



Please write clearly in block capitals.

Centre Number

Candidate Number

Surname

Forename(s)

Candidate signature

GCSE PHYSICS

Predicted Paper (based on AQA)

Higher Tier Paper 2

Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- a ruler
- a scientific calculator
- a protractor
- the Physics Equations Sheet (enclosed).

Instructions

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- In all calculations, show clearly how you work out your answer.

Information

- The maximum mark for this paper is 100.
- The marks for the questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	



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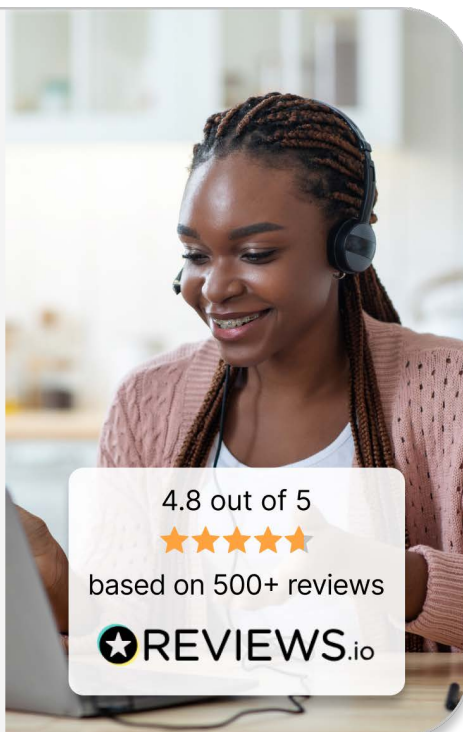
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A student is investigating the effect of a magnetic field on a current-carrying wire.

Figure 1 shows a hand used to apply Fleming's Left Hand Rule, which helps determine the direction of force acting on the wire.

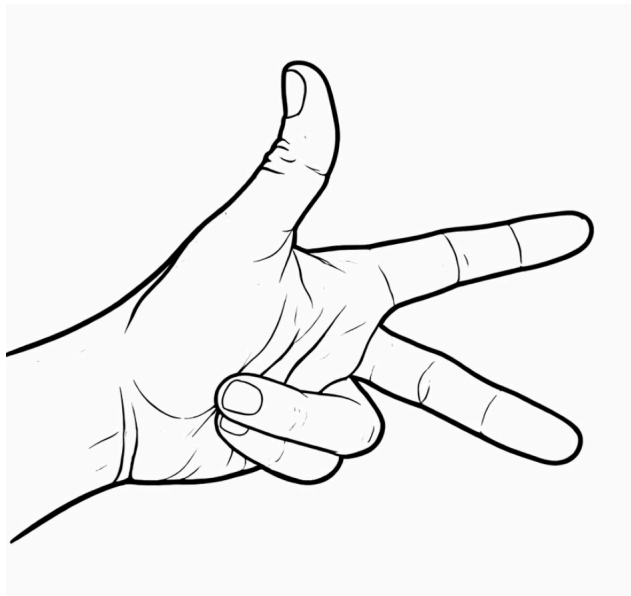


Figure 1

1.1

Explain what each finger represents in **Figure 1**.

[3 marks]

The thumb represents the direction of the force on the wire, ⁽¹⁾ the first finger represents the direction of the magnetic field, ⁽¹⁾ and the second finger represents the direction of conventional current. ⁽¹⁾

Question 1 continues on the next page



1.2 Define the term *magnetic flux density*.

[2 marks]

The Strength of the magnetic field ^① per unit
Current per unit length of wire. ^①
USE $F = BIl \Rightarrow B = \frac{F}{Il}$ \rightarrow greater force
means greater
field strength

1.3 The student moves a straight wire through the magnetic field.

State what is meant by the term *electromagnetic induction*.

[2 marks]

Electromagnetic induction is the production of
a potential difference ^① when a conductor is
moved through a magnetic field. ^①

Question 1 continues on the next page



1.4

Figure 2 shows parts of a moving-coil microphone.

