is connected to the same gas pipe at the same pressure as shown in Fig. 4.1. On Fig. 4.2, draw the levels of the liquid in the manometer if the manometer contains a liquid with density half that of water and has twice the diameter of the manometer in Fig. 4.1. [1]

5 A negatively charged metal ball X is suspended from an insulating thread. An uncharged metal plate Y is mounted on an insulating stand.

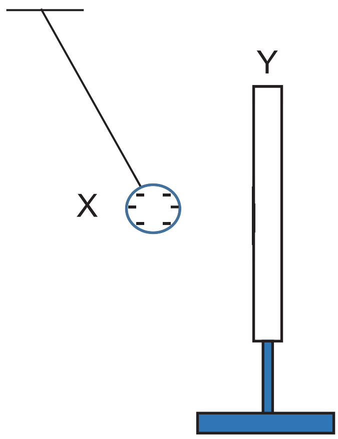


Fig. 5.1

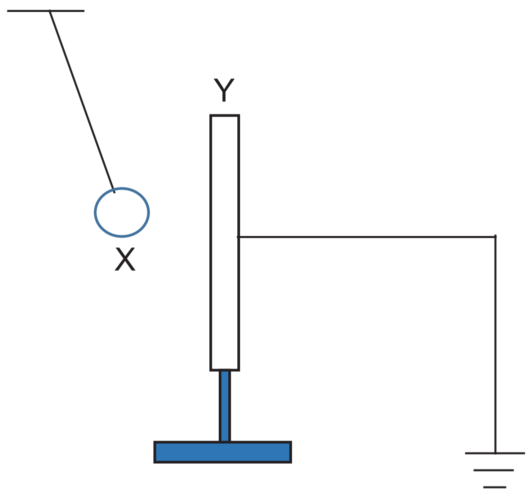


Fig. 5.2

When X is brought near to Y, it is attracted towards Y as shown in Fig. 5.1.

(a) On Fig. 5.1, draw the charges induced on Y. [1]

(b) On Fig. 5.1, draw the electric field in the space between the two conductors. [1]

(c) Explain why X is attracted to Y.

....

....

.... [2]

(d) Y is earthed momentarily as shown in Fig. 5.2. State and explain whether X will move closer, further or remains unchanged.

....

....

.... [2]

6 Fig. 6.1 shows a light ray ABC from the top of an object passing through a lens.

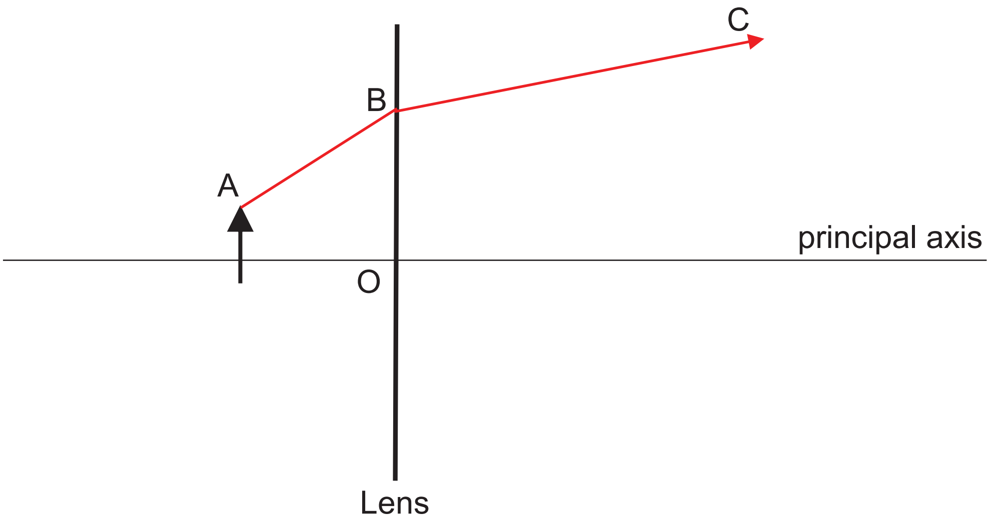


Fig. 6.1

(a) State and explain whether the lens is converging or diverging.

....

....

.... [2]

(b) Draw light ray(s) from the object so that the image of the object can be located. Draw the image and label the image I. [2]

(c) Locate the position of the principal focus of the lens and label the position F. [1]

7 In the circuit shown in Fig. 7.1, a battery of e.m.f. 12 V is connected to resistors A and B, and component C. The I - V characteristic graphs for B and C are shown in Fig. 7.2.

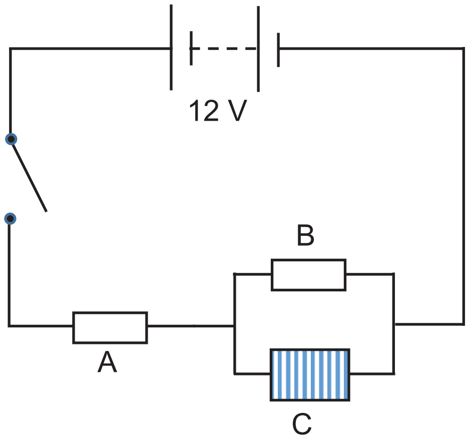


Fig. 7.1

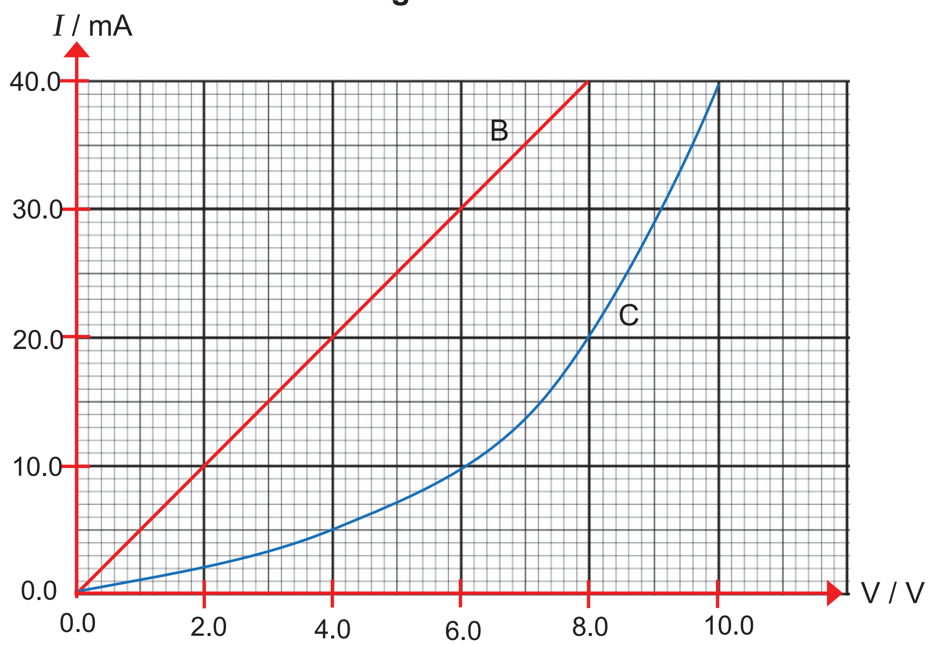


Fig. 7.2

(a) Describe how the resistance of component C changes as the potential difference (p.d.) increases from zero.

....

....

.... [1]

(b) When the switch is closed, the p.d. across resistor A is immediately measured to be 4.0 V. Determine the resistance of A at this instant.

resistance= …………………… [2]

(c) In the circuit shown in Fig. 7.1, component C is removed. Explain whether the p.d. across A increases, decreases or remains unchanged.

……………………………………………………………………………

……………………………………………………………………………

…………………………………………………………………………… [2]

8 A conducting rod PQ is suspended horizontally by two newton-meters. The rod is placed inside the magnetic field of a U-shaped magnet as shown in Fig 8.1.

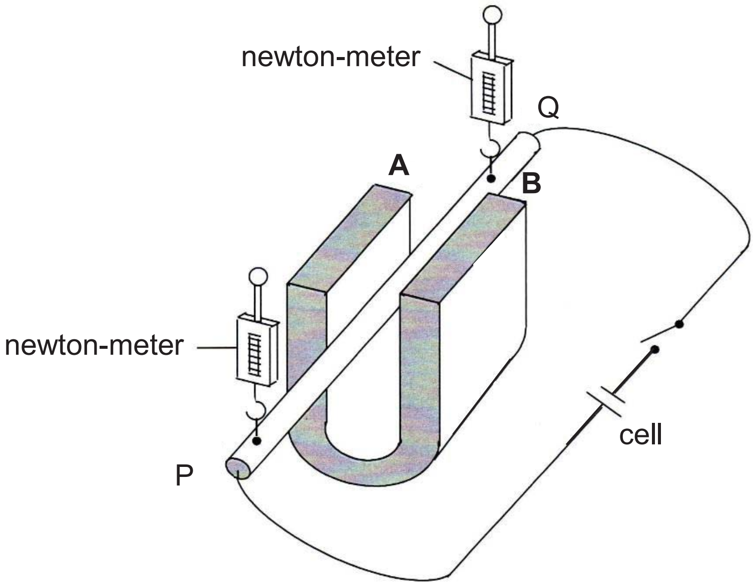


Fig. 8.1

When the switch is closed, the readings on the newton-meters decrease.

(a) Explain why the readings for the newton-meters decreased.

…………………………………………………………………………

…………………………………………………………………………

………………………………………………………………………… [2]

(b) State the polarities of the poles, **A** and **B**, of the magnet.

A : …………… **B** : ……………. [1]

(c) Suggest two ways that would cause the readings on the newton-meters to decrease further.

…………………………………………………………………………

…………………………………………………………………………

…………………………………………………………………………

………………………………………………………………………… [2]

(d) If the cell is replaced by an a.c. source of frequency 3 Hz, describe the motion of the rod when the switch is closed.

....

.... [1]

9 A student attempts to generate an electromotive force (e.m.f.) across a copper rod by swinging it between the poles of a magnet. The setup is shown in Fig. 9.1. When the copper rod in Fig. 9.1 is displaced to position X (as shown in Fig. 9.2) and then released from rest, it swings from X to Y, and continues to oscillate. As the copper rod oscillates, an e.m.f. is induced across the rod.

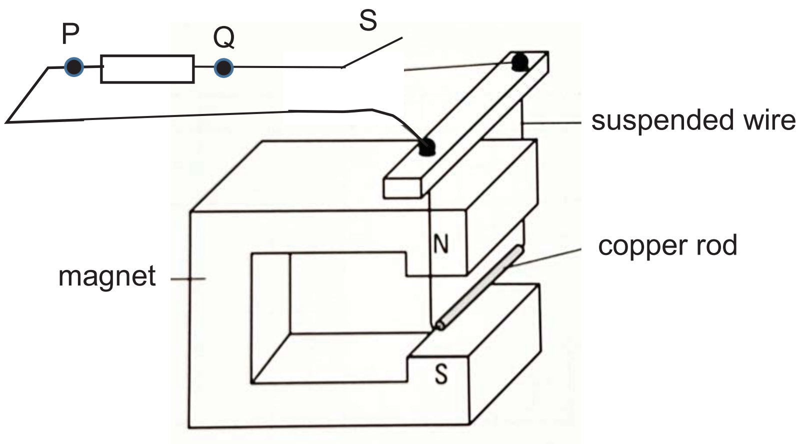


Fig. 9.1

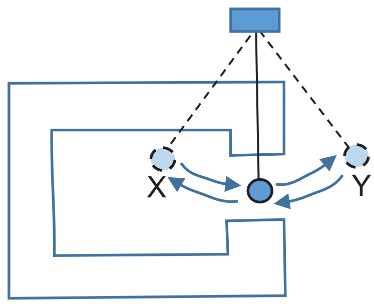


Fig. 9.2 (copper rod swinging)

The ends of the suspended wires are connected to a resistor PQ and switch S.

(a) Explain why an e.m.f. is induced across the copper rod.

....

....

.... [1]

(b) As the rod swings from X to Y, indicate the direction of induced current in the copper rod in Fig. 9.1 if switch S is closed. [1]

(c) Using Lenz's Law, explain why the direction of the e.m.f. is in the direction you indicated in **(b)**.

…………………………………………………………………………………

…………………………………………………………………………………

………………………………………………………………………………… [1]

(d) As the copper rod swings, the maximum output e.m.f. of the setup in Fig. 9.1 is 12 mV. When the two ends of the resistor (points P and Q) is connected to the input of a cathode ray oscilloscope (C.R.O.), a trace is observed.

The time base is set at 50 ms/division and the Y-gain is set at 5 mV/division.

Draw the trace, M that can be seen on the screen of the C.R.O. in Fig. 9.3 when the copper rod makes four complete swings every second. Assume that the rod is at position X at t = 0. [2]

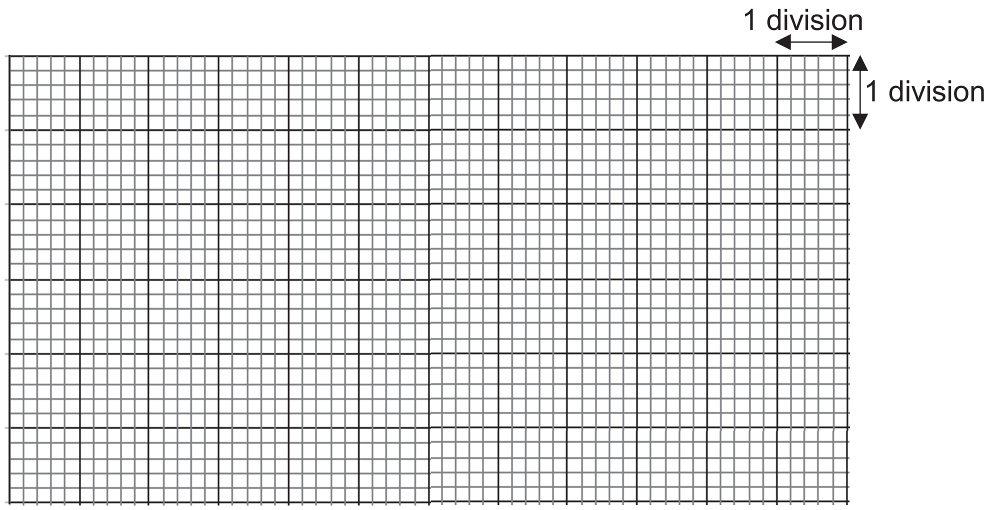


Fig. 9.3

(e) The student closed the switch and set the copper rod to oscillate. Draw a possible trace that can be seen on the screen of the C.R.O. in Fig. 9.3. Label the trace N. [2]

Section B (30 marks)

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 12.**

10 Trucks are vehicles that have the flexibility to carry almost any type of cargo over short to medium distances. Fig. 10.1 shows three trucks that are used by a local company to carry goods from a factory to the same warehouse on a particular day. The trucks have different wheel configurations and each wheel is identical.

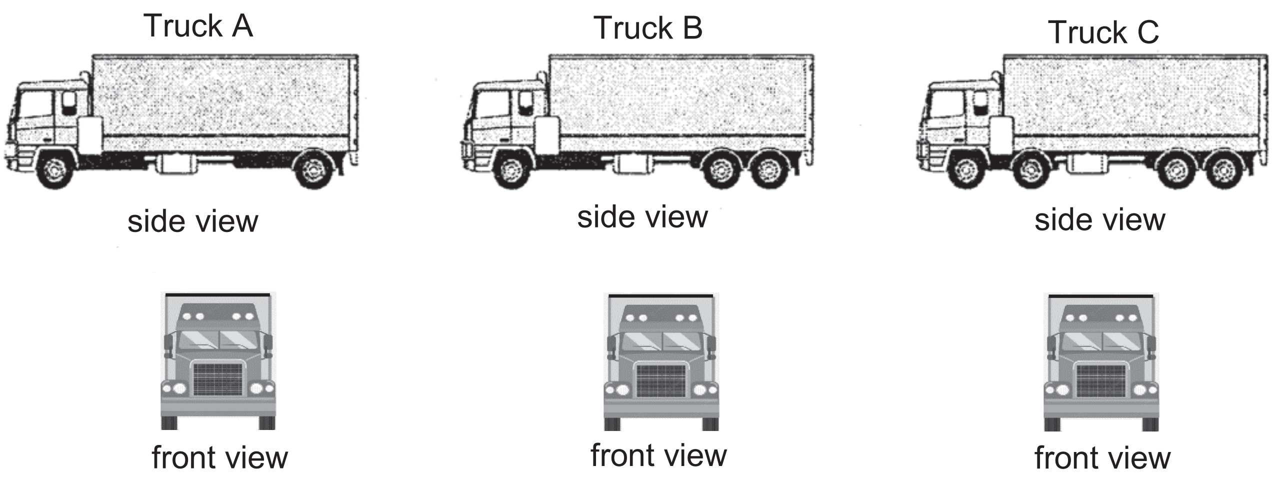


Fig. 10.1 Front and side view of trucks

Truck	Mass of truck with cargo / kg
A	15 600
B	18 800
C	20 500

Fig. 10.2

Fig 10.3 shows the speed of the three trucks at several values of time, *t*.

truck	speed / m/s				
	t = 0.0 s	*t* = 5.0 s	*t* = 10.0 s	*t* = 20.0 s	*t* = 40.0 s
A	0.0	4.0	8.0	16.0	32.0
B	0.0	6.0	12.0	18.0	24.0
C	0.0	8.0	16.0	20.0	20.0

Fig. 10.3

(a) State and explain which truck(s) has a uniform acceleration between t = 0.0 s and t = 20.0 s.

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

………………………………………………………………………………… [2]

(b) **(i)** Determine the distance between truck A and truck C at t = 10 s, assuming the trucks accelerate uniformly.

distance = …………….. [2]

(ii) State any assumption you made when calculating **b(i).**

……………………………………………………………………………

……………………………………………………………………………

…………………………………………………………………………… [1]

(c) State and explain which truck's engine did the greatest amount of work between t = 20 s and t = 40 s.

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

………………………………………………………………………………… [2]

(d) **(i)** The drivers stop the trucks for a rest and realised that the ground is soft. Explain which truck sank into the ground the most.

…………………………………………………………………….

…………………………………………………………………….

…………………………………………………………………….

…………………………………………………………………….

……………………………………………………………………. [2]

(ii) The co-drivers laid two pieces of identical planks in parallel across the soft ground so that the tyres of each truck are on the pair of planks. Explain which truck leaves the deepest plank imprint when driven across the soft ground.

…………………………………………………………………….

…………………………………………………………………….

…………………………………………………………………….

……………………………………………………………………. [1]

11 **(a)** A transformer only works when it is connected to an a.c. power supply. Explain why a transformer does not work when connected to a d.c. power supply.

…………………………………………………………………………

…………………………………………………………………………

…………………………………………………………………………

………………………………………………………………………… [2]

(b) Explain why steel is not a suitable material for the core of a transformer.

…………………………………………………………………………

…………………………………………………………………………

………………………………………………………………………… [2]

(c) Electrical power of 5.20 MW is generated at a power plant and supplied to an industrial park which is 220 km away. This is done by using transformers P and Q, transmission cables and they are represented in the Fig. 11.1 below.

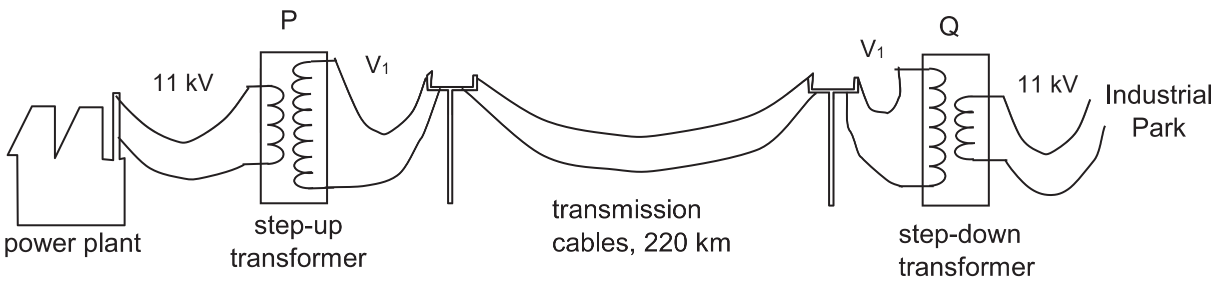


Fig. 11.1

Transformers P and Q are ideal, and the transmission cables are assumed to have resistance of 0.45 Ω/km.

(i) Determine the current generated at the power plant.

current = …………………… [2]

(ii) Determine the resistance of the transmission cables.

resistance = ……………. [1]

(iii) Determine the minimum ratio of the number of turns in the secondary coil to the number of turns in the primary coil for transformer P so that energy loss due to the transmission cables is below 10 %.

minimum turns ratio = …………………… [3]

12 EITHER

A block of lead at 325 °C is transferred to a 120 g copper calorimeter containing 250 g of liquefied methylated spirit at 25 °C. After 92 s, the methylated spirit starts to boil. It continues to boil for 55 s, until the block of lead reaches thermal equilibrium with the methylated spirit.

Boiling point of methylated spirit = 78.5 °C.
Heat capacity of the block of lead = 750 J/°C
Specific heat capacity of copper = 420 J/kg°C
Specific heat capacity of methylated spirit = 2400 J/kg°C
Specific latent heat of vaporisation of methylated spirit = 855 kJ/kg

(a) Explain what is meant by *thermal equilibrium*.

....

.... [1]

(b) The specific heat capacity of lead is 130 J/kg°C.

(i) State the difference between heat capacity and specific heat capacity.

....

....

.... [1]

(ii) Hence, determine the mass of the block of lead.

mass = ... [1]

(c) Calculate the amount of energy that is lost by the block of lead when it reaches thermal equilibrium with the methylated spirit.

energy loss = ... [2]

(d) Calculate the total energy that is needed to raise the temperature of the copper calorimeter and the methylated spirit to 78.5 °C.

energy gain = ………………… [2]

(e) Hence or otherwise, determine the final mass of methylated spirit remaining in the copper calorimeter.

mass = ………………… [2]

(f) Explain why the mass calculated in part **(e)** will be different from the actual value.

………………………………………………………………………………

………………………………………………………………………………

……………………………………………………………………………… [1]

12 OR

A student investigating the effect of temperature on the volume of a gas, uses a column of air sealed in a capillary tube by a short column of mercury as shown in Fig 12.1.

At 20 ^{o}C, the length of the air column is h = 15 cm.

Cross-sectional area of the tube = 2.00 mm^2.
Density of mercury = 1.36 x 10^4 kg/m^3
Atmospheric pressure = 1.02 x 10^5 Pa.

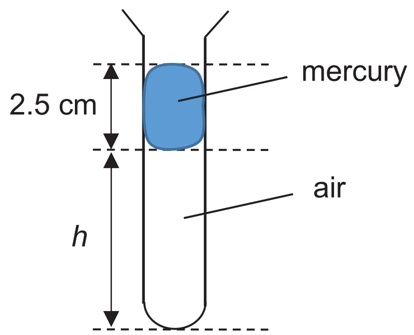


Fig. 12.1 (not drawn to scale)

(a) **(i)** Determine the mass of the mercury column.

mass = ………………… [2]

(ii) Hence determine the pressure exerted on the column of trapped air.

pressure = ………………… [2]

(b) The tube is then slowly rotated and held in a horizontal position as shown in Fig. 12.2.

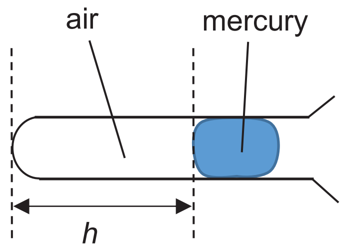


Fig. 12.2 (not drawn to scale)

(i) State whether the length of the air column, *h*, increases, decreases, or remains unchanged at 15 cm.

………………………………………………………………………… [1]

(ii) Explain your answer in **b (i).**

…………………………………………………………………………

…………………………………………………………………………

…………………………………………………………………………

………………………………………………………………………… [2]

(c) With the tube held in horizontal position, the temperature of air is gradually increased until it reaches a steady temperature of 50 ^{o}C.

Using ideas about molecules, explain why the air column increases in length.

…………………………………………………………………………

…………………………………………………………………………

…………………………………………………………………………

…………………………………………………………………………

…………………………………………………………………………

…………………………………………………………………………

………………………………………………………………………… [3]

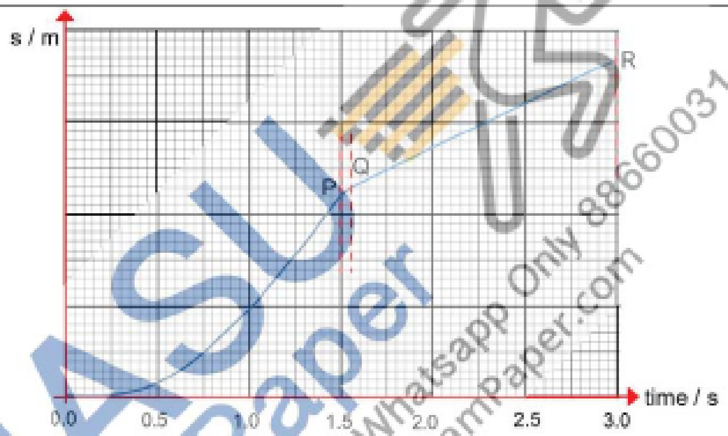
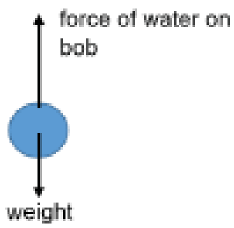
END

Prelim Paper 1 Answers

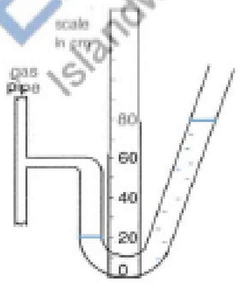
1	C	11	C	21	C	31	A
2	C	12	A	22	A	32	D
3	B	13	D	23	B	33	A
4	B	14	A	24	C	34	A
5	D	15	D	25	C	35	B
6	C	16	A	26	D	36	B
7	A	17	C	27	A	37	B
8	A	18	D	28	D	38	B
9	D	19	A	29	A	39	C
10	A	20	D	30	B	40	B

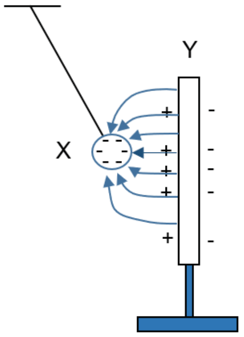
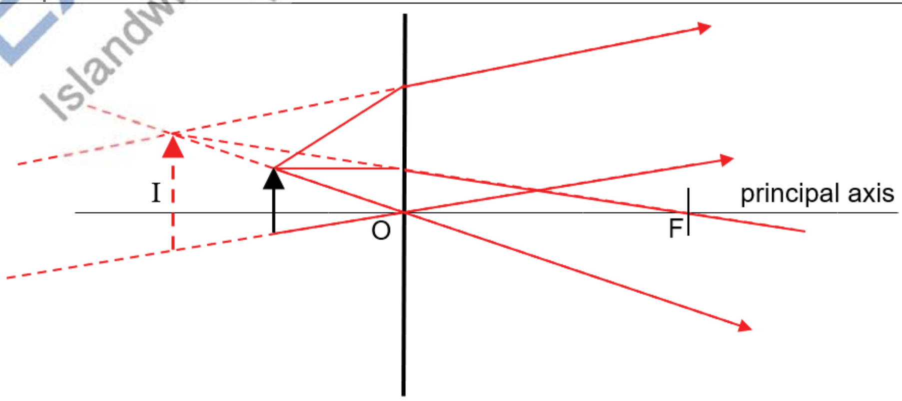
2022 S4 OP Physics Prelim - Mark Scheme

Section A

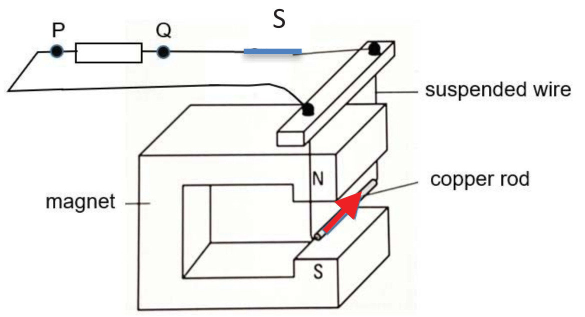
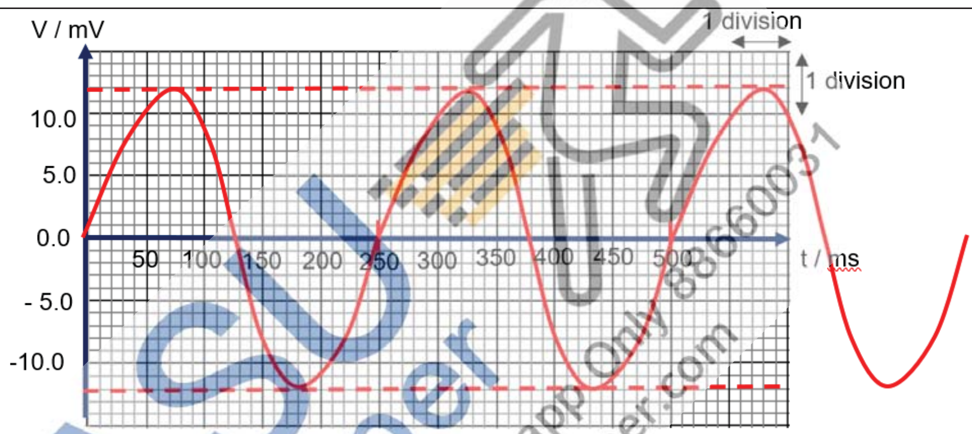
Qn	Ans	Marks
1(ai)	0.0 m/s	B1
1(aii)	5.0 m/s	B1
1(b)	average time interval = 1.50 s (accept 1.5 s) freq of rotation = 1 / (8 x 1.50) = 0.0833 Hz or rev/s	C1 A1
2(a)	10.0 m s^{-2} (units)	B1
2(b)	Determine the area below the v-t graph from point P to R.	B1
2(c)	 Correct axis drawn and labelled Displacement is positive and increasing at from t = 0 to t = 3.0 s OP – increasing gradient PQ – decreasing gradient Q to R – constant gradient	 B1 B1
2(d)	Kinetic energy of the bob is converted to thermal energy of bob / water and sound energy.	B1
2(e)	 can be drag force / water resistance **Fig. 2.3**	

1

	Weight Both forces drawn and labelled (correct direction & touching the bob) Upward force greater than	B1 B1
3(a)	A point where the whole weight of the body appears to act through.	B1
3(b)	X is located directly below the pivot.	B1
3(c)	When there is any slight tilt / displacement, the line of action of the weight will produce a restoring moment about the pivot and return the system to the original position.	B1
3(d)	Removing the penknife, the Centre of Gravity of the pencil is above the pivot. Any slightest tilt will result in the weight of pencil producing a resultant moment about the pivot that causes the pencil to rotate and topple. (cannot just state unstable equilibrium. Explain why it is unstable equilibrium)	B1 B1
4(a)	The water level on the left side of the manometer exposed to the gas is much lower than the water level on the right side of the manometer exposed to the atmosphere. (student must state what is observed in the diagram) Since pressure is equal in a fluid at any horizontal level, the pressure of the gas is greater than the atmospheric pressure by the pressure exerted from the column of water. (force on liquid is greater on the right hand side of tube)	B1 B1
4(b)	Pressure of gas = $h\rho g$ + atmospheric pressure $= [1000 \times 0.3 \times 10] + 10^5$ = 103000 Pa = 100 kPa (2 sf)	C1 A1
4(c)	 Fig. 4.2 Difference in level is 60 cm [B1]	

5(a)	 **Fig. 5.1** draw outside solid if it is a thin piece of material Y is neutral. Positive charges induced on the left of Y Negative charges induced on the right of Y	B1
5(b)	Electric field is non-uniform. Greater field strength at region closest to X and Y (between X and Y).	B1
5(c)	The negatively charged sphere induced positive charges on side of Y close to the sphere and negative charges on the side away from the sphere. The attractive force between the negatively charged sphere and the positive charged surface on Y is greater than the repulsive force between the sphere and the negatively charged surface. Is only state "unlike charges attract" [1] only	B1 B1
5(d)	X will move closer to plate Y. When Y is earthed, negative charges from Y will be repelled by X and flow through the earth wire to earth. Plate Y acquires a net positive charge and the force of attraction between X and Y is greater.	B1 B1
6(a)	converging As light ray AB enters the lens, the emergent ray BC bend towards the principal axis.	B1 B1
6(b)	 Light rays that correctly lead to Image [C1] (include the bottom of the image) Label Image I [A1]	

6(c)	Able to label F correctly.	B1
7(a)	As the p.d. increases from zero, the ratio of V to I decreases, hence the resistance of C decreases. (mention of gradient/rate is incorrect)	B1
7(b)	p.d. across B and C is 8.0 V. From Fig. 7.2, current flowing through B is 40 mA and through C is 20 mA. Hence the total current flowing through A is 60 mA. Resistance of A = V/I = 4.0 / 0.060 = 67 Ω.	C1 A1
7(c)	Removing C, the effective resistance of circuit increases. Current in circuit decreases. Resistance of A remains unchanged. p.d. across A decreases. OR Removing C, the effective resistance of circuit increases. Fraction of resistance of A over effective resistance becomes smaller, hence by potential divider principle, p.d. across A is smaller.	C1 A1 C1 A1
8(a)	Magnetic field produced by current flowing through PQ interacts with the magnetic field from U-shape magnet to produce an upward magnetic force. This reduces the downward force acting on the newton meter and therefore the readings on Newton meters decrease. OR Using Fleming's Left Hand Rule, there is an upward magnetic force acting on PQ. This reduces the tension in the wire of the newton meter.	B1 C1 B1 B1
8(b)	A: South B: North	B1
8(c)	• stronger magnet • greater emf of the cell, leading to greater current	B1 B1
8(d)	The rod will experience a magnetic force upwards and then downwards at 3 cycles per second causing it to oscillate at 3 Hz. (vertical oscillation)	B1
9(a)	As the copper rod swings from X to Y, the rod cuts the magnetic flux of the magnet. Hence by Faraday's law, an e.m.f. is induced across the rod.	B1

9(b)		B1
9(c)	The direction of the induced current in the copper rod indicated above produces a magnetic field that will interact with the magnetic field from C shape magnet to have a force opposing the movement of the rod from X to Y.	B1
9(d)	 Start from 0 mV and every period is 250 ms Sine curve with the amplitude 12 mV (with correct scale)	B1 B1
9(e)	Amplitude getting smaller Period getting longer/constant	B1 B1
	Section B	
10(a)	Only truck A has a uniform acceleration between t = 0 and t = 20 s, with an acceleration of 0.80 ms^{-2}. For truck B and C, the acceleration for the first 10 s is greater than the acceleration for t = 10 s to 20 s.	B1 B1
10(b)(i)	For the first 10 s, distance travelled by truck A = area under the v-t graph = ½ x 10 x 8.0 = 40.0 m Distance travelled by truck C = ½ x 10 x 16.0 = 80.0 m. Distance between the trucks = 40.0 m	C1 A1
10(b)(ii)	Truck A and C travel in the same direction from t = 0 to t =10 s. (same starting point)	B1

10(c)	The trucks increase in kinetic energy is due to the work done by the engine. Increase in KE for truck A = ½ (15600) $(32.0^2 - 16.0^2)$ = 6.0 x 10^6 J Increase in KE for truck B = ½ (18800) $(24.0^2 - 18.0^2)$ = 2.4 x 10^6 J Increase in KE for truck C = ½ (20500) $(20.0^2 - 20.0^2)$ = 0.0 J Engine of truck A did the most work during this period.	C1 B1
10(di)	Truck A Truck B Truck C Number of wheels 4 6 8 (assuming each wheel has equal area of contact with ground) Weight of truck/N 156 000 188 000 205 000 Pressure 39 kN/wheel 31.3 kN/wheel 25.6 kN/wheel Truck A sinks the most.	B1 B1
10(dii)	Truck C having greatest weight will make the deepest imprint since the planks have equal area in contact with the ground.	B1
11(a)	E.m.f. is induced across the secondary coil when there is a change in the magnetic flux linking the secondary coil. Alternating current and not direct current generates a changing/varying magnetic field in the primary coil. Thus there will be no e.m.f. induced in the secondary coil.	B1 B1
11(b)	Steel is a hard magnetic material, hence difficult to be magnetise and demagnetise rapidly as required by the core of a transformer. The magnetic flux density produced by steel is weaker compared to other magnetic materials when the same amount of current flows through the wire coil.	B1 B1
11(c)(i)	P = IV 5200 000 = I (11 000) I = 473 A	M1 A1
11(c)(ii)	Resistance = 0.45 x 220 Ω = 99 Ω	A1
11(c)(iii)	Maximum power loss = 520 000 W [10% of the power] Let the transmission current be I_1. Power loss in transmission cable = $I_1^2 R$ $I_1^2 R$ = 520 000 I_1 = 72.474 A (intermediate working) Current in the transmission cable must be less than 72.4 A	M1

	For transformer P, $$\frac{N_S}{N_P}=\frac{I_P}{I_S}$$ $$\frac{N_S}{N_P}=\frac{473}{72.4}$$ N_s/N_p =6.53. As I_s must be lower than 72.4A, the ratio N_s/N_p must be greater than 6.53 The minimum value of the ratio is thus 6.6 (2 sf)	M1 A1
12	**EITHER**	
E12(a)	Two or more objects are at equal temperature and there is no net flow of thermal energy between them.	B1
E12(bi)	Heat capacity is the amount of thermal energy required of a substance to increase/decrease the temperature of a substance by 1 K / 1 °C. Whereas specific heat capacity is the heat capacity per unit mass.	B1
E12(bii)	let the mass of lead be m mc = C m (130) = 750 m = 5.77 kg unit must be correct	A1
E12(c)	final temperature of lead is 78.5 °C thermal energy loss = C $\Delta\theta$ = 750 (325 – 78.5) = 184 875 J = 185 000 J	M1 A1
E12(d)	total energy required = $[mc\,\Delta\theta]_{copper}$ + $[mc\,\Delta\theta]_{methylated\ spirit}$ = (0.120)(420)(78.5-25) + (0.250)(2400)(78.5-25) = 34800 J	M1 A1
E12(e)	energy used to boil off methylated spirit = 184875 J – 34796.4 J = 150078.6 J let m be the mass of methylated spirit boiled off mL = 150078.6 m = 0.1755 kg [1] remaining methylated spirit = 0.250 – 0.1755 kg = 0.0745 kg	M1 A1
E12(f)	Some thermal energy from lead block is loss to the surrounding. Not all heat loss by block of lead is transferred to the the calorimeter and	B1

	methylated spirit. Thermal energy absorbed by methylated spirit is less. So, less spirit is boiled off.	
12	**OR**	
O12(a)(i)	Vol of mercury = $2.0 \times 10^{-6} \times 0.025$ m^3 = 5.0×10^{-8} m^3 Mass = $\rho \times V$ = $1.36 \times 10^4 \times 5.0 \times 10^{-8}$ = 6.8×10^{-4} kg (award 1 m if convert incorrectly mm^2 to m^2, able to apply m = $\rho \times V$)	 M1 A1
O12(a)(ii)	weight of Hg = 6.8×10^{-3} N $P = P_{Hg} + P_{atm}$ = $0.0068/(2.0 \times 10^{-6}) + 1.02 \times 10^5$ = 105400 Pa = 1.05×10^5 Pa (ecf for mm^2)	 M1 A1
O12(b)(i)	The column of air, h increases in length as temperature increases.	B1
O12(b)(ii)	In the horizontal position, the weight of the mercury column no longer acts on the trapped air. The pressure on the trapped air decreases. At pressure of the trapped gas is greater than atmospheric pressure. Hence the volume of the air column increases. (As volume of air increases, it pressure decreases until it is equal to atmospheric pressure).	B1 B1
O12(c)	A rise in temperature causes an increase in average speed of gas molecules, hence greater average kinetic energy. Molecules collide more vigorously and with greater frequency with the inner surface of container. When gas pressure is greater than atmospheric pressure, pushing it outwards, until the internal and external pressures are equal.	B1 B1 B1

CONVENT OF THE HOLY INFANT JESUS SECONDARY
Preliminary Examination in preparation for
the General Certificate of Education Ordinary Level 2022

CANDIDATE NAME

CLASS

REGISTER NUMBER

PHYSICS 6091/01

Paper 1 Multiple Choice

15 September 2022

1 hour

Additional Materials: Multiple Choice Answer Sheet (OMR)

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 on the Answer Sheet in the spaces provided unless this has been done for you.

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.

[Turn over

1 Which list of SI units contains only base units?

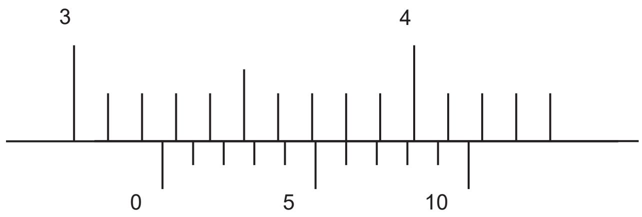
A candela, second, kelvin, watt

B candela, joule, metre, second

C ampere, kelvin, second, pascal

D ampere, metre, second, kelvin

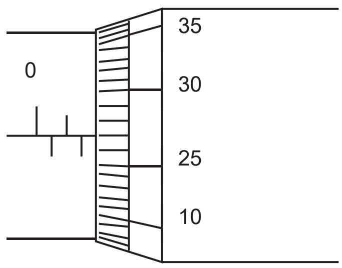
2 The diagram shows the scale of the vernier callipers that is used to measure the diameter of a coin.



What is the radius of the coin?

A 1.63 cm **B** 1.93 cm **C** 3.26 cm **D** 3.86 cm

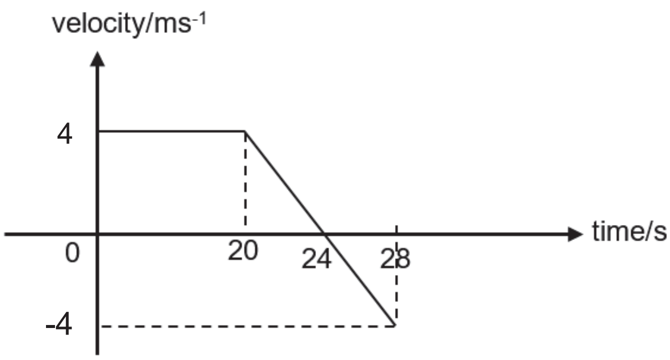
3 The diameter of a piece of wire is measured using a micrometer screw gauge. The diagram shows the enlarged view of the micrometer screw gauge reading.



What is the diameter of the wire?

A 1.27 mm **B** 1.77 mm **C** 2.27 mm **D** 2.77 mm

4 The diagram shows the velocity-time graph of a cyclist's journey.



What is the average speed for the cyclist's entire journey?

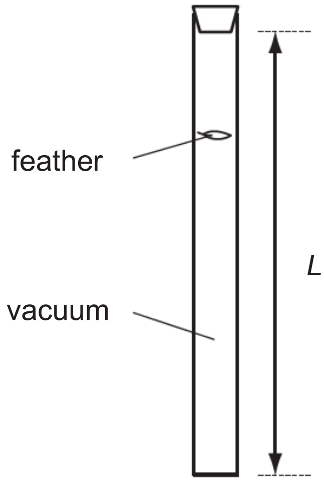
A 2.86 m/s **B** 3.14 m/s **C** 3.43 m/s **D** 3.67 m/s

5 A bottle full of water has a mass of 200 g. When the same bottle is filled with liquid **X**, the mass becomes 180 g.

If the mass of the empty bottle is 100 g, what is the density of liquid **X**?
Take density of water as 1.0 g/cm^3.

A 0.2 g/cm^3 **B** 0.8 g/cm^3 **C** 0.9 g/cm^3 **D** 1.2 g/cm^3

6 The diagram shows a laboratory experiment setup in which a feather falls from rest in a long evacuated vertical tube of length *L* .

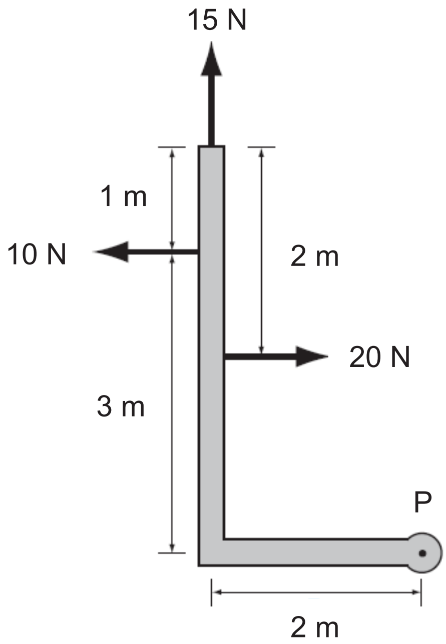


The feather took a time of *t* to fall from the top to the bottom of the tube.

How far will the feather have fallen from the top of the tube in 0.5*t* ?

A 0.13*L* **B** 0.25*L* **C** 0.50*L* **D** 0.75*L*

7 An L-shaped rigid lever arm is pivoted at point P.



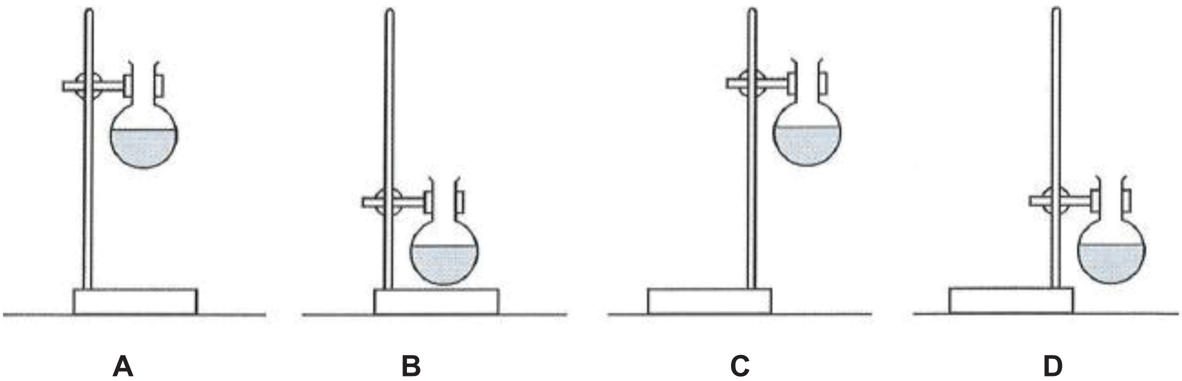
Three forces act on the lever arm, as shown in the diagram.

What is the magnitude of the resultant moment of these forces about point P?

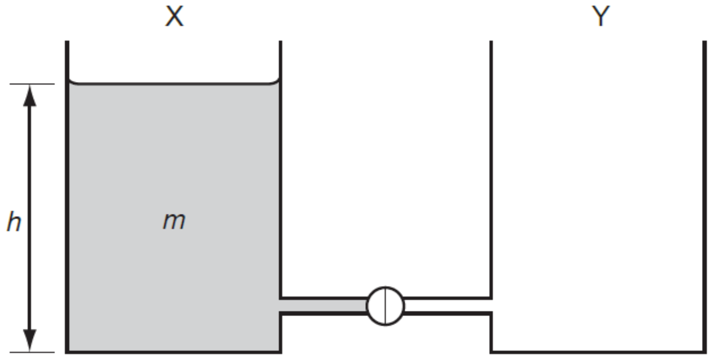
A 20 Nm **B** 30 Nm **C** 40 Nm **D** 50 Nm

8 A student uses a retort stand and a clamp to hold a flask of liquid.

Which diagram shows the most stable arrangement?



9 The diagram shows two identical vessels X and Y connected by a short thin pipe with a tap. At the beginning, X is filled with water of mass *m* to a depth *h*, and Y is empty.

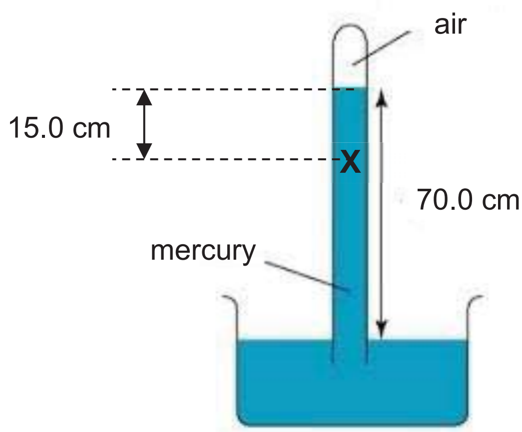


When the tap is opened, water flows from X to Y until the depths of water in both vessels are equal.

How much gravitational potential energy is lost by the water during this process?
(acceleration due to gravity, g = 10 m/s^2)

A 0 J **B** ¼ (*mgh*) J **C** ½ (*mgh*) J **D** *mgh* J

10 The diagram shows a barometer containing some air in the space above the mercury column. The height of mercury column is 70.0 cm. X is a point 15.0 cm below the surface of the mercury in the tube. The atmospheric pressure is 76.0 cmHg.

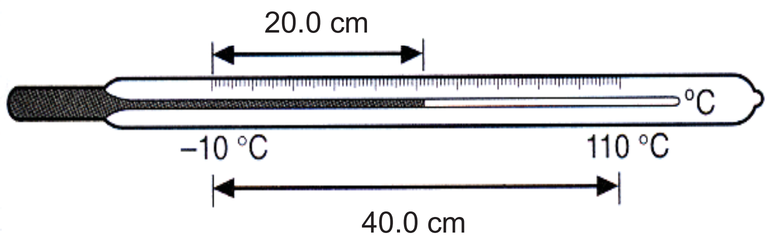


What is the pressure at point X in the mercury?

A 85.0 cmHg **B** 55.0 cmHg **C** 21.0 cmHg **D** 15.0 cmHg

[Turn over

11 The diagram below shows a mercury-in-glass thermometer.
The distance between -10 °C and 110 °C is 40.0 cm.



What is the temperature when the mercury thread is 20.0 cm long?

A 45 °C **B** 50 °C **C** 55 °C **D** 60 °C

12 Heat capacity is the energy required to raise the temperature of the object by 1 °C.

What does this energy do?

A It increases the internal potential energy of the solid molecules.

B It increases the vibration among the solid molecules.

C It increases the average size of the solid molecules.

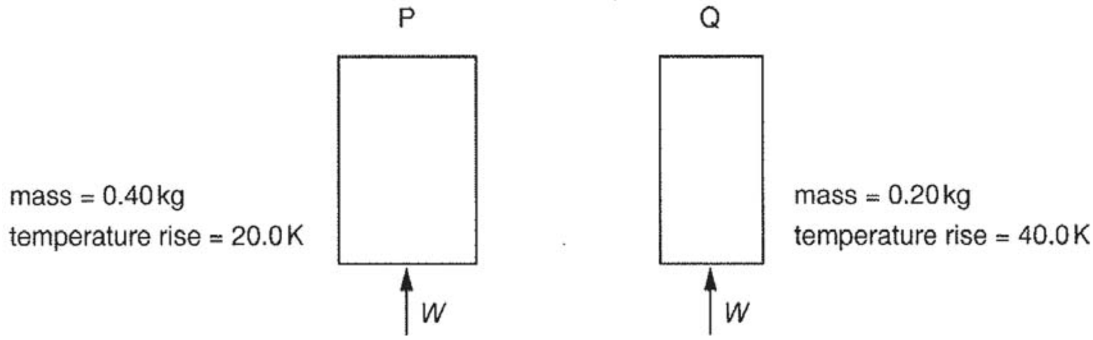
D It increases the forces of attraction between the solid molecules.

13 0.10 kg of ice at its melting point is dropped into 0.80 kg of water at 15 °C.
The specific heat capacity of water is 4200 J/kg°C and the specific latent heat of fusion of ice is 336 000 J/kg.

What is the final temperature of the mixture?

A 12.4 °C **B** 8.8 °C **C** 4.4 °C **D** 2.4 °C

14 The diagram represents two blocks, P and Q. Each of them received the same amount of energy, W. The mass of P is twice the mass of Q. The temperature rise of Q is 2 times the temperature rise of P.



Which statement about P and Q is correct?

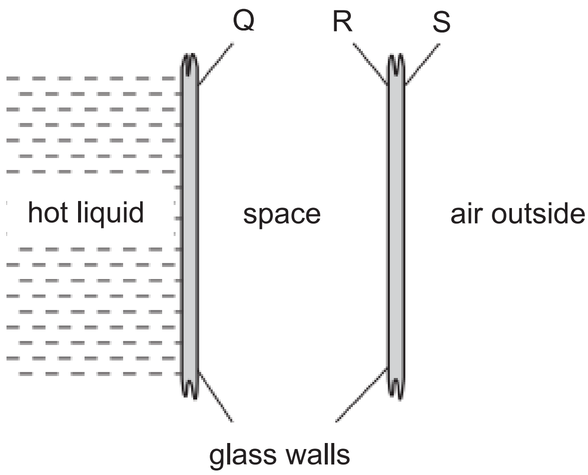
A The heat capacity of P is half the heat capacity of Q.

B The heat capacity of P is twice the heat capacity of Q.

C The specific heat capacity of P is half the specific heat capacity of Q.

D The specific heat capacity of Q is half the specific heat capacity of P.

15 A student uses a double-walled glass vessel to contain a hot liquid.



Which reduces the heat loss by radiation?

A a vacuum in the space between the walls

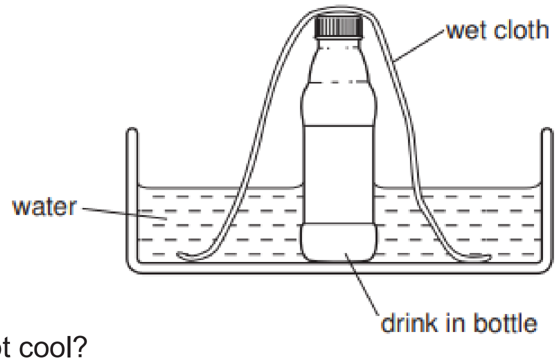
B painting surface Q black

C painting surface R black

D painting surface S white

[Turn over

16 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.



Why is the drink kept cool?

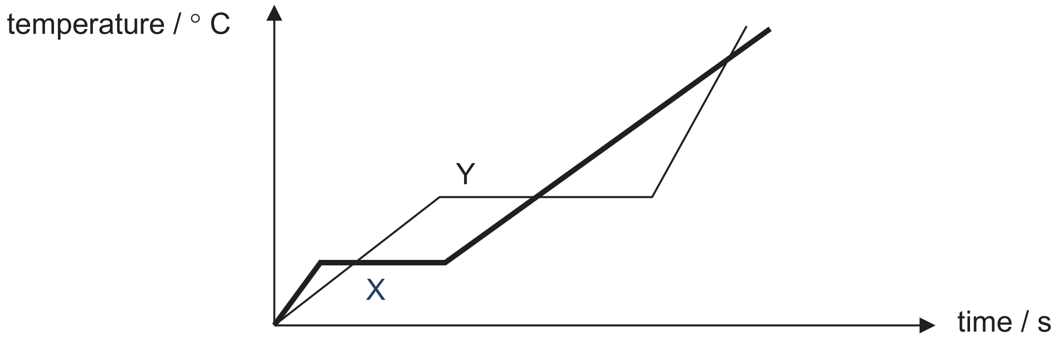
A Cold air cannot escape from the bottle.

B The cloth conducts the heat from the bottle to the water.

C The drink cannot evaporate from the bottle.

D Water evaporates from the cloth and cools the drink.

17 Equal masses of two solids X and Y are heated successively in a well-lagged calorimeter. Thermal energy is supplied to both of them at the same rate. The temperature-time graph for the process is shown.



Which statement about the temperature-time graph is **incorrect**?

A Solid X has a lower specific latent heat of fusion than solid Y.

B Liquid X has a higher specific heat capacity than liquid Y.

C Solid X has a higher specific heat capacity than solid Y.

D Melting point of solid X is lower than melting point of solid Y.

18 The melting point and the boiling point of a pure material X is - 20 °C and 120 °C respectively.

Which physical quantity does **not** change as the material is heated from 0 °C to 110 °C?

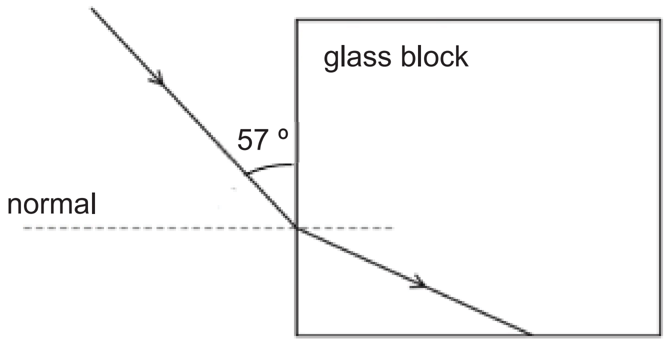
A density of liquid X

B kinetic energy of particles in X

C internal energy of material X

D specific heat capacity of material X

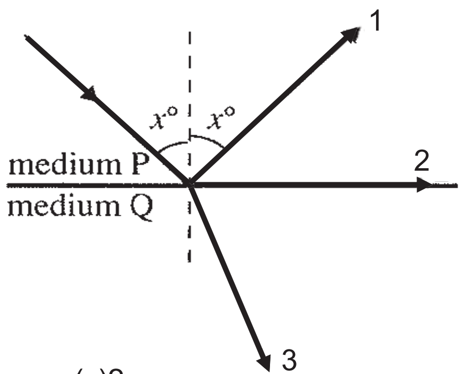
19 The diagram shows a light ray passing from air into a glass block of refractive index 1.5.



What is the angle of refraction in the glass and critical angle of the glass?

	angle of refraction / °	critical angle / °
A	21	42
B	21	60
C	34	42
D	34	60

20 The diagram shows a ray of light travelling from medium P into medium Q.
Medium P has a refractive index lower than medium Q.



Which rays is/are possible outcome(s)?

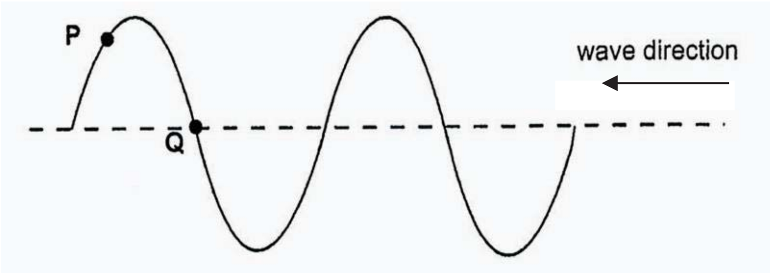
A 3 only

B 1 and 3 only

C 2 and 3 only

D 1, 2 and 3

21 The diagram shows a wave on a string with two points P and Q marked. The wave is moving in the direction shown.



What will happen next?

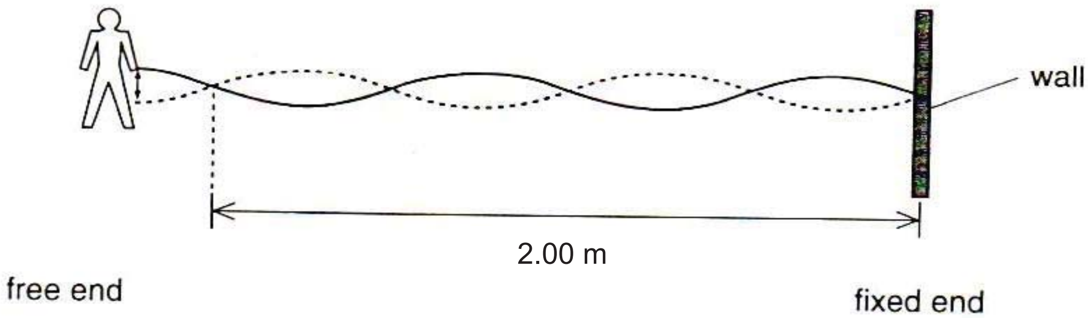
A P will move to the left.

B P will move up.

C Q will not move.

D Q will move up.

22 The diagram shows waves set up in a rope by a student moving the free end up and down at a steady rate.



What is the wavelength of the wave shown, and what will be the wavelength when the student halves the frequency at which the end is moved up and down?

	wavelength as shown	wavelength when frequency is halved
A	0.50 m	1.00 m
B	0.50 m	0.50 m
C	1.00 m	1.00 m
D	1.00 m	2.00 m

23 Microwaves, visible light and ultraviolet are all part of the electromagnetic spectrum.

What is the correct order of increasing frequency?

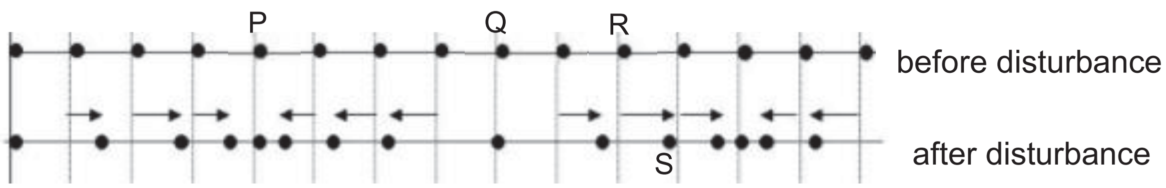
	lowest	→	highest
A	microwaves	visible light	ultraviolet
B	microwaves	ultraviolet	visible light
C	visible light	ultraviolet	microwaves
D	visible light	microwaves	ultraviolet

24 When ultrasound travels from water into air, what happens to its frequency, wavelength and speed?

	frequency	wavelength	speed
A	remains the same	reduced	reduced
B	remains the same	increased	increased
C	remains the same	increased	reduced
D	increased	increased	increased

25 The diagram shows the positions of air particles before and after they were disturbed by a vibrating guitar string.

Points P, Q and R are positions of some air particles at rest before the disturbance while Point S is the new position of R after the disturbance.



Which option correctly shows the lengths associated with PQ and RS?

	PQ	RS
A	half a wavelength	an amplitude
B	a wavelength	an amplitude
C	half an amplitude	half a wavelength
D	an amplitude	half a wavelength

[Turn over

26 The earth wire is always fitted to the metal casing of an appliance as a protective device.

The earth wire protects ________________

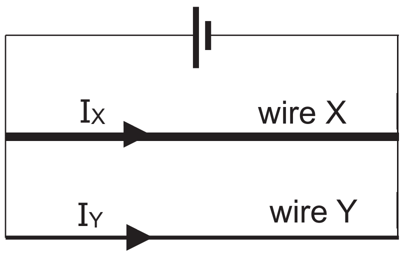
A the live wire.

B the cable connecting the appliance.

C the person using the appliance.

D the fuse in the plug.

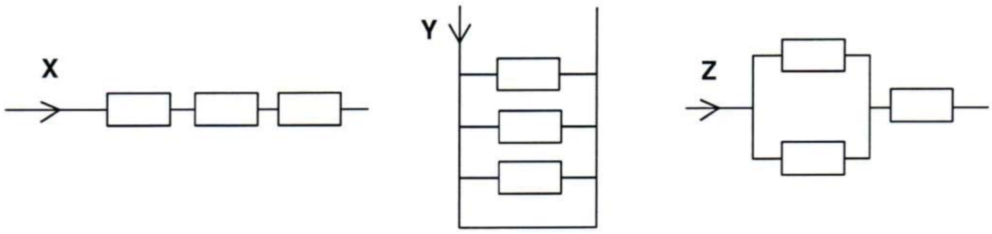
27 Two resistance wires X and Y, are connected across a dry cell. Both wires are made of the same material and of the same length. However, wire Y has a diameter that is half that of wire X. Currents I_X and I_Y flows through resistors X and Y respectively.



What is the ratio of $I_X:I_Y$?

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

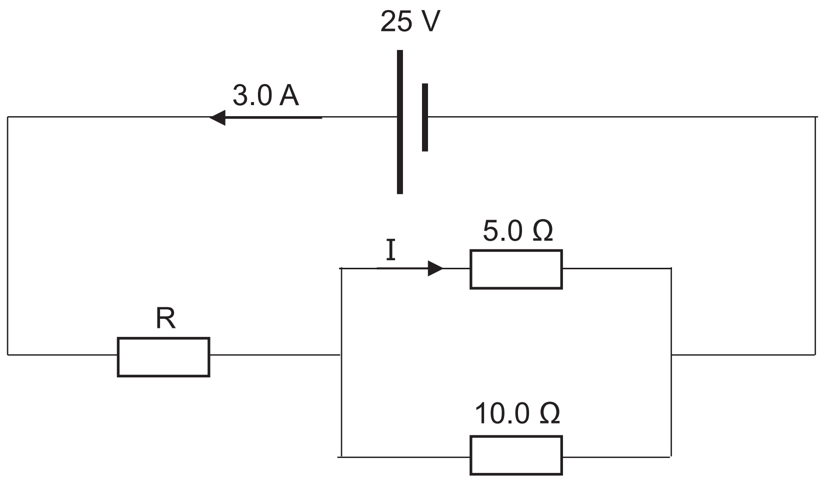
28 Three identical resistors are wired up to the mains of the electrical supply in three ways shown below.



What is the decreasing order of the magnitude of current drawn from the mains supply of these arrangements?

A Z, Y, X **B** Y, Z, X **C** X, Z, Y **D** Z, X, Y

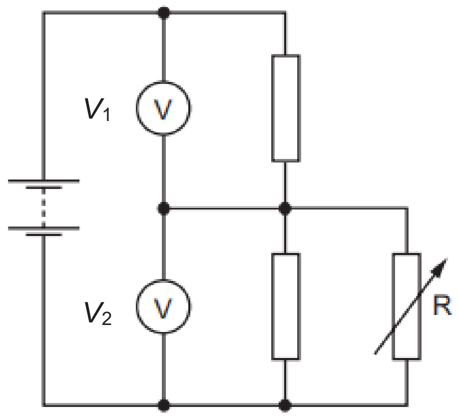
29 A dry cell of 25 V is connected to 3 resistors.



Which row correctly shows current I in the 5.0 Ω resistor and the value of R?

	I/A	R/Ω
A	1.0	8.3
B	1.0	5.0
C	2.0	5.0
D	2.0	8.3

30 The circuit diagram shows a variable resistor R connected in parallel to the lower half of potential divider.



The resistance of R increases.

What happens to the two voltmeter readings?

	V_1	V_2
A	decreases	decreases
B	decreases	increases
C	increases	increases
D	increases	decreases

[Turn over

31 Which row shows the correct colour code for wiring an electric appliance to a 13 A three-pin plug?

	live	**neutral**	**earth**
A	brown	green/yellow	blue
B	brown	blue	green/yellow
C	blue	green/yellow	brown
D	blue	brown	green/yellow

32 Which question will distinguish between a magnetic material and a non-magnetic material?

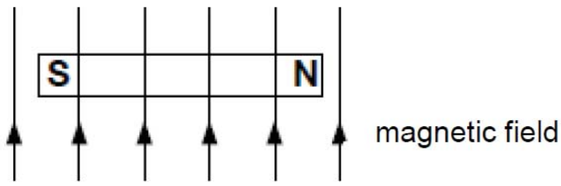
A Is it a metal or non-metal?

B Is it a conductor or an insulator?

C Can it be given an electric charge?

D Does it affects the direction in which a compass needle points?

33 The diagram shows a bar magnet placed inside a uniform magnetic field.



What will happen to the magnet if it is allowed to move freely?

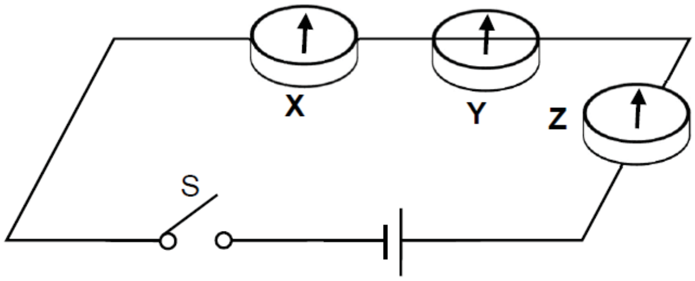
A remain stationary

B turn 90 ° clockwise

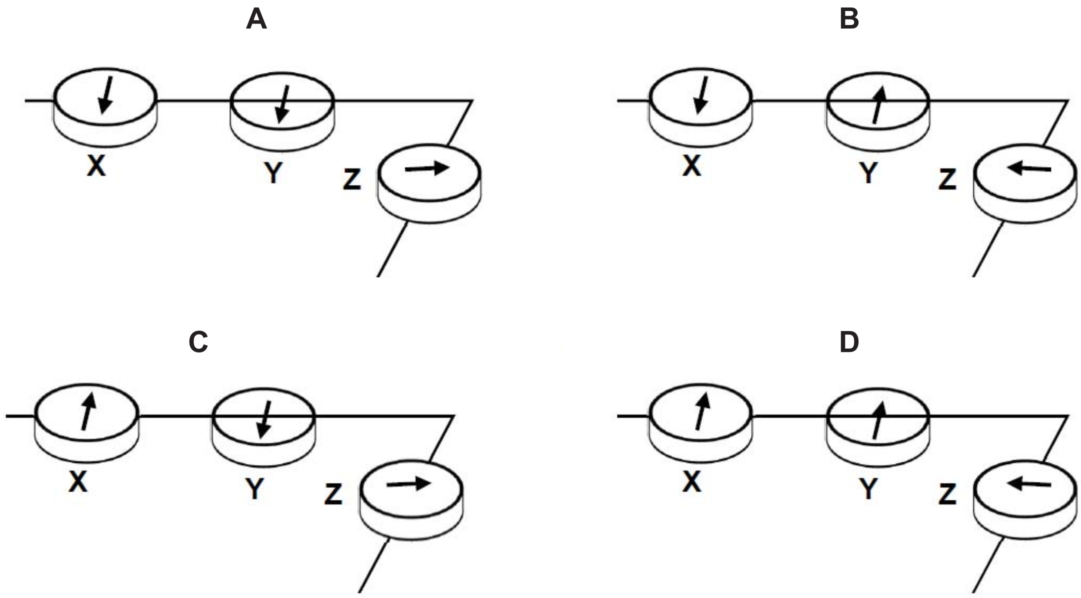
C turn 90 ° anti-clockwise

D turn 180 ° clockwise

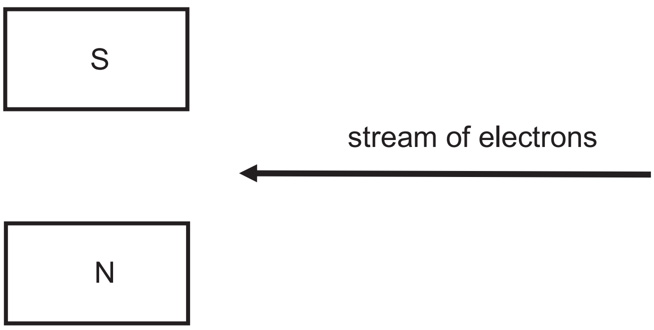
34 The diagram shows a circuit with a wire connected to a battery through a switch S.
The compasses X and Z are placed above the wire and the compass Y is placed below the wire.



When switch S is closed, which figure shows the correct orientations of the compass needles?



35 The diagram shows a stream of electrons moving between two magnetic poles.



In which direction will the beam be deflected?

A towards the north pole

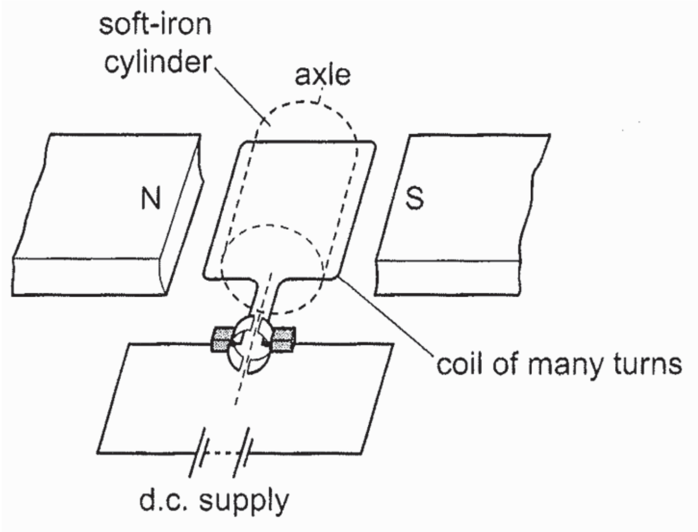
B towards the south pole

C into the page

D out of the page

[Turn over

36 The diagram shows a d.c. motor.



Which change does **not** increase the turning effect on the coil?

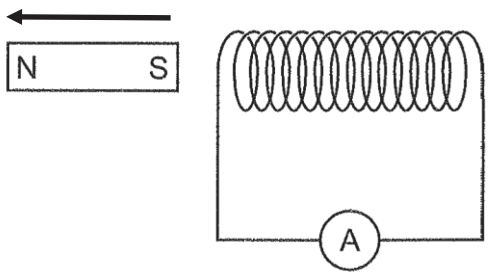
A increasing the diameter of the wire used to make the coil

B increasing the supply voltage

C removing the soft-iron cylinder

D using stronger magnets

37 When a magnet is pulled slowly away from a coil of wire, a deflection to the right is seen on an ammeter connected to the coil.

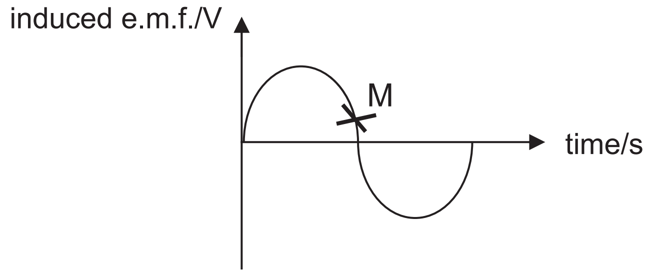


The magnet is moved quickly towards the same end of the coil.

What happens to the direction and size of deflection seen on the ammeter?

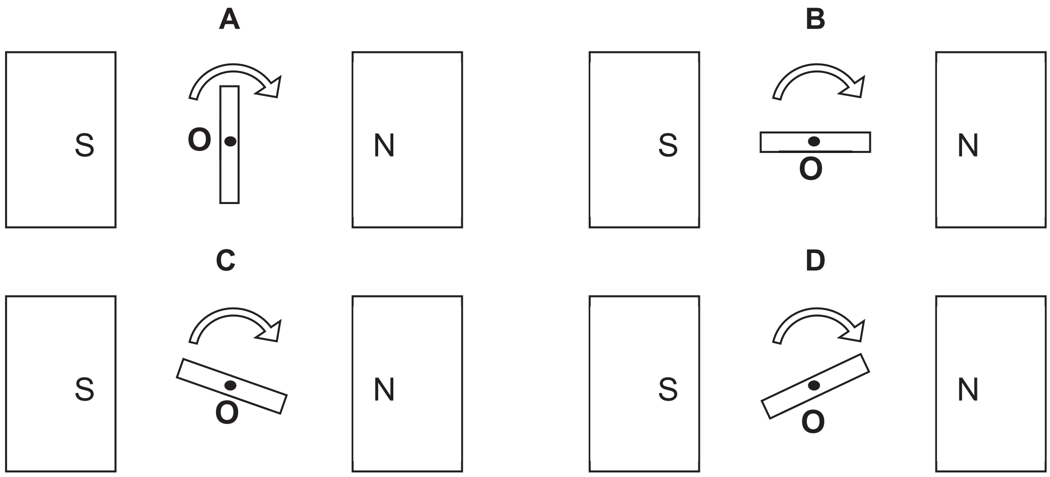
	direction of deflection	size of deflection
A	to the left	increased
B	to the left	unchanged
C	to the right	increased
D	to the right	unchanged

38 The graph shows how the induced e.m.f. of a simple a.c. generator varies with time.



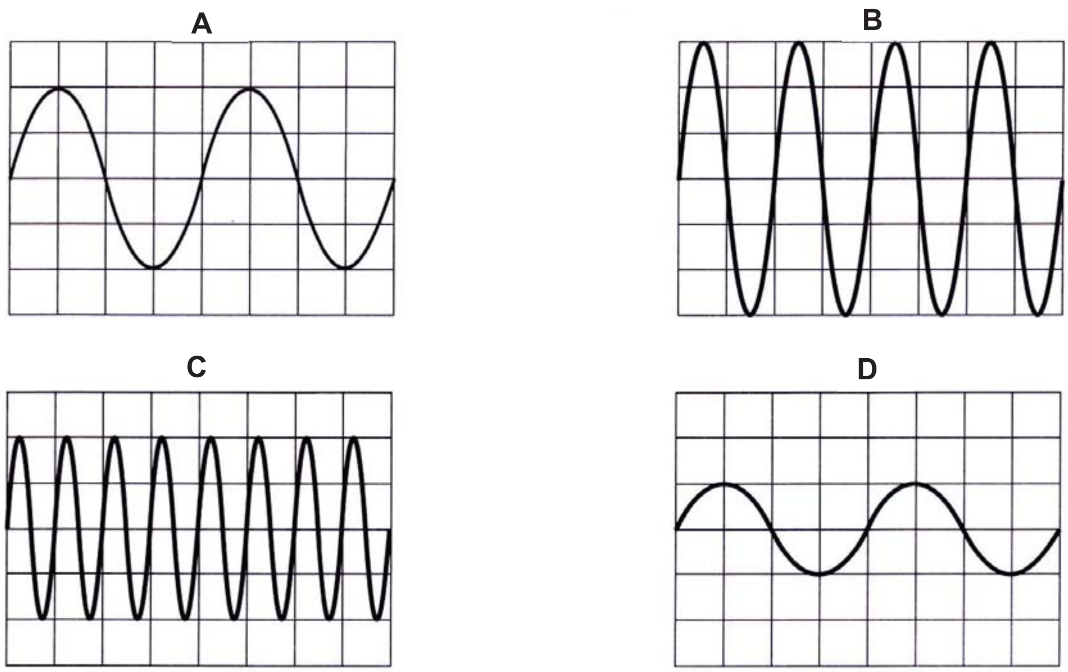
The diagrams below show the front view of the coil of an a.c. generator. The coil is being rotated about an axis through O in a uniform magnetic field.

Which of them shows the position of the coil when the value of the induced emf is at M?



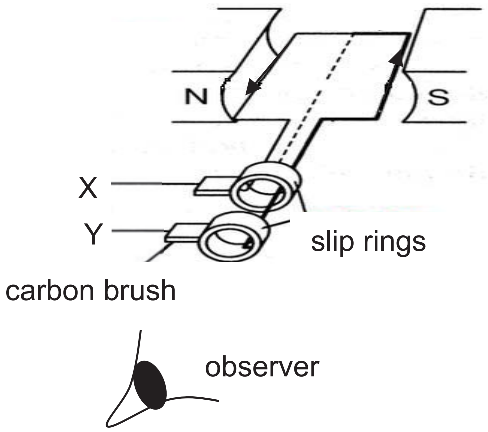
39 A signal of peak voltage 20 V and frequency 10 Hz is applied to the terminals of a c.r.o.. The Y-gain of the c.r.o. is set at 10 V per division and the time-base is set at 25 ms per division.

Which trace can be obtained?



[Turn over

40 The diagram shows an a.c. generator connected to leads X and Y. At the instant shown, the current direction in the coil is as shown.



Which row shows the direction of rotation of the coil as seen by an observer and the rule used to obtain the direction of current as shown?

	direction of rotation	rule used
A	clockwise	Fleming's left hand rule
B	clockwise	Fleming's right hand rule
C	anti-clockwise	Fleming's left hand rule
D	anti- clockwise	Fleming's right hand rule

- End of Paper -

O

CONVENT OF THE HOLY INFANT JESUS SECONDARY
Preliminary Examination in preparation for
the General Certificate of Education Ordinary Level 2022

CANDIDATE NAME

CLASS

INDEX NUMBER

PHYSICS

6091/02

Paper 2 Theory

15 September 2022

1 hour 45 minutes

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

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name 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.

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.

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 document consists of **20** printed pages and **2** blank pages.

[Turn over

Section A

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

1 A ball rolls down a slope as shown in Fig. 1.1.

The metre rule shows the position of the ball at times, t = 0 s, 1.0 s, 2.0 s and 3.0 s.

