AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

# GCSE
# PHYSICS

**H**

Higher Tier Paper 2

Friday 16 June 2023 Morning 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.

| For Examiner's Use | |
|---|---|
| Question | Mark |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| **TOTAL** | |

**Information**
- The maximum mark for this paper is 100.
- The marks for 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.

Answer **all** questions in the spaces provided.

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**0 1** Infrared waves are transverse waves.

**0 1 . 1** Complete the sentence.

**[1 mark]**

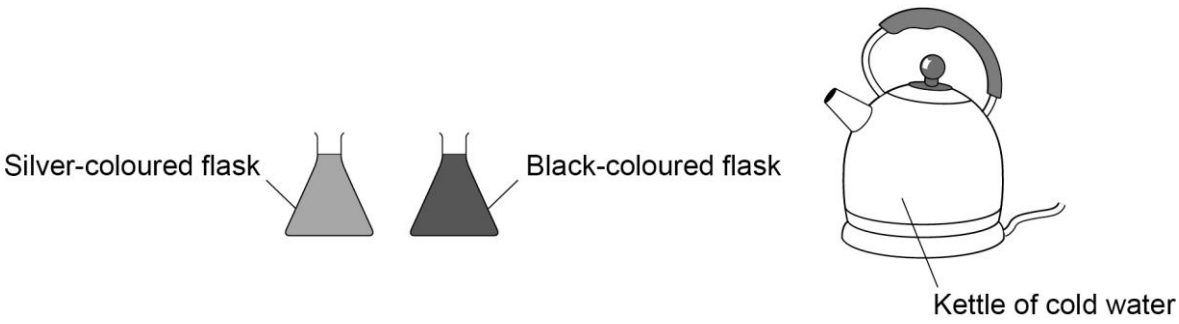
In a transverse wave, the direction of oscillation is perpendicular

to the direction of energy transfer by the wave.

A student investigated how the colour of a surface affects the rate at which the surface emits infrared radiation.

**Figure 1** shows some of the equipment used.

**Figure 1**



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**0 1 . 2** The student wrote the following hypothesis:

'The black-coloured flask will emit more infrared radiation than the silver-coloured flask during 10 minutes of cooling.'

Describe a method to test this hypothesis.

**[6 marks]**

Method:
- heat the water / kettle
- add an equal volume of (hot) water to each flask
- insert a thermometer into each flask
- record the initial temperature from both flasks

**Question 1 continues on the next page**

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**0 1 . 3** When will the flasks emit infrared radiation at the greatest rate?

Give a reason for your answer.

**[2 marks]**

Tick (✓) **one** box.

During the 1st minute ☑

During the 5th minute ☐

During the 9th minute ☐

Reason there is the greatest temperature difference (between the hot water and the surroundings)

*Do not write outside the box*

Another student investigated the absorption of infrared radiation by different surface colours.

The student filled four hollow metal cubes with cold water.

Each cube was the same size but had a different surface colour.

The cubes were then placed the same distance from an infrared heater.

After 10 minutes, the student measured the temperature increase of the water inside each cube.

**0 1 . 4** What was the dependent variable in this investigation?

**[1 mark]**

the temperature (increase /change after 10 minutes)

**0 1 . 5** **Table 1** shows the results.

**Table 1**

| Surface colour of the cube | Temperature increase after 10 minutes in °C |
|---|---|
| Matt white | 3.0 |
| Shiny white | 2.0 |
| Matt black | 6.5 |
| Shiny black | 4.0 |

Give **two** conclusions that can be made from the results in **Table 1**.

**[2 marks]**

1 black surfaces absorb more (infrared than white surfaces)

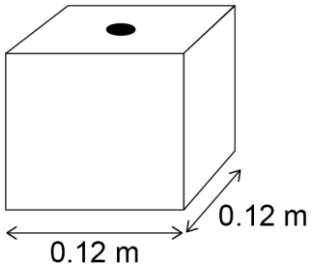
2 matt surfaces absorb more (infrared) than shiny surfaces of the same colour

*Do not write outside the box*

**Figure 2** shows one of the cubes. The cube is filled with water.

The weight of the water exerts a pressure on the bottom of the cube.

**Figure 2**




Use the Physics Equations Sheet to answer questions **01.6** and **01.7**.

**0 1 . 6** Which equation correctly links area, force and pressure?

**[1 mark]**

Tick (✓) **one** box.

pressure = force × area$^2$ ☐

pressure = force × area ☐

pressure = $\frac{\text{force}}{\text{area}}$ ☑

pressure = $\frac{\text{area}}{\text{force}}$ ☐

Do not write outside the box

**0 1 . 7** The water pressure at the bottom of the cube is 1500 Pa.

Calculate the force of the water on the bottom of the cube.

