SINGAPORE CHINESE GIRLS' SCHOOL
PRELIMINARY EXAMINATION 2025
SECONDARY FOUR

CANDIDATE NAME

CLASS 4

REGISTER NUMBER

CENTRE NUMBER

INDEX NUMBER

PHYSICS 6091/1

Paper 1 Multiple Choice

28 August 2025 **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.

1 For which measurement would a micrometer screw gauge be most suitable for accurate measurement?

A diameter of an atom

B diameter of a wire

C length of this page

D length of a pencil

2 A metal ball is attached to a cork with a string and lowered into a measuring cylinder of water until the ball is fully submerged while the cork remains above the water, as shown in Fig. 2.1. The string is then lowered further so that both the ball and the cork are fully submerged, as shown in Fig. 2.2.

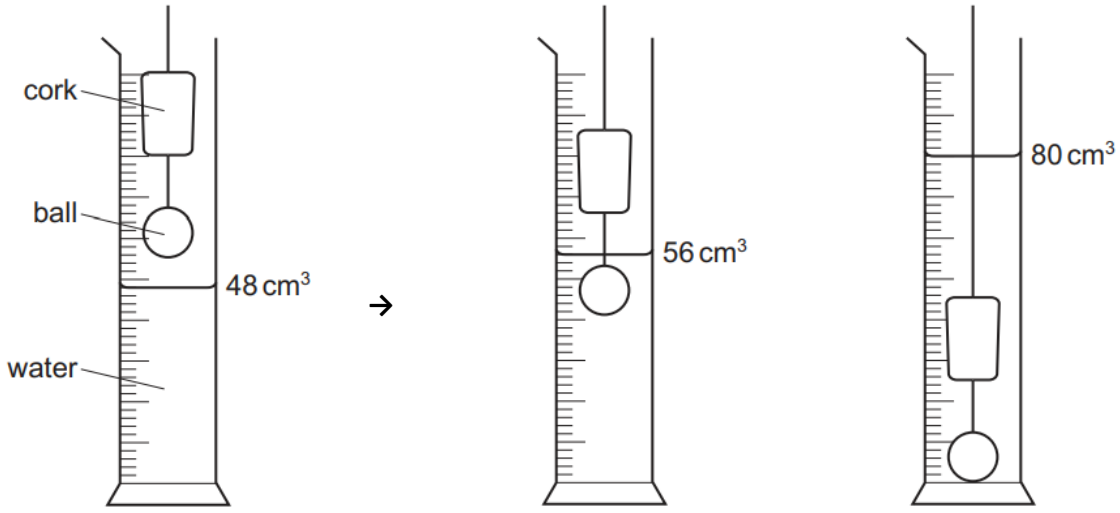


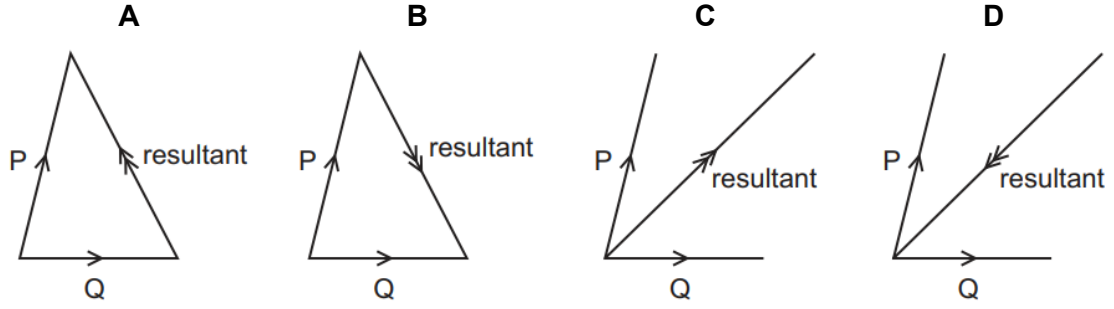
Fig. 2.1 **Fig. 2.2**

The mass of the cork is 4.8 g.

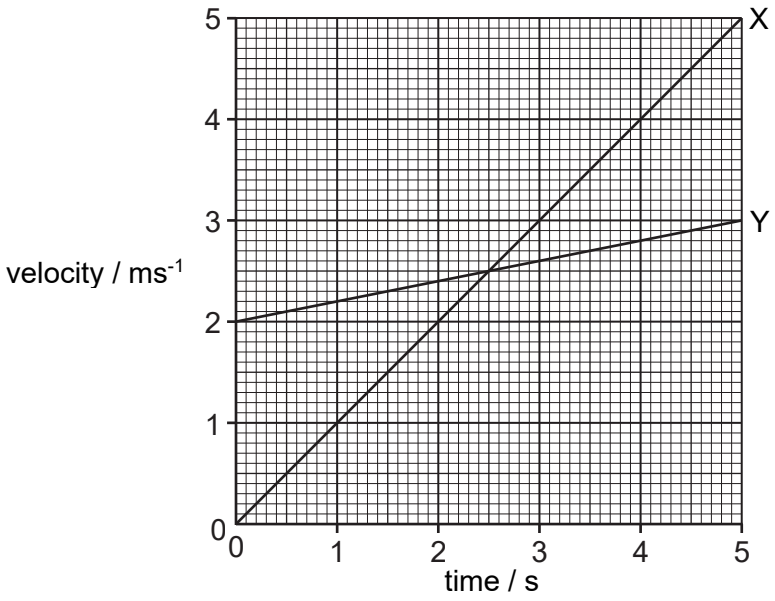
What is the likely density of the cork?

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

3 Two forces P and Q act on an object. Which diagram shows the resultant of these two forces?



4 The figure below shows the velocity-time graphs of two vehicles X and Y. The accelerations and distances travelled by the two vehicles over the 5 s period can be estimated from the graphs.



Which statement is correct?

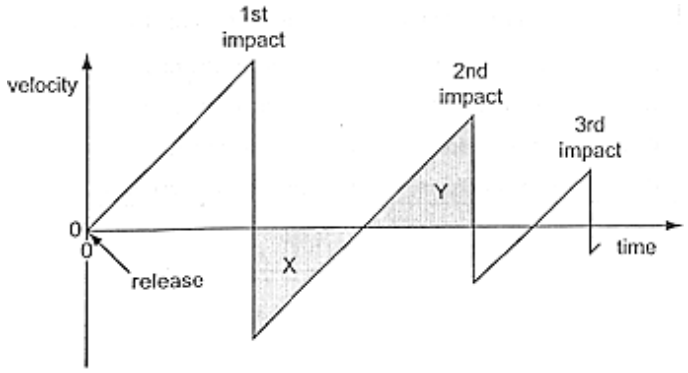
A The accelerations of X and Y are the same at 2.5 s.

B The acceleration of Y is greater than that of X.

C The distance travelled by X is greater than that travelled by Y in the 5 s period.

D The distances travelled by X and Y in the 5 s period are the same.

5 A ball is released from rest above a horizontal surface. The graph below shows the variation of its velocity with time.



Why are areas X and Y equal?

A For one impact, the speed at which the ball hits the surface equals the speed at which it leaves the surface.

B The ball rises and falls through the same distance between impacts.

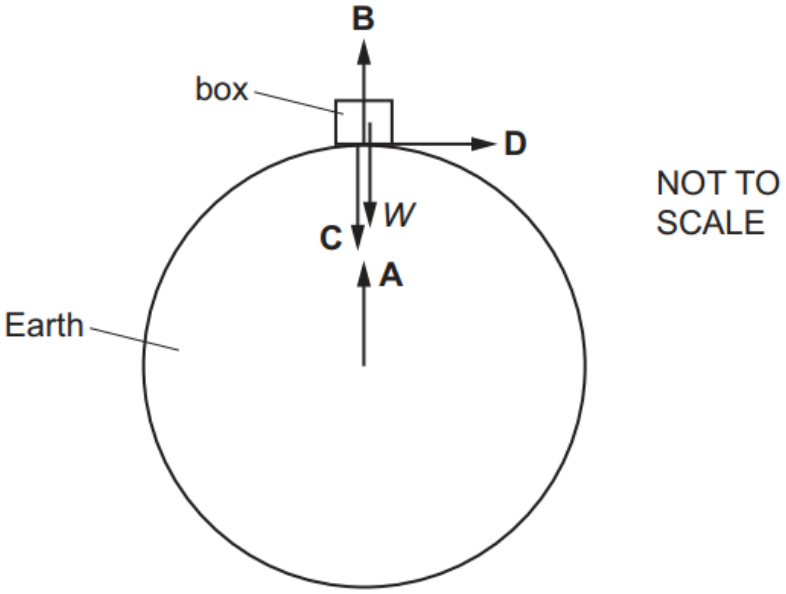
C The ball's acceleration is the same during its upward and downward motion.

D The speed at which the ball leaves the surface after an impact is equal to the speed at which it returns to the surface for the next impact.

6 A box rests on the Earth, as shown in the diagram below.

Newton's third law describes how forces of the same type act in pairs.

If the weight *W* of the box is one of the forces, which arrow represents the other force in this pair?



7 An object is accelerating under the influence of a force, F_1, on a frictionless surface, as shown in Fig. 7.1. A while later, an opposing force, F_2, of the same magnitude acts on it, as shown in Fig 7.2.

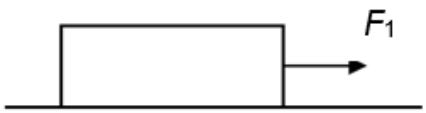


Fig. 7.1

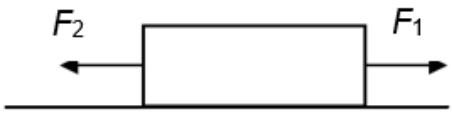


Fig. 7.2

Which statement correctly describes the object's motion immediately after the opposing force acts on it?

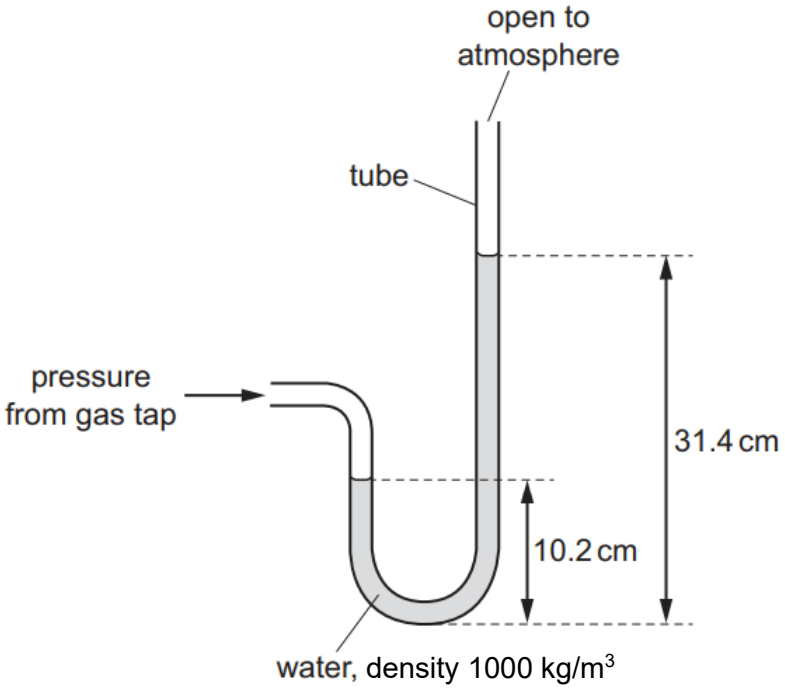
A The object will slow down.

B The object will move at constant velocity.

C The object will move in the opposite direction.

D The object will come to rest.

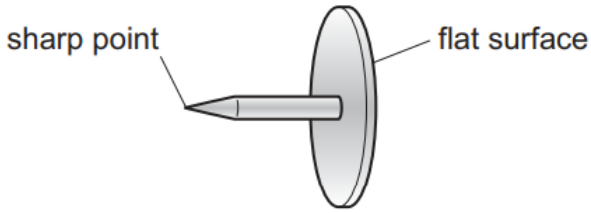
8 One end of a U-shaped tube is connected to a gas tap, with its other end open to the atmosphere, as shown in the diagram. It contains water of density 1000 kg/m^3 and the heights of the water columns on both sides are indicated. The atmospheric pressure is 101 kPa.



What is the pressure of the gas from the gas tap?

A 99 kPa **B** 100 kPa **C** 102 kPa **D** 103 kPa

9 The diagram shows a drawing pin (thumb tack) with a sharp point at one end and a flat surface at the other end.



The pin is pushed into a wooden board.

How do the pressure and the force at the sharp point compare with the pressure and the force on the flat surface?

	force at the sharp point	pressure at the sharp point
A	greater than on the flat surface	greater than on the flat surface
B	greater than on the flat surface	less than on the flat surface
C	the same as on the flat surface	greater than on the flat surface
D	the same as on the flat surface	less than on the flat surface

10 A student states 'If an object is in equilibrium, the sum of clockwise moments about point X is equal to the sum of anticlockwise moments about point Y.'

Under which condition would this statement be correct?

A Either X or Y is the centre of gravity of the object.

B Either X or Y is the pivot of the object.

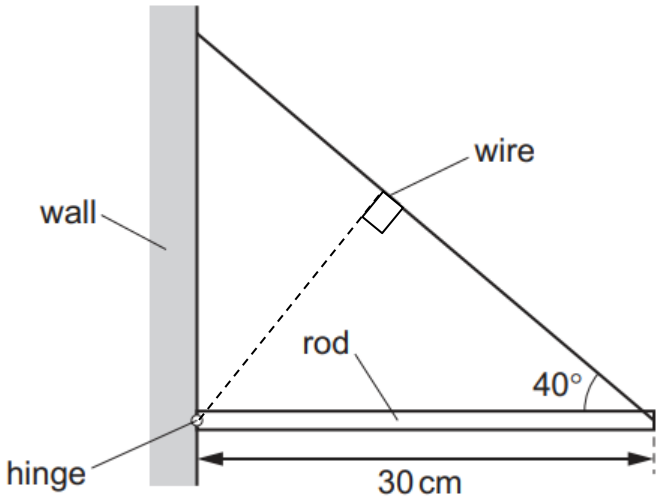
C X and Y are at opposite ends of the object.

D X and Y are the same point on the object.

11 The diagram shows a uniform rod of length 30 cm and weight 5.2 N attached to a wall by a hinge at one end.

The other end of the rod is supported by a wire so that the rod is horizontal and in equilibrium.

The wire is at an angle of 40° to the horizontal.



What is the tension in the wire?

A 3.4 N **B** 4.0 N **C** 6.8 N **D** 8.1 N

12 Car X is travelling at half the speed of car Y. Car X has twice the mass of car Y.

Which statement is correct?

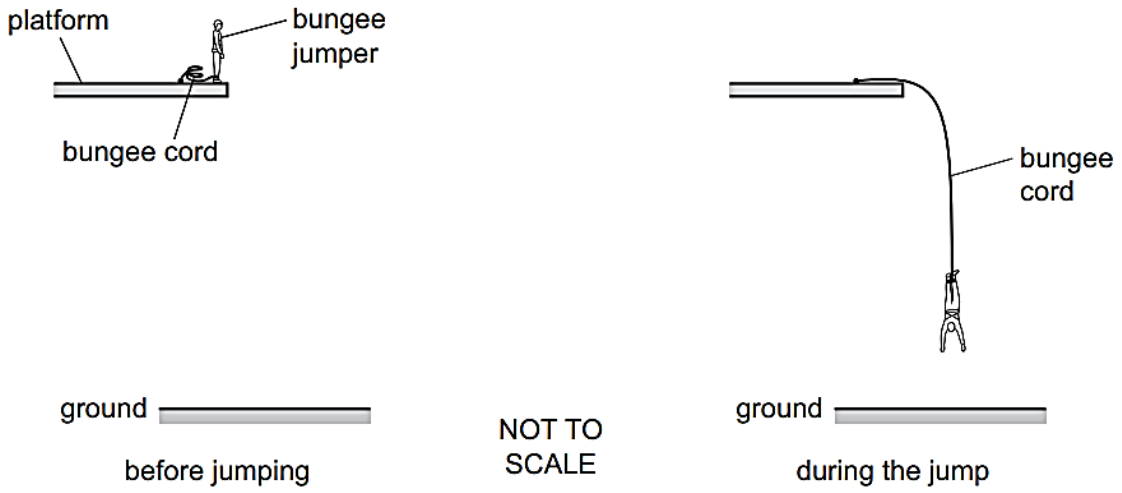
A Car X has half the kinetic energy of car Y.

B Car X has one quarter of the kinetic energy of car Y.

C Car X has twice the kinetic energy of car Y.

D The two cars have the same kinetic energy.

13 A bungee jumper jumps from a platform and is decelerated by an elastic bungee cord, as shown in the diagram.



As the jumper falls, his initial energy in the gravitational potential store is transferred to his kinetic store and the elastic potential store of the cord.

At which part of the jump is energy in all three stores non-zero?

A on the platform before the jump

B on the way down before the cord starts to extend

C on the way down as he decelerates

D at the bottom of the jump when he is momentarily stationary

14 A hydroelectric power station uses energy in the gravitational potential store of water to generate electrical energy.

In a particular power station, the mass of water flowing per unit time is 1.5×10^5 kgs^{-1}. The water falls through a vertical height of 120 m. The electrical power generated is 100 MW.

What is the efficiency of the power station?

A 5.6% **B** 43% **C** 56% **D** 76%

15 The specific heat capacity of solid P is greater than that of solid Q.

What does this statement mean?

A Less energy is needed to raise the temperature of a unit mass of solid P by 1 °C than that of solid Q.

B Less energy is needed to melt a unit mass of solid P than a unit mass of solid Q.

C More energy is needed to raise the temperature of a unit mass of solid P by 1 °C than that of solid Q.

D More energy is needed to melt a unit mass of solid P than a unit mass of solid Q.

16 A student splashes water onto her face. Here are three statements about the effects.

P The water uses energy to evaporate.