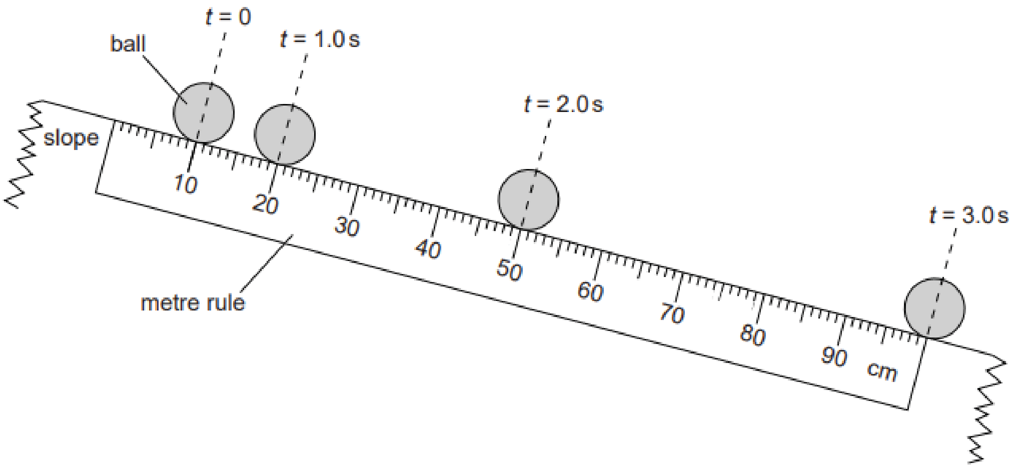


Fig. 1.1

(a) Explain how Fig. 1.1 shows that the ball is accelerating.

....

.... [1]

(b) Calculate the average speed of the ball between t = 1.0 s and 3.0 s.

average speed = ... [2]

(c) Two of the forces that act on the ball are air resistance and weight.
The ball accelerates as it rolls down the slope.

State what, if anything, happens to

(i) air resistance, ...

(ii) weight, ... [2]

2 Two trains P and Q travel between the same two stations on parallel tracks.
Fig. 2.1 shows the distance-time graphs of the two trains.

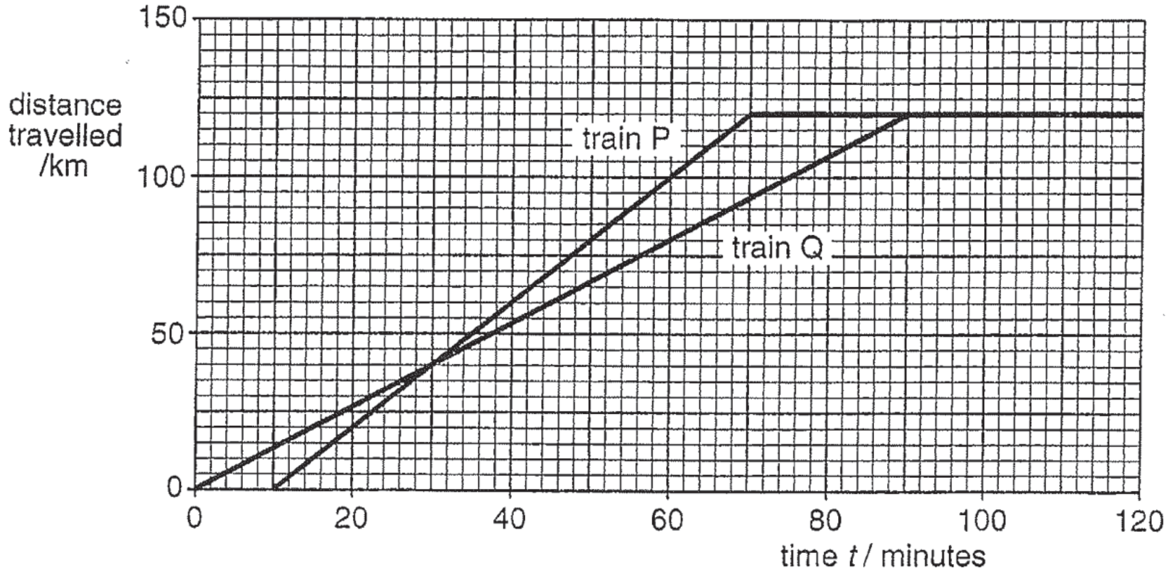


Fig. 2.1

Train Q starts its journey at time t = 0 minutes and train P starts its journey at t = 10 minutes.

(a) Explain how Fig. 2.1 shows that, when moving, train P has a greater speed than train Q.

....

....

.... [2]

(b) What is the distance between the two stations?

distance = ………………………….. [1]

(c) Calculate the speed of train Q when it is moving. Give your answer in km/h.

speed = ………………………….. [2]

(d) Another train R makes the same journey. It travels at the same speed as train P.
Train R leaves 30 minutes later than train P.

On Fig. 2.1, draw the distance-time graph for the train R. [1]

[Turn over

3 Two tugboats are pulling a ship in a harbour. Fig. 3.1 represents the view from above and shows the directions of the forces on the ship.

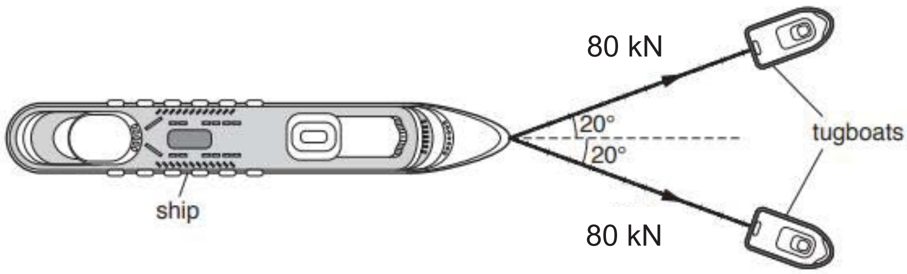


Fig. 3.1 (not to scale)

The pulling force exerted by the two tugboats are 80 kN each.

(a) In the space below, draw a labelled diagram to show the resultant of these two forces.

Determine the magnitude of the resultant force.
State the scale used.

scale: ……………………………..

resultant force = ……..……………………

[3]

(b) The engines of the ship are not operating and the water in the harbour is stationary. The ship is moving in a straight line in the direction of the resultant force exerted by the two tugboats. It is traveling at a constant speed.

Explain, in terms of the forces acting, why the ship is moving in a straight line at constant speed.

………

………

……… [2]

[Turn over

4 Fig. 4.1 shows a painter standing on a wooden plank, directly above the right-hand support.

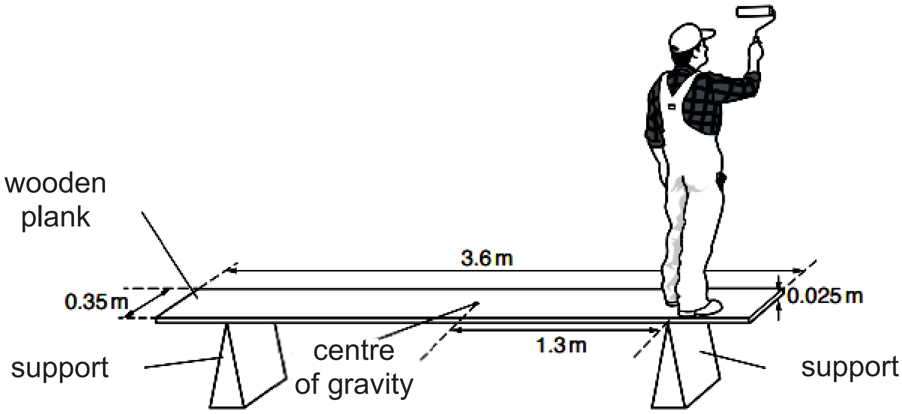


Fig. 4.1

The plank has length 3.6 m, width 0.35 m and thickness 0.025 m.

The gravitational field strength g is 10 N/kg and the mass of the plank is 23 kg.

(a) Calculate the density of the wood from which the plank is made.

density = ………………………………….. [2]

(b) The centre of gravity of the plank is in the middle of the plank at a distance of 1.3 m from each of the supports.

Calculate

(i) the weight of the plank,

weight = ………..…………………………. [2]

(ii) the moment due to the weight of the plank about the right-hand support.

moment = …………………………………… [2]

(c) The painter moves further to the right along the plank and the plank starts to rotate clockwise about the right-hand support.

Explain why the plank rotates clockwise.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

5 Fig 5.1 shows the journey of a cyclist from point A to B. Point A and B are at the same height.

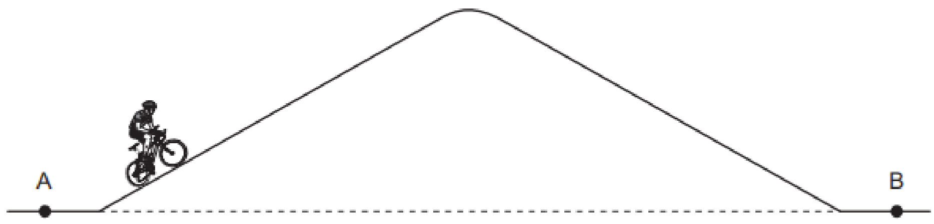


Fig 5.1

The cyclist starts from rest at A and pedals up and over a hill. Near the bottom of the hill, she starts to brake and come to rest at B.

(a) Describe the energy changes that take place as she pedals up the hill at constant speed.

....

.... [2]

(b) Explain how the law of conservation of energy applies to the complete journey from A to B.

....

.... [1]

(c) At one point in the journey, the gravitational potential energy of the cyclist has increased by 5700 J. The total mass of the cyclist and bicycle is 60 kg.
The gravitational field strength is 10 N/kg.

Calculate the height above A of the cyclist at this point.

height above A = ... [2]

[Turn over

6 Fig. 6.1 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. The mass of gas remains constant.

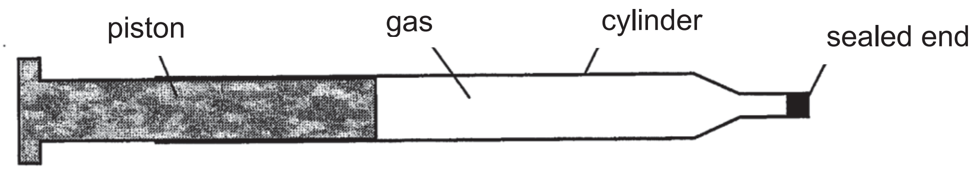


Fig. 6.1

As the syringe is cooled from 90 °C to 10 °C, the piston moves inwards. It stops moving when the temperature is steady.

State how the physical quantities of the cooled air have changed when the piston stops moving at 10 °C, compared to the initial temperature of 90 °C.

Complete Table 6.1, using the terms "*greater*", "*the same*" or "*less*".

Table 6.1

the average distance between the gas molecules	
the pressure of the gas after the piston stops	
the average speed of the gas molecules	
the frequency of the collision between the gas molecules and the piston	
the average diameter of the gas molecules	

[5]

7 **(a)** Fig. 7.1 shows part of a page from a student's notebook. The student attempted to list out all the components of the electromagnetic spectrum.

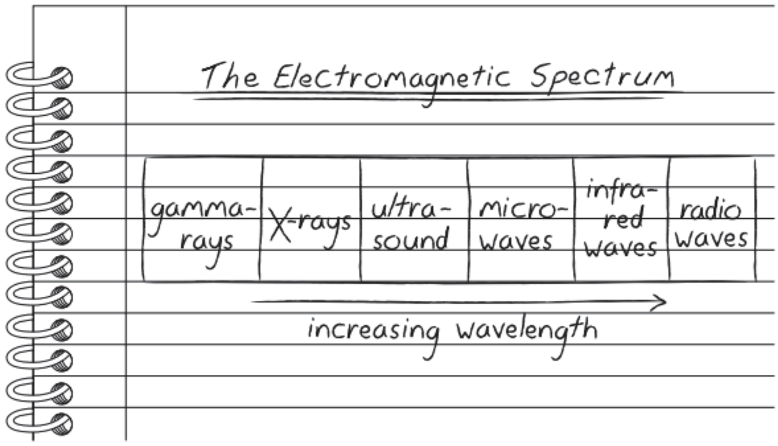


Fig. 7.1

List three errors in the student's notes and state how it should be corrected.

1. ……………………………………………………………………………………………………..

2. ……………………………………………………………………………………………………..

3. …………………………………………………………………………………………………….. [3]

(b) X-rays is used in hospitals for the diagnosis of medical conditions such as fractures or tooth decay.

State one other application of X-rays.

……………………………………………………………………………………………………

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

[Turn over

8 Fig. 8.1 shows a positively charged rod, an uncharged metal sphere on an insulating stand and a connection to earth.

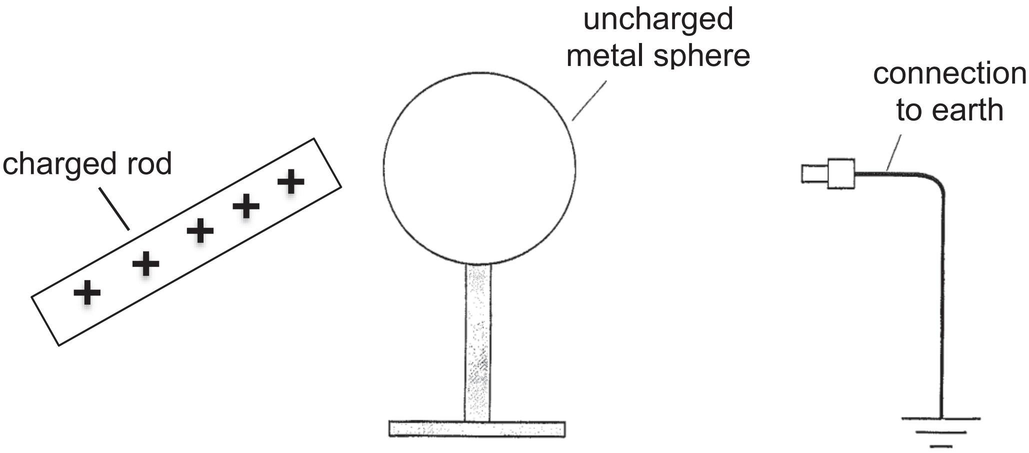


Fig. 8.1

(a) Describe how this apparatus is used to give the metal sphere a negative charge by induction.

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

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

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

……………………………………………………………………………………………………….[3]

(b) State and explain what happens to the free electrons in the metal sphere during the charging process.

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

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

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

(c) At the end of the charging process, the metal sphere has a charge of 2.5 nC.
The charging process takes 4.0 ms.

Calculate the average current during this time.

current = …………………………… [2]

9 Fig. 9.1 shows a design for a simple circuit breaker.

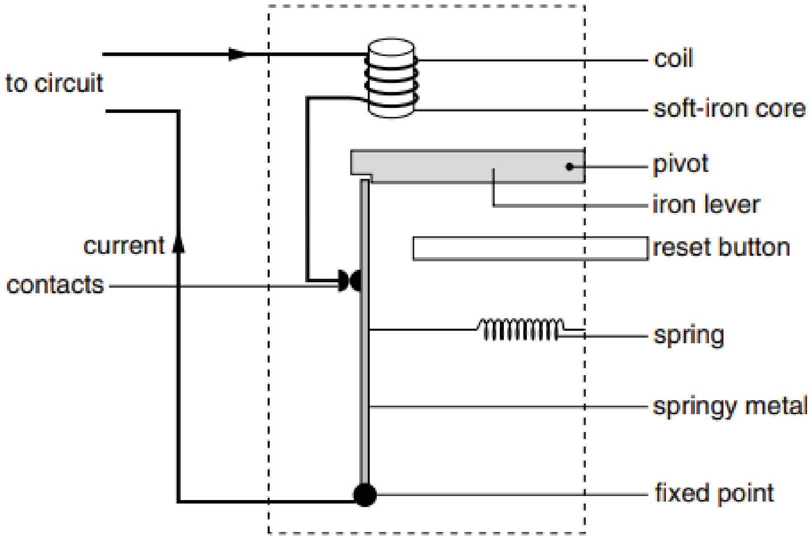


Fig. 9.1

(a) When there is a large current in the circuit, the circuit breaker trips.

Describe what happens to the soft-iron core, iron lever, spring and contacts.

soft-iron core: ………………………………………………………………………………………

iron lever: ……………………………………………………………………………………………

spring: …………………………………………………………………………………………………

contacts: ……………………………………………………………………………………… [4]

(b) Suggest one modification to the circuit breaker so that it will operate at a lower current.

………

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

[Turn over

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Name:	Index number:	Class:

Section B

Answer **all** the questions from this section.
Answer only one of the two alternative questions in **Question 12**.

10 Fig. 10.1 shows a device used to measure the flow of air. The turbine is made to rotate by the air that flows through it. The rim of the turbine contains small magnets. An e.m.f is formed in the coil wound on a soft-iron core nearby.

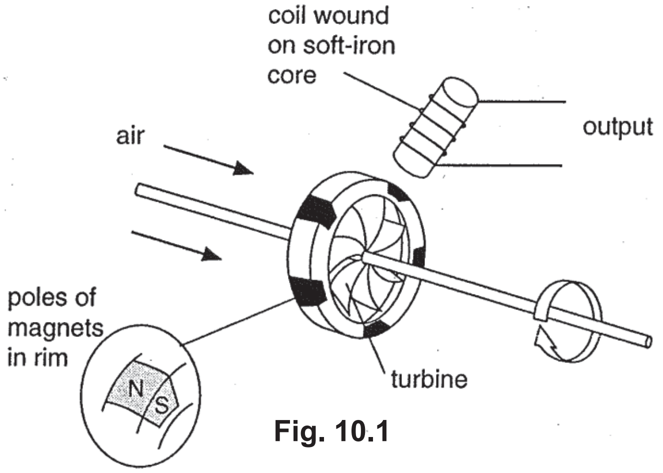

Fig. 10.1

(a) Explain how an e.m.f is formed in the coil.

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

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

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

…………………………………………………………………………………………………… [3]

(b) The line on Fig. 10.2 shows how the induced e.m.f. varies with time when the turbine rotates at a steady speed.

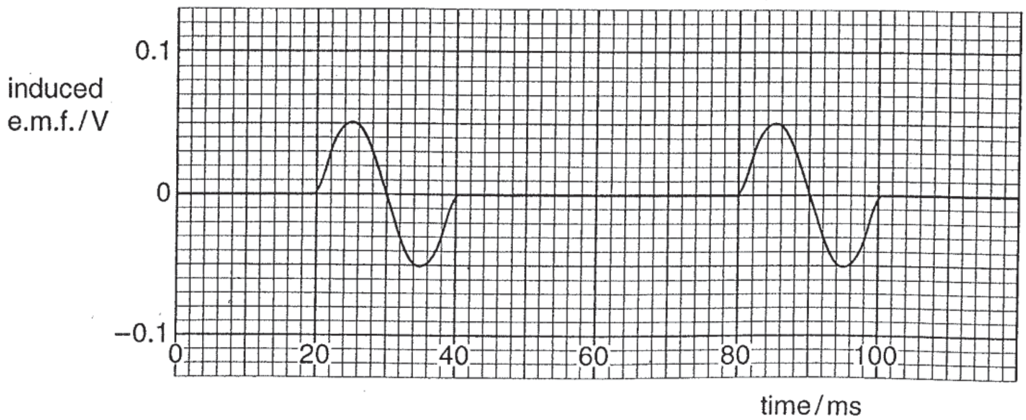

Fig. 10.2

On Fig. 10.2, draw a line to show how the induced e.m.f. varies if the turbine rotates twice as fast.

[3]

[Turn over

A power station generates electrical energy at 25 kV, 12 kA. Fig. 10.3 shows the generator in the power station connected to the primary coil of an ideal transformer. The transformer changes the voltage before the electrical energy is transmitted across the country.

The output from the secondary coil of the transformer is 400 kV.

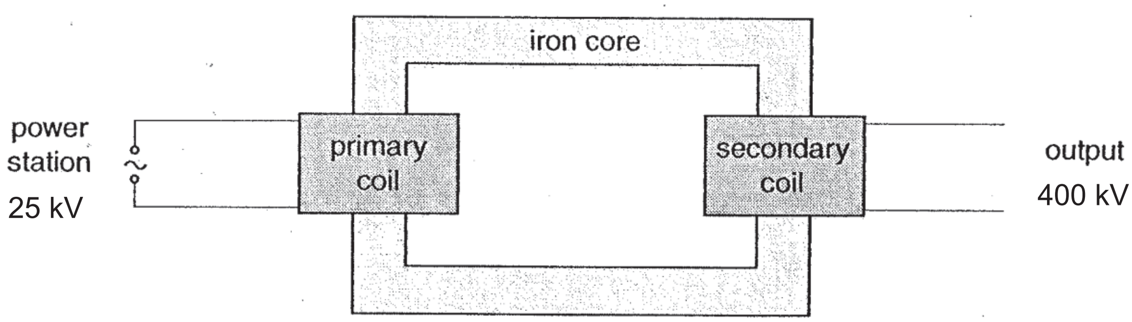

Fig. 10.3

(c) Calculate the turns ratio, the number of turns in the secondary coil to the number of turns in the primary coil.

turns ratio = …………………………….. [1]

(d) Assuming the transformer is ideal, calculate the output current from the transformer.

output current = …………………………….. [2]

(e) State one advantage of using a high voltage for the transmission of the electrical energy.

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

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

11 **(a)** What is the difference between *input* transducers and *output* transducers?

………

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

(b) Fig. 11.1 shows how the resistance of the thermistor changes with temperature.

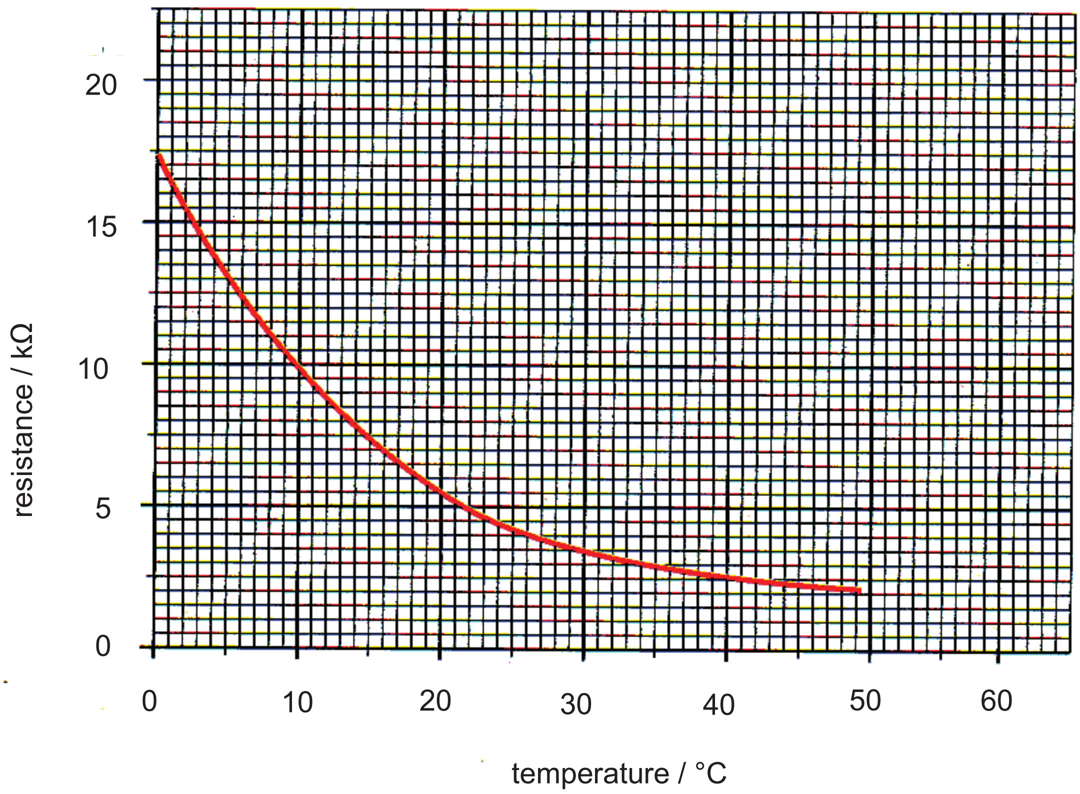

Fig. 11.1

(i) From the graph, determine the resistance of the thermistor at 40 °C.

resistance of thermistor = ……………………… [1]

(ii) Explain why the graph shows that the temperature sensor is a non-ohmic device.

……………………………………………………………………………………………………

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

[Turn over

(c) The thermistor is connected to a circuit in Fig. 11.2. The variable resistor R is set at 7.5 kΩ and the battery has an e.m.f of 20.0 V.

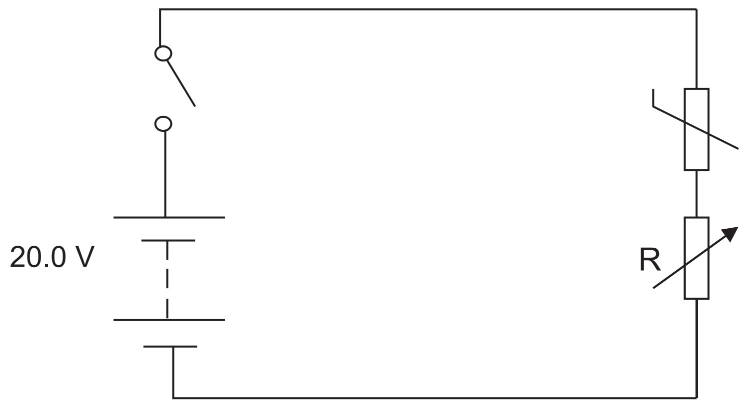

Fig 11.2

When the switch is closed, determine the current (in mA) flowing in the circuit at 40 °C.

current = ………..……………… [2]

(d) The variable resistor R is connected to an electronic circuit as shown in Fig. 11.3. The electronic circuit is switched on when the potential difference across R is between 6.0 V to 10.0 V. The resistance of the variable resistor is still set at 7.5 kΩ.

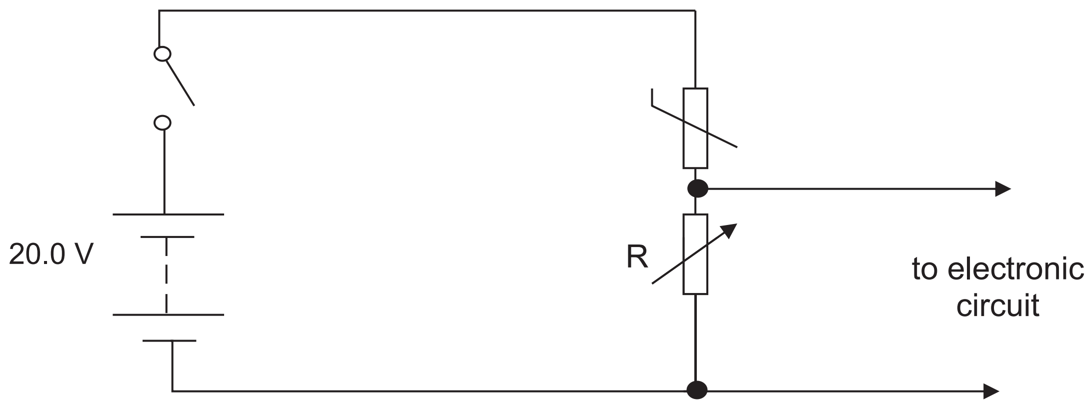

Fig. 11.3

(i) Calculate the output voltage across R when the temperature is 40 °C.

output voltage = ………………… [1]

(ii) Calculate the maximum and minimum temperature for the electric circuit to be switched on.

maximum temperature = ……………………….

minimum temperature = ……………………….
[3]

(iii) Suggest a use for this circuit.

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

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

[Turn over

12 EITHER

Fig. 12.1 shows an electrical circuit with six identical resistors of 10 Ω, a lamp, a voltmeter and a dry cell. The electromotive force of the dry cell is 24 V and the voltmeter connected across the lamp reads 6.0 V.

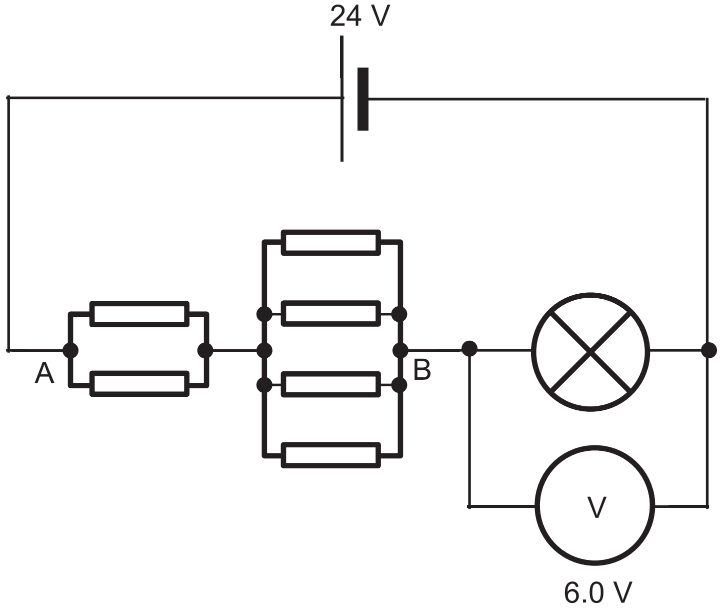

Fig. 12.1

(a) Calculate the effective resistance between the points AB.

effective resistance = ……………………….. [2]

(b) (i) Define *electromotive force* and *potential difference* in terms of work done.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

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

(ii) State the potential difference between AB.

potential difference = ………………………… [1]

(c) **(i)** Calculate the current supplied by the dry cell.

current = ………………………….. [2]

(ii) Calculate the resistance of the lamp.

resistance = …………………………. [1]

(d) Explain why there is a need to earth the metal casings of all electrical appliances.

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

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

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

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

12 OR

(a) (i) Fig. 12.2 shows an object O placed in front of a converging lens. Complete the scaled ray diagram by adding two rays to show how a converging lens forms the virtual image of the object with a linear magnification of 2.0.
(linear magnification = image height/object height)

Mark the focal point and label it as ‘F’. [2]

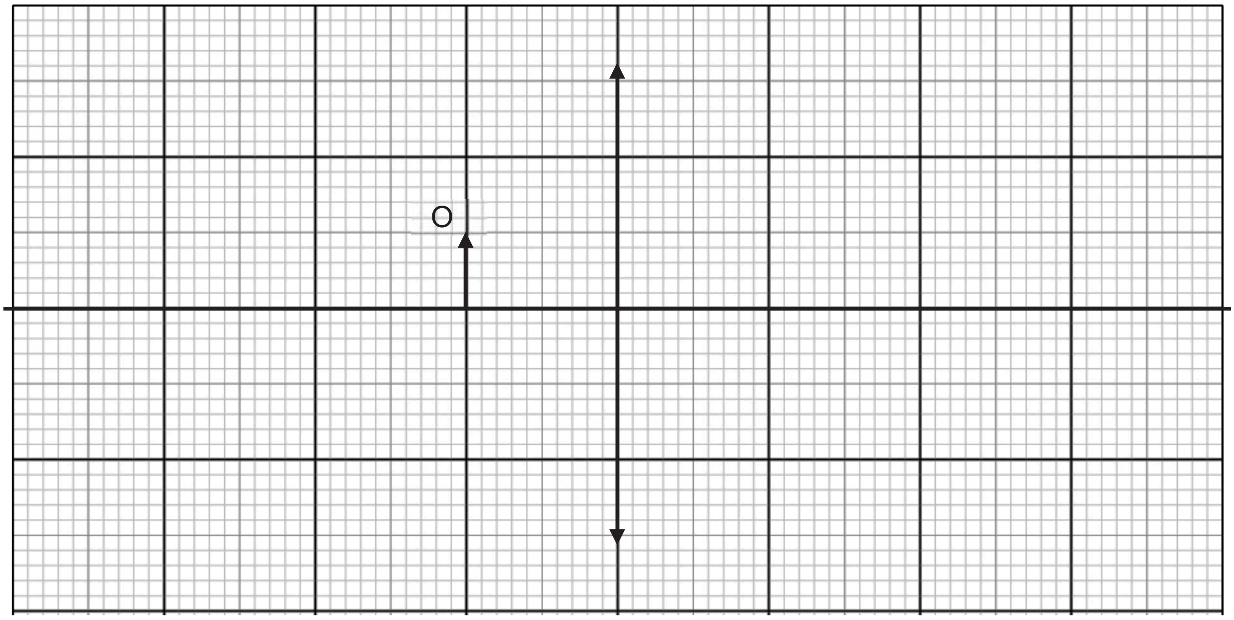

Fig. 12.2

(ii) Fig. 12.3 shows an object O placed in front of a converging lens. Complete the scaled diagram by adding two rays to show how a converging lens forms the real image of the object with a linear magnification of 2.0.

Mark the focal point and label it as ‘F’. [2]

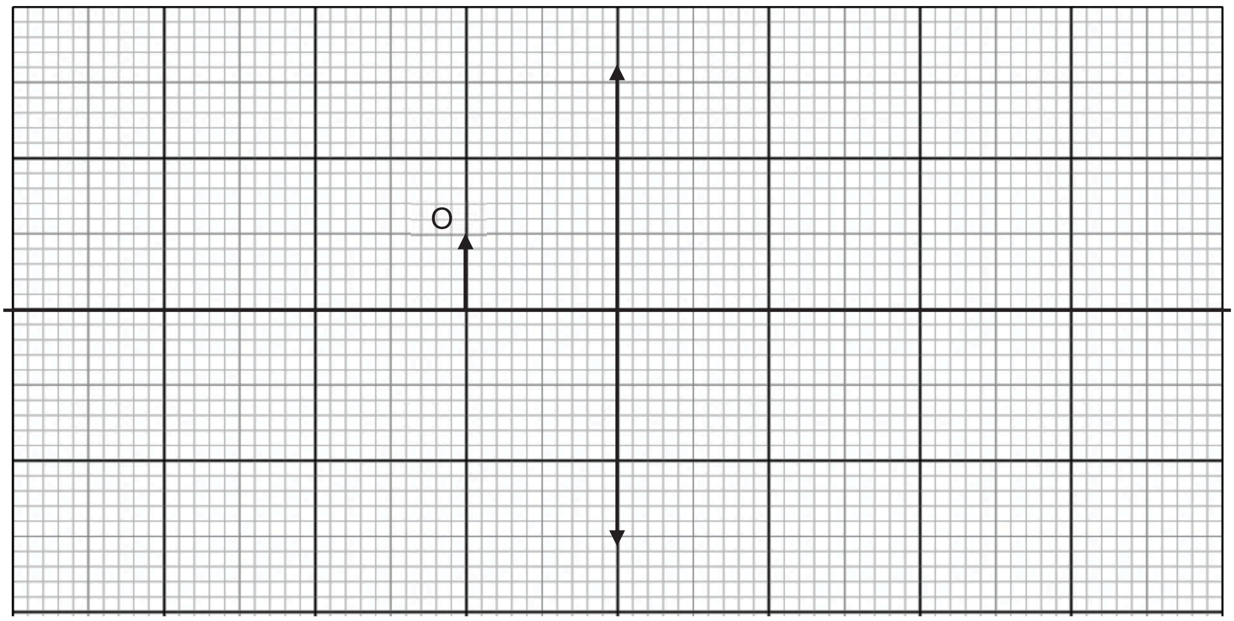

Fig. 12.3

(b) The image formed in Fig. 12.2 is virtual and enlarged.

State one other characteristic of the image in Fig. 12.2.

………………………………………………………………………………………………………

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

(c) Name a particular use of the lens arranged in Fig. 12.3, and explain why the characteristics of the image described is suitable for the use stated.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

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

(d) The converging lens can also be used in a photocopying machine to make identical copies of documents.

With reference to the lens, where should the object be placed so that the lens can be used in a photocopying machine.

………………………………………………………………………………………………………

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

(e) The converging lens works based on the use of curved surfaces and the laws of refraction.

State the two laws of refraction.

1. ……………………………………………………………………………………………………

………………………………………………………………………………………………………

2. ……………………………………………………………………………………………………

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

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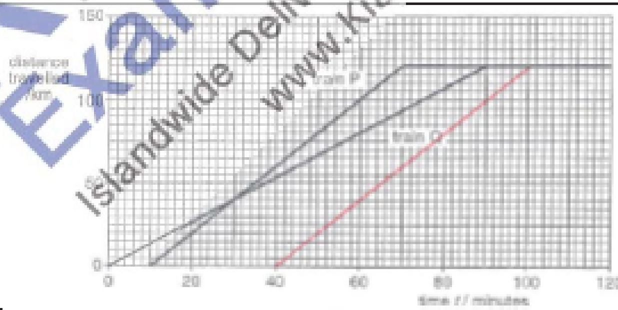
CHIJ SECONDARY (TOA PAYOH)
PRELIMINARY EXAMINATION 2022
SECONDARY 4(EXPRESS)

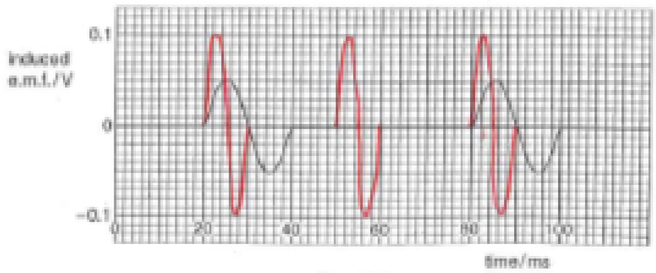
PHYSICS
6091/01
Paper 1

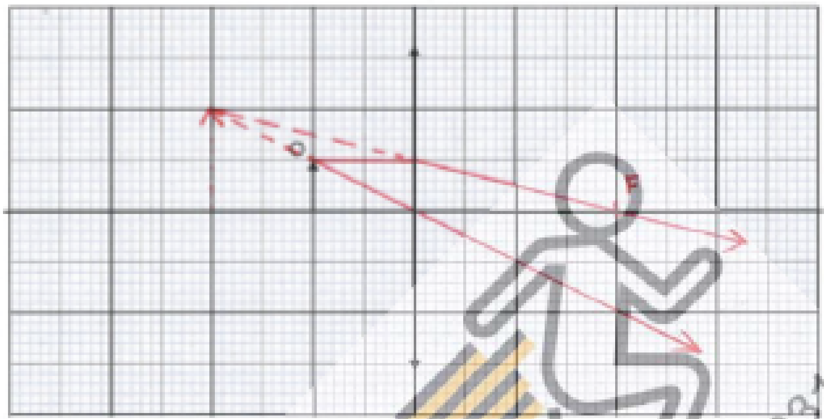
1	D	11	B	21	B	31	B
2	A	12	B	22	D	32	D
3	B	13	C	23	A	33	C
4	C	14	B	24	A	34	C
5	B	15	D	25	A	35	D
6	B	16	D	26	C	36	C
7	C	17	C	27	D	37	A
8	B	18	D	28	B	38	C
9	B	19	A	29	C	39	A
10	C	20	A	30	B	40	D

Paper 2
6091/02

Qn	Answers	Mark	
1(a)	The distance travelled per unit time is increasing.	1	
1(b)	average speed = total distance / total time = 80 cm / 2 s = 40 cm/s or 0.4 m/s	1 1	
1(c)	Air resistance is increasing. Weight is constant/ remain unchanged.	1 1	
2(a)	- Gradient on a distance-time graph represents speed - Gradient of P is greater than gradient of Q	1 1	
2(b)	120 km	1	
2(c)	Speed = distance / time = 120 km / 1.5 hours = 80 km/h	1 1	
2(d)		1	
3(a)	 - Appropriate scale - Correct resultant force indicated with double arrow - Correct addition of forces drawn - Range: 135kN to 165 kN	 1 1 1	

3(b)	- The resultant force of the two tugboats is equal and opposite to the friction between ship and water. - Resultant force on ship is 0 N.	1 1	
4(a)	Volume = 3.6x0.35x0.025 = 0.0315 m^3 Density = mass / volume = 23 / 0.0315 = 730 kg/m^3	1 1	
4(b)(i)	W = mg = 23 x 10 = 230 N	1 1	
4(b)(ii)	Moment = force x perpendicular distance = 230 x 1.3 = 299 Nm	1 1	
4(c)	- When painter moves further to the right, his weight will create a clockwise moment about the right-hand support. - This clockwise moment is greater than the anti-clockwise moment due to the weight of the plank about the same pivot.	1 1	
5(a)	- Chemical potential energy $\longrightarrow$ Kinetic energy + Gravitational potential energy - Chemical potential energy is decreasing, kinetic energy is constant, gravitational potential energy is increasing. OR Chemical potential energy $\longrightarrow$ Gravitational potential energy + thermal energy + sound	1 1	
5(b)	All the chemical potential energy input by the cyclist is converted to thermal energy when the cyclist stops.	1	
5(c)	GPE = mgh 5700 = 60 x 10 x h h = 9.5 m	1 1	
6(a)	less same less greater same	1 1 1 1 1	
7(a)	Three errors: 1. Ultra-sound should be ultraviolet instead 2. The positions of microwaves and infra-red waves should be interchange. 3. Visible light is missing. It should be between ultraviolet and infra-red waves.	 1 1 1	
7(b)	X-rays is used to check for internal cracks in metal structures.	1	
8(a)	- Bring positively charged rod near but not touching sphere. - Connect the earth connection to the sphere. - Remove the earth connection. - Remove the positively charged rod.	1 1 1	
8(b)	- When positively charged rod is brought near the sphere, electrons on sphere will be attracted to the left side of sphere. - When earth connection is connected to sphere, electrons will be attracted from the earth into the sphere.	1 1	
8(c)	Q = It I = Q/t = 2.5×10^{-9} / 4.0×10^{-3} = 625 nA	1 1	
9(a)	- Soft-iron is magetised into a strong electromagnet - Iron lever is attracted by the strong electromagnet and starts <u>to turn clockwise about the pivot</u> - Spring will contract and pull the springy metal towards the reset button - Contact will open	1 1 1 1	
9(b)	Increase the number of turns per unit length in the coil	1	
	END OF SECTION A		

10(a)	- As the turbine rotates, the coil will experience a rate of change of magnetic flux around it. - By <u>Faraday's law of electromagnetic Induction</u>, an <u>induced</u> e.m.f. is formed on the coil.	1 2	
10(a)(ii)	 Fig. 10.2 - Amplitude increased to 0.1 V - Period reduced by ½ - time interval between waveform is reduced from 60 ms to 30 ms.	 1 1 1	
10(c)	Turns ratio = $N_s / N_p = V_s / V_p$ $= 400k / 25k = 16$	 1	
10(d)	$V_s / V_p = I_p / I_s$ $16 = 12 \times 10^3 / I_s$ $I_s = 750$ A	1 1	Power input = power output $I_p V_p = I_s V_s$
10(e)	Reduce energy loss through thermal on the transmission cables.	1	Due to lower current transmitted.
11(a)	Input transducers are electronic devices that convert non-electrical energy to electrical energy while output transducers convert electrical energy to non-electrical energy.	1	
(b)(i)	Resistance at 40 °C = 2.5 kΩ	1	
(b)(ii)	Graph is not a straight line / Resistance of the sensor changes non-linearly	1	
(c)	$I = V / R$ $= 20.0 / [10 \times 10^3] = 2$ mA	1 1	
(d)(i)	$V = I R = 2 \times 10^{-3} \times 7500 = 15$ V	1	
(d)(ii)	$V_{output} = R/[R+R_T] \times 20.0$ V $6.0 = 7500/[7500+R_T] \times 20.0$ V $R_T = 17.5$ kΩ From graph, minimum temperature = 0 °C $10.0 = 7500/[7500+R_T] \times 20.0$ V $R_T = 7.5$ kΩ From the graph, maximum temperature = 15 °C	1 1 1	
(d)(iii)	To switch on a heater when the temperature drops below 15 °C.	1	
12 Either			
12(a)	Effective resistance between AB $= [1/(1/10+1/10) + 1/(1/10+1/10+1/10+1/10)]$ $= 7.5\ \Omega$	 1 1	
12(b)(i)	- E.m.f is defined as the amount of work done <u>by an electrical source</u> in driving one unit charge around a complete circuit. - Potential difference is defined as the amount of work done in driving one unit charge <u>across a component</u> in the electrical circuit.	1 1	

12(b)(ii)	Potential difference across AB = 24 – 6 = 18 V	1	
12(c)(i)	V = IR I = V / R = 18 / 7.5 = 2.4 A	1 1	
12(c)(ii)	R = V / I = 6.0 / 2.4 = 2.5 Ω	1	
12(d)	- In the event of an electrical fault, the earth wire will conduct the large fault current safely to the ground. - This will prevent user from getting an electric shock if user accidentally touches the metal casing	1 1	
12OR			
(a)(i)	 - Correct pair of rays drawn - Correct F labelled	1 1	
(a)(ii)	 - Correct pair of rays drawn - Correct F labelled	1 1	
(b)	Image is upright.	1	
(c)	Overhead Projector It is able to project a big image of a small object onto a screen.	1 1	
(d)	Object should be placed exactly 2 focal length away from lens.	1	
(e)	1. The incident ray, the normal and the refracted ray at the point of incidence all lie on the same plane. 2. For 2 given media, the ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant.	1 1	
	END OF PAPER 2		

O

JURONGVILLE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2022
Secondary 4 Express

STUDENT NAME			
CLASS		INDEX NUMBER	

PHYSICS **6091/01**

Paper 1 Multiple Choice **31 August 2022**

Additional Materials: Multiple Choice Answer Sheet **1 hour**

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, index number and class in the spaces 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** or **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on 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.

Take acceleration due to gravity on Earth, g, to be 10 m/s^2 unless stated otherwise.

For Examiner's Use
40

Setter: Mr Lam Seng Tat

This document consists of **17** printed pages.

[Turn over

1 What is the conversion factor for converting micrometres (μm) to gigametres (Gm)?

A 10^{-15}

B 10^{-12}

C 10^{12}

D 10^{15}

2 What are S.I. base units for Watt?

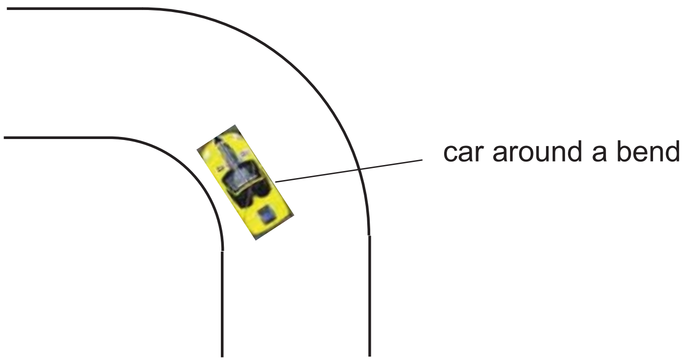
A kg m s^2

B kg m s^{-2}

C kg m^2 s^{-2}

D kg m^2 s^{-3}

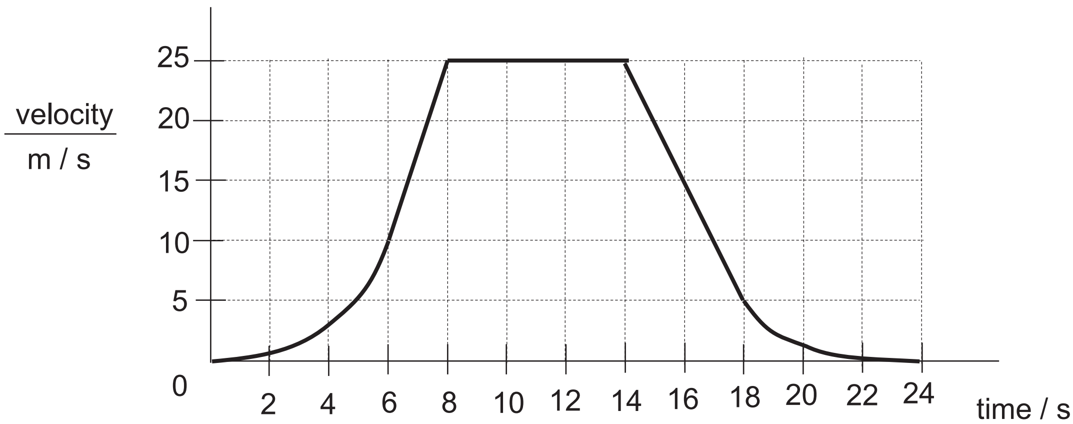
3 The diagram shows a car moving at constant speed when turning around a bend.



Which is correct description of the velocity and acceleration of the car?

	velocity of the car	acceleration of the car
A	constant	non-zero
B	constant	zero
C	changing	non-zero
D	changing	zero

4 The diagram shows the velocity-time graph of an object.



What is the constant deceleration of the object?

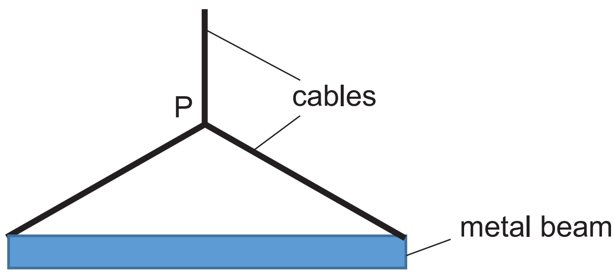
A 2.5 m / s^2

B 3.1 m / s^2

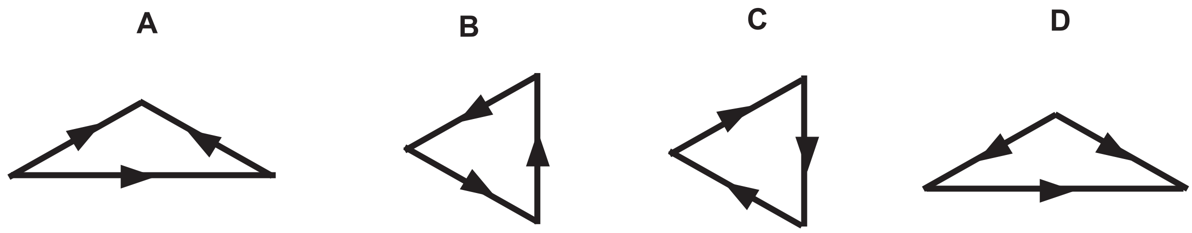
C 5.0 m / s^2

D 7.5 m / s^2

5 The diagram shows a metal beam supported by three cables at a construction site. Point P is where the three cables are joined at and is in equilibrium.



Which vector diagram shows the forces acting at point P?



[Turn over

6 The diagram shows the robotic helicopter Ingenuity exploring Mars. The helicopter weighs 7.20 N on Mars. Mars has a gravitational field strength of 4 N / kg.

NASA

A similar helicopter is used to explore the Moon. Moon has a gravitational field strength of 1.6 N / kg.

What is the weight of the helicopter on the Moon?

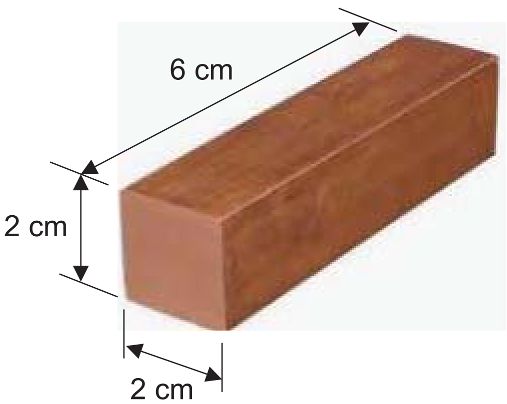
A 1.80 N

B 2.88 N

C 7.20 N

D 11.5 N

7 The diagram shows two objects P and Q. Object P is a copper bar with its dimensions shown and mass of 210 g. Object Q is a copper cup made from melting 200 g of object P.



P

Q

What is the density of the copper cup?

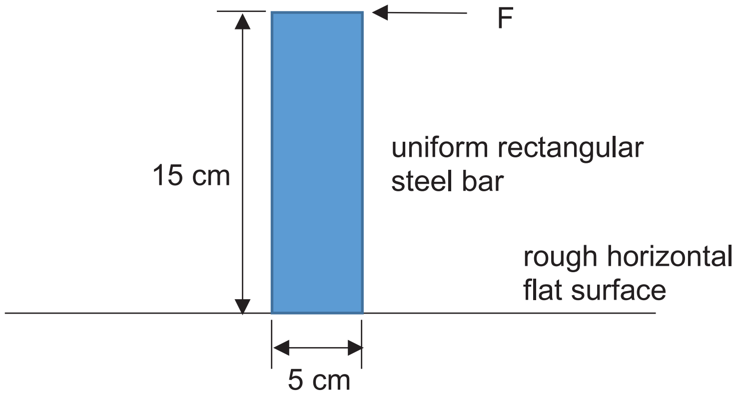
A 8.33 g / cm^3

B 8.75 g / cm^3

C 4800 g / cm^3

D 5040 g / cm^3

8 The diagram shows a uniform rectangular steel bar placed on a rough horizontal flat surface. A horizontal force F acts on the top end of the steel bar. The steel bar weighs 30 N.



What is the force F required to just tilt the steel bar from the horizontal surface?

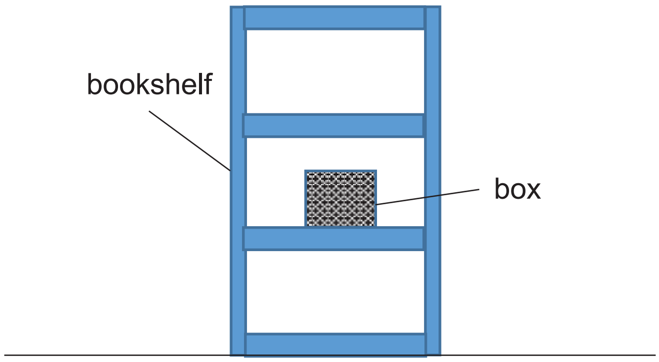
A 2.5 N

B 5 N

C 10 N

D 20 N

9 The diagram shows a three-tier bookshelf. A box is placed on the middle tier of the bookshelf.



Which action would make the bookshelf more stable?

A add another box on the top tier of the bookshelf

B change the bookshelf to another bookshelf of a denser material

C move the box to the top tier of the bookshelf

D place the box on the bottom tier of the bookshelf

[Turn over

10 A crane is used to lift concrete blocks in a construction site. A concrete block weighs 5000 N.

What is the total energy required by the crane to lift the concrete block up 12 m height if the efficiency of the crane is 85%?

A 51.0 kJ

B 70.6 kJ

C 510 kJ

D 706 kJ

11 A bus travels at a constant speed of 20 m / s for 3 km.

What is the power of the bus with a forward force of 4000 N?

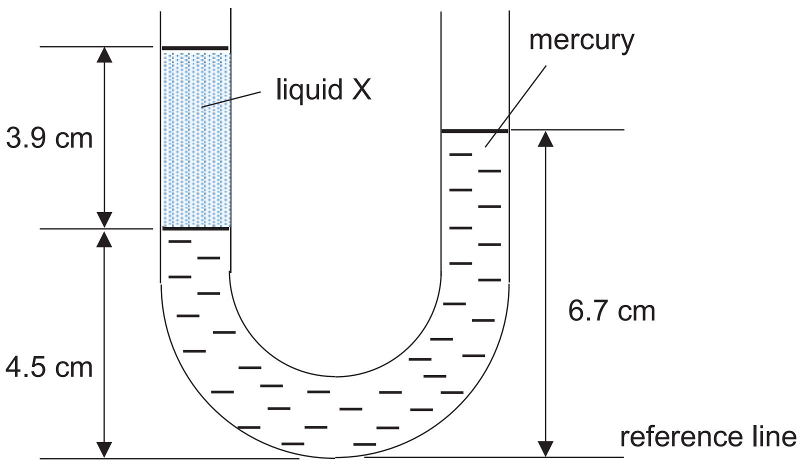
A 80 W

B 600 W

C 80 000 W

D 600 000 W

12 The diagram shows a U-tube filled with mercury and liquid X. Mercury has a density of 13.6 g / cm^3.



What is the density of liquid X?

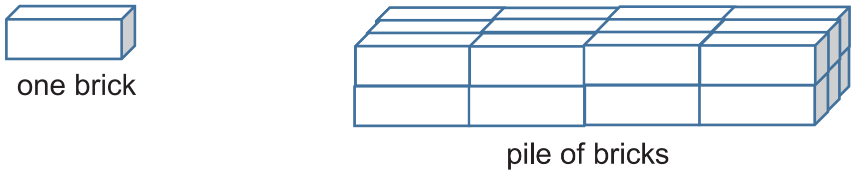
A 7.67 g / cm^3

B 8.00 g / cm^3

C 10.8 g / cm^3

D 17.1 g / cm^3

13 The diagram shows a pile of identical bricks. Each brick is 0.30 m long by 0.10 m wide and 0.15 m high. Each brick has a weight of 12 N.



What is the pressure exerted on the ground by the pile of bricks?

A 33.3 Pa

B 400 Pa

C 800 Pa

D 6400 Pa

14 The pressure of gas in a container is measured and found to be linearly related to the temperature of gas in the container. The following results were obtained.

temperature of gas / °C	pressure of gas / Pa
25.0	560
80.0	730

What is the temperature of gas when the pressure of gas is 620 Pa?

A 26.1 °C

B 44.4 °C

C 60.6 °C

D 76.9 °C

15 A fixed shaped sealed container filled with gas is heated.

Which property of the gas must also increase?

A average force of particles acting on container walls

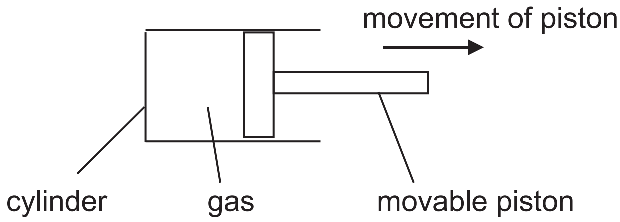
B density of gas

C distance between gas particles

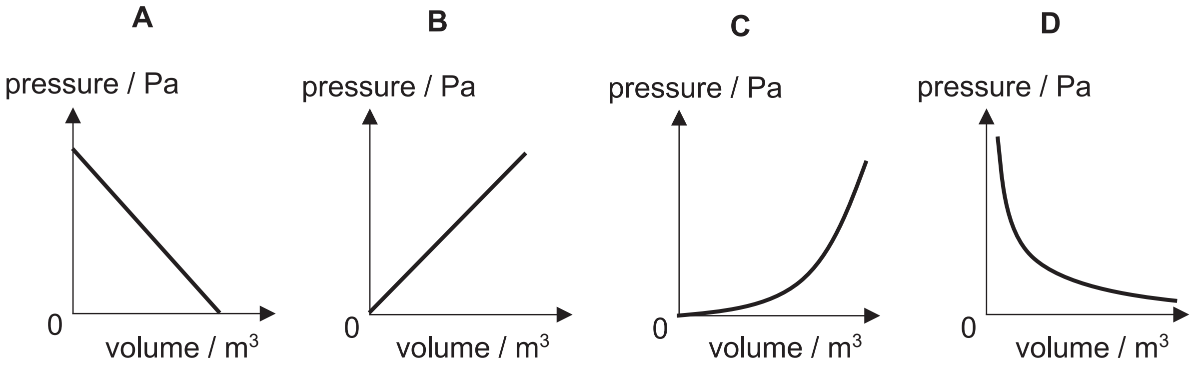
D number of gas particles in container

[Turn over

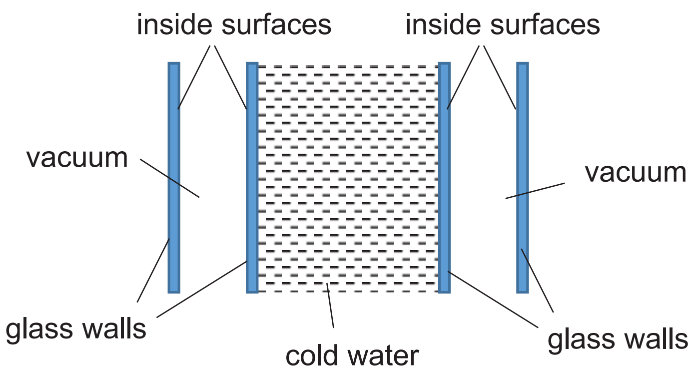
16 The diagram shows a gas trapped in a cylinder with a movable piston.



Which pressure-volume graph shows the relationship between the pressure of the gas in the cylinder and the volume of gas?



17 The diagram shows part of a vacuum flask. The vacuum flask contains cold water.



Which row gives the colour for the inside surfaces to keep the water cold and the explanation?

	colour of inside surfaces	explanation
A	black	good absorber
B	black	good emitter
C	silver	bad absorber
D	silver	bad emitter

18 A metal chair and a wooden chair are placed in a room for some time.

Which statement explains why the metal chair feels colder than the wooden chair of the same temperature?

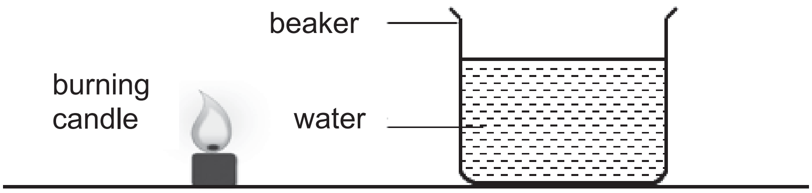
A Metal is a good absorber of thermal energy.

B Metal is a good conductor of thermal energy.

C Metal is a good emitter of thermal energy.

D Metal is a good reflector of thermal energy.

19 The diagram shows a burning candle next to a beaker filled with water.



How does thermal energy transfer from the burning candle to the water?

A conduction → convection

B convection → conduction

C radiation → conduction

D radiation → convection

20 A beaker containing liquid alcohol evaporates into alcohol vapour at room temperature.

What happens to liquid alcohol in the beaker and alcohol vapour during evaporation?

A Liquid alcohol gains kinetic energy and alcohol vapour loses potential energy.

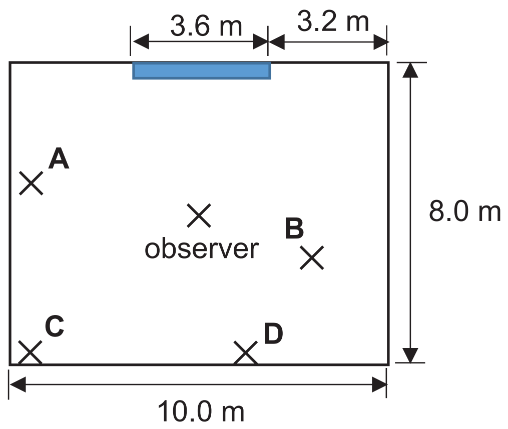
B Liquid alcohol gains potential energy and alcohol vapour loses kinetic energy.

C Liquid alcohol loses kinetic energy and alcohol vapour gains potential energy.

D Liquid alcohol loses potential energy and alcohol vapour gains kinetic energy.

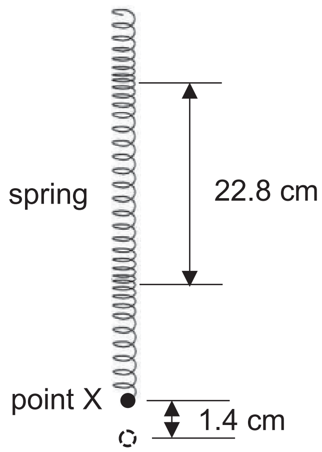
[Turn over

21 The diagram (drawn to scale) shows the top view of a rectangular room. A 3.6 m wide plane mirror is placed in front of the room. An observer is standing in the centre of the room looking for at the mirror.



Which image of the four people, (**A**, **B**, **C**, **D**) standing at the position shown cannot be seen by the observer in the mirror?

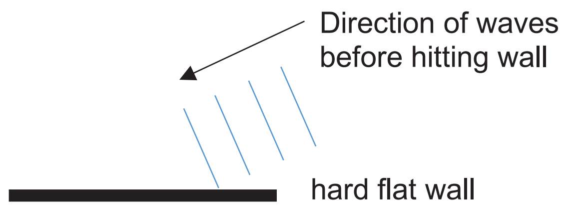
22 The diagram shows a spring oscillating vertically. Point X at the end of the spring is moving between two vertical points 1.4 cm apart.



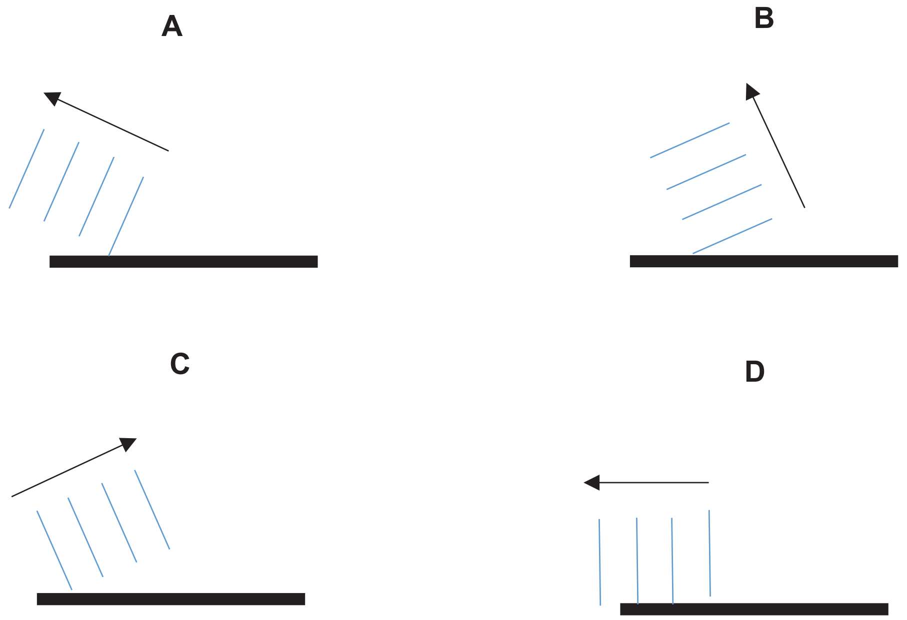
Which row describes the wave?

	amplitude / cm	wavelength / cm
A	0.7	11.4
B	0.7	22.8
C	1.4	11.4
D	1.4	22.8

23 The diagram shows water wavefronts reaching a hard flat wall.



Which shows the wavefronts after hitting the hard flat wall?



24 Which statement about infra-red radiation is **incorrect**?

A Infra-red radiation does not have electric charge.

B Infra-red radiation has a higher frequency than microwaves.

C One use of infra-red radiation is in intruder alarm.

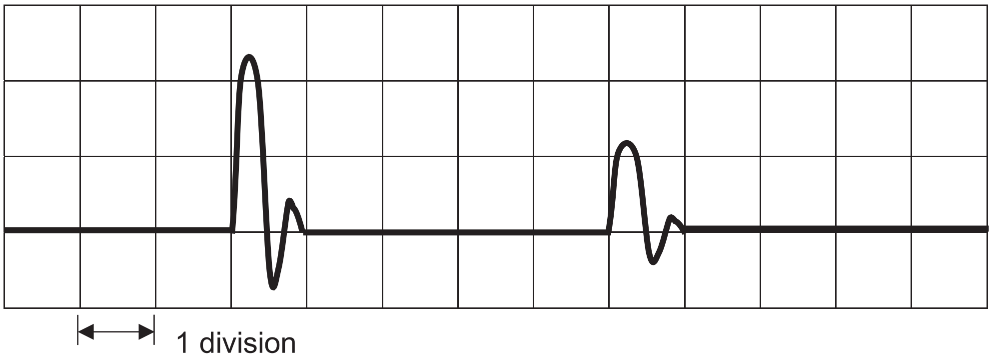
D Visible light has a longer wavelength than infra-red radiation.

25 Which row lists the applications of ultra-violet radiation and microwaves?

	ultra-violet radiation	microwaves
A	treatment of cancer	sterilisation
B	satellite television	treatment of cancer
C	sterilisation	sunbed
D	sunbed	satellite television

[Turn over

26 The diagram shows a cathode-ray oscilloscope screen measuring sound signal and its echo. Each division is set at 20 ms and speed of sound in air is 300 m / s.



What is the distance between the source of sound and the surface where the sound was reflected?

A 12 m

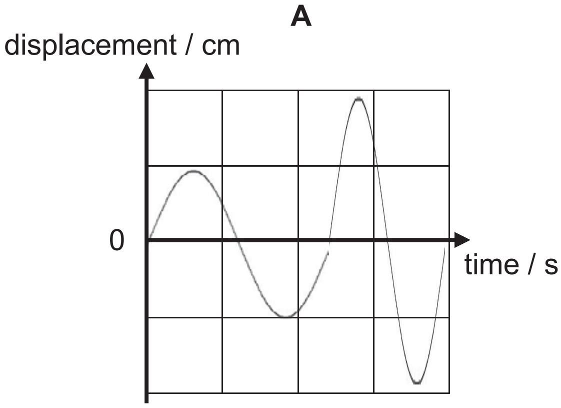
B 15 m

C 24 m

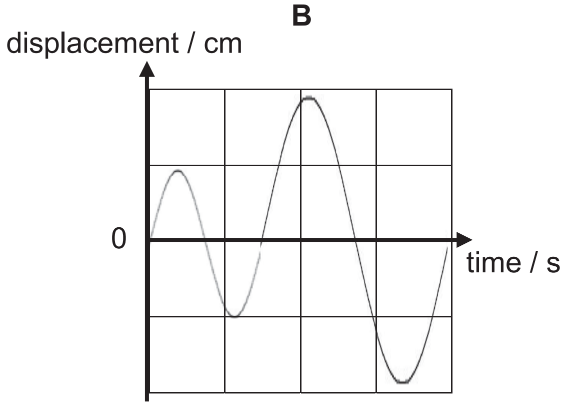
D 30 m

27 Which displacement-time graph correctly describes the waveform of sound increasing both loudness and pitch?

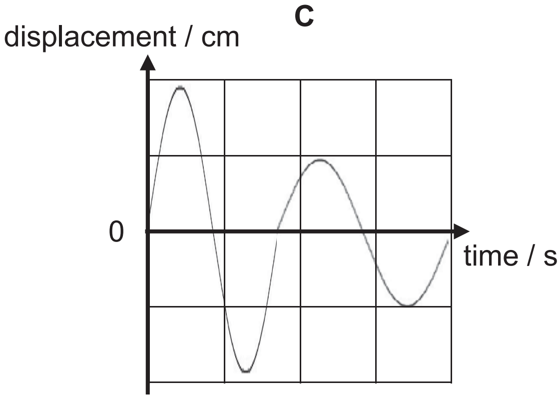
A



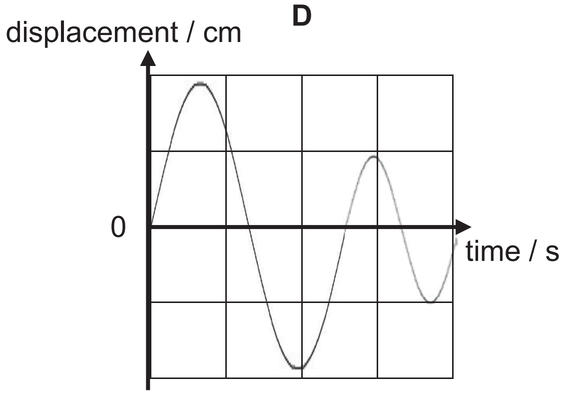
B



C



D



28 The table gives type of charges acquired when some materials are rubbed together.

materials	positive charge	negative charge
glass rod rubbed with silk	glass rod	silk
ebonite rod rubbed with fur	fur	ebonite rod

Which statement is **incorrect**?

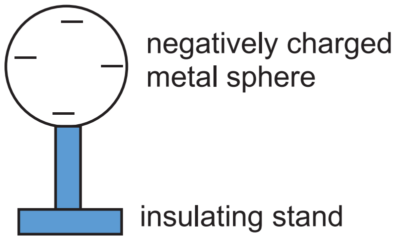
A Ebonite rod gains electrons from fur after rubbing together.

B Glass rod and ebonite rod will be attracted to each other.

C Glass rod loses electrons to silk after rubbing together.

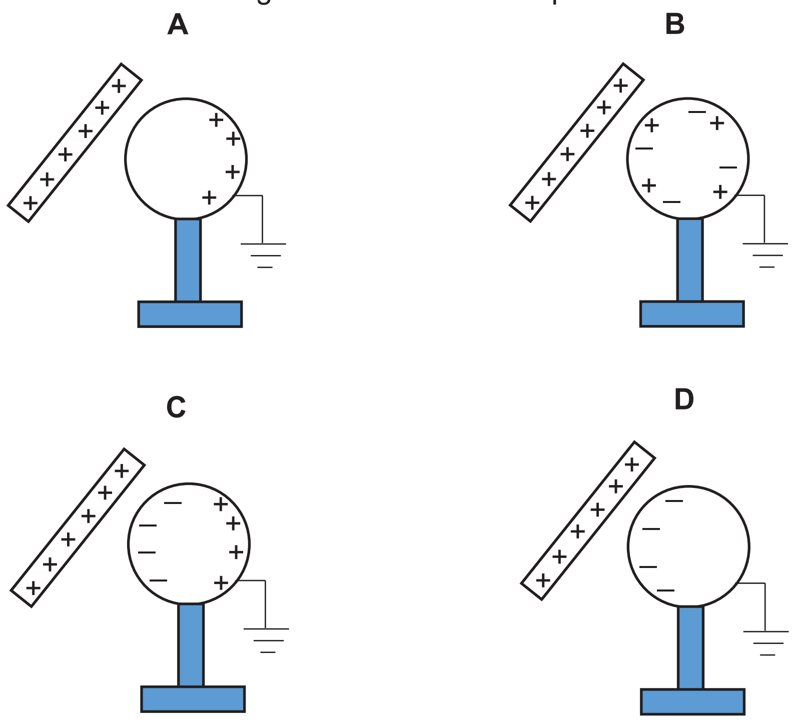
D Silk and fur will repel each other.

29 The diagram shows a negatively charged metal sphere placed on an insulating stand.



A positively charged rod is brought near to the metal sphere and the sphere is earthed.

What diagram shows the charge distribution on the sphere?



[Turn over

30 The potential difference between the ends of a resistance wire is 40 V. A current of 80 mA flows through the resistance wire in 350 μs.

How much electrical energy is converted to other forms of energy in the resistance wire?

A 1.12 mJ

B 1.43 mJ

C 1.12 MJ

D 1.43 MJ

31 A resistor with resistance R is made from a length L of resistance wire with a cross-sectional area A.

A second resistor with resistance $4R$ is made from wire of the same material with a length of $L/2$.

What is the area of cross-sectional area of the wire needed for the second resistor?

A $A/8$

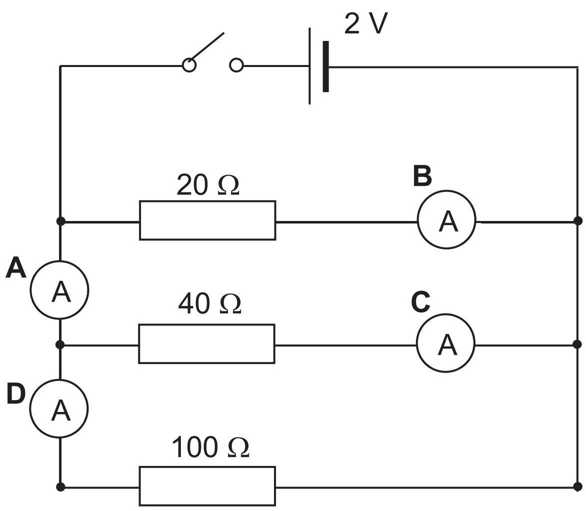
B $A/4$

C $4A$

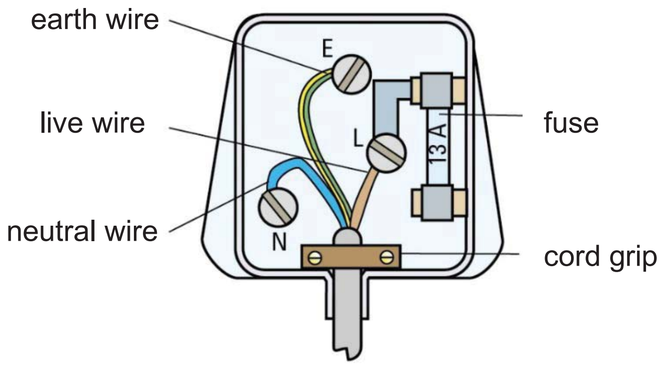
D $8A$

32 The diagram shows three resistors, four ammeters, a battery, and a switch.

Which ammeter reads 0.07 A when the circuit is switched on?



33 The diagram shows an electrical plug of a 1500 W electric kettle connected to a 240 V supply.



What is the current in the three wires when the kettle is working normally?

	live wire / A	neutral wire / A	earth wire / A
A	0	0	6.25
B	6.25	0	0
C	6.25	6.25	0
D	6.25	6.25	6.25

34 A 2.5 kW air-conditioner is switched on for 6 h daily. It cost $0.32 for 1 kW h of electrical energy.

What is the cost to use the air-conditioner for 1 month (30 days)?

A $4.44

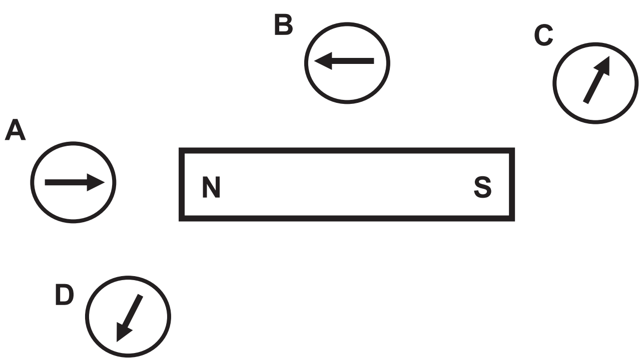
B $23.00

C $144

D $1410

35 The diagram shows a bar magnet with four plotting compasses placed near it.

Which plotting compass needle is pointing at the **correct** direction?



[Turn over

36 Which statement about magnets is **incorrect**?

A All magnets have North and South poles.

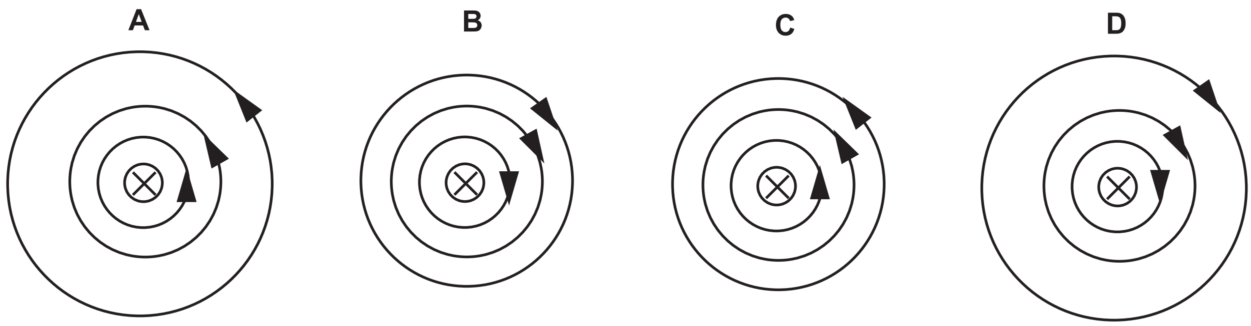
B Magnetic materials can be made into magnets.

C Magnets can repel other magnets.

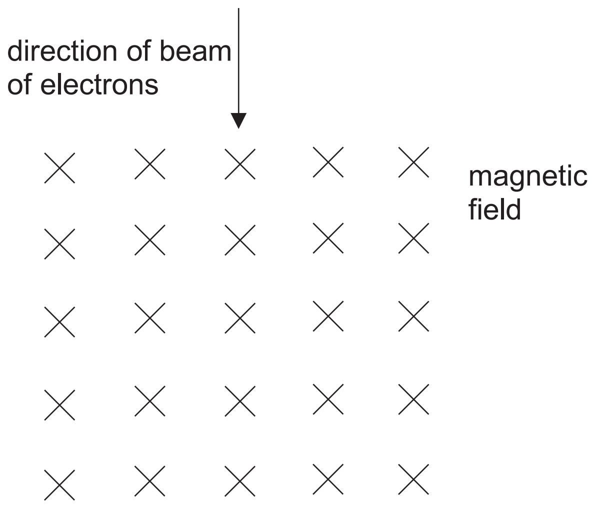
D Magnets have electric field around it.

37 The direction of current flow in a wire is denoted by  .

Which diagram represents the magnetic field around the wire?



38 The diagram shows a beam of electrons entering a magnetic field.



Which of the following describes the movement of the electrons as it enters the magnetic field?

A The electrons are deflected into the paper.

B The electrons are deflected out of the paper.

C The electrons are deflected to the left.