**[4 marks]**

area of base = 0.0144 ($m^2$)

1500 =F/0.0144

F = 1500 × 0.0144

F = 21.6 (N)

Force = 21.6 N

17

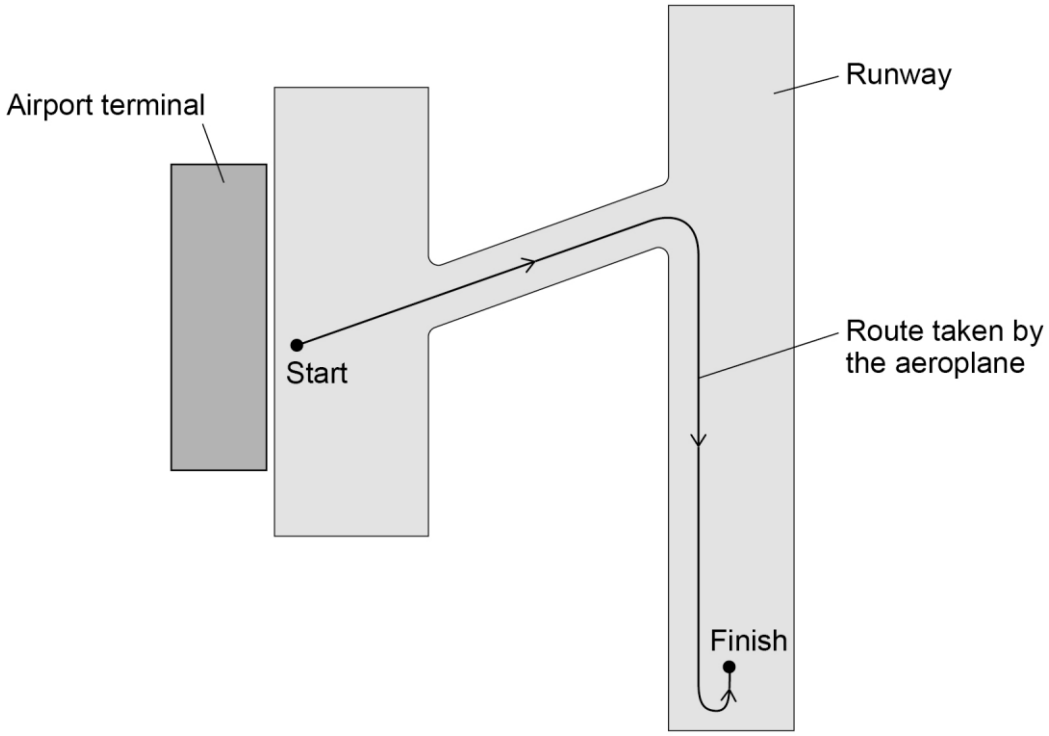
**Turn over for the next question**

*Do not write outside the box*

**0 2** **Figure 3** shows the route an aeroplane takes as it travels from an airport terminal to the runway.

**Figure 3** has been drawn to scale.

**Figure 3**




Scale: 1 cm represents 70 m

**0 2 . 1** Determine the magnitude of the aeroplane's displacement from the start point to the finish point on **Figure 3**.

**[2 marks]**

Displacement = 7.1 (cm) m

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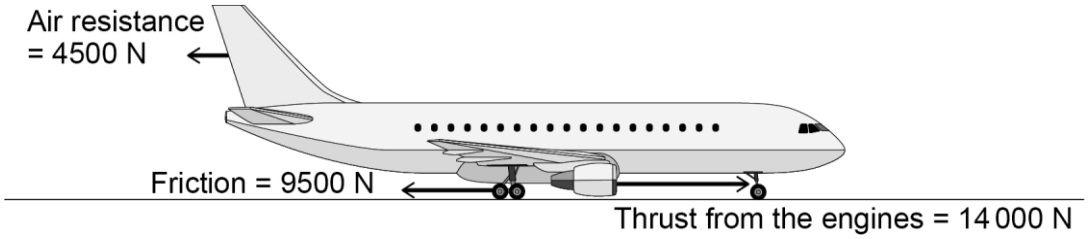
**Figure 4** shows the direction of the horizontal forces acting on the aeroplane as it moves in a straight line towards the runway.

**Figure 4**




**0 2 . 2** Determine the magnitude of the resultant horizontal force on the aeroplane.

**[1 mark]**

Resultant horizontal force = 0 (N) N

**0 2 . 3** Describe the motion of the aeroplane as it moves towards the runway.

**[1 mark]**

constant velocity

**0 2 . 4** Air resistance and friction are contact forces.

Give **one** other example of a contact force.

**[1 mark]**

any one from:
- tension
- normal contact (force)
- upthrust

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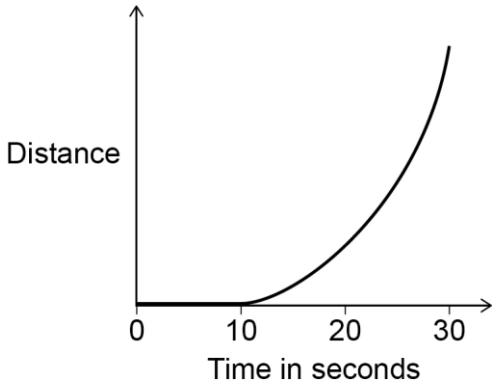
**0 2 . 5** The aeroplane stops for a short time and then accelerates along the runway.