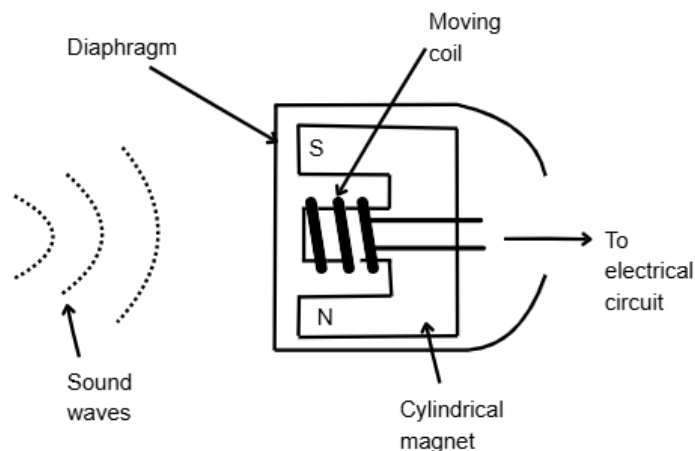


Figure 2

Try to use labels
from the figure
in the answer

Explain how a moving-coil microphone works.

[4 marks]

When sound waves reach the microphone, they cause the diaphragm to vibrate. (1)
 This in turn causes the moving coil to vibrate. (1) This means that the coil moves relative to the magnetic field lines. (1) When this happens, a potential difference is induced in the electrical circuit. (1)



A student is investigating the interaction between two bar magnets.

The magnets are placed close together as shown in **Figure 3**.

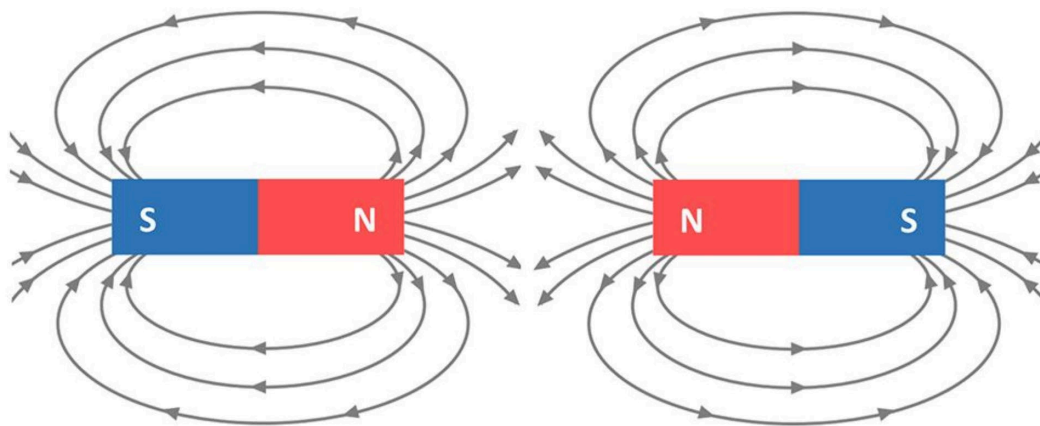


Figure 3

2.1

Name the force that acts between the two magnets in **Figure 3** and describe its effect.

[2 marks]

A magnetic force ^① acts between the two magnets and it causes them to repel each other. ^①

2.2

A bar magnet is cut in half.

Describe what happens to the magnetic poles of each half.

[2 marks]

Each half will become its own magnet ^①
each with a North and South pole. ^①

Question 2 continues on the next page



2.3

A student has three metal blocks.

- One is a permanent magnet. → repelled or attracted by another magnet
- One is made of aluminium. → non-magnetic
- One is made of iron. → induced magnet.

Describe how another permanent magnet can be used to identify the blocks.

[3 marks]

The permanent magnet will have no effect on the aluminium. ① The iron will be attracted to the permanent magnet, regardless of the orientation of the blocks. The permanent magnet can be repelled ① by the other permanent magnet, when they are held together in certain orientations.

2.4

Describe the magnetic field pattern both inside and outside of a solenoid when a current is flowing.

[4 marks]

Inside the solenoid, the magnetic field lines are parallel to each other. ① Outside of the solenoid, the field lines form complete loops. ① The magnetic fields from the individual loops add together, ① creating a North pole and a South pole at the ends of the solenoid. ①



2.5

A straight wire has a length of 20 cm. It is placed in a uniform magnetic field with a current of 1.5 A flowing through it.

The wire is at right angles to the magnetic field. The wire experiences a force of 0.045 N.

Calculate the magnetic flux density.

Include appropriate unit in your answer.