D The electrons are deflected to the right.

39 What happens when a simple a.c. generator doubles the speed of rotation?

A The amplitude of induced e.m.f. is doubled and frequency is doubled.

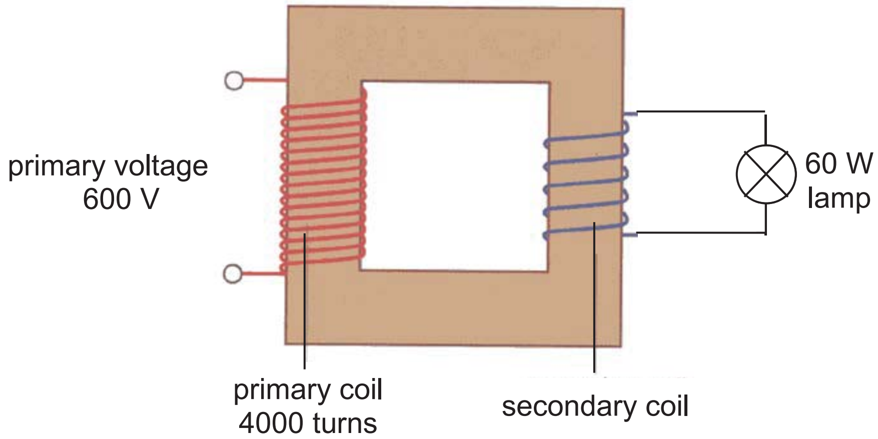
B The amplitude of induced e.m.f. is doubled and frequency is halved.

C The amplitude of induced e.m.f. is halved and frequency is doubled.

D The amplitude of induced e.m.f. is halved and frequency is halved.

40 The diagram shows an ideal transformer which has 4000 turns in the primary coil. The primary voltage is 600 V. The secondary coil is connected to a 60 W lamp.

What is the number of turns required at the secondary coil if the lamp requires 0.5 A to work?



A 500 turns

B 800 turns

C 1200 turns

D 1600 turns

End of Paper

0

JURONGVILLE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2022
Secondary 4 Express

STUDENT NAME			
CLASS		INDEX NUMBER	

PHYSICS 6091/02

Paper 2 Theory **30 August 2022**

Candidates answer on the Question Paper. **1 hour 45 minutes**
No additional materials are required.

READ THESE INSTRUCTIONS FIRST
Do not open this booklet until you are told to do so.

Write your Name, Index number and Class in the spaces at the top of this page.
Write in dark blue or black ink.
You may use an HB soft pencil for any diagrams or graph.
Do not use staples, paper clips, glue or correction fluid.

Section A:
Answer **all** the questions in the spaces provided.

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 the 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 the brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	**/ 50**
Section B	**/ 30**
Total	**/ 80**

Setter: Mr Lam Seng Tat

This document consists of 19 printed pages.

[Turn over

Section A (50 marks)
Answer **all** the questions in this section.

1 Fig. 1.1 shows the velocity-time graph for the motion of an object.

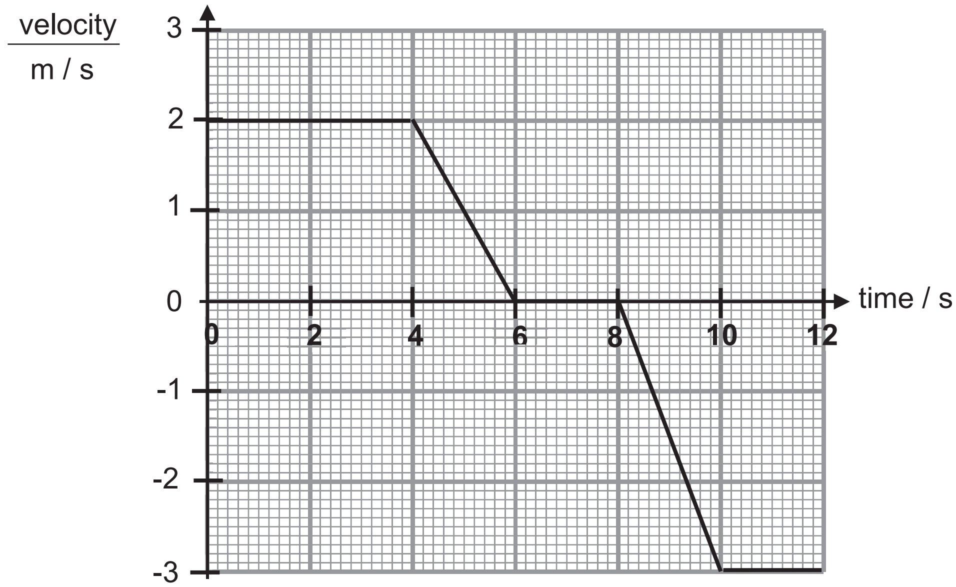


Fig. 1.1

(a) Calculate the displacement of the object from 0 s to 6 s.

displacement = ………………….. [2]

(b) Using a suitable scale for y-axis in Fig. 1.2, sketch a graph to show the displacement of the object with time from t = 0 s to t = 12 s. [3]

[Total:5]

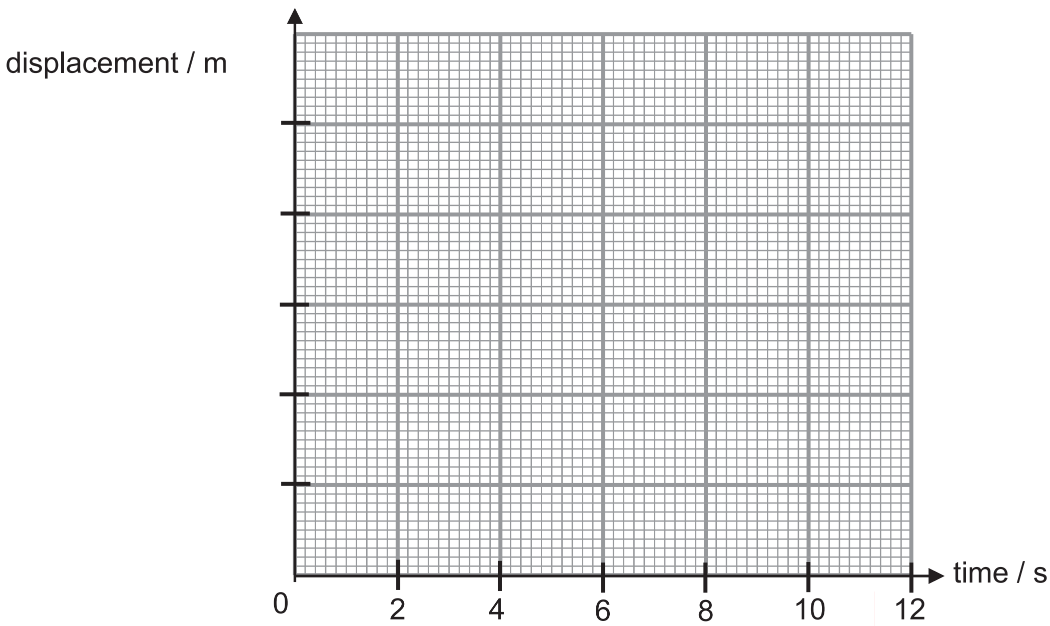


Fig. 1.2

2 Fig. 2.1 shows a bin with a foot pedal mechanism to lift the bin cover. The movable link rotates about the link pivot. When downward force is applied on the foot pedal at the left side of movable link, the movable link pushes the rod at A. The rod at B will push and lift the bin cover about the cover pivot.

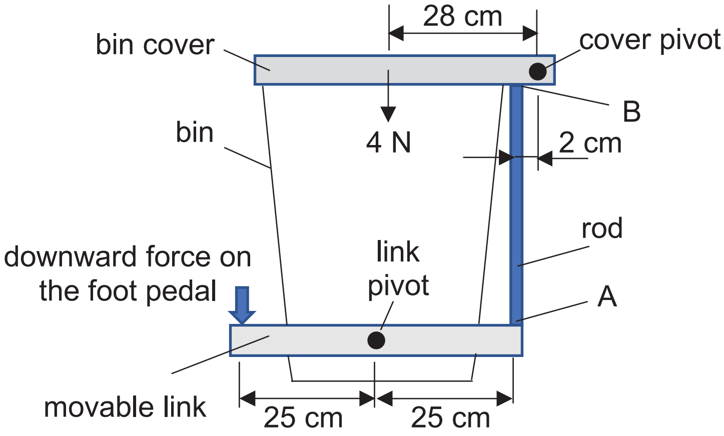


Fig. 2.1

(a) Describe the rotation of the movable link when a downward force is applied at the foot pedal.

………

………[1]

(b) Explain why the rod transmit the same amount of upward force at A as the downward force applied at the foot pedal.

………

………[1]

(c) The bin cover weighs 4 N. The centre of gravity of the bin cover is 28 cm from the cover pivot. The rod at B is 2 cm from the cover pivot.
Calculate the downward force applied at the foot pedal required to just lift the bin cover.

force = …………………….. [2]

(d) Suggest how the distance between rod at B and the cover pivot should be changed to reduce the amount of force to lift the bin cover.

………

………[1]

[Total:5]

[Turn over

3 **(a)** Draw, in the space below, a simple mercury barometer. Use the diagram to describe how it is used to measure the atmospheric pressure.

....

....

....

....

....

....[3]

(b) Fig. 3.1 shows a dropper and a beaker of water.
Explain, in terms of air pressure, how water is obtained from the beaker by the dropper.

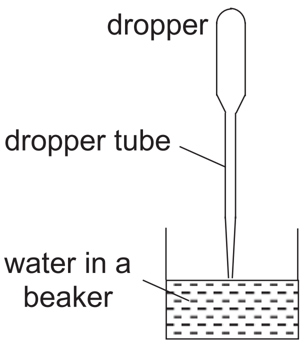


Fig. 3.1

....

....

....

....

....[2]

[Total:5]

4 Fig. 4.1 shows a beaker of water placed in a freezer. The maximum power of the freezer that can be supplied to the water is 150 W. The beaker contains 250 g of water initially at 30 °C. The specific heat capacity of water is 4.2 J / g °C and specific latent heat of fusion of water is 334 J / g.

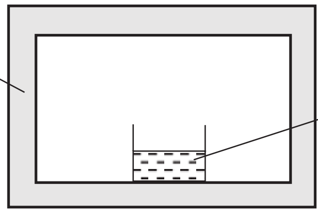


Fig. 4.1

(a) Explain what is meant by

specific heat capacity, : ………………………………………………………………………………

……

……

specific latent heat of fusion. : ………………………………………………………………………..

……

……[2]

(b) Assume that there is no change of state for water and specific heat capacity of the beaker is negligible. Calculate the time taken to cool the water in the beaker to ice point.

time = ……………………… [2]

(c) Calculate the mass of ice produced if the beaker of water at 0 °C is kept in the freezer for another minute.

mass of ice = ……………………… [2]

[Total:6]

[Turn over

5 Fig. 5.1 shows two men standing at points P and Q. Both men are facing towards a wall. A sound is made by the man at Q and the man at P heard it 2.5 seconds later.

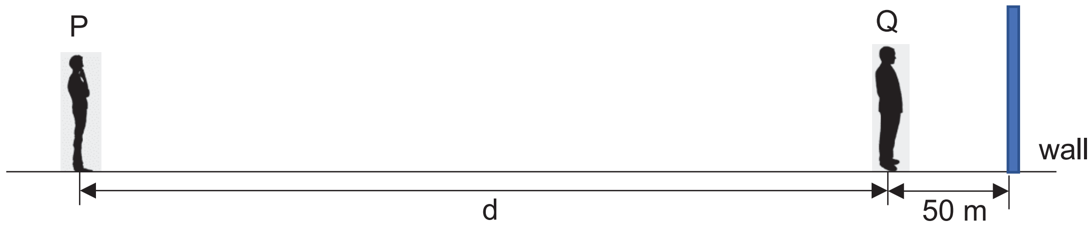


Fig. 5.1

(a) Calculate the distance d between the men at points P and Q if the speed of sound in air is 330 m / s.

d = ……………………… [1]

(b) Calculate the time for the second sound to reach the man at point P if the man at point Q is 50 m in front of a wall.

time = ……………………… [2]

(c) Fig. 5.2 shows a scaled diagram (1 cm representing 0.1 m) of the sound produced by the man at Q. The dots represent the air particles displaced from the equilibrium position represented by vertical lines.

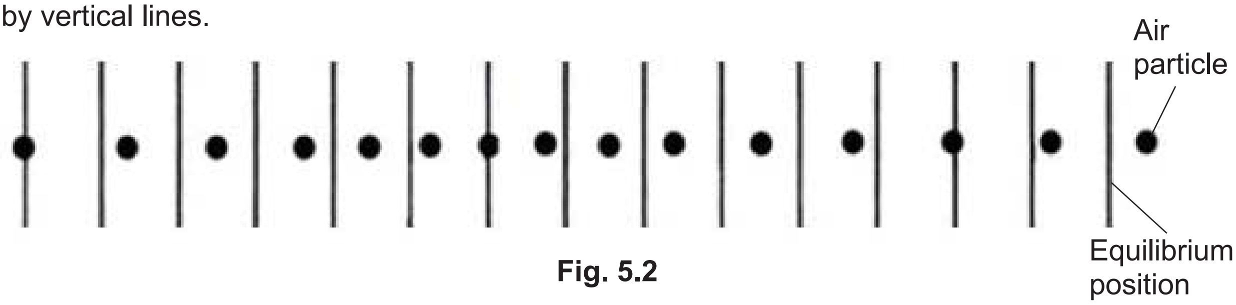


Fig. 5.2

(i) Determine the actual amplitude of the sound.

amplitude = ……………………… [1]

(ii) Determine the actual wavelength of the sound.

wavelength = ……………………… [1]

(iii) Hence, calculate the frequency of the sound.

frequency = ……………………… [1]

[Total:6]

6 Fig. 6.1 shows a positively charged plastic rod held in place on a metal retort stand. One end of the plastic rod is attracting small bits of uncharged paper on a tabletop.

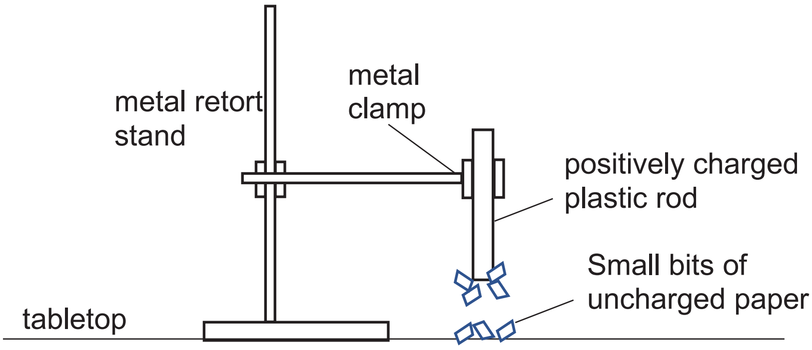


Fig. 6.1

(a) Explain why the positively charged plastic rod is clamped by the metal clamp and retort stand without losing its charges.

....

....

....[1]

(b) Explain how a small bit of uncharged paper is attracted to the positively charged plastic rod.

....

....

....

....

....[2]

(c) State what is meant by an electric field and how the direction is determined.

....

....

....

....

....[2]

[Total:5]

[Turn over

7 Fig. 7.1 shows a circuit diagram. The lamp P has a resistance of 25 Ω. The thermistor Q has a resistance of 10 Ω when the surrounding temperature is high and 200 Ω when the surrounding temperature is low.

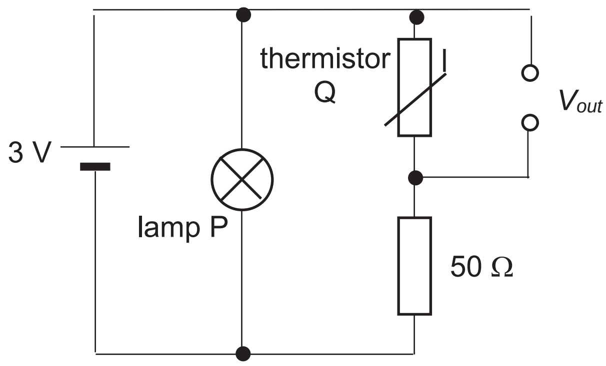


Fig. 7.1

(a) Calculate the current flowing in the battery when the surrounding temperature is low.

current = ……………………… [2]

(b) Calculate V_{out} when the surrounding temperature is high.

V_{out} = ……………………… [2]

(c) State and explain whether the brightness of the lamp will change when the surrounding temperature changes.

……………………………………………………………………………………………

……………………………………………………………………………………………

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

[Total:6]

8 Fig. 8.1 shows a toaster connected to the mains supply with a three-pin plug

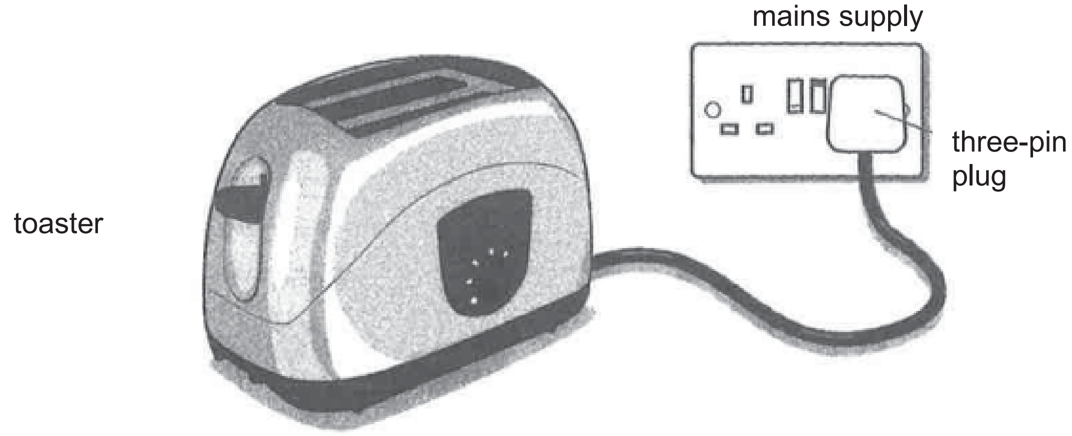

Fig. 8.1

(a) Explain why a three-pin plug is necessary to connect the toaster to the main supply.

....

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....

....

....[2]

(b) The plug has a fuse.
Explain the function of the fuse and how it is connected to the mains supply.

....

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....

....

....[2]

(c) The toaster is rated 2000 W and the mains supply is 240 V.
Determine a suitable fuse for the toaster. The available fuses are 1 A, 3 A, 5 A, 7 A, 10 A and 13 A.

fuse selected = ... [2]

[Total:6]

[Turn over

9 Fig. 9.1 shows two permanent bar magnets placed near each other.

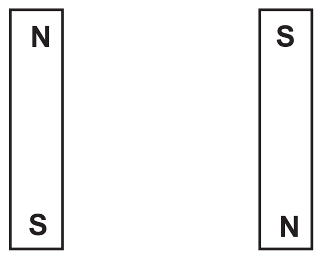

Fig. 9.1

(a) Draw on Fig. 9.1, the magnetic field lines around the two permanent bar magnets. [2]

(b) Explain why steel is a suitable material to make a permanent bar magnet while iron is suitable as an electromagnet.

....

....

....

....

....[2]

(c) Describe, with an aid of a suitable diagram, what is induced magnetism.

....

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....

....

....[2]

[Total:6]

Section B (30 marks)
Answer **all** the questions in this section.
Answer only **one** of the two alternative questions in **Question 12**.

10 **(a)** Fig. 10.1 shows a solar cell placed outdoors in the sun. A ray of light is drawn incident on the solar cell.

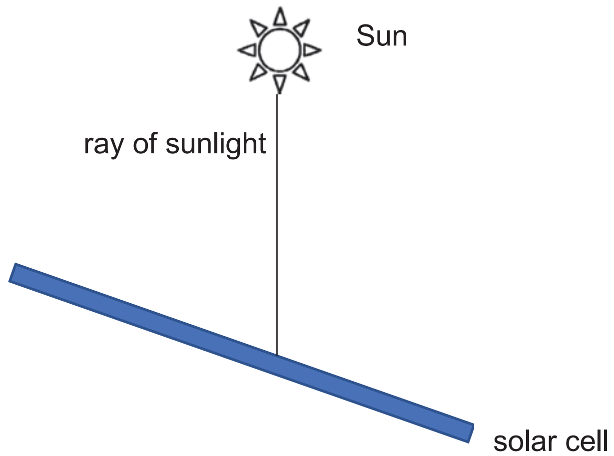

Fig. 10.1

Five similar solar cells (A, B, C, D, E) are placed at five different angles of incidence and the power produced by the solar cells are recorded in Table 10.2 for two days.

Table 10.2

		day 1	day 2
solar cell	angle of incidence / °	power produced / W	power produced / W
A	15	0.765	0.680
B	30	0.723	0.598
C	45	0.640	0.483
D	60	0.525	0.423
E	75	0.403	0.333

(i) Complete Fig. 10.1 by including the normal line and the angle of incidence for the ray of light shown. Label the angle of incidence *i*. [1]

(ii) Using the data from Table 10.2, describe and explain the relationship between the angle of incidence and power produced.

....

....

....

....

....[2]

[Turn over

(iii) If a sixth solar cell is available, deduce the angle of incidence that it should be placed to obtain the maximum power produced.

....

....

....[1]

(iv) The data collected on Table 10.2 for both days are taken at the same time of the day and same location.
Suggest a reason for the difference in power produced by the solar cells.

....

....

....[1]

(d) Fig. 10.3 shows a glass prism. A ray of light is incident on the glass prism. The glass prism has a refractive index of 1.52.

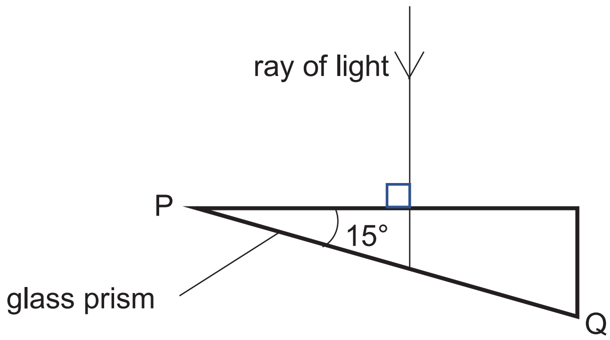

Fig. 10.3

(i) Calculate the critical angle of the glass prism.

critical angle of glass prism = ... [1]

(ii) Complete Fig. 10.3 by continuing the ray of light incident on surface PQ of the glass prism. Determine the angle of refraction if any. [2]

(iii) Fig. 10.4 shows two glass prisms X and Y of the same refractive index but with different angles.

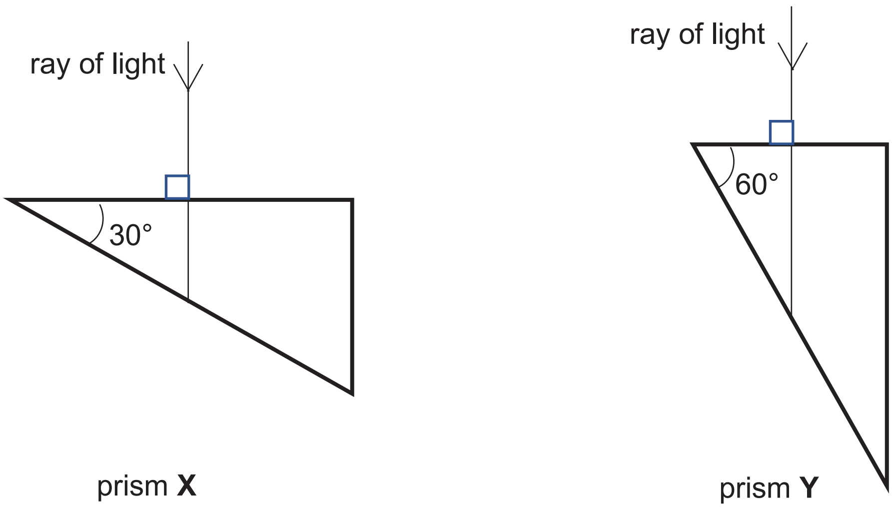

Fig. 10.4

State which prism, if any, would the ray of light be totally internal reflected. Explain your answer.

....

....

....

....

....[2]

[Total:10]

[Turn over

11 **(a)** Fig. 11.1 shows a man pulling a rope tied to a box. The box has a mass of 12 kg. The box moves from rest to 0.8 m / s in 5 s. The friction acting against the box is 60 N.

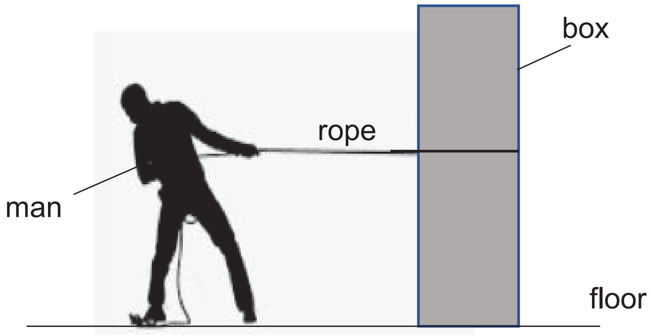

Fig. 11.1

(i) Calculate the acceleration of the box.

acceleration = ………………… [1]

(ii) Calculate the force exerted by the man on the rope to move the box in the first five seconds.

force applied = ………………… [2]

(iii) Calculate the work done to move the box for 7 m at constant speed of 0.8 m / s. Assume friction acting against the box is constant.

work done = ………………… [2]

(b) Fig. 11.2 shows a ball at the top of a 4 m high slope. The ball has a mass of 50 g. It moves down the frictionless slope from rest.

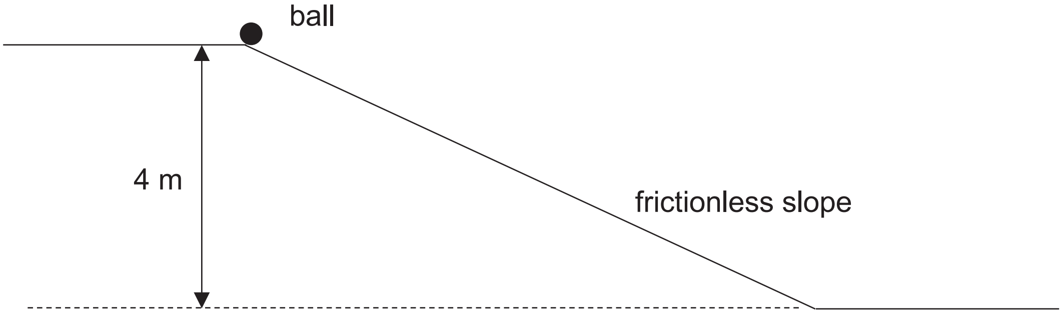

Fig. 11.2

(i) Calculate the height of the ball on the slope when the gravitational potential energy and the kinetic energy of the ball are the same.

height of ball = ………………… [2]

(ii) Calculate the speed of the ball when it reaches the bottom of the slope.

speed of ball = ………………… [2]

(iii) State whether the speed of the ball depends on the mass of the ball.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

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

[Total:10]

[Turn over

12 EITHER

(a) Fig.12.1 shows a relay switch used to operate an electric motor.

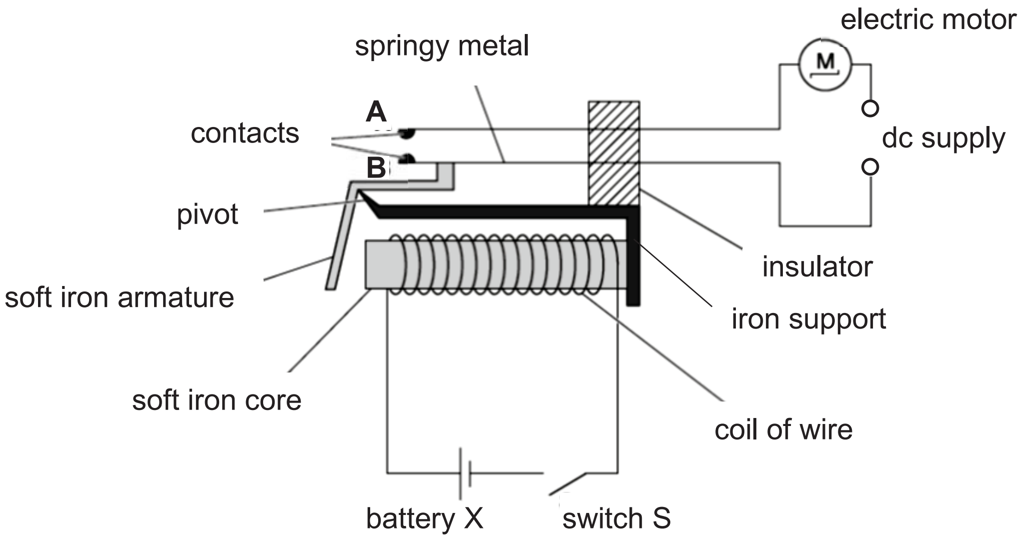

Fig. 12.1

(i) Explain, in terms of its magnetic properties, why the support is made of iron.

....

....

....[1]

(ii) Describe how the relay turns on the electric motor when the switch S is closed.

....

....

....

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....

....

....[3]

(iii) Describe the changes that would occur if the polarity of the battery X next to switch S is reversed.

....

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....[1]

(b) Fig. 12.2 shows part of a single-coil motor.

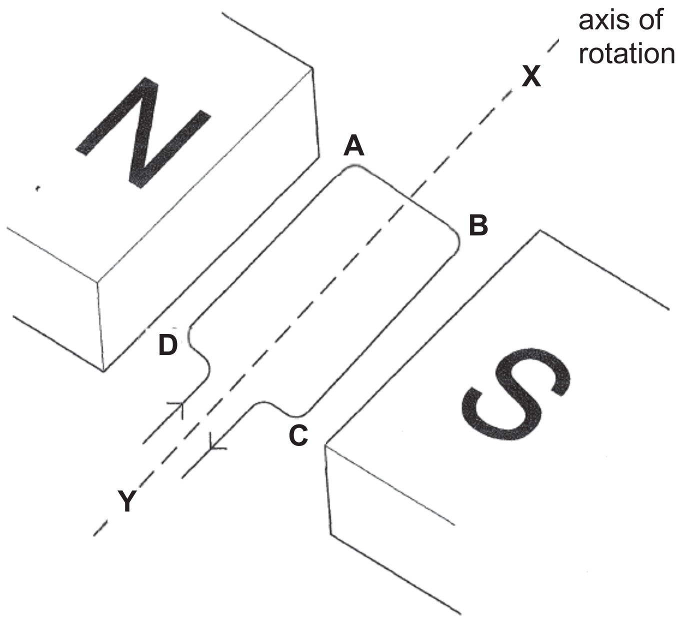

Fig. 12.2

(i) If the direction of current flow in the coil is from A to B to C and D, state the direction of rotation of the coil about axis of rotation XY.

....

....[1]

(ii) Complete Fig. 12.2 by adding the main parts of the motor and external electrical circuit. [2]

(iii) Describe **two** ways to increase the turning effect of the motor.

....

....

....

....

....[2]

[Total:10]

[Turn over

12 OR

(a) Fig. 12.3 shows a permanent magnet hanging on a spring. The poles of the magnet are oscillating vertically. A conducting wire is placed between the oscillating poles. The conducting wire is connected to a sensitive galvanometer.

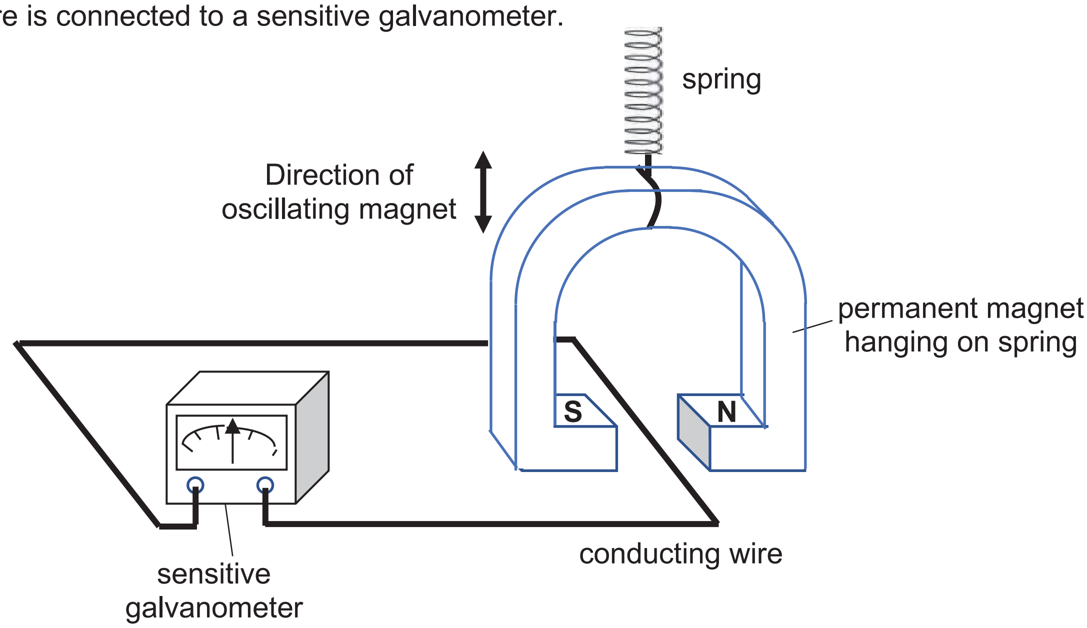

Fig. 12.3

(i) Explain why the needle of the sensitive galvanometer is oscillating about its zero position

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....

....

....

....

....

....[3]

(ii) Draw on Fig. 12.3, arrows to show the direction of current flow in the conducting wire when the magnet is moving upwards. [1]

(iii) If the sensitive galvanometer is replaced by a lamp, explain why the light given out by the lamp would not be suitable for reading.

....

....

....[1]

(b) Fig. 12.4 shows a simple electrical power distribution from a power station to homes.

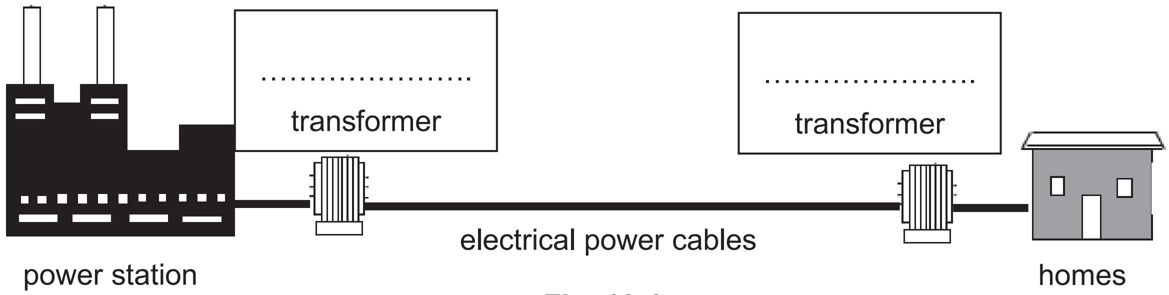

Fig. 12.4

(i) Complete the blanks in Fig. 12.4 by naming the type of transformer located after the power station and before electrical supply reaches the homes. [1]

(ii) Explain the function of these two transformers in terms of distribution of electrical supply.

……………………………………………………………………………………………………

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……………………………………………………………………………………………………

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

(iii) With the aid of a simple labelled diagram of a transformer, describe the structure and principle of operation of a simple iron-core transformer.

……………………………………………………………………………………………………

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

[Total:10]

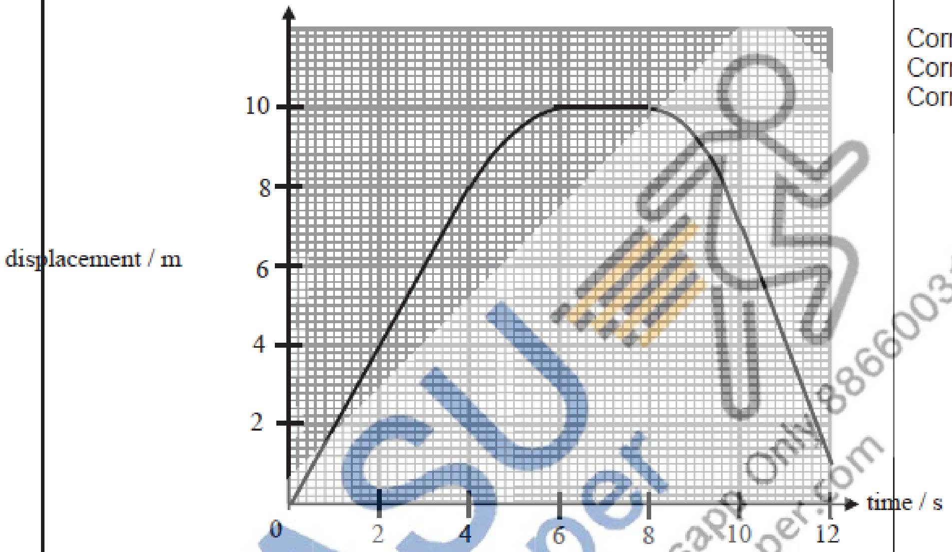
End of Paper

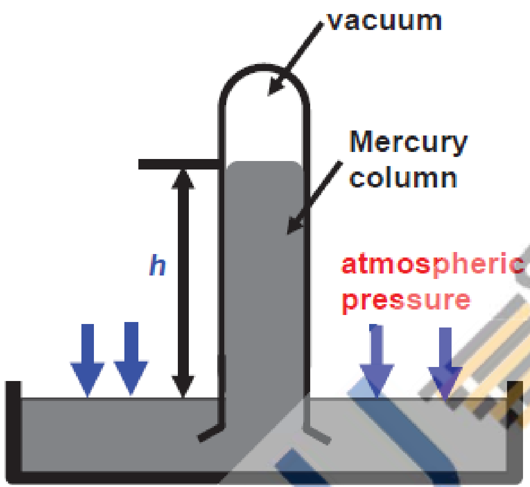
Jurongville Secondary School
Science Department 2022
Marking Scheme

Assessment: **Physics Preliminary Examinations** **Level:** **Sec 4 Exp**

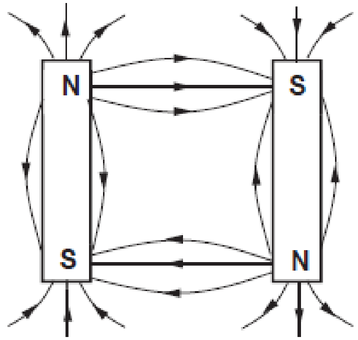
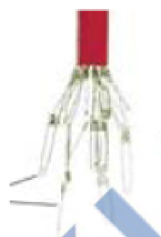
Paper 1

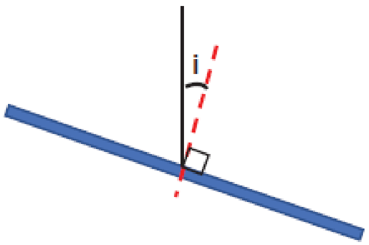
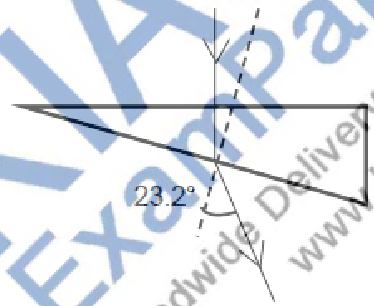
Qn	Ans	Qn	Ans	Qn	Ans	Qn	Ans	Qn	Ans	Qn	Ans	Qn	Ans	Qn	Ans	Qn	Ans	Qn	Ans
1	A	2	D	3	C	4	C	5	B	6	B	7	B	8	B	9	D	10	B
11	C	12	A	13	C	14	B	15	A	16	D	17	C	18	B	19	C	20	C
21	A	22	B	23	A	24	D	25	D	26	B	27	A	28	D	29	D	30	A
31	A	32	A	33	C	34	C	35	D	36	D	37	D	38	C	39	A	40	B

Qn	Marking Scheme	Remarks	Marks
1(a)	Displacement = Area under velocity-time graph	Correct working	C1
1(b)	= ½ (2 x 2) + (2 x 4) = 10 m	Correct answer	A1
		Correct scale for y-axis Correct straight line Correct curve	B1 B1 B1
2(a)	The **movable link will rotate anticlockwise** about the link pivot when a downward force is applied at the foot pedal.	OWTTE	B1
(b)	The rod transmits the same amount of force at A because the **perpendicular distance to the pivot between the forces at both ends is equal**.	OWTTE	B1
(c)	CW moments = ACW moments F x 2 = 4 x 28 F = 4 x 28 / 2 = 56 N	Correct working Correct answer	C1 A1
(d)	The **distance between rod at B and the cover pivot should be increased** to reduce the amount of force to lift the dust bin cover.	OWTTE	B1
3(a)	The barometer has a region above the mercury column that is a **vacuum which has zero pressure**. The atmospheric pressure is determined by measuring the **height of mercury column from the surface of mercury reservoir *h***. By **applying the formula – pressure = density of mercury x gravitational field strength x height of mercury column**, the atmospheric pressure is calculated.	OWTTE	B1 B1

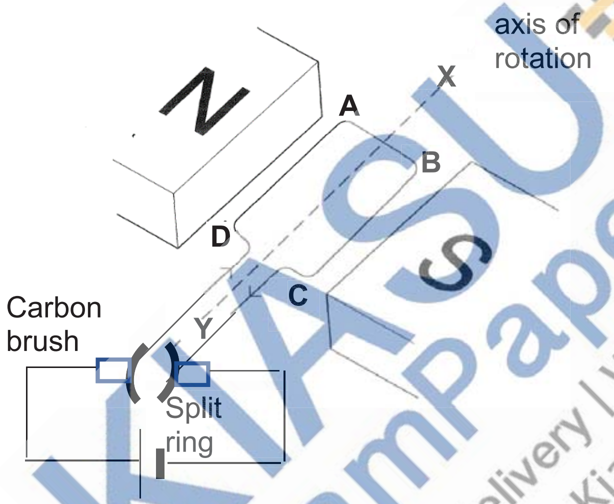
Qn	Marking Scheme	Remarks	Marks
		Labelled diagram for barometer	B1
(b)	The dropper is pressed at the top to expel the air and thus the inner dropper tube becomes a lower pressure region than the outside. Air atmospheric pressure acting at the water surface will push the water into the dropper tube.	OWTTE	B1 B1
4(a)	Specific heat capacity of a substance is the amount of thermal energy required to raise the temperature of a unit mass of the substance by 1K or 1 °C. Specific latent heat of fusion of a substance is the amount of thermal energy required to change unit mass of the substance from solid to liquid or vice versa without any change in temperature.	OWTTE	B1 B1
(b)	$Q = m c \Delta\theta$ $150 \times t = 250 \times 4.2 \times (30 - 0)$ $t = 31\ 500 / 150 = 210$ s	Correct working Correct answer	C1 A1
(c)	$Q = m\, l_f$ $150 \times 60 = m \times 334$ $m = 9000 / 334 = 26.9$ g	Correct working Correct answer	C1 A1

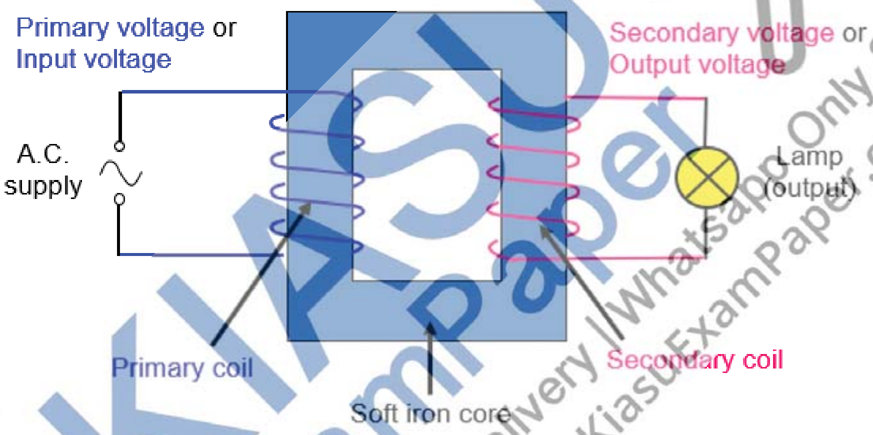
Qn	Marking Scheme	Remarks	Marks
5(a)	Distance = speed x time = 330 x 2.5 = 825 m	 Correct working Correct answer	 B1
(b)	Time = distance / speed = 2.5 + (50 x 2) / 330 = 2.80 s	 Correct working Correct answer	 C1 A1
(c)	(i) 0.6 x 0.1 = 0.06 m (ii) 12 x 0.1 = 1.2 m (iii) Frequency = speed of wave / wavelength = 330 / 1.2 = 275 Hz	Accept 0.05 – 0.07 m Accept 1.19 – 1.21 m Correct working Correct answer	B1 B1 B1
6(a)	**Plastic is an insulator and electrons are not easily moved** from the metal clamp to the plastic rod.	OWTTE	B1
(b)	The **uncharged paper has electrons** that will be **attracted to the positively charged plastic rod as unlike charges attract**.	OWTTE	B1 B1
(c)	An electric field is a **region where an electric charge experiences an electric force**. It is determined by the **direction that a positive test charge would move in the electric field**.	OWTTE	B1 B1
7(a)	Effective resistance when surrounding temperature is low $= [1 / 25 + 1 / (200 + 50)]^{-1} = 22.7\ \Omega$ Current in battery = 3 / 22.7 = 0.132 A	 Correct working Correct answer	 C1 A1
(b)	$V_{out} = [10 / (50 + 10)] \times 3$ = 0.5 V	Correct working Correct answer	C1 A1
(c)	The **brightness of the lamp will not change** when the surrounding temperature changes. This is because the **lamp is connected in parallel to the battery and current flow in the lamp is not affected by changes in resistance of the thermistor**.	OWTTE	B1 B1
8(a)	The three-pin plug is necessary because **the toaster has exposed metal parts**. If there is a fault, the metal parts may become live and the **earth wire in the three-pin plug will provide a low resistance path for current to flow and protect the user**.	OWTTE	B1 B1
(b)	The fuse has a resistance wire that only allows certain amount of current to flow through it. It will **melt and stop current flow if current exceed the allowed current in the fuse**. It is **connected in the live wire**.	OWTTE	B1 B1
(c)	Current = Power / Voltage = 2000 / 240 = 8.33 A The 10 A fuse is selected as it is slightly above 8.33 A	Correct working Correct answer	B1 B1

Qn	Marking Scheme	Remarks	Marks
9(a)		Correct pattern Correct arrow direction	B1 B1
(b)	**Steel does not lose magnetism easily once it is magnetized** and thus good as a permanent magnet.	OWTTE	B1
	Iron can be easily magnetized and loses magnetism easily and thus good as an electromagnet.		B1
(c)		Suitable diagram	B1
	Induced magnetism occurs when a magnetic material is magnetized by a magnet and is able to attract other magnetic material.	OWTTE	B1
			Total: 50

Qn	Marking Scheme	Remarks	Marks
10(a)	(i) 	Correct normal line drawn Correct angle of incidence with label i	B1
	(ii) The power produced **is inversely related to the angle of incidence**. This is because **more sunlight is incident on the solar cell when the angle of incident is smaller**.	OWTTE	B1 B1
	(iii) Maximum power will be produced if the solar cell is placed when angle of incidence is 0°.	OWTTE	B1
	(iv) It could be that day 2 is more cloudy and less sunlight is incident on the solar cell.	Any suitable answer	B1
(b)	(i) Critical angle = $\sin^{-1}(1/n)$ $= \sin^{-1}(1/1.52) = 41.1°$	Correct working Correct answer and unit	B1
	(ii) $n_i \sin i = n_r \sin r$ $1.52 \times \sin 15° = 1 \times \sin r$ Angle of refraction = $\sin^{-1}(0.3934) = 23.2°$	Correct working Correct answer and unit	B1
		Correct path for ray of light	B1
	(iii) Light will be totally internal reflected **in prism Y** because the **angle of incidence is 60° is greater than critical angle**.		B1 B1

Qn	Marking Scheme	Remarks	Marks
11(a)	(i) Acceleration = (v – u) / t		
	= (0.8 – 0) / 5	Correct working	
	= 0.16 m/s^2	Correct answer and unit	B1
	(ii) F = ma	Allow for e.c.f. in (i)	
	Applied force – 60 = 12 x 0.16	Correct working	C1
	Applied force = 1.92 + 60 = 61.9 N (3 s.f.)	Correct answer and unit	A1
	(iii) Work done = force x distance moved		
	= 60 x 7	Correct working	C1
	= 420 J	Correct answer and unit	A1
(b)	(i) Gravitational energy at top of slope = m g h		
	= (50 / 1000) x 10 x 4		
	= 2 J		
	Height of ball when it has the same amount of gravitational potential energy and kinetic energy is when it has 1 J of GPE	Correct answer Suitable explanation	B1 B1
	That occurs at height 2 m on the slope.		
	(ii) Kinetic energy at bottom of slope = ½ m v^2		
	2 = ½ x (50 / 1000) v^2	Correct working	C1
	Speed = √ 80 = 8.94 m / s (3 sf)	Correct answer and unit	A1
	(iii) **Speed of ball does not depend on mass of the ball**.	OWTTE	B1

Qn	Marking Scheme	Remarks	Marks
12E(a) (i)	The support is made of iron so that **magnetic field is shielded so that the soft iron armature is attracted at the end of the soft iron core only**.	OWTTE	B1
(ii)	When the switch is closed, the **soft iron core becomes an electromagnet**. It **attracts the soft iron armature and the soft iron armature rotates anticlockwise** pushing **contact B and A together. The circuit closes and electric motor is turned on**.	OWTTE	B1 B1 B1
(iii)	If the polarity of the battery is reversed, the **magnetic poles of the soft iron core is also reversed**.	OWTTE	B1
E(b) (i)	The coil is **rotating anticlockwise** about XY axis.	OWTTE	B1
(ii)		Battery (DC supply with correct polarity), split ring and carbon brush must be added to the diagram Label parts correctly	B1 B1
(iii)	The turning effect of the motor can be increased by increasing the voltage and by increasing the number of turns in the coil.	Any suitable answer	B1 B1

Qn	Marking Scheme	Remarks	Marks
12O(a) (i)	The needle of the galvanometer is oscillating about its zero position because the **permanent magnet is oscillating, and magnetic field is changing near the conducting wire. Induced emf is generated to oppose the changing magnetic field felt by the conducting wire.**	OWTTE	B1 B1 B1
(ii)	**Arrow indicating out of the paper**	CAO	B1
(iii)	**The brightness of the lamp is not of the same brightness all the time.**	OWTTE	B1
(b) (i)	**Step-up transformer, step-down transformer**	CAO	B1
(ii)	**Step-up transformer increases the voltage in the transmission line while step-down transformer decreases the voltage supply to the homes. This would reduce power losses in the transmission wires.**	OWTTE	B1 B1
(iii)	 **The AC supply produces a changing magnetic field at the primary coil. This causes the secondary coil to induce emf to oppose the changing magnetic field. The difference in turns in the primary coil and secondary coil will cause the primary voltage and secondary voltage to be different.**	Suitable labelled diagram OWTTE	B1 B1
			Total: 40

Candidate Name: ____________________________ (   ) Class: _______

4E
Session 3

KRANJI SECONDARY SCHOOL
Preliminary Examination
Secondary 4 Express

PHYSICS **6091/01**
Paper 1 Multiple Choice

Wednesday **31 August 2022** 1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, papers clips, glue or correction fluid.
Write your name and index number on the Answer Sheet in the spaces provided unless this has been done for you.

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 to be correct and record your choice in **soft pencil** on the separate 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.

Set by: Ms Jennifer Teo

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

[Turn over

1 Fig. 1.1 shows the reading of a micrometer screw gauge when the spindle is totally closed.

Fig. 1.2 shows the reading of the same micrometer screw gauge when it measures the diameter of a wire.

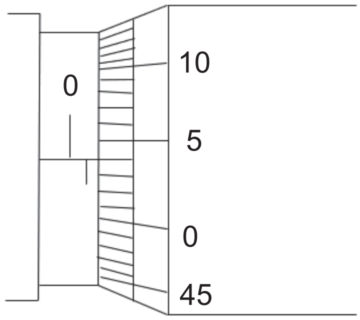


Fig. 1.1

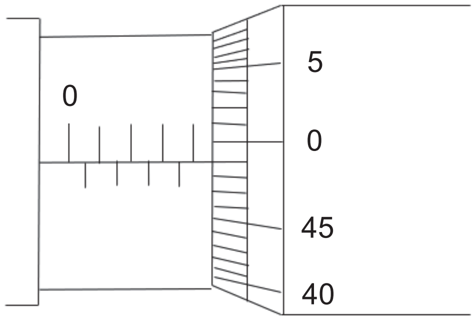


Fig. 1.2

What is the diameter of the wire?

A 3.95 mm **B** 4.45 mm **C** 4.53 mm **D** 5.03 mm

2 Two vector quantities are added to produce a resultant.

Which statement about the resultant is correct?

A It may sometimes be a scalar quantity.

B It may sometimes be zero.

C Its direction is always different from the directions of the two original vectors.

D Its magnitude is always different from the magnitudes of the two original vectors.

3 A car decelerates at a constant rate from 6.0 m/s to v m/s for 2.0 s. It covers a distance of 10 m during the deceleration.

How much longer will it take the car to come to rest if it continues to decelerate at the same constant rate?

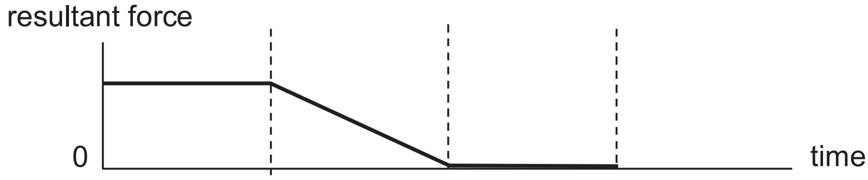
A 2.0 s **B** 3.0 s **C** 4.0 s **D** 5.0 s

4 The cable of a crane is used to lift a load of mass 500 kg. The cable exerts a force of 7 500 N on the load.

What is the acceleration of the load?

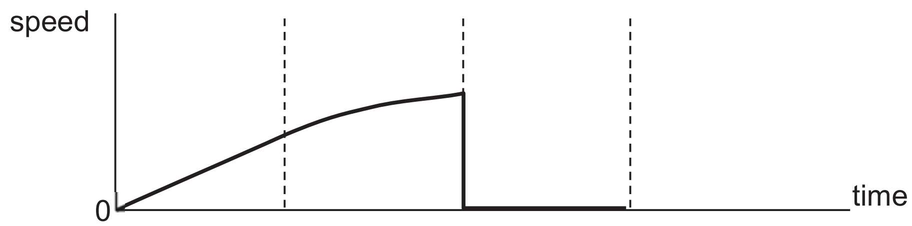
A 5.0 m/s^2 **B** 10 m/s^2 **C** 15 m/s^2 **D** 25 m/s^2

5 The graph below shows how the resultant force acting on an object varies with time.

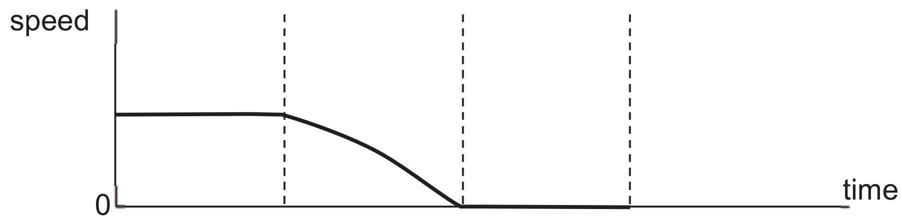


Which graph correctly shows how the speed of the object varies with time?

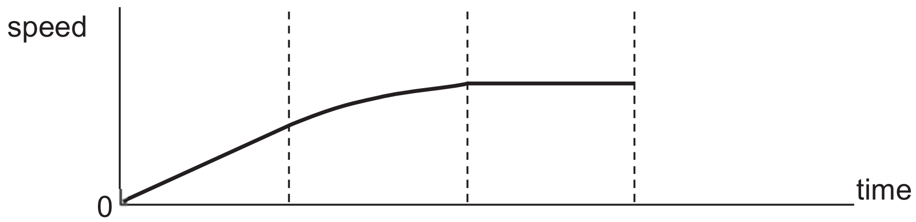
A



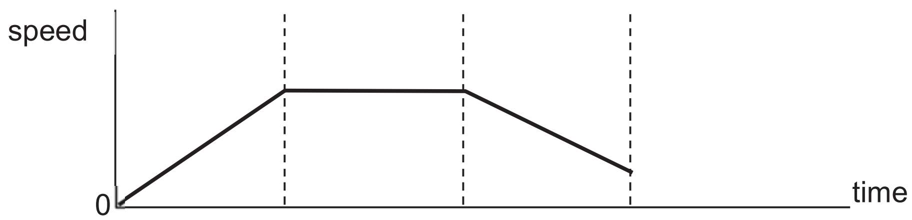
B



C



D



6 Two copper spheres P and Q are at rest on a frictionless surface.

The same force F acts on sphere P and on sphere Q for the same time t.

The volume of sphere Q is less than that of sphere P.

Which quantity is the same for both spheres?

A density

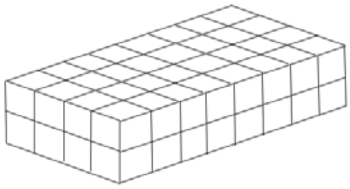
B kinetic energy gained

C weight

D inertia

[Turn over

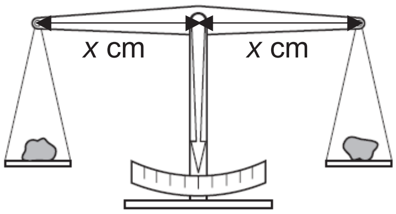
7 64 identical small cubes are arranged in a 8 × 4 × 2 block to form a big rectangular block. Each small cube has a density of ρ.



If 16 small cubes are removed from the top layer of the rectangular block, what is the density of the remaining block consisting of 48 small cubes?

A ρ **B** $\frac{48}{64}\rho$ **C** $\frac{64}{48}\rho$ **D** $\frac{80}{64}\rho$

8 The diagram shows two objects on a beam balance in equilibrium.



Which of the following need **not** be the same?

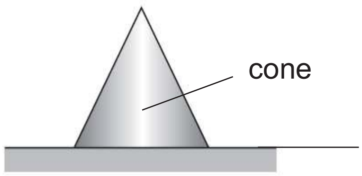
A the masses of the two objects

B the moments about the pivot of the two objects

C the volumes of the two objects

D the weights of the two objects

9 A metal cone with a circular base is placed on a flat surface.



The stability of the cone depends on

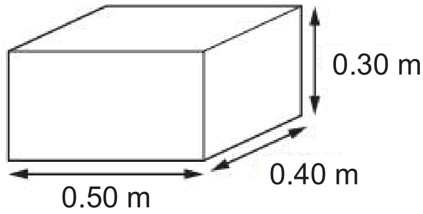
A its weight and the position of its centre of gravity.

B the diameter of its base and the position of its centre of gravity.

C the diameter of its base only.

D the position of its centre of gravity only.

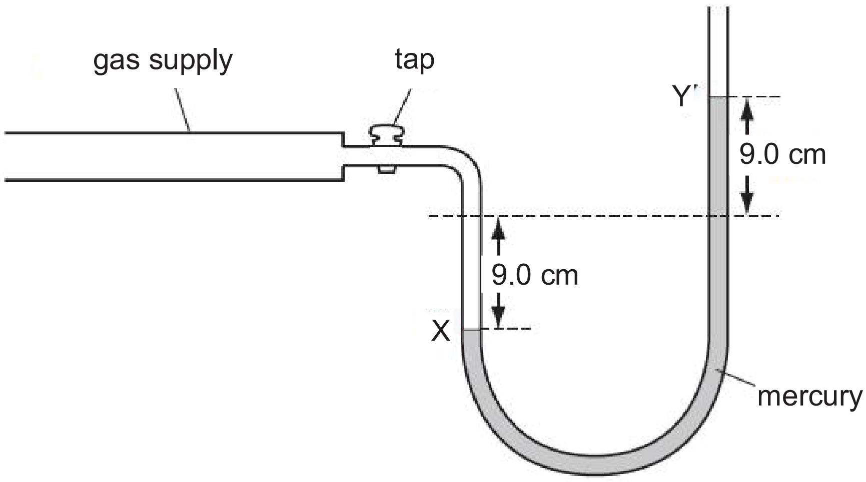
10 The diagram shows the lengths of the sides of a block. The block can rest on any of its faces.



What is the weight of the block if the minimum pressure it can exert is 50 Pa?

A 5.0 N **B** 6.0 N **C** 7.5 N **D** 10 N

11 The diagram shows the level X and Y in a liquid manometer connected to a gas supply.



What is the pressure of the gas supply?

A 9 cmHg above atmospheric pressure

B 9 cmHg below atmospheric pressure

C 18 cmHg above atmospheric pressure

D 18 cmHg below atmospheric pressure

12 A fish swims at a depth of 8.0 m below the surface of a lake.

The atmospheric pressure is 1.0×10^5 Pa.

The density of the water is 1000 kg/m^3 and the gravitational field strength, g is 10 N/kg.

What is the total pressure acting on the fish at this depth?

A 2.0×10^4 Pa **C** 1.1×10^5 Pa

B 8.0×10^4 Pa **D** 1.8×10^5 Pa

[Turn over

13 Four cars start from rest and are driven along a road.

The table shows the maximum speed achieved and the time taken to achieve the maximum speed.

Which engine produces the highest average power?

	maximum speed / km/h	time / s
A	80	10
B	80	20
C	120	10
D	120	20

14 What happens to the molecules of mercury when it freezes?

A They attract each other more strongly.

B They get smaller.

C They slow down.

D They stop moving.

15 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 they hit each other harder.

16 A beaker of water is heated at the bottom to form a convection current in the water.

An explanation of convection current contains four statements.

1 The water at the bottom becomes warmer.

2 The density of the water decreases.

3 Less dense water rises and cold water moves in to replace it.

4 The water expands.

Which option shows the correct order?

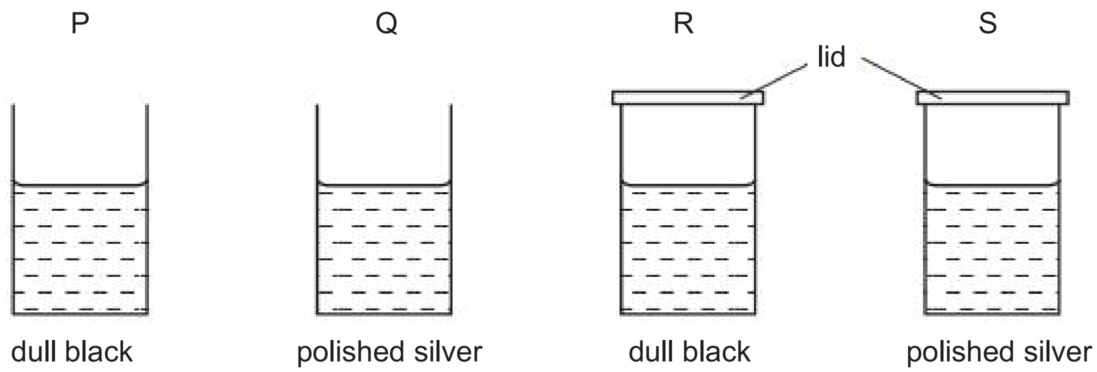
A $1 \rightarrow 2 \rightarrow 3 \rightarrow 4$

B $1 \rightarrow 3 \rightarrow 4 \rightarrow 2$

C $1 \rightarrow 4 \rightarrow 2 \rightarrow 3$

D $1 \rightarrow 4 \rightarrow 3 \rightarrow 2$

17 The diagrams show four identical cans with their outside surfaces painted either dull black or polished silver. Each can contains the same volume of hot water, initially at 90°C.



After five minutes in a cool room, which can contains the hottest water and which can contains the coolest water?

	hottest	coolest
A	R	Q
B	R	P
C	S	Q
D	S	P

[Turn over

18 Which physical property **cannot** be used to define a scale of temperature?

A the mass of a column of liquid

B the volume of a gas at a constant pressure

C the electromotive force produced between junctions of wires of different metals

D the resistance of a metal wire

19 A block of copper is at room temperature.

Which row describes a smaller block of copper at the same temperature?

	internal energy	heat capacity	specific heat capacity
A	less	less	same
B	less	same	less
C	same	less	same
D	same	same	same

20 Which changes of state occur as a result of the removal of thermal energy?

A boiling and melting

B boiling and solidification

C condensation and melting

D condensation and solidification

21 Which row gives an example of a longitudinal wave and of a transverse wave?

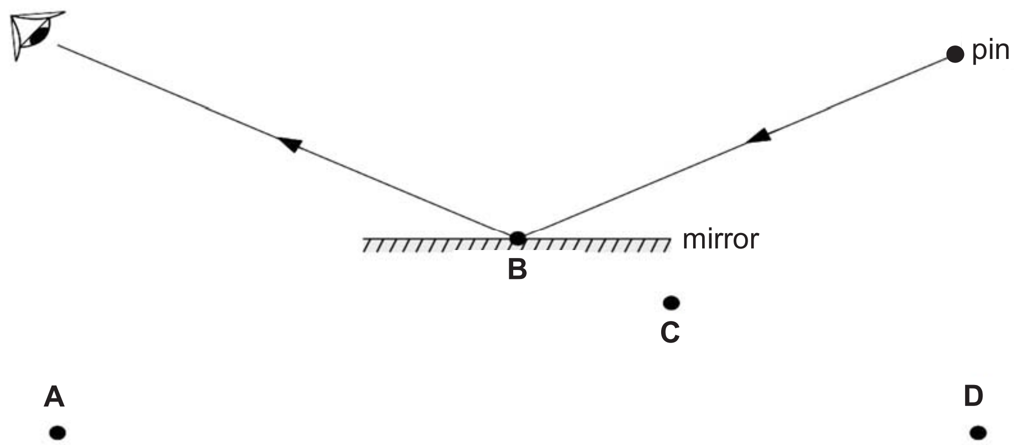
	longitudinal wave	transverse wave
A	light	ultrasound
B	microwaves	radio waves
C	radio waves	microwaves
D	ultrasound	light

22 What happens to the speed, frequency and wavelength of a wave as it is refracted?

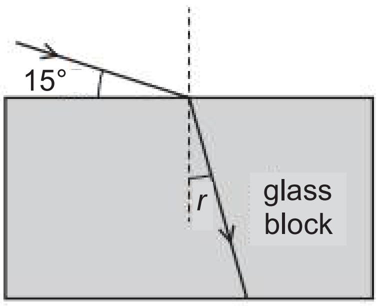
	speed	frequency	wavelength
A	changes	changes	stays the same
B	changes	stays the same	changes
C	changes	stays the same	stays the same
D	stays the same	stays the same	changes

23 A pin is placed in front of a plane mirror as shown.

Where is the image of the pin?



24 Light strikes the top surface of a glass block at an angle of 15° as shown.



(not drawn to scale)

The speed of light in the glass block is approximately 2.0×10^8 m/s.

What is the angle of refraction *r* ?

A 9.9 ° **B** 23 ° **C** 37 ° **D** 40 °

[Turn over

25 Statements 1 and 2 are about signals passing through an optical fibre of refractive index 1.5.

1 The speed of the signal in the optical fibre is 3.0×10^{8} m/s.

2 There is less signal loss in the optical fibre than in a copper cable.

Which statement(s) is/are correct?

A both statements 1 and 2

B neither of the statements

C statement 1 only

D statement 2 only

26 The diagram shows the main sections of the electromagnetic spectrum in order of increasing frequency. Some of the sections are labelled.

radio waves		Q	visible light			gamma ways

lower frequency → higher frequency

The component Q has frequencies below visible light.

What are the electromagnetic waves in component Q used for?

A killing cancerous cells

B satellite television

C sterilisation

D television remote controller

27 A metal plate is oscillating up and down continuously. In 4.0 ms, it moves from the bottom position to the top position.

The oscillation of the plate causes sound waves to be generated in the surrounding air. Sound travels at a speed of 340 m/s.

What is the wavelength of these sound waves?

A 0.37 m **B** 0.74 m **C** 1.4 m **D** 2.7 m

28 A student played two musical notes, X and Y.

The sound waves of X and Y have the same amplitude.

The frequencies of X and Y are 256 Hz and 512 Hz respectively.

A student made the following statements:

1 **Y** has a higher pitch than **X**.

2 **Y** is louder than **X**.

3 The wavelength of **Y** is longer than that of **X**.

Which statements is/are true?

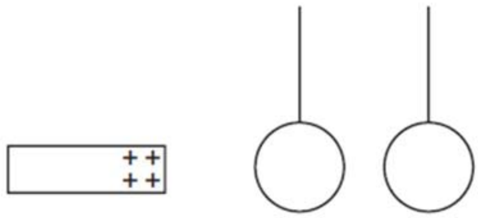
A 1 only

B 3 only

C 1 and 3 only

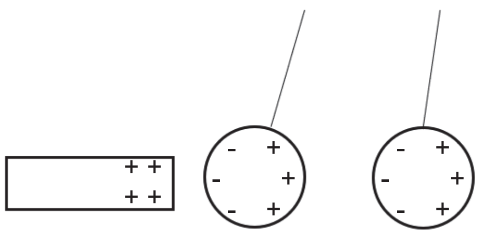
D 2 and 3 only

29 Two uncharged metal spheres, not touching one another, are suspended by means of cotton thread. A positively charged rod is brought near to the spheres as shown in the diagram.

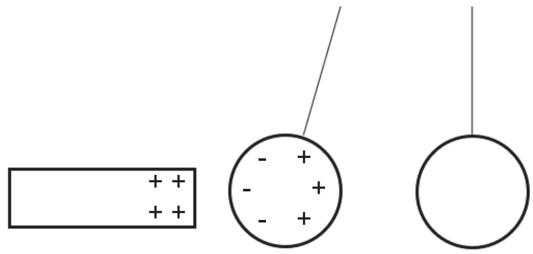


Which diagram shows what happens to the spheres?

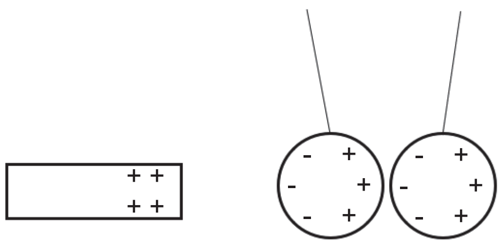
A



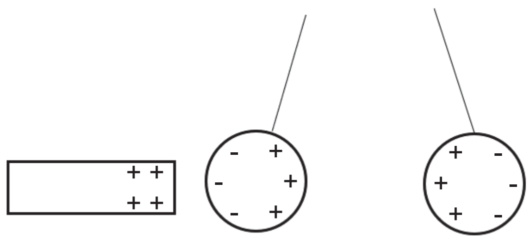
C



B



D



[Turn over

30 A piece of polythene is rubbed with a cloth duster. The polythene becomes negatively charged and the cloth becomes positively charged.

What happens to the polythene and to the cloth to cause this?

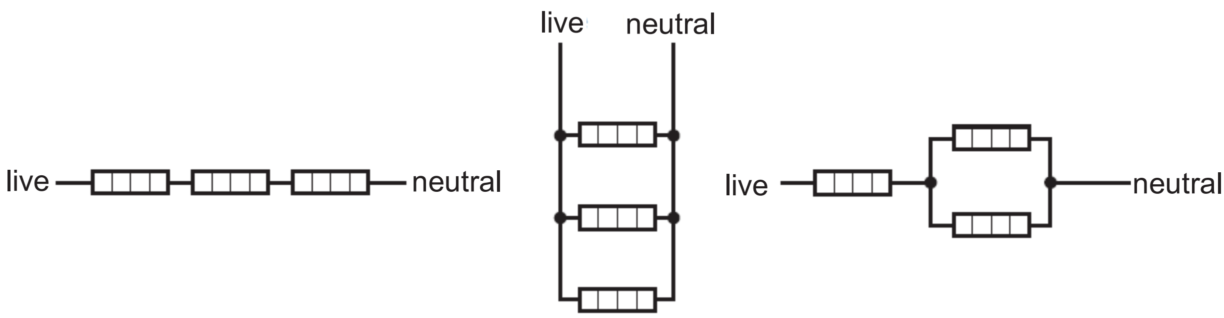
	polythene	cloth
A	gains electrons	gains protons
B	gains electrons	loses electrons
C	loses protons	gains protons
D	loses protons	loses electrons

31 A 12 V car battery is fully charged. It is connected in series to a lamp labelled 12 V, 24 W. The lamp shines at normal brightness for 25 hours.

What is the size of the charge that passes through the lamp in this time?

A 3000 C **B** 45000 C **C** 180000 C **D** 1100000 C

32 Three identical heating elements are wired up to the mains supply in the three arrangements shown.

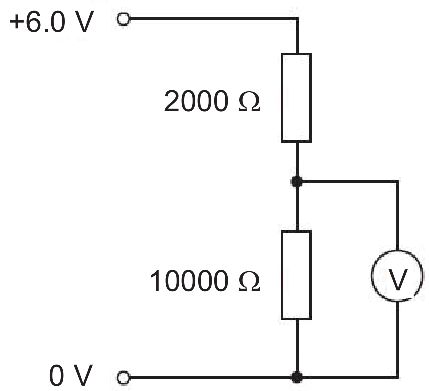


arrangement X arrangement Y arrangement Z

What is order of the resistance values of the arrangements X, Y and Z?

	smallest	$\longrightarrow$	largest
A	X	Y	Z
B	X	Z	Y
C	Y	X	Z
D	Y	Z	X

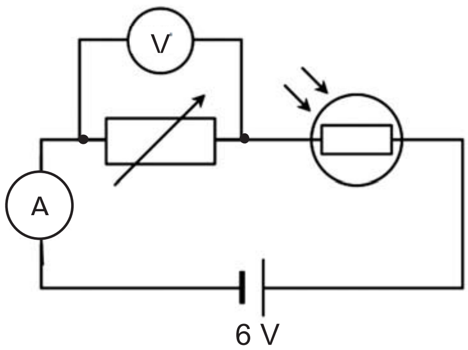
33 The diagram shows a potential divider system of two resistors connected to a 6.0 V power supply.



What is the reading on the voltmeter?

A 1.0 V **B** 1.2 V **C** 2.0 V **D** 5.0 V

34 The diagram below shows a circuit with a variable resistor and light dependent resistor (LDR) connected in series.

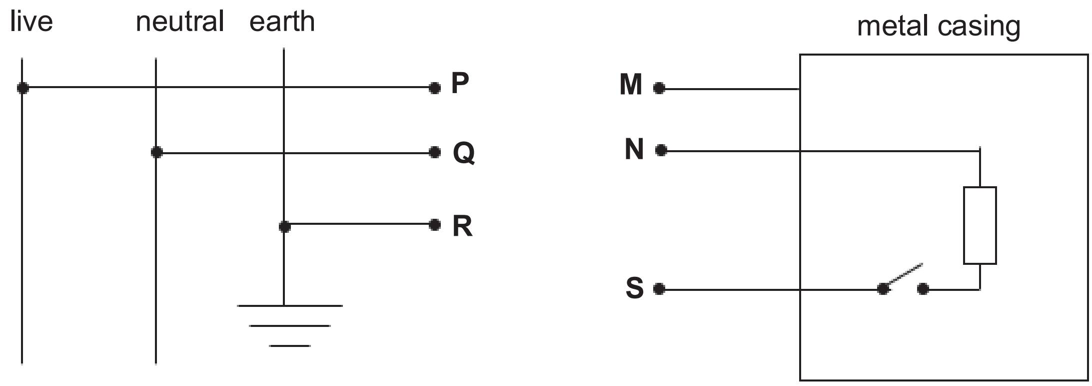


When light shines brightly on the LDR, what will happen to the reading on the ammeter and voltmeter?

	ammeter reading	voltmeter reading
A	increases	increases
B	increases	decreases
C	decreases	increases
D	decreases	decreases

[Turn over

35 The diagram shows an electrical appliance with a metal casing connected to the mains supply.



Which row shows the correct connection of the wires from **P**, **Q** and **R** respectively?

	P	**Q**	**R**
A	N	M	S
B	N	S	M
C	S	M	N
D	S	N	M

36 A current-carrying solenoid is used to demagnetise a bar magnet.

What must be part of the procedure for demagnetising the bar magnet?

A Alternating current (a.c.) is used.

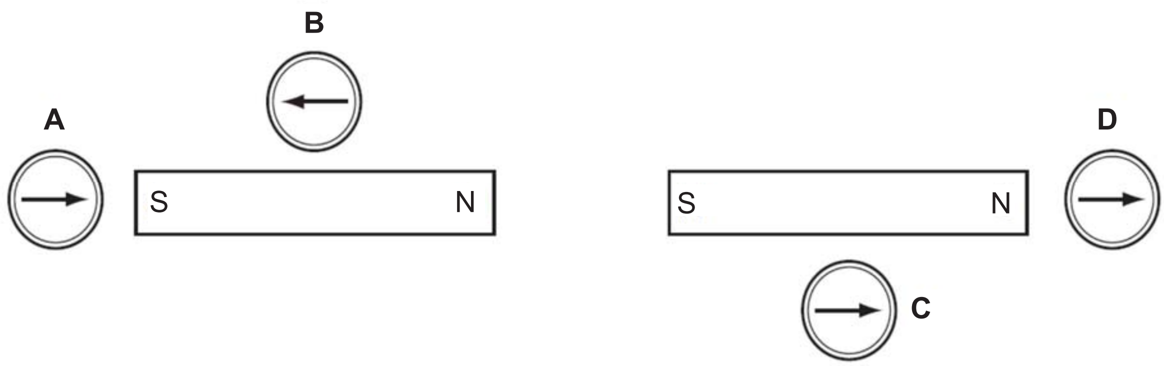
B Direct current (d.c.) is used.

C The magnet is inserted slowly into the solenoid.

D The magnet is withdrawn quickly from the solenoid.

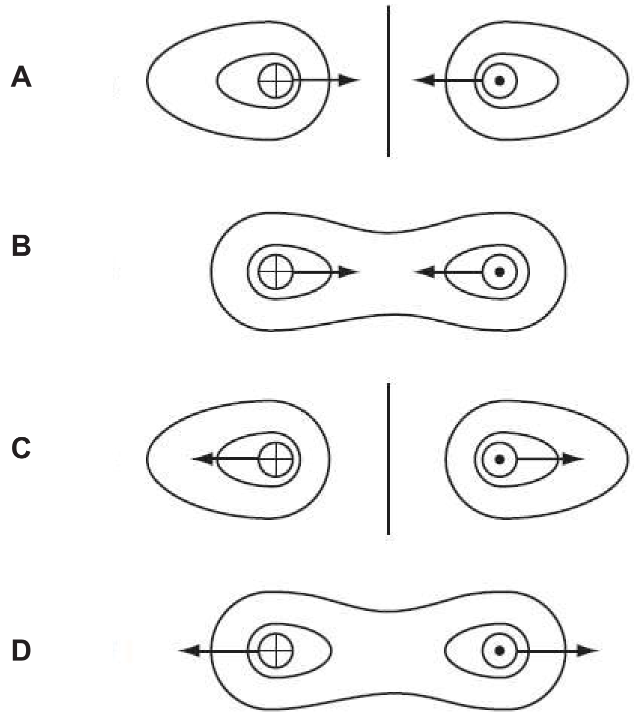
37 Four plotting compasses are placed in the magnetic field of two identical bar magnets.

Which compass is shown pointing in the **wrong** direction?



38 Two parallel wires each carry a current.

Which diagram shows the correct magnetic field pattern and the directions of the forces on the two conductors?



key

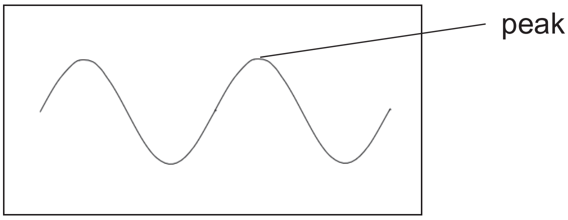
⊕ conductor carrying current into page

⊙ conductor carrying current out of page

[Turn over

39 A cathode-ray oscilloscope (c.r.o.) is connected to an a.c. generator.

A trace is seen on the screen of the cathode-ray oscilloscope.