**Figure 5** shows a distance–time sketch-graph for this stage of the journey.

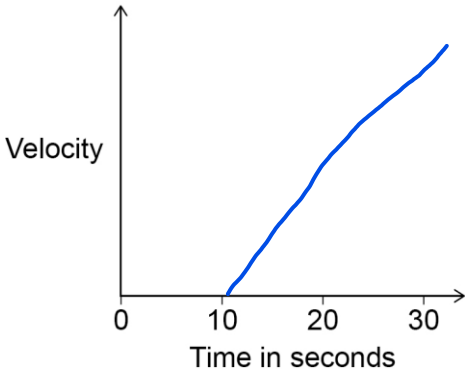
**Figure 5**




Draw the velocity–time sketch-graph for this stage of the journey on **Figure 6**.

**[2 marks]**

**Figure 6**

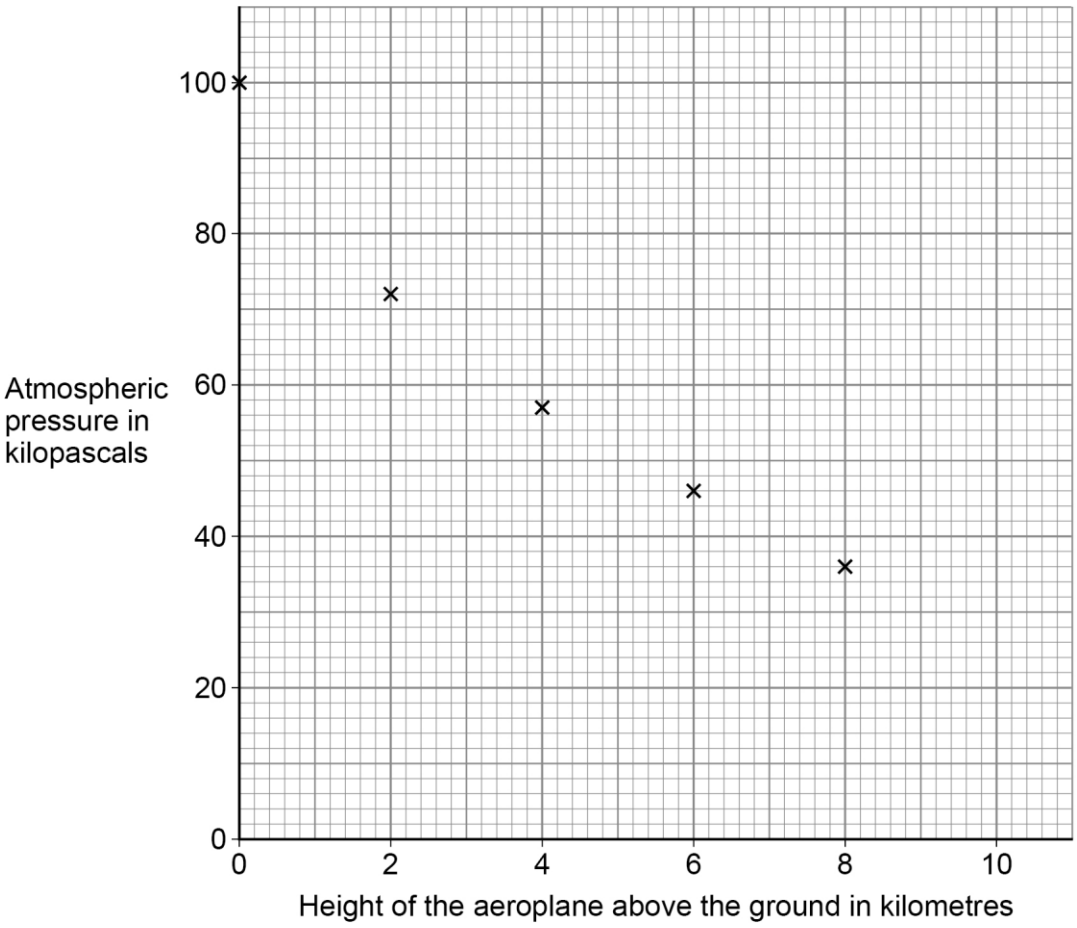



horizontal line drawn to 10s along the x-axis
line with a positive gradient starting from 10 s

**0 2 . 6** The aeroplane takes off from the runway, so its height above the ground increases.

**Figure 7** shows how atmospheric pressure varies with the height of the aeroplane above the ground.

**Figure 7**




Estimate the atmospheric pressure when the height of the aeroplane above the ground is 10 km.

**[2 marks]**

Atmospheric pressure = 28 (kPa) kPa

**Question 2 continues on the next page**

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**0 2 . 7** What happens to the air surrounding the aeroplane as the height of the aeroplane above the ground increases?

**[1 mark]**

Tick (✓) **one** box.