[4 marks]

$$F = BIl$$

$$l = 20 \text{ cm} = 0.2 \text{ m} \quad \textcircled{1} \quad \text{To convert from cm to m, divide by 100}$$

$$0.045 = B \times 1.5 \times 0.2 \quad \textcircled{1}$$

$$\frac{0.045}{1.5 \times 0.2} = B$$

$$0.15 \text{ T} = B$$

magnetic flux density = 0.15 $\textcircled{1}$ unit T $\textcircled{1}$





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3.1

An astronomer is giving a talk about how stars form and eventually die.

They explain that stars begin as clouds of gas and dust and change over billions of years depending on their size.

Describe the life cycle of a star that has a similar size to the Sun from its formation to its final stage.

[6 marks]

The star begins as a nebula, a cloud of gas and dust. As the matter gravitationally attracts more material, it condenses and collapses into a protostar. The temperature and pressure increase until nuclear fusion of hydrogen begins to happen in the core. The outward pressure due to fusion is balanced by the inward gravitational forces, so the star is in equilibrium and described as main sequence. Eventually, the hydrogen runs out and fusion of larger elements starts to happen. This makes the outward pressure from fusion larger and the star expands to a red giant. When the red giant later loses its outer layers, the core remains as a white dwarf. After a long time, this white dwarf cools down to become a black dwarf. ⑥

This is a levels question. This is level 3 as the ideas are listed in order with key terminology and brief explanations of key processes. Question 3 continues on the next page



3.2

An artificial satellite is in a stable **circular orbit** around the Earth.

The satellite is moving at a constant speed.

Explain why the satellite is **accelerating** even though it is travelling with a **constant speed**.

[3 marks]

In a circular orbit, the satellite is constantly changing direction. ^① This means its velocity is changing as velocity is a vector quantity, with size and direction. ^① This means the satellite is accelerating since acceleration is the rate of change of velocity. ^①

3.3

The Big Bang Theory is one idea on how the universe began.

Red-shift and Cosmic Microwave Background (CMB) Radiation both act as evidence for the Big Bang Theory.

Describe what is meant by the term *red-shift*.

[3 marks]

When galaxies are moving away from us, ^① we see the light from their stars shifted towards the red end of the spectrum. ^① This is because the wavelengths have been stretched and ^① \therefore increased.

Question 3 continues on the next page



3.4

Explain how the presence of CMB radiation provides evidence for the Big Bang Theory.

[2 marks]

The CMB radiation is the remnants of energy that was released during the Big Bang's initial explosion.

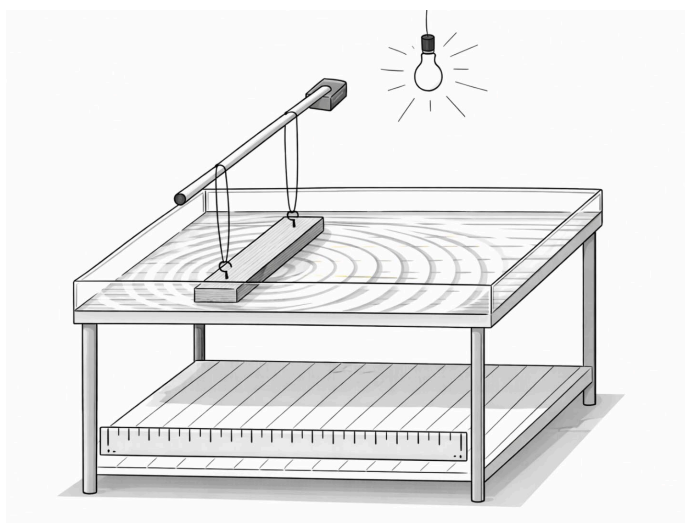


A student performs an experiment to investigate the properties of waves.

A shallow ripple tank is filled with water to a depth of 5 mm.

A wooden rod attached to a motor vibrates on the water surface, producing straight wavefronts.

A lamp above the tank projects the wave pattern onto a white paper beneath the tank, making the wavefronts visible.



n h i
 3 wavefronts |
 ↳ 2 waves
 The number of waves is one less than the wavefronts

4.1

The distance across 8 wavefronts is measured as 140 mm.

The time taken for 25 waves to pass a single point is 500 ms.

Calculate the speed of the wave.