The speed of rotation of the generator is halved.

What is the effect on the trace?

	number of peaks on the screen	amplitude of trace on the screen
A	halved	halved
B	halved	same
C	same	halved
D	same	same

40 Which material is used for the core of a transformer and what is the reason?

	material	reason
A	copper	good conductor of electricity
B	copper	easy to magnetise and demagnetise
C	iron	good conductor of electricity
D	iron	easy to magnetise and demagnetise

Candidate Name: _________________________ (   ) Class: _________

4Exp
Session 2

KRANJI SECONDARY SCHOOL
Preliminary Examination
Secondary 4 Express

PHYSICS **6091/02**
Paper 2

Monday **29 August 2022** 1 hr 45 min

READ THESE INSTRUCTIONS FIRST

For Examiners' Use	
Section A	/ 50
Section B	/ 30
Total	/ 80

Write your name, index number and class 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.

Section A
Answer **all** the questions in the spaces provided in the question paper.

Section B
Answer **all** the questions in the spaces provided.
Question **14** 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.

The gravitational field strength is 10 N/kg.

Set by: Ms Jennifer Teo

This Question Paper consists of **22** printed pages.

[Turn over

Section A

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

1 Fig. 1.1 shows a boy on a sledge travelling down a slope.

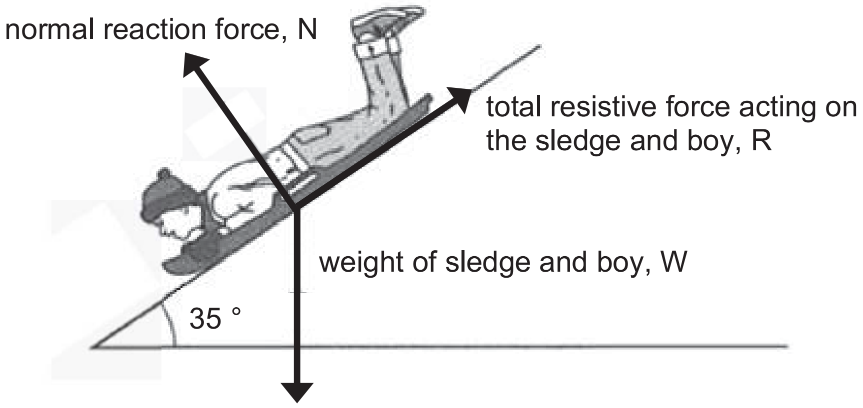


Fig. 1.1 (not drawn to scale)

(a) The boy and the sledge have a total weight of 600 N and they are travelling at a constant speed. The angle of the slope to the horizontal is 35° and the total resistive force on the sledge and boy is R.

By means of a scaled diagram, determine the magnitude of the total resistive force R acting on the sledge and boy.

total resistive force, R = ……………………………………….. [3]

(b) Explain why the boy is travelling at constant speed even though he is moving down a slope.

………

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

[Turn over

2 Fig. 2.1 shows a rectangular stone block, PQRS, of dimensions 1.5 m × 1.0 m × 0.20 m. It has a density of 1600 kg/m^3, held stationary at **P** by a cable attached to a wall. Point **R** is 1.2 m away from the wall and the line of action of the weight of the stone block at **C** is 0.40 m from R.

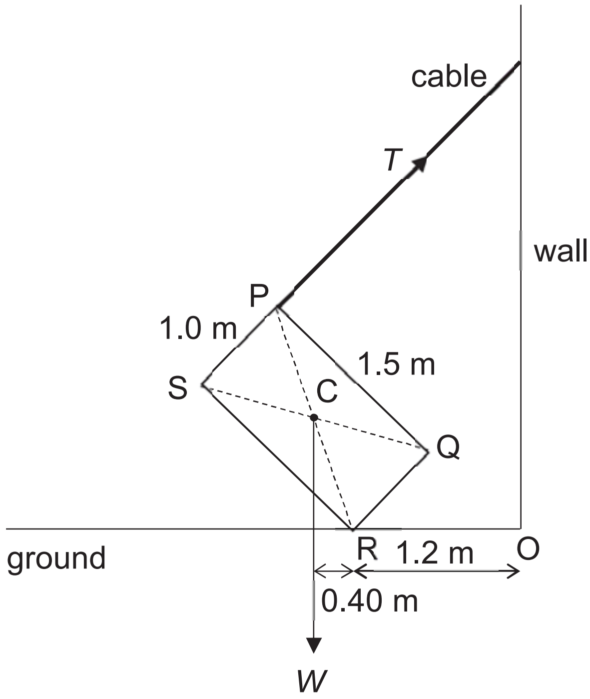


Fig. 2.1

(a) Calculate the weight W of the stone block.

weight W of the stone block = …………………..………………….. [2]

(b) Calculate the tension T in the cable.

tension T in the cable = …………………..………………….. [3]

3 Fig. 3.1 shows an oil tank. A small crack appears in it, and a stream of oil is pushed out through the crack. The oil hits the floor at Z where a puddle of oil starts to form.

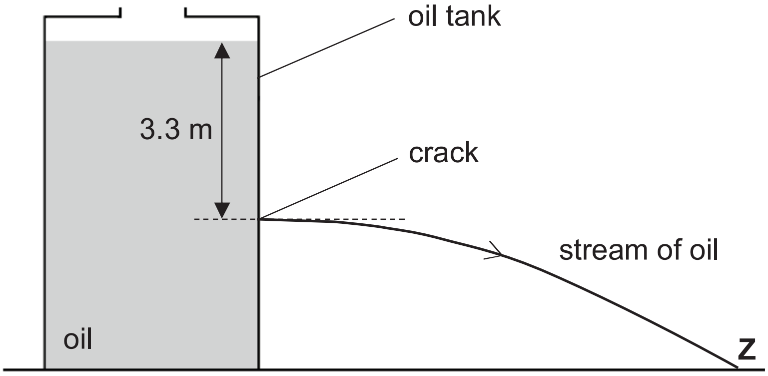


Fig. 3.1

(a) Initially, the density of the oil is 940 kg/m^3 and the crack is 3.3 m below the surface of the oil.

(i) Calculate the pressure due to the oil at the level of the crack initially.

pressure = ……………….………………….. [2]

(ii) Explain why the atmospheric pressure does not affect the rate at which the oil is pushed out through the crack.

…………………………………………………………………………………………………

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

(b) As time passes, the point where the oil hits the floor moves away from **Z** and towards the tank.

Explain why this happens.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

[Turn over

4 Fig. 4.1 shows a loaded cart pulled at a constant speed along an inclined plane from point A to point B, moving a distance of 0.60 m. The inclined plane is frictionless.

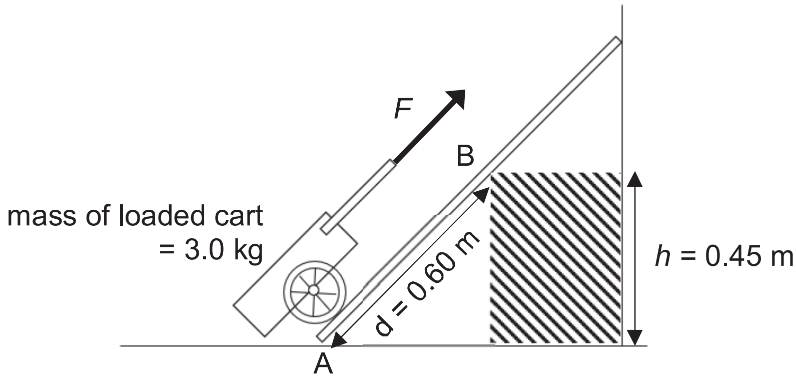


Fig. 4.1

The mass of the loaded cart is 3.0 kg and the height of point B on the inclined plane from the ground is 0.45 m. The distance travelled by the loaded cart along the inclined plane to point B is 0.60 m. Take gravitational field strength, g, to be 10 N / kg.

(a) Calculate the gain in gravitational potential energy of the loaded cart when it moves from point A to point B.

gain in gravitational potential energy = …………………..………………….. [2]

(b) **(i)** State the principle of conservation of energy and explain how it applies as the loaded cart is pulled up the inclined plane.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [3]

(ii) Hence, determine the force, F that is used to pull the loaded cart along the inclined plane.

force = …………………..………………….. [2]

5 Fig. 5.1 shows how the length *L* of a mercury thread in a thermometer varies with temperature *T*.

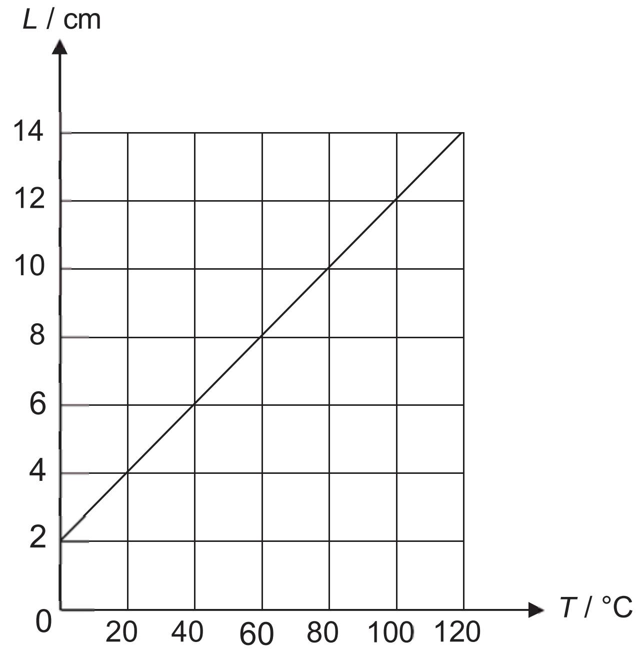


Fig. 5.1

(a) For this thermometer, 0 °C is the lower fixed point.

Explain why there is a need for fixed points in the process of calibration of a liquid-in-glass thermometer.

....

....

....

.... [1]

(b) The thermometer could be used to measure temperature below 0 °C.

Calculate the temperature when the length of the mercury thread is 0.5 cm

temperature = ... [2]

[Turn over

6 Fig. 6.1 shows the displacement-distance graph of a transverse wave that travels at a speed of 5.0 m/s. Particle P is a water particle at zero displacement.

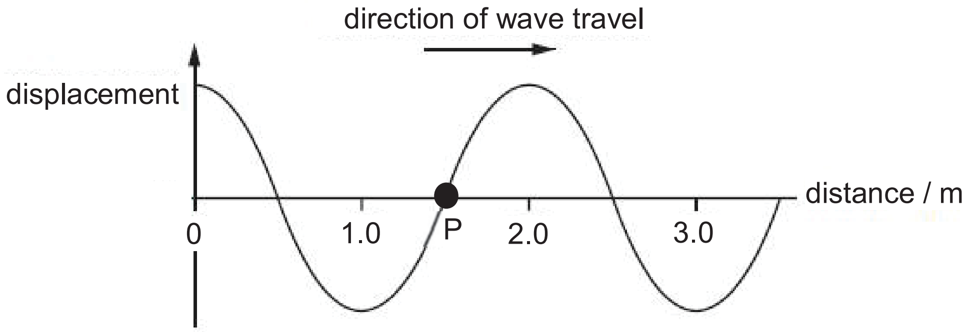


Fig. 6.1

(a) Calculate the period of the wave.

period = ……………….…………………... [2]

(b) Hence mark with an "X" on Fig 6.1 the position of particle P at 0.10 s later. [1]

7 Ultrasound is used in quality control to detect cracks in metal. Pulses of ultrasound are sent into the metal from a transmitter. A detector is placed next to the transmitter on the front surface of the metal as shown in Fig. 7.1.

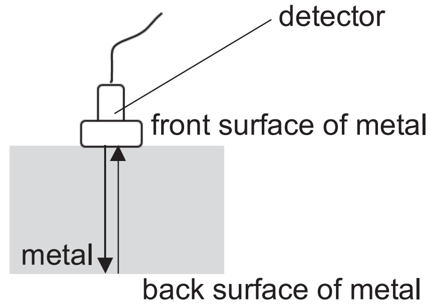


Fig. 7.1

Fig. 7.2 shows the oscilloscope trace of the ultrasound pulses produced if the metal contains no cracks.

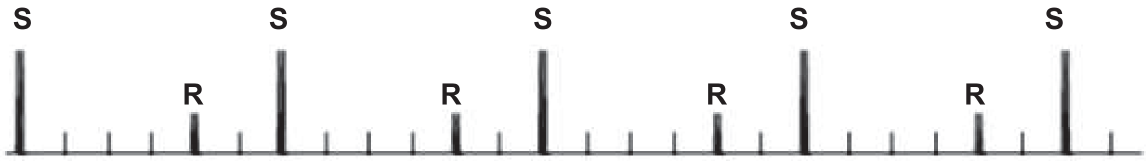


Fig. 7.2

One division along the x-axis represents 1.0×10^{-6} s. Pulses labelled S are the pulses initially sent out from the transmitter. Each pulse labelled R is the reflection of the pulse S from the back surface of the metal.

(a) State what is meant by *ultrasound*.

………

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

(b) Using Fig. 7.2, calculate the number of pulses sent out by the source in one second.

number of pulses = ……………………………………… [1]

(c) Suggest one reason why the amplitude of R is less than the amplitude of S.

………

………

………

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

[Turn over

8 Fig. 8.1 shows a thin converging lens of a simple camera being used to take the photograph of an object.

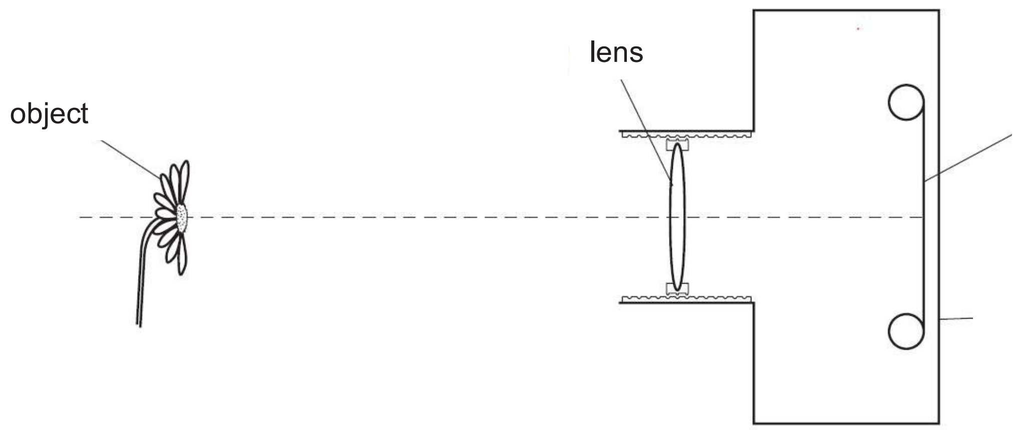


Fig. 8.1

The lens of the camera formed a focused image of the object on the film.

(a) Draw **two** rays from the top of the object to show how the lens forms the image. [2]

(b) State **three** characteristics of the image formed on the film in Fig. 8.1.

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

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

(c) The bottom half of the lens is now being covered with a leaf.

State and explain what happens to the image.

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

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

9 **(a)** Fig. 9.1 shows a small, negatively charged sphere.

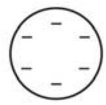


Fig. 9.1

(i) On Fig. 9.1, draw the electric field pattern outside the sphere. [1]

(ii) Explain what is meant by an *electric field*.

…………………………………………………………………………………………………

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

(iii) State what is shown by the direction of the electric field lines.

…………………………………………………………………………………………………

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

(b) The sphere is then suspended between two charged metal plates.

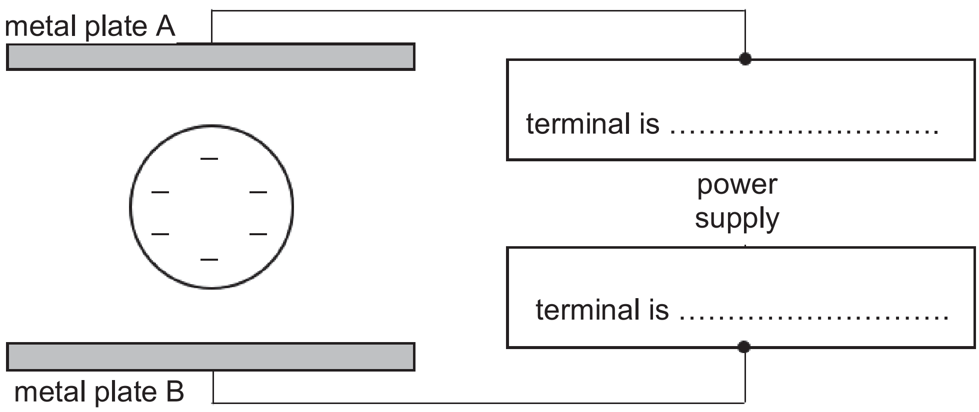


Fig. 9.2

(i) On. Fig. 9.2, write in the boxes the terminals of the power supply. [1]

(ii) Explain why the terminals of the power supply are arranged as stated in **(b)(i)**.

…………………………………………………………………………………………………

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

[Turn over

10 In Fig. 10.1 below, an electrical circuit is set up with a battery of e.m.f. 6.0 V, connected to four resistors.

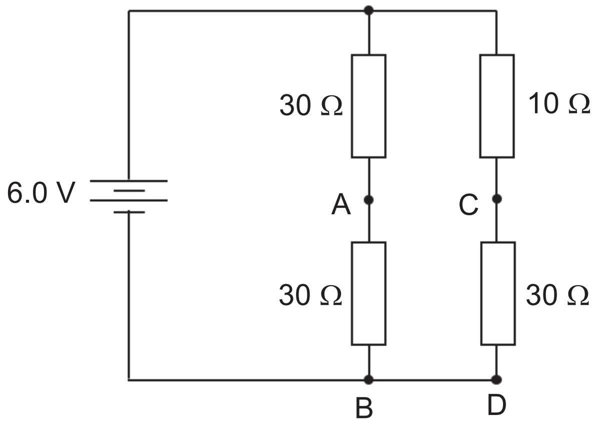


Fig. 10.1

(a) The potential difference between A and B is 3.0 V.

Explain what this means.

……………………………………………………………………………………………………

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

(b) Determine the potential difference between C and D.

potential difference between C and D = …………………………………….. [2]

(c) Determine the potential difference between A and C.

potential difference between A and C = …………………………………….. [1]

11 Fig. 11.1 shows the coil of a d.c. motor placed between the poles of a magnet.

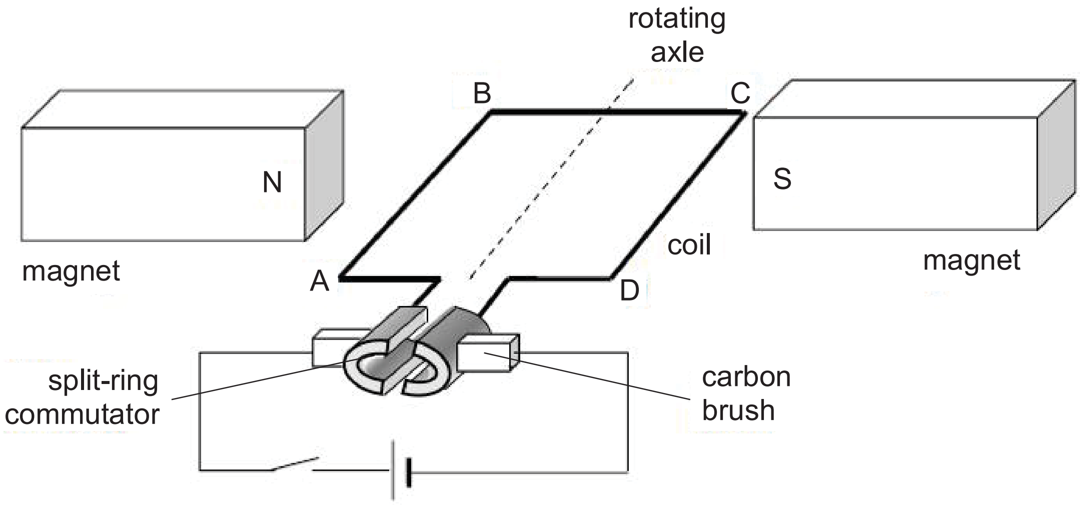


Fig. 11.1

(a) On Fig. 11.1, draw the forces that act on sides AB and CD of the coil, when the switch is closed. [1]

(b) Describe how you determined the direction of the force acting on the side AB of the coil.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

(c) The coil begins to rotate about the axle from the position as shown in Fig 11.1.

With reference to side AB of the coil, explain how the split-ring commutator ensures the coils continues to turn in the same direction when it has turned 180°.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

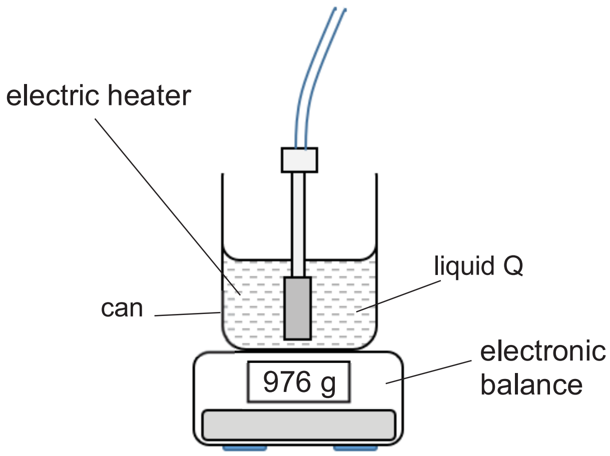
……………………………………………………………………………………………... [2]

[Turn over

Section B

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 14**

12 Fig 12.1 shows an experimental set up that can be used to calculate the specific heat capacity and specific latent heat of vaporisation of a liquid Q. Heat is continuously provided by a 100 W electric heater to liquid Q. The temperature and electronic balance readings are recorded at regular intervals of time.



power of electric heater = 100 W

mass of empty can = 100 g

mass of liquid Q and can = 976 g

specific latent heat of vaporisation of liquid Q = 330 kJ/kg

Fig. 12.1

Fig. 12.2 shows how the total mass (mass of can + mass of liquid Q) changes with time.
Fig. 12.3 shows how temperature of liquid Q changes with time.

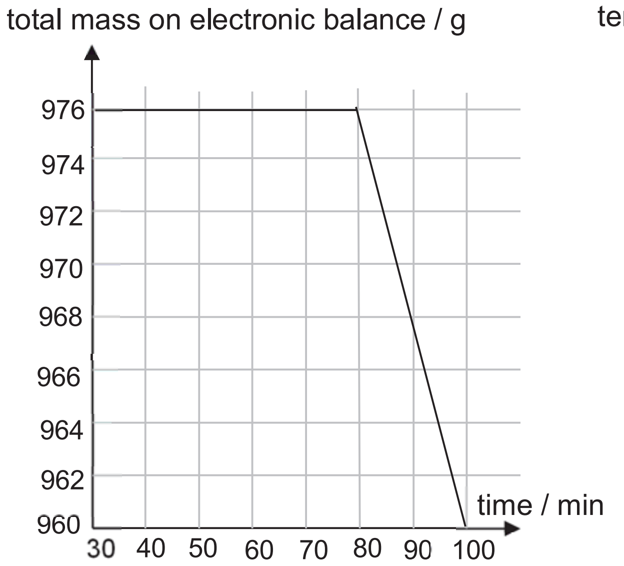


Fig. 12.2

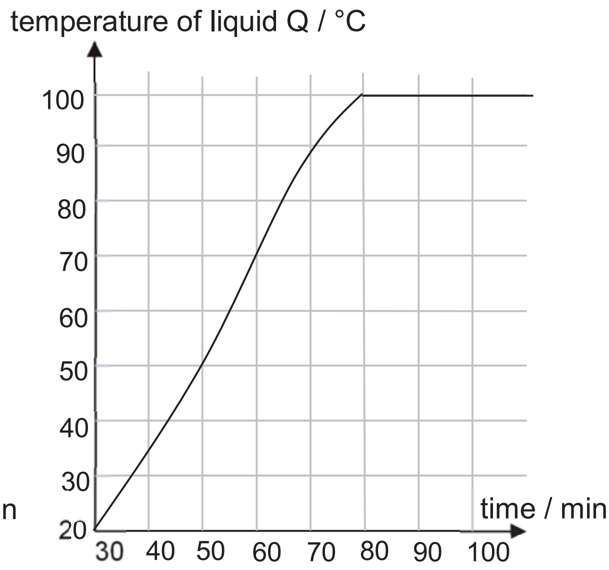


Fig. 12.3

(a) Define *specific latent heat of vaporisation.*

....

.... [1]

(b) **(i)** Calculate the amount of thermal energy supplied by the heater from 30 minutes to 80 minutes.

thermal energy supplied = ……………….………………….. [2]

(ii) Given that 60 000 J of thermal energy is transferred from the experimental set up to the surroundings from 30 minutes to 80 minutes, calculate the specific heat capacity of the liquid Q. Assume the can has negligible specific heat capacity.

specific heat capacity of liquid Q = ……………….………………….. [3]

(iii) With reference to your calculation in (b)(ii), explain whether the value of the specific heat capacity of liquid Q calculated is higher or lower than the actual specific heat capacity of the liquid if specific heat capacity of the can is not negligible.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

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

(c) **(i)** Calculate the amount of thermal energy needed to boil off liquid Q from 80 minutes to 100 minutes.

thermal energy needed to boil liquid Q = ……………….………………….. [1]

(ii) The mass of the liquid remains relatively constant from 0 minutes to 80 minutes. The rate of evaporation is hence insignificant. Suggest why the rate of evaporation is insignificant.

……………………………………………………………………………………………

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

[Turn over

13 A driver drives a sports car at a constant speed of 40 m/s on a straight, flat road.

The sports car passes by a police car. The police car is initially at rest on the same road.

At the time where the sports car passes it (t = 0 s), the police car starts moving at a constant acceleration in the same direction. The police car catches up with and reaches the sports car in 50 s.

(a) Find the distance covered by the sports car in 50 s.

distance covered = ……………….………………….. [2]

The police car maintains this constant acceleration until it reaches the sports car.

(b) Sketch and label the distance-time graph of the two vehicles (police car and sports car) on Fig. 13.1.

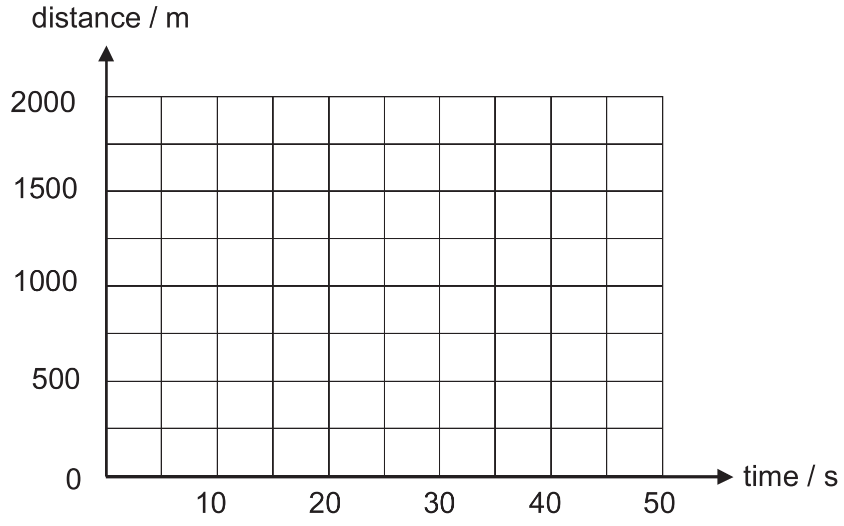


Fig. 13.1

[2]

(c) Calculate the final speed of the police car at the instant where it reaches the sports car.

final speed of the police car = ……………….………………….. [2]

(d) Calculate the acceleration of the police car.

acceleration of the police car = ……………….………………….. [2]

(e) The driving force of the police car is 2 800 N.

The friction acting against the forward motion of the police car is 400 N.

Using your answer from **(d)**, calculate the mass of the police car.

mass of the police car = ……………….………………….. [2]

[Turn over

14 **EITHER**

Fig. 14.1 shows an electric kettle used to heat water to its boiling point.

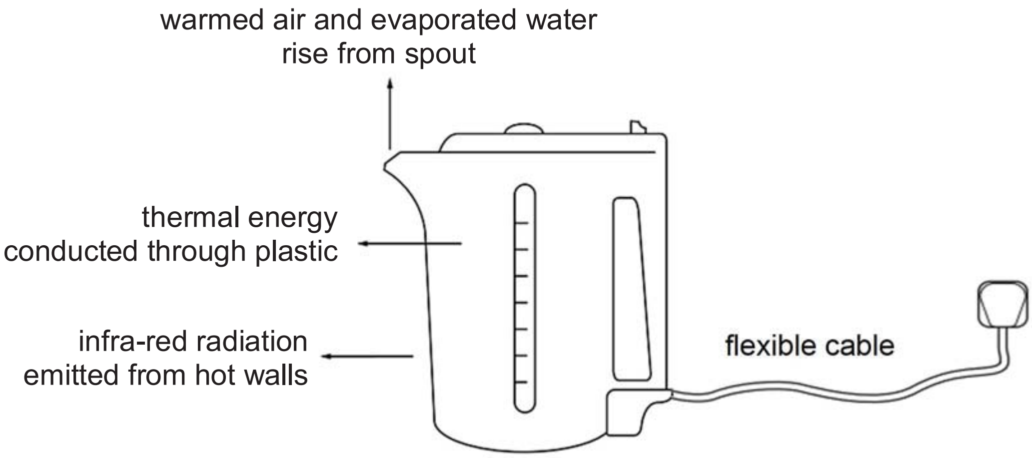


Fig. 14.1

(a) Describe, in terms of the particles, how thermal energy is conducted through the walls of the kettle.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

………………………………………………………………………………………………………

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

(b) Explain why evaporation of water will result in cooling of the boiled water in the kettle.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

………………………………………………………………………………………………………

………………………………………………………………………………………………………

………………………………………………………………………………………………………

……………………………………………………………………………………………….. [3]

(c) The electric kettle is connected to the 240 V mains supply by a flexible cable, and has a power rating of 2500 W. Table 14.2 shows the maximum current that may be carried safely by wires of various diameters.

Table 14.2

wire diameter / mm	maximum current / A
0.50	3
0.75	6
1.00	10
1.25	13
1.50	15

(i) Show that the current in the cable when the kettle is in use is 10.4 A.

[1]

(ii) Explain the relationship between wire diameter and maximum current in the wire.

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

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

(iii) From the table, state the smallest diameter of wire that can safely be used for this kettle.

Explain what could happen if a wire thinner than your answer is used.

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

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

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

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

(iv) Describe one fault that may occur in the flexible cable that will cause the fuse in the plug to melt.

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

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

[Turn over

OR

Two coils, A and B, are placed one on top of the other, as shown in Fig. 14.3. and Fig 14.4

Coil A is connected in series with a battery and a switch. A millivoltmeter is connected across the terminals of coil B.

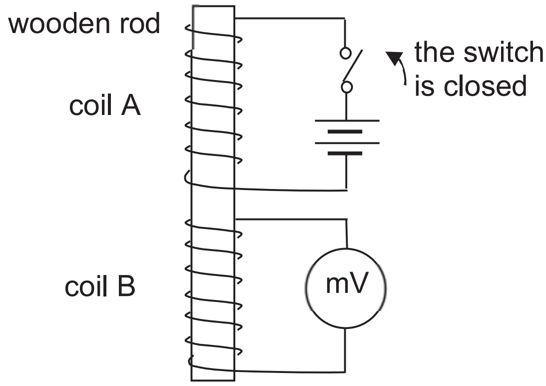


Fig. 14.3

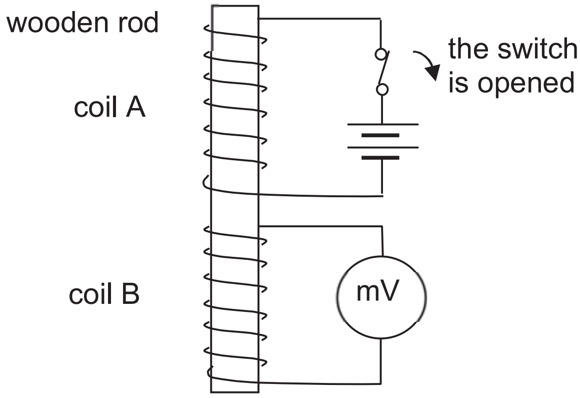


Fig. 14.4

(a) When the switch in coil A is closed, explain why the millivoltmeter indicates an induced e.m.f. for a short period of time and then reduces to zero rapidly in Fig. 14.3

……

……

……

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

(b) **(i)** On Fig. 14.4, draw an arrow on coil B to show the direction of the induced current in coil B when the switch was **just opened**. [1]

(ii) Explain the direction drawn in **(b)(i)**.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

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

Fig. 14.5 shows two coils of insulated wire wound on a soft iron core to make a transformer. One coil is connected to a 16 V a.c. supply. The other coil is connected to a lamp, which is rated 12 V, 24 W.

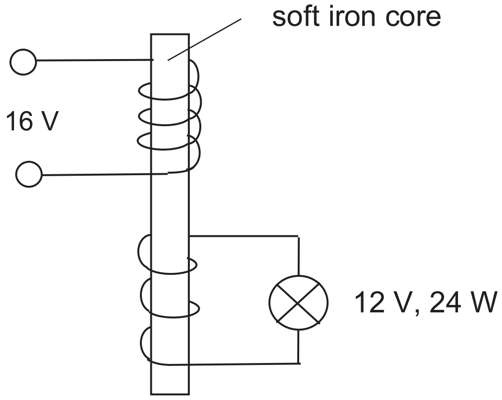


Fig. 14.5

(c) The lamp is operating at its correct rating.

Calculate the minimum current drawn from the 16 V supply.

minimum current = ……………………………………….. [2]

(d) However the current drawn from the supply is found to be 1.7 A.

(i) Calculate the input power to the transformer.

input power = ……………………………………….. [1]

[Turn over

(ii) Calculate the electrical energy lost by the transformer each second.

electrical energy lost per second = ………………..………………….. [1]

(iii) State one reason why a transformer is **not** 100% efficient.

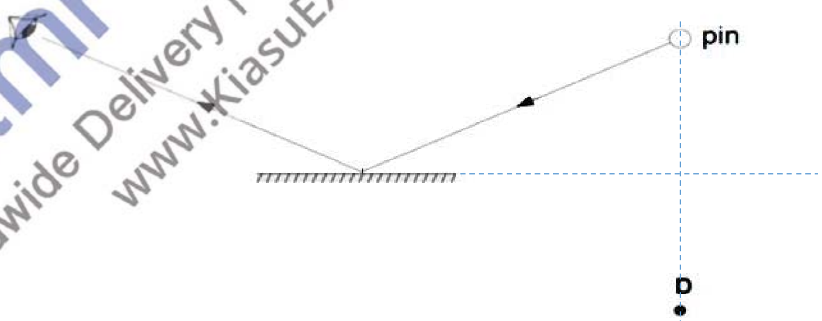
…………………………………….………………………………….……………………….…

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

KRANJI SECONDARY SCHOOL
Physics (6091) Sec 4 Express
Preliminary Examination 2022 Mark Scheme

Paper 1

Qn	Answer	Remarks
1	A	zero error = 0.54 mm reading on micrometer = 4.49 mm diameter of wire = 4.49 – 0.54 = 3.95 mm
2	B	A vector is a physical quantity with a magnitude and a direction. If two vectors of equal magnitudes are acting in opposite directions, the resultant force will be zero.
3	C	½ (6 + v) (2) = 10 v = 4 m/s Car is travelling at 4 m/s after decelerating for 2 s. The deceleration is 1 m/s^2 a = (v-u)/t, car will take another 4 s before it comes to rest.
4	A	Resultant force = 7500 – 5000 = 2500 N F = ma a = F/m = 2500 / 500 = 5.0 m/s^2
5	C	F = ma first segment: resultant force is constant, acceleration is constant, speed is increasing at a constant rate (straight line with a positive gradient) second segment: resultant force decreases, acceleration decreases, speed is increasing at a decreasing rate third segment: resultant force is zero, acceleration is zero, speed is constant
6	A	Density is the same as they are both made of copper. Since the volume of Q is lesser, it must have lesser mass. As inertia is dependent on mass, inertia is lesser too. The kinetic energy gained is different as Q would accelerate at a greater rate due to its smaller mass.
7	A	As all the cubes are identical, despite moving some cubes away, the remaining cubes will still have the same density.
8	C	For the beam balance to be in equilibrium, total anticlockwise moment about the pivot must be equal to the total clockwise moment about the same pivot.
9	B	An object can be made more stable is: • its centre of gravity can be made lower • its base area can be made larger
10	D	Minimum pressure is applied when the contact surface area is maximum P = F/A 50 = F/(0.50 x 0.40) F = 10 N
11	C	Pressure of the gas supply = 9.0 cm + 9.0 cm above atmospheric pressure = 18.0 cm above atmospheric pressure
12	D	total pressure = pressure due to 8 m of water + atmospheric pressure = hpg + 1.0×10^5 = 8 (1000) (10) + 1.0×10^5 = 1.8×10^5 Pa

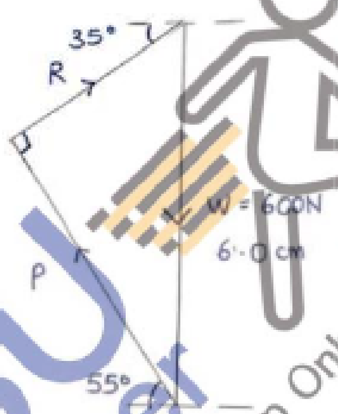
13	C	Power = (Change in KE) / (time taken) The car with the highest average power is the car that reached the higher maximum speed with lesser time.
14	A	During freezing which is a change in state from liquid to sold, intermolecular forces of attraction are strengthened, which means that the molecules attract each other more strongly. There is no change in average speed of the molecules, as there is no change in temperature during freezing.
15	A	Since the temperature is constant, the molecules move at the same average speed. Due to a decrease in volume, the molecules are closer together and collide with each other and with the walls of the container more often, giving rise to a larger pressure.
16	C	The water nearest to the heat source at the bottom gets heated and becomes warmer. It expands, becomes less dense and rises. The cooler denser water sinks to replace this warm water.
17	D	A is the coolest as dull black is a better emitter of radiation compared to a polished silver surface. The absence of lid on A allows for thermal energy to escape through evaporation as well. On the other hand, S is the hottest as polished silver is a poorer emitter of radiation compared to dull black. The lid on S prevents thermal energy to escape through evaporation.
18	A	Since the mass of a substance does not change with temperature, we cannot use it to define a scale of temperature.
19	A	A smaller block of copper has the same specific heat capacity, which is dependent on the material. However, the amount of internal energy and heat capacity are lesser as the block of copper is smaller (smaller mass).
20	D	A removal of thermal energy could result in a change of state from gas to liquid (condensation) or liquid to solid (solidification).
21	D	Ultrasound (sound) is a longitudinal wave. Light, microwaves and radio waves are transverse waves.
22	B	The frequency remains the same during refraction If wavelength changes, speed changes by using $v = f\lambda$
23	D	distance from pin to mirror = distance from image to mirror 
24	D	$\eta = \frac{\sin i}{\sin r} = \frac{\text{speed of light in air / vacuum}}{\text{speed of light in glass block}}$ $\eta = \frac{\sin (90-15)^\circ}{\sin r} = \frac{3 \times 10^8}{2 \times 10^8}$ $r = 40.087^\circ = 40^\circ$
25	D	The speed of the signal in the optical fibre will be less than 3.0×10^8 m/s and an optical fibre is able to transmit signals with little loss over long distance.
26	D	Q is infrared rays which is used in television remote controller.

27	D	period, T = 4.0 ms x 2 = 8.0 ms f = $\frac{1}{T}$ = $\frac{1}{0.008}$ = 125 Hz v = fλ 340 = 125 λ λ = 2.72 m
28	A	The higher the frequency, the higher the pitch. As Y has a higher frequency, it has a higher pitch. As both X and Y have the same amplitude, they have the same loudness. As speed of sound in air for both notes are the same, using v = fλ, as Y has a higher frequency, it has a shorter wavelength.
29	A	When the positively charged rod is brought near, the free electrons in the sphere are drawn towards the side near the positively charged rod. As unlike charges attract, the sphere is attracted and moves towards the rod. Similarly the two spheres are attracted to one another.
30	B	The polythene gains electrons and becomes negatively charge. The cloth losses electrons and becomes positively charged.
31	C	P = IV 24 = I (12) I = 2.0 A Q = It Q = 2 (25 x 3600) Q = 180000 C
32	D	Arrangement Y has the smallest resistance as the heating elements are connected in parallel. Arrangement X has the largest resistance as the heating elements are connected in series.
33	D	$V_{out} = \frac{R_2}{R_1 + R_2} \times V$ $V_{out} = \frac{10000}{2000 + 10000} \times 6$ V_{out} = 5.0 V
34	A	When light shines brighter on the LDR, its resistance decreases. As total resistance of the circuit decreases, I = V/R, I increases, thus ammeter reading increases. V = IR, as current increases, the potential difference across the variable resistor increases, thus voltmeter reading increases.
35	D	P (live wire) is connected to S (switch) Q (neutral wire) is connected to N R (earth wire) is connected to M (metal casing)
36	A	Electrical method to demagnetise magnets 1) Place a magnet inside a solenoid in the East-West direction. 2) Connect the solenoid to an alternating current (a.c.) supply. An alternating current is an electric current that varies its direction many times per second. 3) Withdraw the magnet **slowly with the alternating current still flowing** in the solenoid, until it is some distance away.
37	C	The needle of the compass will point in the direction of the magnetic field. Magnetic field lines are directed outward from the N pole and towards the S pole.
38	C	Conductors carrying currents in opposite directions repel. Conductors carrying currents in same direction attract.
39	A	When the speed is halved, the frequency of rotation is halved, resulting in half the number of waves produced in the same time. Also, the amplitude of the induced e.m.f. is also halved as the rate of change of magnetic flux linkage is reduced.
40	D	The core of a transformer is made of soft iron as it is easily magnetised and demagnetised. This ensures better magnetic flux linkage between the two coils.

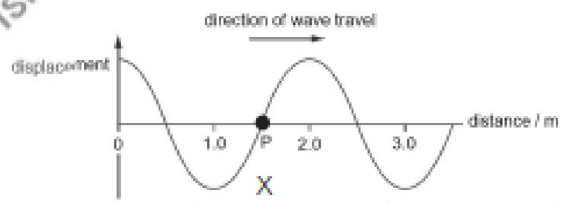
Paper 2

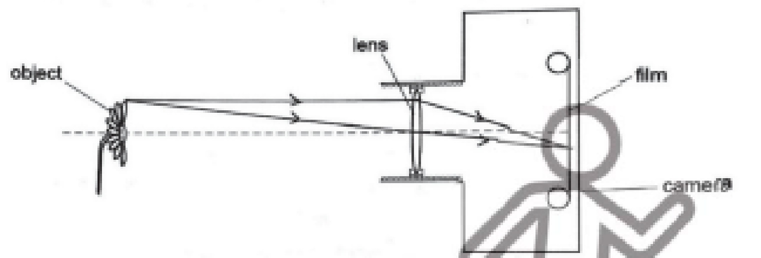
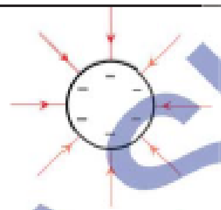
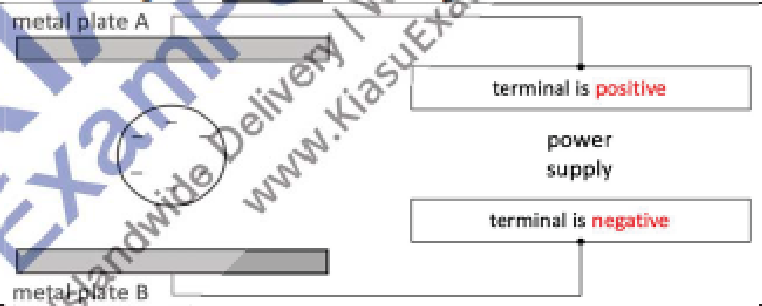
- minus 1 mark for each sub question for missing or incorrect formulae
- minus 1 mark for each sub-question for missing or incorrect units
- minus 1 mark for the whole paper for answer that is not expressed in 2 s.f. or 3 s.f.

Section A

Question		Answer	Marks / Remarks
1	(a)	R is 35° to horizontal and resultant force drawn perpendicular to P. Parallelogram/Triangular/Tip to Tail Law correctly applied Deduct 1 m for missing labels or arrows on forces or inappropriate scale R = 3.4 x 100 Scale = 1 cm : 100 N = 340 N (323 N to 357 N) 	1 1 1
	(b)	There is no resultant force (forces are balanced) acting on the boy and sledge. F = ma hence there is no acceleration and the boy moves at constant speed.	1 (student to mention no R and no acc)
2	(a)	$\rho = \frac{m}{V}$ $1600 = \frac{m}{1.5 \times 1.0 \times 0.2}$ m = 48 kg W = mg W = 480 x 10 W = 4800 N	 1 1
	(b)	Taking moments about R, total anticlockwise moments = total clockwise moments $4800 \times 0.4 = T \times 1.5$ $T = 1280$ N	 1: 4800 x 0.4 1: T x 1.5 1: ECF from (a)
3	(a)	(i) pressure = ρgh = 940 × 10 × 3.3 = 3.1×10^4 Pa	 1 1
		(ii) atmospheric pressure acts at both ends of crack (inside the tank and outside the tank)	1
	(b)	Inside the tank, the height of oil above the crack decreases. pressure = ρgh As height decreases, pressure (at level of crack) decreases, horizontal distance moved by the stream of oil decreases.	1 1

4

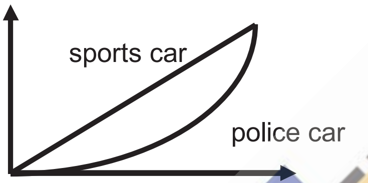
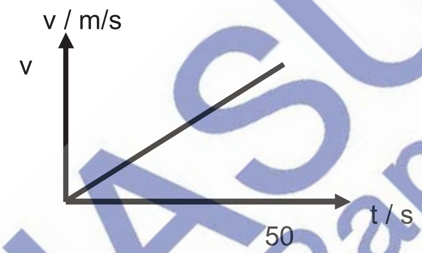
4	(a)	Gain in g.p.e. = mgh = 3.0 x 10 x 0.45 = 13.5 J	 1 1
	(b) (i)	Principle of Conservation of Energy states that • energy cannot be created / destroyed; • energy can be converted from one form to another; • the total amount of energy remains the same As the loaded cart is pulled up the inclined plane, there is no change in kinetic energy as it is pulled at a constant speed. The work done by the force is converted to gravitational potential energy gained by the loaded cart.	All 3 points – 2 marks 1 or 2 points – 1 mark 1
	(b) (ii)	work done = gain in g.p.e. F x 0.60 = 13.5 F = 22.5 N	 1 1
5	(a)	Fixed points are needed to set up temperature scale and they give the standard degree of hotness or coldness that are easily obtainable and reproducible.	1
	(b)	For every 2 cm change in length, temperature change is 20 °C. At 0.5 cm of mercury, the length of mercury below the 0 °C mark = 0.5 – 2 cm = -1.5 cm Hence, temperature = $\frac{20}{2} x\ (-1.5)$ = -15 °C Or θ = $\frac{l_\theta - l_0}{l_{100} - l_0} \times 100\ ^\circ C$ = $\frac{0.5-2.0}{12.0-2.0} \times 100\ ^\circ C$ = -15 °C	 1 1 1 1
6	(a)	wavelength = 2.0 m v = fλ 5 = f (2) f = 2.5 Hz Period = 1/f = 1/2.5 T = 0.40 s (2 sf)	 1 1
	(b)	P moves a quarter of an oscillation and moves down to the trough (allow for slightly vertically above or below the point), directly below old position of P. 	1: ECF – T from (a)
7	(a)	Sound with high frequencies, above the upper limit of the human range of audibility.	1
	(b)	1 period is 6 x 10^{-6} s	1

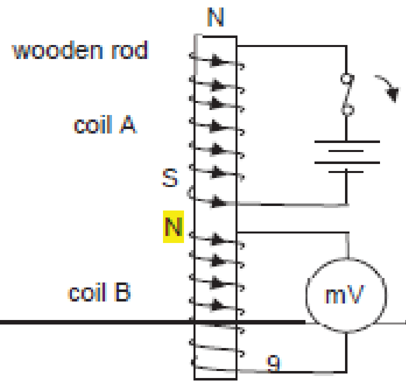
		$f=\dfrac{1}{T}=\dfrac{1}{(6\times10^{-6})}=1.67\times10^{5}\quad or\quad 1.7\times10^{5}$		
	(c)	• Some sound energy passed through the back metal surface and did not reflect to the detector • Sound energy is absorbed by metal as it travelled from the front to the back and back to the front metal surface. • Sound energy scatters in other direction		1: any one
8	(a)			1 1
	(b)	inverted, diminished and real		2M:3 correct 1M:2 or 1
	(c)	dimmer as there are less light rays passing through lens		1
9	(a)	(i)		1 Correct lines and arrows of direction
		(ii)	A region where an electric charge experiences a force.	1
		(iii)	The direction of the electric field lines gives the direction of the force acting on a positive test charge.	1
	(b)	(i)		1: both correct
		(ii)	Weight of sphere is acting downwards. To suspend the sphere requires the charges at metal plate A to attract the charges in sphere. As unlike charges attract, metal plate A must be positively charged. The charges at metal plate B must repel the charges in sphere. As like charges repel, metal plate B must be negatively charged.	1 1
10	(a)	For every coulomb of charge that passes from A to B, 3.0 J of electrical energy is converted to non-electrical forms. Or		1

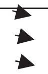
		3.0 J of work is done to drive a unit change through a component.	1
	(b)	I = V / R I = 6 / (10 +30) = 0.15 A CD: V = IR V = 0.15 x 30 = **4.5 V**	 1 1
	(c)	4.5 – 3.0 = **1.5 V**	1
11	**(a)**	AB – force is acting down CD – force is acting up	1
	(b)	Using **Fleming's Left Hand Rule**, where the **thumb, index and middle fingers are at right angles** to one another. The **index finger points towards the right (or from North to South) and the middle finger points into the paper (or from A to B) and thus the thumb points towards the direction of the force exerting on AB**.	1 1
	(c)	As side AB moves downwards to the bottom-most point, the force acting on AB is still downwards as the direction of the current is still from A to B. For the coil to rotate continuously, AB will need to have an upward force, combined with the momentum of rotation. The **split ring commutator therefore reverses the current in the coil**, such that the **current flows from B to A and therefore an upward force is generated on AB when it moves to side near to the S magnet.** Similarly, when AB reaches the topmost point, the split ring commutator will reverse the current as well. (split-ring commutator reverses the current every 180° rotation)	1 1

Section B

Question			Answer	Marks / Remarks
12	**(a)**		The **energy** needed to **change unit mass of substance from liquid to gas (or vice versa) without a change in temperature**.	1
	(b)	**(i)**	thermal energy supplied = Pt = 100 x (80-30) (60) = **3.0×10^5 J**	 1: time in s 1
		(ii)	thermal energy supplied by heater = thermal energy gained by liquid Q + thermal losses $3.0 \times 10^5 = mc\Delta\theta + Pt$ $3.0 \times 10^5 = \frac{976-100}{1000}$ (c) (100-20) + 60 000 c = 3424.66 J/kg°C = **3420 J/ (kg °C)** (3 s.f.)	1: net amt of thermal energy, ecf 1: $\frac{876}{100}$ (c) (80) 1
		(iii)	The **calculated value is higher than the actual value.** When c of container is not negligible, it absorbs thermal energy, the thermal energy supplied by heater is distributed as follows: thermal energy supplied by heater = thermal energy gained by liquid + thermal energy gained by can + thermal losses If heat supplied is the same, **thermal energy gained by liquid reduces**.	 1 1

			If the temperature in liquid is the same, for the same mass, actual specific heat capacity of liquid is lesser than the calculated.	
	(c)	(i)	thermal energy needed to boil = ml_v $= \frac{976-960}{1000}(330 \times 10^3)$ $=$ **5.28×10^3 J**	1
		(ii)	• The **humidity** in the room is high • Liquid Q has **low volatility** • The **water loss due to evaporation is much lesser than that due to boiling (after 80 minutes).** In comparison, evaporation rates at temperature less than 100 ºC is insignificant.	Any 1
13	(a)	d = vt = 40 x 50 = **2000 m**		1 1
	(b)		1 – police [constant acceleration] 1 – sports car [constant speed] Must label Both to start from (0,0) and end at (50,2000)	
	(c)	You can drawing a speed-time graph to help you, a straight diagonal line up.  t = 50 s, initial speed u = 0 m/s d = area under graph = 2000 m ½ (50) (v) = 2000 final speed v = (2x2000/50) = **80 m/s**		1: ECF – d from (a) 1
	(d)	a = (v-u)/t = 80/50 = **1.6 m/s^2**		1 ECF – v 1 from (c)
	(e)	resultant force = 2800 – 400 = 2400 N m = F/a = 2400/1.6 = **1500 kg**		1 ECF – a 1 from (e)
E 14	(a)	When the molecules on the inside of the kettle is being heated by the hot water, they would **gain kinetic energy and vibrate more vigorously and faster.** They would **collide with the neighbouring molecules and transfer the thermal energy to their neighbouring molecules.** Thermal energy is transmitted without transfer of particles. This process will repeat and eventually the particles at the outer surface of the walls of the kettle are also set into vigorous vibration and becomes heated up. .		1 1
	(b)	Evaporation causes cooling. When evaporation occurs, • **water molecules at the surface with greater kinetic energy escapes** from boiled water by overcoming the intermolecular forces of attraction, • **leaving behind molecules with lower kinetic energy**.		1 1

			• There is a net decrease in average kinetic energy of the particles, which results in a cooling of the boiled water (decrease in temperature). As the temperature of the boiled water is high, the rate of evaporation of the boiled water is high.	1 [or]
	(c)	(i)	P = IV 2500 = I (240) I = 10.4 A (3 sf) [Shown]	1
		(ii)	As wire diameter increases, resistance decreases, the maximum current that can flow through increases.	1
		(iii)	1.25 mm When a thinner wire is used, it can cause overheating of cables and may lead to fires.	1 1
		(iv)	• Insulating materiall can become worn with time and expose the conducting wires inside. The exposed conducting wires can cause the a short circuit if the live and neutral wires come into contact with one another. • A short circuit may occur when electrical appliances are used under damp conditions, as water is able to provide a conducting path for an electric current to flow between parts of the electrical appliance (which is not normally exposed) and the person nearby, thus causing current many thousands of times larger than the normal operating current of the system to surge through. • Overloading can occur when many multi-plug adaptors are used. When many appliances are connected to the mains socket, a large current flow through the house wiring • Live wire touches the metal casing of the electrical kettle. the earth wire provides a much lower resistance path (compared to a person's body) for current to flow between the "live" metal casing and the earth. This large current will cause the circuit breaker to trip or a fuse to melt. Thus, disconnecting the appliance from the electrical mains.	1
OR 14	(a)		When current is switched on, coil A will become an electromagnet. There is a sudden change (from zero to maximum) in magnetic flux linkage to coil B which induces an emf. When the current flowing through the circuit is constant, magnetic field in coil A is stable, there will be no more changes in magnetic flux linkage to coil B so there will be no more induced emf, thus the reading on the millivoltmeter is zero.	 1 1
	(b)	(i)		1: direction of induced current correctly shown using

			 S Fig 14.4	arrows on coil B
		(ii)	**Coil A initially has a S pole nearest to coil B**. When the **switch is opened, the decrease in magnetic field** causes the **coil B to have a N pole induced at the end closer to coil A** to oppose the change (according to Lenz's Law). **Using right-hand grip rule**, we can determine the direction of the induced current drawn in b (i).	1: ECF based on drawing in (b)(i) 1: reverse in direction from Fig 14.3 & right-hand grip rule
	(c)	Current in lamp = P / V = 24 / 12 = **2 A** $V_s/V_p = I_p/I_s$ or $V_s I_s = V_p I_p$ $12/16 = I_p/2$ $24 = 16 I_p$ I_p = **1.5 A** I_p = **1.5 A**		 1 1
	(d)	**(i)**	Input power = VI = 16 x 1.7 = **27.2 W**	1
		(ii)	Energy loss per sec = 27.2 – 24 = **3.2 J**	1
		(iii)	There will be **some energy loss in the form of heat** (due to hysteresis, eddy current, flux leakage and resistance of winding)	1

1 Which row shows the correct unit for the quantity shown?

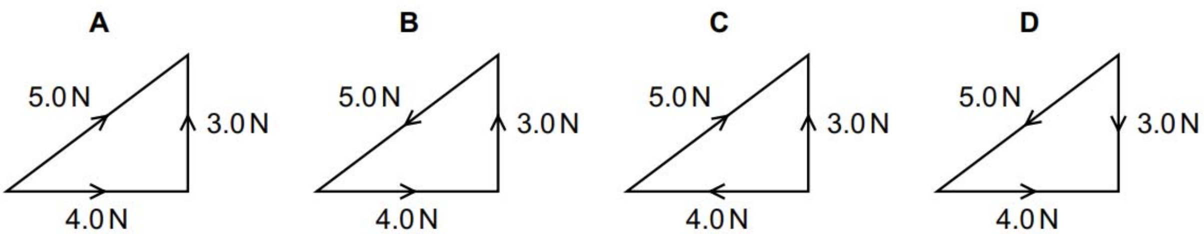
	quantity	unit
A	density	kgm^3
B	electromotive force	N
C	latent heat	J/g
D	mass	g

2 Micrometers, metre rules, tapes and vernier calipers are used for measuring lengths.

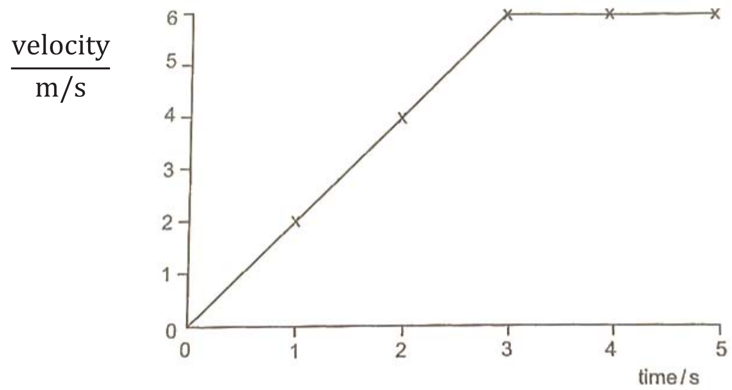
Which row identifies the most suitable device for accurately measuring the stated length?

	length	measuring instrument
A	0.15 mm	micrometer
B	0.50 mm	metre rule
C	0.15 m	measuring tape
D	0.50 m	vernier calipers

3 Which diagram shows the vector addition of a 4.0 N force and a 3.0 N force?



4 The graph shows the first five seconds of a car journey.



How far did the car travel in the first three seconds?

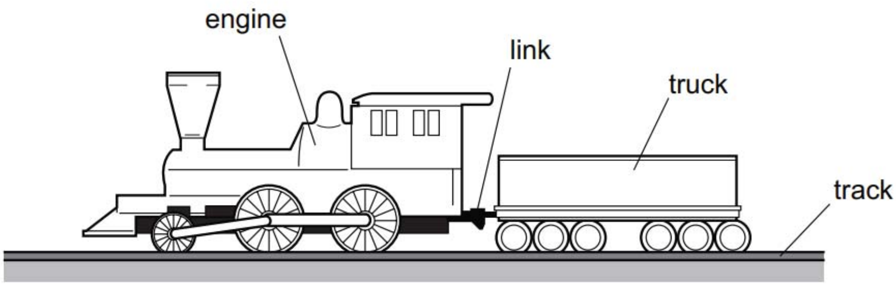
A 6 m

B 9 m

C 15 m

D 18 m

5 An engine pulls a truck at constant speed on a level track.



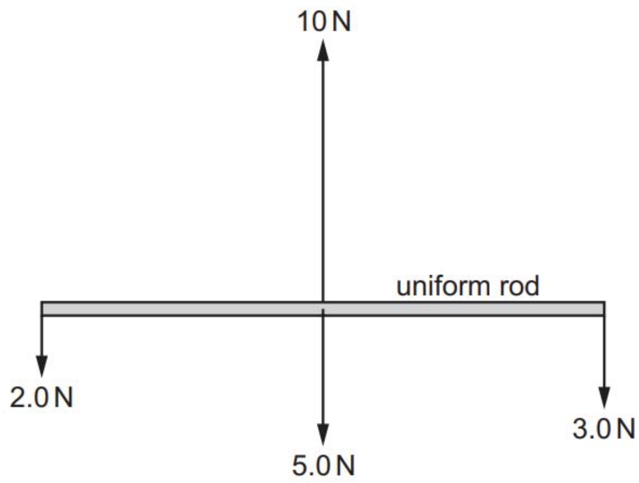
The link between the engine and the truck breaks. The driving force on the engine remains constant.

What effect does this have on the engine and on the truck?

	engine	truck
A	speed stays constant	speed decreases
B	speed increases	speed decreases
C	speed stays constant	stops immediately
D	speed increases	stops immediately

6 A uniform rod of weight 5.0 N is held initially at rest.

The diagram shows the forces acting on the rod when it is released.



What happens to the rod when it is released?

A It does not move.

B It moves to the right.

C It moves upwards.

D It starts to rotate.

7 A car of mass 1000 kg is moving at 20 m/s. The brakes are applied and the car slows down to 10 m/s.

What is the thermal energy produced by the brakes in kJ?

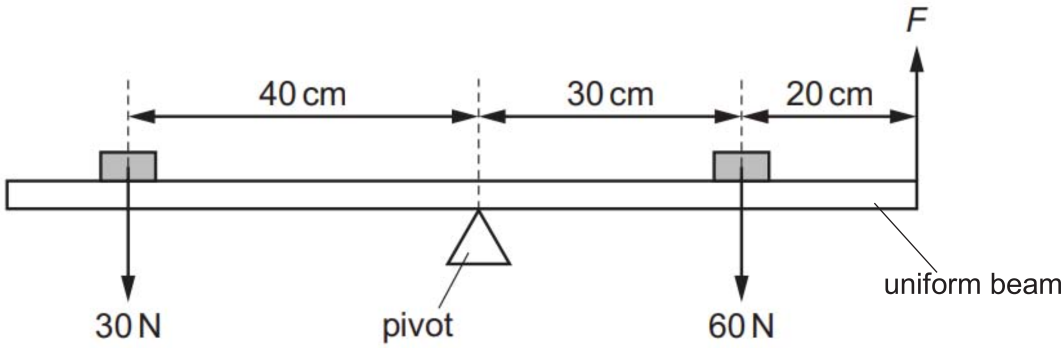
A 50

B 150

C 200

D 300

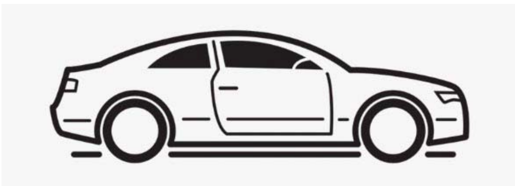
8 A uniform beam is pivoted at its centre. Two weights are placed on the beam in the positions shown and the beam is balanced by an upward force F.



What is the size of F?

A 6N **B** 12N **C** 30N **D** 60N

9 A car is designed to be stable.



Where must the centre of gravity of the car be?

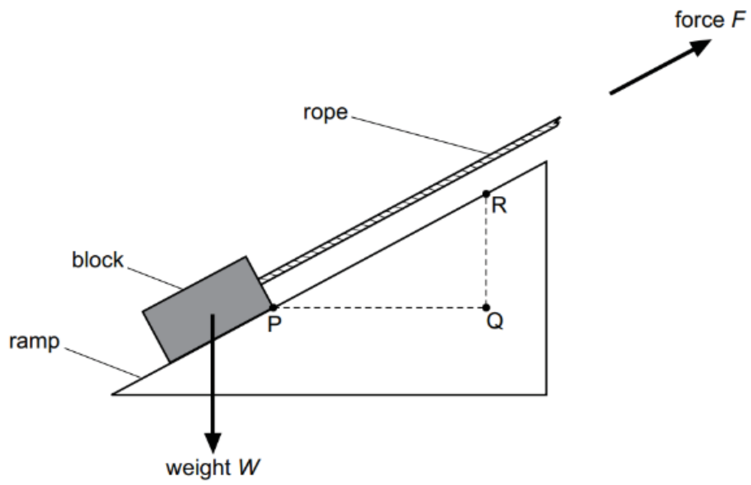
A above the front wheels.

B above the rear wheels.

C as high in the car as possible.

D as low in the car as possible.

10 The diagram shows a block being pulled up a ramp by a rope.



The block has weight W and the rope is pulled with force *F*.

The block moves distance PR and is raised through vertical height QR.

What is the equation for the work done on the block by the rope?

A force *F* × distance PR

B force *F* × height QR

C weight *W* × distance PQ

D weight *W* × distance PR

11 Four objects of different masses are situated in places with different gravitational field strengths.

Which object has the greatest weight?

	mass / kg	gravitational field strength N/kg
A	3.0	10.4
B	3.5	9.5
C	4.0	10.2
D	4.5	9.0

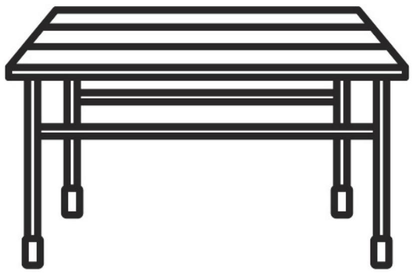
12 A builder lifts eight slabs from the ground on to the back of a lorry 1.5 m high.

The total time taken is 48 s and each slab weighs 200 N.

How much useful power does the builder produce?

A 50 W **B** 400 W **C** 2400 W **D** 3200 W

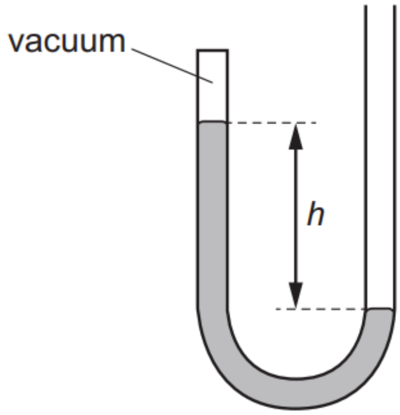
13 A garden table weighs 60 N and has a top surface of area 2.0 m^2. It is raining and the rain produces a pressure of 4.0 N/m^2 on the table.



Ignoring the pressure of the atmosphere, what is the force exerted by the table on the ground?

A 52 N **B** 58 N **C** 62 N **D** 68 N

14 The diagram shows a manometer containing mercury that is sealed at one end.



What happens to the distance *h* when the manometer is taken higher up a mountain?

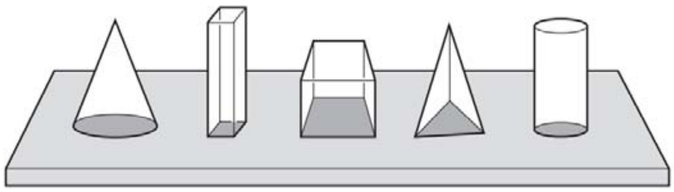
A It decreases, because atmospheric pressure decreases with height.

B It decreases, because atmospheric pressure increases with height.

C It increases, because atmospheric pressure decreases with height.

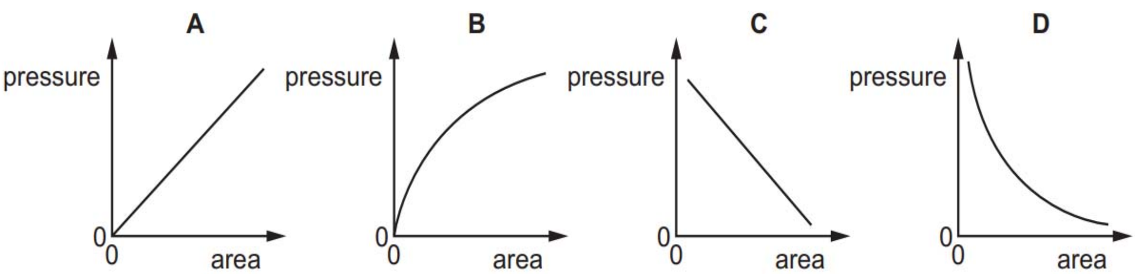
D It increases, because atmospheric pressure increases with height.

15 Five blocks have the same mass but different base areas. They all rest on a horizontal table.

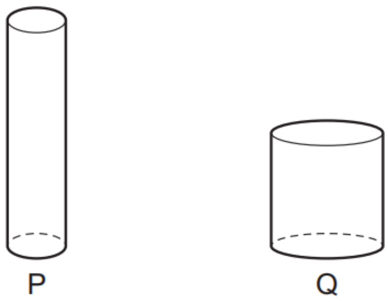


A graph is plotted to show the relationship between the pressure exerted on the table and the base area of the block.

Which graph shows this relationship?



16 Two cylinders P and Q are made of copper.



The height of P is twice the height of Q. The diameter of P is half the diameter of Q.

Which statement is correct?

A The density of cylinder P is four times that of cylinder Q

B The density of cylinder P is twice that of cylinder Q.

C The density of cylinder P is equal to that of cylinder Q.

D The density of cylinder P is half that of cylinder Q.

17 In a Brownian motion experiment with smoke particles in air, heavier particles settle more quickly but small particles remain suspended for a longer period of time.

Which statement explains why the small smoke particles remained suspended in the air?

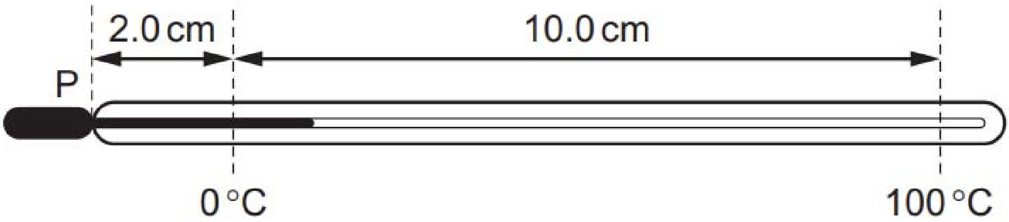
A Air pressure has a greater effect on small particles.

B Gravitational force does not act on small particles.

C Random bombardment by air molecules keeps the particles suspended.

D The small smoke particles have the same density as the air.

18 In a liquid-in-glass thermometer, the liquid column is 2.0 cm long at 0°C and it expands 10.0 cm when heated to 100°C.



Measuring from P, how long is the liquid column at 30°C?

A 2.3 cm **B** 3.0 cm **C** 5.0 cm **D** 7.0 cm

19 The heat capacity of an object, of mass 2.0 kg, is C. The change in temperature is given by Δt.

Which of the following statements about the use of thermal energy is correct?

A Thermal energy required to increase the temperature of the whole object by Δt is $C\Delta t$.

B Thermal energy required to increase the temperature of unit mass of the object by Δt is $C\Delta t$.

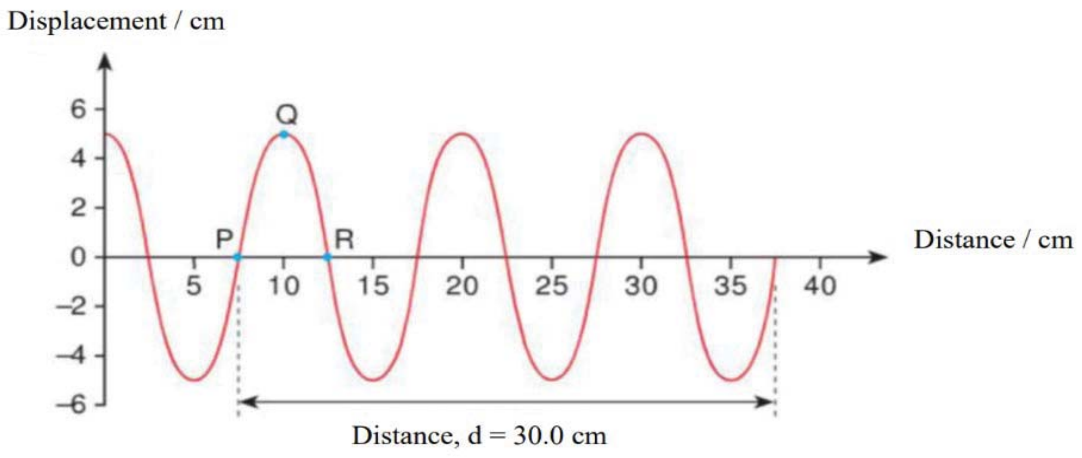
C Thermal energy required to melt the whole object is C.

D Thermal energy required to melt unit mass of the object is C.

20 What surrounds the bulb of a thermometer when marking the upper and lower fixed points?

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

21 The figure shows the displacement-distance graph of a transverse wave of velocity 1.5 m/s.



What is the frequency of the wave?

A 0.15 Hz

B 0.45 Hz

C 5.0 Hz

D 15 Hz

22 A 50 Hz wave is travelling from left to right through a series of particles.

Fig. A shows the equilibrium positions of the particles.
Fig. B shows the positions of the particles at time *t*.

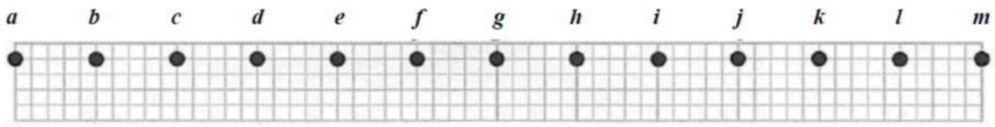


Fig. A

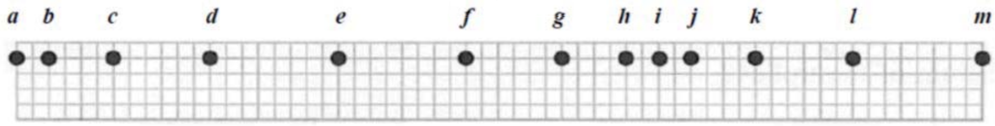


Fig. B

Which of the following statements best describes the particles in Fig. B?

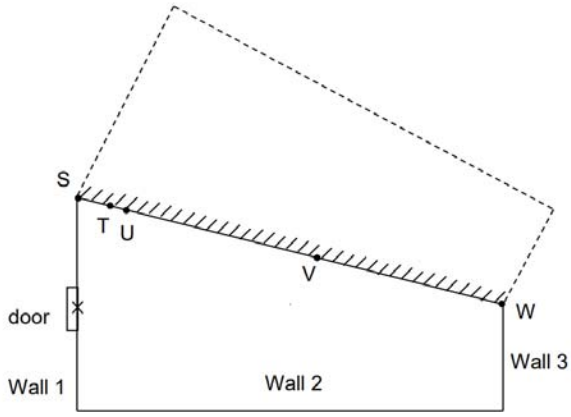
A Particles ***b*** and ***h*** are one wavelength apart.

B Particle ***c*** is moving at maximum speed.

C Particle ***g*** is at maximum displacement from undisturbed position.

D Particle ***m*** is momentarily at rest.

23 A room has an odd shape and with a mirror covering the biggest side of the wall. The diagram shows the top view of the room and the image of the walls 1, 2 and 3 is represented by the dotted lines.



A person standing at the door, represented by an X, wants to see the reflection of the full length of wall 2 of the room from the mirror.

What is the minimum length of the mirror needed to see this reflection?

A SW

B TU

C TV

D UV

24 The speed of light in a transparent medium is 2.5×10^8 m/s.

Which of the following shows the correct path of a ray of light through a right angled prism made of the same transparent medium?

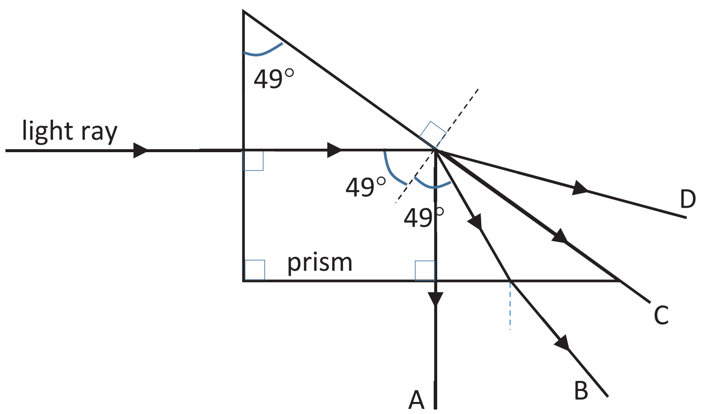


Diagram not drawn to scale

25 The diagram shows a diverging lens with O and F being the optical center and the focal point of the lens respectively.

Which of the following emergent rays indicated the correct light ray after passing through the lens?

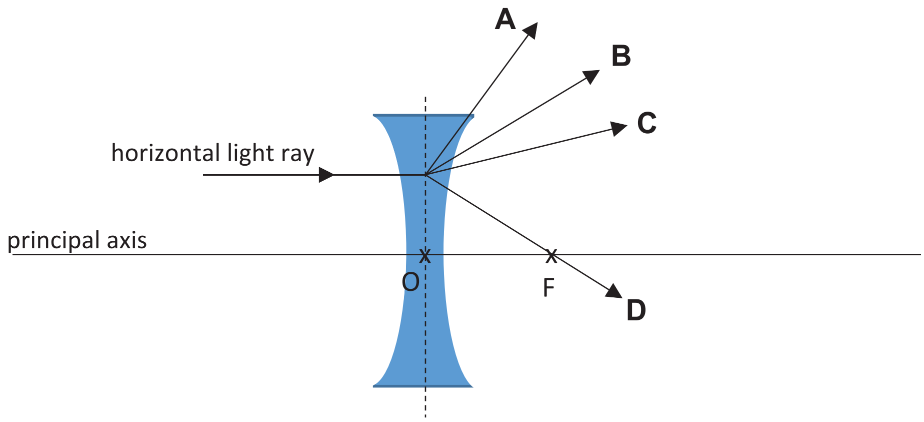


Diagram is drawn to scale

26 Telecommunication infrastructure can be damaged during any disaster. Back-up arrangements such as satellite phones for effective communication during disaster will be important.

Which of the following electromagnetic waves is used by satellite phones?

A low frequency radio wave

B infra-red

C microwave

D ultrasound

27 The diagram shows different regions of the electromagnetic spectrum.

radio waves		Z	visible light			gamma rays

Which of the statements is true of the radiation found in region Z?

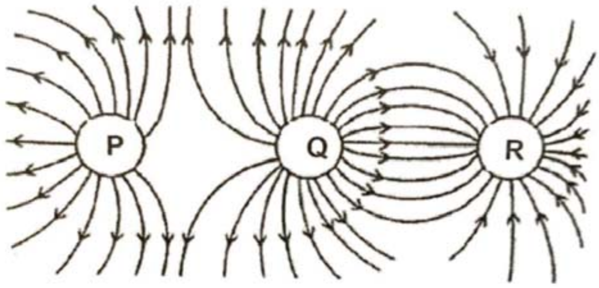
A It can be used in a remote controller.

B It has a higher speed in glass than in air.

C It has a lower frequency than radio waves.

D It has a smaller wavelength than gamma rays.

28 The electric field patterns produced by three charged spheres P, Q and R is as shown.



Which of following statements about a negatively charged object S is correct?

A S placed at the mid-point between P and Q will experience a force in the direction of P.

B S will be attracted to Q when it is placed near Q.

C S will be attracted to R when it is placed near R.

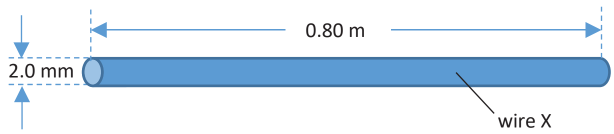
D S will be repelled by P when it is placed near P.

29 A power source has an e.m.f. of 20 000 V. The ammeter in the circuit 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** 3.8×10^{15} **C** 7.5×10^{14} **D** 7.5×10^{15}

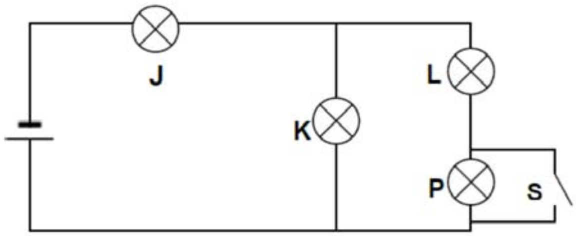
30 A metal wire X has a diameter of 2.0 mm and a length of 0.80 m.