- The average density of the air above the aeroplane decreases. ☑
- The mass of air above the aeroplane increases. ☐
- The temperature of the air increases. ☐
- The volume of air below the aeroplane decreases. ☐

10

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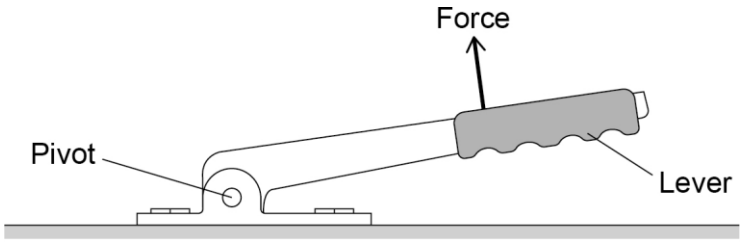
**0 3** Some cars have a lever that is used to apply the handbrake.

**Figure 8** shows the handbrake lever in a car.

**Figure 8**




**0 3 . 1** The driver applies the force shown in **Figure 8**. The force produces a moment about the pivot.

How could the driver increase the moment about the pivot without increasing the size of the force?

**[1 mark]**

apply the force further away from the pivot

**Question 3 continues on the next page**

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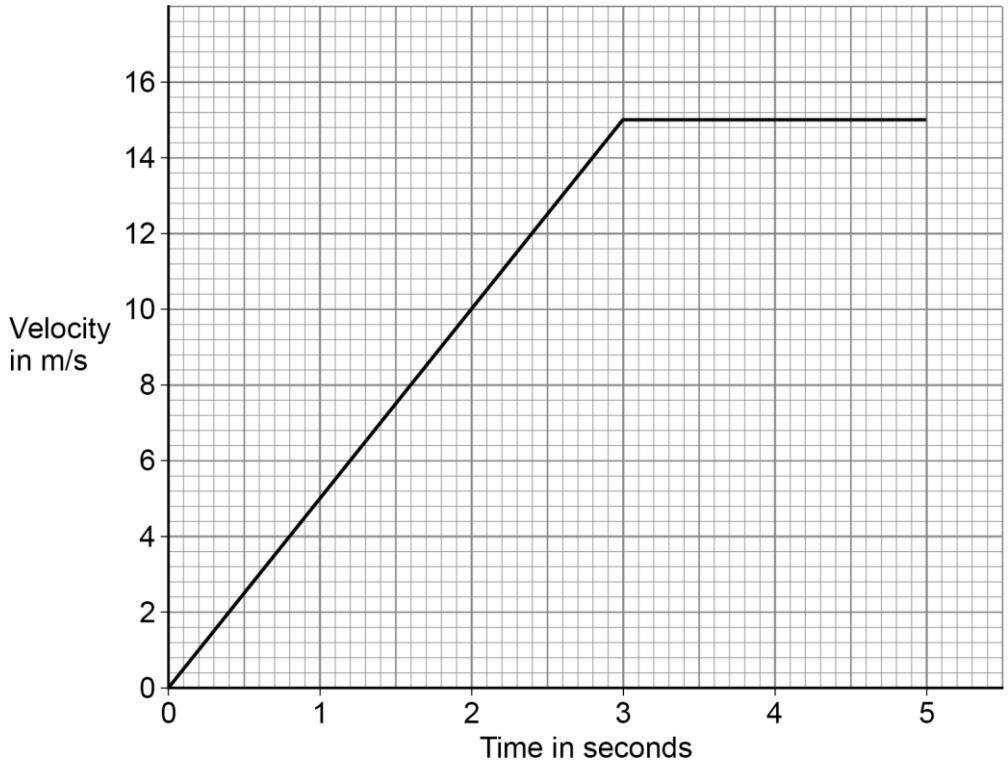
The driver releases the handbrake.

**Figure 9** shows how the velocity of the car changes during the first 5 seconds of a journey.

**Figure 9**




**0 3 . 2** After 3 seconds, the momentum of the car is 24 000 kg m/s.

Calculate the mass of the car.

Use the Physics Equations Sheet.

**[4 marks]**

v = 15 (m/s)

24 000 = m × 15

m =24 000/15

m = 1600 (kg)

Mass = 1600 kg

Do not write outside the box

**0 3 . 3** Determine the distance travelled by the car during the first 5 seconds of the journey.

Use **Figure 9**.

**[3 marks]**

distance travelled during first 3 seconds = 22.5 (m)
distance travelled during last 2 seconds = 30 (m)
total distance = 52.5 (m)

Distance travelled by the car = 52.5 m

**Question 3 continues on the next page**

Do not write outside the box

**0 3 . 4** In an emergency the driver needs to apply the brakes suddenly to stop the car quickly.

The driver of the car is distracted.

Explain why the distraction will increase the stopping distance.