[5 marks]

8 wavefronts means 7 waves are being timed ①

$\lambda = \text{Distance for 7 waves} \div 7$

$140 \text{ mm} = 0.14 \text{ m}$

$\lambda = \frac{0.14}{7} = 0.02 \text{ m}$ ①

$f = 1 \div \text{time period for one wave}$
 $= 1 \div (\text{time for 25 waves} \div 25)$

$500 \text{ ms} = 0.5 \text{ s}$ ①

$f = \frac{1}{0.5 \div 25} = 50 \text{ Hz}$ ①

$v = f \lambda$
 $= 50 \times 0.02$
 $= 1.0$ ①

wave speed = 1.0 ms⁻¹



After completing the experiment, the student notices that the tank has been leaking via a hole in the bottom of the tank.

The student observes that the water leaves the tank much faster when the tank is full compared to when the tank is nearly empty.

4.2

Explain why the pressure in a liquid, like the water in the ripple tank, increases with depth.

[3 marks]

As the depth increases, there is a larger column of liquid above every point. ^① The larger amount of liquid exerts more weight on the particles below, ^① which means the force is larger, and pressure is force per unit area ^①

4.3

The water used to fill the ripple tank was collected from a deep storage tank.

Calculate the total pressure exerted on a sensor located 150 cm below the surface of the water.

Give your answer in Pa.

Density of the water = 1000 kg / m^3

Gravitational field strength = 9.8 N / kg

Atmospheric pressure = $101\,000 \text{ Pa}$

[4 marks]

$$P_{\text{due to water}} = \rho gh$$

$$h = 150 \text{ cm} = 1.5 \text{ m} \quad \textcircled{1}$$

$$P_w = 1000 \times 9.8 \times 1.5 = 14,700 \text{ Pa} \quad \textcircled{1}$$

The atmospheric pressure is also exerted above the tank, so must be added to the pressure due to water.

$$P_{\text{total}} = 101\,000 + 14\,700 \quad \textcircled{1}$$

$$= 115,700 \text{ Pa}$$

$$\text{pressure} = \underline{115,700} \quad \textcircled{1} \text{ Pa}$$



Figure 4 shows a bottle being supported by a wall.

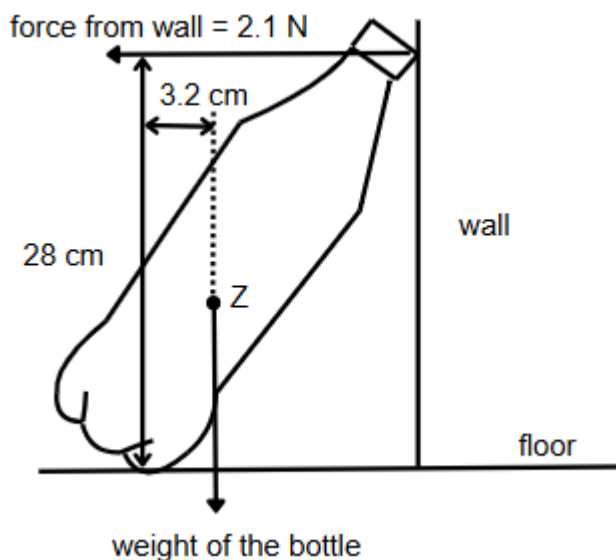


Figure 4

5.1 State the name of Point Z in Figure 4.

[1 mark]

The centre of mass of the bottle. (1)

5.2 Write down the equation which links distance (d), force (F) and moment of a force (M).

[1 mark]

Moment of a force = Force x Distance (1)

Question 5 continues on the next page



5.3 The bottle shown in **Figure 4** is **balanced**.

Calculate the **weight** of the bottle.

[4 marks]

Taking moments about the point where the bottle rests on the floor:

$$\Sigma \text{clockwise moments} = \Sigma \text{anticlockwise moments}$$

$$3.2W = 28 \times 2.1 \quad (1)$$

$$W = \frac{28 \times 2.1}{3.2} = 18.4 \text{ N} \quad (1)$$

You could convert 3.2 and 28 from cm to metres here BUT it's not necessary - the same units are used on both the left and the right so they cancel out.

weight = 18.4 N (1)

A student stands the bottle upright.

A cricket ball is then thrown at the bottle.