Which wire, made of the same material, would have the same resistance as wire X?

	diameter / mm	length / m
A	1.0	0.20
B	1.0	0.40
C	4.0	0.40
D	4.0	0.64

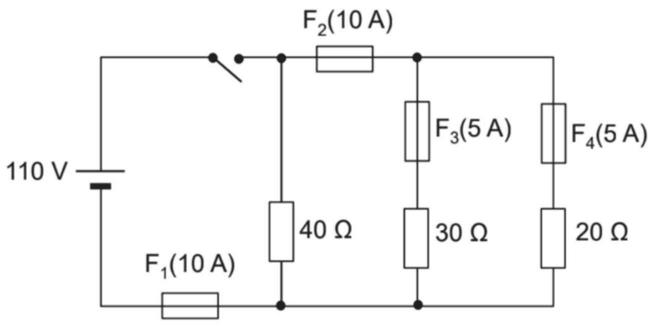
31 The diagram shows a circuit with four identical light bulbs **J**, **K**, **L** and **P**.



Which option describes the changes in brightness of the bulbs **J** and **K** when switch **S** is closed?

	Bulb J	Bulb K
A	brighter	dimmer
B	brighter	brighter
C	dimmer	dimmer
D	dimmer	brighter

32 3 resistors and 4 fuses (fuse rating shown within the bracket) are connected together as shown in the circuit.



When the switch is closed, which two fuses will blow?

A F_1 and F_2 only

B F_1 and F_3 only

C F_1 and F_4 only

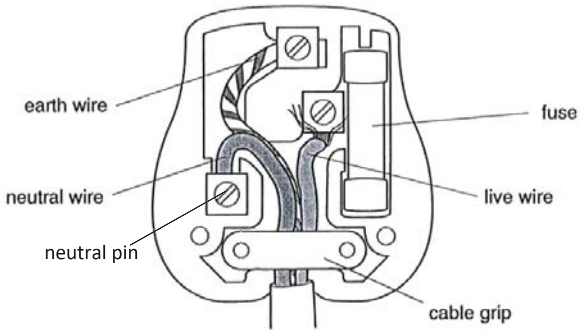
D F_3 and F_4 only

33 The following electrical devices are operated from the same voltage supply at the stated duration.

Which one of the devices is the most costly to operate?

	Power rating of device	Duration of usage
A	5.0 kW	50 s
B	200 W	20 min
C	30 W	2 h
D	7.5 W	One day

34 The diagram shows a three pin plug of a kettle whose live wire has not been connected properly.



The equipment with this plug connected to the mains is in operation.

Which of the following will occur when the exposed copper wire strands of the live wire touch the neutral pin?

A The current increases and the fuse will blow to prevent any electrical fire risk.

B The earth wire will divert the high current to the ground to prevent any electrical risk.

C The metal casing of the kettle will be at high potential and pose an electrocution risk.

D The neutral wire will divert the high current to the ground to prevent any electrical risk.

35 Fig. M shows a solenoid connected to a d.c. power supply XY. A steel needle is inserted inside the solenoid to be magnetised.

After the needle is magnetised, the needle is then placed on a piece of cardboard that is floating on the water. Fig. N shows the top view of the final position of the needle on the floating cardboard and the direction of the earth's magnetic field.

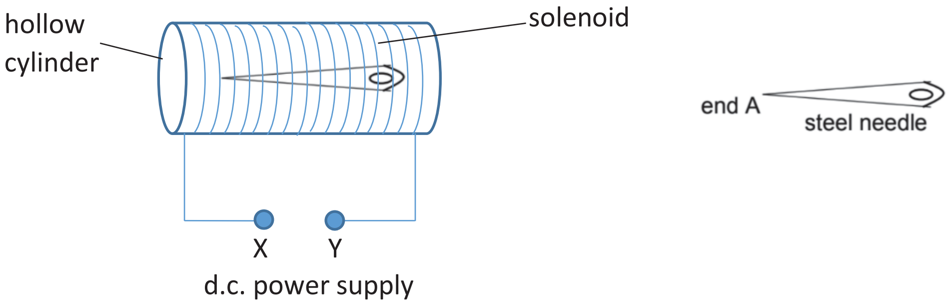


Fig. M

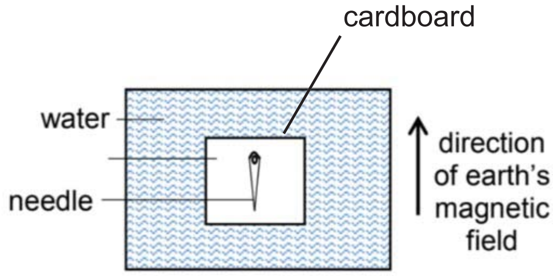


Fig. N

Which row shows the polarities for end A of the needle and the positive terminal of the d.c. power supply?

	End A of needle	Positive terminal of the d.c. supply
A	north	X
B	south	X
C	north	Y
D	south	Y

36 A match-box cover, with a magnet placed on top of it, is placed in a tray of paperclips. As the match-box cover is lifted up, a large number of paperclips are attracted to the bottom surface of the match-box as shown in Fig. A.

Two different sheets of metal (X and Y) are then placed inside the match-box cover, between the magnet and the paperclips, one after another as shown in Fig. B.

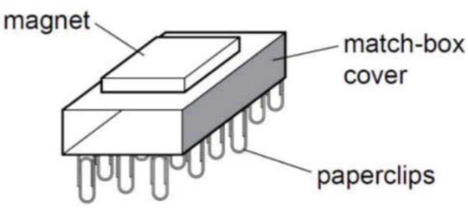


Fig. A

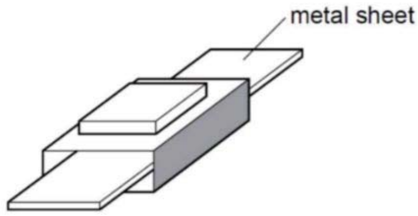


Fig. B

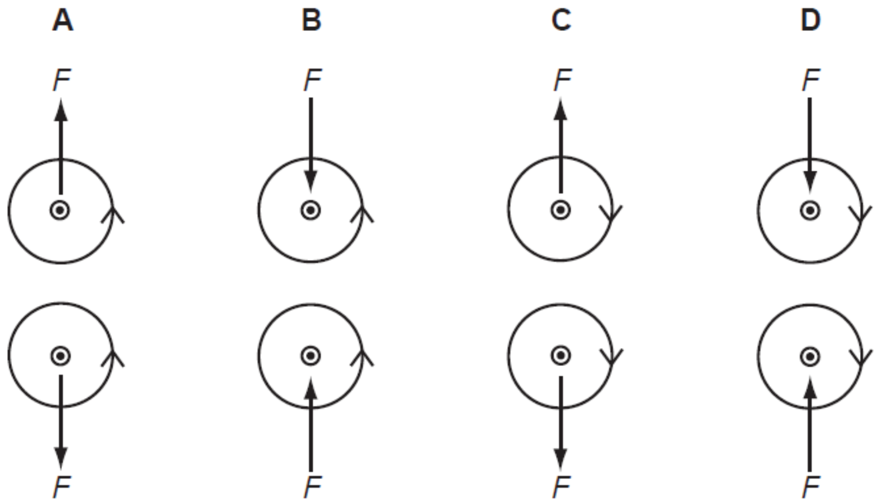
When sheet X is placed inside the match-box cover, the paperclips remain attached while when sheet Y is placed inside the match-box cover, all the paperclips fall off.

What are sheet X and sheet Y made of?

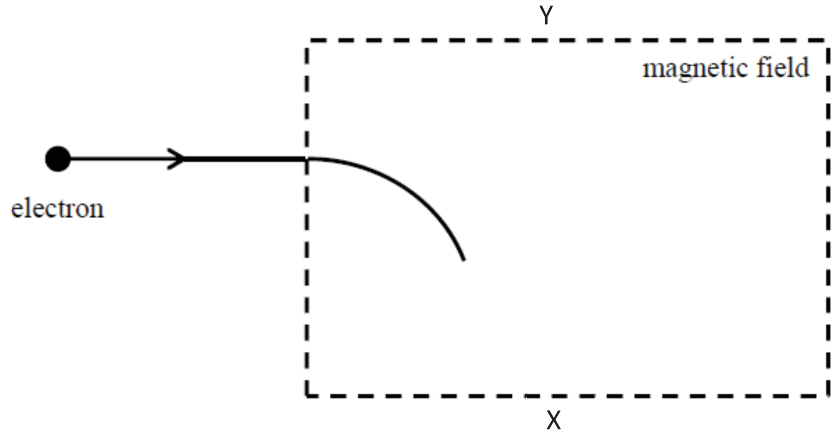
	metal X	metal Y
A	aluminium	copper
B	copper	iron
C	iron	aluminium
D	iron	steel

37 The diagrams show the forces *F* between two wires carrying currents out of the page. The magnetic fields close to the wires are also shown.

Which diagram is correct?



38 The figure shows the path of an electron as it moves into a uniform magnetic field. The location of the magnetic field is shown, but its direction is unknown.



Which of the followings indicate the direction of the magnetic field?

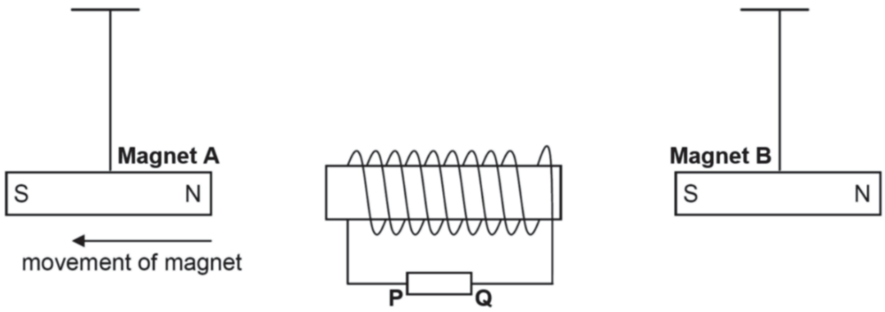
A Downwards, from Y to X

B Into the paper

C Out of the paper

D Upwards, from X to Y

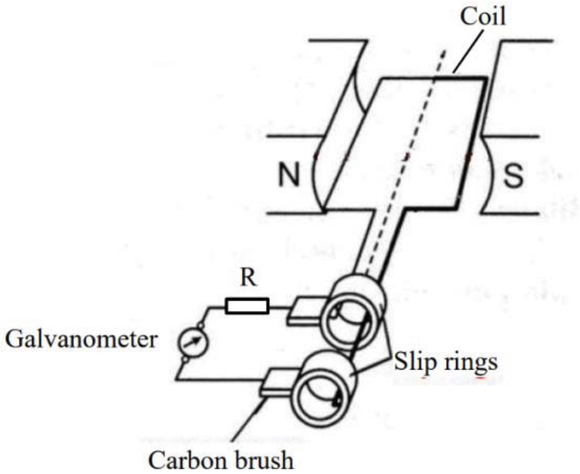
39 The diagram shows a solenoid placed between two magnets (A and B) that are freely suspended from the ceiling.



If magnet A is moved to the left, away from the solenoid, what is the direction of the induced current through resistor PQ and the direction in which magnet B will move?

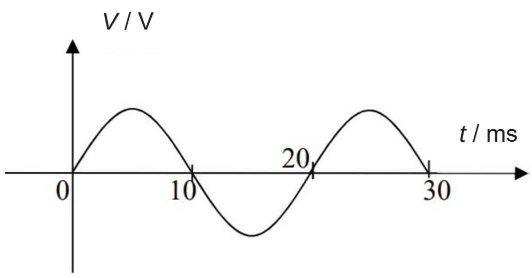
	Direction of induced current through resistor PQ	Movement of magnet B
A	from P to Q	attracts towards solenoid
B	from P to Q	repels away from solenoid
C	from Q to P	attracts towards solenoid
D	from Q to P	repels away from solenoid

40 The diagram shows an a.c. generator with a coil that is turning at a frequency of 50 Hz.

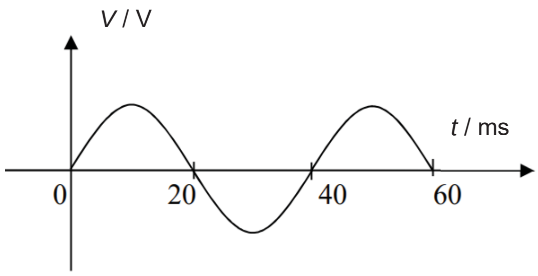


Which graph corresponds to the variation of the induced voltage with time of the a.c. generator starting from the position shown in the diagram?

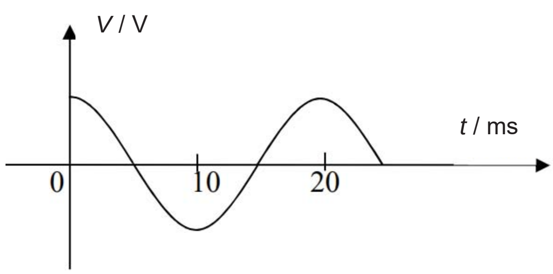
A



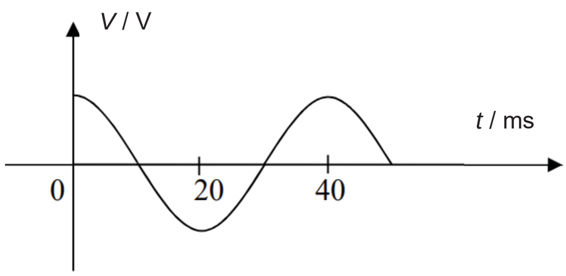
B



C



D



End of Paper

Section A (50 marks)
Answer **all** the questions in this section.

1 A student wants to determine the density of a square metal plate.
Fig. 1.1 shows the length, width and mass of the metal plate she has measured.

length of metal plate / cm	width of metal plate / cm	mass of metal plate / kg
30.0	30.0	2.5

Fig.1.1

She decides to use a pair of vernier calipers to measure the thickness of the metal plate.
Fig. 1.2 shows the reading taken by the student.

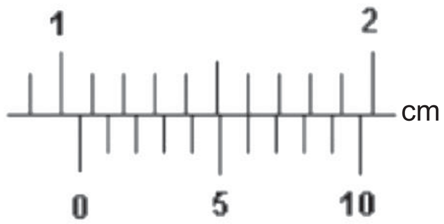


Fig 1.2

(a) **(i)** Determine the thickness of the metal plate.

thickness = ……………………………[1]

(ii) Suggest how the student can improve her accuracy in measuring the thickness of the metal plate.

....

....

[1]
....

(b) Calculate the density of the metal plate.

Leave your answer in g/cm^3. Show your working clearly.

density = ……………………………[3]

2 A student is sitting on a chair as shown in Fig. 2.1.

Fig. 2.1

The student tips his chair back to the position shown in Fig. 2.2.
A horizontal force of 150 N is applied at point C to keep the chair in this position.

Lengths

AB = 15.0 cm

CD = 70.0 cm

BD = 20.0 cm

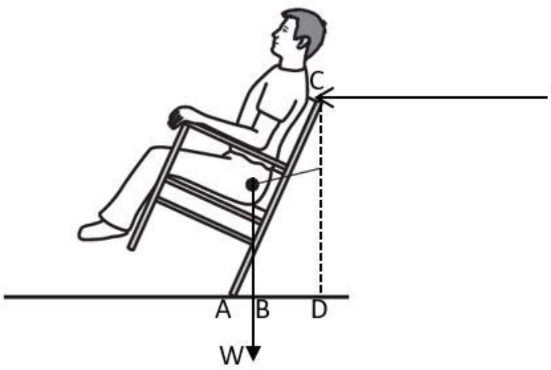


Fig. 2.2

(a) State the principle of moments.

....

.... [1]

(b) By taking moments about A, determine *W* the weight of the student and chair.

weight = ...[2]

(c) Explain what will happen to the student and the chair in Fig. 2.2 when the horizontal force is removed.

....

.... [2]

3 Fig. 3.1 shows a glass which contains water at 22°C.
22 g of ice at a temperature of -12°C was put inside the water.

Fig. 3.1

The specific heat capacity of ice = 2100 J/kg K
The latent heat of fusion of ice = 3.3×10^5 J/kg

(a) **(i)** Calculate the amount of thermal energy needed to raise the temperature of ice from -12°C to 0.0°C.

thermal energy = ………………………….[2]

(ii) Calculate the latent heat needed to change the ice to water.

thermal energy = ………………………….[2]

(b) The temperature of the water in the cup falls after the ice has been added.
Specific heat capacity of water = 4200 J/(kg°C)

Calculate the mass of water in the cup if the lowest temperature reached by the water is 8.0°C.

mass of water = ………………………….[2]

(c) The internal energy of the ice increases as it turns into water at its melting point. Explain, using ideas about molecules, why this increase occurs.

....

....

[1]
....

4 Fig. 4.1 shows a U-tube mercury manometer connected to a sealed cylinder containing a gas. The piston is held in place and is not free to move.

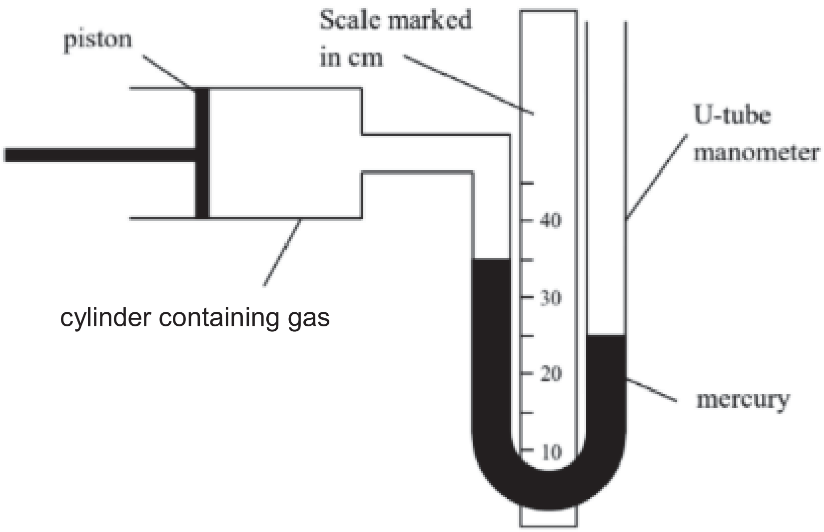


Fig. 4.1

The atmospheric pressure surrounding the manometer is 1.0×10^5 Pa.
The density of mercury is 13600 kg/m^3. The gravitational field strength g is 10 N/kg.

(a) Calculate the pressure of the gas in the cylinder as shown in Fig. 4.1. Give your answer in Pa.

pressure = ……………………….[2]

(b) The temperature remains constant as the piston is pushed inwards slowly.
Using ideas about molecules, explain the change in the volume and pressure of the gas.

....

....

....

....

....

.... [2]

5 A student releases the pendulum bob from point P from a vertical height *h* as shown in Fig. 5.1 and measures the speed of the bob from P to Q to R.

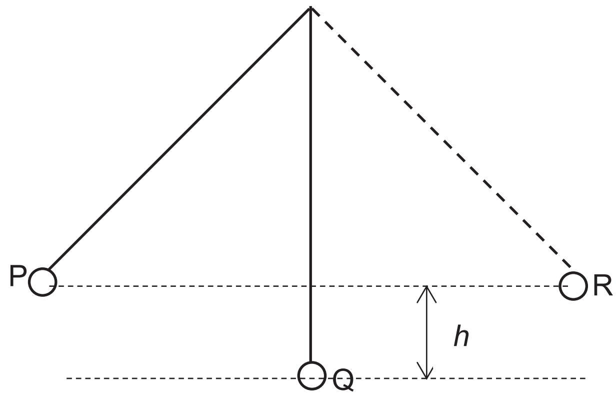


Fig. 5.1

Fig. 5.2 shows how the speed *v* of the pendulum bob varies with time *t.*

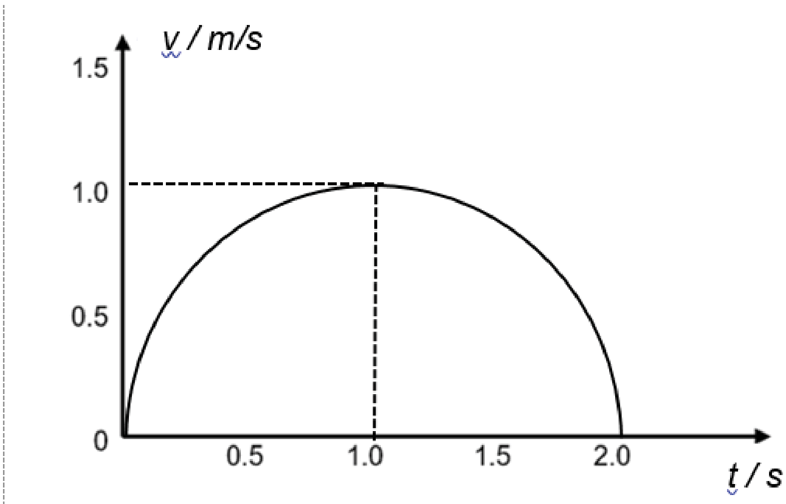


Fig 5.2

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

(a) State the main energy change when the bob swings from P to Q.

....[1]

(b) Assuming that there is no energy loss, calculate the vertical height *h* from which the pendulum is released.

h = ……………………….[2]

(c) Using Fig. 5.2, determine the period of the pendulum.

period = ……………………….[1]

6 Fig. 6.1 shows the graph of a wave motion produced by a sound that is captured by a microphone.

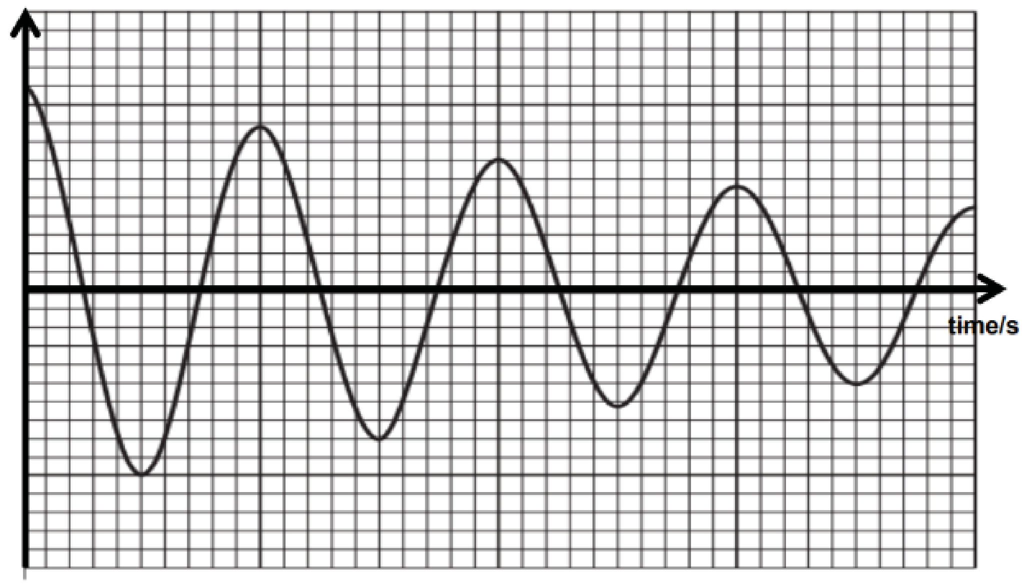


Fig. 6.1

(a) State and explain how the waveform indicates how the loudness and pitch of the sound changes (if any) with time.

(i) loudness

....

....

.... [1]

(ii) pitch

....

....

.... [1]

(b) Another sound wave is captured by the microphone. Fig. 6.2 shows how the output voltage of the microphone varies with time.

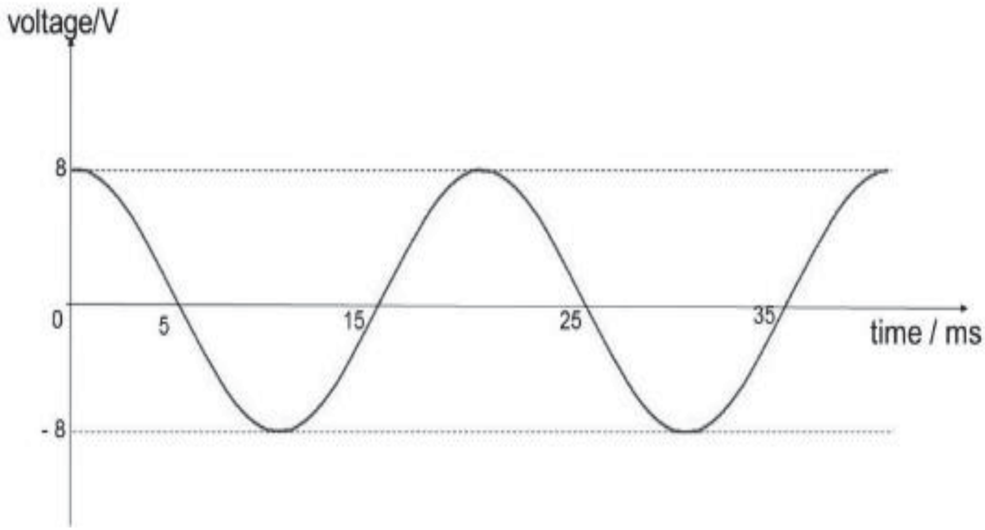


Fig. 6.2

The microphone is connected to a cathode-ray oscilloscope (c.r.o.). The Y-gain of the oscilloscope is set at 4 V/division and the time base is set at 5 ms/division.

On Fig. 6.3, draw the waveform(s) of the sound as seen on the screen of the oscilloscope.

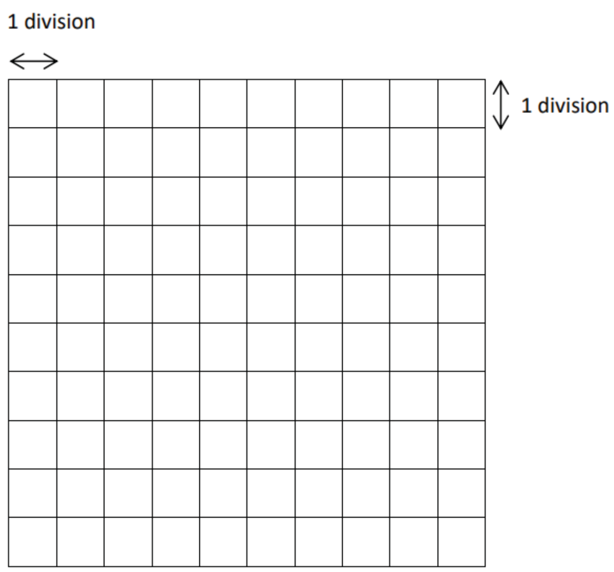


Fig. 6.3

[2]

7 Fig. 7.1 shows a virtual image I formed by a converging lens from an object of height 1.0 cm.

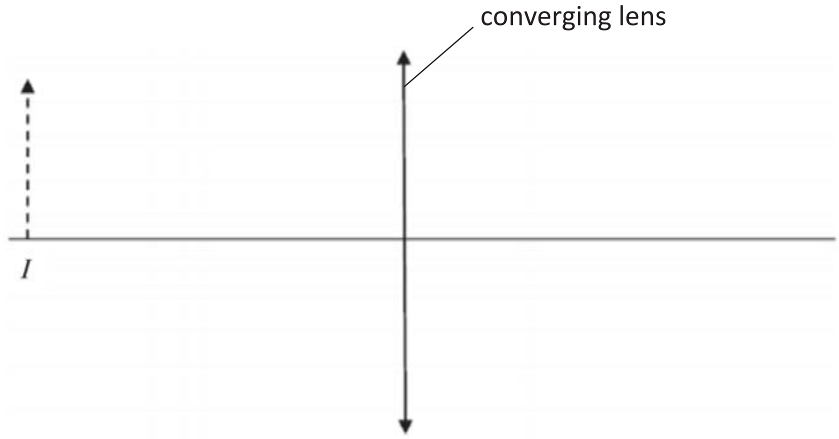


Fig. 7.1 (Diagram drawn to scale)

(a) On Fig. 7.1 above, draw rays to determine

(i) the position of the object and label it O, [2]

(ii) the focal length of the lens.

focal length = ………………………..[1]

(b) Fig. 7.2 shows a light ray travelling in a converging lens of refractive index 1.5.

Fig. 7.2 is not drawn to scale.

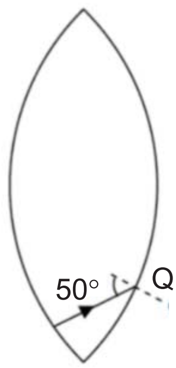


Fig. 7.2 (Diagram not drawn to scale)

(i) Calculate the critical angle

critical angle = ……………………. [1]

(ii) Explain the behaviour of the light ray immediately after it is incident on surface Q.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

………………………………………………………………………………………………………

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

8 Plaque is a sticky film of bacteria that constantly forms on teeth as shown in Fig. 8.1.

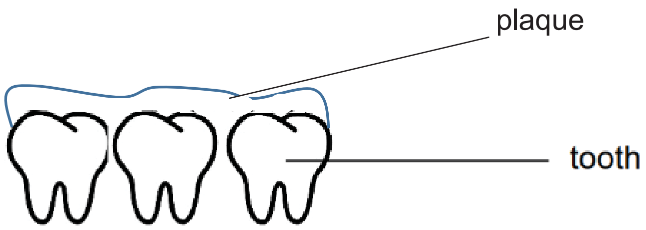
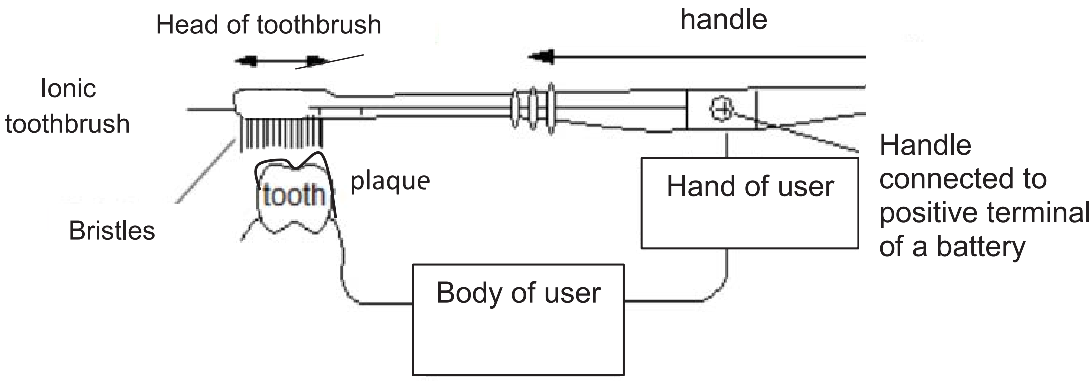


Fig. 8.1

Fig. 8.2 shows an ionic toothbrush with a small battery built into the handle of the toothbrush. The battery in the toothbrush enable the bristles to be negatively charged when it is switched on and the positive terminal of the battery makes contact with the hand of a user.

Fig. 8.2



(a) **(i)** State the charge(s) that is/are acquired on the plaque and tooth when the user's hand is on the handle.

.... [1]

(ii) Explain your answer to **(a)(i)**

....

....

.... [1]

(b) Explain, in terms of charges, how this toothbrush helps to remove the plaque effectively.

____

____

____

____

____

____ [2]

9 Fig. 9.1 shows a washing machine with a metal casing connected to the main power source. The machine is rated at 3.0 kW, 240 V.

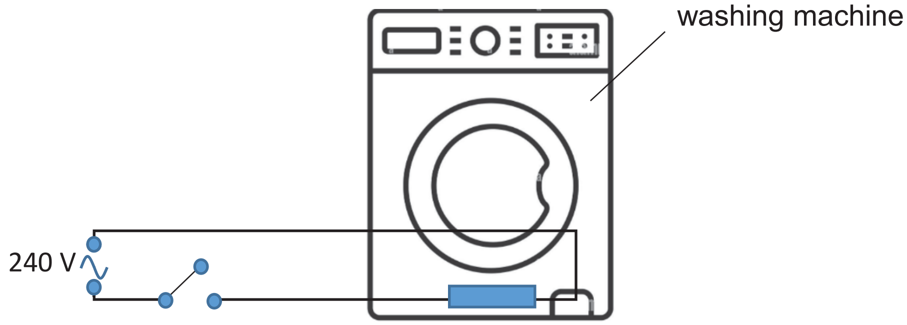


Fig. 9.1

(a) Draw, on Fig. 9.1, an electrical component that will protect the washing machine from being damaged by a sudden surge of current.

Label this component as K. [1]

(b) An electrician noticed that the earth wire is not connected as part of the circuit.

(i) State what hazard may happen as a result of not having the earth wire in the circuit.

....

....

....[1]

(ii) Draw, on Fig. 9.1, to show how the earth wire should be connected as part of the circuit. [1]

(c) Calculate the operating current of the washing machine when the switch is closed.

current = ………………………..[2]

10 Fig. 10.1 shows two strong permanent magnets with the N-pole of one magnet facing the S-pole of another.

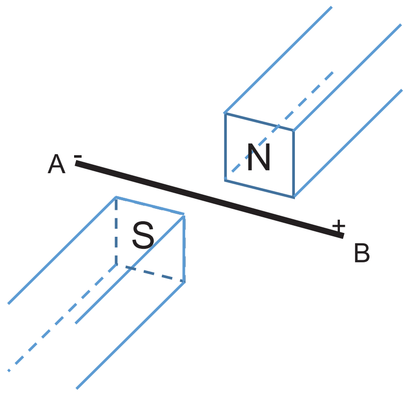


Fig. 10.1

A section of a horizontal, wire AB lies in the magnetic field between the two magnetic poles. End A of the wire is connected to the negative terminal of the battery and end B is connected to the positive terminal.

(a) Suggest and explain a suitable material for the two magnets.

....

....

.... [2]

(b) The part of wire AB that is in the magnetic field experiences a force *F*.

On Fig. 10.1, draw an arrow to indicate the direction of *F* and describe how this direction is deduced. Label this force as *F*.

....

....

....

.... [2]

(c) The equipment in Fig. 10.2 is used in a similar experiment except that the S pole of the magnet is replaced with another N pole of the same magnetic field strength.

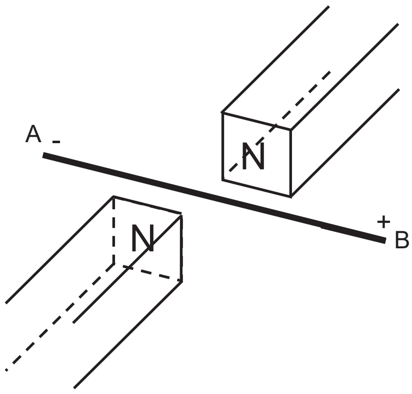


Fig. 10.2

AB is connected to the battery in the same way as before.

State and explain what happens to magnitude of the force *F* on the wire.

....

....

....

.... [2]

Section B (*30* marks)

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

11 Fig. 11.1 shows two circuits which powers a heater when the room is cold.

Circuit 1 has a source of e.m.f, 12.0 V, a variable resistor, X set to its maximum resistance of 600 Ω and a thermistor, T. The thermistor is connected across a relay with a very high resistance.

The relay is an electromagnet that controls the operation of Circuit 2 by attracting the switch and turns the heater on when the room temperature falls below a certain value. When the relay is not in operation, the switch in circuit 2 remains open. Circuit 2 has an input alternating voltage of 120 V.

Table 11.2 shows the resistance of the thermistor, T at different surrounding temperatures.

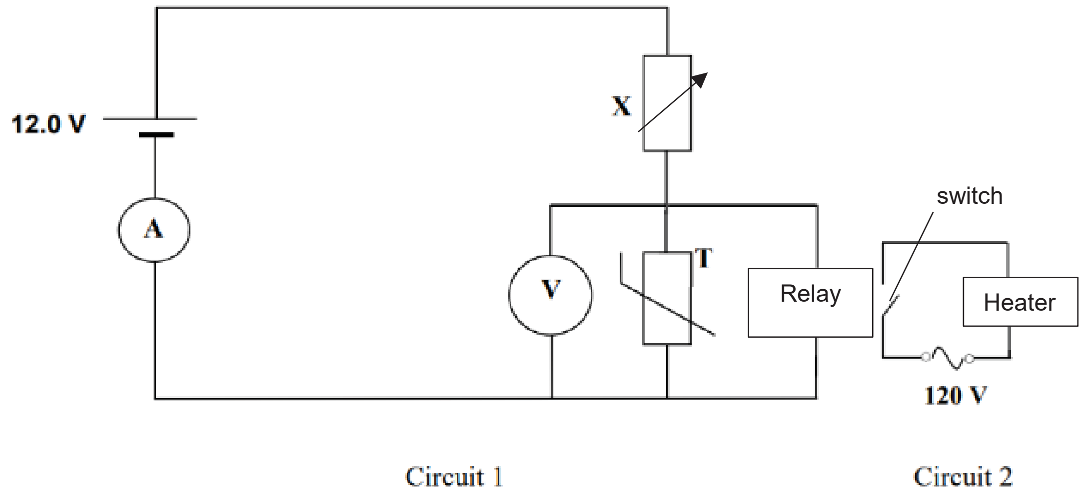


Fig. 11.1

Temperature / °C	Thermistor resistance / Ω
10.0	280
20.0	150
30.0	80
40.0	50
60.0	25
70.0	20

Table 11.2

(a) Using Fig. 11.1 and Table 11.2, determine the voltmeter reading when the temperature reaches 30 ºC and X is set to its maximum resistance.

voltmeter reading = …………………… [2]

(b) Explain why the heater is activated when the temperature of the room falls.

....

....

....

....

.... [3]

(c) The switch in Circuit 2 closes and activates the heater when the potential difference across the relay is 2.4 V or higher.

Using Fig. 11.1 and Table 11.2, determine the range of temperatures of the room that can activate the heater when the variable resistor, X is set to 600 Ω.

range of temperature = ……………………………. [3]

(d) The resistance of the variable resistor, X is reduced.

Explain how this action will affect the operation of the heater in circuit 2.

....

....

....

....

....

.... [2]

12 Fig. 12.1 shows a car, which starts from rest and travels in a straight line.

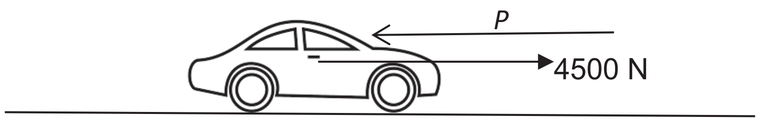


Fig. 12.1

The force on the car due to the engine has a constant value of 4500 N. When the car is moving there is air resistance acting on the car.

Fig. 12.2 shows how the acceleration *a* of the car varies with the air resistance *P.*

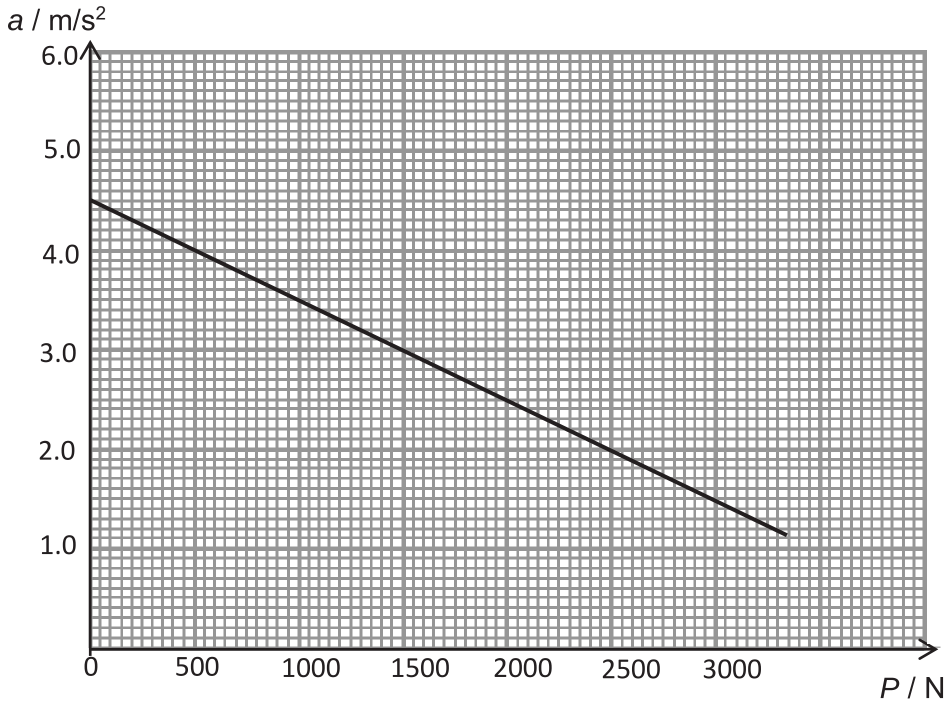


Fig. 12.2

(a) State the initial value of *P* when the car is at rest.

P = …………………….[1]

(b) **(i)** State the equation that relates resultant force *F*, the mass *m* of the car and the acceleration *a*.

....[1]

(ii) Using Fig. 12.2 , calculate *m.*

m = …………………………[2]

(c) Using Fig. 2.2, explain how the acceleration of the car changes with air resistance *P*.

....

....

....

.... [2]

(d) The air resistance *P* and the force due to the engine in Fig. 12.1 are not Newton's Third Law action-reaction pair.

Describe the other force that is part of the action-reaction pair with *P*. and state the body on which it acts.

....

....

....

.... [2]

(e) The brakes were applied at time t = 30 minutes. The velocity of the car decreases. In the next 10 min, the car travels a distance of 1.0 km. At the end of 10 min the car comes to a complete stop.

On the grid in Fig.12.3 sketch a graph to show the displacement d of the car from time t = 30 to t = 50 minutes. Take displacement as zero from the position where the brakes are applied.

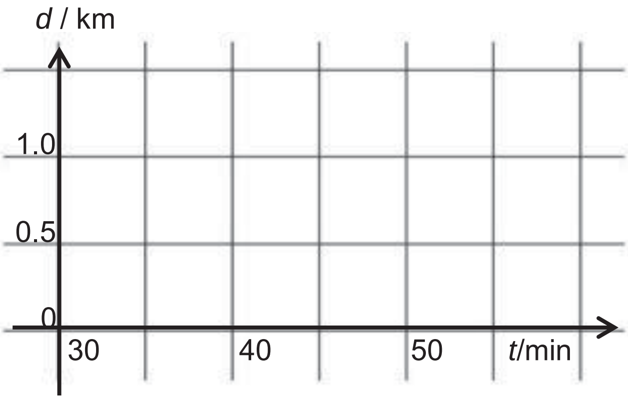


Fig. 12.3

[2]

13 Either

(a) Fig. 13.1 shows a throat microphone used by a teacher in class. The vibrations from his throat will be picked up by sensors in the throat microphone.

Fig 13.2 shows the electric circuit setup that converts the vibrations from the throat to electric current in the throat microphone.

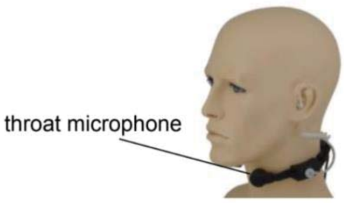


Fig. 13.1

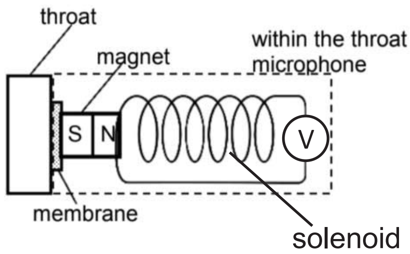


Fig. 13.2

(i) State Faraday's Law of electromagnetic induction.

....

.... [1]

(ii) Explain how the movement of the throat can create an electric current in the solenoid in Fig. 13.2.

....

....

....

....

.... [2]

(iii) Explain, in terms of Lenz's law, why the electric current produced in the microphone is alternating.

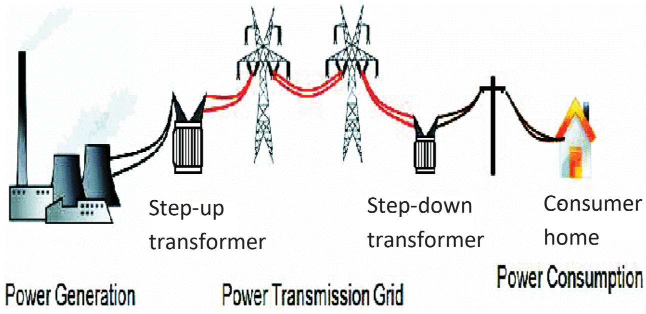
....

....

....

.... [2]

(b) When electricity is transmitted over long distances, a transformer is used to step-up the voltage before transmission. A second transformer is used at the destination to step-down the voltage to the usual mains value.



A power station generates electrical energy at 25 000 V, 12 000 A. The generator in the power station is connected to the primary coil of an ideal transformer shown in Fig. 13.3. The transformer changes the voltage before the electrical energy is transmitted across the country through the long cables.

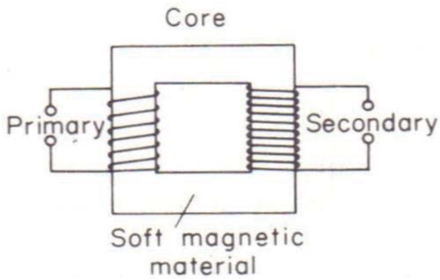


Fig. 13.3

The output from the secondary coil of the transformer is 400 000 V.

(i) Calculate the turns ratio.

turns ratio = …………………….. [1]

(ii) Calculate the output current from the transformer.

output current = ……………… [2]

(iii) Explain one advantage of transmitting electricity through the long cables at a high voltage.

....

....

....

....

.... [2]

OR

(a) State two differences between boiling and evaporation.

1.

....

....

2.

....

[2]

....

(b) Fig.13.4 shows an electric kettle.

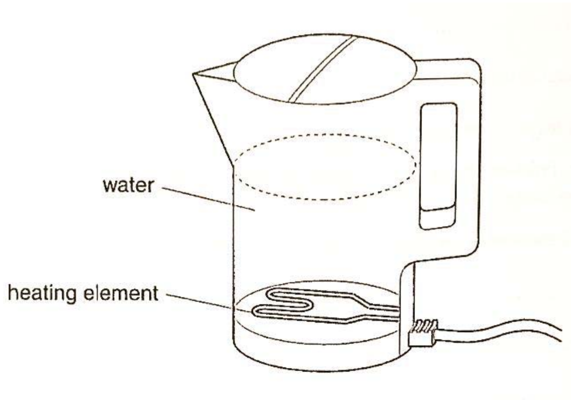


Fig. 13.4

The circuit in Fig.13.5 shows the circuit representing the kettle used in Fig.13.4.

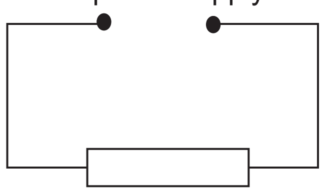


Fig. 13.5

A student decides to determine the power of the heater.

(i) On Fig.13.5, draw the appropriate instruments needed to determine the power of the heater.

(ii) State the formula the student uses to determine the power of the heater.

....[2]

(iii) The kettle has an electrical power input of 2000 W and is switched on for a further 6.0 minutes after the water has reached its boiling point.

The specific latent heat of vaporisation of water is 2.36×10^6 J/kg.

Calculate the mass of steam (in grams) produced in 6.0 minutes.

mass = ……………………….[2]

(c) When the kettle is switched off, the remaining water in the kettle cools down.

Explain in terms of molecules, how evaporation causes a drop in the temperature of the water.

....

....

....

....[2]

(d) The surface of the kettle radiates a certain amount of thermal energy (infra-red radiation).

Suggest and explain a suitable type of surface and colour used for the kettle.

....

....

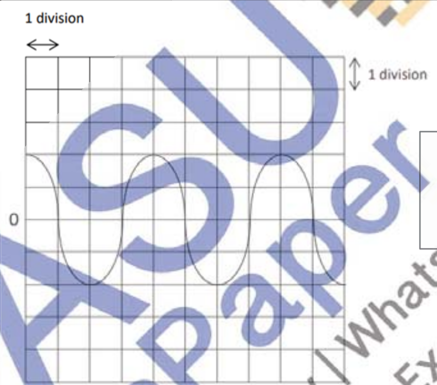
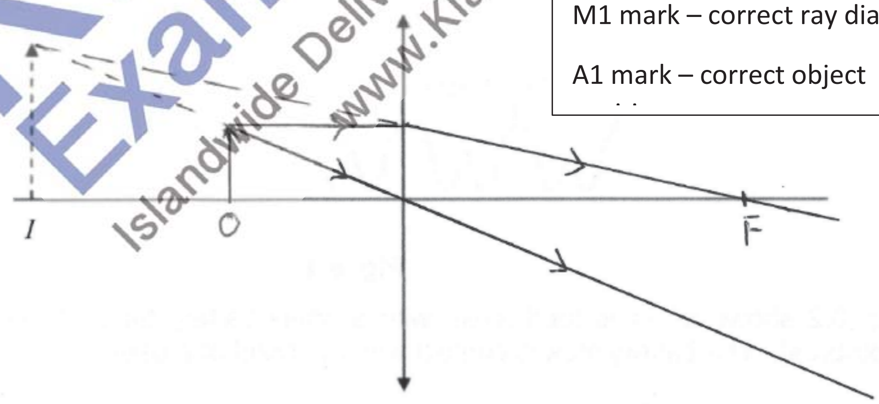
....[2]

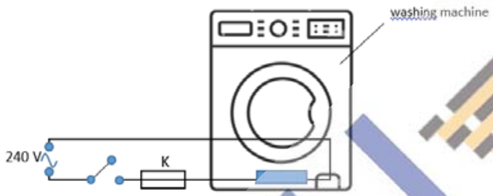
End of paper

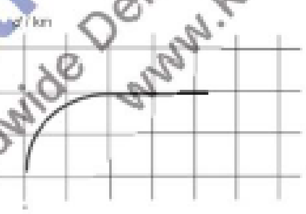
Answers to 2022 Prelim Physics P1 and P2

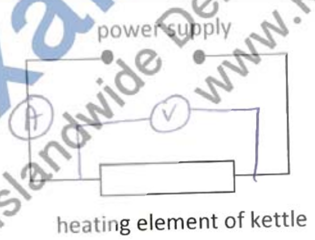
1	2	3	4	5	6	7	8	9	10
D	A	A	B	B	D	B	B	D	A
11	12	13	14	15	16	17	18	19	20
C	A	D	A	D	C	C	C	A	C
21	22	23	24	25	26	27	28	29	30
A	C	C	D	B	C	A	B	D	A
31	32	33	34	35	36	37	38	39	40
A	C	D	A	B	B	B	B	C	C

Question	Suggested answers	Marks
1 a (i)	1.06 cm	A1
a (ii)	Volume of metal plate = 30.0 x30.0 x 1.06 = 954 cm^3 Density = $\frac{mass}{volume}$ = $\frac{2500}{954}$ = 2.62 g/cm^3	M1 A1
b	1. Check for zero error. 2. Take 2 readings and find the average.	C1
2a	When an object is in equilibrium, the sum of clockwise moments about any point is equal to the sum of clockwise moments about the same point.	B1
2b	$W \times 15.0 = 150 \times 70.0$ $W = \frac{150 \times 70.0}{15.0}$ = 700 N	C1 A1
2c	The student and chair will topple as the weight W will produce a clockwise moment about A.	B1 C1
3a(i)	Amount of thermal energy = $mc\Delta\theta$ = 0.022 x2100 x12 = 554 J	C1 A1
3a(ii)	Latent heat needed = m x l = 0.022 x 3.3 x 10^5 = 7300 J (7260 J)	C1 A1
3b	Let the mass be m kg 554 + 7300 +(0.022 x 4200 x 8) = m x 4200 x 8	C1

	m = 0.146 kg	A1
3c	Latent heat absorbed by the ice molecules is used to break the bonds and separate the molecules further away. The potential energy of the molecules increases.	C1
4a	Difference in height is 35-25 = 10 cm Pressure of gas = $1.0 \times 10^5 - (0.1 \times 13600 \times 10)$ = 86400 Pa	B1 A1
4b	The volume of the gas decreases and the pressure increases. The number of molecules per unit volume increases and this will increase the rate/number of collisions. The average force per unit area increases.	C1 B1
5a	GPE to KE	B1
5b	$mgh = ½ v^2$ $10 \times h = ½ \times 1.0^2$ h = 0.050 m	C1 A1
5c	4.0 s	B1
6ai	Loudness decreases. Its amplitude decreases with time.	B1
6aii	Pitch remains the same as its periodic time remains the same. Hence the frequency remains the same.	B1
6b	 B1 mark – correct amplitude B1 mark – correct period	
7ai	 M1 mark – correct ray diagram A1 mark – correct object	
7aii	4.5 cm	A1
7b	$C = \sin^{-1}\left(\frac{1}{n}\right) = \sin^{-1}\left(\frac{1}{1.5}\right)$ $= 42°$	B1

	Total internal reflection occurs at Q. Angle of incidence is larger than critical angle of lens and the light is travelling from denser medium to less dense medium.	B1
8a	Some negative charges from the plaque and tooth is transferred to the positive terminal at the handle of the toothbrush.	B1 B1
8b	The bristles are negatively charged and attract the positively charged plaque as unlike charges attract. The tooth is which positively charged repels the plaque as like charges repel. Hence the plaque will be removed from the tooth.	B1 B1 B1
9a		A1
9b	In the event that the casing becomes live, the user may get electrocuted.	B1
9c	Connect the earth wire to the casing of the washing machine.	B1
9d	$I = \frac{3000}{240}$ $= 12.5A$	C1 A1
10a	Steel. It is a hard magnetic material that does not lose magnetism easily.	B1B1
10b	Use Fleming's left hand rule. Direction of thumb points in the direction of the force, index finger points in the direction of the magnetic field and the middle finger points in the direction of the current.	B1 B1
10c	The magnitude of the force is reduced to zero. (decreases) AS the N poles are facing each other the magnetic field in the middle of the wire is zero (weak). Little or no interaction of magnetic field to produce a force.	B1 B1
11a	$V = \frac{80}{600+80} \times 12.0$ $= 1.4 V$	C1 A1
11b	Temperature increase, resistance of T increases. Potential difference across T will increase.	B1 B1

	Current through/potential difference across relay will increase and operate the relay to activate the heater.	B1
11c	When the pd across the thermistor is 2.4V by calculation the resistance of thermistor R is given by $2.4 = \frac{R}{R+600} \times 12$ R = 150 Ω From Table 11.2 this correspond to a temperature of 20° C Hence the heater will activate between 10° C and 20 °C	
11d	When resistance of X is reduced, the heater will be turned on at a higher temperature. The resistance of T can be at a lower value to have the same potential difference across T to activate the relay. Hence the temperature of the surrounding can be higher for heater to operate.	B1 B1
12a	0	B1
12b(i)	F = ma	B1
12b(ii)	Choose one suitable from graph. When P = 1000 a = 3.5 4500 – 1000 = m x 3.5 m = 1000 kg	C1 A1
12(c)	From F = ma 4500 – P = ma From equation, P is directly proportional to *a* with a negative gradient. This means that change in a is a constant.	C1 C1
12(d)	Force of car on air. This force acts on the air molecules.	B1 C1
12(e)	 Fig. 12.3	B1 B1
EITHER		
13ai	Magnitude of the induced emf is directly proportional to the rate of change of magnetic flux linking the conductor.	B1
aii	Movement of the throat causes the magnet to vibrate horizontally. This causes a changing magnetic flux linking the solenoid.	B1 B1

	Hence inducing an emf across the solenoid and since the circuit is complete, current is induced.	
aiii	The current induced in the solenoid flows in a direction that generates polarity at the side of the solenoid facing the magnet to oppose the movement of the magnet. As the magnet vibrates in and out of the solenoid, the current induced has to alternate in order to generate opposite polarities to oppose this movement.	B1 B1
bi	$\frac{N_s}{N_p} = \frac{V_s}{V_p} = \frac{400000}{25000}$ $= 16 : 1$	A1
bii	$\frac{V_s}{V_p} = \frac{I_p}{I_s}$ $\quad I_s = 750\text{ A}.$ $\frac{400000}{25000} = \frac{12000}{I_s}$	C1 A1
biii	When voltage is high, the current through the transmitting cable is low. This will reduce the amount of energy lost as thermal energy when current goes through the long cables.	B1 B1
OR		
13a	1. Boiling occurs throughout the liquid. Evaporation occurs at the surface. 2. Boiling occurs at a fixed temperature and evaporation occurs at any temperature.	C1 C1
13b(i)	 Power = I V	B1 B1
13b(ii)	P x t = ml 2000 x 6 x60 = m x 2.36 x 10^6 m = 0.31 kg = 310 g	C1 A1
13(c)	The faster moving molecules are able to leave the surface of the liquid. The average speed of the molecules in the liquid decreases hence the average KE decrease. This results in loss of energy.	C1 C1

13(d)	Shiny smooth surface so that less thermal energy is lost by radiation as shiny surfaces are poor radiators of thermal energy.	B1 B1

SERANGOON SECONDARY SCHOOL
PRELIMINARY EXAMINATION
SECONDARY 4 EXPRESS

CANDIDATE NAME	( )		CLASS			
CENTRE NUMBER	S				INDEX NUMBER	

PHYSICS **6091/01**
Aug 2022
Paper 1 Multiple Choice **1 hour**

Additional Materials: Multiple Choice Answer Sheet

Setter(s):

READ THESE INSTRUCTIONS FIRST

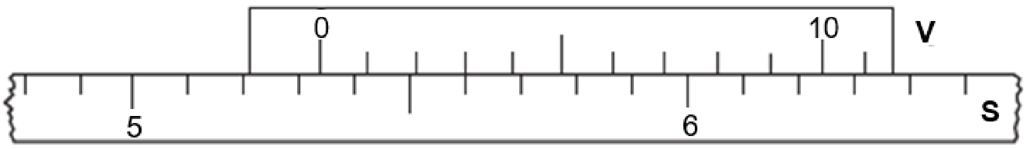
Write in soft pencil.
Write your name, class and index number on the Answer Sheet in the spaces provided unless this has been done for you.

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

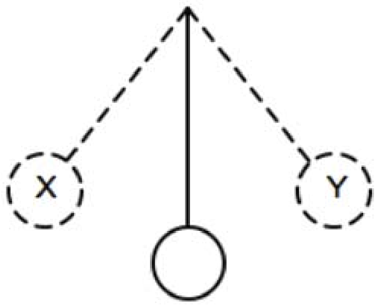
1 The diagram shows vernier scale **V** placed against a main scale **S**.



What is the reading on the vernier caliper?

A 5.23 cm **B** 5.26 cm **C** 5.33 cm **D** 5.43 cm

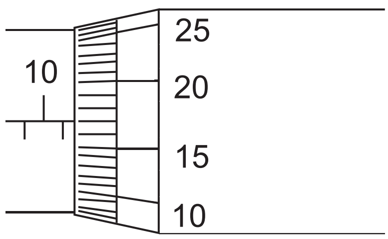
2 A pendulum swings from **X** to **Y** and back to **X** again twenty times in 37.4 s.



What is the frequency of the pendulum?

A 0.0267 Hz **B** 0.267 Hz **C** 0.535 Hz **D** 1.87 Hz

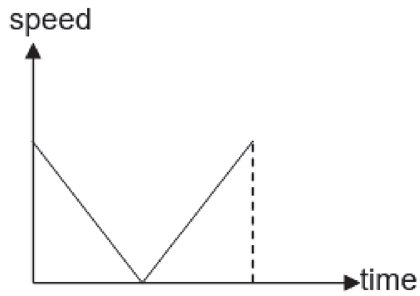
3 The diagram shows a micrometer reading when a ball-bearing was gripped between the anvil and the spindle. If the instrument has a zero error of +0.02 mm, what is the actual diameter of the ball bearing in mm?



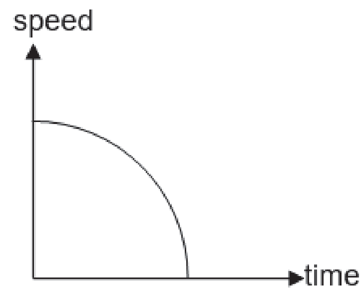
A 10.65 mm **B** 10.67 mm **C** 10.69 mm **D** 11.17 mm

4 A ball is thrown vertically upwards.
Which graph best demonstrates the entire motion of the ball as observed from the ground?

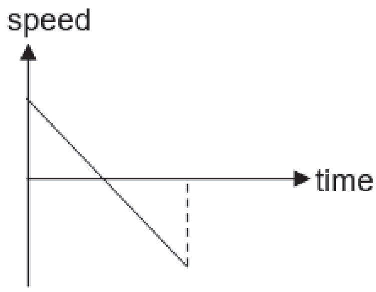
A



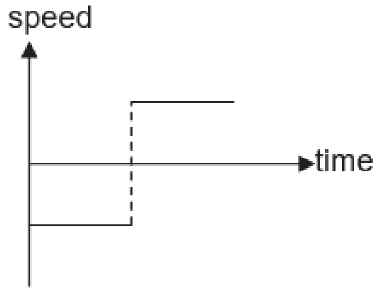
B



C



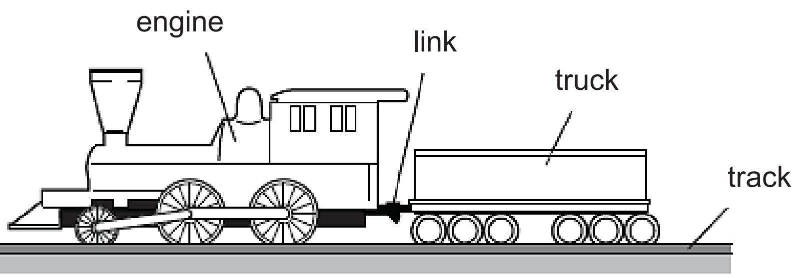
D



5 A car moving with a speed of 15 m/s can be stopped in a distance of 15 m under constant deceleration. What is the time taken to brake?

A 1.0 s **B** 2.0 s **C** 3.0 s **D** 4.0 s

6 An engine pulls a truck at constant speed on a level track.



The link between the engine and the truck breaks. The driving force on the engine remains constant. What effect does this have on the engine and on the truck?

	engine	truck
A	speed stays constant	slows down
B	speeds up	slows down
C	speed stays constant	stops immediately
D	speeds up	stops immediately

7 A rocket has a mass of 100 kg. The force produced by the engine of the rocket is 3000 N in the direction against the force of gravity. [g = 10 N/kg]

What is the acceleration of the rocket?

A 10 m/s^2 **B** 20 m/s^2 **C** 30 m/s^2 **D** 40 m/s^2

8 Which of the following physical quantities consist only of scalar quantities?

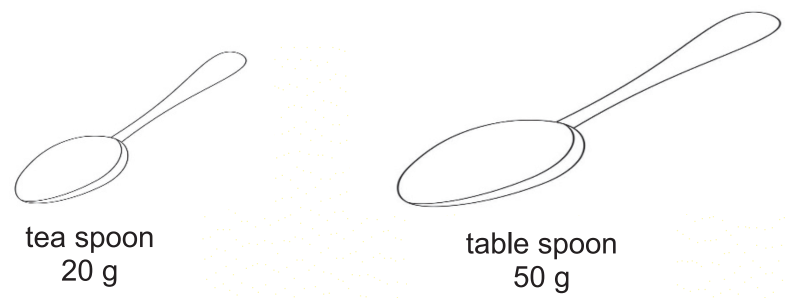
A acceleration, force, velocity

B acceleration, force, volume

C acceleration, mass, velocity

D mass, time, speed

9 The diagram shows a tea spoon and a table spoon that are made of pure silver.



Which statement is correct about the densities of the two types of spoons?

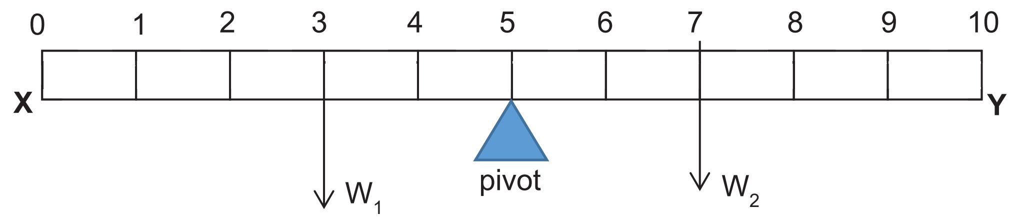
A Both spoons have the same density.

B The densities for the tea spoon and the table spoon are 20 g/cm^3 and 50 g/cm^3 respectively.

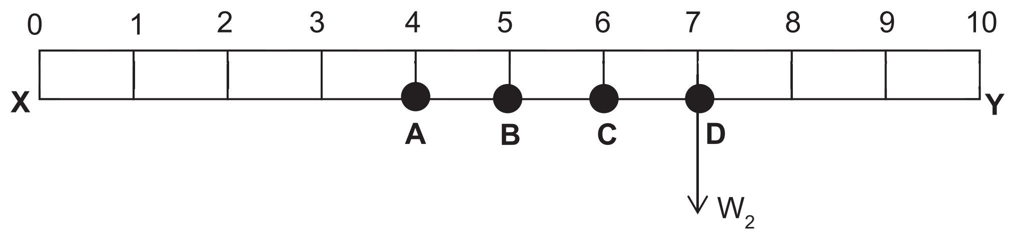
C The table spoon has a higher density than the tea spoon.

D The tea spoon has a higher density than the table spoon.

10 A uniform beam XY is balanced on a pivot with two weights, W_1 and W_2 hung at equal distances from the pivot.

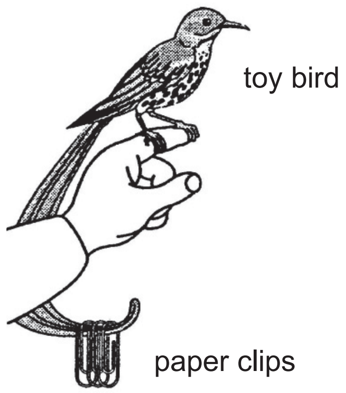


It is observed that the end Y moves downward when W_1 is removed.



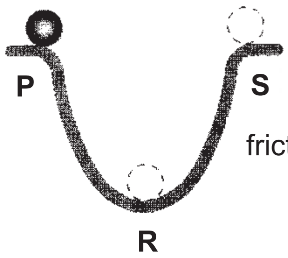
Where should the pivot be in order to balance the beam again?

11 A boy uses paper clips to balance a toy bird on his finger as shown.
What is the effect of the paper clips?



A They help to raise the centre of gravity of the toy bird to a position as high as his finger.
B They help to lower the centre of gravity of the toy bird to a position as high as his finger.
C They help to raise the centre of gravity of the toy bird to a position above his finger.
D They help to lower the centre of gravity of the toy bird to a position below his finger.

12 The diagram shows a metal sphere oscillating on a frictionless track.



Which statement is true?

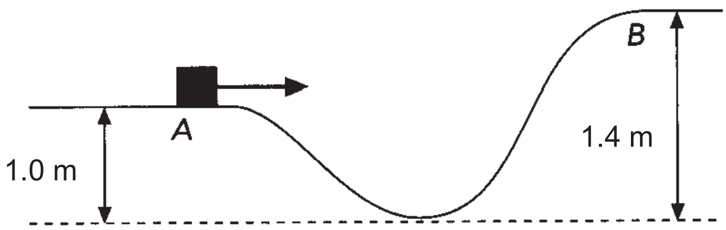
A The kinetic energy of the metal sphere is minimum at R.

B The kinetic energy of the metal sphere is the same at all times.

C The potential energy of the metal sphere is minimum at P.

D The total energy of the metal sphere at S, R and P are equal.

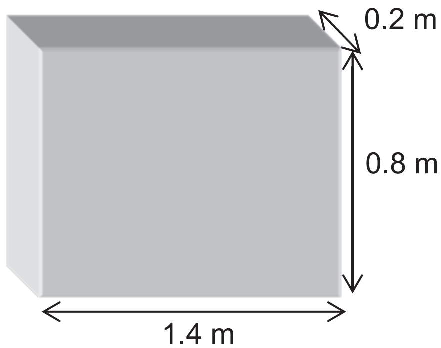
13 The diagram shows a small object of mass 2.0 kg moving along a track. The speeds of the object at point A and B are 4.0 m/s and 1.0 m/s respectively. The length of the track AB is 2.5 m. [g = 10 N/kg]



What is the average value of frictional force acting on the object as it is moving from A to B?

A 2.8 N **B** 5.6 N **C** 11.2 N **D** 22.4 N

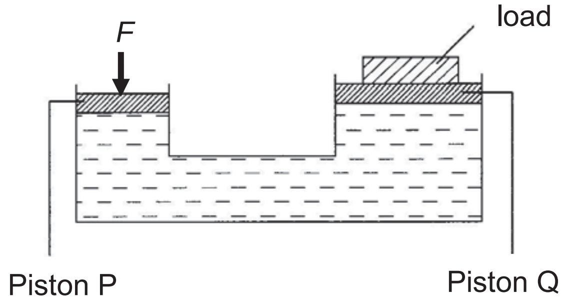
14 A box with a mass of 20 kg has dimensions as shown.



What is the maximum pressure that the box can exert on the ground? [g = 10 N/kg]

A 125 Pa **B** 179 Pa **C** 714.3 Pa **D** 1250 Pa

15 The diagram shows a hydraulic pump.



Which statement is correct?

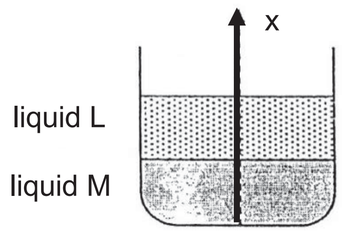
A The force *F* is greater than the weight of the load.

B The force *F* is the same as the weight of the load.

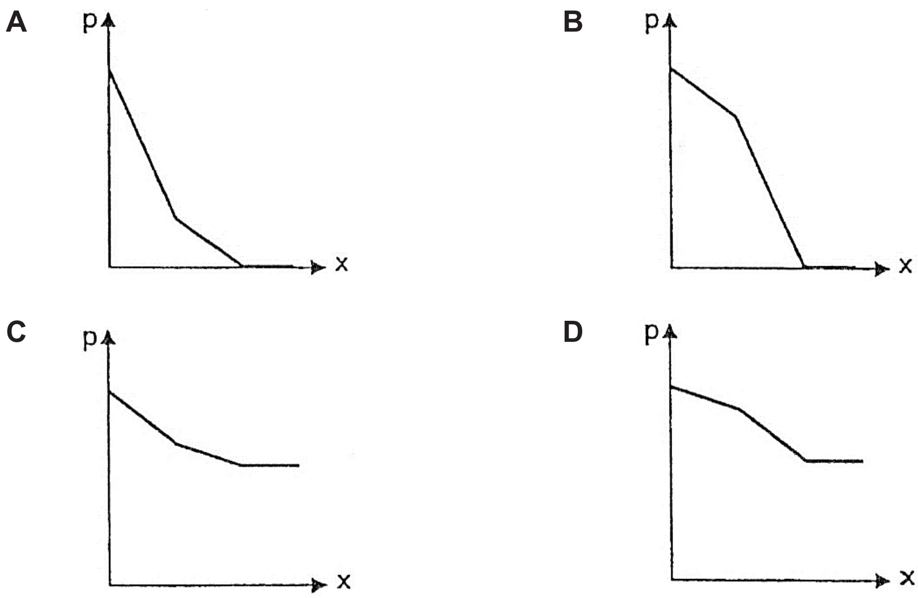
C The pressure on piston P is the same as the pressure on piston Q.

D The pressure on piston P is smaller than the pressure on piston Q.

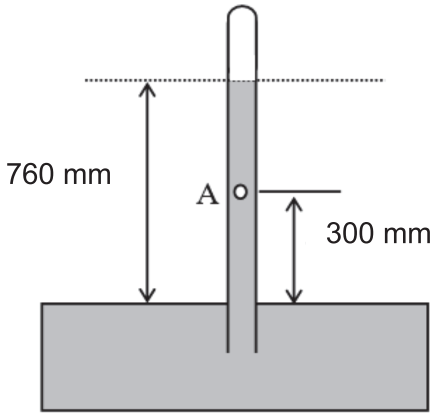
16 A container which is open to the atmosphere contains a layer of liquid L floating on liquid M. Liquid M has a density which is twice as great as that of liquid L.



Which graph shows how the pressure p, at a point varies with its height x, above the base of the container?



17 What is the pressure at point A in the mercury barometer shown below?



A 300 mmHg **B** 460 mmHg **C** 760 mmHg **D** 1060 mmHg

18 Brownian motion is often demonstrated by viewing through a low power microscope illuminated smoke particles contained in a sealed transparent cell.

Which statement is **not** correct?

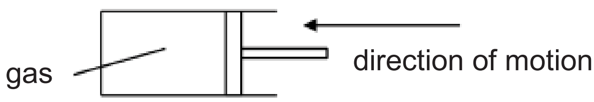
A The observed motion is caused by the random motion of the smoke particles.

B Small specks of light are seen moving about in a random motion.

C Air molecules are too tiny to be observed through the microscope.

D The speed of the observed motion would decrease if the temperature drops.

19 Gas inside a cylinder is cooled slowly to a lower temperature. The pressure inside the cylinder remains constant as the piston moves inwards.



How do the speed of the particles and their rate of collisions with the cylinder and piston compare with their initial values at the higher temperature?

	average speed	rate of collision
A	decreases	decreases
B	decreases	increases
C	same	same

D	same	decreases

20 Which change in physical property **cannot** be used for temperature measurement?

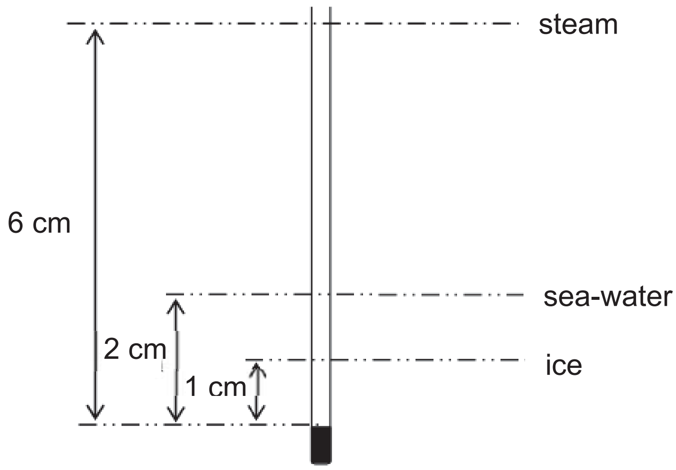
A e.m.f. of a battery

B electrical resistance of a solid

C pressure of a gas

D volume of a liquid

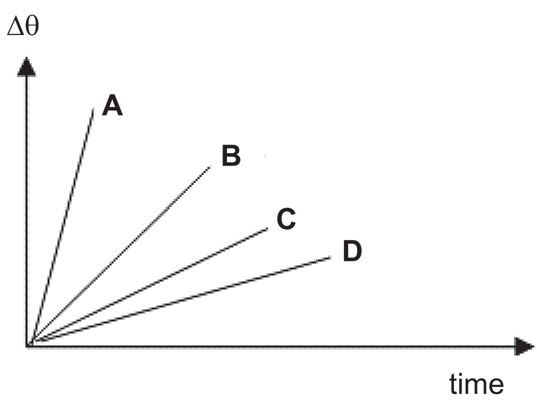
21 A student puts the bulb of an unmarked liquid-in-glass thermometer into melting ice, then into steam and finally into sea-water. The diagram shows the liquid levels measured from the bulb.



What is the temperature of the sea-water?

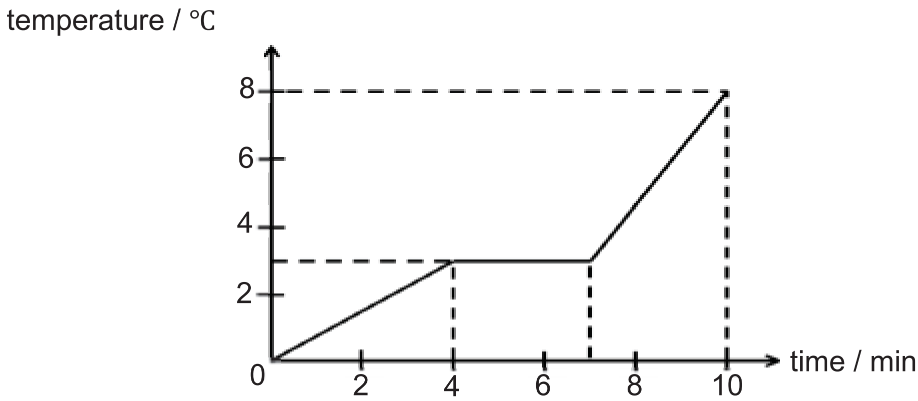
A 2 °C **B** 6 °C **C** 20 °C **D** 33 °C

22 Four different objects, A, B, C and D are heated by the same heater. The change in temperature, $\Delta\theta$ for four different objects, A, B, C and D is plotted against time as shown below.



Which object has the highest heat capacity?

23 The diagram shows the rise in temperature of 2.0 kg of a substance, X. The substance is initially in solid state and it was heated uniformly at the rate of 2000 J/min.



Which set of data about X is correct?

	specific heat capacity of solid X in J / (kg °C)	specific latent heat of fusion of X in J / kg
A	8000	6000
B	1330	6000
C	4000	3000
D	1330	3000

24 The outer surface of an electric kettle is always kept polished and shiny. What is the purpose of this?

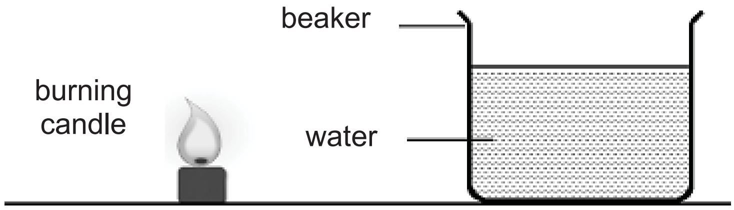
A to reduce energy loss by conduction

B to reduce energy loss by radiation

C to reduce energy loss by convection

D to reduce energy loss by evaporation

25 The diagram shows a beaker of water placed near a burning candle.



How does thermal energy from the candle reach the water in the beaker?

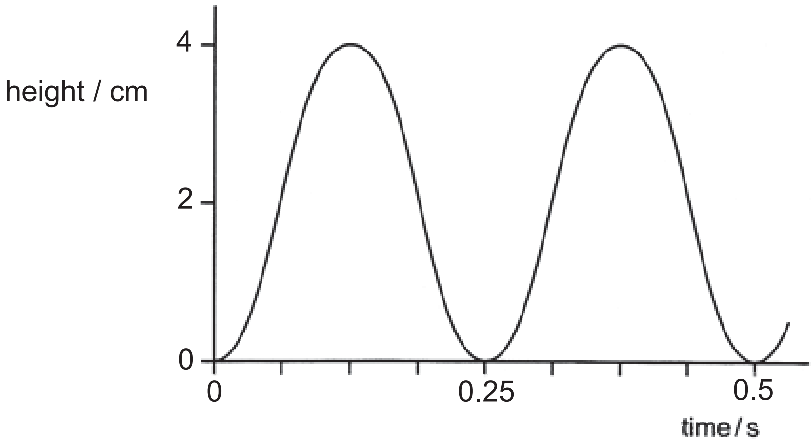
A conduction, followed by convection

B radiation, followed by conduction

C convection, followed by conduction

D radiation, followed by convection

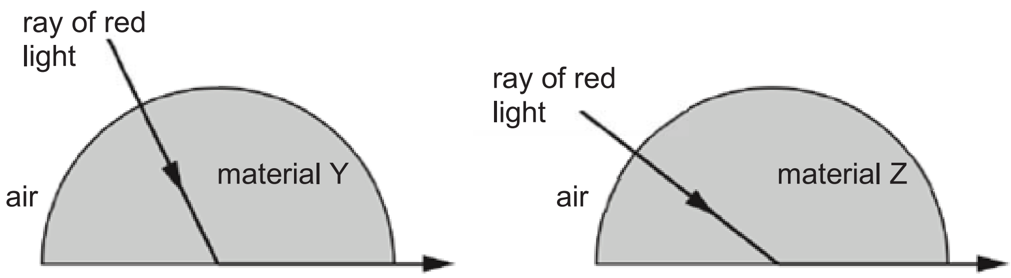
26 The diagram shows the motion of a wave in a ripple tank.