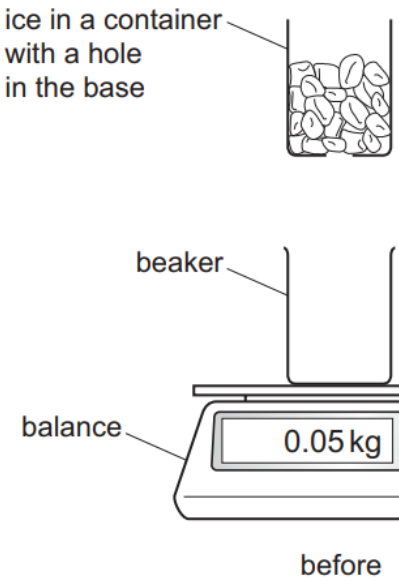
Q The water gains energy from the student.

R The face of the student cools.

Which statements are correct?

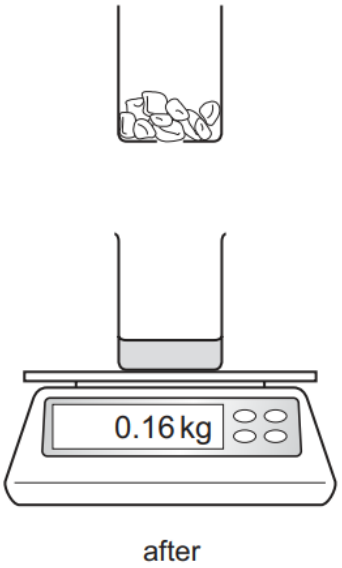
A P and Q only **B** P and R only **C** Q and R only **D** P, Q and R

17 A student placed a number of ice cubes in a container with a hole in the base. He left them to melt so that the water dripped into a beaker placed on a balance. The student recorded the initial mass of the beaker as shown in Fig. 17.1 and the final mass of the beaker and water as shown in Fig. 17.2 after five minutes.



before

Fig. 17.1



after

Fig. 17.2

The specific latent heat of fusion for water is 334 J /g.

How much energy was absorbed from the surroundings in order to melt the ice?

A 37 J **B** 53 J **C** 37 000 J **D** 53 000 J

18 One end of a copper rod is placed in hot water. Thermal energy travels along the rod, making the other end warmer.

What is the behaviour of the copper at an atomic level that accounts for most of the transfer of thermal energy from one end to the other?

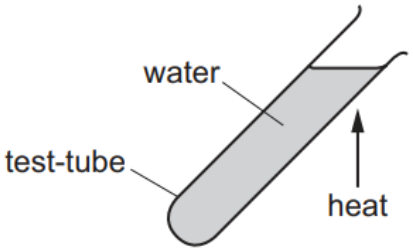
A Atoms at the hot end gain kinetic energy and move towards the other end.

B Atoms at the hot end expand, colliding with other atoms and transferring energy.

C Free electrons at the hot end gain energy and move towards the other end, colliding with atoms along the rod.

D Free electrons at the hot end gain energy from the hot water and move directly to the other end.

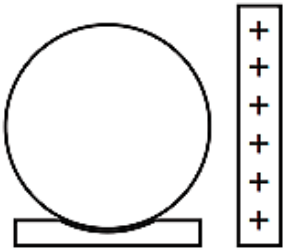
19 A glass test-tube containing water is heated at the top, as shown in the diagram. The water at the top boils, but the water at the bottom remains cold.



Which row explains why the water at the bottom of the test-tube remains cold?

	glass	water
A	good thermal conductor	good thermal conductor
B	good thermal conductor	poor thermal conductor
C	poor thermal conductor	good thermal conductor
D	poor thermal conductor	poor thermal conductor

20 The diagram shows an uncharged metal sphere placed on an insulating support. A positively charged rod is brought close to the sphere, but does not touch it.



How do the charges in the sphere move and what is now the charge on the sphere?

	movement on charges	charge on sphere
A	positive charges move to the left of the sphere	positive
B	positive charges move to the left of the sphere	neutral
C	negative charges (electrons) move to the right of the sphere	positive
D	negative charges (electrons) move to the right of the sphere	neutral

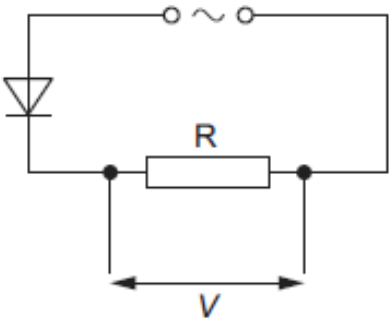
21 P is a point near to charge X, as shown in the diagram.

When a negatively charged test charge is placed at point P, it experiences a force of repulsion directed radially away from X.

Which arrow correctly shows the direction of the electric field at point P due to the charge X?

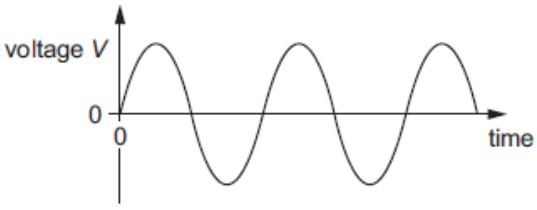
A **B** **C** **D**

22 The diagram shows an alternating current (a.c.) power supply connected in series with a resistor R and a diode.

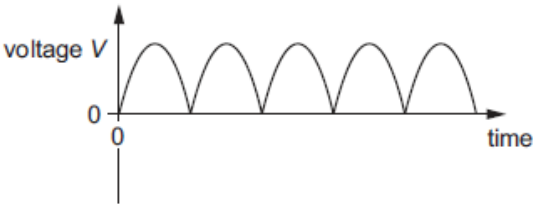


Which graph shows how the voltage *V* across the resistor R varies with time?

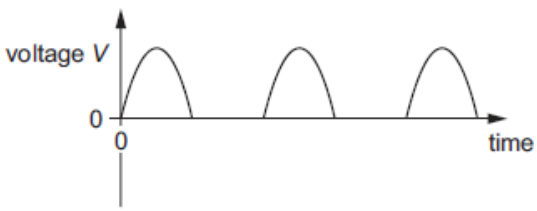
A



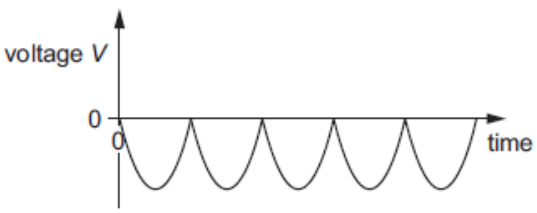
B



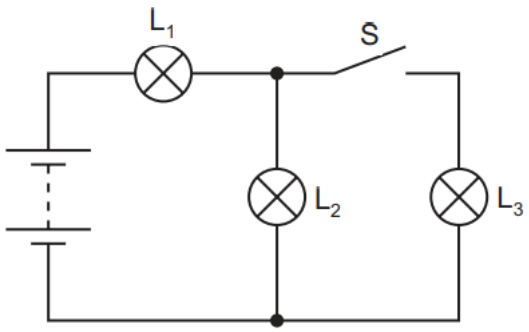
C



D



23 Three identical lamps L_1, L_2 and L_3 are connected to a battery with negligible internal resistance, as shown in the diagram.



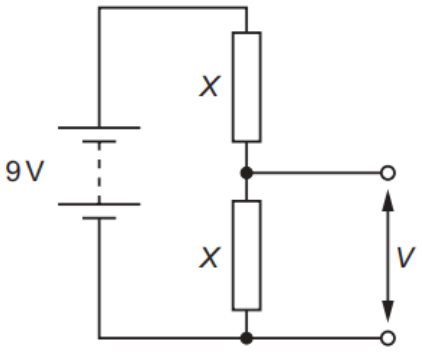
What happens to the brightness of lamps L_1 and L_2 when the switch S is closed?

	lamp L_1	lamp L_2
A	brighter	brighter
B	brighter	dimmer
C	dimmer	brighter
D	dimmer	dimmer

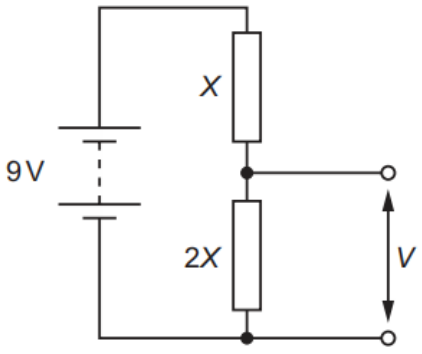
24 Four potential divider circuits each consist of a battery of electromotive force 9 V and negligible internal resistance connected to a combination of resistors. Each resistor in the circuits has a resistance of either X or $2X$.

Which circuit diagram has the largest output voltage V?

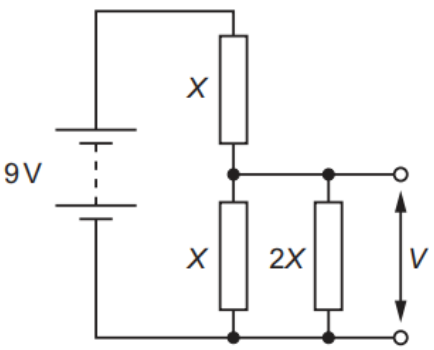
A



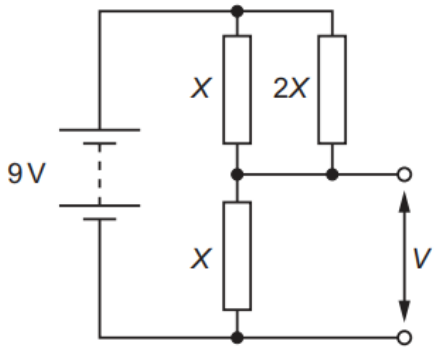
B



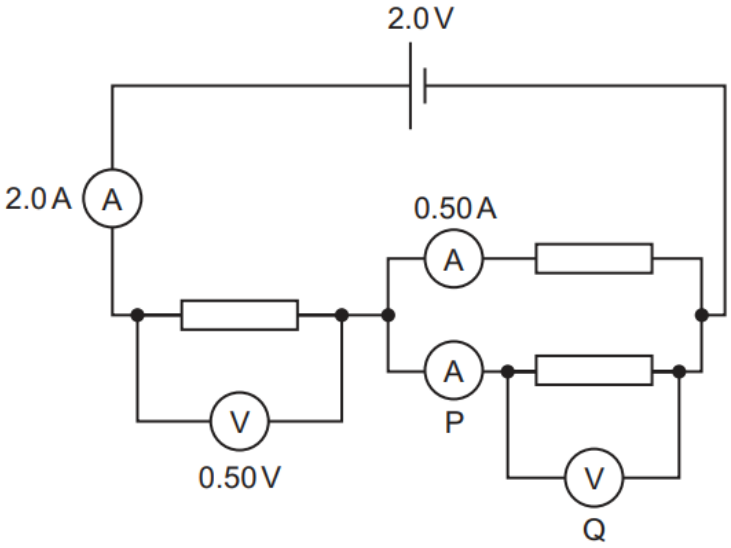
C



D



25 The diagram shows a circuit containing a cell of electromotive force (e.m.f.) 2.0 V, three resistors, three ammeters and two voltmeters. One ammeter is labelled P and one voltmeter is labelled Q. The readings on the other two ammeters and the other voltmeter are shown.



What are the readings on ammeter P and voltmeter Q?

	reading on P / A	reading on Q / V
A	1.5	1.5
B	1.5	2.5
C	2.5	1.5
D	2.5	2.5

26 Some sources of electromagnetic waves are listed.

1 a radio wave transmitter
2 a source of X-rays
3 a 30 mm wavelength radar transmitter
4 a light-emitting diode that emits red light

Which list gives the sources in order of increasing wavelength, from left to right, of the waves they emit?

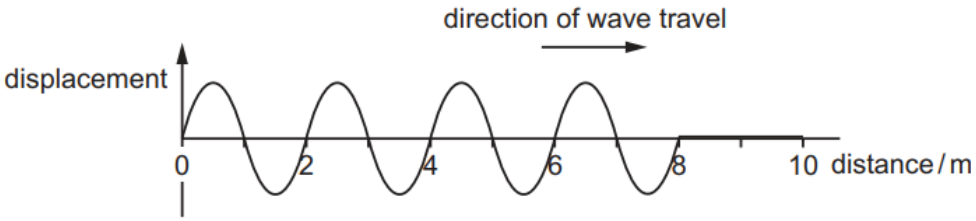
A $1 \rightarrow 3 \rightarrow 4 \rightarrow 2$

B $2 \rightarrow 4 \rightarrow 1 \rightarrow 3$

C $2 \rightarrow 4 \rightarrow 3 \rightarrow 1$

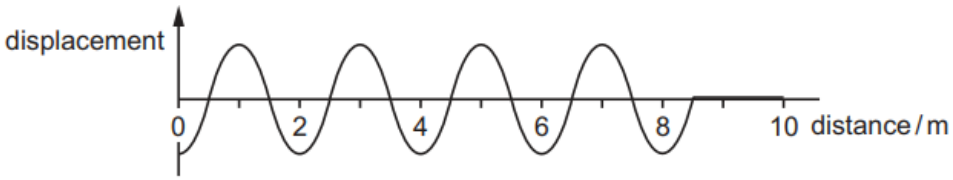
D $3 \rightarrow 1 \rightarrow 4 \rightarrow 2$

27 A transverse wave is travelling along a rope. The frequency of the wave is 2.0 Hz. The graph below shows the variation of the displacement of the wave with distance at time t = 0 s.

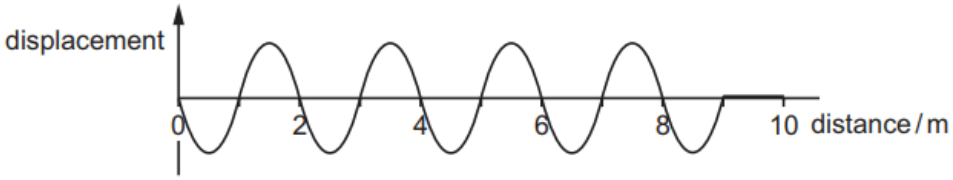


Which diagram shows the position of the wave at time t = 0.5 s?

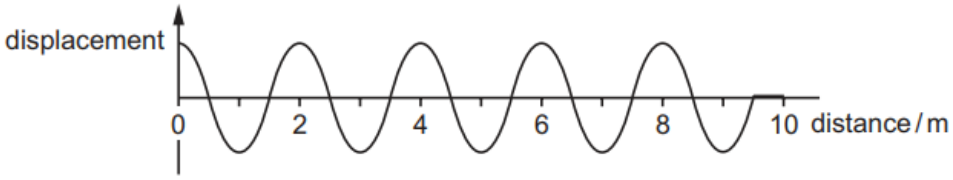
A



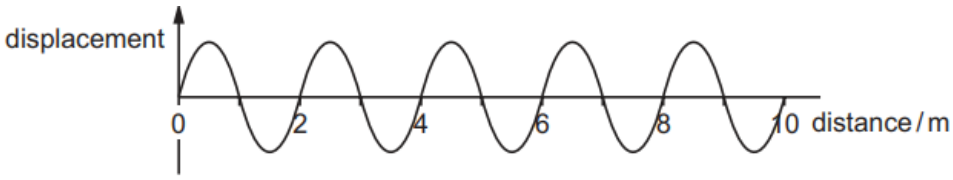
B



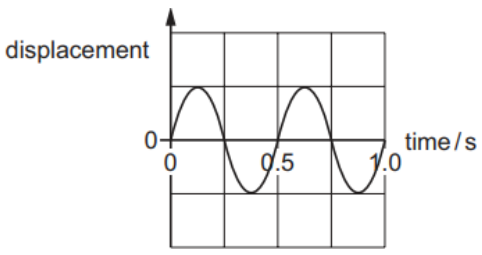
C



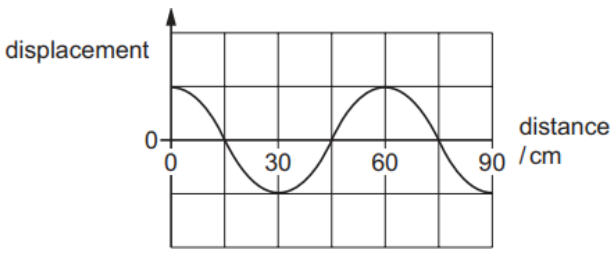
D



28 The two graphs below represent the same wave. Graph 1 shows the variation of the displacement with time at a particular distance. Graph 2 shows the variation of the displacement with distance at one instant.



graph 1

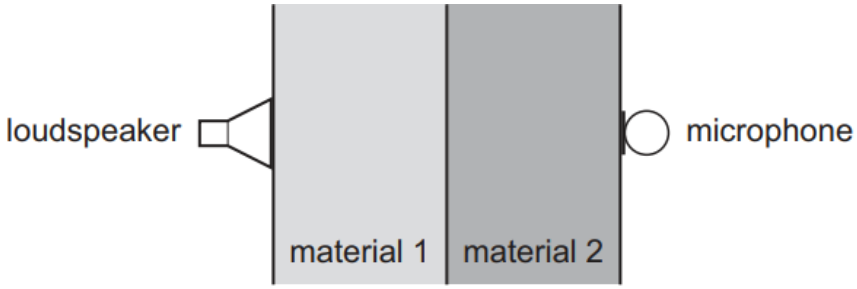


graph 2

What is the speed of the wave?

A 22.5 cms^{-1} **B** 30.0 cms^{-1} **C** 90.0 cms^{-1} **D** 120 cms^{-1}

29 The sound from a loudspeaker must pass through two materials to reach a microphone, as shown in the diagram below.



Which combination of materials gives the shortest time for the sound to reach the microphone?

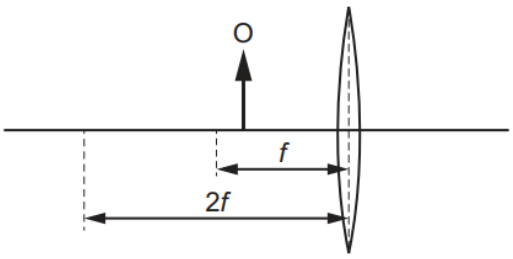
	material 1	material 2
A	air	hydrogen
B	air	water
C	copper	aluminium
D	water	oil

30 A converging lens produces an image of an object O.

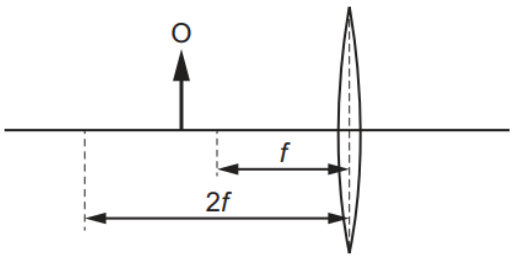
The focal length of the lens is *f*.