**[3 marks]**

stopping distance includes thinking distance there is an additional time before the driver applies the brakes.so the thinking distance will increase

**0 3 . 5** Explain why the temperature of the brakes increases as they are used.

**[2 marks]**

work is done due to friction (in the brakes) (causing) an increase in the internal / thermal energy (of the brakes)

13

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**Turn over for the next question**

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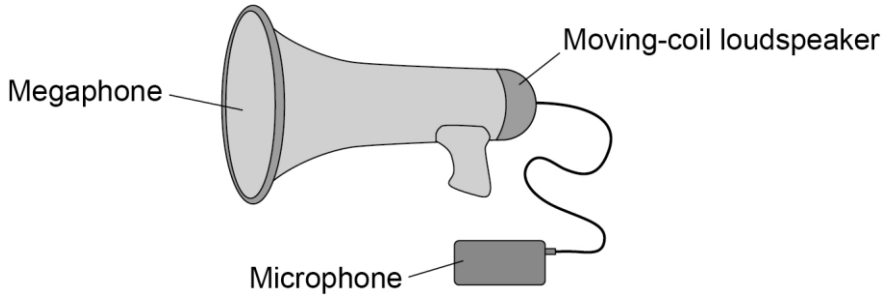
**ANSWER IN THE SPACES PROVIDED**

**0 4** A megaphone uses a loudspeaker to amplify sounds that are detected by a microphone.

**Figure 10** shows a megaphone and microphone.

**Figure 10**




**0 4 . 1** Complete the sentence.

**[1 mark]**

The microphone is used to convert the pressure variations in sound waves into variations in potential difference .

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**0 4 . 2** The loudspeaker contains a permanent magnet.

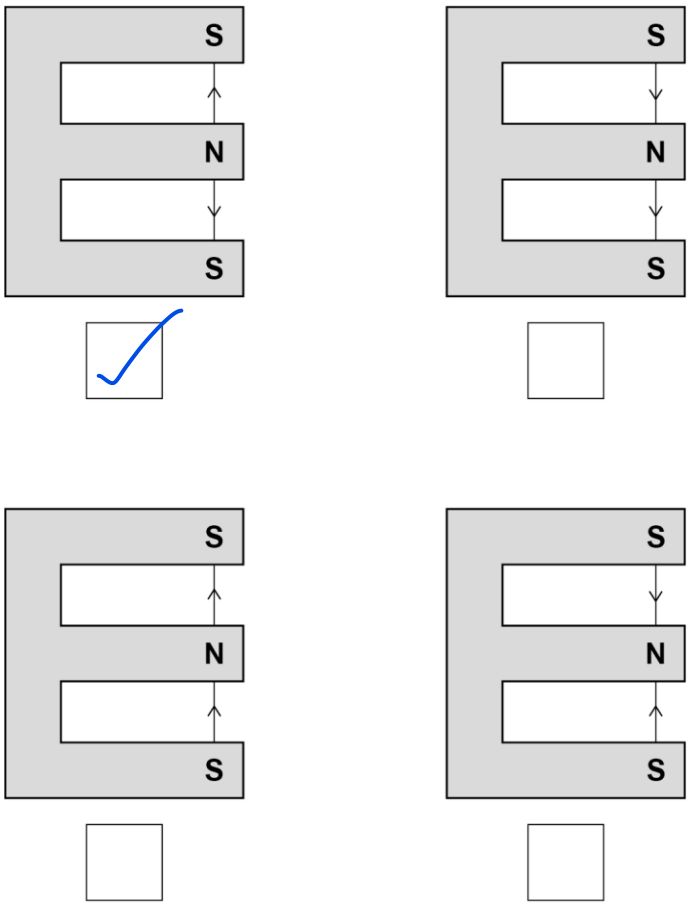
Which diagram in **Figure 11** shows the direction of the magnetic field between the north pole and the south pole of the magnet?

The magnets are shown in cross-section.

**[1 mark]**

Tick (✓) **one** box.

**Figure 11**




**0 4 . 3** Some magnets are permanent magnets and some are induced magnets.

What is an induced magnet?

**[1 mark]**

an induced magnet is a material that becomes a magnet when it is placed in a magnetic field

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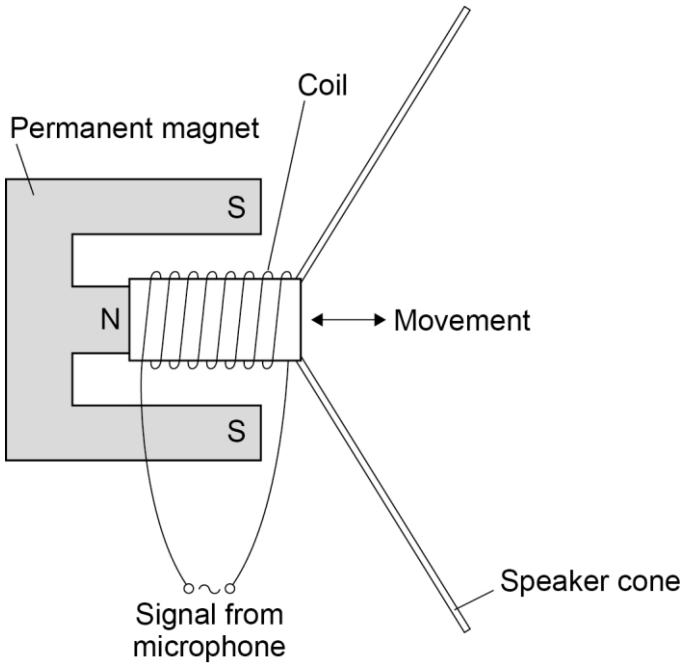
**Figure 12** shows the parts of the loudspeaker in the megaphone.