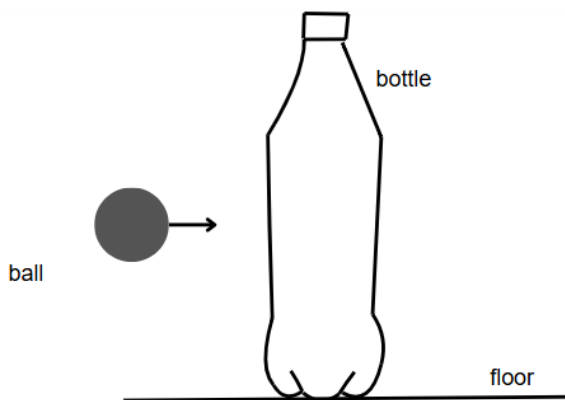


Figure 5

Question 5 continues on the next page



5.4

The ball and the bottle collide and then move forward together.

The mass of the ball is 160 g. = 0.16 kg (1)

The mass of the bottle is 300g. = 0.3 kg (1)

The velocity of the ball before the collision is 38 ms⁻¹.

Calculate the velocity of the bottle and the ball after the collision.

Momentum before = Momentum after [4 marks]

$$0.16 \times 38 = (0.16 + 0.3) v$$

$$6.08 = 0.46 v$$

$$\frac{6.08}{0.46} = v$$

$$13.2 \text{ ms}^{-1} = v$$

velocity = 13.2 ms⁻¹

5.5

The collision lasts for 12 ms. = 0.012 s (1)

Calculate the force on the bottle during the collision.

Use your answer from Question 5.4.

$F = \frac{\text{Change in momentum}}{\text{Time}}$ [3 marks]

Momentum of bottle at end = $mv = 0.3 \times 13.2 = 3.96$

" at start = $mv = 0$ (not moving)

$$\Delta p = 3.96 \text{ kgms}^{-1}$$

$$F = \frac{3.96}{0.012} = 330 \text{ N}$$

force = 330 N



5.6

Cricket players wear protective padding.

Explain how the padding reduces the force exerted on the players when they are hit with cricket balls.

[3 marks]

The padding means that the ball takes a longer time to stop. ^① This decreases the rate of change of momentum, ^① which in turn decreases the resultant force on the player. ^①

Turn over for next question





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A skydiver jumps from a plane.



6.1

The skydiver accelerates downwards. Explain why.

[1 mark]

There is a resultant force acting downwards. ①

6.2

The skydiver stops accelerating and reaches a terminal velocity.

Explain why the skydiver reaches a terminal velocity.

[3 marks]

As the velocity of the skydiver increases, the air resistance increases. ① Eventually, the air resistance becomes equal in size to the weight. ① This means the resultant force on the skydiver is zero, ① meaning no further acceleration.



The skydiver has a mass of 80 kg and is falling with a terminal velocity of 55 ms⁻¹.


They open the parachute as they decelerate. There are 20 identical chords connecting the parachute to the skydiver.

6.3

When the skydiver opens the parachute, the skydiver experiences an initial upward deceleration of 15 ms⁻².

Show that the total upwards force exerted on the skydiver by the parachute is approximately 2000 N.

Use $g = 9.8 \text{ N/kg}$



$$\begin{aligned}
 W &= mg \quad (1) \\
 &= 80 \times 9.8 \\
 &= 784 \text{ N} \quad (1)
 \end{aligned}$$

↗ The resultant force must be upwards as the drag is bigger than the weight.

$$\begin{aligned}
 F &= ma \\
 D - W &= ma \\
 D &= ma + W \\
 &= 80 \times 15 + 784 \\
 &= 1200 + 784 \\
 &= 1984 \text{ N} \quad (1) \\
 &\approx 2000 \text{ N}
 \end{aligned}$$

[5 marks]

6.4

Each individual chord has a spring constant of 3000 N/m.

Assuming the total upward force is shared equally between the 20 chords, calculate the elastic potential energy stored by each chord.

Total force = 1984 N

[4 marks]

Force per chord = $1984 \div 20 = 99.2 \text{ N}$ (1)

$$F = ke$$

$$99.2 = 3000 e$$

$$99.2 = e \quad (1)$$

$$\frac{99.2}{3000}$$

$$0.033 \text{ m} = e \quad (1)$$

$$E_e = \frac{1}{2} ke^2$$

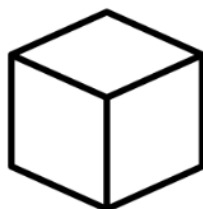
$$= \frac{1}{2} \times 3000 \times (0.033)^2$$

$$= 1.63 \text{ J} \quad (1)$$

elastic potential energy = 1.63 J



A student investigates how the temperature of a metal cube changes when it is placed in direct sunlight.