At which position the object must be placed for the lens to produce a real, enlarged image?

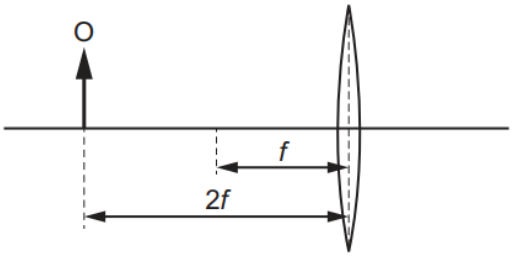
A



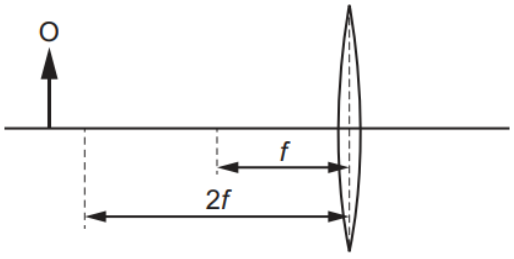
B



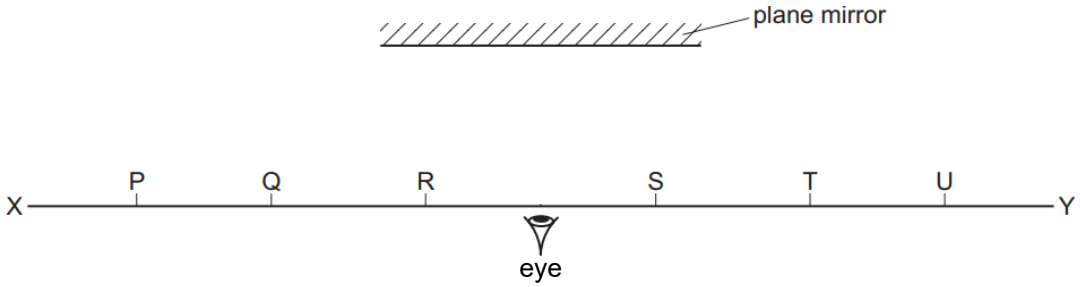
C



D



31 A student uses one eye to look at images in a plane mirror, as shown in the diagram below.



Objects are placed on the line XY.

Which objects will produce images that can be seen by the eye?

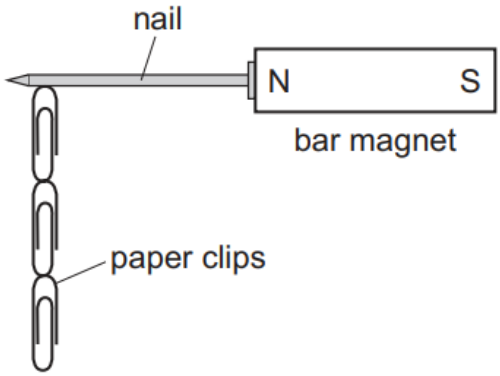
A P, Q, R, S, T and U

B Q, R, S and T only

C P and U only

D R and S only

32 Four nails A, B, C and D are tested to find which makes the strongest permanent magnet. One of the nails is placed against a bar magnet, as shown in the diagram below. The number of paper clips which the nail can support is recorded.



The bar magnet is then removed and the number of paper clips remaining attached to the nail is recorded. Each nail is tested individually.

Which nail becomes the strongest permanent magnet?

	number of paper clips attached to the nail	
	bar magnet present	bar magnet removed
A	2	0
B	2	1
C	4	3
D	5	2

33 A steel bar is placed in an East-West direction for it to be demagnetised. No other magnet is nearby.

Which method is not suitable for demagnetising the steel bar?

A hammering the bar

B heating the bar to a very high temperature

C slowly taking the bar out of a coil that carries an alternating current

D slowly taking the bar out of a coil that carries a direct current

34 Diagram 1 shows a coil of wire P between the poles of a magnet. The ends of coil P are connected to a battery using slip rings.

Diagram 2 shows a coil of wire Q between the poles of a different magnet. The ends of coil Q are connected to a battery using a split-ring commutator.

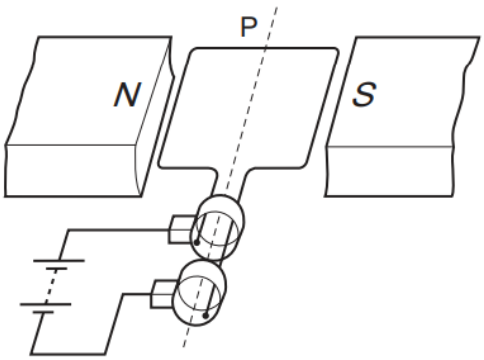


diagram 1

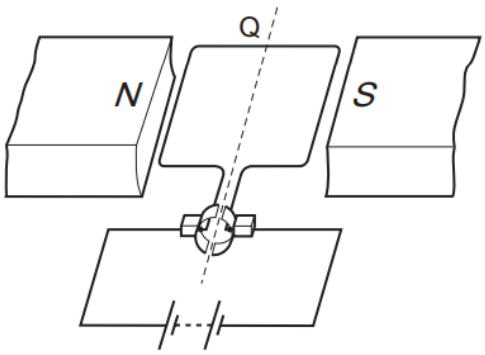


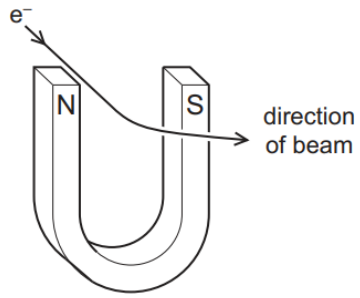
diagram 2

What happens to coils P and Q?

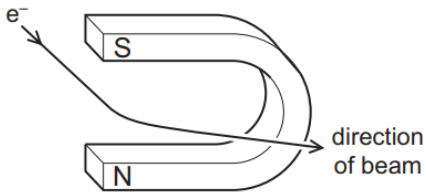
	coil P	coil Q
A	continuously turns anticlockwise	makes one quarter turn anticlockwise then stops
B	continuously turns clockwise	makes one quarter turn clockwise then stops
C	makes one quarter turn anticlockwise then stops	continuously turns anticlockwise
D	makes one quarter turn clockwise then stops	continuously turns clockwise

35 A beam of electrons is passed through the magnetic field of a magnet. How must the magnet be positioned to deflect the beam in the direction shown?

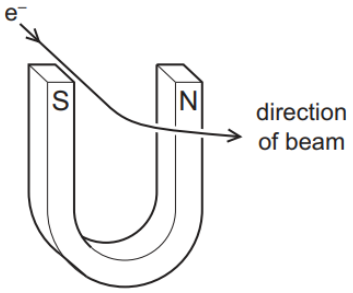
A



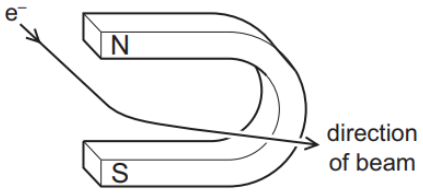
B



C



D



36 A magnet is dropped vertically through a solenoid, as shown in the diagrams below. This induces magnetic poles at both ends of the solenoid.

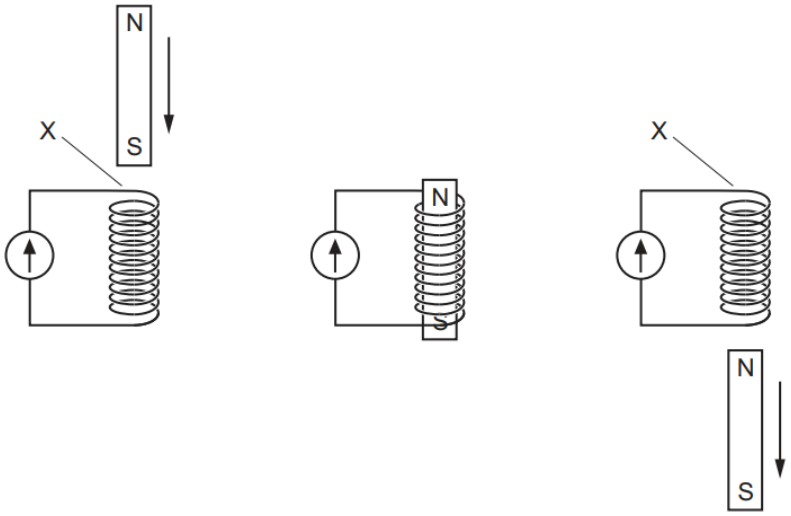
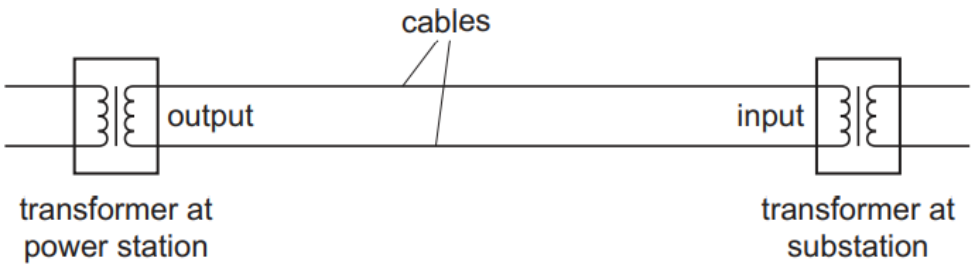


diagram 1 diagram 2 diagram 3

Which magnetic poles are induced at position X in diagram 1 and diagram 3?

	diagram 1	diagram 3
A	N pole	N pole
B	N pole	S pole
C	S pole	N pole
D	S pole	S pole

37 Cables transmit electrical power from the output of the transformer at a power station to the input of the transformer at a substation, as shown in the diagram.



The power at the output of the transformer at the power station is 400 MW. Which situation delivers the most power to the input of the transformer at the substation?

	potential difference at power station transformer output / kV	diameter of cables
A	200	large
B	200	small
C	400	large
D	400	small

38 Four students are asked to comment on the processes of nuclear fission and nuclear fusion.

Their comments are recorded in the table.

Which row is correct?

	fission	fusion
A	energy is absorbed	a large unstable nucleus splits
B	energy is released	two light nuclei join
C	a large unstable nuclei splits	energy is absorbed
D	two light nuclei join	energy is absorbed

39 Which statement about all three types of radioactive emissions is correct?

A They are all completely absorbed by a thin aluminium sheet.

B They are all deflected by electric fields.

C They are all deflected by magnetic fields.

D They all cause ionisation of gases.

40 A teacher holds a radioactive source near a detector.

The reading on the detector is 320 counts/min.

The detector is switched on again after the source has been removed and it shows a reading of 20 counts/min.

What is the counts/min solely due to the source and why is there a reading on the detector when there is no radioactive source present?

	counts/min due to the source	reason for reading with no source
A	300	zero error on detector
B	300	background radiation
C	340	zero error on detector
D	340	background radiation

END OF PAPER

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2025 PRELIMINARY EXAMINATION
SUGGESTED ANSWER SCHEME

PAPER 1 (40 marks)

Qn	Ans	Explanation
1	**B**	Options C and D are not in the range of the micrometer screw gauge. Diameter of an atom is measured using an electron microscope
2	**B**	Density of cork = (4.8 g) / (80 – 56) cm^3 = 0.20 g/cm^3
3	**C**	Resultant force should originate from the same point as the two component forces. D is wrong as it acts in the opposite direction to the resultant force.
4	**D**	Area under v-t graph for X = area under v-t graph for Y in 5 s.
5	**B**	X and Y represents the area - X is the height reached after rebounding , Y is the same height dropped just before impact
6	**A**	Earth exerts an attractive force (weight - action) on box ; Box exerts an equal bit opposite force (reaction) on Earth.
7	**B**	Two opposing forces of the same magnitude produces a zero resultant force and since the object is already in motion, it will continue in its state of motion at a constant velocity
8	**D**	Pressure of gas = 101 kPa + (0.212 x 10 x 1000) Pa = 103120 Pa = 103 kPa (3 s.f.)
9	**C**	Force is the same at the sharp point. Due to the small area of the sharp point, pressure (force/area) will be greater than on the flat surface which has a larger area.
10	**D**	Moment must be taken about the same point (i.e. pivot) for an object in equilibrium
11	**B**	Tension in wire x 30 cm $\sin 40^o$ = 5.2 N x 15 cm Tension in wire = 4.044 N = 4.0 N (2 s.f.)
12	**A**	$KE_Y = ½ (m_Y)(v_Y)^2$; $KE_X = ½ (2m_Y)(v_Y/2)^2 = (m_Y v_Y^2)/4 = ½ KE_Y$
13	**C**	A – KE is zero ; B – EPE is zero ; D – KE is zero
14	**C**	Efficiency = (100 x 10^6 W)/ (1.5 x 10^5 kgs^{-1} x 10 N/kg x 120 m) x 100% = 55.5 % = 56% (2 s.f.)
15	**C**	Specific heat capacity definition

Qn	Ans	Explanation
16	**D**	P speaks of the bombardment of molecules at the surface by molecules below; Thermal energy is supplied to the water molecules by the body as it is at a higher temperature ; the drawing of thermal energy from the face cools the face
17	**C**	Q = (0.11 x 1000 g) x 334 J /g = 36740 J = 37000 J (2 s.f.)
18	**C**	Atoms are not mobile and cannot expand. Electrons will have collision with atoms as they move to the cooler end of the rod.
19	**D**	Glass is poor thermal conductor as it does not transfer thermal energy quickly from the heated end ; convection is confined at the top and water is a poor thermal conductor
20	**D**	In electrostatic induction, only negative charges (electrons) are mobile. By the conservation of charge, the amount of negative charge induced is equal to the amount of positive charges hence the sphere is neutral even during electrostatic induction.
21	**C**	The direction of the electric field is the direction a (free) positive charge will move when place at P. Since X is negatively charged, the positive charge will move from P to X, hence the direction.
22	**C**	Diode allows current to flow in one direction. It will cut off the negative half of the a.c.
23	**B**	Both lamps were at same brightness before closing switch. After closing, total resistance dropped leading to a higher current. L_1 has a larger current compared to L_2. So L_1 becomes brighter while L_2 dims.
24	**B**	Applying potential divider equation A: $V_{output} = 4.5\ V$; B: $V_{output} = \frac{2X}{3X} 9.0\ V = 6.0\ V$; C: $V_{output} = \frac{2X/3}{5X/3} 9.0\ V = 3.6\ V$; D: $V_{output} = 9.0\ V - \frac{2X/3}{5X/3} 9.0\ V = 5.4\ V$
25	**A**	$V_Q = (2.0 - 0.5)V$; $I_P = (2.0A - 0.5A) = 1.5\ A$
26	**C**	Radio wave has the longest wavelength
27	**D**	v = 2.0 Hz x 2 m = 4.0 ms^{-1}. At t= 0.5 s, the distance moved by the waveform is 2.0 m (1 wavelength)
28	**D**	v = (1/0.5) (60 cm) = 120 cms^{-1}
29	**C**	Speed of sound through solid is the highest.
30	**B**	Only for object distance f <u < 2f can a real enlarged image.

Qn	Ans	Explanation
31	**B**	By ray construction, Image of Q and T can still be seen by the eye at E.
32	**C**	C still attracts the most number of clips(3) after the magnet is removed
33	**D**	Actions describes in A, B and C disturbs the magnetic domains and cause the little magnets in the domains to disorientate. Passing a direct current will align the domains inside the steel bar and it will become a permanent magnet.
34	**C**	Applying Fleming's LHR. No rotation for diagram 1 as there is a restoring force when the coil reaches the vertical
35	**B**	A -electron beam deflected to the bottom of page. (Fleming's LHR) C – electron beam deflected to top of page D – electron beam to the left of page.
36	**C**	Diagram 1 : X is an induced S-pole when the magnet approaches. As the N-pole recedes away from the coil, a S-pole is induced at the bottom of the coil. Hence X will be a N-pole (Lenz's law)
37	**C**	Output will be high voltage low current to minimize power loss. Since power loss = I^2R , resistance of cables will be small when cross sectional area is large.
38	**B**	Both processes result in energy release.
39	**D**	Gamma radiation pass through aluminium and is not deflected by magnetic and electric fields
40	**B**	Background radiation accounts for the 20 counts per min

SINGAPORE CHINESE GIRLS' SCHOOL
PRELIMINARY EXAMINATION 2025
SECONDARY FOUR

CANDIDATE NAME								
CLASS	4			REGISTER NUMBER				
CENTRE NUMBER					INDEX NUMBER			

PHYSICS 6091/2

Paper 2

27 August 2025 **1 hour 45 mins**

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

READ THESE INSTRUCTIONS FIRST

Section A

Answer **all** questions.

Write your answers in the spaces provided.

Section B

Answer **one** question.

Write your answers in the spaces provided.

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	/70
Section B	/10
Total	/80

Section A

Answer **all** questions.

1 Fig. 1.1 shows the descent of a skydiver from a stationary balloon.

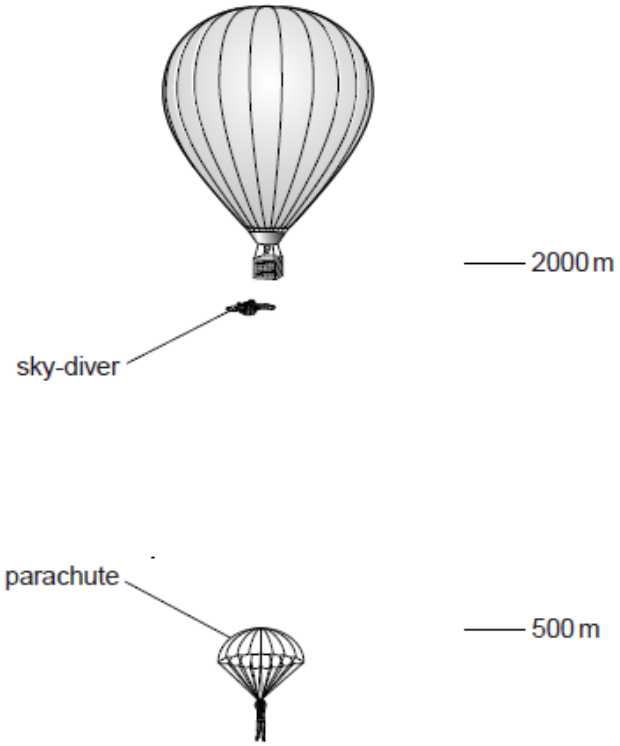


Fig. 1.1 (not to scale)

The skydiver steps off the balloon at a height of 2000 m and accelerates downwards.
His speed is 52 m/s at a height of 500 m. He then opens his parachute.
From 400 m to ground level, he falls at constant speed.