What are the amplitude and frequency of the wave?

	amplitude / cm	frequency / Hz
A	1.0	2.0
B	1.0	4.0
C	2.0	2.0
D	2.0	4.0

27 The diagram shows a ray of red light used to investigate the critical angle of two materials Y and Z.



Which statement is correct?

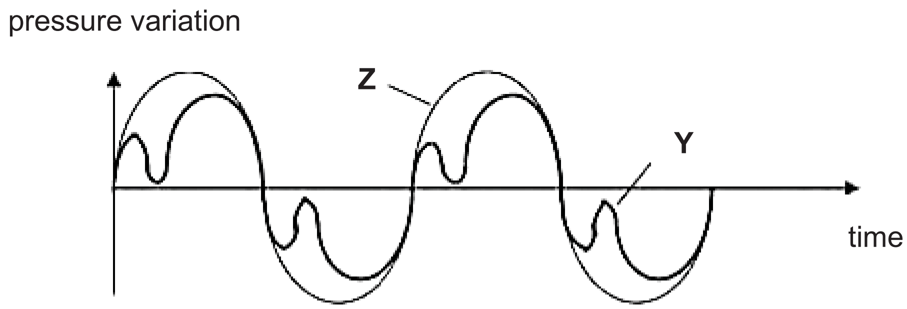
A The frequency of red light is greater in material Y than in material Z.

B The speed of red light is the same in materials Y and Z.

C The refractive index of material Y is larger than that of material Z.

D The wavelength of red light is longer in material Y than in material Z.

28 The diagram shows waveforms produced by a flute (Y) and turning fork (Z) played by two students.



How does the loudness and pitch of the sound from the turning fork Z compare to flute Y?

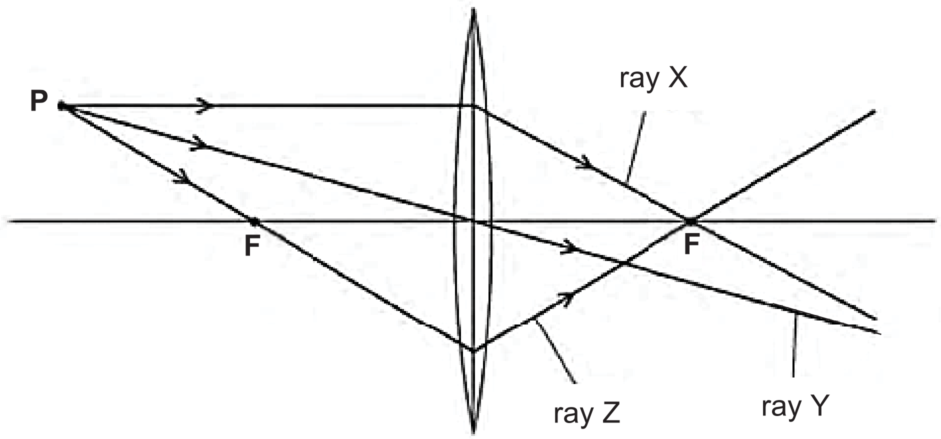
A The loudness of Y is lower but has the same pitch as compared to Z.

B Both Y and Z have the same pitch and loudness.

C The loudness of Y is higher and the pitch is lower as compared to Z.

D The loudness of Y is the same and the pitch is higher as compared to Z.

29 A student draws three rays of light from point **P** through a converging lens. Each point labelled **F** is a principal focus of the lens.



Which of the rays is/are drawn correctly?

A ray Y only

B ray Z only

C ray X and Y

D ray X and Z

30 The diagram shows different regions of the electromagnetic spectrum.

radio waves		**Z**	visible light			gamma rays

Which statement is correct about the electromagnetic wave found in Z?

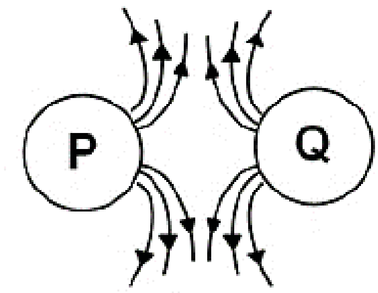
A It has a higher speed in glass than in air.

B It can be used in a remote controller.

C It has a lower frequency than radio waves.

D It has a smaller wavelength than gamma rays.

31 The diagram shows the electric field lines in the vicinity of two isolated electric charges, P and Q.



Which statement correctly identifies the charges P and Q?

A Both P and Q are positive.

B Both P and Q are negative.

C P is positive and Q is negative.

D P is negative and Q is positive.

32 The electromotive force of a cell is 2.0 V.
Which statement about the cell is correct?

A The cell can supply 2.0 C of charge per second.

B The cell can supply 2.0 W of electrical power per second.

C The cell can supply 2.0 J of energy per coulomb of charge.

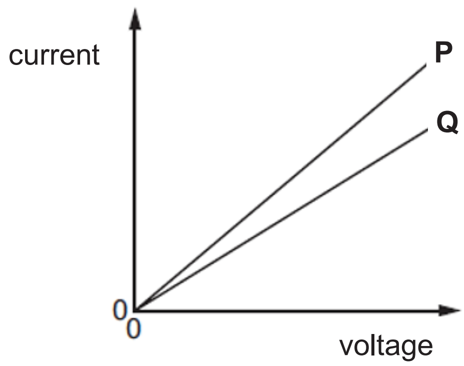
D The cell can supply 2.0 J of energy per coulomb of charge per second.

33 The potential difference between the clouds and the earth during a lightning strike is estimated to be 6.0×10^5 V. The lightning transfers 6.0 C of charge from a cloud to the ground in 2.0 ms.

What is the average current during this event?

A 0.012 A **B** 3.0 A **C** 3000 A **D** 12 000 A

34 The graph shows the current-voltage relationship respectively for two resistance wires **P** and **Q**.

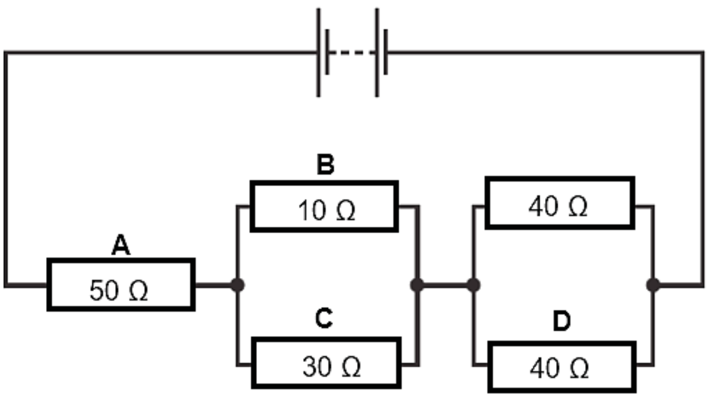


The wires are made from the same material and have equal lengths. The resistances of the wires and their cross-sectional areas are different.

Which wire has the greater resistance and which wire has the larger cross-sectional area?

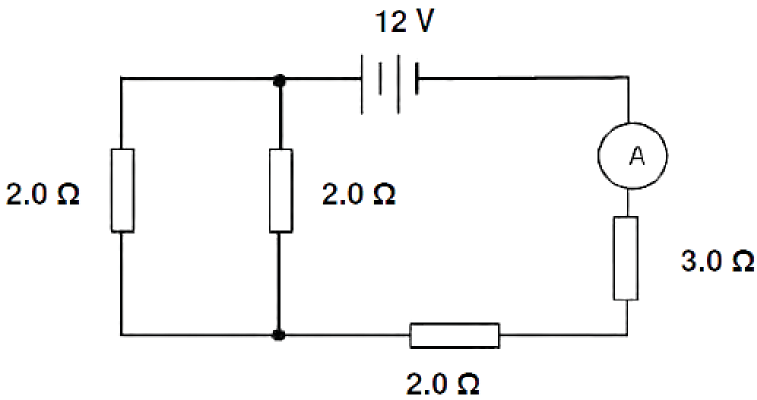
	greater resistance	larger cross-sectional area
A	P	P
B	Q	P
C	P	Q
D	Q	Q

35 The diagram shows a circuit containing five resistors connected to a battery.



In which resistor is the current the smallest?

36 A circuit is set up in the diagram.

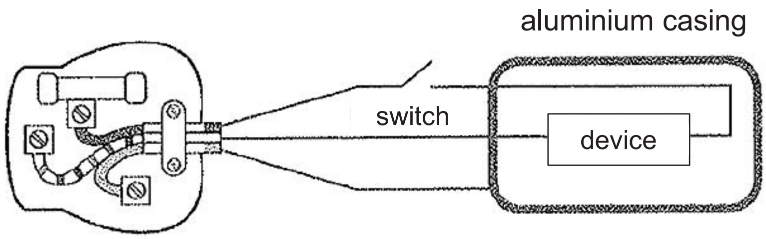


What is the ammeter reading in the circuit?

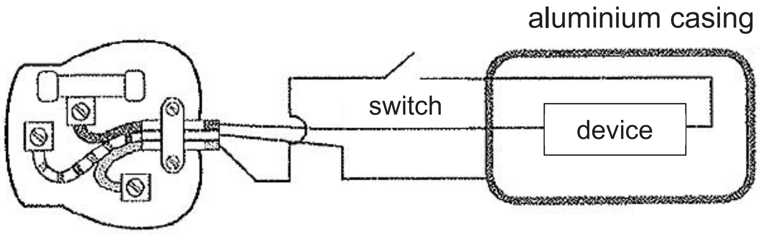
A 0.50 A **B** 0.67 A **C** 1.5 A **D** 2.0 A

37 Which electrical appliance is correctly wired to a three-pin plug?

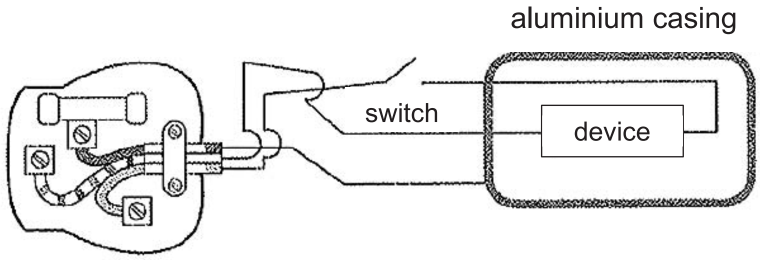
A



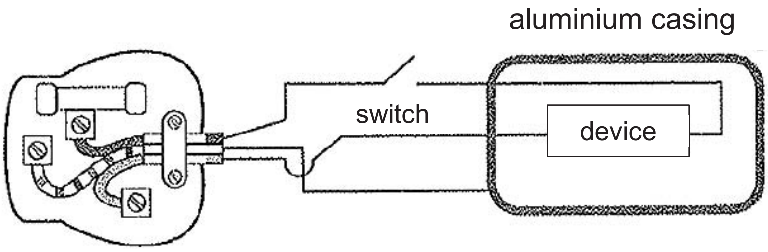
B



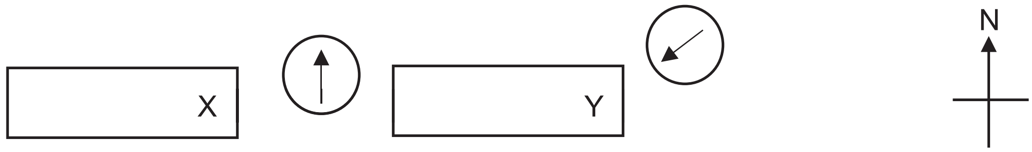
C



D



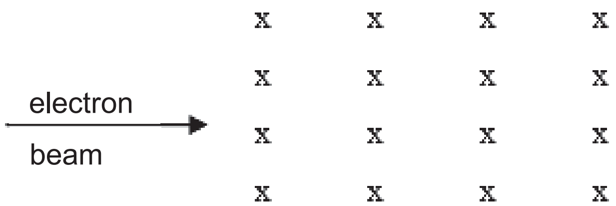
38 The diagram shows the direction of the compass needle when placed near two bar magnets.



What are the likely poles at X and Y?

	pole at X	pole at Y
A	North	South
B	North	North
C	South	North
D	South	South

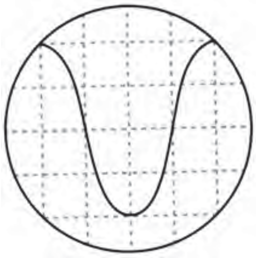
39 The diagram shows an electron beam entering a magnetic field. The direction of the magnetic field is into the page.



What will be the initial direction of the deflection as the beam passes through the field?

A into the page
B out of the page
C towards the top of the page
D towards the bottom of the page

40 The diagram shows the trace obtained on the screen of an oscilloscope when a given signal is applied to the input terminals.
The time-base is set at 2.0 ms / div and the y-gain is set at 2.0 V / div.



Which row correctly represents the peak voltage and frequency of the signal?

	peak voltage / V	frequency / Hz
A	4.0	83.3
B	4.0	125
C	8.0	83.3
D	8.0	125

END OF PAPER

CV

SERANGOON SECONDARY SCHOOL
PRELIMINARY EXAMINATION
SECONDARY 4 EXPRESS

CANDIDATE NAME	( )	CLASS	
CENTRE NUMBER	S	INDEX NUMBER	

PHYSICS — **6091/02**
Aug 2022

Paper 2 Theory — **1 hour 45 mins**

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

Setter(s):

READ THESE INSTRUCTIONS FIRST

Write your name and index number on the cover page.
Write in dark blue or black pen on both sides of the paper.
You may use a pencil for any diagrams or graphs or rough working.
Do not use 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 working in a clear and orderly manner, as 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	
Section B	
Total	**/80**

This paper consists of **19** printed pages, including the cover page.

Section A [50 marks]
Answer **all** the questions in this section.

1 Fig. 1.1 shows the horizontal forces acting on a moving car. The forward driving force remains constant throughout the journey.

Fig. 1.1

Fig. 1.2 shows the total resistive force that acts on the car.
Fig. 1.3 shows the speed-time graph for the first 24 s of the motion of the car along a straight road.

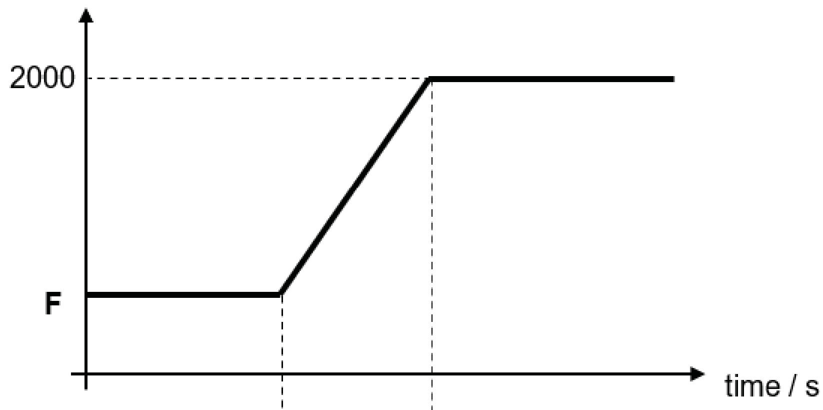


Fig. 1.2

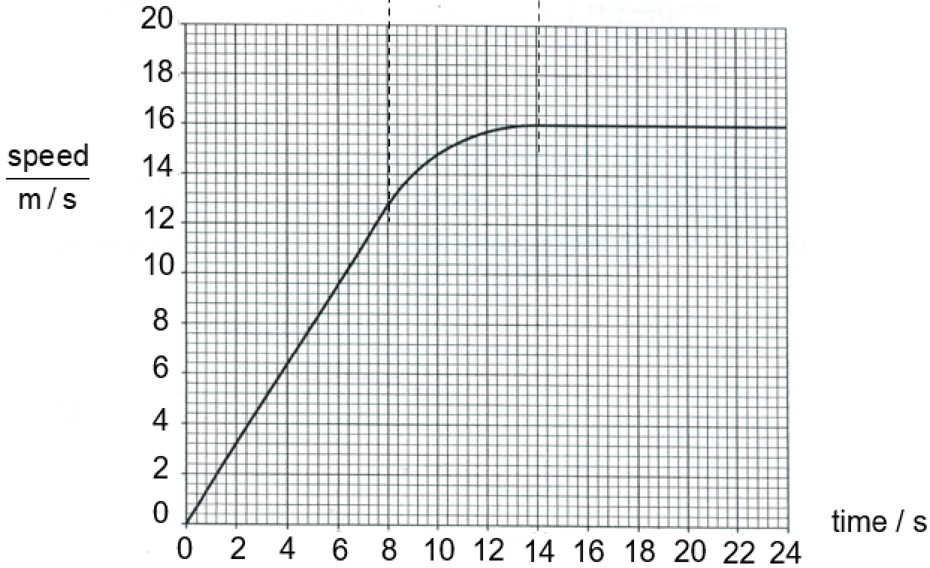


Fig. 1.3

(a) **(i)** State the terminal velocity of the car.

terminal velocity = ………………………… [1]

(ii) Determine the driving force of the car.

driving force = ………………………… [1]

(b) With respect to the forces acting on the car, describe the motion of the car during the first 24 s of motion.

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……………………………………………………………………………………… [3]

(c) The car has a mass of 800 kg.

(i) Calculate the resultant force of the car for the first 8 s of the journey.

resultant force = ………………………… [2]

(ii) Determine the total resistive force, **F**, on the car during the first 8 seconds of the journey.

F = ………………………… [2]

2 In Fig. 2.1, XY represents a flat kite of weight 5.0 N. XY is inclined at 30 ° to the horizontal and the wind exerts a steady force of 8.0 N at a right angle to XY so that the kite flies freely.

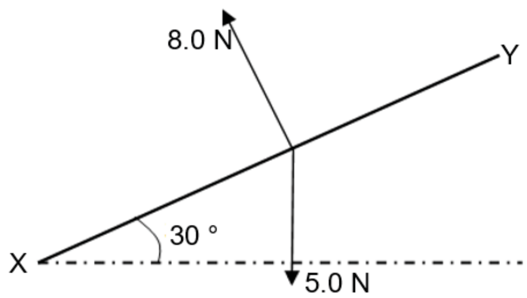

Fig. 2.1 (not to scale)

(a) In the space below, draw a scaled diagram to find the magnitude of the resultant force acting on the kite and the angle to the horizontal at which the force acts.

resultant force = ...

angle to the horizontal = ... [3]

(b) The string holding to the kite snaps and the kite flies off under the effect of the two forces in part **(a).** Describe the motion of the kite.

....

.... [1]

3 A plastic bottle is partially filled with boiling water and sealed after 20 seconds. The bottle is then placed into a tub of ice, as shown in Fig. 3.1. The bottle becomes partially crushed.

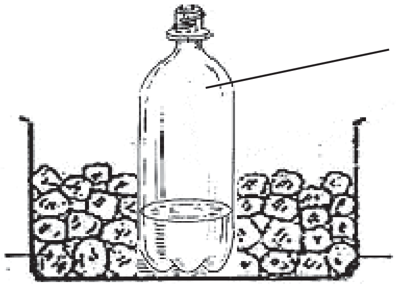

Fig. 3.1

(a) Explain how the air molecules in the bottle exert a pressure on the bottle.

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

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

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

(b) Explain, in terms of the molecules of the air inside and outside the bottle, why the bottle becomes partially crushed after placing it in ice.

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………………………………………………………………………………………… [3]

(c) Suggest what could be done to restore the plastic bottle to its original shape.

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

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

4 A beaker is filled with water and placed on a hot-plate to boil, as shown in Fig. 4.1. The hot-plate is on top of a balance, which measures the mass of water in the beaker.

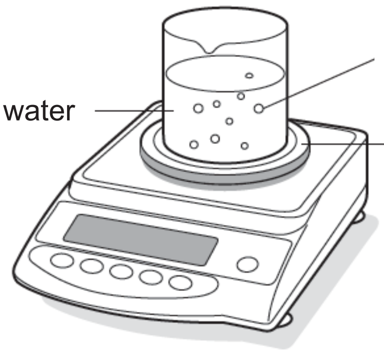

Fig. 4.1

The liquid boils for a long time. There are bubbles within the boiling water.

(a) State what is inside each bubble.

.... [1]

(b) The mass of water is measured at two different times, while the water is boiling steadily.

During this time

- the mass of water in the beaker decreases by 20 g
- the energy supplied to the hot-plate is 52 000 J
- the energy lost from the hot-plate and beaker to the atmosphere is 6000 J

Calculate the specific latent heat of vaporisation of water.

specific latent heat of vaporisation = ... [2]

(c) The beaker of water is taken off the hot-plate. The boiling stops but evaporation still continues and the water cools.

Explain, using ideas about molecules, how evaporation causes cooling.

…………………………………………………………………………………………..

…………………………………………………………………………………………..

…………………………………………………………………………………………..

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

5 Fig. 5.1 shows two glass containers, one painted black and one painted white, containing gases A and B respectively. They are connected together by a tube containing mercury.

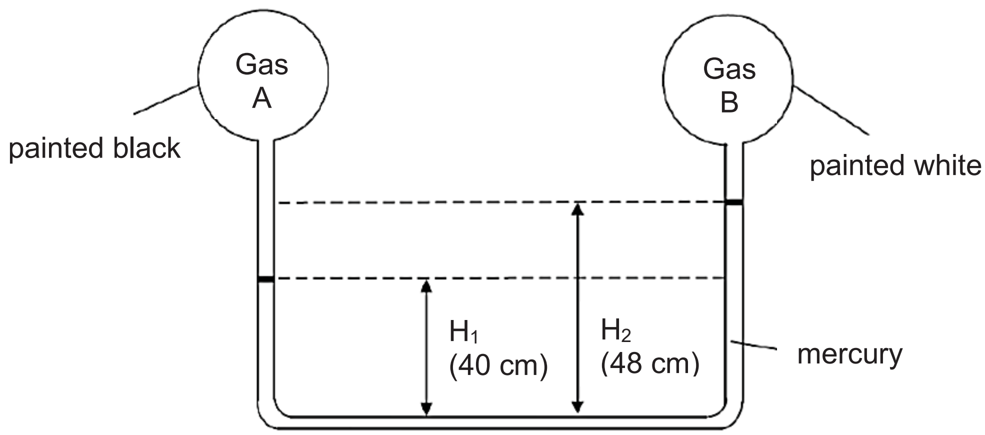

Fig. 5.1

The density of mercury is 13 600 kg/m^3.

(a) State which gas is of a higher pressure.

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

(b) Given that Gas A is at 120 000 Pa, calculate the pressure of Gas B. [g = 10 N/kg]

pressure of Gas B = ………………………… [2]

(c) The whole set up is then placed under strong sunlight. Describe and explain how H_1 and H_2 would change.

…………………………………………………………………………………………..

…………………………………………………………………………………………..

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…………………………………………………………………………………………..

…………………………………………………………………………………………..

………………………………………………………………………………………… [3]

6 Two different kettles are used to heat water, as shown in Fig. 6.1.

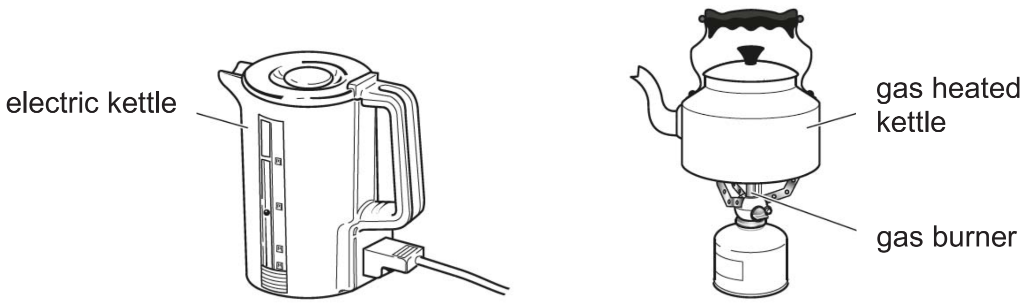


Fig. 6.1

Data for the two kettles is shown in Fig. 6.2.

	energy supplied to the kettle in one minute / J	thermal energy supplied by the kettle to the water in one minute / J
electric kettle	120 000	95 000
gas heated kettle	130 000	90 000

Fig. 6.2

(a) Calculate the efficiency of the gas heated kettle.

efficiency of kettle = ………………………… [1]

(b) Calculate the useful power of the electric kettle.

useful power = ………………………… [2]

(c) The boiling water produces steam at 100 °C.

(i) Using ideas about particle arrangement and attractive forces, state two differences between the particles of boiling water and steam.

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………… [2]

(ii) Explain why the temperature of boiling water remains constant at 100 °C.

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………… [2]

7 Plaque is a thin layer of bacteria on teeth. When it is on the teeth, the surfaces of the teeth are negatively-charged and the plaque is positively-charged as shown in Fig. 7.1.

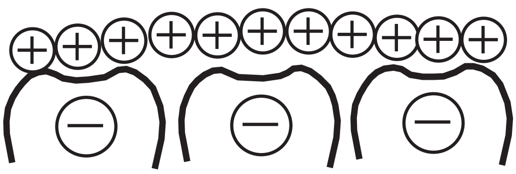


Fig. 7.1

(a) Explain why plaque clings on the teeth and is difficult to remove.

……………………………………………………………………………………..

…………………………………………………………………………………… [1]

(b) A new type of toothbrush, Ionic Toothbrush, as shown in Fig. 7.2, helps to clean teeth using electrostatic charge. The handle of the Ionic Toothbrush is connected to the positive terminal of the battery and hence becomes highly positively-charged. The head and bristles of the toothbrush is connected to the negative terminal of the battery and becomes negatively-charged.

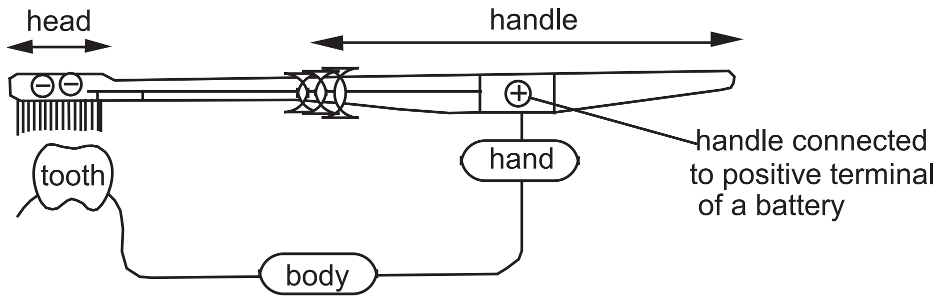


Fig. 7.2

(i) Describe how the teeth becomes positively-charged when the Ionic Toothbrush is used.

....

....

....

.... [2]

(ii) State two reasons why the plaque leaves the surface of the tooth.

....

....

....

.... [2]

(c) It is recommended that the teeth should be brushed for 5 minutes. Calculate the total charge passing through the brush in this duration, given that a steady current of 0.1 mA passes.

total charge = ... [2]

8 Fig. 8.1 shows a battery of 12.0 V, an ammeter, a 10.0 Ω resistor, a potentiometer of total resistance 30.0 Ω and a 5.0 Ω light bulb connected in a circuit.

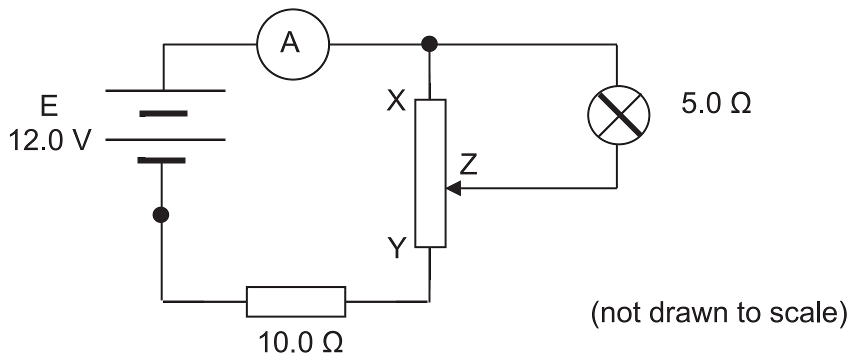


Fig. 8.1

The jockey is now placed on Z, which is a point on the potentiometer such that the distance XZ is twice the distance YZ.

(a) Calculate the total resistance of the circuit when the jockey is at Z.

total resistance = ………………………… [2]

(b) Determine the ammeter reading.

ammeter reading = ………………………… [2]

(c) The 10.0 Ω resistor is now replaced with a thermistor, which has a resistance between 2.0 Ω and 12.0 Ω depending on the environment.

Explain how the brightness of the light bulb changes when the surrounding temperature is high.

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

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

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

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

Section B

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

9 A hot-drinks vending machine company wants to determine the best type of cup dispensed by the machine that will keep the hot drinks warm for as long as possible.

Fig. 9.1 shows two possible designs that the company are considering.

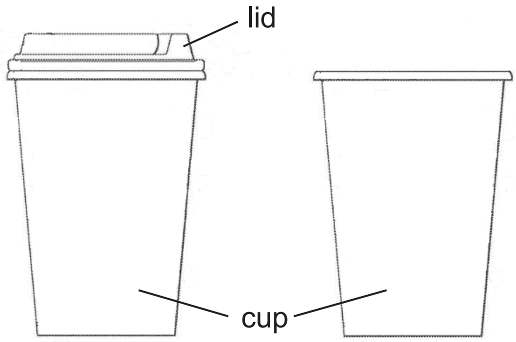


Fig. 9.1

Fig. 9.2 shows the temperature drop over twelve minutes for two cups, of the same size but of different materials, filled with 200 g of hot tea.

	cup made from **paper pulp**		cup made from **polystyrene**	
	without lid	with lid	without lid	with lid
time / min	temperature/ °C	temperature/ °C	temperature/ °C	temperature/ °C
0	100	100	100	100
2	85	85	88	88
4	75	76	79	80
6	66	67	71	73
8	54	56	64	66
10	50	53	59	63
12	48	51	57	61

Fig. 9.2

(a) Suggest a reason why the temperature decrease over 12 minutes for the polystyrene cup is lower than that of the paper cup.

....

.... [1]

(b) **(i)** Explain how the data in Fig. 9.2 shows that the lid keeps the tea warm.

……………………………………………………………………………………………

…………………………………………………………………………………… [1]

(ii) Explain, using ideas about conduction, convection and evaporation, how the presence of the lid keeps the tea warm.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………… [3]

(iii) Suggest one possible disadvantage for the company if the lid is used.

……………………………………………………………………………………………

…………………………………………………………………………………… [1]

(c) With reference to the data in Fig. 9.2, state and explain whether it is effective to choose the right material for the cup or to have a lid to keep the contents in the cup warm.

……………………………………………………………………………………………..

……………………………………………………………………………………………..

……………………………………………………………………………………………..

…………………………………………………………………………………… [2]

(d) An employee of the company claims that the cups should be coloured black as black surfaces are good absorbers of thermal energy, thus keeping the hot drinks warm for a longer duration. State and explain whether the claim is valid.

……………………………………………………………………………………………..

……………………………………………………………………………………………..

…………………………………………………………………………………… [2]

10 A laser produces a beam of red light.

(a) The red light from the laser has a frequency of 4.3×10^{14} Hz.

(i) State the speed of red light in air.

speed of red light = ... [1]

(ii) Calculate the wavelength of this red light in air.

wavelength of red light = ... [2]

(b) The beam of red light from the laser strikes one side of a glass prism at an angle of incidence *i*. The red light refracts towards the normal as it enters the prism.

Fig. 10.1 shows the prism, the red light and a screen.

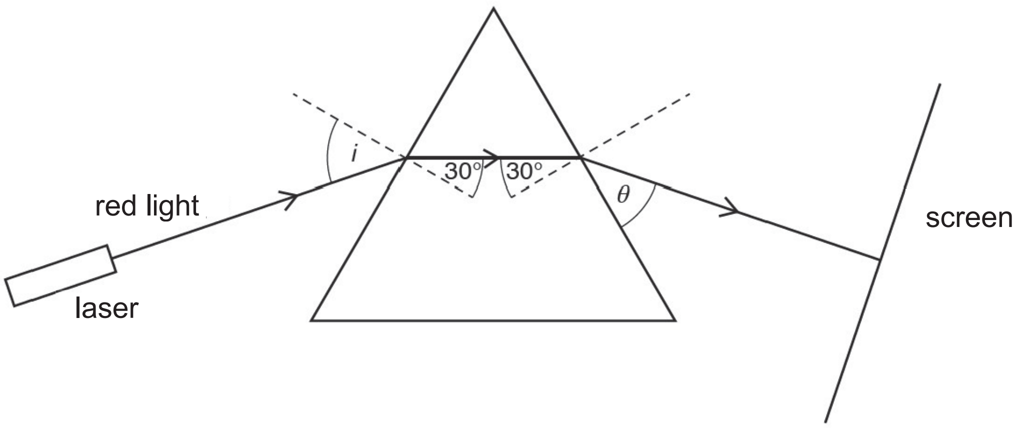


Fig. 10.1 (not to scale)

The refractive index of the glass for red light is 1.52. The angle of refraction in the glass, where the light enters the prism, is 30º.

Calculate the angle θ.

angle θ = ... [2]

(c) The laser in (b) is replaced with a filament lamp and a slit, as shown in Fig. 10.2. The filament lamp emits white light that consists of several colours, including red and blue light.

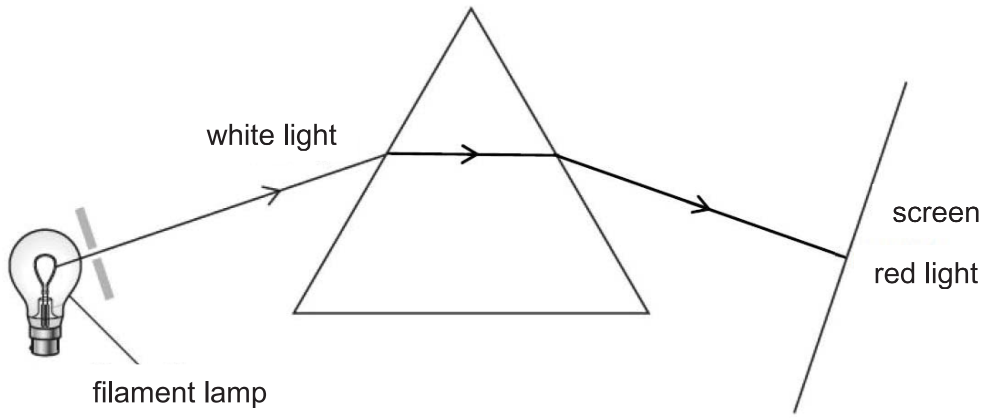


Fig. 10.2 (not to scale)

A ray of white light now strikes the prism.

(i) The refractive index of glass for blue light is 1.56.

On Fig. 10.2, draw how the blue light travels as it passes through the prism and strikes the screen. [2]

(ii) In addition to visible light, the filament lamp also emits some infra-red radiation. This infra-red radiation is able to pass through glass.

1. Infra-red radiation is often detected by using a sensitive thermometer with a bulb that has been painted black.

Explain why the blackened bulb makes the thermometer a good detector of infra-red radiation.

……………………………………………………………………………………………

…………………………………………………………………………………… [2]

2. On the screen in Fig. 10.2, mark with an X to indicate a suitable position to place the thermometer to detect the infra-red radiation. [1]

11 EITHER

(a) Fig 11.1 shows an iron rod AB resting in a magnetic field and connected to a circuit with a potentiometer. The rod can move freely in the magnetic field.

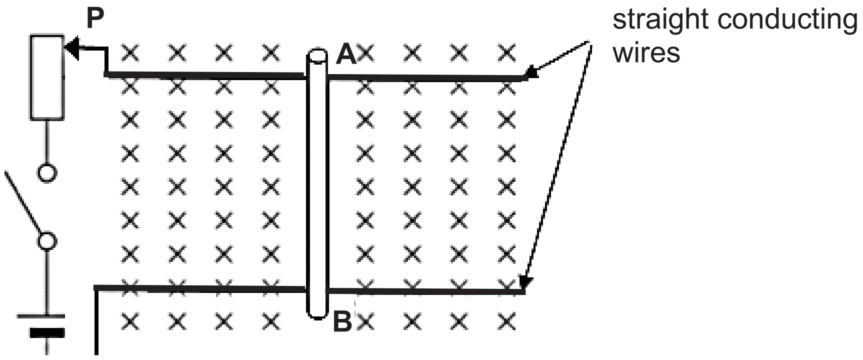


Fig. 11.1

Describe what happens to the rod when:

(i) the switch is closed.

....

....

.... [2]

(ii) the switch is closed and ***P*** is moved downwards on the potentiometer.

....

....

.... [2]

(iii) the polarity of the battery is changed before closing the switch.

....

....

.... [2]

(b) Fig. 11.2 shows the structure of a bicycle dynamo.

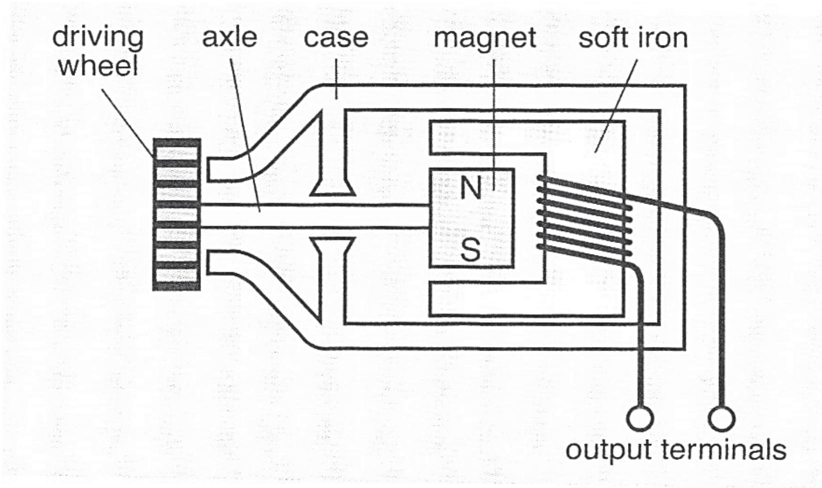


Fig. 11.2

(i) Explain briefly why the rotation of the driving wheel produces an alternating e.m.f. across the output terminals.

....

....

....

....

....

....

.... [3]

(ii) In the graph provided below, sketch two complete cycles of the output voltage of the dynamo with time.

[1]

11 OR

(a) Two coils, A and B, are placed one on top of the other, as shown in Fig. 11.3. Coil A is connected in series with a battery and a switch. A millivoltmeter is connected across the terminals of coil B.

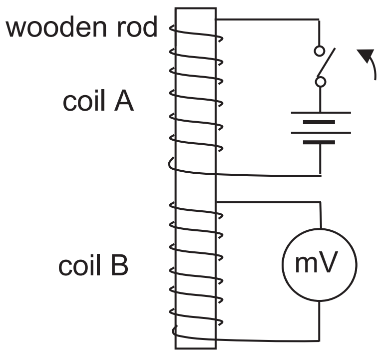


Fig. 11.3

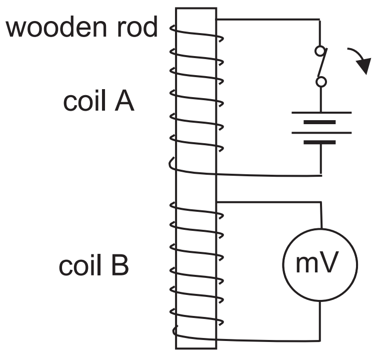


Fig. 11.4

(i) Describe what happens to the millivoltmeter reading in Fig. 11.3 when the switch is closed and a current flows in coil A.

....

....

....

.... [3]

(ii) On Fig. 11.4, draw an arrow on coil B to indicate the direction of the induced current in coil B when the switch was just opened.

[1]

(iii) Explain the direction of the inducted current drawn in **(ii)**.

....

....

.... [2]

(b) **Fig. 11.5** shows two coils of insulated wire wound on an iron core to make a transformer.

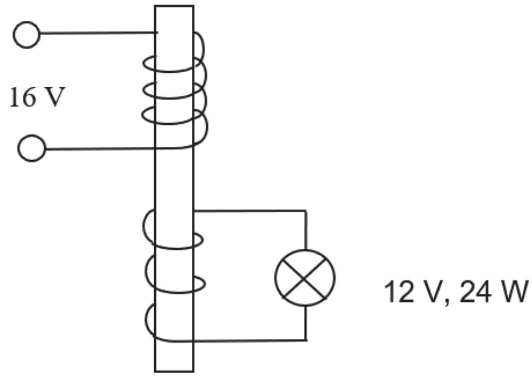


Fig. 11.5

One coil is connected to a 16 V a.c. supply. The other coil is connected to a lamp, which is rated 12 V, 24 W.

(i) The lamp is operating at its correct rating.
Calculate the minimum current drawn from the 16 V supply.

current = ... [2]

The current drawn from the supply is found to be 1.7 A instead. Calculate

(ii) the input power to the transformer, and

input power = ... [1]

(iii) the energy lost by the transformer each second.

energy lost = ... [1]

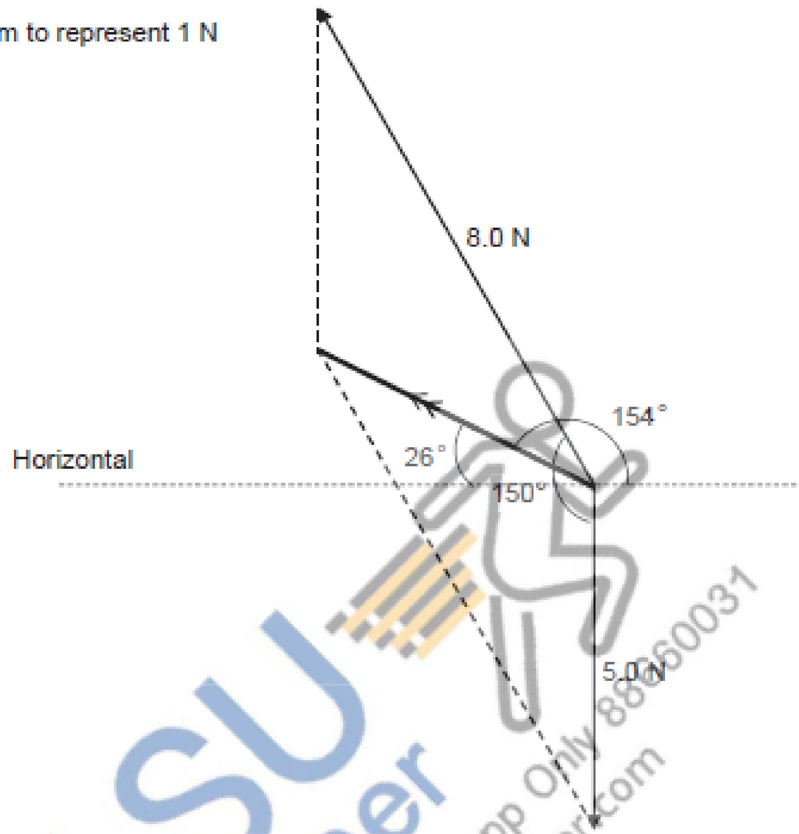
END OF PAPER

SSS 2022 4E Physics Prelim Paper 1 Mark Scheme [40 marks]

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

2022 4E Physics Prelim Paper 2 Mark Scheme
Section A [50 marks]

1ai	16 m/s	1	
1aii	2000 N	1	
1b	From 0 s to 8 s, the car undergoes constant acceleration as the driving force is greater than the total resistive forces. This causes a resultant force on the car (keeping mass constant). From 8 s to 14 s, the car undergoes decreasing acceleration as the total resistive force increases, reducing the resultant force. From 14 s to 24 s, the car undergoes zero acceleration / constant velocity as the total resistive force equals to the driving force, i.e. zero resultant force (keeping mass constant).	1 1 1	
1ci	$a = \frac{v-u}{t}$ $= \frac{12.8-0}{8-0} = 1.6\ m/s^2$ Resultant force = ma = 800 x 1.6 = 1280 N	1 1	No ecf within question
1cii	2400 – F = 1280 N F = 720 N	1 1	Allow for ecf from 1c

2a	1 cm to represent 1 N  Scale, drawing of forces with arrows, correct magnitude and correct angles (1m) Drawing of resultant force with double arrow (1m) Resultant force = 4.4 N (1m with correct angle stated) Angle to the horizontal = 26 ° or 154 °		
2b	The kite will accelerate uniformly in a straight line at an angle of 26° or 154° to the horizontal.	1	Allow ecf from 2a
3a	The air molecules collide with the walls of the bottle and exerts a force on them. Since pressure = force/area, the force exerted by air molecules per unit area causes a pressure to be exerted on the bottle.	1 1	

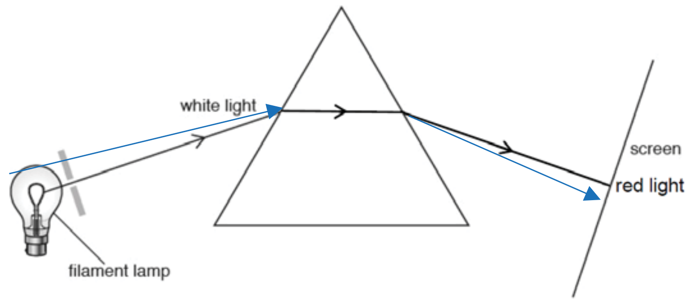
3b	When the bottle is placed in ice, the air molecules inside the bottle loses thermal energy. Thus, it has lower average kinetic energy and moves slower/at lower speeds. This cause the air molecules to bombard the walls of the bottle less frequently and exert a lower average force per unit area. The air molecules outside the bottle exerts a greater force per unit area compared to air molecules inside the bottle. Thus, there is a resultant/net force pushing the bottle inwards.	1 1 1	
3c	Place the bottle in warm water.	1	
4a	Water vapour / water in gaseous state.	1	
4b	$Q = ml_v$ $52\,000 - 6000 = 20 \times l_v$ $l_v = 2300$ J/g	 1 1	
4c	The more energetic molecules at the water surface has enough energy to overcome the atmospheric pressure and attractive forces and leaves the surface of the liquid. The remaining molecules have lower average kinetic energy and since temperature is related to the average kinetic energy per molecules, hence, temperature decreases and cooling occurs.	1 1	Point on overcome atm pressure must be in answer
5a	Gas A	1	
5b	$P_B + (0.08)(13600)(10) = 120\,000$ $P_B = 1.09 \times 10^5$ Pa or 1.1×10^5 Pa.	1 1	
5c	H_1 will drop and H_2 will rise. Black surfaces are good absorbers of radiation/thermal energy. Gas A receives the thermal energy, resulting in an increase in gas pressure. This increase in pressure pushes the level of mercury down in the left arm and up in the right arm, thus increasing the height difference between the two levels.	1 1 1	

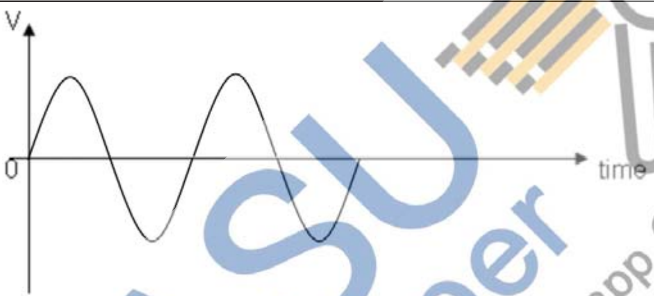
6a	Efficiency = 90 000 / 130 000 x 100% = 69.2 %	1	Working and final ans = 1 m
6b	useful power = 95 000 / 60 = 1580 W	1 1	
6ci	1. The distance between boiling water particles are closer compared to that between the steam particles. 2. The boiling water particles have stronger intermolecular forces/attractive forces than steam particles.	1 1	
6cii	1. Internal kinetic energy remains unchanged since there is no change in temperature. 2. Internal potential energy increases and is used to overcome forces of attraction between water molecules until the water changes to a gas.	1 1	
7a	Since opposite charges attract, the positive charges on the plaque are attracted to the negative charges on the surfaces of the teeth.	1	
7bi	The negatively charged head and bristles of the toothbrush repel negative charges on the surfaces of the teeth, causing the electrons to flow through the body and hand. There will be excess of positive charges on the teeth, causing the teeth to become positively charged.	1 1	
7bii	Since like charges repel and the teeth becomes positively charged, the positive charges on the surfaces of the teeth repel the positively charged plaque. Since unlike charges attract, the positive charges on the plaque are also attracted to the negative charges on the head and bristles of the toothbrush.	1 1	
7c	I = Q/t $0.1 \times 10^{-3} = Q/(5 \times 60)$ Q = 0.030 C	 1 1	

8a	Total resistance = 10 + 10 + $(1/5.0+1/20)^{-1}$ = 24 Ω [1]	1 1	
8b	I = V/R = 12.0 V / 24 Ω = 0.50 A	 1 1	Allow ecf from 8a
8c	The thermistor has a low resistance when hot, hence causing the potential difference and current across the bulb to increase. Since P = VI and both pd and current increase, the brightness of the bulb also increases.	1 1	

Section B [30 marks]

9a	The polystyrene cup is likely to be a poorer conductor of heat compared to the paper cup.	1	
9bi	At time = 12 min, the temperature of the tea when placed in cups with lids (51 °C in paper cup and 61 °C in polystyrene cup) is higher than that without lids (48 °C in paper cup and 57 °C in polystyrene cup).	1	Need to cite data from the table
9bii	The lid is a poor conductor of heat, thus reduces heat loss via conduction. The lid prevents hot air from escaping upwards, thus reduces heat loss via convection current. The lid increases the humidity of the air above the tea / prevent removal of the saturated air, thus reduces the rate of evaporation.	1 1 1	
9biii	The company has to spend more money / having a lid creates more waste and thus less environmentally friendly.	1	
9c	It is more effective to choose the right material. The material will cause a temperature difference of 9-10°C, while the lid will only cause a difference of 1-3°C.	1 1	
9d	The claim is not valid. Since the tea is hotter than the surroundings, black surfaces are good emitters of infra-red radiation, and thus lose heat faster.	1 1	
10ai	3.0×10^8 m/s	1	
10aii	$v = f\lambda$ $3.0 \times 10^8 = (4.3 \times 10^{14})(\lambda)$ $\lambda = 6.98 \times 10^{-7}$ m	 1 1	
10b	$n = \sin i / \sin r$ $1.52 = \sin i / \sin 30^o$ $i = 49^o$ $\theta = 90^o - 49^o = 41^o$	 1 1	

10ci	 Blue light bends towards normal more than red light in glass, [1] and bends away from normal more in air. [1]	1m for each correct drawing of light ray with arrow	No marks for no arrows on light rays
10cii	**1.** Black surfaces are good absorbers of infra-red radiation. Hence, thermal energy can be transferred at a faster rate/more quickly through the bulb of the thermometer. **2.**  X is marked above red light on the screen.	1 1 1	
11	**Either**		
ai	The rod moves to the right. The magnetic field of the current flowing along AB interacts with the magnetic field to create a force to move the rod to the right.	1 1	
aii	The effective resistance of the circuit decreases and thus the current increases. The rod moves faster to the right due to increase in the force exerted on it.	1 1	

aiii	The rod moves to the left. As the current is reversed, by Fleming's left hand rule, the rod experience a force that causes it to move in the opposite direction.	1 1	
bi	When the driving wheel rotates, it causes the magnet to rotate inside the soft iron core which creates a constant change/cutting of magnetic flux linkages. The rate at which the magnetic field changes is directly proportional to the induced emf (by Faraday's law) across the output terminals. The output voltage alternates due to the change in direction of the magnetic field when the magnet rotates.	1 1 1	
bii	 	1	
11	**OR**		
ai	The induced e.m.f in coil B is due to a change in the magnetic flux linkage created by coil A on coil B. Thus there will be a deflection on the millivoltmeter. When the current is steady, there is no change in magnetic flux linkage between the two coils although there is magnetic flux linkage between the 2 coils. Zero change results in no emf induced (based on Faraday's law of electromagnetic induction).	1 1 1	
aii	Direction of current in the outer coil of B is to the right.	1	
aiii	By Lenz's Law, the induced current must be in such a direction as to oppose the change in magnetic flux in coil B. The induced current thus produces a North pole at the end of coil B that is facing coil A to oppose the weakening or moving away south pole at the bottom of coil A..	1 1	

bi	P=VI I_S = 24/12 = 2.0 A $I_P/I_S = V_S/V_P$ I_P = (12/16) x 2.0 = 1.5 A	 1 1	
bii	Input Power = IV = 1.7 x 16 = 27.2 W	1	Working and final ans = 1 m
biii	Lost power = 27.2 – 24 = 3.2 W	1	Working and final ans = 1 m

SINGAPORE CHINESE GIRLS' SCHOOL
PRELIMINARY EXAMINATION 2022
SECONDARY FOUR

CANDIDATE NAME	

CLASS				REGISTER NUMBER			

PHYSICS

PAPER 1 Multiple Choice

Monday **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, class and index number on the Question Paper **and** 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**, **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.
Take g = 10 ms^{-2} or 10 Nkg^{-1} unless specified otherwise.

This question paper consists of 24 printed pages

1 A student is given a reel of wire of diameter less than 0.2 mm and is asked to find the density of the metal.

Which pair of instruments would be most suitable for finding the volume of the wire?

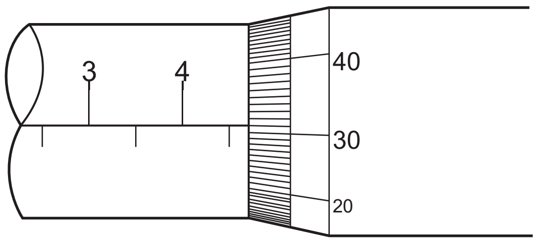
A Balance and micrometer

B Metre rule and micrometer

C Metre rule and vernier calipers

D Micrometer and vernier calipers

2 The diameter of a solid metal sphere is measured using a micrometer screw gauge. The diagram shows an enlargement of the shaft of the micrometer screw gauge when taking the measurement.



The mass of the sphere is 0.450 g.

What is the density of the metal used to make the sphere?

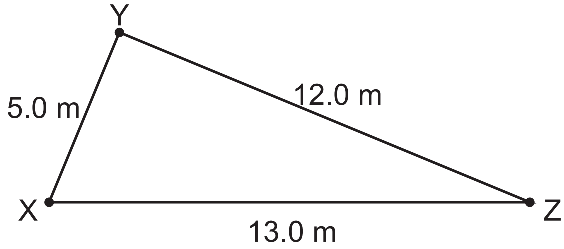
A 965 kg m^{-3}

B 1340 kg m^{-3}

C 7720 kg m^{-3}

D 10 700 kg m^{-3}

3 Paths are laid as shown between points X, Y and Z.

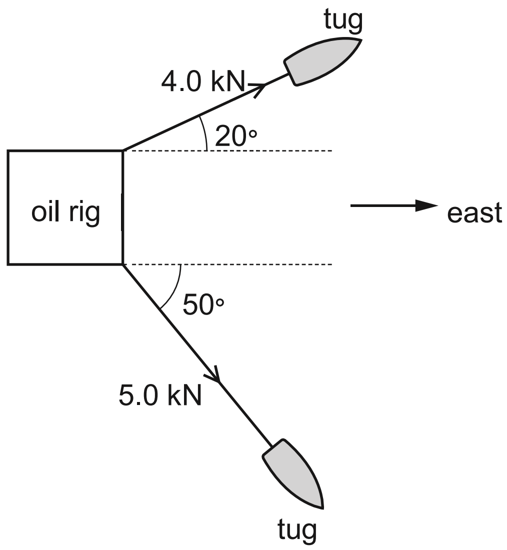


A person walks along the paths from X to Y to Z and then back to X.

What is the value of the total displacement and of the total distance travelled?

	total displacement / m	total distance travelled / m
A	0	0
B	0	30
C	30	0
D	30	30

4 Two tugs are towing an oil rig as shown



The tensions in the towing cables are 4.0 kN and 5.0 kN.

What is the total force acting on the rig due to the cables, in the direction to the east?

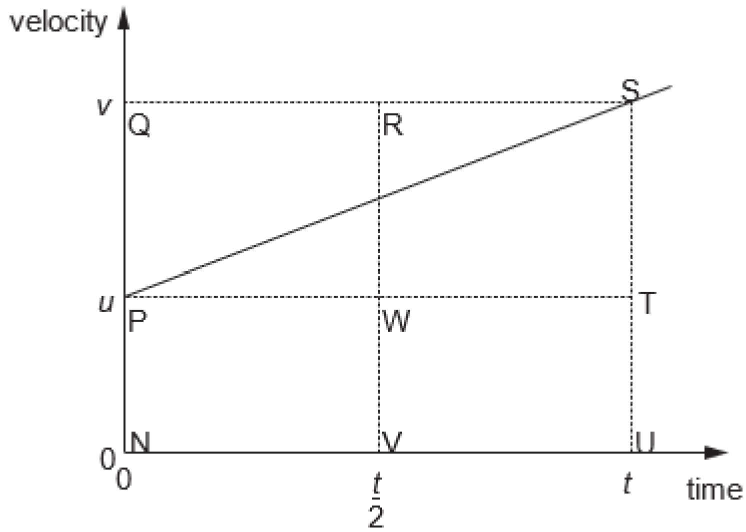
A 3.1 kN

B 5.2 kN

C 7.0 kN

D 8.3 Kn

5 A car accelerates uniformly from velocity u to velocity v in time t.



On the graph, which area equals the distance travelled by the car in time t?

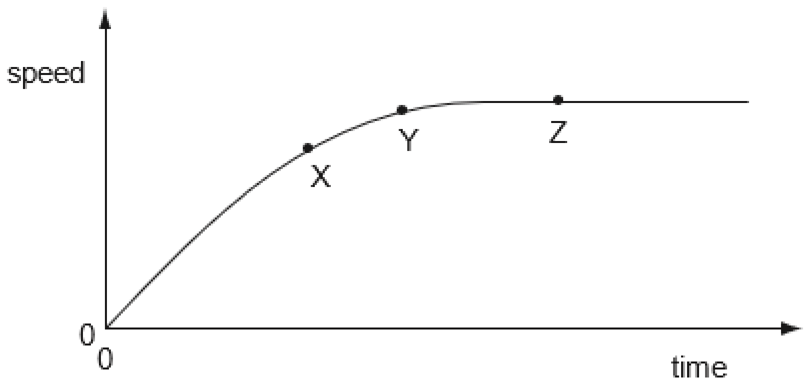
A NPTU + PQST

B NPWV + VRSU

C NPWV + WRST

D PST + PQS

6 A raindrop falls vertically from rest in air. The variation with time of the speed of the raindrop is shown in the graph.



Which statement about the raindrop is correct?

A At point X, the raindrop has an acceleration of 10 m s^{-2}.

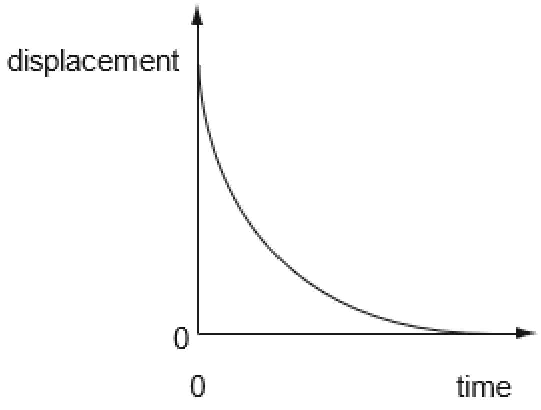
B At point Z, the force on the raindrop due to air resistance has reached its maximum value and so the acceleration of the raindrop has also reached its maximum value.

C At point Z, the force due to air resistance is equal and opposite to the weight of the raindrop and so the speed of the raindrop is zero.

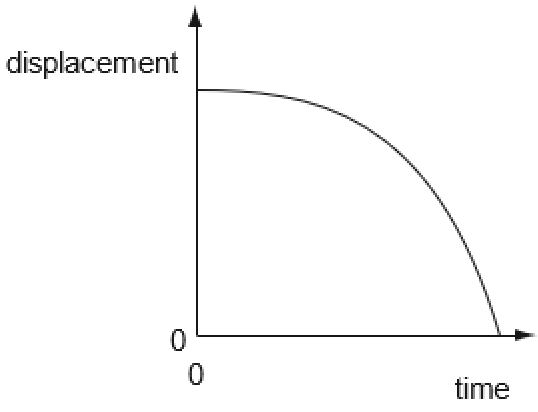
D The resultant force on the raindrop at point Y is less than the resultant force on the raindrop at point X.

7 A sphere is released and falls. Its initial acceleration decreases until it eventually begins to travel at constant terminal velocity. Which displacement-time graph best represents the motion of the sphere?

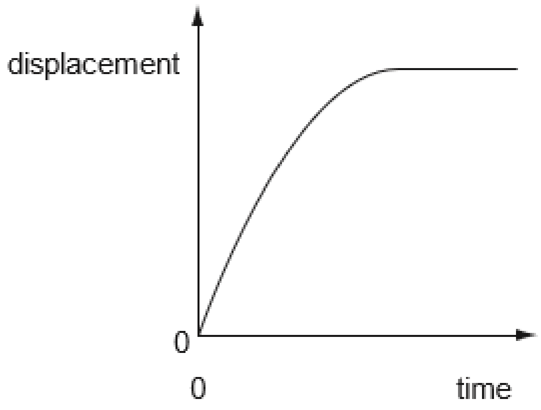
A



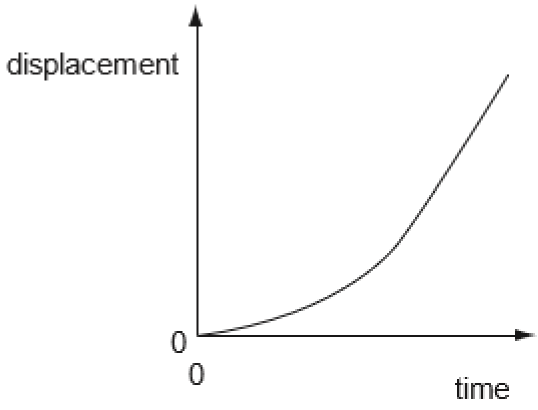
B



C

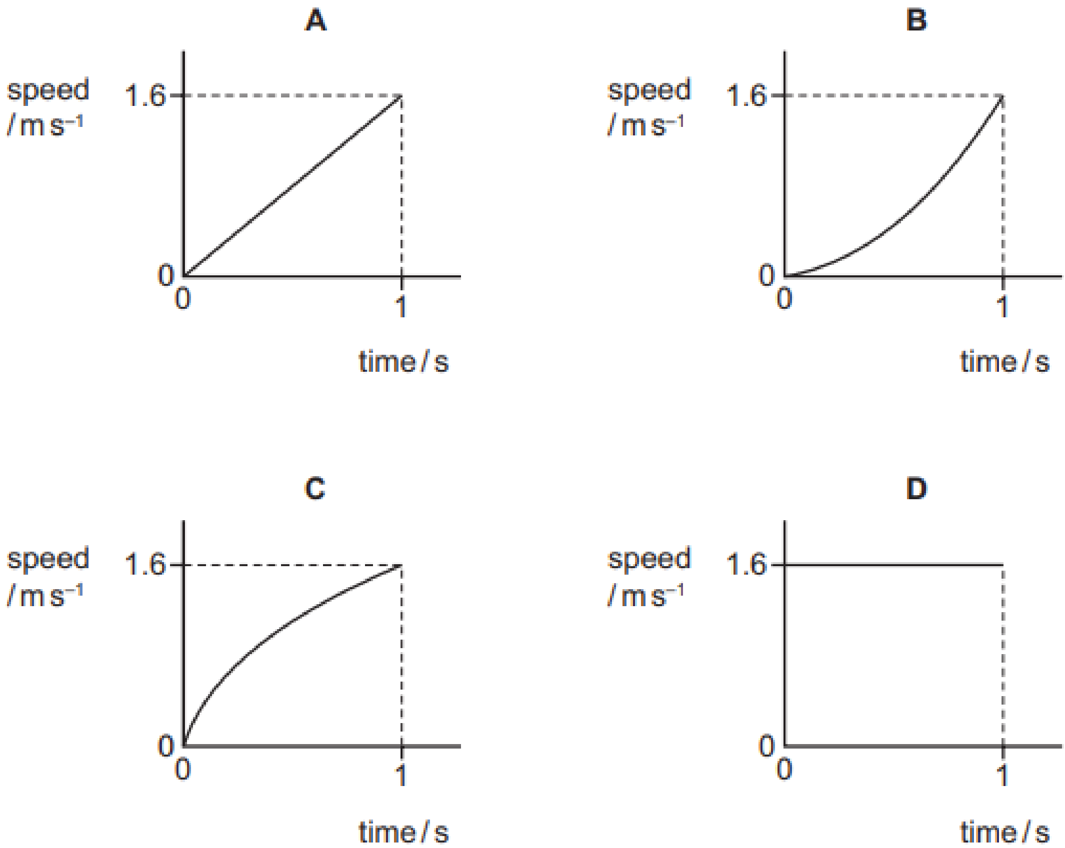


D

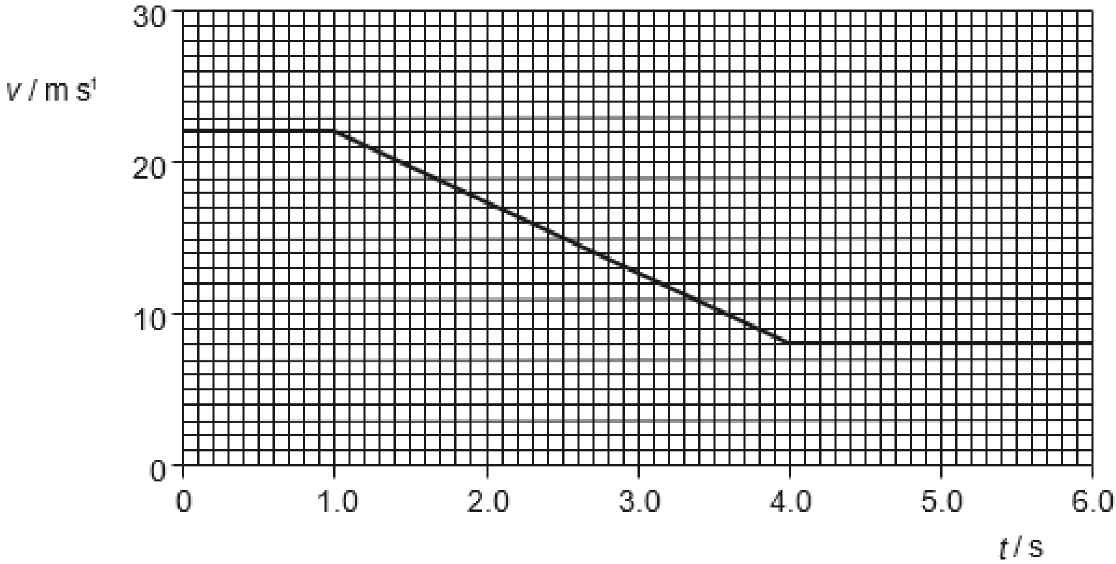


8 The acceleration of free fall on the Moon is $1.6\,m\,s^{-2}$. The Moon has no atmosphere. An astronaut standing on the surface of the Moon drops a feather.

Which graph shows the variation with time of the speed of the feather during the first second of its fall?



9 A car travels along a straight horizontal road. The graph shows the variation of the velocity v of the car with time t for 6.0 s of its journey.



The brakes of the car are applied from t = 1.0 s to t = 4.0 s.

How far does the car travel while the brakes are applied?

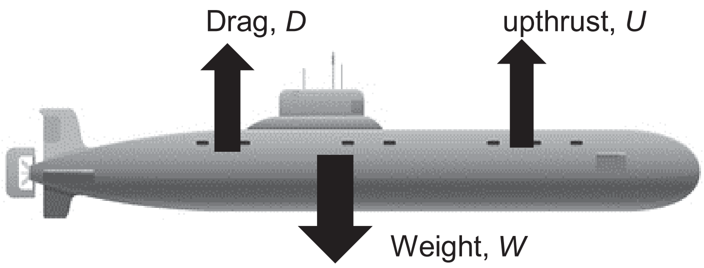
A 21 m

B 45 m

C 67 m

D 83 m

10 A submarine descends vertically at constant velocity. The three forces acting on the submarine are drag, upthrust and weight as shown in the diagram below.



Which relationship between their magnitudes is correct?

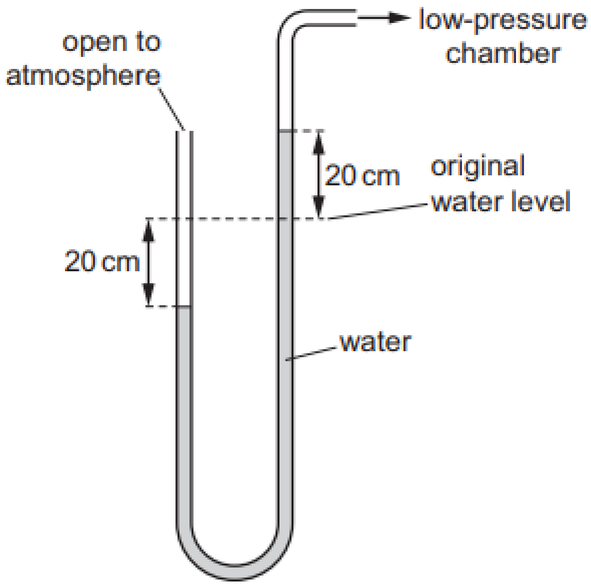
A $W \neq D + U$

B $W > D + U$

C $W = D + U$

D $W < D + U$

11 A U-tube containing water is used as a manometer.



When one end of the manometer is connected to a low-pressure chamber, both water levels in the manometer change by 20 cm. The gravitational field strength g is 10 N / kg.

The density of water is 1000 kg / m^3.

How far below atmospheric pressure is the pressure in this chamber?

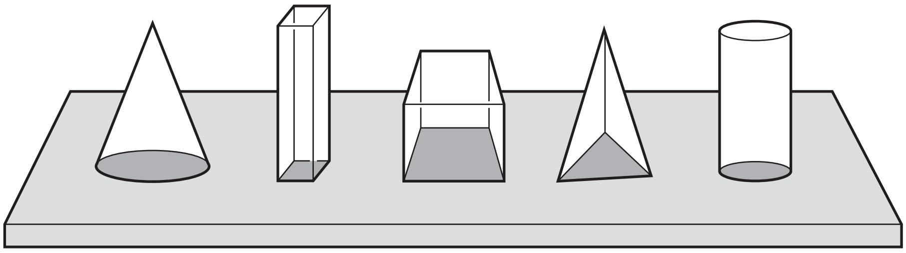
A 2000 Pa

B 4000 Pa

C 200000 Pa

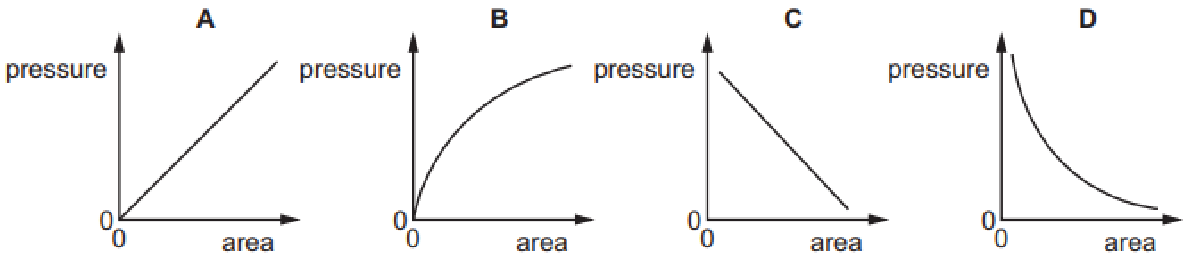
D 400000 Pa

12 Five blocks have the same mass but different base areas. They all rest on a horizontal table.

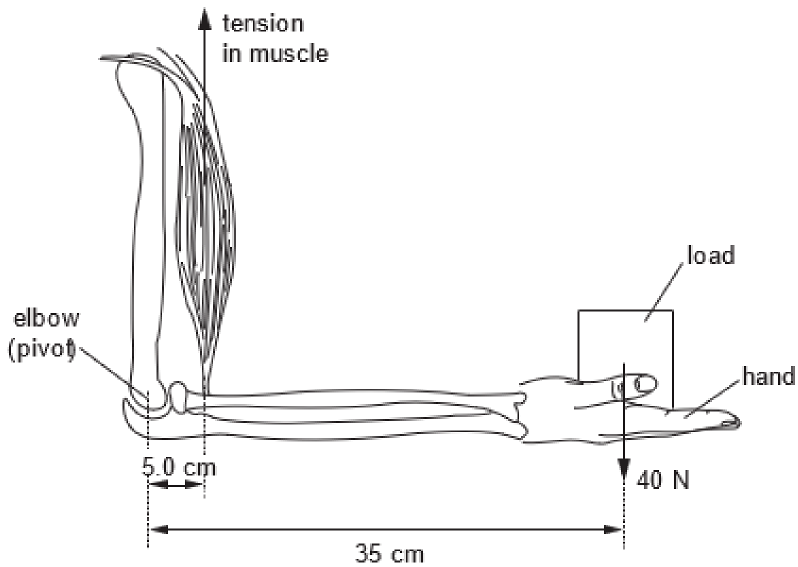


A graph is plotted to show the relationship between the pressure exerted on the table and the base area of the block.

Which graph shows this relationship?



13 The diagram shows a muscle and bones in a person's arm. The hand holds a load of weight 40 N. The elbow acts as a pivot and the tension in the muscle keeps the lower part of the arm horizontal.



What is the tension in the muscle due to the load?

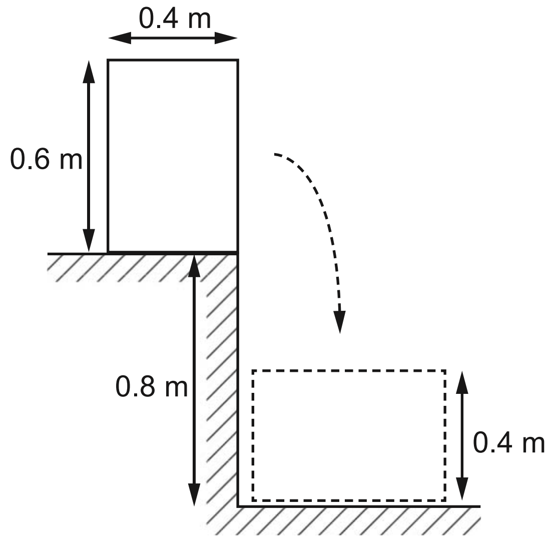
A 200 N

B 240 N

C 280 N

D 1400 N

14 A uniform solid block has weight 500 N, width 0.4 m and height 0.6 m. The block rests on the edge of a step of depth 0.8 m, as shown.



The block is knocked over the edge of the step and rotates through 90° before coming to rest with the 0.6 m edge horizontal.

What is the change in gravitational potential energy of the block?

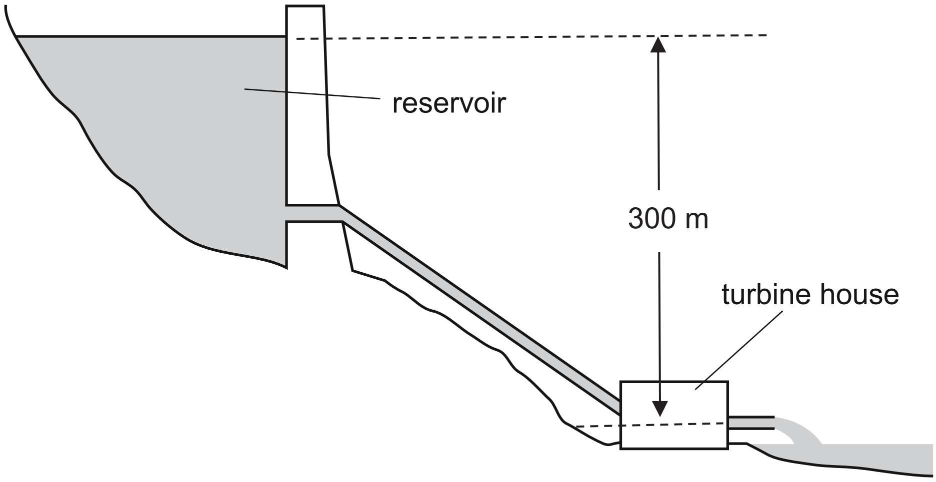
A 300 J
B 400 J
C 450 J
D 550 J

15 A student can run or walk up the stairs to her classroom.

Which statement describes the power required and the gravitational potential energy gained while running up the stairs compared to walking up them?

A Running provides more gravitational potential energy and uses more power.
B Running provides more gravitational potential energy and uses the same power.
C Running provides the same gravitational potential energy and uses more power.
D Running provides the same gravitational potential energy and uses the same power

16 The diagram shows a hydroelectric power station.



The reservoir is 300 m above the level of the turbine and is linked to it by a pipe.

Water from a reservoir is fed to the turbine of a hydroelectric system at a rate of 500 kg s^{-1}. The electrical output from the generator driven by the turbine is 200 A at a potential difference of 6000 V.

What is the efficiency of the generator ?

A 8.0 %

B 8.2%

C 80%

D 82%

17 What happens when a solid is heated and expands?

A The molecules do not change size and the spaces between the molecules become larger.

B The molecules expand and the spaces between the molecules become larger.

C The molecules expand and the spaces between the molecules become smaller.

D The molecules expand and the spaces between the molecules do not change size.

18 Some of the liquid in a dish evaporates, as shown in the diagrams.

before evaporation after evaporation

Which molecules leave the liquid and which molecules in the liquid have greater average kinetic energy?

	molecules that leave have	molecules in the liquid have greater average kinetic energy
A	high energy	before evaporation
B	high energy	after evaporation
C	low energy	before evaporation
D	low energy	after evaporation

19 An electric shower takes in cold water at 17 °C. The shower gives 6000 J of energy every second to the cold water and heats it to 37 °C. The specific heat capacity of water is 4200 J / (kg °C).

What is the mass of hot water supplied by the shower in one second?

A 0.035 kg

B 0.039 kg

C 0.071 kg

D 0.084 kg

20 Latent heat of vaporisation is

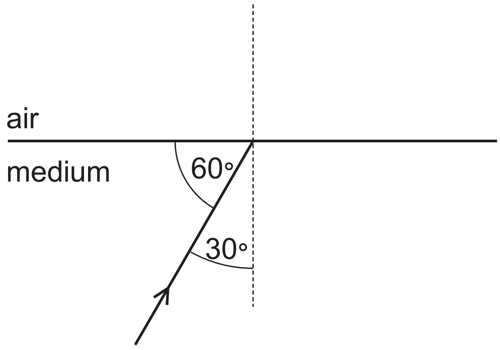
A the energy required to make molecules expand

B the energy required to make molecules expand and move apart

C the energy required to make molecules move apart

D the energy required to make molecules move faster

21 A ray of light in a transparent medium of refractive index 1.8 is incident on the surface as shown. The light then enters air.



What is the angle between the refracted ray and the normal in air?

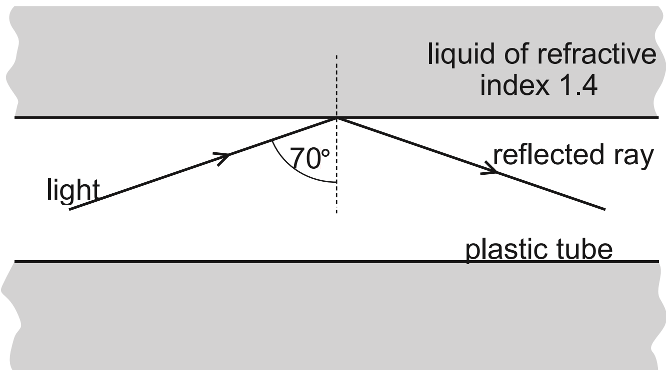
A 29°

B 33°

C 54°

D 64°

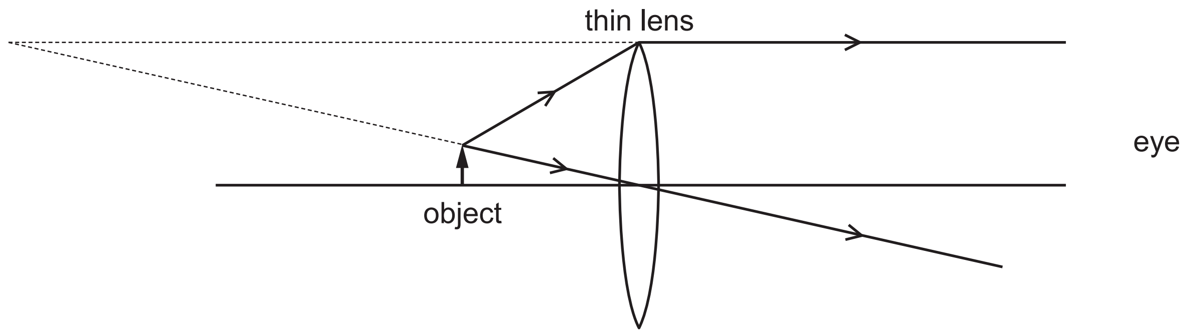
22 A plastic tube is immersed in a liquid of refractive index 1.4. Light travelling in the plastic tube strikes the inside surface at an angle of incidence of 70°. The light undergoes total internal reflection.