**Figure 12**




A current in the coil of the loudspeaker causes the coil to move.

**0 4 . 4** What is the name of the effect that causes the coil to move?

**[1 mark]**

Tick (✓) **one** box.

- Electromagnet effect ☐
- Induction effect ☐
- Motor effect ☑
- Speaker effect ☐

Do not write outside the box

**0 4 . 5** When the current in the coil is 16 mA, the force on the coil is 0.013 N.

The length of the wire that makes up the coil is 6.5 m.

Calculate the magnetic flux density around the coil in the electromagnet.

Use the Physics Equations Sheet.

**[4 marks]**

16 mA = 0.016 A

$0.013 = B \times 0.016 \times 6.5$

$B = 0.013 / 0.016 \times 6.5$

$B = 0.125$ (T)

Magnetic flux density = 0.125 T

**Question 4 continues on the next page**

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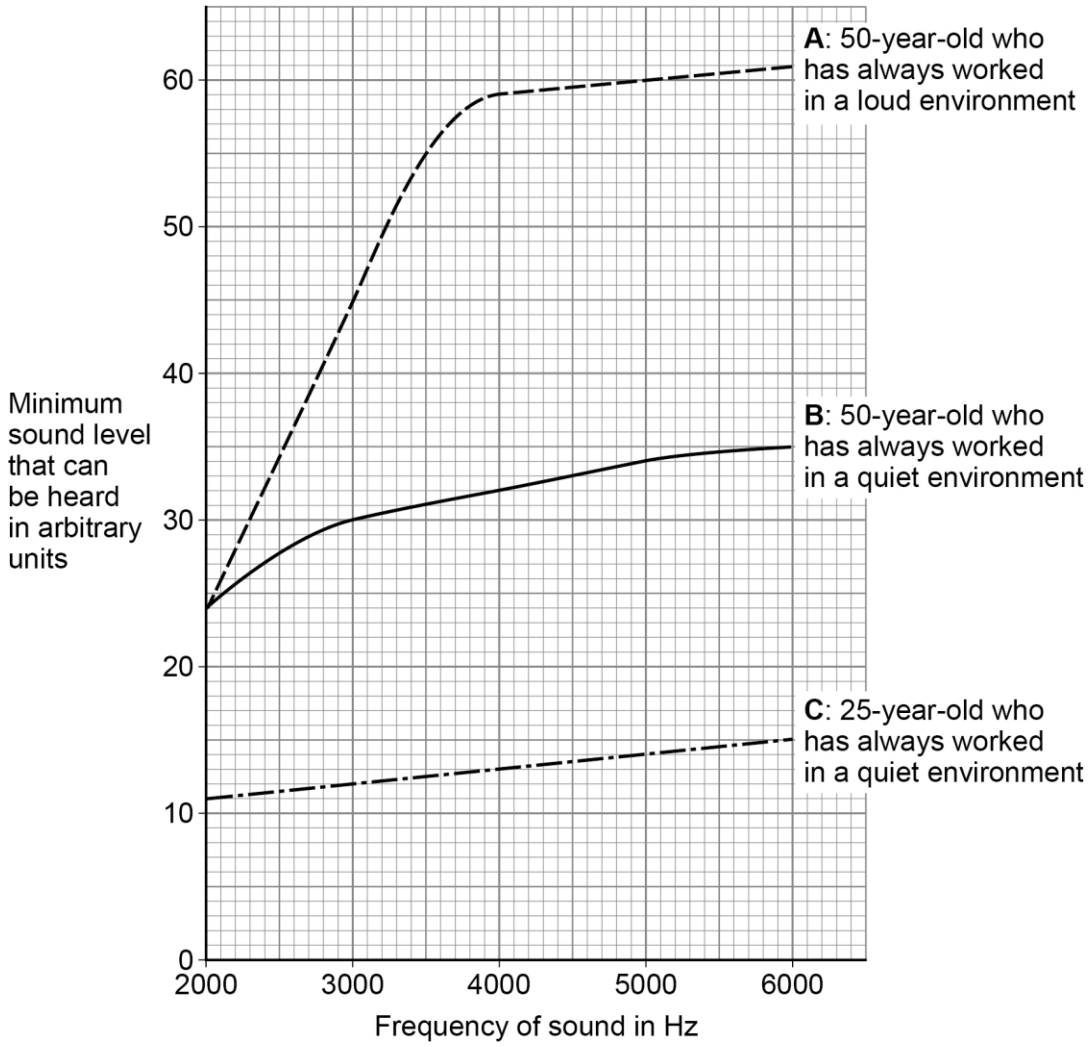
**0 4 . 6** Megaphones can produce very loud sounds.

A person's hearing can be affected by age and by working in a loud environment.

**Figure 13** shows how frequency affects the minimum sound level that can be heard by three different people, **A**, **B** and **C**.

**Figure 13**



Do not write outside the box

Compare how different factors affect the minimum sound level that these people can hear.