(a) The total mass of the skydiver and his equipment is 92 kg.

(i) Calculate, for the skydiver,

1. the decrease in energy in the gravitational potential store as he falls from 2000 m to 500 m,

decrease in energy in the gravitational potential store = ... [2]

2. the energy in the kinetic store at the height of 500 m.

energy in the kinetic store = ... [2]

(ii) The energy in the kinetic store at 500 m is not equal to the decrease in energy in the gravitational potential store.

Explain why there is a difference in the values.

……...

……...

…….. [1]

(b) State

(i) what happens to the air resistance acting on the skydiver as he falls from 2000 m to 1500 m,

…….. [1]

(ii) the value of air resistance during the fall from 400 m to the ground.

air resistance = ……..…… [1]

[Total : 7 m]

2 A block is pulled by a force X in a straight line along a rough horizontal surface, as shown in Fig. 2.1.

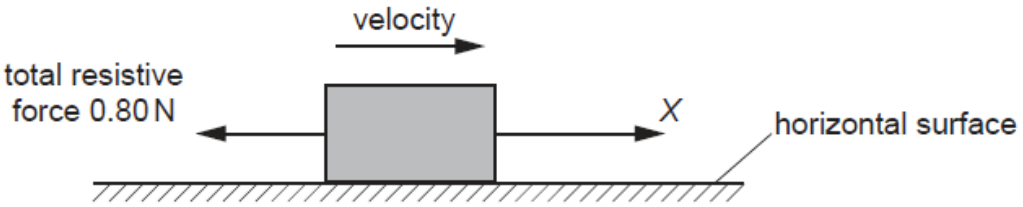


Fig. 2.1

Assume that the total resistive force opposing the motion of the block is 0.80 N at all speeds of the block.

The variation of the magnitude of the force X with time t is shown in Fig. 2.2.

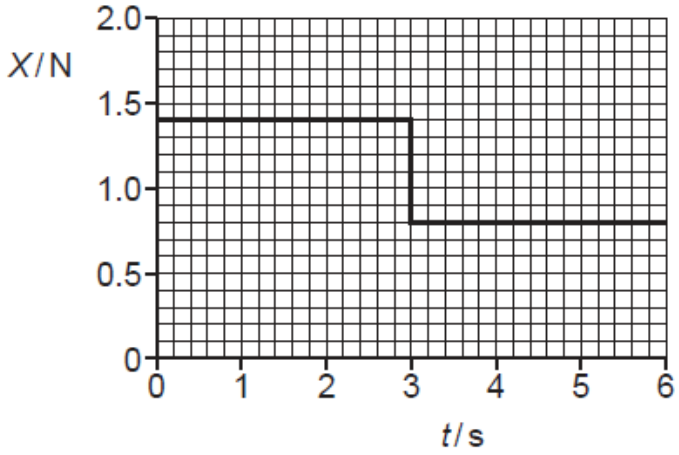


Fig. 2.2

(a) **(i)** Describe and explain the motion of the block between t = 0.0 s and t = 3.0 s.

.....

.....

.....

..... [2]

(ii) Describe and explain the motion of the block between t = 3.0 s and t = 6.0 s.

.....

.....

.....

..... [2]

(b) Force *X* produces a total power of 2.0 W when moving the block between time *t* = 3.0 s and time *t* = 6.0 s.

Calculate the distance moved by the block during this time interval.

distance = ……..…… [2]

(c) Explain the difference in the power produced between *t* = 0.0 s and *t* = 3.0 s, and that in **(b)**.

……...

……...

…….. [1]

[Total : 7 m]

3 A uniform rectangular sheet of card of weight *W* is suspended from a wooden rod. The card is held initially to one side, as shown in Fig. 3.1.

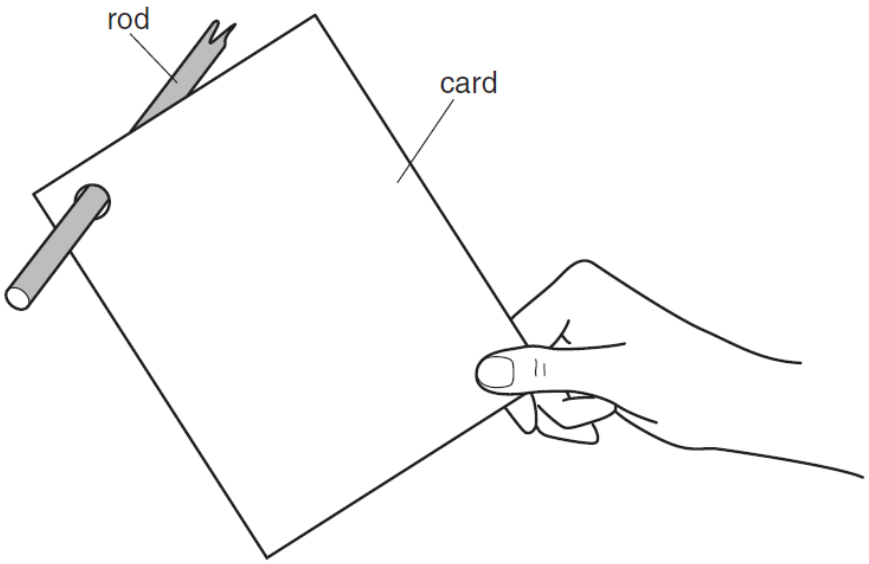


Fig. 3.1

The card is then released. It swings on the rod and eventually comes to rest.

(a) List two key forces, other than its weight and air resistance, that act on the card during the time that it is swinging. State where the forces act.

1. ……

……

2. ……

…… [2]

(b) A student claims that the two forces listed in **(a)** are not an action-reaction pair. Explain whether his claim is correct or incorrect.

……

……

……

…… [2]

[Total : 4 m]

4 The Brownian motion of smoke particles in air may be observed using the apparatus shown in Fig. 4.1.

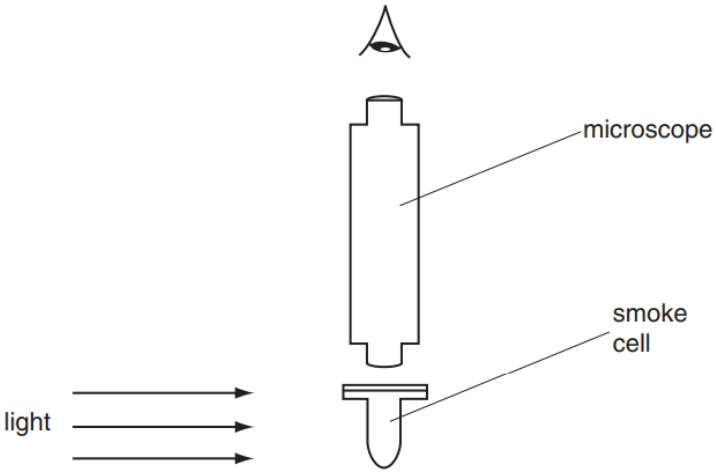


Fig. 4.1

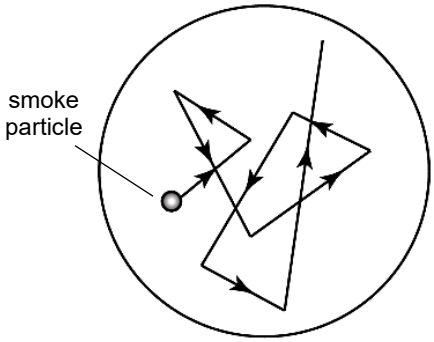


Fig. 4.2

Fig. 4.2 shows the motion of a smoke particle.

(a) Explain the motion of the smoke particle.

……...

……...

…….. [2]

(b) **(i)** Suggest what would be observed in the movement of smoke particles when the temperature in the smoke cell is increased.

……...

…….. [1]

(ii) Explain, in term of molecules, your answer to **(b)(i)**.

……...

……...

……...

…….. [2]

[Total : 5 m]

5 **(a)** A semicircular glass block G is originally placed with its flat surface parallel to a vertical wall. A beam of red laser light is directed along the radius of the block and towards a point A on the wall. The distance from the centre of the glass block, O, to point A is 1.50 m.

With the path of the light beam from the source unchanged, the glass block is rotated about its centre. The bright spot where the beam strikes the wall moves down from point A to B and then disappears.

Fig. 5.1 shows how the spot moves from A to B as the block rotates.

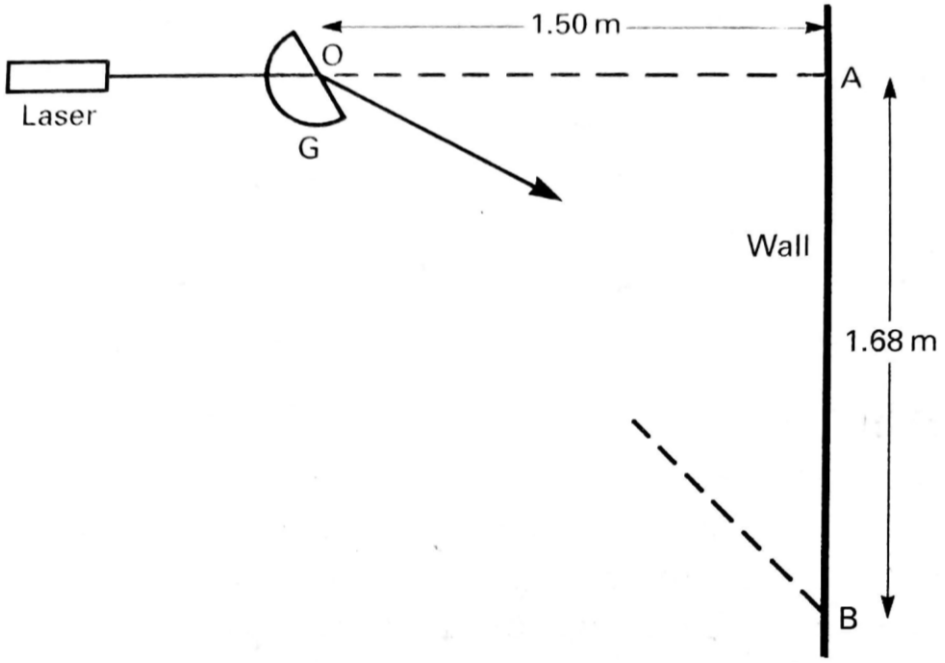


Fig. 5.1 (not to scale)

(i) Explain why the spot disappears.

……...

…….. [1]

(ii) Determine the refractive index of the material of the glass block G.

refractive index = …… [3]

(iii) Explain whether AB would be longer or shorter if a higher refractive index glass block is used.

……...

……...

…….. [1]

(b) Fig. 5.2 shows a slide projector, which is an optical instrument for image projection. Light from a lamp is converged onto a slide and a convex lens is used to form an image of the slide on a screen.

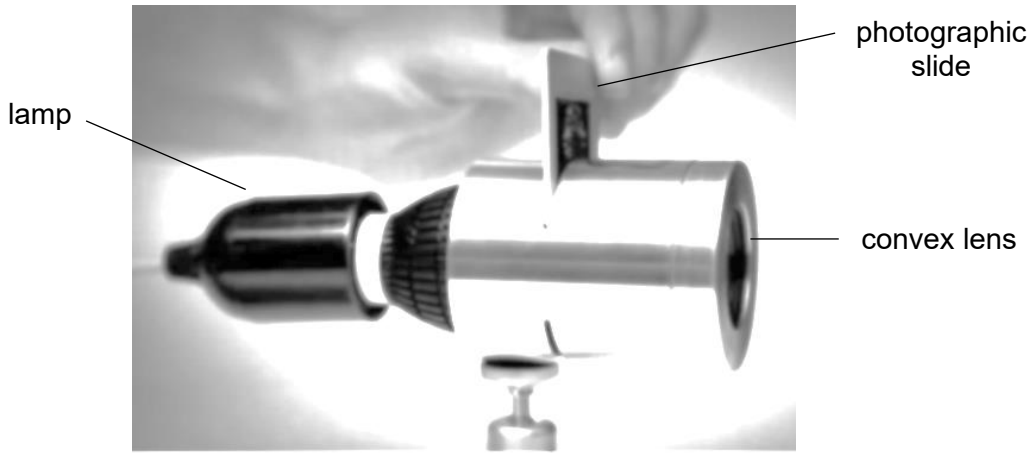


Fig. 5.2

Fig. 5.3 shows a slide PQ, the lens and the screen. The lamp which illuminates the slide is not shown in the figure.

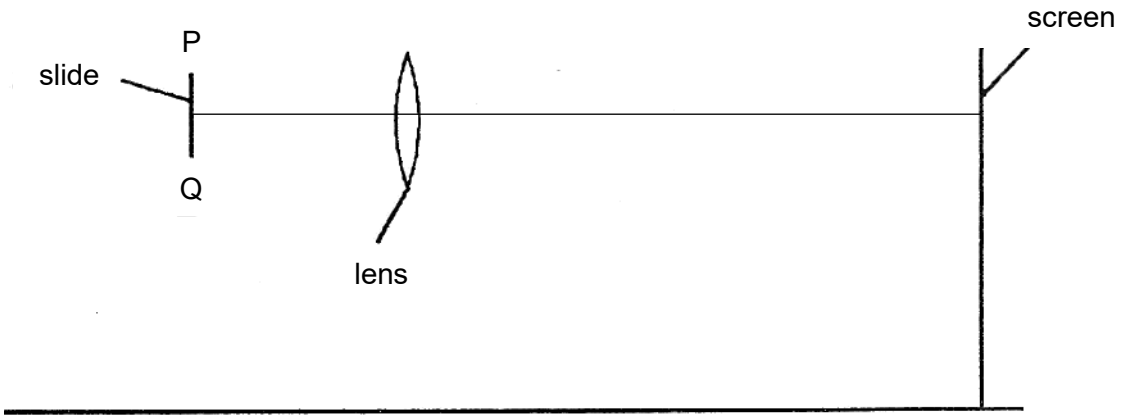


Fig. 5.3

(i) On Fig. 5.3, draw two rays each from P and Q, to show how a focused image of the slide is formed on the screen. Label the image points as **P'** and **Q'**. [2]

(ii) Explain why the slide must be placed upside down.

……...

…….. [1]

[Total : 8 m]

6 A battery of electromotive force (e.m.f.) 9.6 V and negligible internal resistance is connected in series with two fixed resistors and a negative temperature coefficient (NTC) thermistor, as shown in Fig. 6.1.

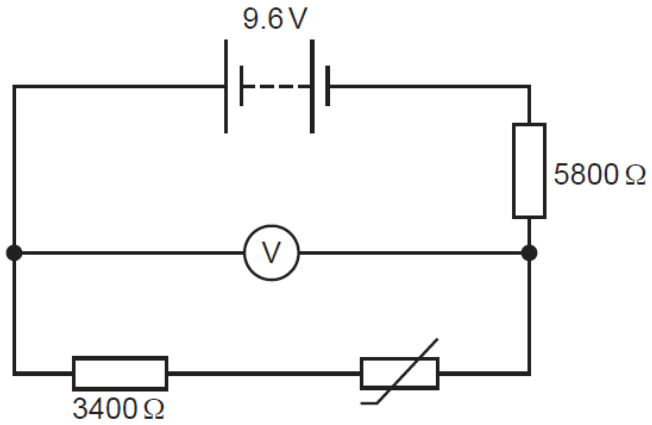


Fig. 6.1

The fixed resistors have resistances of 3400 Ω and 5800 Ω. The reading on the voltmeter in the circuit is 6.0 V.

(a) Calculate the current in the 5800 Ω resistor.

current = ... [2]

(b) Calculate the resistance of the thermistor.

resistance = ... [2]

(c) The change in the environmental conditions causes an increase in the resistance of the thermistor.

State whether there is a *decrease*, *increase* or *no change* to:

(i) the temperature of the thermistor

..... [1]

(ii) the current in the thermistor

..... [1]

(iii) the potential difference across the thermistor

..... [1]

[Total : 7 m]

7 **(a)** The spontaneous and random decay of a radioactive substance involves the emission of either α-radiation or β-radiation and/or γ-radiation.

Explain what is meant by *random decay*.

……...

…….. [1]

(b) **(i)** Two isotopes of the element uranium are $^{235}_{92}\text{U}$ and $^{238}_{92}\text{U}$. Explain the term *isotopes*.

……...

…….. [1]

(ii) When a nucleus of uranium-235 absorbs a neutron, the following reaction may take place.

$$^{235}_{92}\text{U} + ^{a}_{b}\text{n} \rightarrow ^{141}_{x}\text{Ba} + ^{y}_{36}\text{Kr} + 3\,^{a}_{b}\text{n}$$

State the values of *a*, *b*, *x* and *y*.

a = ……

b = ……

x = ……

y = …… [2]

(iii) When the nucleus of $^{238}_{92}\text{U}$ absorbs a neutron, the nucleus decays, emitting an α-particle.

State the proton number and nucleon number of the nucleus that is formed as a result of the emission of the α-particle.

proton number = ……

nucleon number = …… [2]

[Total : 6 m]

8 Fig. 8.1 shows a simple experimental setup to study the motion of a motor. *AB* and *CD* are solenoids connected to a battery *E*.