What describes the values of the critical angle in the plastic and the refractive index of the plastic?

	critical angle in plastic	refractive index of plastic
A	greater than 70°	greater than 1.4
B	greater than 70°	less than 1.4
C	less than 70°	greater than 1.4
D	less than 70°	less than 1.4

23 An object is viewed through a converging lens.
The diagram shows the paths of two rays from the top of the object to an eye.



How does the image compare with the object?

A It is larger and inverted.

B It is larger and upright.

C It is smaller and inverted.

D It is smaller and upright.

24 Which equation is used to define resistance?

A energy = $(\text{current})^2$ × resistance × time

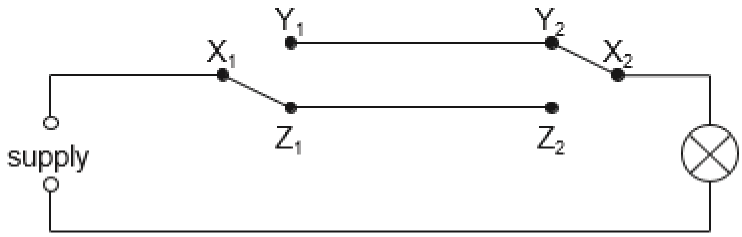
B potential difference = current × resistance

C power = $(\text{current})^2$ × resistance

D resistivity = resistance × area ÷ length

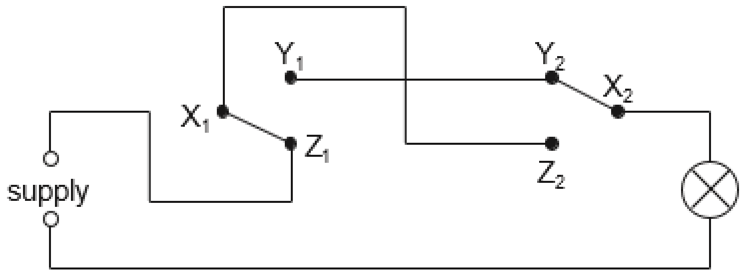
25 Diagram 1 is a circuit for a lighting up a lamp installed on a staircase.

diagram 1



During repairs, an electrician mistakenly reverses the connections X_1 and Z_1, so that Z_1 is connected to the supply and X_1 to the other switch at Z_2, as shown in diagram 2.

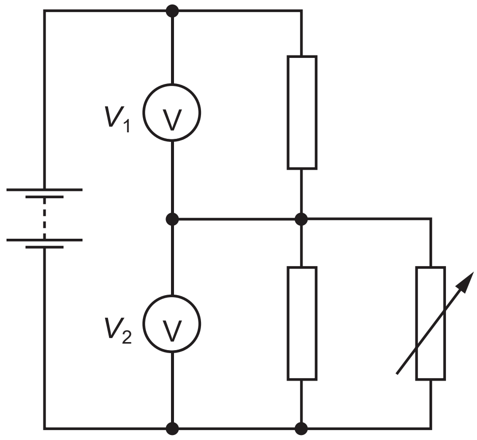
diagram 2



Which switch positions will now light the lamp?

A	X_1 to Y_1	X_2 to Y_2
B	X_1 to Y_1	X_2 to Z_2
C	X_1 to Z_1	X_2 to Y_2
D	X_1 to Z_1	X_2 to Z_2

26 The circuit diagram shows a variable resistor connected in parallel to the lower half of a potential divider consisting of two resistors. All three resistors have the same resistance.

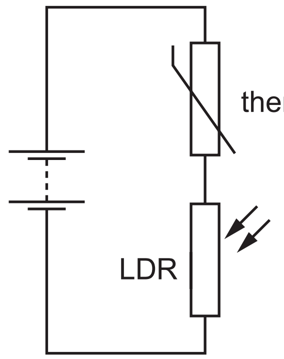


The resistance of the variable resistor is now increase.

What happens to the two voltmeter readings?

	V_1	V_2
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

27 In the circuit shown, the temperature of the room and the amount of light affect the current.



Under which conditions is the current in the circuit the largest?

	Temperature	Amount of light
A	High	In bright light
B	High	In the dark
C	Low	In bright light
D	Low	In the dark

28 An electrical appliance is plugged into a socket in the wall. The plug contains a fuse.

What is the main purpose of the fuse?

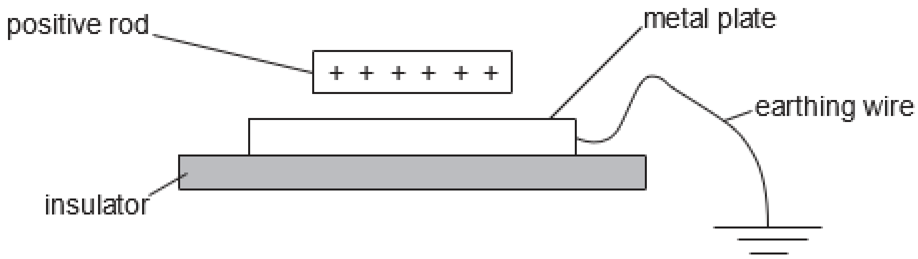
A to earth the appliance

B to earth the plug

C to protect the user from electric shock

D to protect the wiring from overheating

29 A positively-charged plastic rod is placed just above a thick metal plate. The metal plate rests on an insulator and is connected to the earth by a wire.



A student disconnects the earthing wire and then removes the positively charged rod. The experiment is repeated. This time the student removes the positively charged rod and then removes the earthing wire.

Which statement is correct?

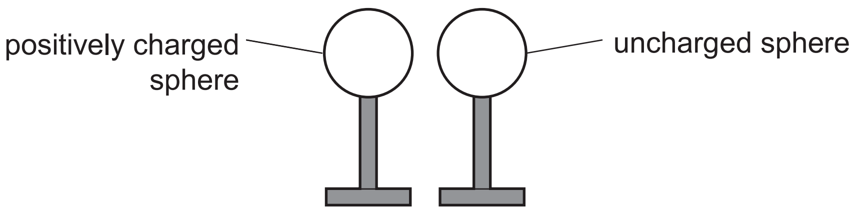
A When the earthing wire is disconnected first, the metal plate becomes positively charged.

B When the earthing wire is disconnected first, the metal plate becomes negatively charged.

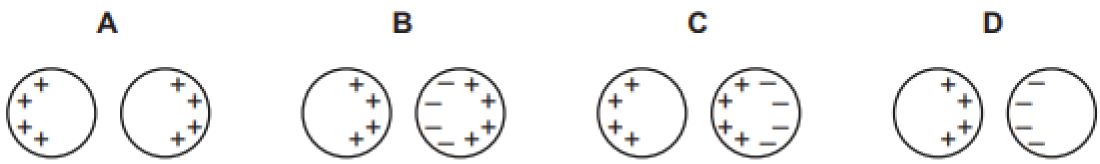
C When the plastic rod is removed first, the metal plate becomes positively charged.

D When the plastic rod is removed first, the metal plate becomes negatively charged.

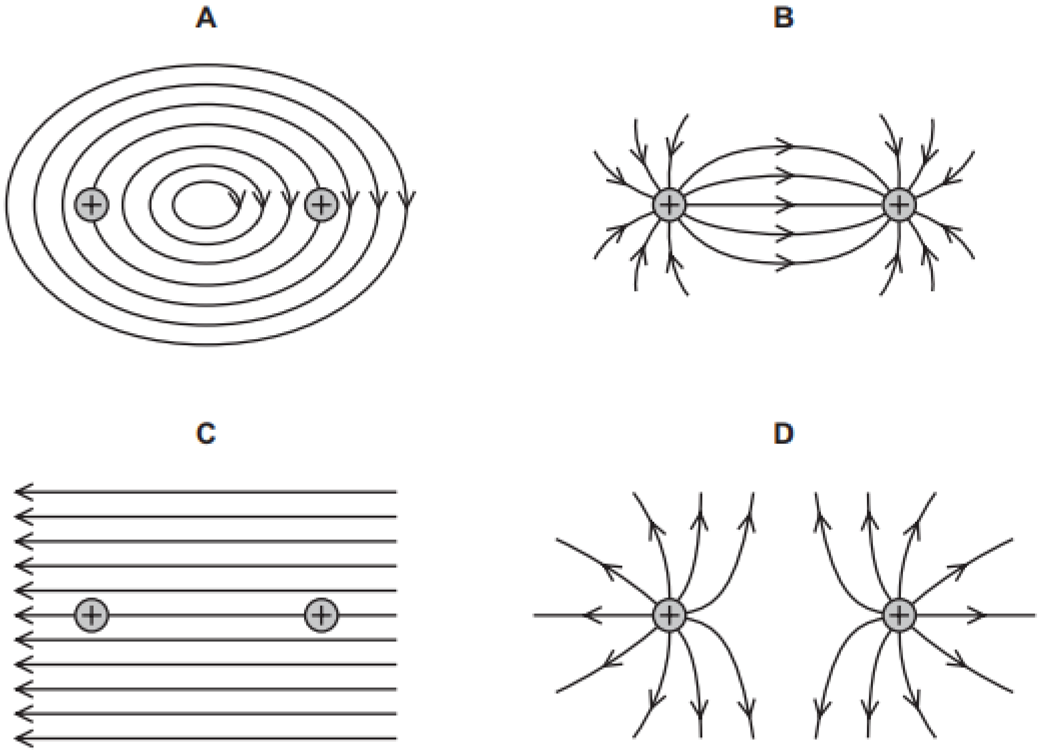
30 A positively charged insulated metal sphere is brought close to an uncharged insulated metal sphere.



Which diagram shows the charge distribution on the spheres?



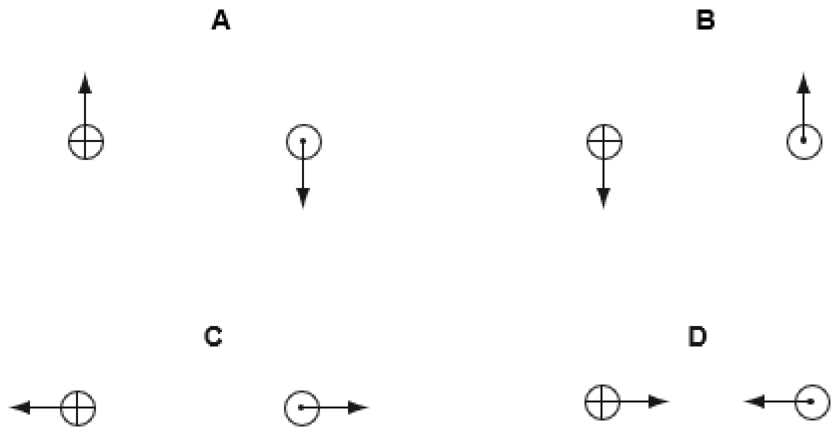
31 Which diagram represents the electric field line pattern due to a combination of two positive charges?



32 Each diagram shows a cross-section through two parallel conductors, each carrying an electric current.

In the conductor on the left, the current is into the page; on the right, it is out of the page.

Which diagram shows the directions of the forces on the two conductors?



33 Two medical examinations P and Q carried out in hospitals use different types of waves. The pictures, X and Y, obtained from these two examinations are also shown

Medical Examination P

Medical examination Q

Picture X

Picture Y

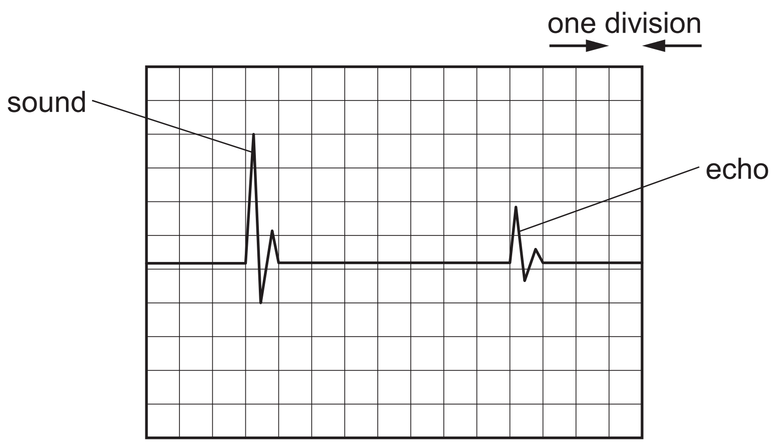
Which combination used in these two medical examinations is correct ?

	Medical Examination	Picture	Wave used in column 1	Medical Examination	Picture	Wave used in column 4
A	P	Y	X-rays	Q	X	Ultra-sound
B	P	X	infra-sound	Q	Y	Microwave
C	Q	X	X-rays	P	Y	Gamma-rays
D	Q	Y	Ultra-sound	P	X	X-rays

34 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

35 Which statement about a water wave is correct?

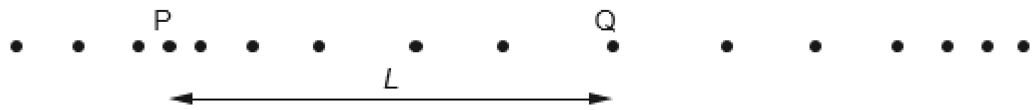
A The amplitude is the vertical distance between a trough and a peak.

B The frequency is the number of troughs passing a point in one second added to the number of peaks passing a point in one second.

C The speed is the horizontal distance travelled per second by a peak.

D The wavelength is the horizontal distance between a trough and a peak

36 The diagram illustrates the position of particles of a sound wave at one instant in time.



The speed of the wave is *V*. P and Q are two points in the wave a distance *L* apart.

What is an expression for the frequency of the wave?

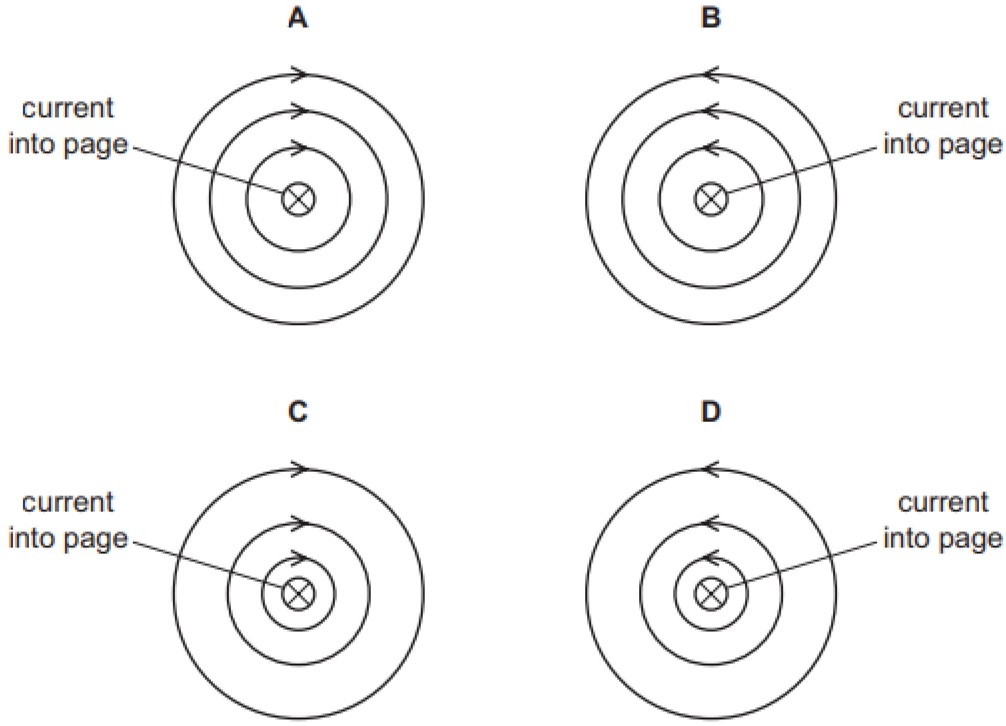
A $V / 2L$

B V / L

C $2V / L$

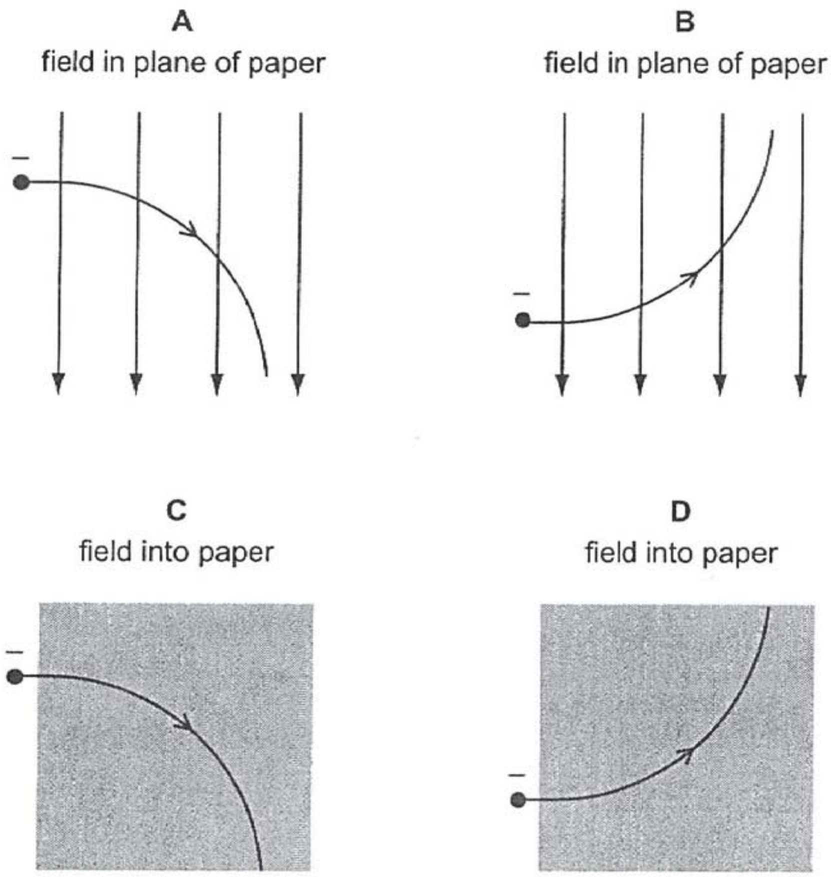
D L / V

37 An electric current in a wire is into the page. Which diagram shows the shape and direction of the magnetic field around the wire?

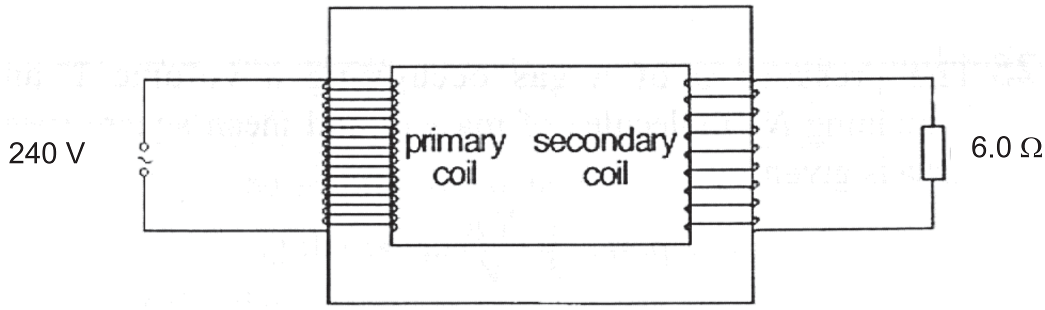


38 A negatively-charged particle enters a uniform field.

Which diagram represents the path of the particle in the magnetic field ?



39 The diagram shows a transformer which is assumed to be 100% efficient. The ratio of the secondary turns to the primary turns is 1: 20.



A 240 V a.c. supply is connected to the primary coil and a 6.0 Ω resistor is connected to the secondary coil.

What is the current in the primary coil ?

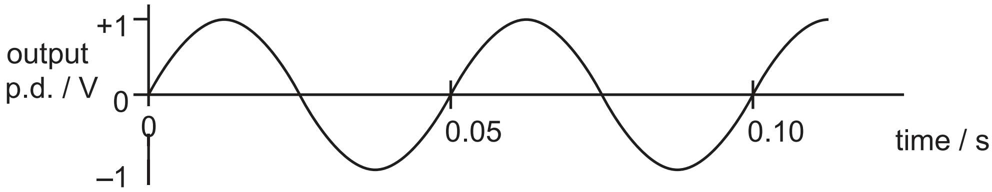
A 0.10 A

B 0.14 A

C 2.0 A

D 40 A

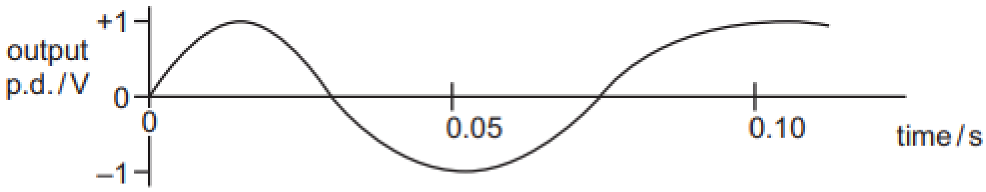
40 The graph shows the output of an a.c. generator. The coil in the generator rotates 20 times in one second.



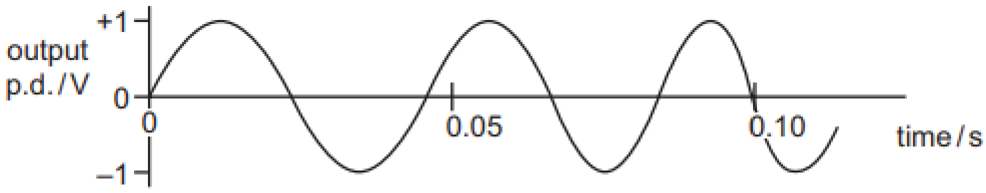
The speed of rotation of the coil steadily increases.

Which graph best shows how the output changes

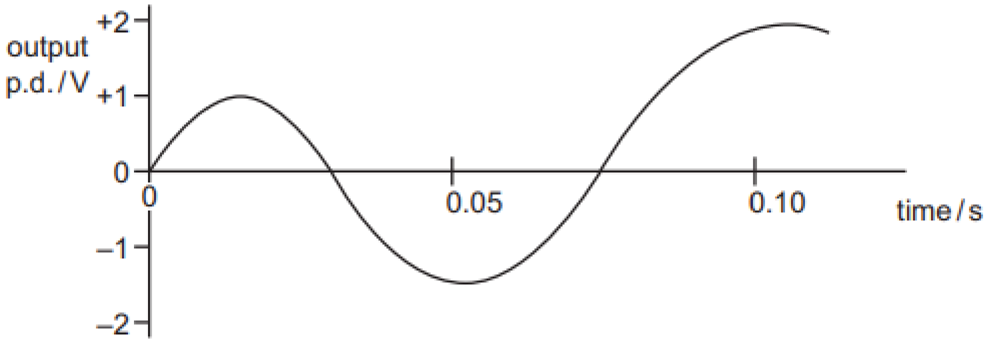
A



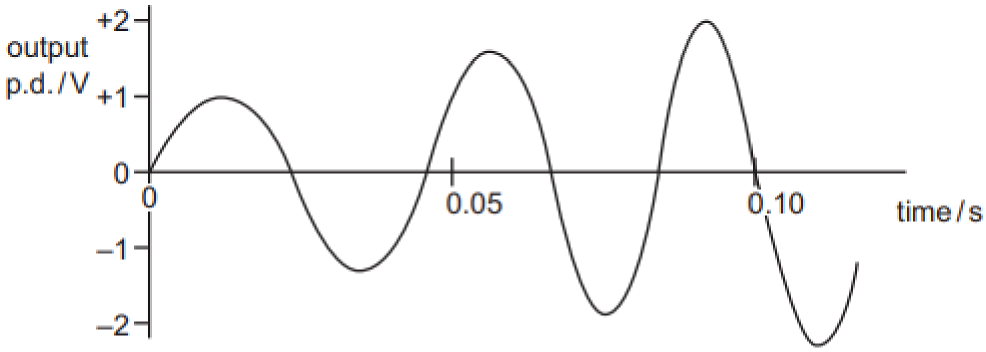
B



C



D



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SINGAPORE CHINESE GIRLS' SCHOOL
PRELIMINARY EXAMINATION 2022
SECONDARY FOUR

CANDIDATE NAME						
CLASS	4			REGISTER NUMBER		
CENTRE NUMBER				INDEX NUMBER		

PHYSICS **6091/2**

Monday **29 August 2022** **1 hour 45 mins**

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

READ THESE INSTRUCTIONS FIRST

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.

Take g = 10 ms^{-2} or 10 Nkg^{-1} unless stated otherwise.

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

This question paper consists of 26 printed pages.

SECTION A

Answer all the questions in this section.

1 **Fig. 1.1** shows two engineers measuring the length of a wall made from concrete.

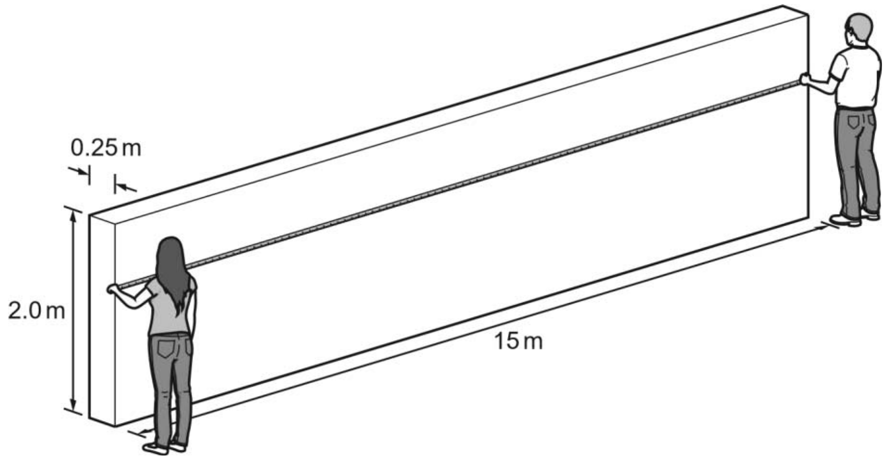


Fig. 1.1 (not to scale)

The wall is 2.0 m high, 15.0 m long and 0.25 m thick. The mass of the wall is 18 000 kg.

(a) The engineers measure the length of the wall in one single measurement.
State the name of the measuring instrument they use.

………………………………………………………………….. [1]

(b) The engineers state that the density of the concrete affects the pressure exerted by the wall on the ground but that the length of the wall does not affect this pressure.

(i) Calculate the average density of the concrete.

Average density = ……………….. [2]

(ii) Calculate the average pressure exerted by the wall on the ground.

Average pressure = …………….. [2]

(iii) Without further calculation, explain why doubling the length of the wall does not change the pressure that the wall exerts on the ground.

………………………………………………………………………………………….

………………………………………………………………………………………..

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

[Total : 6 m]

2 Fig. 2.1 shows a cricket ball as it comes into contact with a cricket bat.

Fig. 2.1

The cricket ball has a mass of 0.16 kg and it hits the bat with a speed of 25 m / s. After being in contact with the bat for 0.0013 s, the ball rebounds with a speed of 22 m / s in the direction exactly opposite to its original direction.

(a) State the difference between *speed* and *velocity*.

....

....

.... [2]

(b) Calculate

(i) the change in velocity of the cricket ball,

Velocity change = ... [1]

(ii) the average acceleration of the ball whilst it is contact with the bat,

Acceleration = ………….. [2]

(iii) the average force exerted on the ball by the bat.

Force = ……………… [2]

[Total : 7 m]

3 (a) Explain what is meant by *centre of gravity*.

....

.... [1]

(b) A student is being weighed. The student, of weight W, stands 0.30 m from end A of a uniform plank AB, as shown in Fig. 3.1.

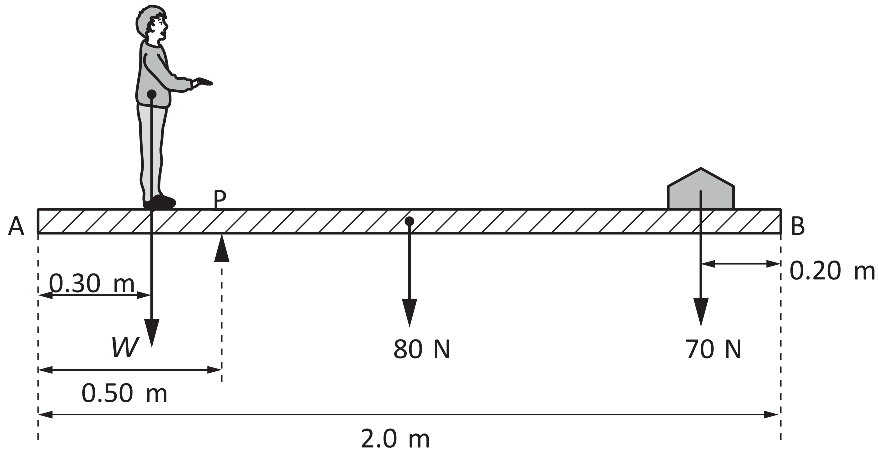


Fig. 3.1 (not to scale)

The plank has weight 80 N and length 2.0 m. A pivot P supports the plank and is 0.50 m from end A. A weight of 70 N is moved to balance the weight of the student. The plank is in equilibrium when the weight is 0.20 m from end B.

(i) Determine the weight W of the student.

Weight = …………… [2]

(ii) If only the 70 N weight is moved, there is a maximum weight of student that can be determined using the arrangement shown in Fig. 3.1. State and explain **one** change that can be made to increase this maximum weight.

....

....

.... [2]

[Total : 5m]

4 Fig. 4.1 shows the variation in volume of ice when the temperature changes from -5°C to 10°C. The mass of ice is 30 g.

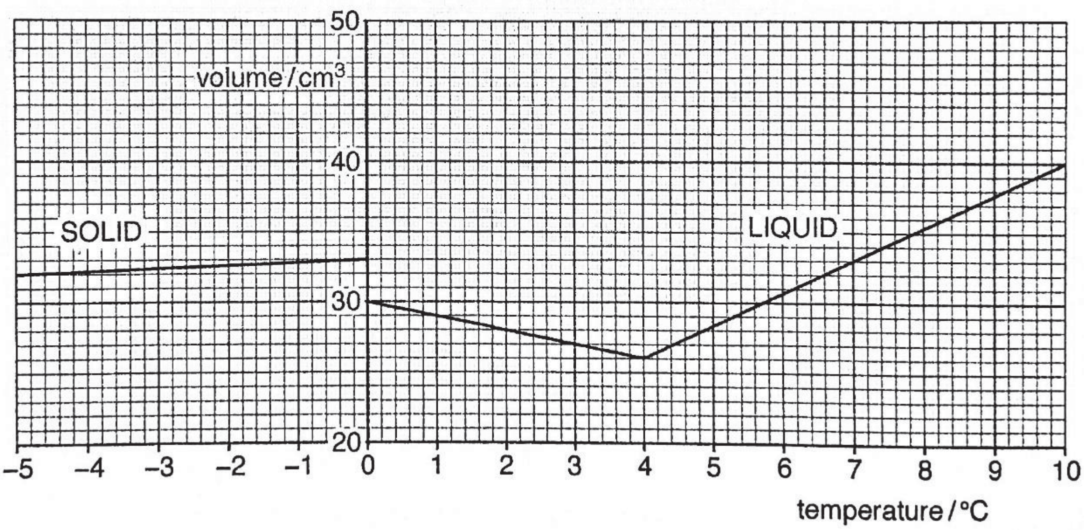


Fig. 4.1

(a) Describe how the density of the ice changes as its temperature increases from -5°C to 0°C.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

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

(b) Calculate the change in the density of ice at 0°C in g/cm^3.

Density = ………….. [2]

(c) The volume of some ice cubes in a freezer decreases when they are left in the freezer for some time. This is because the ice changes from a solid to a vapour without becoming a liquid.

Describe, in terms of molecules, how ice changes from solid to vapour.

....

....

....

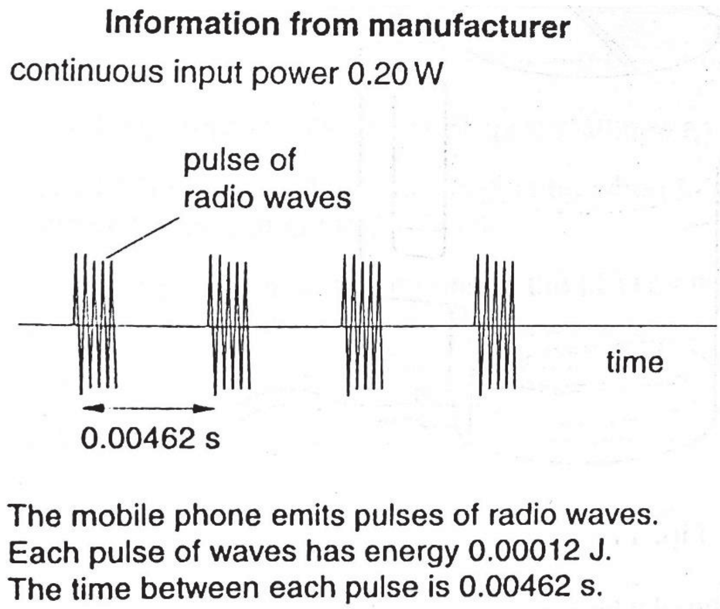
....

....

.... [2]

[Total : 6 m]

5 A student wishes to find out whether the energy from the radio waves emitted by mobile phones may affect a temperature rise in his brain. He first obtains the information from the mobile phone's manufacturer shown in Fig. 5.1a.



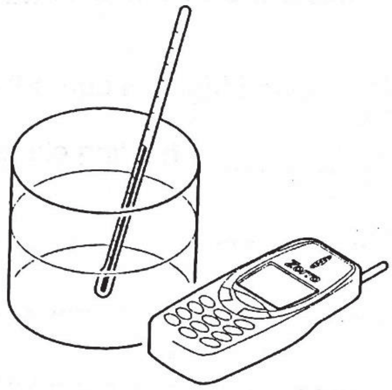


Fig. 5.1a **Fig. 5.1b**

(a) The student switches on the phone for 6 minutes and places it next to a glass beaker containing 50 g of water (Fig. 5.1b). Calculate

(i) the number of pulses of radio waves produced during the 6 minutes of call;

Number of pulses = …………… [1]

(ii) the total energy of the radio waves emitted during the phone call.

Total energy = ………… [1]

(iii) the maximum temperature rise produced in the 50 g of water if all the energy calculated in **(ii)** is absorbed by the water. The specific heat capacity of water is 4.2 $Jg^{-1}{}^{o}C^{-1}$.

Rise in temperature = …………….[2]

(b) Explain why the temperature rise produced in the brain during a 6-minute phone call is different from the calculated temperature rise in the water.

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

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

(c) The phone is powered by a battery which provides a continuous input power of 0.20 W .

Calculate the fraction of the energy supplied by the battery that is converted into radio wave energy during the 6-minute phone call. Express your answer in decimals.

Fraction = ………… [2]

[Total : 7 m]

6 Fig. 6.1a shows a barometer tube in which the mercury column is 760 mm high.

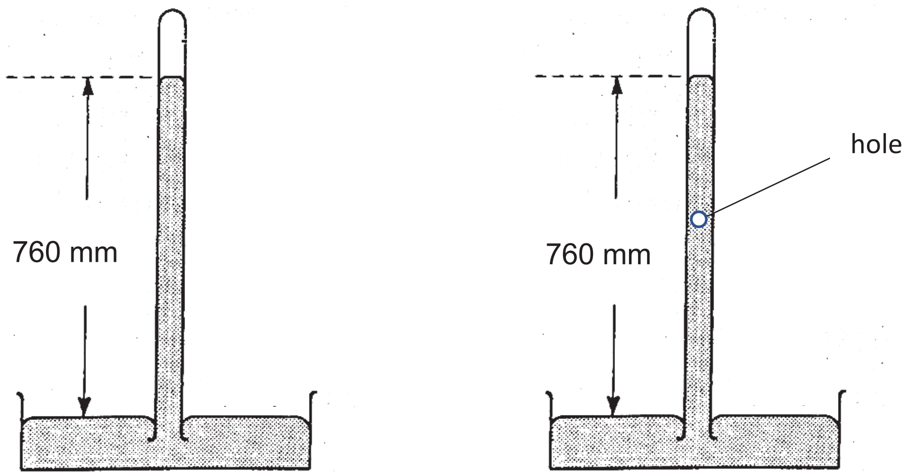


Fig. 6.1a **Fig. 6.1b**

(a) Given that the density of mercury is 13.6×10^3 kgm^{-3}, determine the atmospheric pressure. (Take g = 10 Nkg^{-1})

Atmospheric pressure = …………….. [2]

(b) Fig. 6.1(b) shows an upright barometer with a hole which was initially covered with a tape.

The tape is subsequently removed. State and explain what happens next.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [3]

[Total : 5 m]

7 **Fig. 7.1** below shows a circuit diagram. **A_1, A_2, A_3** and **A_4** are ammeters of negligible internal resistance. **P, Q, R** and **S** are resistance wires of the same material. **Q** is short and thick while **R** is long and thin when compared with **P**. **K** is a switch.

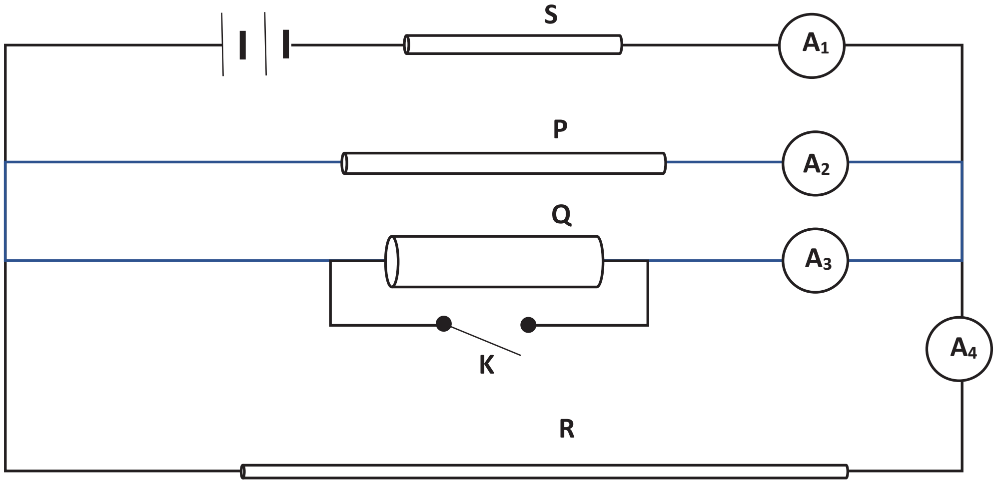


Fig. 7.1 (not drawn to scale)

(a) Identify 2 conductors that are arranged in parallel.

………………………………………………………………….. [1]

(b) If the lengths of **P** and **R** are in the ratio of 3:4 and their cross-sectional areas are in the ratio of 2:1, calculate the ratio of the resistance of **P** to that of **R**. Express your answer as a decimal.

Ratio = …………. [2]

(c) The readings of the ammeters **A_1, A_2, A_3** and **A_4** are a_1, a_2, a_3 and a_4 respectively.

(i) Explain which ammeter registers the highest reading when the switch is not closed.

…………………………………………………………………………………………..

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

(ii) Explain which ammeter registers the highest reading when the switch is closed.

…………………………………………………………………………………………..

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

(d) Which ammeter(s) would be ruined on closing switch **K** if the resistance **S** were absent? Explain your answer.

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

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

………………………………………………………………………………………………………

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

[Total : 7 m]

8 Fig. 8.1 shows a trumpet producing a single note in front of a microphone

Fig. 8.1

Fig. 8.2 shows the variation of the pressure with time of the air between the trumpet and the microphone.

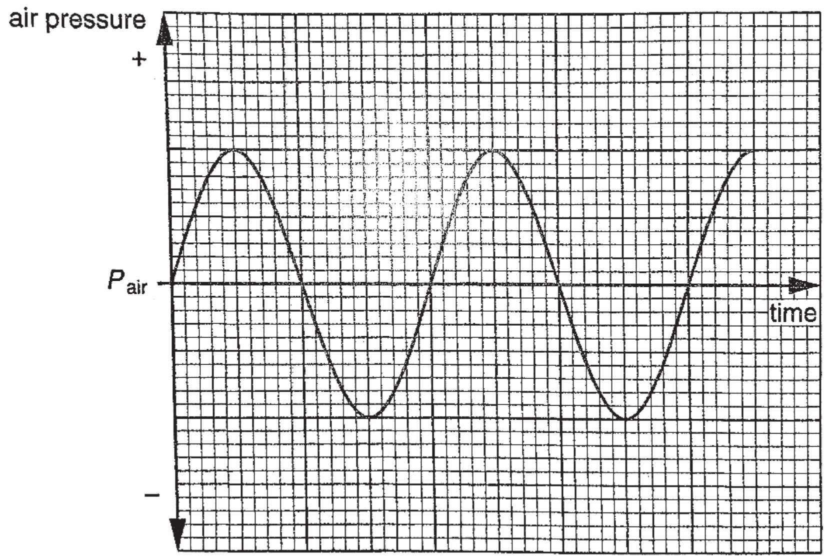


Fig. 8.2

The air pressure when there is no sound is P_{air}.

(a) **(i)** The same note is played again but is now louder. On Fig. 8.2, draw the graph to show the waveform of this louder note. [1]

(ii) A new note of higher pitch but of the same loudness as the note produced in Fig. 8.1. Describe how the graph would be different compared to Fig. 8.2.

....

.... [1]

(b) The note produced by the microphone is first converted into an electrical signal. This signal is then fed into a mixer, an amplifier and finally to speaker as shown in Fig. 8.3a.

.

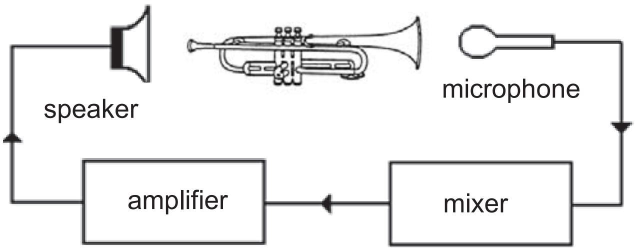


Fig. 8.3a

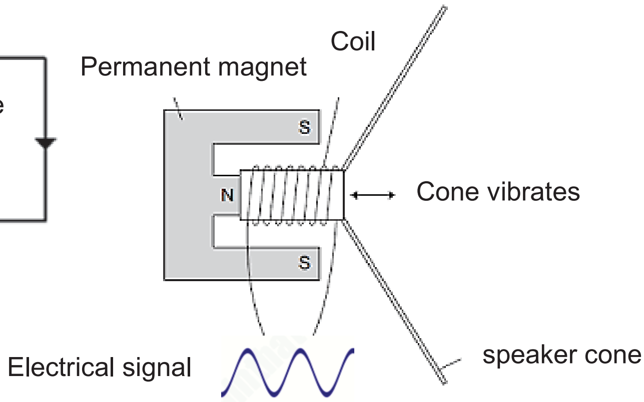


Fig. 8.3b

Fig. 8.3b shows the internal structure of a speaker. The speaker cone vibrates when the electrical signal flows through the coil.

Explain how the speaker cone vibrates when this electrical signal flows through the coil.

....

....

....

....

....

....

.... [3]

(c) The single note on a trumpet is then analysed using an oscilloscope. Fig. 8.4 shows the waveform displayed on the oscilloscope screen.

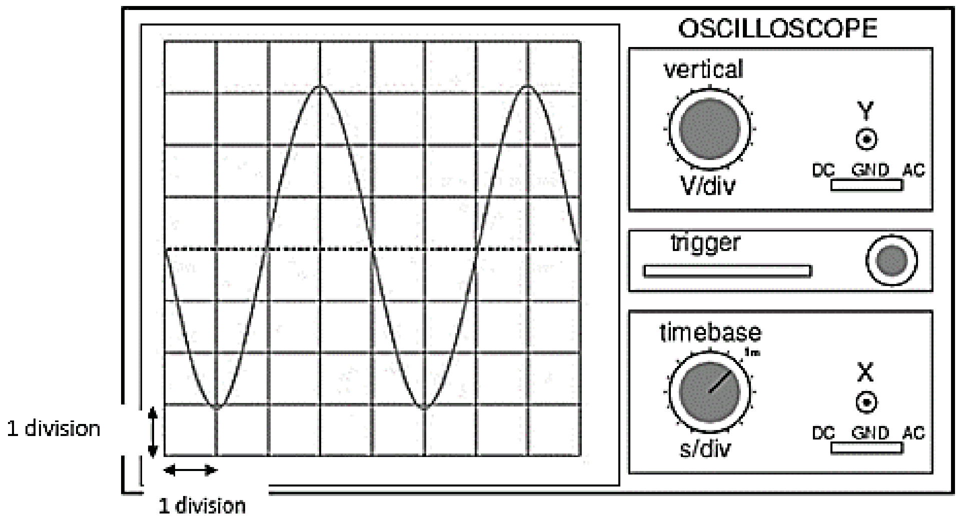


Fig. 8.4

(i) Given that the time-base is set at 200 ms / div, determine the frequency of the note produced by the trumpet.

Frequency = ……………… [1]

(ii) The time-base is now adjusted to 50 ms/div. Draw on Fig. 8.4 the appearance of the waveform after this adjustment. [1]

[Total : 7 m]

SECTION B

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

9 **Fig. 9.1** shows a student doing a bungee jump from a bridge. The student has a mass of 80 kg and he jumps from a bridge which is 85 m above the river. His legs are tied to an elastic rope which starts to stretch after 30 m of free fall.

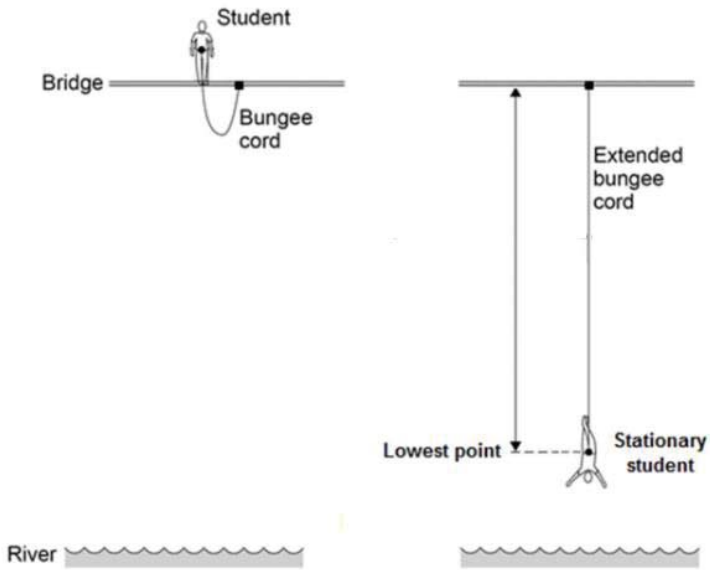


Fig. 9.1

Fig. 9.2 below shows the values of gravitational potential energy, kinetic energy of the jumper, elastic potential energy stored in the elastic rope at various stages of jump, height of the man above the river, *h* and his speed, *v.*

h / m	Gravitational potential energy / kJ	Kinetic energy / kJ	Elastic potential energy / kJ	*v* / ms^{-1}
85	68.0	0	0	0
80	64.0	4.0	0	10.0
70	56.0	12.0	0	17.3
60	48.0	20.0	0	22.4
50	40.0	27.3	0.7	26.1
45	36.0	29.0	3.0	26.9
40	32.0		6.7	
35	28.0	28.1	11.9	26.5
30	24.0	25.5	18.5	25.2
25	20.0	21.3	26.7	23.1
20	16.0	15.7	36.3	19.8
15	12.0	8.6	47.4	14.7
10	8.00	0	60.0	0

Fig. 9.2

The total distance of fall for the student before he stops for the first time is 75 m.

(a) Show that the gravitational potential energy of the student at the bridge is 68.0 kJ. [1]

(b) Explain how the data from **Fig. 9.2** shows that energy is conserved during the jump.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

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

(c) Determine the values in **Fig. 9.2** for h = 40 m.

Kinetic energy = ………………….. Speed = ……………… [1]

(d) Describe the changes in the acceleration of the student when h = 60 m to h = 25 m.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

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

(e) With reference to **Fig. 9.2**, explain the variation in the resultant force acting on the student from h = 60 m to h = 25 m.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

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

(f) **Fig. 9.3** shows the different forces acting on the student at one point of the jump when h = 40 m.

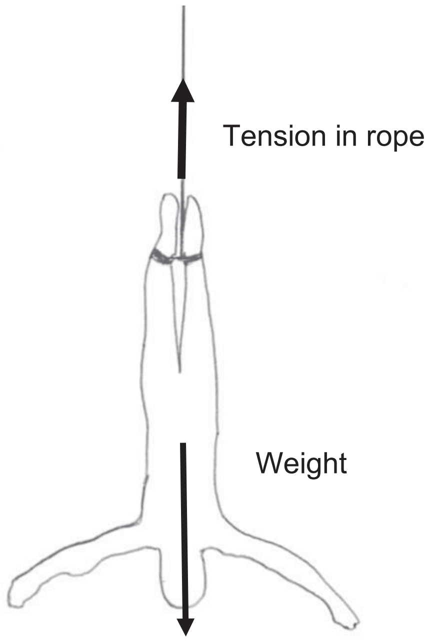


Fig. 9.3a

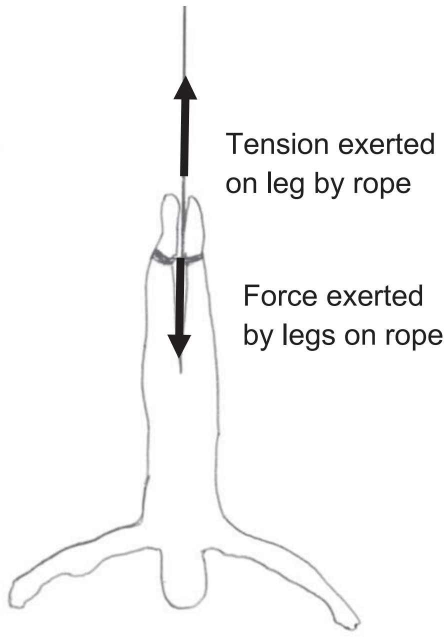


Fig. 9.3b

Explain the difference between the labelled forces in Fig. 9.3a and those in Fig. 9.3b.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

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

10(a) Distinguish between *electromagnetic induction* and *magnetic induction.*

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.... [2]

(b) A simple apparatus used to demonstrate electromagnetic induction is shown in Fig. 10.1(a).

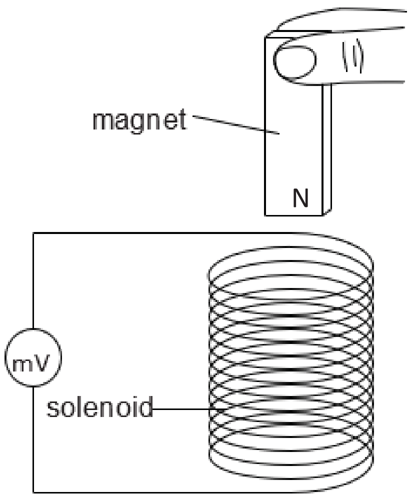

Fig. 10.1(a)

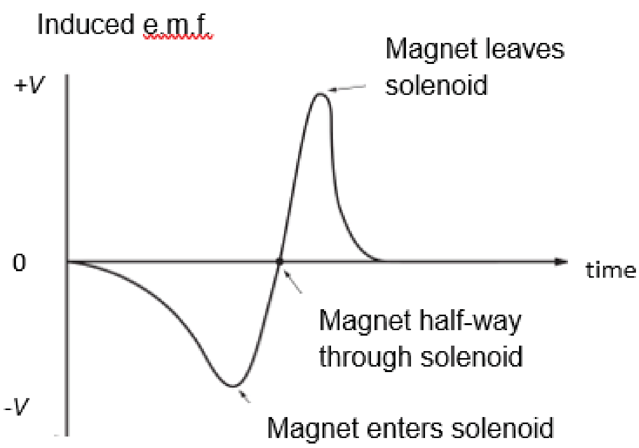

Fig. 10.1 (b)

A student drops a magnet so that it falls vertically through the solenoid. Fig. 10.1(b) shows the induced electromotive force (induced e.m.f.) from the moment of dropping the magnet to its leaving the solenoid.

(i) By indicating the direction of the induced current in the solenoid, explain why there is a build-up of the induced e.m.f. from the time the magnet is released to just before it enters the solenoid. Explain also why the increase is non-uniform.

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.... [3]

(ii) When the magnet is half-way through the solenoid, the e.m.f. is zero.

Explain why the induced e.m.f. drops to zero from the point when the magnet enters the coil to when it is half-way through the solenoid.

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(c) Fig. 10.3a shows a circuit breaker with the contacts closed. Fig.10.3b shows the same circuit breaker when a large current has passed through the circuit.

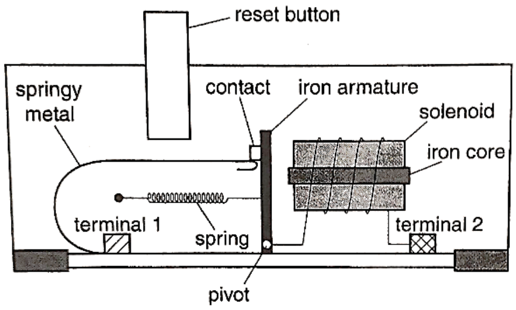

Fig. 10.3a

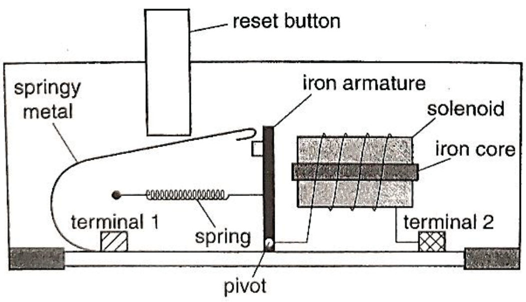

Fig. 10.3b

Explain how the circuit breaker is able to switch off the current when a fault causes the current to become too large.

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EITHER

11 **Fig. 11.1** shows the formation of an image on a screen using a converging lens.

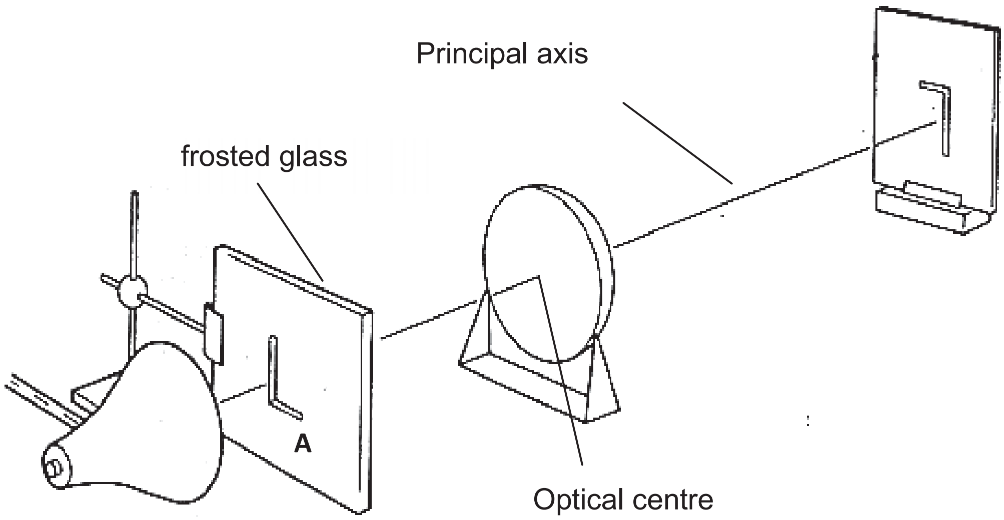

Fig. 11.1 (not to scale)

(a) By drawing a ray parallel to the principal axis on **Fig. 11.2** below, show clearly how the image of point **A** on the letter L is formed on the screen. Indicate on **Fig. 11.2** the principal focus, **F**, of the lens. [2]

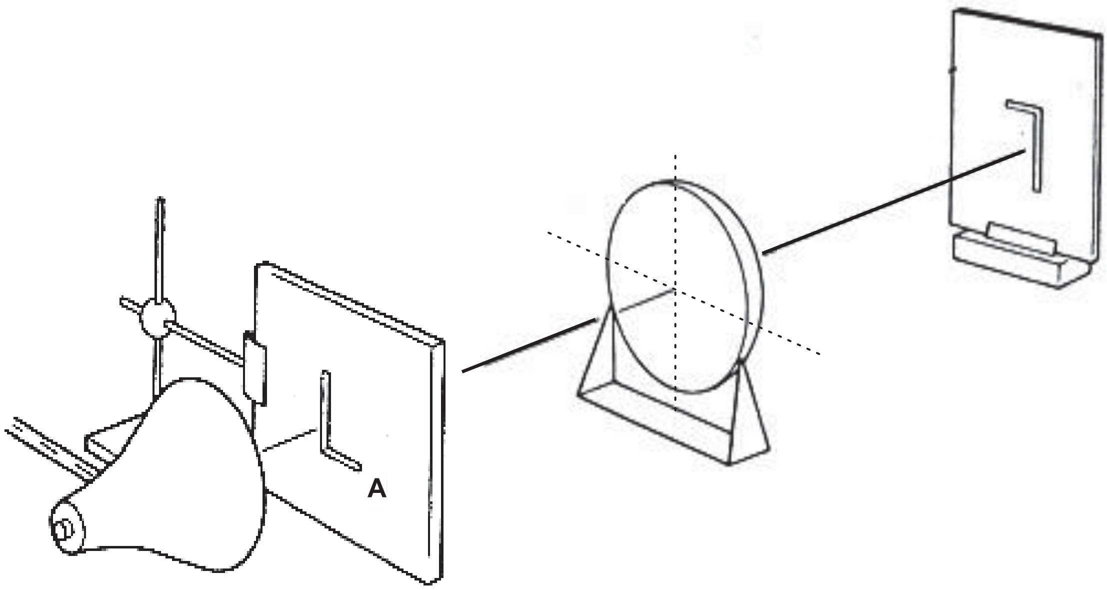

Fig. 11.2

(b) Describe the nature of image formed on the screen.

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(c) A lens is used to focus a parallel beam of light to a point on a plastic rectangular disc. In order for this to occur, the plastic disc must be at the correct height.

10 x scale drawing

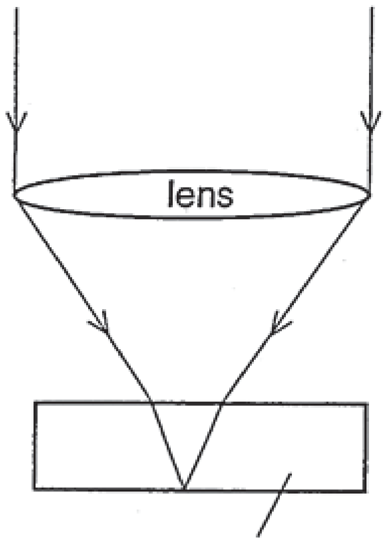

Fig. 11.3

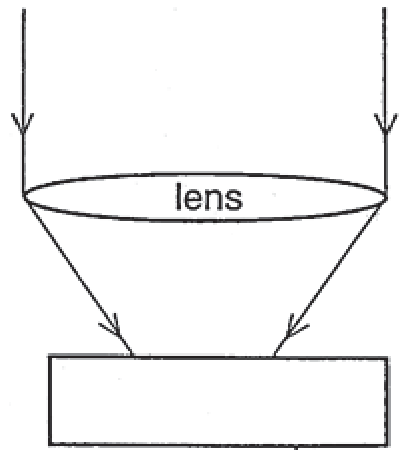

Fig. 11.4

Fig. 11.3 shows the side-view of the disc in the correct position, and Fig 11.4 shows the disc raised too high. Each drawing is drawn to scale and is 10 times larger than the true size of this set-up.

(i) Define the focal length of a converging lens.

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

(ii) Estimate the focal length of the lens.

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

(iii) Describe what happens to the light as it enters the plastic disc.

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

(iv) 1. Complete Fig. 11.4 to show the rays of light inside the plastic disc. [1]

2. Measure and state the diameter of the spot of light formed on the bottom of the disc in Fig. 11.4. You should take account of the scale of the diagram.

Diameter = ……………………………………………………………………………… [1]

(v) State one adjustment that may be made to the lens in Fig. 11.4 so that the rays meet at the point on the bottom of the disc.

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

OR

11(a) Fig. 11.5 shows an electric kettle connected to a 240 V mains supply by a flexible cable. The kettle has a power rating of 2500 W.

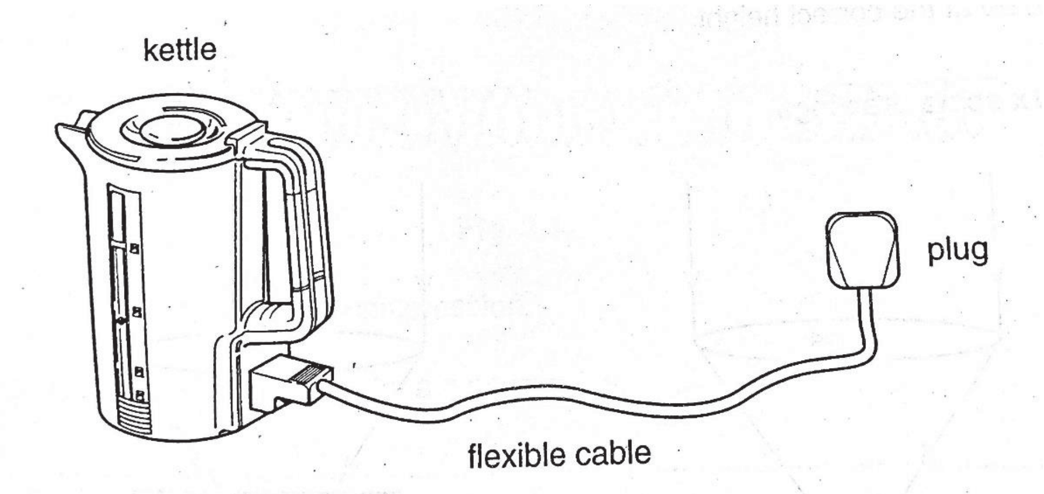

Fig. 11.5

The table shows the maximum current that may be carried by wires of various diameters.

Wire diameter / mm	Maximum current / A
0.50	3
0.75	6
1.00	10
1.25	13
1.50	15

(i) Show that the current in the cable when the kettle is in use is 10.4 A. State clearly any equation that you use. [2]

(ii) From the table select the smallest diameter of wire that can safely be used for this kettle. Explain why it is dangerous to use a wire thinner than the diameter you selected.

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(iii) Describe one fault that may occur in the flexible cable that will cause the fuse in the plug to melt.

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.... [1]

(iv) Fig. 11.6 shows an electrical plug that is used to connect the kettle to the wall socket.

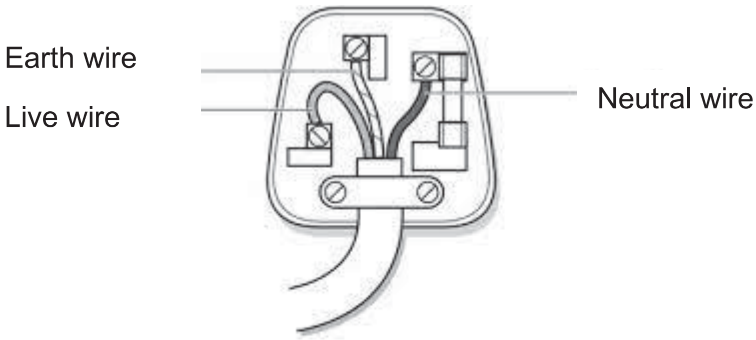

Fig. 11.6

Explain why the wiring in Fig .11.6 causes a hazard even when the switch of the kettle is turned off.

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.... [1]

(b) Fig. 11.7 shows a girl using a hair dryer. The hair dryer is double-insulated.

Fig. 11.7

(i) Explain what you understand by double-insulation.

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.... [2]

(ii) The hair dryer delivers a power of 1.25 kW energy.

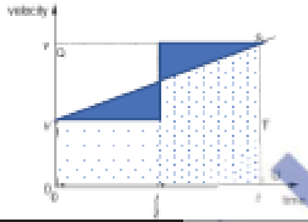
If the hair dryer is used for 45 mins per week and the kettle in **(a)** is used for 15 mins per day, calculate the cost of using both appliances in two weeks if 1 kWh of electricity costs 40 cents.

Cost = …………….[3]

END OF PAPER

2022 PRELIMINARY EXAM
SUGGESTED ANSWER SCHEME

PAPER 1 (40 marks)

Qn	Answer	Explanation
1	B	Micrometer must be a choice for measuring diameter. Vernier calipers are not suitable for measuring length of wires.
2	C	Volume of sphere = $\pi/6$ $(0.481\text{cm})^3$; Density = (0.450 / 0.058)x 1000 kgm^{-3} = 7720 kgm^{-3}
3	B	Returning back to the starting point will result in zero displacement. Total distance is non-zero
4	C	A & B are not possible as the value is less than $\sqrt{4^2+5^2}$ kN or 6.4 kN. 8.3 kN is closer to 9.0 kN when the two forces are parallel to each other.
5	B	 The solid shaded region are of the same area
6	D	The gradient, which is the acceleration, is greater at X than at Y. Therefore the resultant force is acting on the raindrop is greater at X.
7	D	The graph shows increasing velocity (increasing gradient) followed by constant velocity (constant gradient)
8	A	There is no atmosphere to slow down the feather. It moves with constant acceleration.
9	B	Distance travelled = ½(3.0s)(22+8)ms^{-1} = 45 m
10	C	At constant speed, resultant force = 0. Total upward force = total downward force.
11	B	$P_{atm} - P_{chamber} = P_{40\,cmH2O}$ = (0.4m)(1000kgm^{-3})(10Nkg^{-1}) = 4000 Nm^{-2}
12	D	P = W/A. Since all 5 blocks have the same mass, P $\propto$ 1/A $\Rightarrow$ an inverse function graph
13	C	T x 5.0 cm = 40 x 35 cm $\Rightarrow$ T = 280 N
14	C	The CG of the block falls through a height of 0.9 m. ΔGPE = 500 N x 0.9 m = 450 J
15	C	Shortest time to reach her classroom is by running. More power is used to gain the same amount of GPE as Power = work done / time
16	C	Efficiency = (200 x 6000)W / (500 x 10 x 300)W x 100% = 80%
17	A	Molecules do not expand when a solid is heated
18	A	Evaporation resulted in the lowering of the KE of the remaining molecules in the liquid. Molecules leaving need to attain the necessary KE to overcome the bonds and escape into the atmosphere. Therefore they must possess high energy.
19	C	In one second 6000 J = m x 4200 $\text{Jkg}^{-1}{}^{\circ}\text{C}$ x 20°C $\Rightarrow$ m = 0.0714 kg
20	C	Molecules do not expand. The KE of molecules do not increase – only PE increases during change of state

Question	Answer	Explanation
21	D	$1.8 = \sin R / \sin 30^\circ \Rightarrow R = \sin^{-1}(0.9) = 64.15^\circ$
22	C	Total internal reflection occurs when angle of incidence in the optically denser medium is greater than critical angle and can only occur inthe optically denser medium
23	B	The dotted lines locate the image to the left and on the same side as the object. This is the image formed when image is less than the focal length of the lens.
24	B	R = V/I
25	D	All other choices have an open circuit
26	B	Variable resistor is connected in parallel to the fixed resistor. Voltmeter will register an increase when resistance is increased. (alternative explanation : Increasing the variable resistor increases the total resistance of the two parallel resistors . Using potential divider eqn before and after adjustment, V_1 decreases and V_2 increases)
27	A	Resistance is lowest when temperature for thermistor is high and LDR is placed in bright light.
28	D	Overheating is due to high current than allowed by the fuse
29	B	Mobile electrons are attracted to the positively-charged sphere. Electrons from earth discharges the positive charges at the bottom of the plate. Removing the earthing wire first results in metal having a net negative charge.
30	B	Bringing the positive rod near will induce electrons on top and positive charges at the bottom
31	D	Like charges repel each other
32	C	Currents flowing in difference direction create a strong field in the centre.
33	A	Recall question
34	B	Distance = (0.04 s x 300 m/s) = 12 m
35	C	The crest/ trough moves forward, thus constituting the wave velocity.
36	A	$\lambda/2 = L$; $V = f\lambda \Rightarrow f = V/\lambda = V/2L$
37	C	Use right-hand grip rule
38	C	Apply Fleming's Left-hand rule with the centre finger pointing in the direction opposite to the motion of the -ve charge
39	A	$N_s/N_p = V_s/V_p \Rightarrow V_s = 1/20 \times 240 = 12$ V. $I_p = 12$ V/ 6.0 Ω = 2.0 A. From $I_pV_p = I_sV_s \Rightarrow I_p(240V) = 2.0$ A (12 V) Thus $I_p = 0.1$ A
40	D	Increasing coil speed increases the frequency as well as the amplitude

PAPER 2 SECTION A (50 marks)

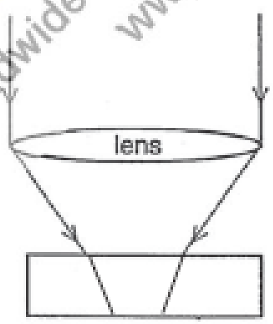
Qn	Part	Answer	Mark	Remarks
1	(a)	Measuring tape		
	(b)(i)	Average density = 18000 kg / (2.0 x 15.0 x 0.25)m^3 = 2400 kgm^{-3}		
	(ii)	Average pressure = (18000 x 10)N / (0.25 x 15)m^2 = 4.8 x 10^6 Nm^{-2}		
	(iii)	Doubling the length doubles the volume. Since density is constant, mass/weight is doubled. Since area is also doubled, pressure remains unchanged		
2	(a)	Speed is rate of change of distance while velocity is the rate of change of displacement. Since displacement is a vector, velocity has a direction and magnitude while speed is a scalar		
	(b)(i)	Velocity change = (+25m/s)-(-22m/s) = +47 m/s		
	(ii)	Average acceleration = (+47m/s)/0.0013 s = +3.6 x 10^4 ms^{-2}		
	(iii)	Average force F = ma = 0.16 kg x [+3.6 x 10^4]ms^{-2} = + 5.8 x 10^3 N		
3	(a)	A point where the whole weight of the body appears to act regardless of the body's orientation		
	(b)(i)	Applying principle of moments, W x 0.2m = 80 N x 0.5 m +70 N x 1.3 m = 40 Nm + 91 Nm $\Rightarrow$ W = 655 N		
	(iii)	Either : Move the 70 N weight to the right until the CG of the weight is directly above B. Reason : the weight of the stationary student must be the maximum to produce the corresponding anticlockwise moment to keep the plank in equilibrium. OR : Move the pivot to the left . Reason: This creates a greater clockwise moment . To keep the plank in equilibrium, the weight of the student will need to increase.		
4	(a)	▪ Density of ice **decreases** as the temperature increases from – 5°C to 0°C ▪ At 0°C, the density **increases (when its volume decreases)** from 33 cm^3 to 30 cm^3.		
	(b)	Density of ice at volume 33 cm^3 = (30/33) gcm^{-3} = 0.91 gcm^{-3} Density of ice at volume 30 cm^3 = (30/30) gcm^{-3} = 1.00 gcm^{-3} Change in density = (1.00 – 0.91) gcm^{-3} = 0.09 gcm^{-3}		

	(c)	▪ Water molecules/particles at the surface of the ice obtain sufficient **(vibrational) kinetic energy** to overcome the forces of attraction between each other and exist as free molecules. ▪ These water molecules must also have sufficient **(translational) kinetic energy** to escape into the space above the ice and exists as free molecules.		
5	(a)(i)	Number of pulses = (6 x 60 s) / 0.00462 s^{-1} = 77921 = 78000		
	(ii)	Total energy = 77921 x 0.00012 J = 9.35 J		
	(iii)	From $Q = mc\Delta\theta$ $9.35\ J = 50\ g \times 4.2\ Jg^{-1o}C^{-1} \times \Delta\theta$ $\Rightarrow \Delta\theta = 0.045\ ^oC$		
	(b)	▪ Energy absorbed by the skull resulted in less energy transmitted to the brain ▪ Nature of the fluid in the brain is different from water. Thus the specific heat capacity differs.		
	(c)	Input energy = 0.20 W x (60 x 6)s = 72 J Fraction of energy converted into radio waves = 9.35 J/72 J = 0.13		
6	(a)	$P_{atm} = 0.76\ m \times 13.6 \times 10^{3}\ kgm^{-3} \times 10\ Nkg^{-1}$ $= 103360\ Nm^{-2}$ $= 100000$ or $10^5\ Nm^{-2}$		
	(b)	▪ Since vertical height below mercury meniscus in tube is less than 760mm, higher atmospheric pressure forces air through the hole and bubbles through the mercury upwards. ▪ Air pressure in the space above meniscus increases and pushes the mercury meniscus down slowly. ▪ When the meniscus move past the hole, the meniscus will go down quickly since the pressure inside the tube is the same as P_{atm}.		
7	(a)	P & Q ; Q & R ; P and R		
	(b)	Given that $\frac{l_P}{l_R} = \frac{3}{4}$ and $\frac{A_P}{A_R} = \frac{2}{1}$ $\Rightarrow \frac{R_P}{R_R} = \frac{l_P}{l_R} \times \frac{A_R}{A_P}$ $= \frac{3}{4} \times \frac{1}{2} = \frac{3}{8}$		
	(c)(i)	A_1. The current in A_1 is the sum of the currents in A_2, A_3 and A_4.		
	(ii)	A_1/A_3 . Current bypasses P, Q and R as the resistance of switch is very low.		
	(d)	A_3 and A_1 will be ruined. The closing of the switch and the absence of resistor S results in the bulk of the current passing through only ammeter A_3 and A_1 and bypassing P and R.		
8	(a)(i)	Sinusoidal graph with no change in period but higher amplitude.		
	(ii)	Crests/troughs will be closer to each other.		

	(b)	The (sinusoidal) electrical signal/current from the amplifier produces a changing magnetic field and in the coil of wire . This changing magnetic field interacts with the radial magnetic field of the permanent magnet producing a varying force of **<u>different magnitudes</u>** per cycle of the signal and **<u>in different directions</u>**. Since the coil is attached to the paper cone, the changing force (both in magnitude and direction) will oscillate the cone back and forth , thereby setting the volume of air into oscillation. (This oscillation of the air layers is the sound which was played on the trumpet.)		
	(d)(i)	*<u>Method 1</u>* f_{base} = 1/ (8 x 200 x 10^{-3} s) From $\frac{f_{note}}{f_{base}}$ = 2 f_{note} = 2 x f_{base} = 1.25 Hz *<u>Method 2</u>* T_{note} = 4 x 200 ms f_{note} = 1/ 4 x 200 x 10^{-3} s) = 1.25 Hz		
	(ii)	Half-cycle drawn across 8 divisions of the same peak.		

SECTION B (30 m)

Qn	Part	Answer		
9	(a)	Gravitational PE = 80 kg x 10 Nkg^{-1} x 85 m = 68000 J or 68 kJ		
	(b)	The sum of the kinetic, gravitational and elastic potential energy is always constant during the jump and is equal to 68kJ.		
	(c)	Kinetic Energy/kJ: 29.3 ; v / ms^{-1}: 27.1		
	(d)	▪ The bungee jump experiences **decreasing acceleration** from h = 60 m to h = 40 m ▪ Between 40 m to 20 m, he is experiencing **increasing deceleration.**		
	(e)	▪ Resultant force ($W - T$) between h = 60 m and h = 40 m, is **<u>decreasing downwards</u>** as the tension is increasing ▪ Resultant force between from h = 40 m to h =20 m is **increasing upwards** as (T -W) is increasing since the tension in the rope is increasing		
	(f)	In Fig. 9.3 a, the forces are all acting on the student and a thus free-body diagram forces. In Fig. 9.3 b, the two forces are action-reaction pair forces as they are acting on separate bodies.		
10	(a)	Magnetic induction is the temporary transformation of a magnetic material into a magnet when it is placed in a magnetic field while electromagnetic induction is the production of an induced electromotive force (e.m.f.) by a changing magnetic flux linkage.		
	(b)(i)	▪ There is a rate of change of magnetic flux linkage with the solenoid as the N-pole of the magnet approaches the coil. ▪ As it is a closed circuit, an induced current thus flows such as to produce a N-pole at the coil facing the approaching N-pole. ▪ As the magnet is accelerating under gravity, the rate of change of magnetic flux is increasing non-uniformly, thereby producing a non-uniform increase in the induced e.m.f.		
	(ii)	As the magnet enters the magnet, the induced emf and hence the direction of the induced current in the coil differs in direction and magnitude. ▪ The induced current in the coils at the bottom coils flows in such a direction as to produce a N-pole at the bottom coils and decreasing in magnitude. ▪ As the S-pole recedes from the coils at the top, the induced e.m.f. and hence the induced current flows in the opposite direction to that at the bottom and induces a N-pole at the top coils but increasing in magnitude. ▪ The two opposing currents cancel out when the magnet reached the middle of the coil as the e.m.f.		

		induced by both poles are the same in magnitude but opposite in direction.		
	(c)	▪ A large current flowing will produce a stronger magnetic field already existing in the solenoid. This stronger magnetic field is further concentrated by the iron core in the solenoid besides already inducing it to become a temporary magnet. ▪ The resulting stronger magnetic field, already attracting the iron armature due to the opposite polarity , attracts it with <u>a larger attractive force</u>. ▪ The iron armature rotates clockwise about the pivot and breaks contact with the springy metal which is connected to terminal 1. An open circuit results and current ceases to flow when the springy metal touches the reset button.		
11	EITHER			
	(a)			
	(b)	Laterally inverted; vertically inverted; real		
	(c)(i)	It the distance between the optical centre of the lens and the principal focus.		
	(ii)	0.35 cm / 3.5 mm		
	(iii)	▪ The light ray bend towards the normal ▪ It then converges to a point and does not emerge out of the plastic disc.		
	(iv)1			
	(iv)2	0.1 cm /1 mm		
	(v)	Raised the lens <u>by the same amount</u> that the disc is raised.		

11	OR			
	(a)(i)	From P = VI I = 2500 W/240 V = 10.4 A		
	(ii)	1.25 mm. Thinner wire will result in a fire as the resistance is very high.		
	(iii)	Constant bending of the wire will result in the wires breaking the insulation. The live wire may touch the neutral wire /earth wire which will result in a large current bypassing the heating element and flows through the fuse , thereby melting it.		
	(iv)	When the power is switched off, the appliance is still live as the live wire is still connected to the appliance and is at a high potential.		
	(b)(i)	▪ The electrical cables are insulated from the internal components . ▪ The internal components are insulated from the external casing.		
	(ii)	Total power consumed in two weeks by hairdryer = 1.25 kW x 2 x 0.75 h = 1.875 kWh Total power consumed by kettle in one week = 2.5 kW x 14 x 0.25 h = 8.75 kWh Total cost = (1.875 + 8.75)kWh x \$0.40 = \$4.25		

Name	Class	Register Number

6091/01 **22/4P/6091/1**

PHYSICS
PAPER 1

Tuesday **13 September 2022** **1 hour**

NIL SINE LABORE

VICTORIA SCHOOL

PRELIMINARY EXAMINATION
SECONDARY FOUR

Additional materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Write your name, class and index number on all the work you hand in.
Do not use staples, paper clips, 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** that 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 question paper consists of 18 printed pages, including the cover page.

[Turn Over

1 A micro-meter screw gauge is used to measure the diameter of a steel ball.

Fig. 1.1 shows the reading on the micro-meter when it is closed without an object. Fig. 1.2 shows the reading taken with the steel ball between the jaws.