7.1

All objects emit and absorb infrared radiation.

State **two** factors that affect the intensity and wavelength of the radiation emitted by the cube.

[2 marks]

The temperature of the cube and the colour of the cube.

①

7.2

The cube is painted **matte black**. After 20 minutes in the sun, the temperature of the cube stops increasing.

Explain why the temperature of the cube remains constant, even though it is still absorbing the same amount of radiation.

[2 marks]

As the cube becomes hotter, its rate of emission increases. Eventually, the rate of emission equals the rate of absorption, so there is no net heat flow.



7.3

A second identical cube is painted shiny silver.

Explain why the shiny silver cube reaches a lower constant temperature than the black cube.

[2 marks]

Shiny materials are poor absorbers of heat radiation. ① This means the rate of emission equals the rate of absorption at a lower temperature. ①

7.4

The temperature of the Earth is determined by several factors.

Greenhouse gases in the atmosphere absorb radiation emitted by the Earth's surface.

Explain why an increased amount of greenhouse gases in the atmosphere leads to an increase in global temperature.

[4 marks]

When there are more greenhouse gases, more of the radiation emitted by Earth is absorbed in the atmosphere, rather than escaping into space. ①
Later, this radiation is re-emitted to the Earth from the atmosphere. ① Since more radiation is absorbed in Earth than emitted, the temperature of the Earth will increase ① until the rate of absorption equals the rate of emission again. ①

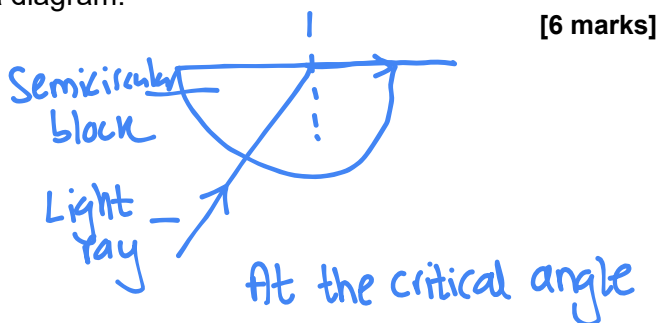
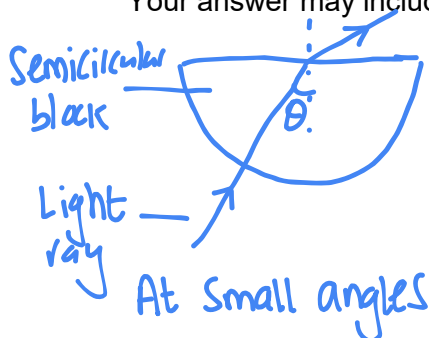


8.1

A student is provided a ray box, a semicircular glass block, a protractor, and other standard laboratory equipment.

Describe a method the student could use to determine the critical angle of the glass.

Your answer may include a diagram.



[6 marks]

Place the Semicircular glass block on a piece of paper and trace its outline and draw the normal to the flat edge. Set up the ray box so that a thin beam of light can enter the block at the curved edge. Start with the labelled angle θ relatively small - this is a small angle of incidence. The ray should refract through the flat face of the block as shown on the left diagram. Slowly increase the angle of incidence, until the refracted ray moves along the block's surface, like the diagram on the right. Trace over the ray using a pencil, then measure the angle of incidence with a protractor. Repeat the process 2 or more times to calculate a mean and detect anomalies. The mean angle θ is the critical angle.

① Level 3 as the experiment would work and it is detailed in order with labelled diagrams.



8.2

The student carried out the method to find the critical angle.

The student noticed that the **beam of light** used was quite wide.

Explain why using a wide beam of light makes the measurement of the critical angle **less accurate**.

[1 mark]

It would be more difficult to judge where the centre of the beam is

①

8.3

State **one hazard** associated with using a ray box for an extended period of time and describe **one** precaution the student could take to reduce this risk.

[2 marks]

A hazard is that the ray box could become very hot. ① To reduce this, the box could be switched off between measurements. ①

END OF QUESTIONS