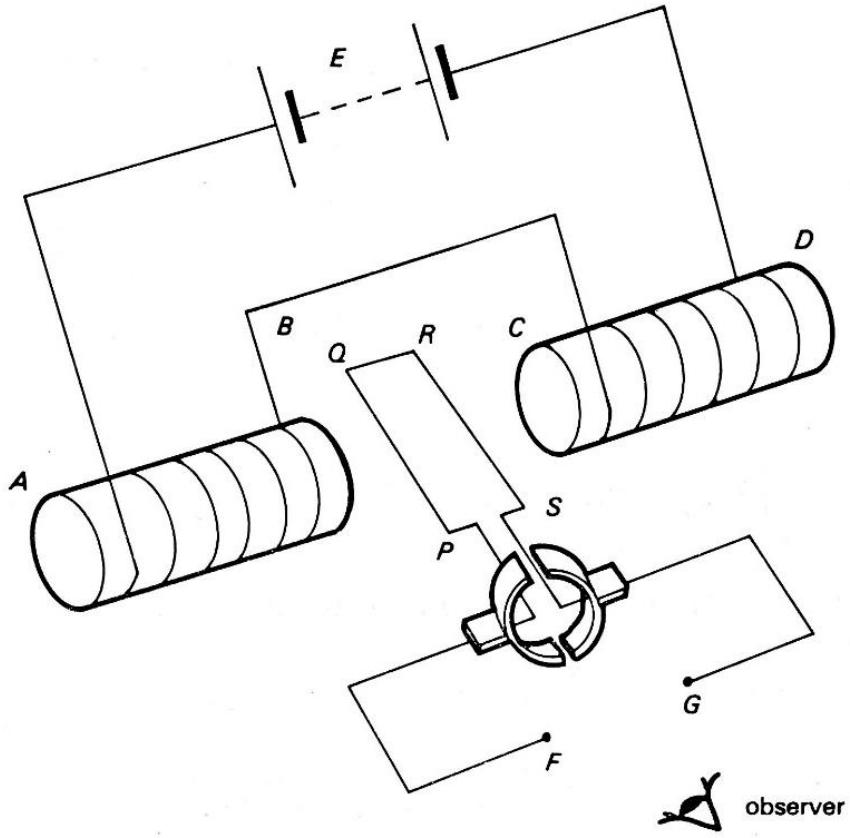


Fig. 8.1

(a) State the polarity of the solenoid at C.

…….. [1]

(b) Fig. 8.2 shows the voltage *V* applied to F against time *t*. Every minute corresponds to the time one half of a split-ring commutator is in contact with the carbon brushes.

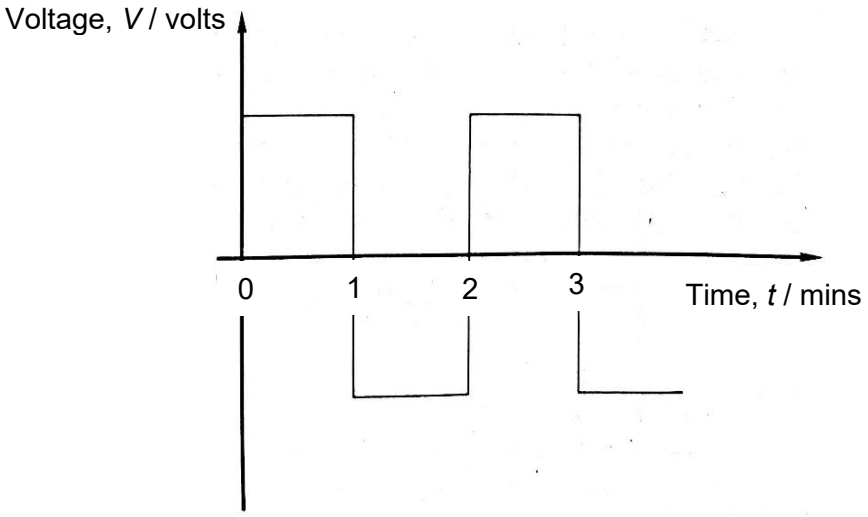


Fig. 8.2

(i) State the direction of rotation of the coil *PQRS*, as viewed by the observer, in the 1st minute.

…….. [1]

(ii) State and explain the motion of the coil in the 2nd minute.

……...

……...

……...

…….. [2]

(iii) State what can be deduced about the magnitude of the force acting on the arms *PQ* and *RS* in one cycle of the voltage.

…….. [1]

(iv) A student suggests replacing the voltage supply at FG with a battery. Explain how this change will affect the rotation of the coil, if any.

……...

…….. [1]

[Total : 6 m]

9 **(a)** The transformer in Fig. 9.1 is used to convert 240 V a.c. to 6 V a.c.

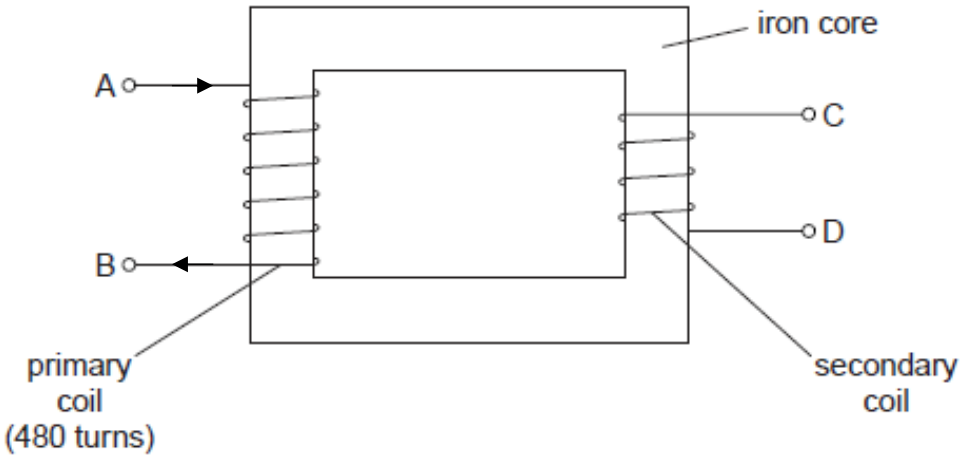


Fig. 9.1

(i) Using the information above, calculate the number of turns on the secondary coil.

number of turns = ... [2]

(ii) The current in the primary coil flowing from A to B and is increasing. Indicate the direction of the current in the secondary coil. [1]

(iii) A transformer supplying electrical energy to a factory changes the 11 000 V a.c. supply to 440 V a.c. for use in the factory. The current in the secondary coil is 200 A.

Calculate the current in the primary coil, assuming no energy losses from the transformer.

current = ... [2]

(b) Fig. 9.2 shows a bar magnet suspended by a spring over a coil. The coil is connected to a sensitive centre-zero millivoltmeter.

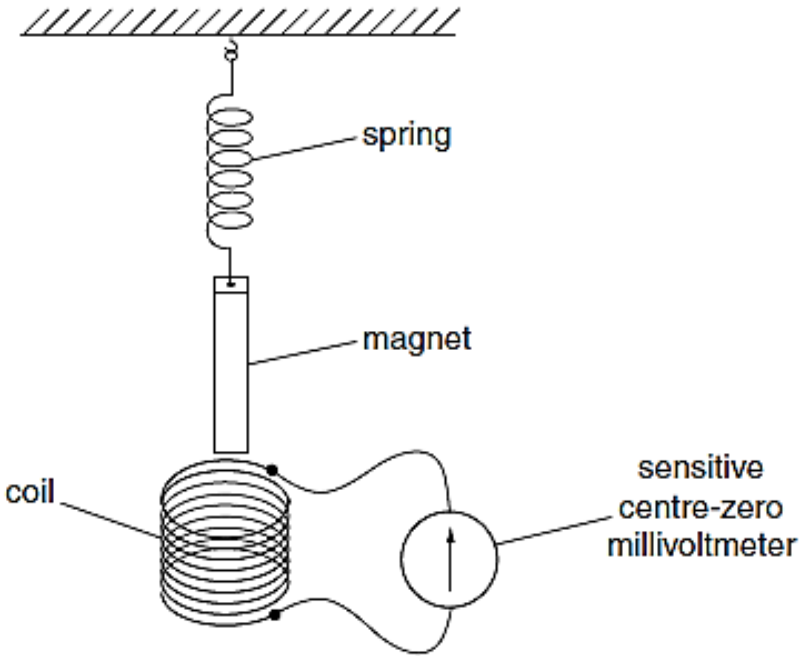


Fig. 9.2

The lower end of the magnet is pushed down into the upper end of the coil and held at rest. During the movement, an e.m.f. is induced in the coil. The meter shows an increasing deflection to the right and then returns rapidly to zero.

Explain why

(i) an e.m.f. is induced in the coil when magnet is pushed down,

……...

……...

…….. [1]

(ii) the meter deflects to the right and then returns rapidly to zero.

……...

……...

……...

…….. [2]

[Total : 8 m]

10 **(a)** A sound wave in air consists of alternate compressions and rarefactions along its path.

(i) Explain how a compression differs from a rarefaction.

……...

…….. [1]

(ii) Explain in terms of compressions, what is meant by

1. the wavelength of the sound wave,

……

…… [1]

2. the frequency of the sound wave.

……

…… [1]

(b) Table 10.1 shows how the speed of sound in air varies with temperature.
Table 10.2 shows the speed of sound at 0 °C in different gases.

Table 10.1

Temperature / °C	Speed / ms^{-1}
0	331
5	224
10	337
15	340

Table 10.2

Gas		Speed / ms^{-1}
Carbon dioxide	Increasing molecular mass ↑	259
Oxygen		316
Helium		965
Hydrogen		1290

(i) Explain, using ideas of particles, why the speed of sound in air decreases as it moves from a high temperature region to a low temperature region.

……...

……...

……...

…….. [2]

(ii) A carbon dioxide molecule is heavier than a hydrogen molecule.

Explain, using ideas of particles, why the speed of sound is lower in a heavier gas than in a lighter one.

……...

…….. [1]

(c) Fig. 10.3 shows an elastic string with beads fixed on it at equal intervals. The separation between any two consecutive beads is 2.0 cm. One end of the string is connected to a vibrator and the other to a wall. The vibrator then vibrates to and fro along the direction of the elastic string.

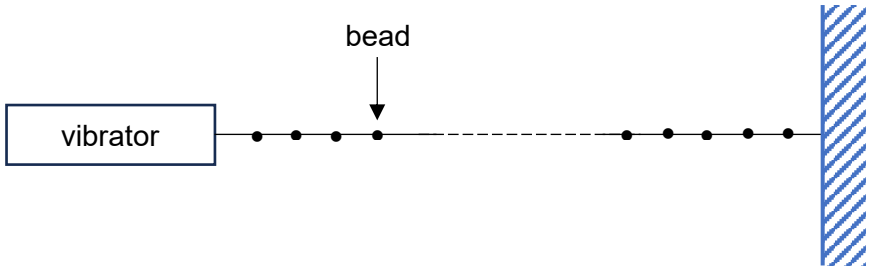


Fig. 10.3

Fig. 10.4 shows the positions of some of the beads at different times.

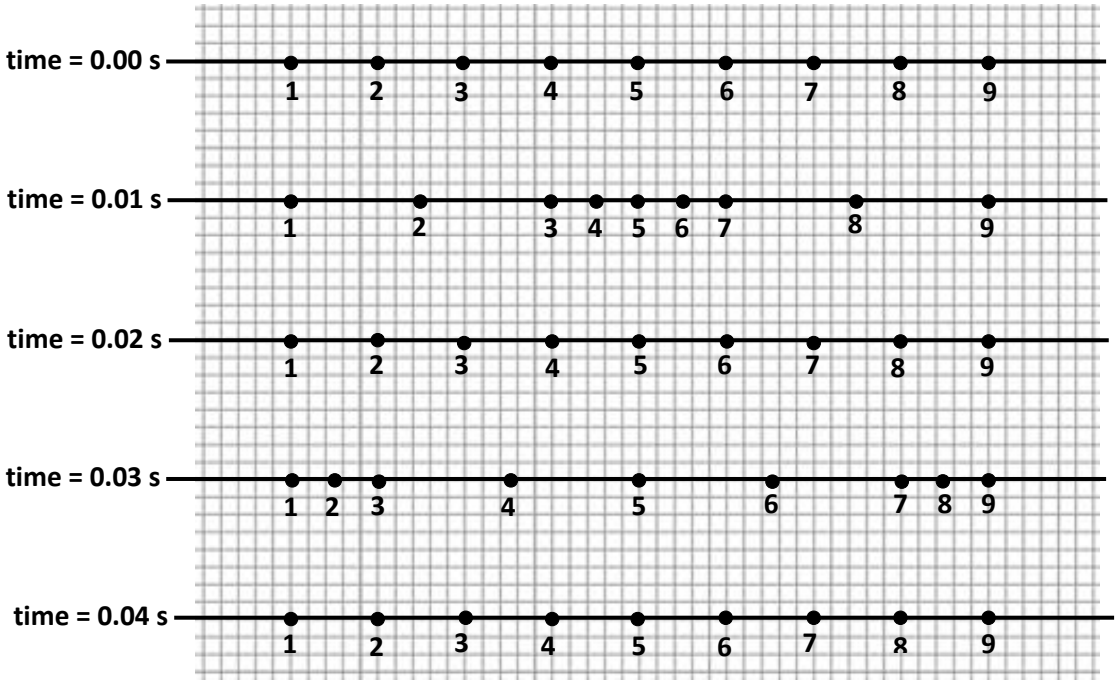


Fig. 10.4

(i) Determine the frequency of the wave motion set up in the string.

frequency = ... [1]

(ii) Determine the wavelength of the wave.

wavelength = ... [1]

(iii) Determine the velocity of the wave.

velocity = …… [2]

(iv) On Fig.10.5, sketch, on the axes provided, the displacement-time graph of bead 7 from 0.00 s to 0.04 s, taking displacement to the right as positive. [2]

Fig. 10.5

[Total : 12 m]

END OF SECTION A

Section B

Answer **one** question from this section.

11 (a) A crankshaft is a shaped metal bar that is part of a car engine. It is free to rotate about an axis, as shown in Fig. 11.1.

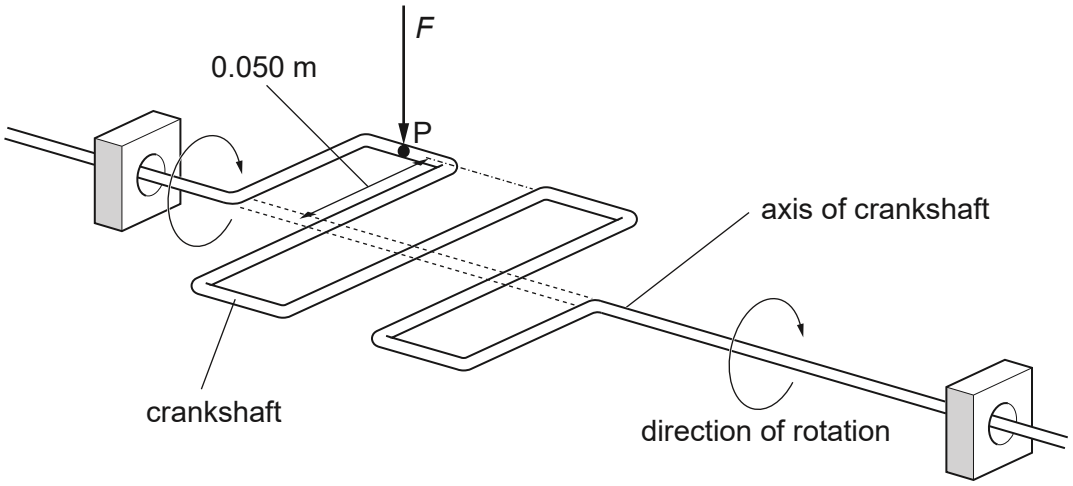


Fig. 11.1

When the crankshaft is horizontal, a vertical force *F* of 8200 N acts downwards on it at point P. This causes the crankshaft to rotate. The distance between P and the axis of the crankshaft is 0.050 m.

(i) State what is meant by the *moment of a force*.

……...

…….. [1]

(ii) Calculate the moment of *F* about the axis of the crankshaft.

moment = ……. [1]

(iii) The size and direction of the vertical force *F*, acting on the crankshaft at P, remain constant. Explain why the moment of *F* decreases as the crankshaft rotates through a small angle.

……...

…….. [1]

(b) The force *F* of 8200 N on the crankshaft at P is exerted by a metal rod connected to a piston. The piston traps high-pressure gas in a cylinder, as shown in Fig. 11.2.

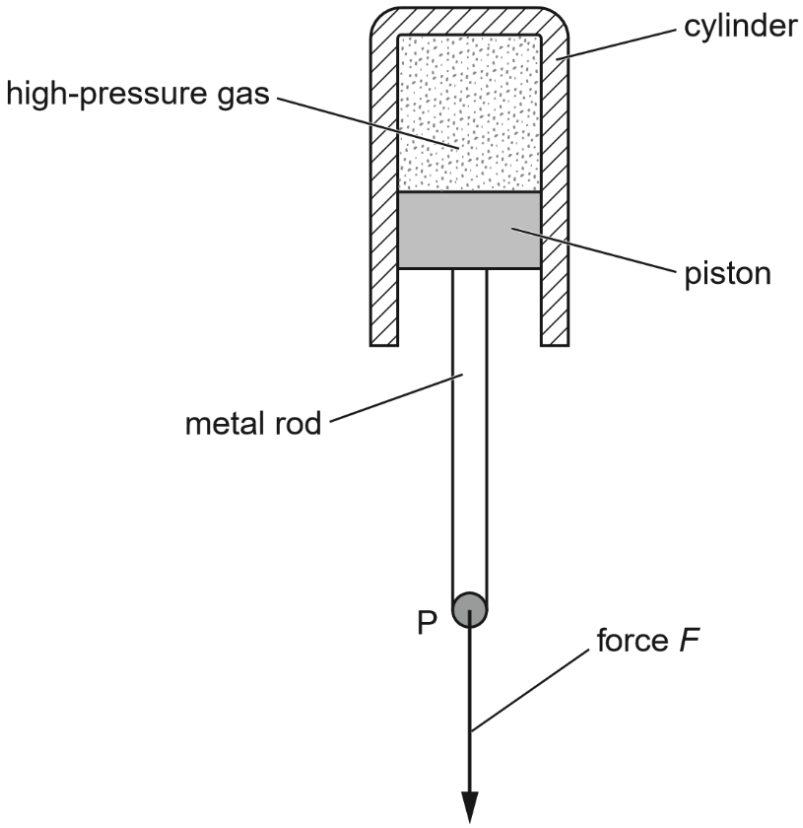


Fig. 11.2

The air pressure outside the cylinder is 1.0×10^5 Pa and the cross-sectional area of the piston is 0.0067 m^2.