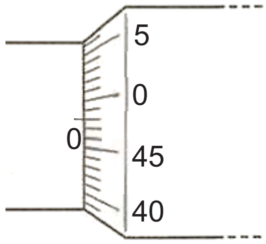


Fig. 1.1

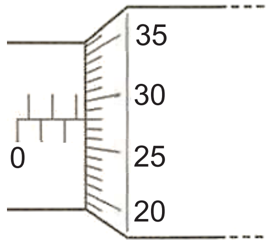
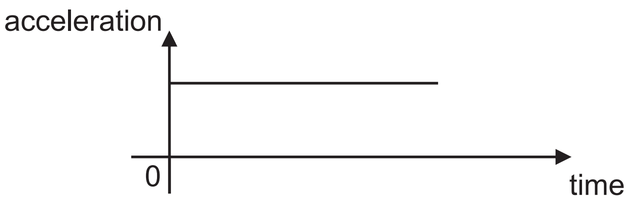


Fig. 1.2

What is the diameter of the steel ball?

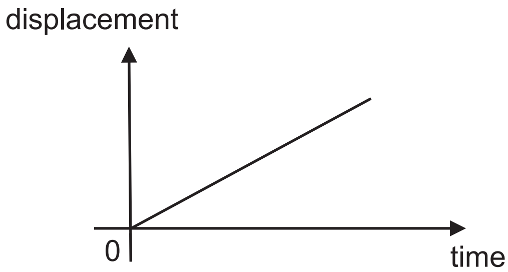
A 2.78 mm **B** 2.80 mm **C** 5.28 mm **D** 5.30 mm

2 A car is at rest at a traffic light. When the traffic light turns green, the car driver steps on the accelerator. The graph shows the variation of the acceleration with time of the car. The traffic light turns green at time = 0.

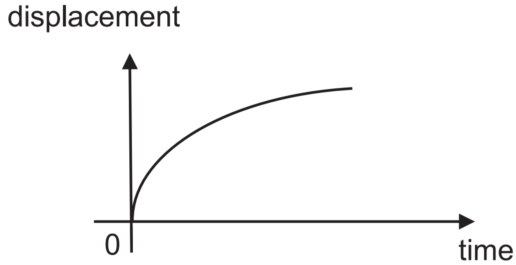


Which graph represents the displacement-time graph of the car?

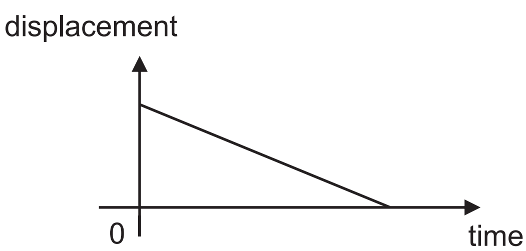
A



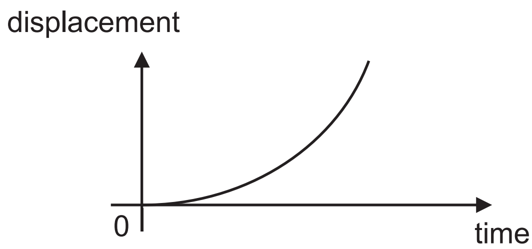
B



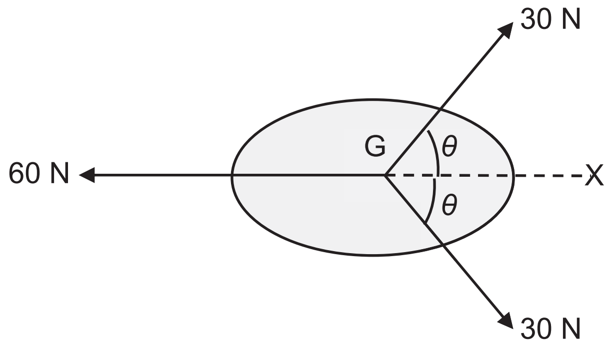
C



D



3 The diagram shows three forces acting on the centre of gravity G of a body which is initially at rest. The 30 N forces make an angle θ with the line GX.



What is the motion of the body?

A It accelerates in the direction GX.

B It accelerates in the direction XG.

C It moves at constant speed in the direction GX.

D It moves at constant speed in the direction XG.

4 There is a small air bubble in some water.

The volume of the bubble is 2.37×10^{-8} m^3.
The density of air is 1.29 kg / m^3.
The density of water is 1000 kg / m^3.
The gravitational field strength is 10 N / kg.

What is the weight of the air in the air bubble?

A 3.06×10^{-8} N

B 1.84×10^{-7} N

C 3.06×10^{-7} N

D 2.37×10^{-4} N

5 Which of the following statements is true?

A Mass is the gravitational force acting on an object.

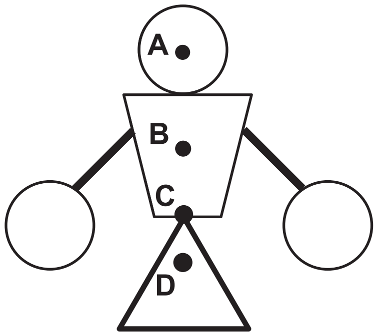
B The mass of an object is dependent on the gravitational field strength at that point.

C The reluctance of a body to change its state of rest or uniform motion is dependent on its mass.

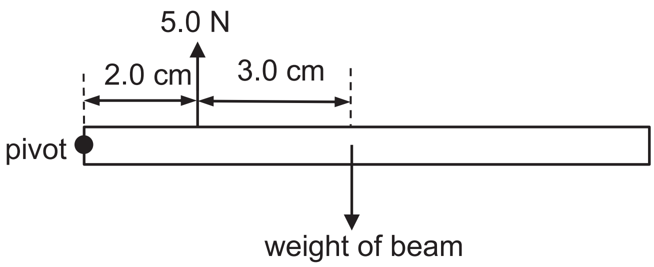
D The unit for weight is kilogram.

6 The diagram shows a balancing toy pivoted on a triangular stand. When the toy is tilted slightly, it remains stationary at the new position.

Where is the centre of gravity of the balancing toy?



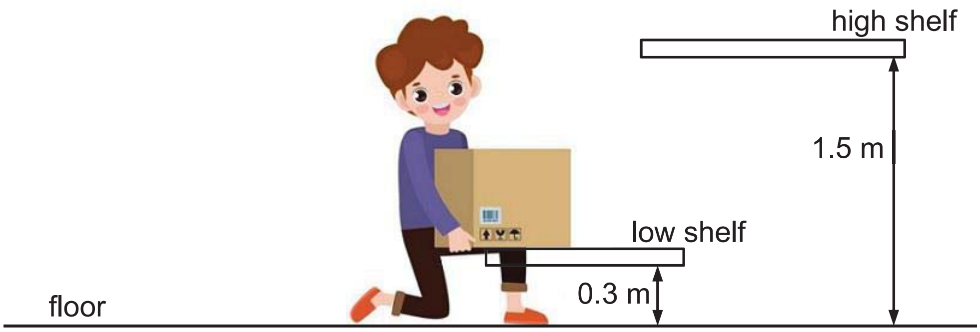
7 A beam is pivoted at one end. A force of 5.0 N is acting vertically upwards on it as shown. The beam is in equilibrium.



What is the weight of the beam?

A 2.0 N **B** 3.0 N **C** 3.3 N **D** 5.0 N

8 The diagram shows a student lifting a box of weight 50 N from a low shelf to a high shelf.



How much work is done by the student?

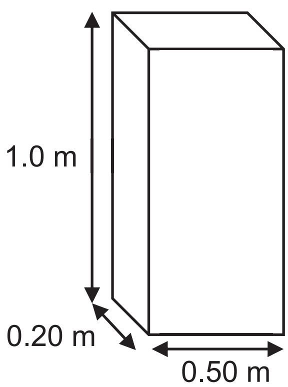
A 30 J **B** 60 J **C** 75 J **D** 90 J

9 A 5.0 kg box that is initially at rest is pushed horizontally across a smooth floor. At a time of 3.0 s, the speed of the box is 3.0 m / s. At a time of 5.0 s, the speed of the box is 7.0 m / s.

What is the gain in kinetic energy from 3.0 s to 5.0 s?

A 20 J **B** 40 J **C** 100 J **D** 120 J

10 The diagram shows an aluminium block with density of 2700 kg / m^3 resting on one side.

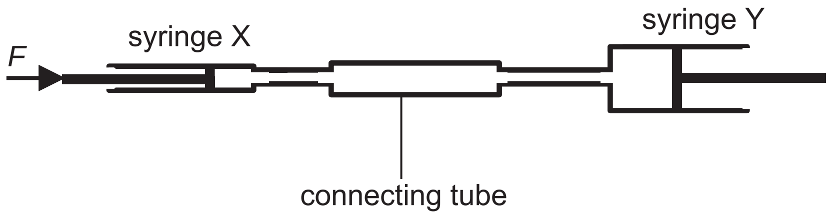


What is the smallest pressure that it can exert on the floor?

A 1400 Pa **B** 5400 Pa **C** 27 000 Pa **D** 54 000 Pa

11 In the diagram, syringe X is connected to syringe Y through a connecting tube. Both syringes and the connecting tube are filled with water.

The radius of the piston in syringe Y is twice the radius of the piston in syringe X. A force, *F*, is applied on the piston in syringe X.



What is the force experienced by the piston in syringe Y?

A 0.25 *F* **B** 0.50 *F* **C** 2.0 *F* **D** 4.0 *F*

12 The resistance of a copper wire when placed in water at 20 °C is 0.50 Ω. When the same wire is placed in a beaker of boiling water, its resistance is 2.1 Ω.

What is the temperature when the resistance of the wire is 1.6 Ω?

A 45 °C **B** 55 °C **C** 65 °C **D** 75 °C

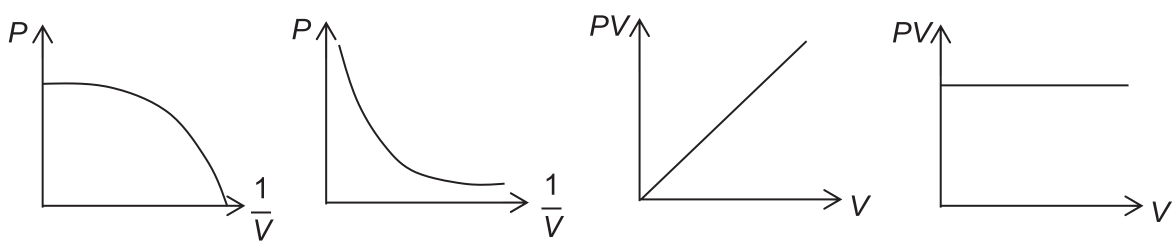
13 Which of the following statements about temperature is true?

A Temperature is a form of energy.
B Temperature is a measure of the amount of heat within a body.
C Temperature is a measure of the degree of hotness or coldness of a body.
D Temperature will flow from a hotter region to a cooler region.

14 Robert Boyle in 1662, states that the pressure *P* of a given quantity of gas varies inversely with its volume *V* at constant temperature.

Which graph is correct?

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

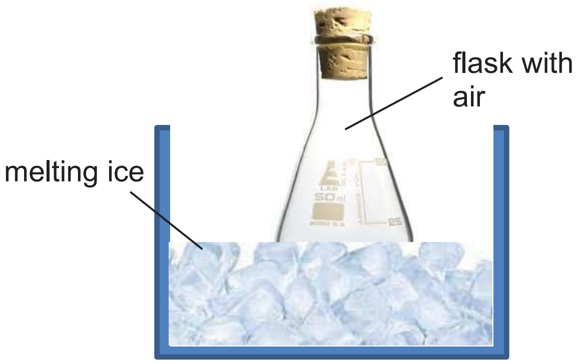


15 A gas in a container is compressed to half its original volume at constant temperature.

What effect does this have on the average speed of the molecules and the pressure they exert?

	average speed of molecules	pressure of gas
A	decreases	decreases
B	increases	increases
C	remains constant	decreases
D	remains constant	increases

16 A flask is filled with air and tightly capped at room temperature. The flask is then placed in melting ice.



Which of the following is true about the pressure and the speed of air molecules in the flask?

	pressure	speed of molecules
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

17 Which statement correctly describes thermal energy transfer?

A Conduction is a process of thermal energy transfer that involves the vibration of particles.

B Heat flows from a hotter body to a colder body, and coldness flows in the opposite direction.

C Radiation refers to the process of heat transfer by the movement of fluid due to density differences.

D There is no heat flow when two bodies are in thermal equilibrium.

18 Two metal pots that are identical except that one has a silver exterior and the other has a black exterior are placed on an electric hot plate to heat up the water.

Which pot should he use and how does heat transfer occur between the pot and water?

	colour of pot	heat transfer by
A	black	conduction and convection
B	black	radiation and conduction
C	silver	conduction and convection
D	silver	convection and radiation

19 A burn from steam at 100 °C can be worse than a burn from water at 100 °C.

Which statements correctly explains the reason?

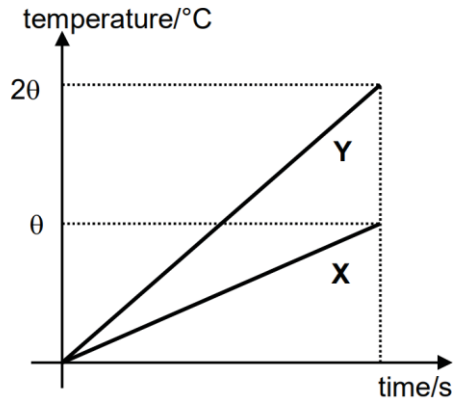
A Steam contains more energy than water.

B Steam has a greater specific heat capacity than water.

C Steam hits your skin with greater force.

D Steam is hotter than water.

20 Liquid X and liquid Y are placed in similar containers. They are heated with the same electric heater. The graph shows how the temperature of the liquids changes with time.



If the mass of liquid X is half that of liquid Y, what is the relationship between the heat capacity of liquid X, C_X to the heat capacity of liquid Y, C_Y?

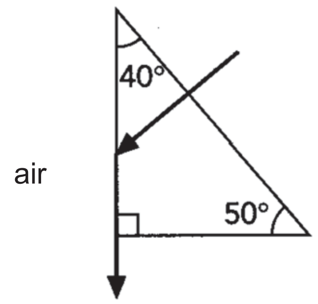
A $4C_X = C_Y$

B $C_X = 2C_Y$

C $2C_X = C_Y$

D $C_X = 4C_Y$

21 A ray of light enters a glass prism normal to the surface and travels along the path as shown.



(diagram not drawn to scale)

What is the refractive index of the glass?

A 1.31

B 1.33

C 1.50

D 1.56

22 An object is placed at 18.0 cm from a convex lens of focal length 15.0 cm.

What is the characteristic of the image formed?

A real, inverted and diminished

B real, inverted and magnified

C virtual, upright and magnified

D virtual, upright and diminished

23 In determining the speed of sound in a medium, a man strikes one end of the medium, while a boy, who stands 2 km away, measures the time taken for the sound to travel to him.

The boy measures the time taken to be 6.0 s.

What is the speed of sound in the medium?

A 14 m s^{-1}

B 50 m s^{-1}

C 70 m s^{-1}

D 333 m s^{-1}

24 A sound is produced by a musical instrument in air with a frequency f_1 and wavelength λ_1.

The sound then enters the water and has a frequency f_2 and wavelength λ_2.

Which of the following is correct?

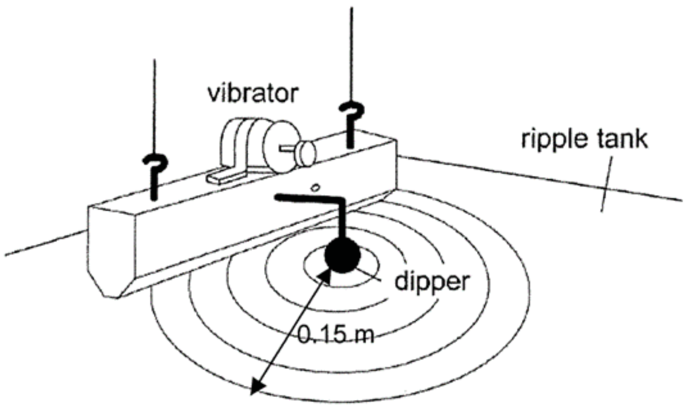
A $f_2 < f_1$ and $\lambda_2 = \lambda_1$

B $f_2 < f_1$ and $\lambda_2 < \lambda_1$

C $f_2 = f_1$ and $\lambda_2 < \lambda_1$

D $f_2 = f_1$ and $\lambda_2 > \lambda_1$

25 A circular dipper connected to a vibrator produces waves at a frequency of 30 Hz in the ripple tank.



The distance between the centre of the dipper and the outermost ring of the wave is 0.15 m.

What is the speed of the wave?

A 0.90 m s^{-1}

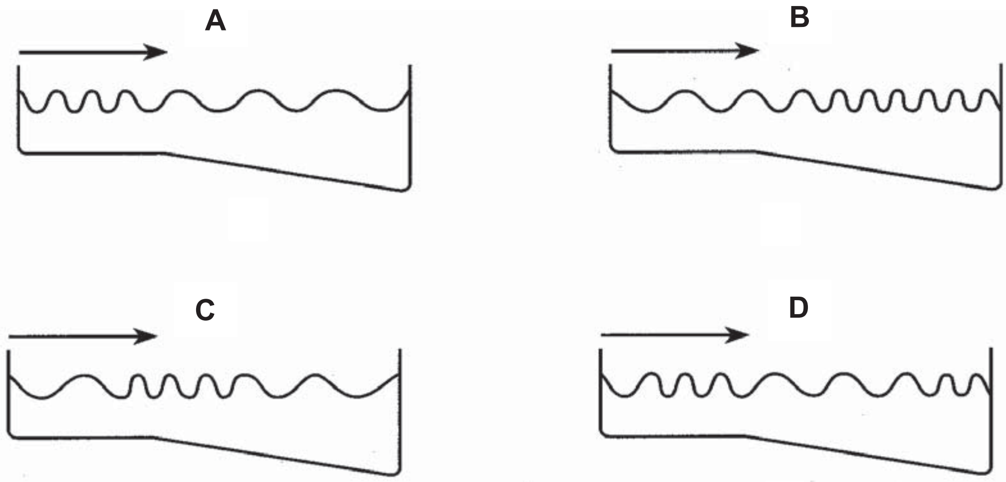
B 4.5 m s^{-1}

C 90 m s^{-1}

D 450 m s^{-1}

26 A ripple tank contains water of varying depths.

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



27 Electromagnetic waves are known to share certain common characteristics.

Which of the following is **incorrect**?

A They all travel with the speed of 3.0×10^8 m s^{-1} in vacuum.

B They are all transverse waves.

C They always obey the laws of reflection and refraction.

D When they pass from one optical medium into another medium, their frequencies, wavelengths and speeds always change.

28 Microwaves, visible light and X-rays are all part of the electromagnetic spectrum.

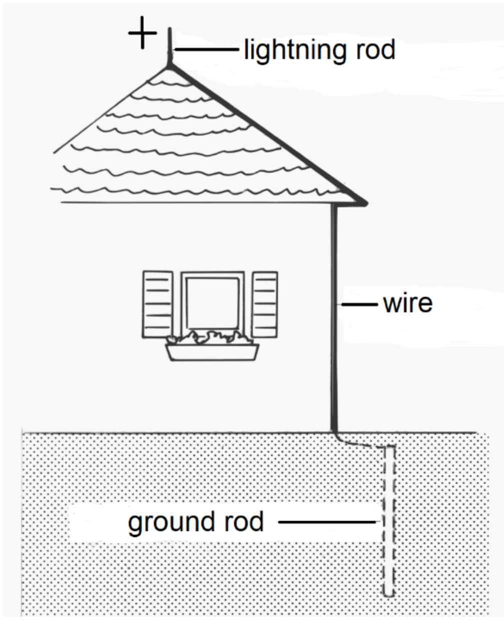
What is the correct order of increasing wavelength?

	shortest	⟶	*longest*
A	microwaves	visible light	X-rays
B	microwaves	X-rays	visible light
C	X-rays	microwaves	visible light
D	X-rays	visible light	microwaves

29 A metallic lightning rod is placed on top of a house.

The lighting rod is connected to the ground rod by a metallic wire.

When a negatively charged cloud passes over the building, the lightning rod becomes positively charged.



Which of the following explains the positive charge at the tip of the lightning rod?

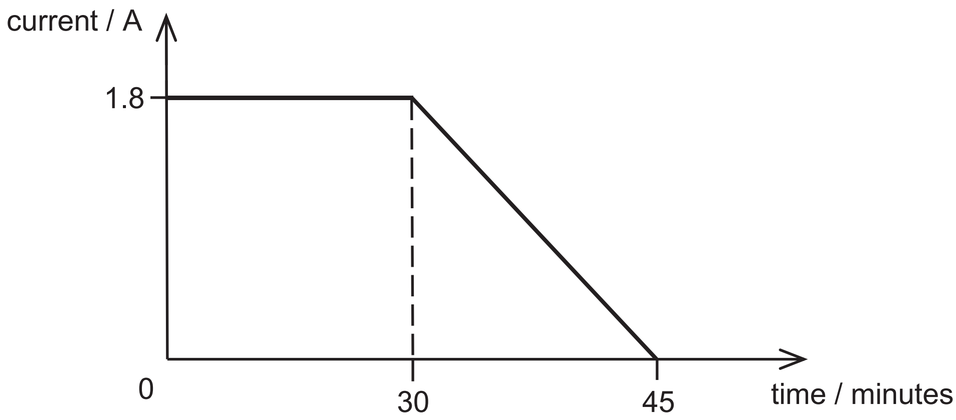
A Protons in the air are attracted and stay with the lightning rod.

B Protons in the ground rod are attracted towards the negatively charged cloud.

C The electrons in the conductor are repelled by the negatively charged cloud.

D The electrons move to the ground rod while the protons move to the lightning rod.

30 A laptop battery is charged by connecting it to a constant potential difference of 9.0 V. After a duration of 30 minutes, the initial current of 1.8 A slowly decreases to zero as shown.

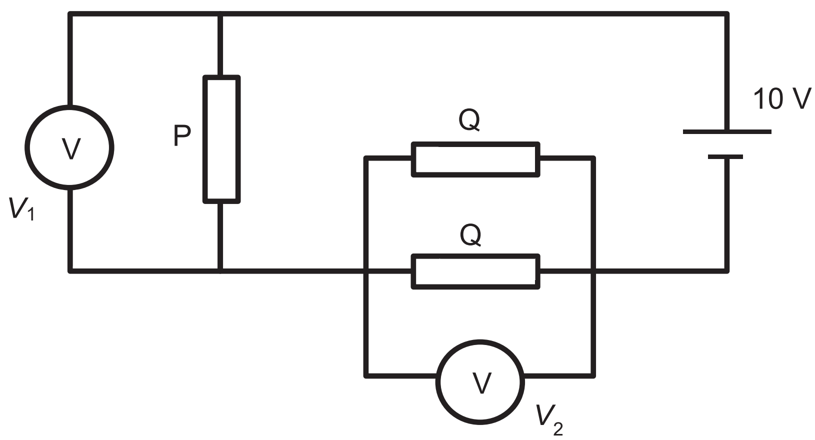


What is the amount of charge that passes through the laptop battery during the time of 45 minutes shown in the graph?

A 67.5 C **B** 81.0 C **C** 608 C **D** 4050 C

31 In the circuit shown, the resistance of resistor P is twice the resistance of resistor Q. A cell with an electromotive force of 10 V forms part of the circuit.

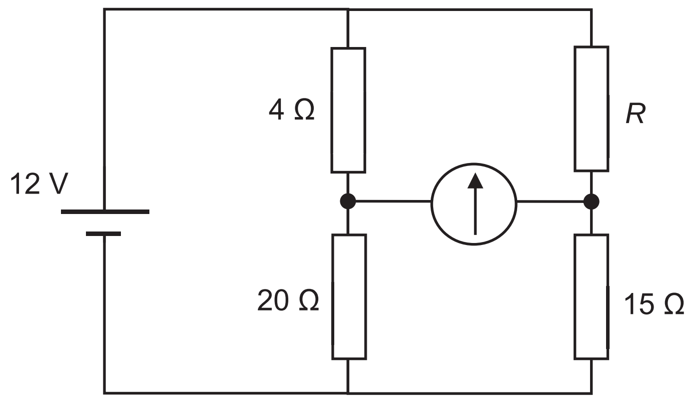
Two voltmeters display the readings of V_1 and V_2.



What is the difference between V_1 and V_2 of the voltages shown on the voltmeters?

A 3.3 V **B** 6.0 V **C** 8.0 V **D** 10 V

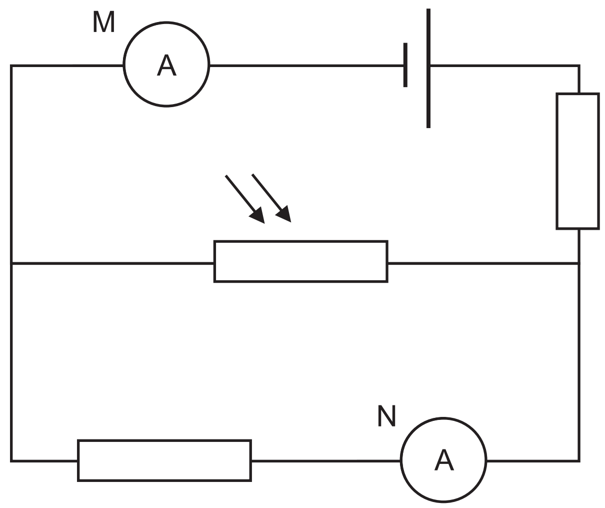
32 The circuit shows a cell with an electromotive force of 12 V and the reading on the galvanometer is zero.



What is the value of resistor *R*?

A 3 Ω **B** 4 Ω **C** 9 Ω **D** 45 Ω

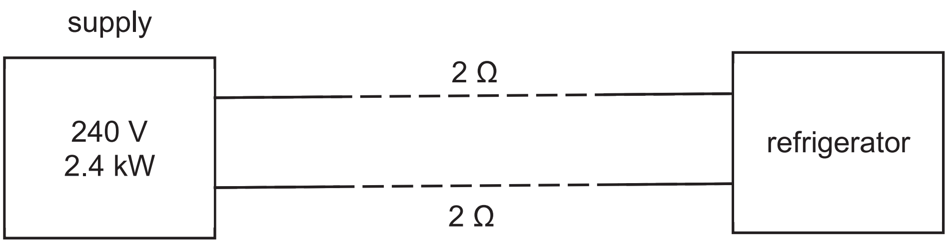
33 The diagram shows a circuit connected to a light dependent resistor (LDR) and two fixed resistors.



What effect will a strong light shining on the LDR have on the readings of ammeters M and N?

	reading on ammeter M	reading on ammeter N
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

34 The power output of an electrical supply is 2.4 kW at a potential difference (p.d.) of 240 V. The two wires between the supply and the refrigerator each have a resistance of 2 Ω, as shown.



What is the power supplied to the refrigerator and what is the p.d. across the refrigerator?

	power / kW	p.d. / V
A	2.0	200
B	2.2	220
C	2.2	240
D	2.4	240

35 A rice cooker is connected to the 240 V mains supply using a plug containing a 12 A fuse.

The rice cooker is filled with water and rice. When it is switched on, the fuse blows. This happens again after a new fuse is fitted. A student then replaces the fuse with a steel paper clip, and the rice cooker works.

What else might happen because of replacing the fuse with a paper clip?

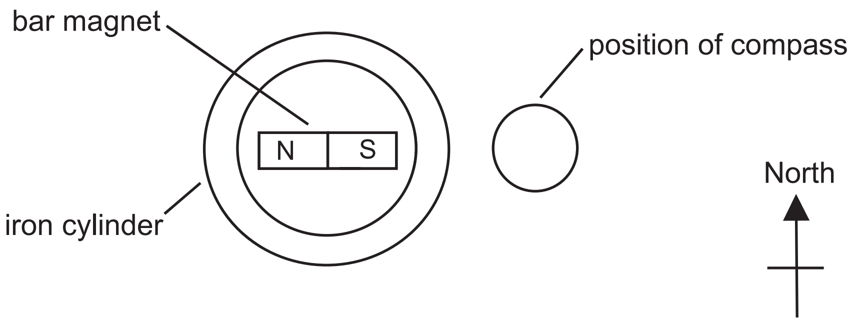
A More energy will be used up by the rice cooker as steel has a higher resistance.

B The current in the plug will magnetise the paper clip and makes it a better conductor.

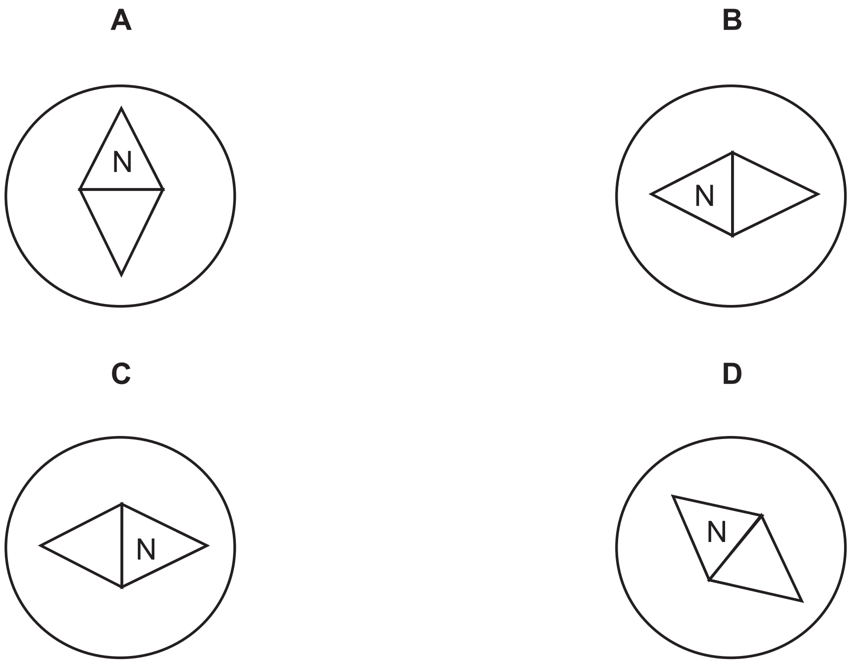
C The rice cooker will be overloaded with a very large current and catches fire.

D The rice will cook faster as steel is a better conductor of electricity than the fuse.

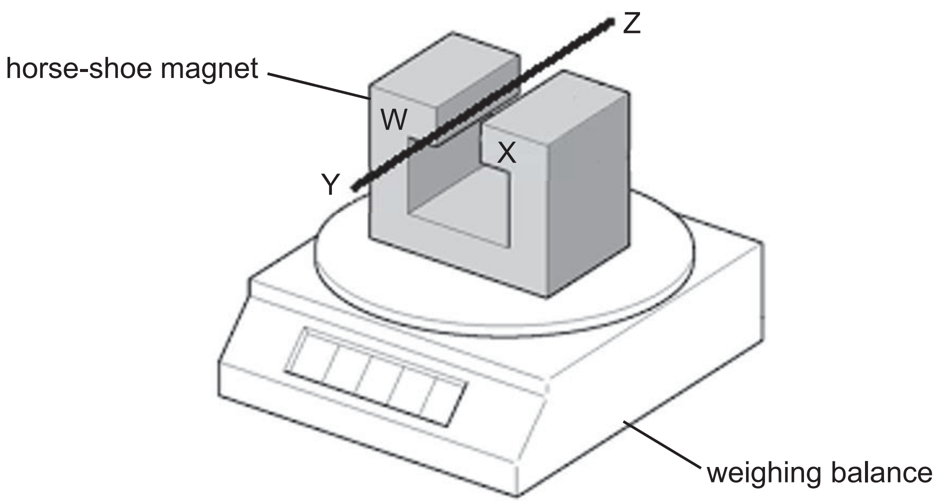
36 A bar magnet is placed in a hollow iron cylinder. A small plotting compass is placed near the bar magnet as shown.



Which diagram shows the direction in which the compass needle points?



37 The diagram shows a current-carrying conductor YZ between the poles W and X of a magnet. The weighing balance shows the mass of the horse-shoe magnet before a current starts to flow in the conductor YZ.

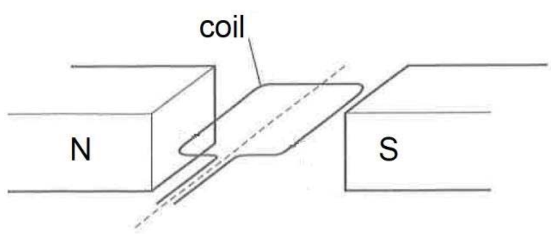


When a current flows in the conductor YZ, the weighing balance reads a mass that is greater than the mass of the horse-shoe magnet.

What should be the magnetic poles of W and X of the horse-shoe magnet and the terminals of conductor Y and Z?

	pole W	pole X	terminal Y	terminal Z
A	north	south	negative	positive
B	north	south	no current	no current
C	south	north	negative	positive
D	south	north	no current	no current

38 The diagram shows a pivoted coil between the two poles of a magnet. The pivoted coil carries a constant current, and the coil rotates about the pivot.



Which action does not, on its own, increase the size of the turning effect exerted on the coil?

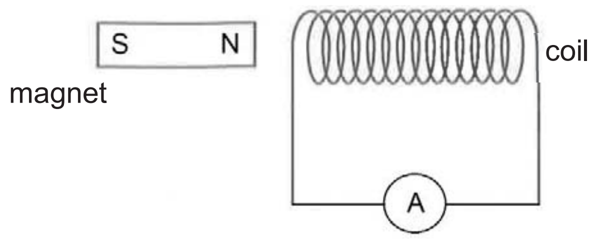
A increasing the current in the coil

B increasing the number of turns of the coil

C increasing the strength of the magnet

D reversing the current and magnetic poles

39 The diagram shows a coil connected to a sensitive ammeter. A magnet is placed next to the coil.



Which action results in a zero reading on the sensitive ammeter?

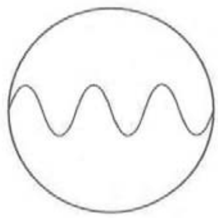
A moving the magnet and the coil away from each other at the same speed

B moving the magnet and the coil at the same velocity

C moving the magnet and the coil towards each other

D moving the magnet perpendicularly away from the coil

40 The diagram shows the waveform seen on the screen of a cathode-ray oscilloscope (c.r.o.) when the signal from a musical sound is fed to the c.r.o. through a microphone.



The duration of time across the display of the c.r.o. screen is 2.1 ms.

What is the frequency of the musical sound?

A 48 Hz **B** 480 Hz **C** 1400 Hz **D** 2900 Hz

End of Paper

	Class	Register Number
Name ______________________		

6091/02
PHYSICS
Paper 2

22/4P/6091/02

Wednesday **31 August 2022** **1 hour 45 minutes**

NIL SINE LABORE

VICTORIA SCHOOL

PRELIMINARY EXAMINATION
SECONDARY FOUR

READ THESE INSTRUCTIONS FIRST
Do not open this booklet until you are told to do so.

INSTRUCTIONS TO CANDIDATES

Write your name, class and index number in the spaces at the top of this page.
Write in dark blue or black pen. Answer all the questions within 1 hour 45 minutes.
You may use a HB pencil for any diagrams or graphs.

INFORMATION FOR CANDIDATES

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

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.

For Marker's Use		
Section A	/50	
Section B	/30	
Deduction	s. f.	
Total	/80	

Setters: Pang JH, Nordin Poh, Koh CK

This paper consists of **21** printed pages, including the cover page.

[Turn over]

Section A

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

1 Limestone is a common type of carbonate sedimentary rock which is the main source of the material lime. Limestone typically has a density of 2.71 g / cm^3.

(a) **(i)** Define *density*.

....

.... [1]

(ii) The sides of a cube of limestone is 0.50 m.

Show that the mass of this cube is 340 kg. [1]

(b) A 1000 kg forklift as shown in Fig. 1.1 is used to lift a cube of limestone as in **(a)**.

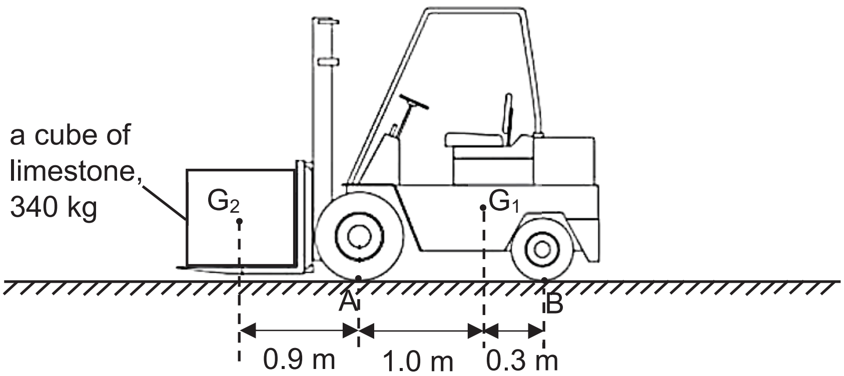


Fig. 1.1

The weight of the forklift acts at G_1 and the weight of the cube of limestone acts at G_2. Points A and B are the points where the wheels are in contact with the ground.

(i) On Fig. 1.2, draw the forces acting on the stationary forklift. [2]

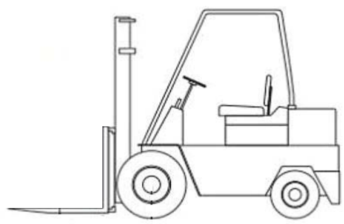


Fig. 1.2

(ii) Determine the maximum number of identical limestone blocks that can be lifted by the forklift before the wheel at point B loses contact with the ground.

The gravitational field strength g = 10 N / kg.

number of blocks = **...........................** [2]

2 A student throws a basketball of mass 0.60 kg to another student. The basketball rises from point A to a vertical height of 5.0 m at B, as shown in Fig. 2.1.

The effect of air resistance is negligible.

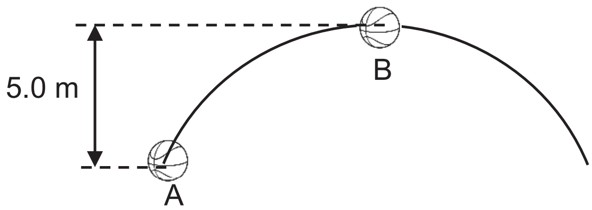


Fig. 2.1

(a) Show that the increase in gravitational potential energy of the basketball between A and B is 30 J. [1]

(b) At B, the kinetic energy of the basketball is 8.5 J.

Determine the kinetic energy of the ball at A.

kinetic energy = **........................** [2]

(c) The student claims that when the basketball was thrown in the air, it was able to reach its maximum height as there is an upwards acceleration of the basketball throughout this part of its motion.

Comment, in terms of the forces acting, whether the student's claim is valid.

……

……

……

…… [2]

3 Fig. 3.1 shows a mercury manometer. The left arm of the manometer contains some trapped gas. The density of mercury is 13 600 kg / m^3. The gravitational field strength g is 10 N / kg.

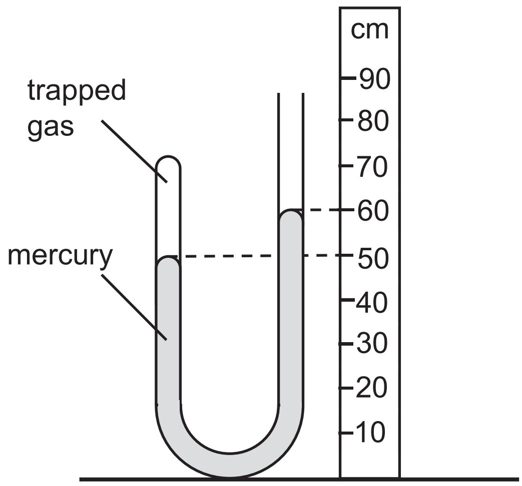


Fig. 3.1

(a) The atmospheric pressure is 76.0 cm Hg.

Determine the pressure in Pascals.

pressure = ……………………. Pa [1]

(b) **(i)** Calculate the pressure of the trapped gas.

pressure = ……………………. Pa [2]

(ii) A small hole is discovered in the left arm of the manometer such that the trapped gas can escape to the surroundings.

In Fig. 3.2 indicate the new mercury levels in both arms of the manometer. [1]

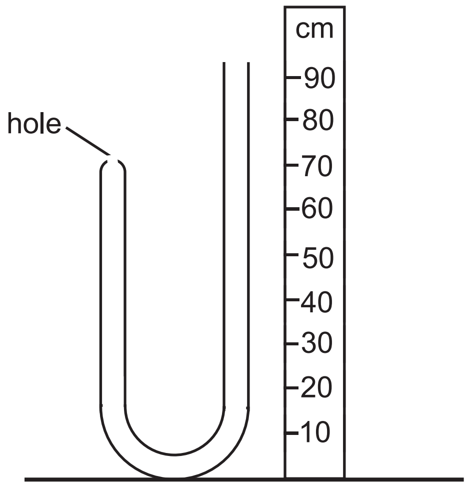


Fig. 3.2

(c) A student tilted a barometer as shown in Fig. 3.3 such that the vertical height of the barometer is 70 cm.

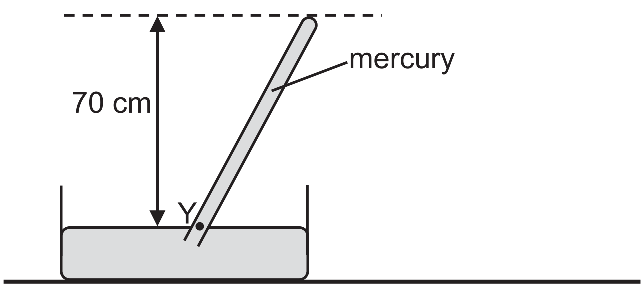


Fig. 3.3

The student then suggests that the pressure at point Y in the barometer is now 70 cm Hg. The surrounding pressure is 76 cm Hg.

Explain whether the student's reading is correct.

……………………………………………………………………………………………

……………………………………………………………………………………………

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

4 Fig. 4.1 shows an air-tight beaker completely filled with water.

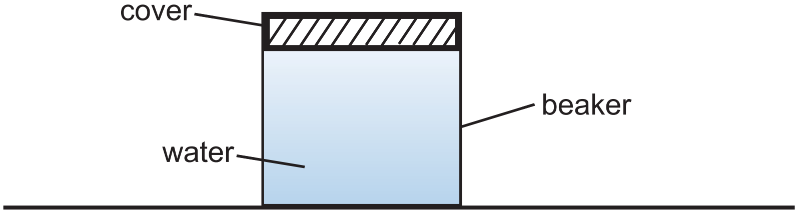


Fig. 4.1

(a) Describe the motion of the water particles in the beaker.

………………………………………………………………………………………………

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

(b) The water in Fig. 4.1 is now heated. Using the kinetic model of matter, explain how the pressure in the beaker is affected.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

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

(c) Fig. 4.2 shows the scale on a voltmeter connected to a thermocouple thermometer when the probe is placed in melting ice, steam point and in the water of the beaker respectively.

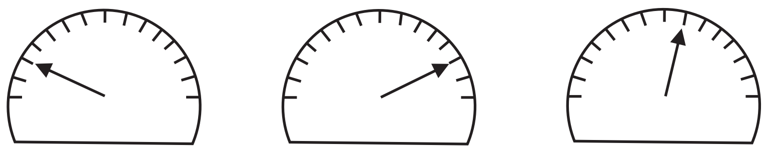


Fig. 4.2

Determine the temperature of the water.

temperature = ……………….. [2]

5 A stick is held against a rotating toothed wheel, as shown in Fig. 5.1.

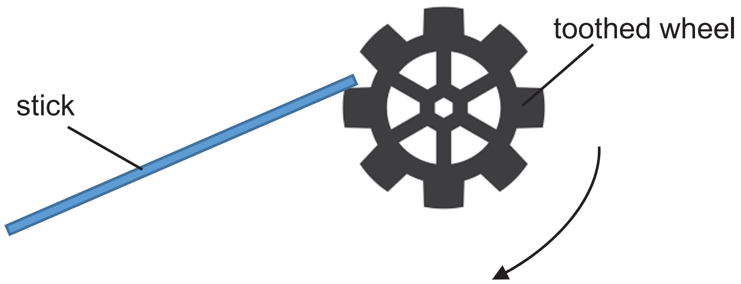


Fig. 5.1

There are 8 teeth on the wheel and it rotates at a frequency of 2.0 Hz. Every time the stick moves from one tooth to the next it produces a click.

(a) State what is meant by *a frequency of 2.0 Hz*.

....

.... [1]

(b) Given that the speed of sound in air is 330 m s^{-1}, determine the wavelength of the sound produced.

wavelength = ... [2]

(c) The waveform of the sound produced is shown in Fig. 5.2.

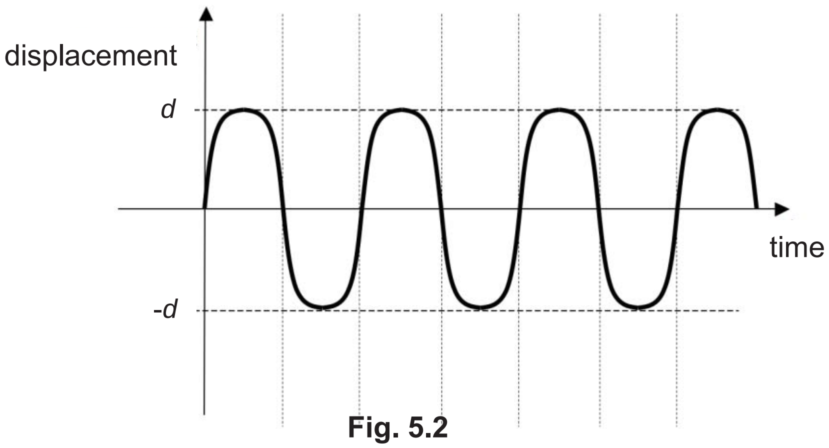


Fig. 5.2

If the wheel rotates at half the frequency and produces a sound half as loud, state the change(s) to the waveform in Fig. 5.2.

....

....

.... [2]

6 Fig. 6.1 shows a beam of uncharged particles and a beam of gamma wave entering a region of strong electric field below a positively charged plate.

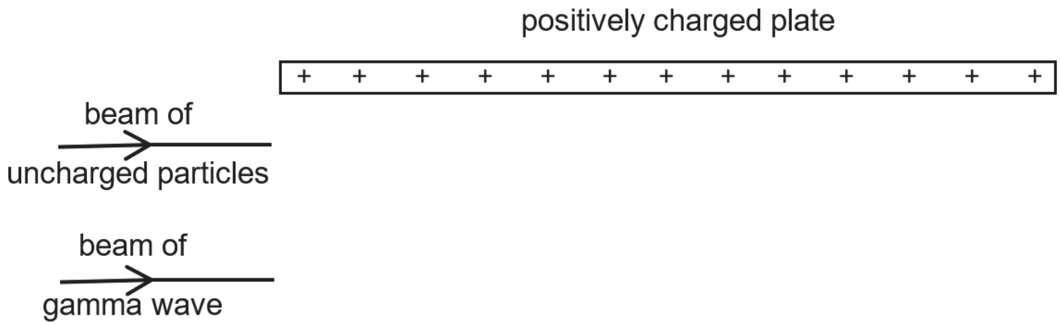


Fig. 6.1 (not to scale)

(a) State what is meant by *an electric field*.

………

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

(b) On Fig. 6.1, draw the two paths below the charged plate for the beam of uncharged particles and the beam of gamma wave. [2]

(c) Explain the path taken by the beams of uncharged particles and the gamma wave as shown in **(b)**.

………

………

………

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

.

7 A student measures the current and potential difference (p.d.) to determine the resistance of a fixed resistor P. The variable resistor is set to maximum resistance.

Fig. 7.1 shows the circuit diagram of part of the circuit that he uses.

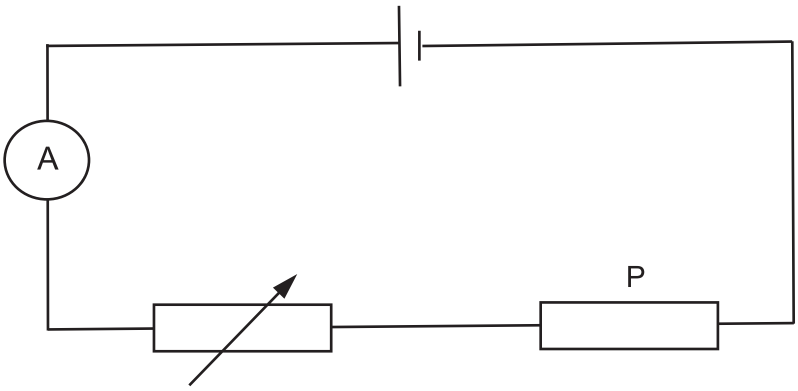


Fig. 7.1

(a) On Fig. 7.1, complete the circuit by adding the voltmeter at the correct position. [1]

(b) The potential difference across the fixed resistor P is 1.2 V and the ammeter reading is 0.12 A.

(i) Calculate the resistance of fixed resistor P.

resistance of P = ………..………… [1]

(ii) The cross-sectional area of the fixed resistor P is 6.0×10^{-3} cm^2 and its length is 4.0 cm.

Determine the resistivity of fixed resistor P.

resistivity = …………………… Ω m [2]

(c) Fixed resistor P is now connected in parallel with another fixed resistor Q with identical resistance value.

Suggest, with a reason, what will happen to the reading of the ammeter.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

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

8 The variation with temperature of the resistance *R* of a thermistor is shown in Fig. 8.1.

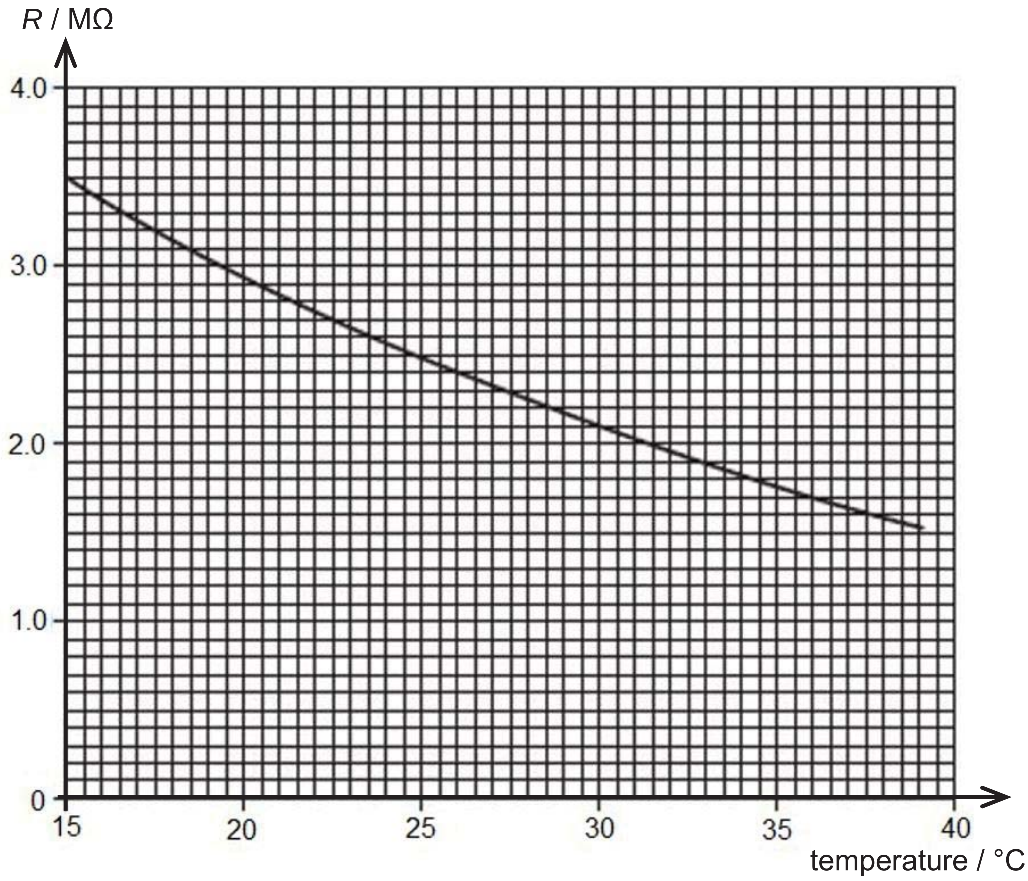


Fig. 8.1

The thermistor is connected into the circuit of Fig. 8.2.

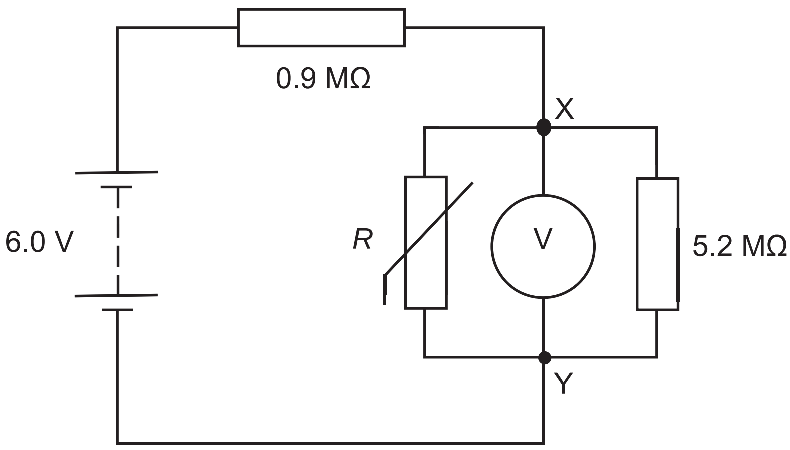


Fig. 8.2

The battery has an electromotive force (e.m.f.) of 6.0 V.

The voltmeter reads 4.0 V.

(a) Determine

(i) the total resistance between points X and Y,

total resistance = ……………….. [2]

(ii) the temperature of the thermistor using Fig. 8.1.

temperature = ………………… [2]

(b) A student suggests that the circuit in Fig. 8.2 could be calibrated to measure temperature.

Suggest a disadvantage of using the thermistor for the measurement of temperature.

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

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

9 A lamp is rated at 50 W and is designed to be used with a 230 V supply.

(a) Calculate the resistance of the lamp.

resistance = ... [2]

(b) A room is lit by three of these lamps connected in parallel.

The lamps are lit for an average time of 3.6 hours a day for a year. Electricity costs \$0.29 / kWh.

Calculate the cost of using these lamps for a year.

cost = ... [2]

10 Fig. 10.1 shows a vertical solenoid of steel wire connected in series with a battery and a switch.

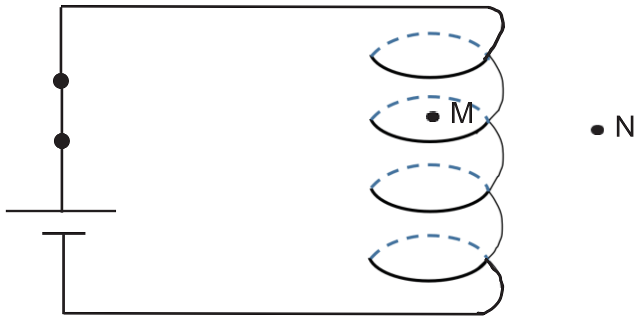


Fig. 10.1

(a) Describe two ways in which the magnetic field at M differs from the magnetic field at N.

1 ……………………………………………………………………………………………

……………………………………………………………………………………………

2 ……………………………………………………………………………………………

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

(b) A student holds a steel paper clip and touches the bottom of the solenoid. When he releases the paper clip, it stays in contact with the solenoid.

(i) Explain why the paper clip does not fall upon release.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

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

(ii) The switch is now opened.

Explain whether the paper clip would remain in contact with the solenoid.

……………………………………………………………………………………………

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

Section B

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

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

11 A favourite drink at our local drink stall is Milo Kosong, a hot drink with only Milo powder added to hot water.

(a) The drink maker in our school canteen added Milo powder to a cup of hot water.

Using ideas about molecules, explain how the powder gains heat from the hot water in the cup.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

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

(b) The hot drink is placed on the table and after 15 minutes it was noted that the temperature dropped by 20 °C.

(i) Explain the process(es) of transfer of thermal energy leading to the cooling.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

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

(ii) State and explain the most effective way to minimize heat lost by the drink to its surrounding.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

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

(c) Another favourite version is Milo ice which involves the adding of ice to hot Milo drink.

The drink maker has prepared 400 cm^3 of hot Milo drink at 90 ^oC in a cup.

He adds 50 g of ice at 0 ^oC to the Milo drink.

Given:

mass of 1 cm^3 of hot Milo drink = 1.0 g
specific heat capacity of water/Milo drink = 4200 J kg^{-1} K^{-1}
specific latent heat of fusion of ice = 3.36 x 10^5 J kg^{-1}

(i) Define *specific latent heat of fusion of ice*.

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

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

(ii) Calculate the final temperature of the Milo drink.

You may assume that the evaporation and heat loss to cup and surrounding are negligible.

temperature = ………………… [3]

12 **(a)** Besides emitting visible light, the Sun also emits ultraviolet rays.

(i) State a difference between visible light and ultraviolet rays.

……………………………………………………………………………………………………

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

(ii) Describe an effect on living tissues when ultraviolet rays are absorbed.

……………………………………………………………………………………………………

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

(b) A progressive wave is represented by the following displacement-position graph and displacement-time graph in Fig. 12.1.

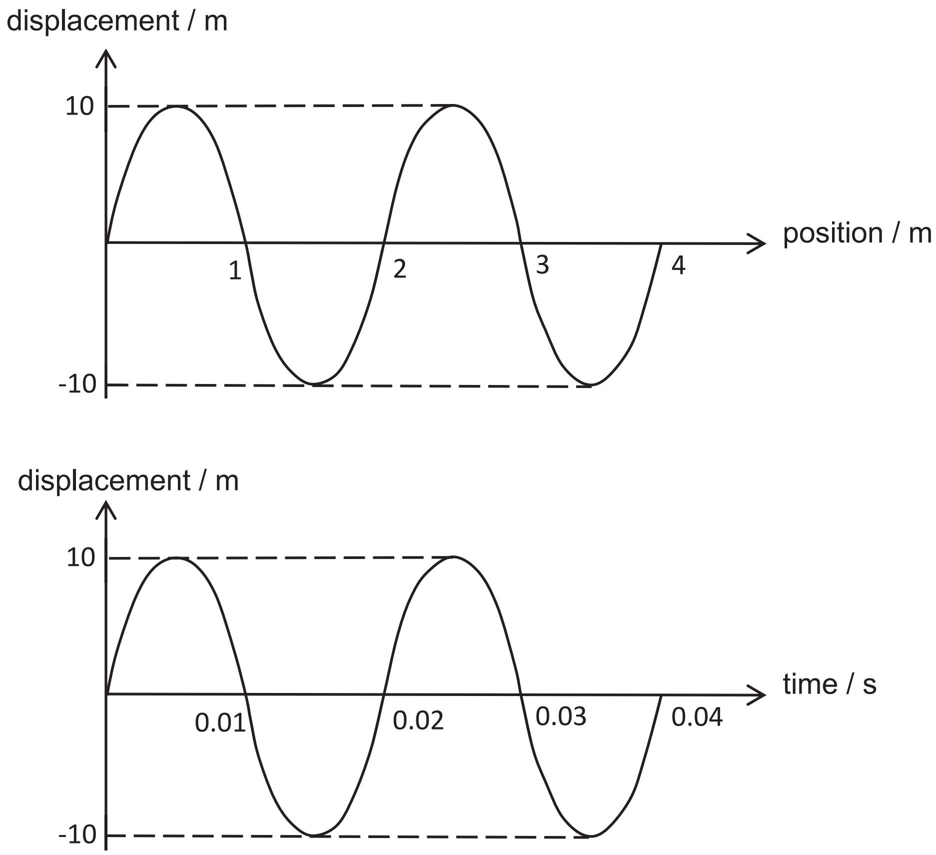


Fig. 12.1

(i) Determine the speed of the wave.

speed of wave = …………………….. [2]

(ii) On Fig. 12.1, sketch the new wave on the displacement-position graph after half a period has passed. [1]

(iii) If the frequency of the wave increases, state the effect on the speed of the wave.

....

.... [1]

(c) Fig. 12.2 shows a converging lens used in a camera to form an image **IA'** of the object **OA**. F represents the principal foci of the lens.

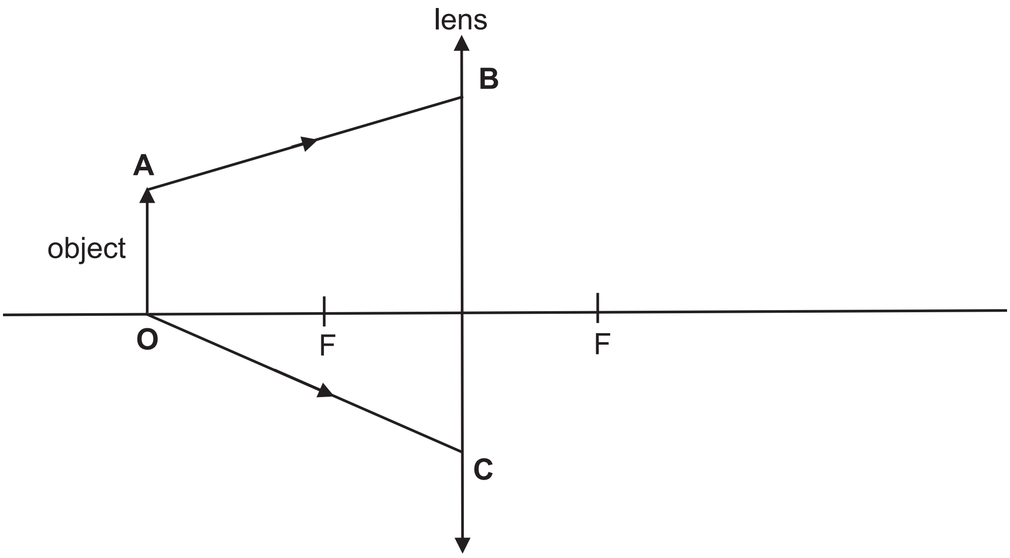


Fig. 12.2

(i) Draw construction rays from **OA** to locate the image **IA'**. [2]

(ii) Complete the paths of the rays **AB** and **OC** to the image **IA'**. [1]

(iii) State what would happen to the image when the object **OA** is shifted slightly further away from the lens.

.... [1]

13 Either

A car of mass 1500 kg moves along a straight, horizontal road. The variation with time t of the velocity v of the car is shown in Fig. 13.1.

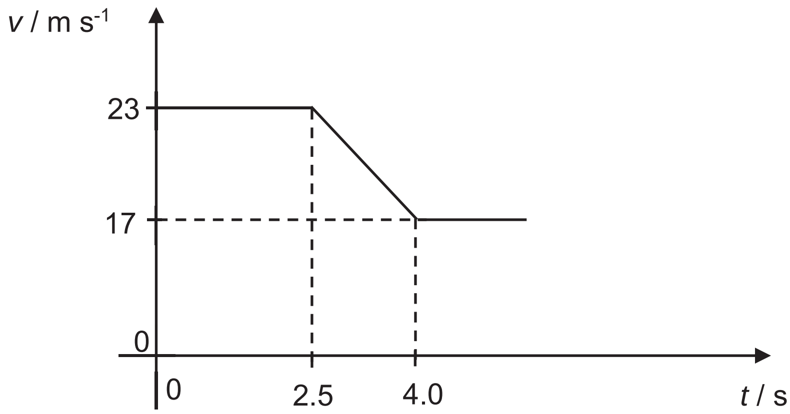


Fig. 13.1

(a) The car is moving at a uniform speed of 23 m / s. State the meaning of *uniform speed*.

....

.... [1]

(b) The brakes of the car are applied from t = 2.5 s to t = 4.0 s.

For the time when the brakes are applied,

(i) calculate the distance moved by the car,

distance = ... [2]

(ii) calculate the magnitude of the resultant force on the car.

resultant force = ... [2]

(c) Sketch the distance-time graph of the motion of the car for the first 4 seconds in Fig. 13.2. [2]

Fig. 13.2

(d) The direction of motion of the car in **(b)** at time t = 3.0 s is shown in Fig. 13.3.

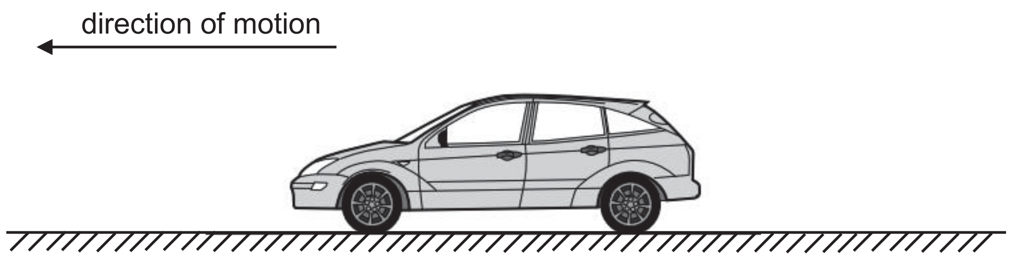


Fig. 13.3

On Fig. 13.3, show with arrows the direction of the forces acting on the wheels of the car by the ground. [1]

(e) The car then turns around a bend at constant speed from t = 4.0 s onwards.

Explain why the car is accelerating even though its speed is constant.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

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

13 Or

(a) Fig. 13.4 shows a simple relay used to switch a mains electric motor on and off.

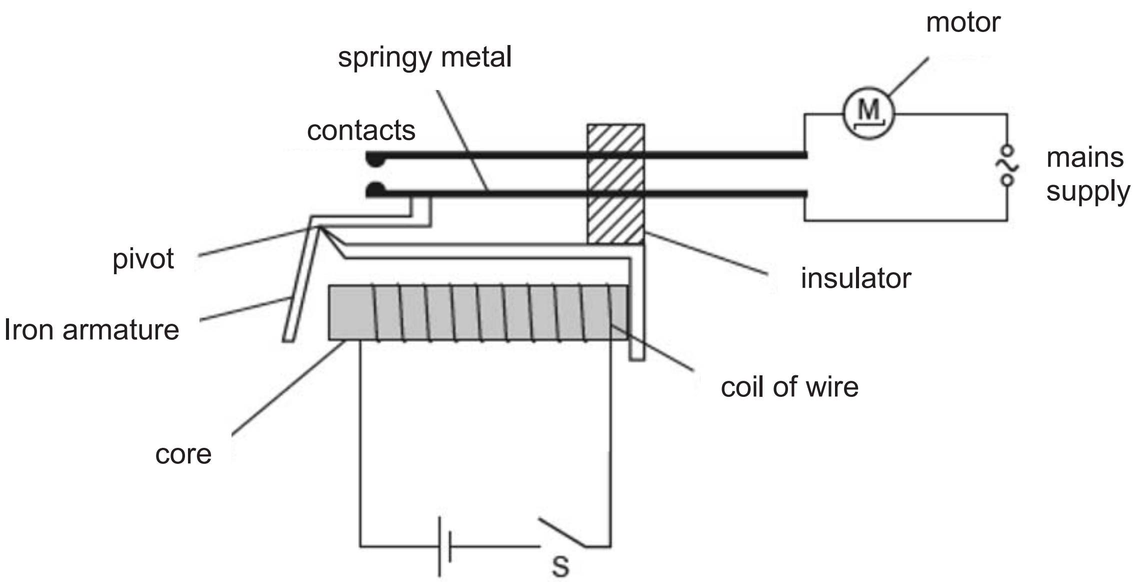


Fig. 13.4

(i) Explain why the motor turns on when switch S is closed.

....

....

....

....

....

.... [3]

(ii) A student suggests that the motor can be turned on and off without a relay.

He suggests connecting the mains supply to a simple switch in series with the motor.

Suggest a reason why, in some situations, using the relay is a better choice for this application.

....

.... [1]

(b) Fig. 13.5 shows an ideal transformer that can be found inside the motor in Fig. 13.4.

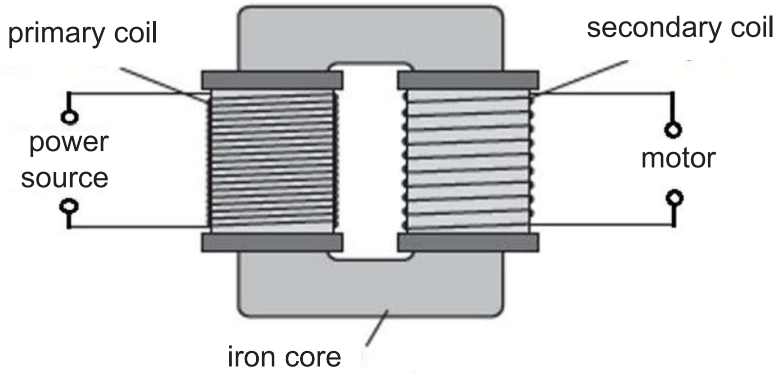


Fig. 13.5

(i) State the purpose of the iron core in the transformer.

....

.... [1]

(ii) Explain why there is an output voltage produced in the secondary coil.

....

....

....

....

....

.... [3]

(iii) The primary coil is connected to the 230 V power source. There are 1950 turns on the primary coil. The output voltage to the motor is 20 V.

Calculate the number of turns on the secondary coil.

number of turns = ... [2]

End of Paper

Physics Prelim 2022 Answers

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

		Suggested Solution
1	(a)(i)	Density is defined as mass per unit volume.
	(a)(ii)	Mass of a 1 m^3 cube of limestone = density x volume = 2.71 x $(50)^3$ g = 340 kg (correct to 2 s.f.) (shown)
	(b)(i)	
	(b)(ii)	Take y to be the number of identical limestone blocks that can be lifted. Taking moments about the front wheel, Sum of clockwise moments = Sum of anti-clockwise moments (1000) x (1.0) x (10) = (340) x (0.9) x (10) x (y) y = 3.27 blocks Therefore the maximum number of blocks is 3.

		Suggested Solution
2	(a)	Increase in gravitational potential energy of ball = mgΔh = (0.60)(10)(5) = 30 J
	(b)	Kinetic energy at A = Potential energy at B + Kinetic energy at B = 30 J + 8.5 J = 38.5 J

	(c)	The student is incorrect as weight is the only force acting on the basketball after it leaves the student's hand. And weight is the resultant force that causes the (downwards) acceleration of the basketball rather than an upwards acceleration that explains the motion of the ball upwards.
		Suggested Solution
3	(a)	Pressure at X = (0.76)(13600)(10) = 1.03×10^5 Pa
	(b)(i) (ii)	Pressure of trapped gas= Atmospheric Pressure + Pressure due to 10 cm Hg = 76 cm Hg + 10 cm Hg = $(86 \times 10^{-2})(13\ 600)(10)$ = 1.17×10^3 Pa Both levels are correctly drawn at 55 cm
	(c)	The pressure at Y is still 76 cm Hg as the additional pressure is due to the reaction force acting downward on mercury column by barometer.

		Suggested Solution
4	(a) (b)	The water particles are in constant random motion and slide over one another. 1. As the liquid is heated, its temperature increases that cause the average speed of the particles to increase. 2. This leads to a higher force per collision and higher rate of collision with the walls of the container. Force exerted per unit area increases causing a rise in pressure.
	(c)	Number of divisions between ice point and steam point = 10 divisions Number of divisions from ice point = 6 divisions Temperature of unknown liquid = $\frac{6}{10} \times 100$ °C = 60 °C Or any other relevant mathematical calculations

		Suggested solution
5	(a)	It means there is 2 complete rotations/waves produced per second.
	(b)	$f = 2 \times 8 = 16$ Hz $v = f\lambda$ $330 = 16 \times \lambda$ $\lambda = 20.6$ m
	(c)	New waveform has half the original amplitude (0.5 d). It will have a period that is doubled. So will show 1.75 waves.

		Suggested solution
6	(a)	Electric field is a region in which an electric charge experiences an electrostatic force.
	(b)	(i) the beam of uncharged particles deflects upwards and is attracted to the positively charged plate. (ii) the beam of electromagnetic wave continues undeflected in a straight line.
	(c)	There is electrostatic induction and the electrons in the uncharged particles are attracted to the side closer to the positively charged plate. Since the negative side is closer to the plate than the positive side of the uncharged particles, the particles are attracted to the plate. The gamma wave is uncharged and will not be attracted to the plate hence it continues moving along a straight line.

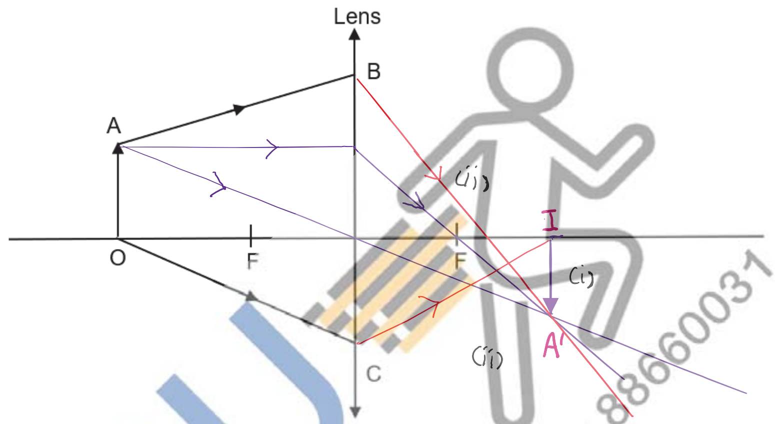
		Suggested solution
7	(a)	Voltmeter is connected in parallel to the fixed resistor P.
	(b) (i)	$R_p = \frac{V}{I} = \frac{1.2\ V}{0.12\ A}$ = 10 Ω
	(b) (ii)	$R = \frac{\rho L}{A}$ $\rho = \frac{AR}{L} = \frac{(6.0 \times 10^{-3} \times 10^{-4}) \times (10)}{4.0 \times 10^{-2}}$ $= 1.5 \times 10^{-4}$ Ωm
	(c)	The ammeter reading increases. When the fixed resistor Q is connected in parallel with fixed resistor P, the effective resistance of the circuit decreases.

		Suggested solution
8	(a) (i)	2 V across 0.9 MΩ 4 V across the voltmeter will be twice the resistance according to potential divider principle, total resistance across points X and Y = 0.9 × 2 = 1.8 MΩ
	(a) (ii)	Resistance across the thermistor, R $\frac{1}{1.8} = \frac{1}{R} + \frac{1}{5.2}$ R = 2.75 MΩ From Fig. 8.1, the temperature of the thermistor = 22.0 °C
	(b)	Disadvantage of using the thermistor is its resistance does not vary linearly with temperature.

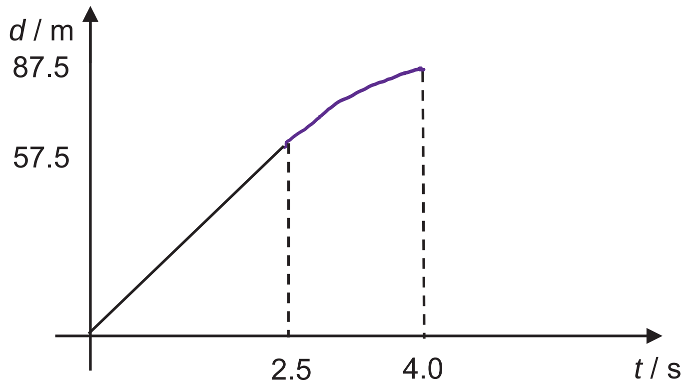
		Suggested solution
9	**(a)**	P = $\frac{V^2}{R}$ $R = \frac{230^2}{50}$ = 1060 Ω (3 s.f.)
	(b)	Energy used in a year = 0.050 kW × 3.6 h × 365 = 65.7 kWh Cost in a year = 65.7 × 0.29 × 3 = $57.16

		Suggested solution
10	**(a)**	1. The direction of the magnetic field in M and N are opposite. 2. The strength of the magnetic field in M and N are different. Magnetic field strength of M is stronger than N.
	(b) (i)	The solenoid is an electromagnet that induces magnetism in the paper clip. The opposite pole of the paper clip is attracted to the magnetic pole of the solenoid.
	(b) (ii)	Since the solenoid is made of steel wire, it retains its magnetism after the switch is opened. So it remains attracted to the solenoid.

		Suggested solution
11	**(a)**	Hot water particles at higher temperature have higher kinetic energy . It collides with the powder and transfers some of its kinetic energy. The average kinetic energy of powder increases, its temperature rises as it gains heat.
	(b) (i)	Heat transfer away by convection as the air above the hot drink heats up by conduction, it expands and rises due to lower density. Cooler air of higher density would move in to be heated and the process repeats.
	(b) (ii)	Cover the cup. This minimizes heat loss by convection of air as the warm air is trapped within the cup.
	(c) (i)	Specific latent heat of fusion of ice is the amount of thermal energy required to change unit mass of ice from solid state to liquid state, without a change of temperature.
	(c) (ii)	Given the assumption of no other heat loss, Heat loss by milo = Heat gain by ice melting + Heat gain by melted ice (0.4)(4200)(90-ϴ) = (0.05)(3.36 x 10^5) + (0.05)(4200)(ϴ-0) ϴ = 71.1 ^{O}C

		Suggested solution
12	(a)(i)	Visible light has a lower frequency than ultraviolet rays.
	(a)(ii)	Lead to premature aging of skin tissues and even skin cancer.
	(b)(i)	V = wavelength / period = 2.0 / 0.02 = 100 m s^{-1}
	(b)(ii)	Correct wave drawn. (shifted by half a wavelength to the right)
	(b)(iii)	The speed will remain constant.
	(c)(i) (ii)	 (i) Correct construction of 2 rays to locate image of point A Correct drawing of image IA'. (ii) Both rays from AB and OC must converge on A'. Note: Minus 1m if no arrow head drawn for rays.
	(iii)	Image becomes smaller and nearer to the lens.
		Suggested Solution
13	(a)	It means covering equal distance in equal interval of time.
	(b)(i)	Distance travelled = Area bounded by graph and the time axis = $\frac{1}{2}$(17+23)(4.0-2.5) = 30.0 m (2 or 3 s.f. accepted)
	(ii)	Acceleration of car = gradient of velocity-time graph = $\frac{23-17}{4.0-2.5}$ = 4.00 m s^{-2} Resultant force = ma = (1500)(4.00) = 6.00 kN (2 or 3 s.f. accepted)

(c)



Correct graph shape.
Correct values for both key positions

(d)

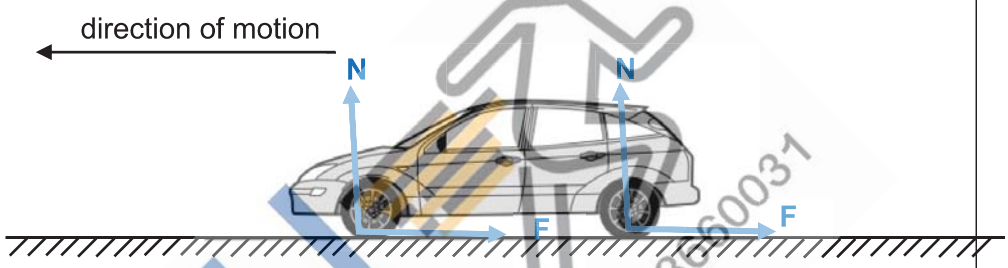


Fig. 13.3

(e)

As the car turns, **<u>its direction is constantly changing</u>**. Velocity is thus changing.

Since **<u>acceleration is defined as the rate of change of velocity, the car experiences acceleration</u>** during the turn at constant speed.

Or

13		Suggested solution
	(a)(i)	Core becomes magnetized due to the current flowing in the coil. Iron armature is attracted to the core and rotates about the pivot. Iron armature pushes the springy metal upwards and closes the contact for current to flow through the motor.
	(a)(ii)	A lower current flows through the switch when it is connected to the relay hence safer as it is connected to a low voltage.
	(b)(i)	It increases the strength of the magnetic field passing through the secondary coil.
	(b)(ii)	The magnetic field of the power source produces an alternating magnetic field that cuts the secondary coil. This results in a changing magnetic flux linkage through the secondary coil. According to Faraday's law of electromagnetic induction, the induced electromotive force produced at the secondary coil is directly proportional to the rate of change of magnetic flux linkage across it causing an output voltage to be produced across the secondary coil.
	(b)(iii)	Using $\frac{V_S}{V_P} = \frac{N_S}{N_P}$, $\frac{20\ V}{230\ V} = \frac{N_S}{1950\ turns}$ N_s = 170 turns