**[4 marks]**

Age
• the minimum sound level that can be heard increases with age
• between 2000 and 3000 Hz the minimum sound level that can be heard increases more in B compared to C
• C has very little variation in the minimum sound level that can be heard at all frequencies
Working in a loud environment:
• increases the minimum sound level that can be heard at all frequencies above 2000 Hz compared to working in a quiet environment
• the minimum sound level that can be heard increases more as frequency increases from 2000 to 4000 Hz compared to working in a quiet environment
• doesn't affect the minimum sound level that can be heard at 2000 Hz

12

**Turn over for the next question**

*Do not write outside the box*

**0 5** **Figure 14** shows some bumper cars.

Bumper cars are designed to withstand collisions at low speeds.

**Figure 14**


**0 5 . 1** During a collision between a bumper car and the barrier, the bumper car and barrier act as a closed system.

What is meant by a 'closed system'?

**[1 mark]**

total momentum (of bumper car and barrier) before collision equals total momentum (of bumper car and barrier) after collision

Do not write outside the box

**0 5 . 2** How does Newton's Third Law of motion apply to the collision between the bumper car and the barrier?

**[1 mark]**

the force of the car on the barrier is equal to the force of the barrier on the car and in the opposite direction

**0 5 . 3** During the collision, the change in momentum of the bumper car is 700 kg m/s.

The time taken for the collision is 0.28 s.

Calculate the force on the bumper car during the collision.

Use the Physics Equations Sheet.

**[2 marks]**

F =700/0.28

F = 2500 (N)

Force = 2500 N

**Question 5 continues on the next page**

Do not write outside the box

**0 5 . 4** The bumper car has a flexible bumper.

Explain how the flexible bumper reduces the risk of injury to the people in the bumper car during the collision.

**[3 marks]**

increases the time taken for the collision to occur (so) the rate of change of momentum decreases reducing the force (on the people)

**0 5 . 5** A bumper car moved with an initial constant velocity and then accelerated at 2.0 m/s$^2$.

While accelerating, the bumper car travelled a distance of 1.5 m.

The final velocity of the bumper car was 2.5 m/s.

Calculate the initial constant velocity of the bumper car.

Use the Physics Equations Sheet.

**[3 marks]**

$2.5^2 - u^2 = 2 \times 2.0 \times 1.5$

$u^2 = 2.5^2 - (2 \times 2.0 \times 1.5)$

$u = 0.50$ (m/s)

Initial constant velocity = 0.50 m/s

**10**

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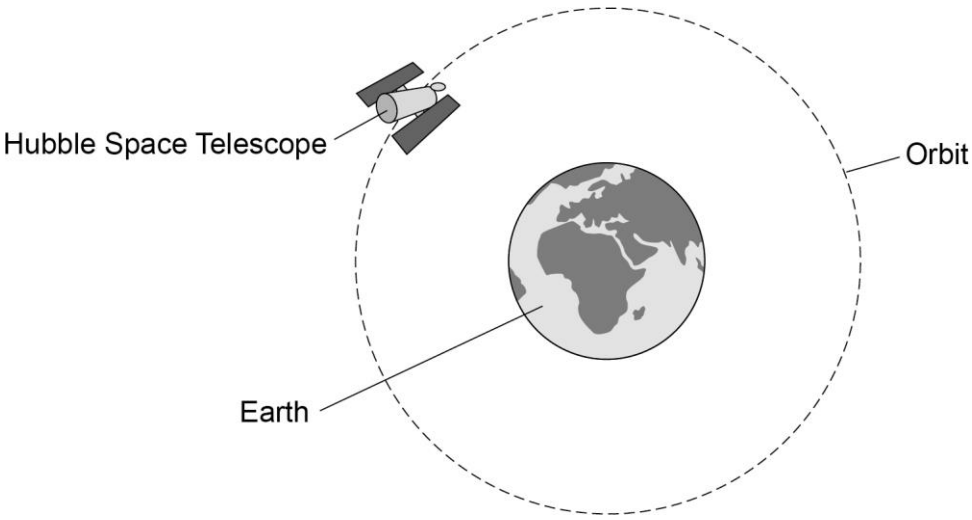
**0 6** **Figure 15** shows the Hubble Space Telescope orbiting the Earth.

**Figure 15**




**0 6 . 1** What name is given to objects that orbit a planet?

**[1 mark]**

satellite

**Question 6 continues on the next page**

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**0 6 . 2** A space telescope uses microwaves to communicate with the Earth.

A microwave has a wavelength of 12.5 cm.

The speed of microwaves through space is $3.0 \times 10^8$ m/s.

Calculate the frequency of the microwave.

Use the Physics Equations Sheet.

Give your answer in standard form.