(i) Calculate the minimum value of the gas pressure the cylinder.

minimum gas pressure = ……. [2]

(ii) Suggest why, in practice, the pressure of the gas in the cylinder is greater than the value calculated in **(i)**.

……...

…….. [1]

(c) The piston moves downwards and the gas expands. State and explain, in terms of molecules, what happens to the force *F*.

……...

……...

……...

…….. [2]

(d) Explain, in molecular terms, why heating a gas at constant volume causes its pressure to increase.

……...

……...

……...

…….. [2]

[Total : 10 m]

12 **(a)** Fig. 12.1 shows a cyclist riding on a flat road. Fig. 12.2 shows his front view.

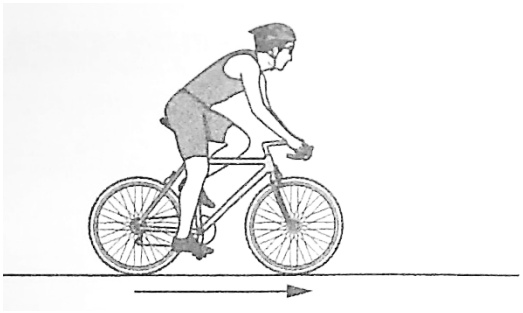


Fig. 12.1

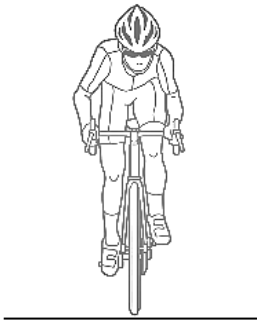


Fig. 12.2

(i) While travelling along a straight horizontal road, he applies a constant force to maintain a constant speed. Explain why his speed remains constant even though he is applying a constant force.

……...

……...

…….. [1]

(ii) The cyclist in Fig. 12.2 may topple to either the left or the right. Explain why in terms of moments.

……...

……...

…….. [1]

(b) The overall stopping distance of a cyclist is made up of two parts, as shown in Fig. 12.3:
- Thinking distance – the distance the cyclist travels during the reaction time of the cyclist
- Braking distance – the distance the cyclist travels after the brakes are applied

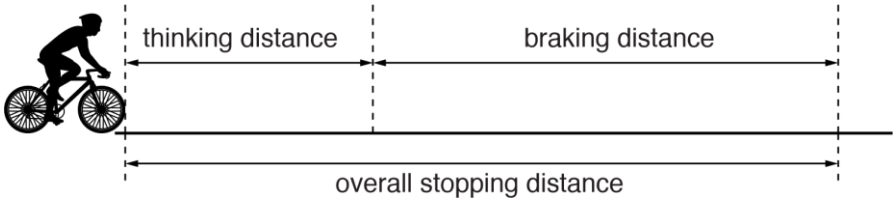


Fig. 12.3 (not to scale)

A ball rolls in front of a cyclist at time $t = 0$. The cyclist brakes and comes to a stop.

Fig. 12.4 shows the velocity-time graph for the cyclist.

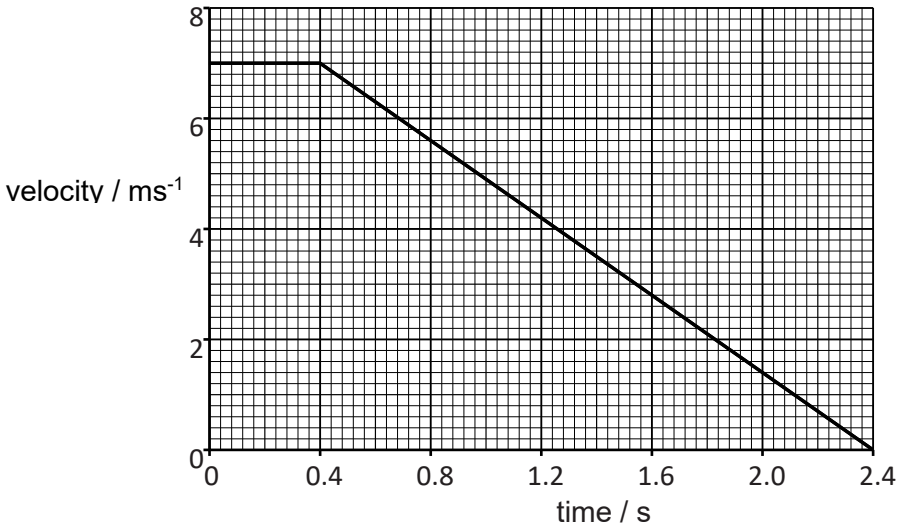


Fig. 12.4

Using Fig. 12.4, calculate the overall stopping distance.

overall stopping distance = ... [2]

(c) On another occasion, the same cyclist travels at an initial speed of 8.0 m/s. A ball rolls in front of him at time $t = 0$.

The cyclist has the same reaction time but he brakes harder such that the overall stopping distance is the same as that he covered in **(b)**.

(i) On Fig. 12.4, draw the new velocity-time graph of the cyclist. [2]

(ii) Determine the new deceleration of the cyclist.

deceleration = ... [1]

(d) Fig. 12.5 shows the hydraulic braking system of the bicycle.

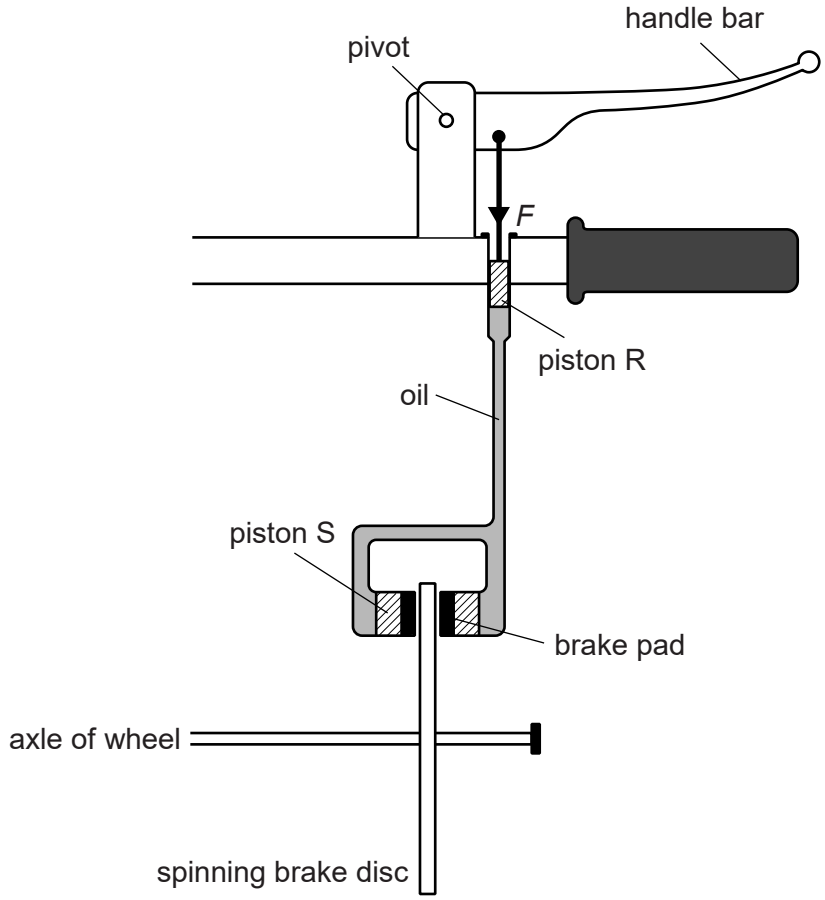


Fig. 12.5 (not to scale)

(i) When the cyclist applies a force *F* on the handle bar, a pressure of 1.2×10^{6} Pa is exerted on piston R. The cross-sectional area of piston R is 5.0×10^{-5} m^2.

Calculate the force *F*.

force *F* = ……. [2]

(ii) The force applied to each brake pad is larger than *F*. Explain why.

……...

……...

…….. [1]

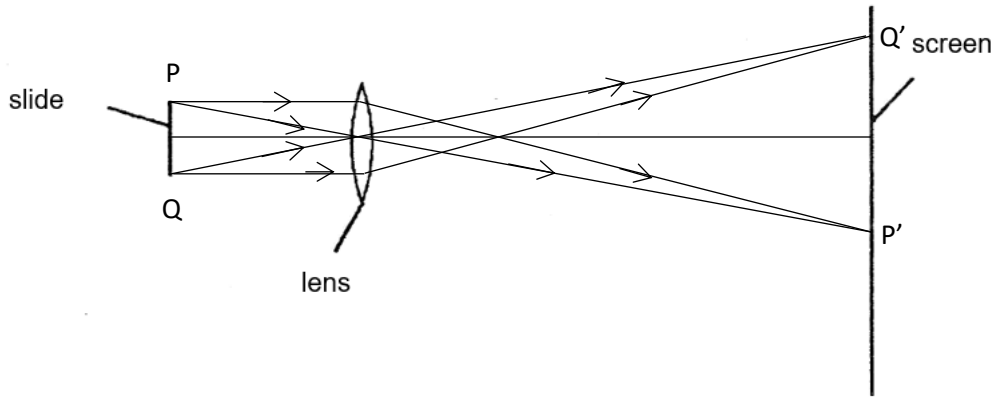
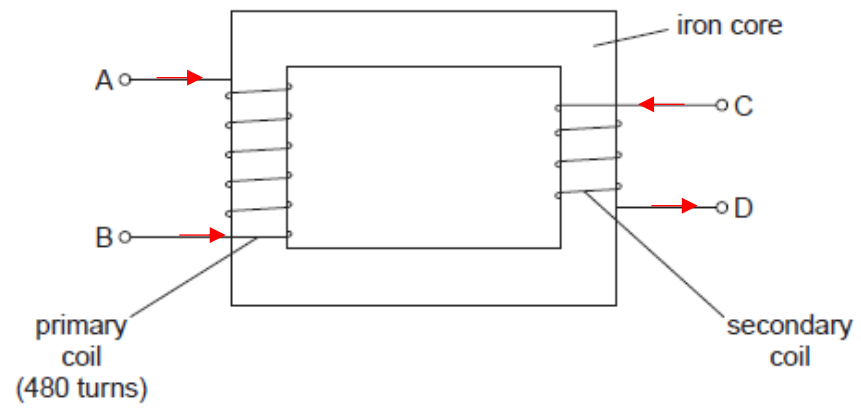
[Total : 10 m]

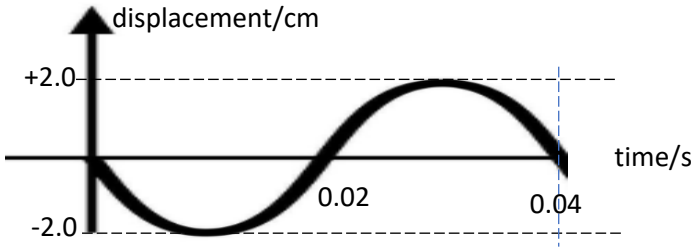
END OF PAPER

2025 PRELIMINARY EXAMINATION
SUGGESTED ANSWER SCHEME

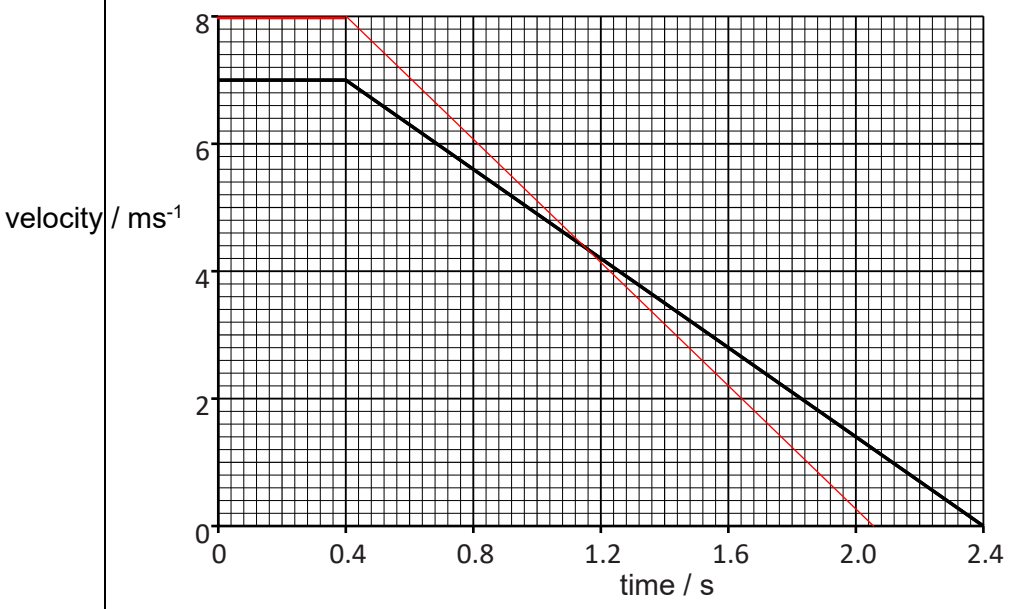
PAPER 2 SECTION A (50 marks)

Qn	Part	Answer	Remark
1	(a)(i)	1. Loss of GPE = 92 kg x 10 N/kg x 1500 m = 1380000 J = 1.4 x 10^6 J (2 s.f.)	
		2. Kinetic energy = ½ (92kg)(52 m/s)^2 = 124384 J = 1.2 x 10^5 J	
	(ii)	Some energy in the gravitational potential store is transferred to the internal store of the surroundings due to air resistance.	
	(b)(i)	The air resistance is increasing	
	(ii)	W = mg = 92 kg x 10N/kg = 920 N	
2	(a)(i)	▪ Block moves with uniform acceleration. ▪ Resultant force of 0.6 N acting to the right.	
	(ii)	▪ Block moves at **constant velocity**/same speed same direction ▪ Force X = total resistive force. **Zero <u>resultant force</u>** acting on the block.	
	(b)	Power = Force x velocity 2.0 W = 0.80 N x *v* v = 2.5 ms^{-1} Distance = 2.5 ms^{-1} x 3.0 s = 7.5 m	
	(c)	During the first three seconds, the power delivered is not constant since the velocity is changing while in (b), the velocity is constant and the power delivered is constant.	
3	(a)	1 Frictional force acting at the rod 2 Normal (Reaction) Force acted on card by rod	
	(b)	Since the direction and magnitudes of the two forces In (b) are different/ are of different nature/acting on the same body they do not satisfy the conditions for action-reaction pair.	
4	(a)	▪ The uneven bombardment on all sides by air particles ▪ The random/ erratic and continuous movement is caused by to the resultant force on the smoke particle at any position	
	(b)(i)	The number of erratic paths compared to that at the lower temperature will be more	
	(ii)	▪ Air particles impacted the smoke particles at higher velocities. The frequency of collisions also increased. ▪ The greater force of impact and frequent collisions resulted in more frequent change in direction of the particle in shorter intervals compared to that at lower temperature, thus explaining the more erratic movement * Reject in increase in pressure / average force per unit area as these leads to pressure of the gas.	
5	(a)(i)	The angle of incidence in the glass block has exceeded critical angle of glass.	
	(ii)	When the critical angle is reached, the beam is at B. Using trigonometry, Critical angle, c = 90° - $tan^{-1}(\frac{1.68}{1.50})$ = 90° – 48.2° = 41.8° Refractive index = $\frac{1}{\sin c}$ = $\frac{1}{\sin 41.8^o}$ = 1.50	
	(iii)	Higher refractive index→smaller critical angle. Hence AB will be shorter.	

Qn	Part	Answer	Remark
	(b)(i)		
	(ii)	To enable the formation of an upright image on the screen/to give an image that is right side up.	
6	(a)	From $I = \frac{V}{R}$ $= \frac{3.6\ V}{5800\Omega}$ $= 6.2 \times 10^{-4}$ A	
	(b)	From $R = V/I$ $3400\Omega + R_{thermistor} = 6.0\ V/6.2 \times 10^{-4}$ A $R_{thermistor} = 6277\ \Omega$ $= 6.3 \times 10^{3}\ \Omega$ (2 s.f.)	
	(c)(i)	Temperature decreases	
	(ii)	Current decreases	
	(iii)	Potential difference increases	
7	(a)	Random - cannot predict when a radioactive nucleus will emit radiation and in which direction/time between emissions is unpredictable/emission can occur at any time in any direction	
	(b)(i)	Atoms of the same element that have the same number of protons but different number of neutrons	
	(ii)	$a = 1$; $b = 0$; $x = 56$; $y = 92$	3 correct 1 m
	(iii)	Proton number = 90 ; Nucleon number = 235	
8	(a)	South/ S-pole	
	(b)(i)	Anticlockwise (1st minute)	
	(ii)	The coil will now rotate clockwise. In the 2nd minute, F is negative. Current now flows from S to R and from Q to P. The forces acting on both arms are now reversed	
	(iii)	The force acting on each arm of the coil is a constant.	
	(iv)	The coil will rotate continuously in one direction since the forces acting on each arm changes direction every half-cycle of rotation / one minute	
9	(a)(i)	From $\frac{V_s}{V_p} = \frac{N_s}{N_p}$ $\Rightarrow \quad N_s = \frac{6V}{240V} \times 480$ $= 12$	
	(ii)		

Qn	Part	Answer	Remark
	(iii)	From $P_{primary} = P_{secondary}$ $I_{primary} = \frac{440\ V\ x\ 200\ A}{11000\ V}$ = 8.0 A	
	(b)(i)	rate of change of flux linkage/changing flux linkage *reject answer with no mention of rate of change/ changing magnetic field.	
	(ii)	▪ Increasing rate of change of flux linkage when pushed down →increased reading ▪ Magnet stop moving → Magnetic field stationary*→no change in flux linkage→hence no induced e.m.f. *reject magnetic field not changing	
10	(a)(i)	**EITHER** ▪ Compression – higher pressure region ; rarefaction – lower pressure region **OR** ▪ Compression – higher particle density ; rarefaction – lower particle density	
	(ii)	1. Wavelength is the distance between any compressions 2. The number of oscillations a layer of air made in one second/number of compressions that passes a point in one second	
	(b(i)	Low temperature→particles closer→smaller compressions → $\lambda\downarrow$, $v\ (= f\ \lambda) \downarrow$	
	(ii)	Heavier molecule→bigger inertia to move/more slower→ less displacement→smaller compressions → $\lambda\downarrow$, $v\ (= f\ \lambda) \downarrow$	
	(c)(i)	Frequency = 1/0.04 s = 25 Hz	
	(ii)	Wavelength = 16 cm	
	(iii)	$v = f\ \lambda$ = 25 Hz x 16 cm = 400 cms^{-1}	
	(iv)		

SECTION B(10 m)

Qn	Part	Answer	Remark
11	EITHER		
	(a)(i)	The product of the force with the perpendicular distance measured from the line of action of the force to the pivot or axis about which moment is taken	
	(a)(ii)	Moment of F = 8200 N $\times$ 0.050 m = 410 Nm clockwise	
	(a)(iii)	As the crankshaft rotates through a small angle, the perpendicular distance from the line of action for the force to the axis of rotation is reduced. This causes the moment of F to decrease.	
	(b)(i)	$(P_{gas} - P_{atm}) \times 0.0067\ m^2 = 8200\ N$ $\Rightarrow$ $P_{gas} = 1.0 \times 10^5\ Nm^{-2} + 8200\ N / 0.0067\ m^2$ $= 1.3 \times 10^6\ Nm^{-2}$	
	(b)(ii)	There is work done against friction between the moving piston and walls of the cylinder. This resulted in a bigger opposing force, resulting in a bigger pressure.	
	(c)	▪ Number of particles per unit volume decreases with expansion, resulting in decrease in the frequency of collisions with the inner walls of the cylinder ▪ Average force per unit area decreases, resulting in a drop in pressure of the gas. The downward F therefore decreases	
	(d)	▪ molecules move faster at higher temperatures/kinetic energy increases ▪ molecules collide harder and more frequently (with walls) resulting in increase in the average force of collision with per unit area of the inner walls. Higher pressure results.	
12	OR		
	(a)(i)	The total resistive force acting in the direction opposite to his motion is equal to his applied force. He does not undergo any acceleration as the resultant force is zero.	
	(ii)	When the centre of gravity is not in the same straight line as the point of wheel contact with the ground, the weight of the cyclist will produce a clockwise or anticlockwise moment, thus toppling him.	
	(b)	Overall stopping distance = Area under-v-t graph = ½ (7.0 m/s)(0.4s + 2.4 s) = 9.8 m	
	(c)(i)	Horizontal line at 8.0 m/s; Slope line meeting t-axis at 2.05 s  	
	(c)(ii)	Deceleration = (8/1.65) ms^{-2} = 4.8 ms^{-2} (2 s.f.)	
	(d)(i)	F = 1.2 x $10^6\ Nm^{-2}$ x 5.0 x $10^{-5}\ m^2$ = 60 N	

Qn	Part	Answer	Remark
	(d)(ii)	Piston S on either side has a larger cross sectional area compared to Piston R. Since is same pressure is transmitted through the oil, the same pressure multiplied by a bigger cross-sectional area will produce a bigger force at S.	

SINGAPORE CHINESE GIRLS' SCHOOL
PRELIMINARY EXAMINATION
SECONDARY FOUR

CANDIDATE NAME					
CLASS	4			REGISTER NUMBER	

PHYSICS 6091/03

Paper 3 **30 July 2025**

1 hour 50 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, register number and class on all the work you hand in.
Give details of the practical shift and laboratory in the boxes provided.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction tape.

Answer **all** questions in the spaces provided on the Question Paper: scrap paper must not be used. Graph paper is provided in this Question Paper.

You will be allowed to work with the apparatus for a maximum of 55 minutes for each section.

You are expected to record all your observations as soon as they are made.
The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the practical, fasten all your work securely together.

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

Shift
Laboratory

For Examiner's Use	
1	/ 10
2	/ 10
3	/ 20
Total	/ 40

This question paper consists of **17** printed pages and **3** blank pages.

BLANK PAGE

1 *In this experiment, you will investigate the force needed to pull a cylinder up a step.*

You are provided with:

- a half-metre rule
- a digital caliper
- a newton meter
- two 100 g slotted masses
- a loop of thread

(a) Measure and record the thickness *h* of the half-metre rule, as shown in Fig. 1.1.

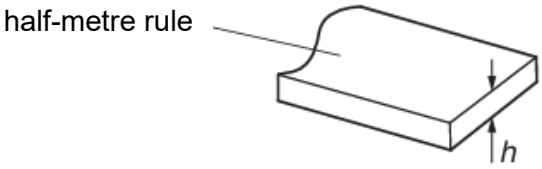


Fig. 1.1

h = ... [1]

(b) **(i)** Suspend the two slotted masses from the newton meter using the loop of thread as shown in Fig. 1.2.

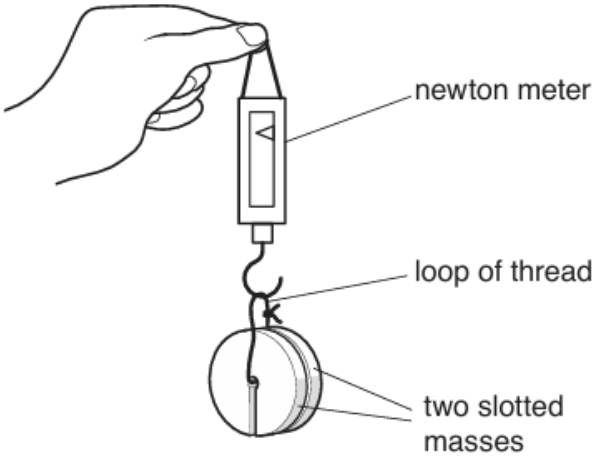


Fig. 1.2

(ii) Measure and record the total weight *W* of these masses.

W = ... [1]

(c) Measure and record the diameter *d* of one of the slotted masses. Determine the radius *r* of this slotted mass.

d = ...

r = ... [1]

(d) **(i)** Place the half-metre rule on the bench. Stand two slotted masses on their edges next to one end of the rule, with their slots at the top, as shown in Fig. 1.3. Attach the loop of thread to the masses and the newton meter, as shown in Fig. 1.3.

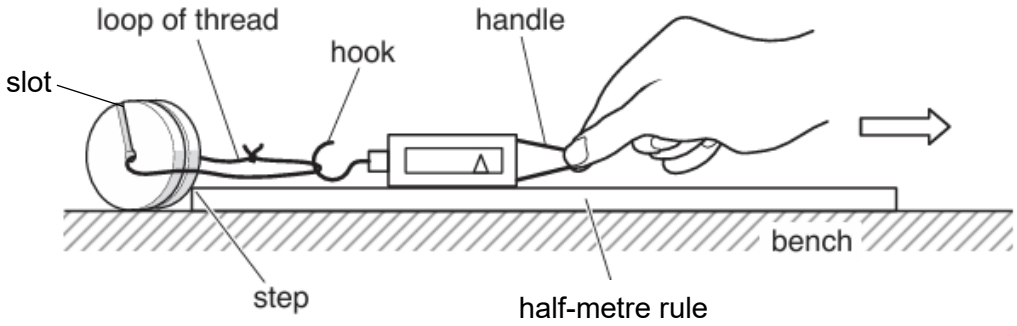


Fig. 1.3

Pull the handle of the newton meter horizontally and at right angles to the step. The force required to just start the slotted masses rolling up the step is *F*. Measure and record *F*.

F = ... [1]

(ii) Determine the angle α, given by

$$\sin\alpha = \frac{(r-h)}{r}$$

α = ... [1]

Plan

It is suggested that F, W and α are related by the equation

$$F = \frac{kW}{\tan \alpha}$$

where k is a constant.

You are to plan an experiment to investigate the above relationship.

You can also use other apparatus and materials that are usually available in a school laboratory.

Your plan should include:

- the independent and dependent variables,
- the quantities that you will be keeping constant in the investigation,
- a detailed description of how you will perform the investigation,
- an indication of how you will achieve accurate results,
- explanation on how to use the readings to reach the conclusion.

A diagram is not required but you may draw one if it helps in your explanation.

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……..[5]

[Total : 10 m]

2 *In this experiment, you will determine the focal length of a semicircular block using two methods.*

You are provided with

- a transparent semicircular block
- a protractor
- a half-metre rule
- a digital caliper
- a piece of paper labelled P
- a corkboard
- 3 optical pins

METHOD 1

(a) Take measurements to determine the radius of curvature *R* of the curved surface, as shown in Fig. 2.1.

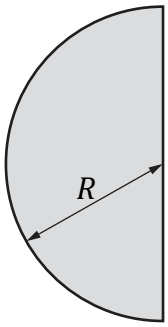


Fig. 2.1

R = ... [1]

(b) **(i)** A piece of paper labelled P, with four parallel lines drawn on it, is provided.

Measure and record lengths *A* and *B*.

A = ...

B = ...

Calculate *E* using $E = \frac{B}{A}$

E = ... [1]

(ii) Arrange the apparatus as shown in Fig. 2.2.

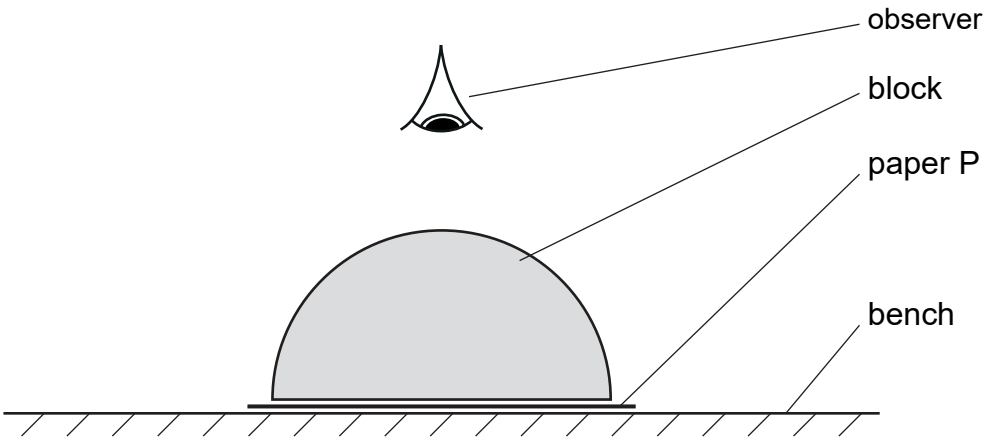


Fig. 2.2

Look down through the block and close one eye. The appearance of the lines should be similar to Fig. 2.3.

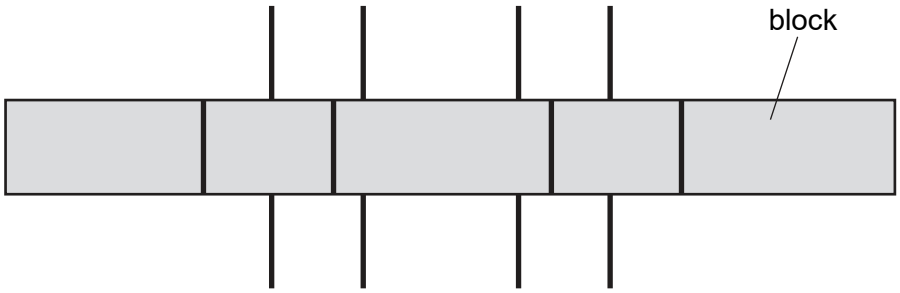


Fig. 2.3

Gradually raise the block until the two central lines seen through the block are aligned with the two outer lines seen outside the block, as shown in Fig. 2.4.

You may have to move your head sideways to see this alignment.

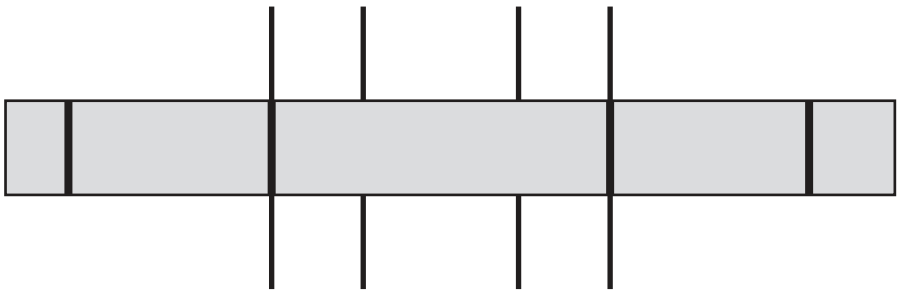


Fig. 2.4

With the block in this position, measure and record the height d_1 of the block above the paper, as shown in Fig. 2.5.

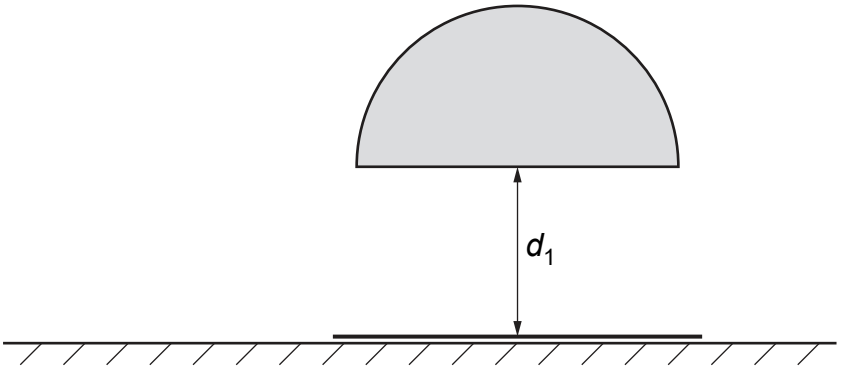


Fig. 2.5

d_1 = ... cm [1]

(iii) Turn the block over and place the curved face onto the paper. Look down through the block with one eye. Gradually raise the block until the two central lines seen through the block are aligned with the two outer lines seen outside the block.

Measure and record the height d_2 of the block above the paper, as shown in Fig. 2.6.

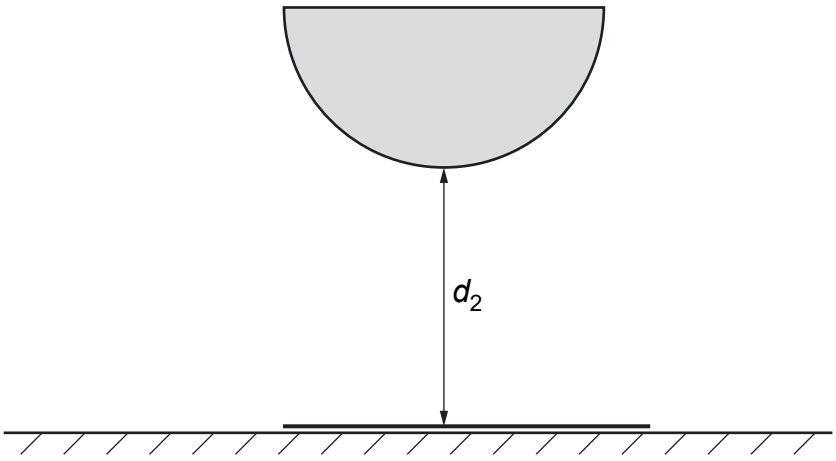


Fig. 2.6

d_2 = ... cm [1]

(c) It is suggested that the relationship between R, d_1 and d_2 is

$$2k = R + d_1 - d_2$$

where k is a constant.

Using your data, calculate k. Give the appropriate unit.

k = ... [1]

(d) The focal length f of the block is given by

$$f = \frac{E(d_2 + k)}{(E - 1)}$$

Calculate the value of f. Give the appropriate unit.

f = ... [1]

METHOD 2

(e) **(i)** You are given an A4 paper with two lines labelled **AB** and **CD** (refer to page 13). Place the semicircular block on **AB** such that the centre of the block coincides with the point **O,** as shown in Fig 2.7. Trace the outline of the block on the paper.

(ii) Draw a line **OM** from **O** to the circumference of the block such that the angle made by this line with **AB**, θ, is 60°.

(iii) By placing two pins **P1** and **P2** on the line **OM**, view the two pins through the straight edge of the glass block. Shift your line of vision slowly until a position is reached when the two pins appear in a straight line.

(iv) Using a third pin **P3**, locate and mark this position on the paper.

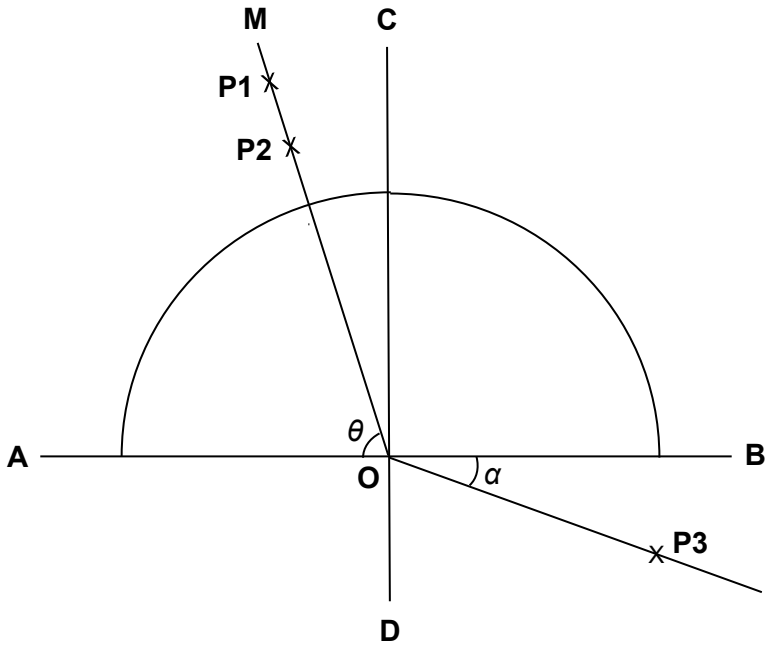


Fig. 2.7 (not to scale)

(v) Draw a line joining **P3** to **O**. Measure and record α, the angle made by this line with the line **AB**, as shown in Fig. 2.7.

α = ... [1]

(f) The refractive index of the glass block, n_{glass}, is given by the equation

$$n_{glass} = \frac{\cos \alpha}{\cos \theta}$$

Determine the refractive index of the glass.

n_{glass} = ... [1]

(g) It was theorised that the focal length, *f*, of the semicircular glass block is given by

$$\frac{1}{f} = (n_{\text{glass}} - 1)\left(\frac{1}{R}\right)$$

Calculate the focal length *f* of the semicircular glass block.

f = …… [1]

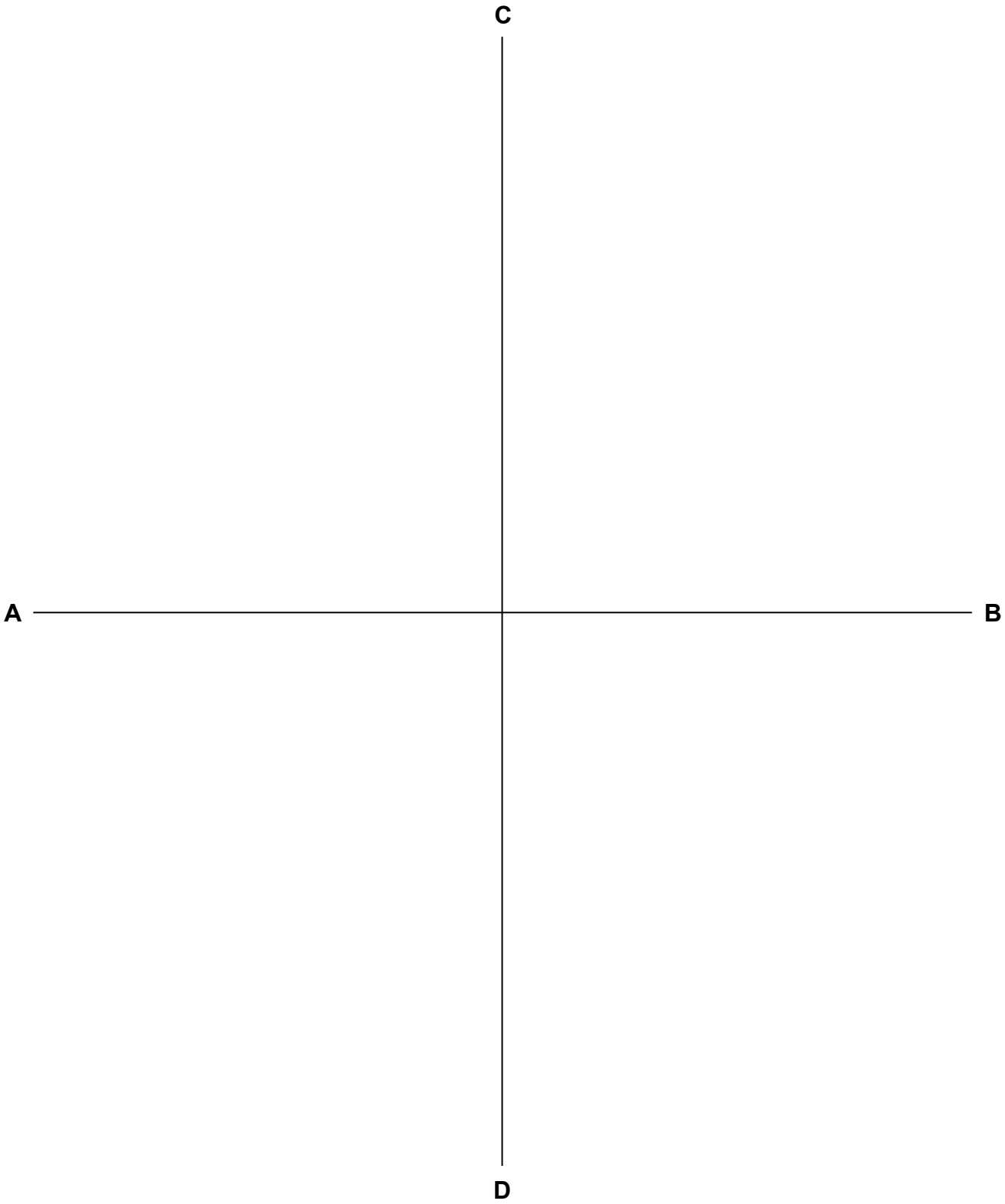
(h) Describe one improvement that could be made to the two methods. You may suggest the use of other apparatus or different procedures.

……

……

……[1]

[Total : 10 m]


C
A
B
D

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3 *In this experiment, you will investigate an electrical circuit.*

You are provided with

- a power supply
- a switch
- an unknown resistor Y
- a wire mounted on a wooden board with a metre rule
- connecting leads
- a voltmeter
- an ammeter

(a) Measure and record *E*, the electromotive force (e.m.f.) of the power supply.

E = ... [1]

(b) Set up the circuit as shown in Fig. 3.1.

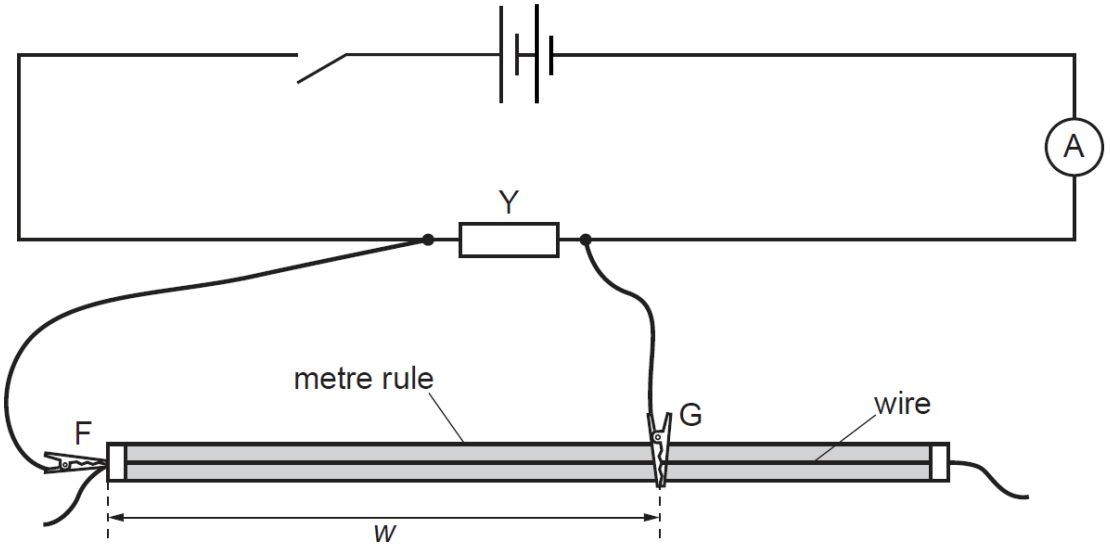

Fig. 3.1

The distance between F and G, *w*, is approximately 70 cm.

Close the switch. Measure and record the value of *w* and the ammeter reading I_1. Open the switch.

w = ...

I_1 = ... [1]

(c) Using values of *w* greater than 50 cm, vary *w* until you have six sets of readings of *w* and I_1. These readings will be tabulated in **(f)**.

(d) Set up the circuit shown in Fig. 3.2.

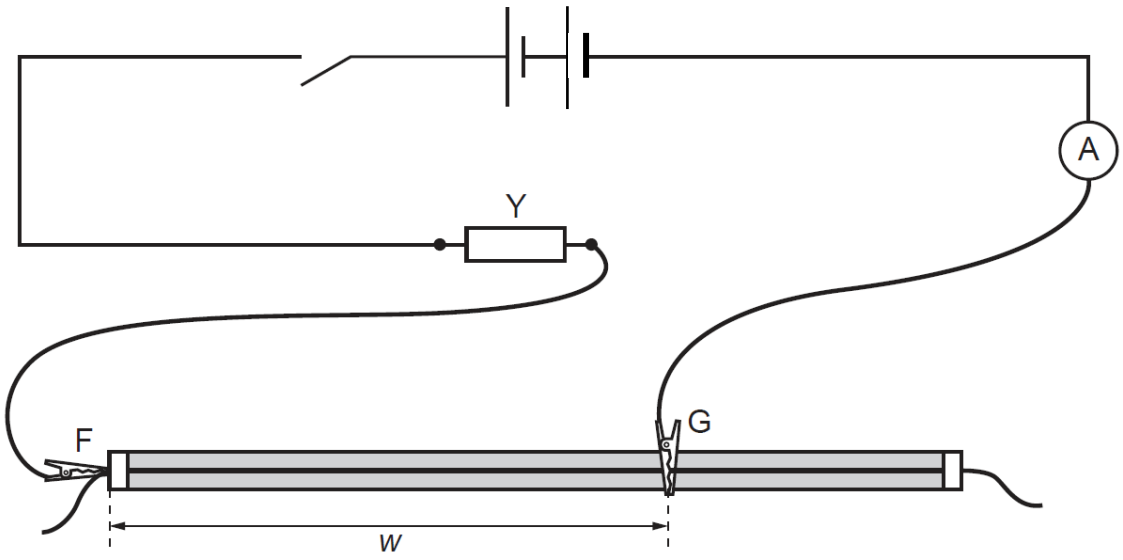

Fig. 3.2

(e) Close the switch. Measure and record the ammeter reading I_2. Open the switch.

I_2 = ... [1]

(f) Repeat **(e)**, using the **same** values of w in **(b)** and **(c)**, to obtain six corresponding readings of I_2. Tabulate all readings of w, I_1 and I_2. Include in your table I_1I_2 and $\frac{1}{w}$. [4]

(g) Using the grid provided on **page 17**, plot a graph of I_1I_2 against $\frac{1}{w}$. [4]

(h) Determine the gradient of your line of best fit.

Gradient = …… [2]

(i) The resistance of resistor Y, R_Y, can be determined using an alternative circuit.

1. Draw a suitable circuit diagram that can be used to determine R_Y. [1]

2. Set up the circuit as shown in your diagram. Measure and record all the necessary readings required to determine R_Y. [2]

3. Using the recorded readings, calculate the value of R_Y.

R_Y = …… [2]

(j) State one key source of error and indicate how it affects the accuracy of the readings.

……

……[1]

(k) A student theorised that the general equation for the experiment can be written as

$$I_1 I_2 = \frac{E^2}{R_Y}\left(\frac{1}{R_V}\right)$$ where R_V is a variable resistor.

He further suggested that the equation is valid for a light-dependent resistor (LDR) and a thermistor. Comment on the validity of this proposed theory.

……

……

……

……[1]

[Total : 20 m]

END OF PAPER

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1 *To investigate the force needed to pull a cylinder up a step.*

Qn	Marking criteria	Mark	Remark
1(a)	Evidence that more than one measurement is made **and** average calculated. Correct d.p. of measured/average value*	**1**	No mark awarded if **BOTH** criteria are not evident Mark awarded for correct d.p and with correct unit
1(b)(ii)	Correct d.p. of measured value.	**1**	
1(c)	Evidence that more than one measurement is made **and** average calculated Radius *r* determined	**1**	No mark awarded if **BOTH** criteria are not evident Working optional
1(d)(i)	Correct d.p. of measured value.	**1**	
1(d)(ii)	Angle α calculated. Working shown.	**1**	
PLAN	▪ Independent, dependent variable ▪ one measurable controlled variable given ▪ Detail instructions on how the experiment is carried out to investigate relationship including instructions of how accurate results are achieved and instructions on tabulation and graph to be sketched. ▪ Explanation on how to reach conclusion from sketched graph.	**1** **1** **2** **1**	Award mark for only for all three correct variables given
	Total	**10**	

***all readings are expected to have the correct unit**

Independent variable: mass, *m*
Dependent variable: applied force, *F*
Controlled variable: Height of string loop above the benchtop; loop parallel to ½ metre rule; newton meter parallel to benchtop.

Procedure

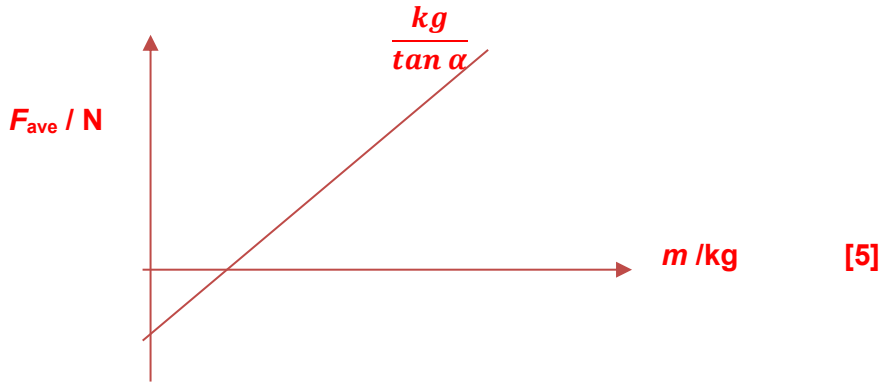
1. **Measure the mass each of the circular weight using the digital balance. Record the reading as *m*.**
2. **Take corresponding measurements for the diameter of the circular weight. Determine its radius *r*.**
3. **Measure the height *h* of the ½ metre rule using a vernier caliper. Determine the average height, h_{ave}.**
4. **Set up the experiment as shown in Fig. 1.3**
5. **Pull the mass and ensure that the string is taut.**
6. **Measure the height of the string loop above the bench top. This height is to be measured and remain constant for every repeated measurement of the applied force.**
7. **View the string loop and the newton meter from the top. Ensure that both are aligned parallel to the benchtop.**
8. **Increase the applied force slowly until the mass is just about to roll up the edge of the ruler. Note the newton meter reading, *F*.**
9. **Repeat 4 to 8 to obtain another reading for *F*. Determine the average force applied, F_{ave}.**
10. **Repeat steps (6) and (7) to obtain five other values of F_{ave} .**
11. **Tabulate all readings. Convert the mass to kg. Include**

Reading	*m*/kg	F_1/N	F_2/N	F_{ave}/N
1				
2				
3				
4				
5				

12. **Plot a graph of F_{ave} against *m*.**
13. **Determine the gradient of the graph.**
14. **The equation is re-written as**

$$F = \frac{kmg}{\tan \alpha}$$ **where *g* = 10 N/kg is the acceleration due to gravity**

15. **A graph of F_{ave} against *m* is expected to yield a straight line passing through the origin with gradient.**



[5]

2 *In this experiment you will determine the focal length of a semicircular block using two methods.*

Qn	Marking criteria	Mark	Remark
METHOD 1			
2(a)	*R* measured to correct d.p.	**1**	either ruler or digital caliper is used
2(b)(i)	*A* and *B* measured to correct d.p. *E* = *B/A* calculated to correct s.f.	**1**	
2(b)(ii)	d_1 measured to correct d.p.	**1**	
2(b)(iii)	d_2 measured to correct d.p.	**1**	
2(c)	*k* determined to correct d.p.	**1**	d.p. determined by instrument used.
2(d)	*f* calculated to correct s.f.	**1**	
METHOD 2			
2(e)(v)	α recorded to correct 1°	**1**	
2(f)	n_{glass} calculated to correct sig.fig. Working shown	**1**	
2(g)	*f* calculated to correct sig.fig. Working shown	**1**	
2(h)	One improvement suggested	**1**	
	Total	**10**	

***all readings are expected to have the correct unit**

3 *In this experiment you will investigate an electrical circuit.*

Qn	Marking criteria	Mark	Remark
3(a)	E recorded to correct d.p.	**1**	
3(b)	w and l_1 recorded to correct d.p.	**1**	
3(e)	l_2 recorded to correct d.p.	**1**	
3(f)	▪ Table with quantities recorded using solidus notation with correct unit in headings ▪ 5 sets of readings of I_1, I_2 and w recorded ▪ $I_1\, I_2$ and $\frac{1}{w}$ calculated to correct sig.fig. ▪ Good range recorded (98 cm > w > 40 cm)	**1** **1** **1** **1**	e.c.f. for d.p.
3(g)	▪ Axes labeled with units and correct orientation (allow ecf from wrong unit in table). (A) ▪ Suitable scale; graph occupying ½ of graph paper. (S) ▪ All points plotted correctly. (P) ▪ Best fit line and fine crosses. (L)	**1** **1** **1** **1**	-1 m for incorrect axis labelling
3(h)	▪ Triangle drawn that uses more than half the drawn line ▪ Coordinates (not points plotted) for determining gradient indicated on graph. ▪ Calculation of gradient shown to correct sig.fig. No unit.	**1** **1**	Collective mark. Deduct if one condition not satisfied.
3(i)	1. Correct circuit diagram 2. Record of V and I to correct d.p. 3. Working shown clearly for the determination of R_Y.	**1** **2** **2**	
3(j)	Key source of error • The crocodile clip G is not clipped to the actual reading due to the large area of contact with the wire and this affects the accuracy of the value of w. • There may exist kinks in the wire and this affects the current flowing through the wire.	**1**	

Qn	Marking criteria	Mark	Remark
(k)	▪ The equation is not valid for LDR and thermistors because the resistance of the resistors listed varies non-linearly with corresponding changes in environmental conditions e.g. light intensity, temperature. The graph of I_1I_2 against R_V will not be linear. ▪ The resistance of a wire is directly proportional to its length. The resistance of a thermistor is not directly proportional to its length. Hence graph of I_1I_2 against R_V will not be linear. ▪ The proposed theory will be valid (subject to further investigation) for the two variable resistors mentioned if the axes are changed to $lg(I_1I_2)\ [y\ axis]\ and\ \ lgS$ [x-axis]*	**1**	$*\ R_V = \frac{K}{S^n}$ (a generalised inverse function to the power *n*) where *K* is a constant, *S* is the environmental conditions (temperature, light intensity) The equation $I_1I_2 = \frac{E^2}{R_Y}\left(\frac{1}{R_V}\right)$ can be linearized to $lg(I_1I_2) = 2\lg E - lgR_Y + lgK - nlgS$ *y = c + mc*
	Total	**20**	