**[5 marks]**

$f = 3 \times 10^8 / 0.125$

$f = 2400000000$ (Hz)

$f = 2.4 \times 10^9$ (Hz)

Frequency (in standard form) = $2.4 \times 10^9$ Hz

**0 6 . 3** Explain the effect of the Earth's gravitational force on the motion of the Hubble Space Telescope.

**[3 marks]**

gravitational force causes the Hubble Space Telescope to accelerate towards the Earth this changes the direction of motion (but not the speed) so changes the velocity of the Hubble Space Telescope

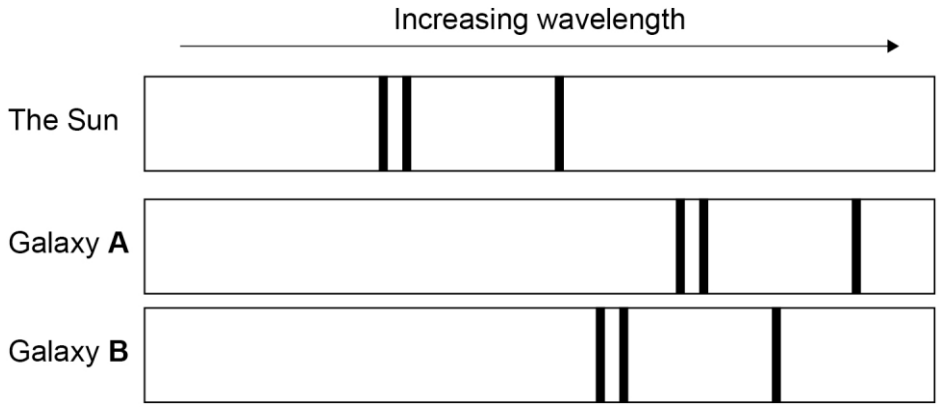
Do not write outside the box

**0 6 . 4** The Hubble Space Telescope can detect visible light from distant galaxies.

The visible light spectra from stars and galaxies include dark lines at specific wavelengths.

**Figure 16** shows the visible light spectra from the Sun and two galaxies.

**Figure 16**




Explain what conclusions can be made about galaxies **A** and **B**.

**[3 marks]**

galaxy A has the greater red shift so A is travelling (away from us) faster (than B) (because) A is further away (from us than B)

12

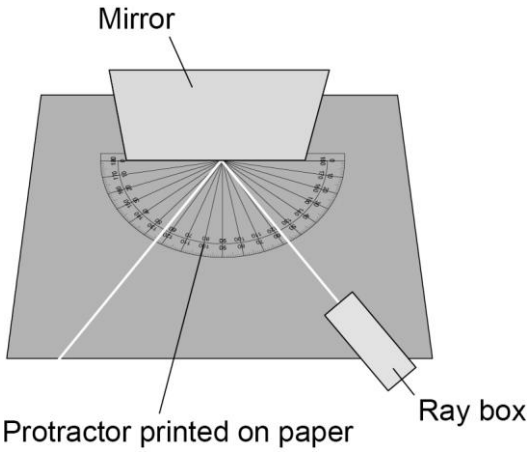
**Turn over for the next question**

**0 7** A student investigated the behaviour of light.

The student used a mirror with a smooth surface to investigate reflection.

**Figure 17** shows the equipment used.

**Figure 17**




**0 7 . 1** What name is given to reflection from a smooth surface?

**[1 mark]**

specular (reflection)

*Do not write outside the box*

The student measured the angle of reflection for different angles of incidence.

**Table 2** shows the results.

**Table 2**

| **Angle of incidence in degrees** | **Angle of reflection in degrees** | | | |
|---|---|---|---|---|
| | Test 1 | Test 2 | Test 3 | Mean |
| 10 | 8 | 10 | 11 | 10 |
| 20 | 20 | 21 | 20 | 20 |
| 30 | 28 | 29 | 32 | 30 |
| 40 | 39 | 41 | 41 | 40 |
| 50 | 49 | 50 | 52 | 50 |

**0 7 . 2** What conclusion can be made from the results in **Table 2**?

**[1 mark]**

the angle of incidence = the (mean) angle of reflection

**0 7 . 3** What type of error caused the variation in the results for the angle of reflection?

Suggest **one** cause of this error.

**[2 marks]**

Type of error random

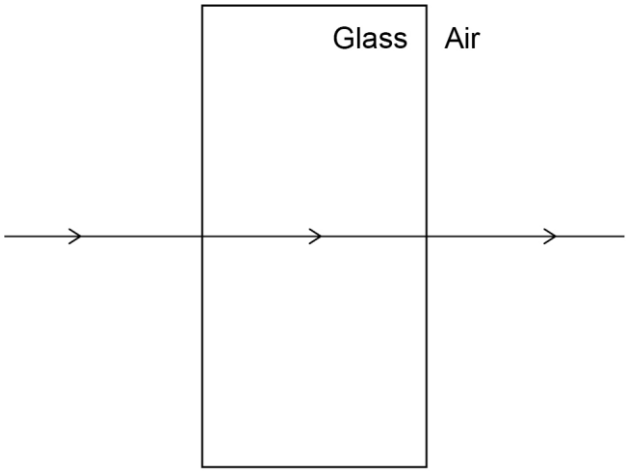
Cause of error the student's eye / head might not be in the same position each time

the centre of the ray may not have been marked correctly

The student also investigated the refraction of light.

**0 7 . 4** **Figure 18** shows the path of a ray of light through a glass block.

**Figure 18**




Why has refraction **not** occurred?

**[1 mark]**

all points on a wavefront enter the glass at the same time

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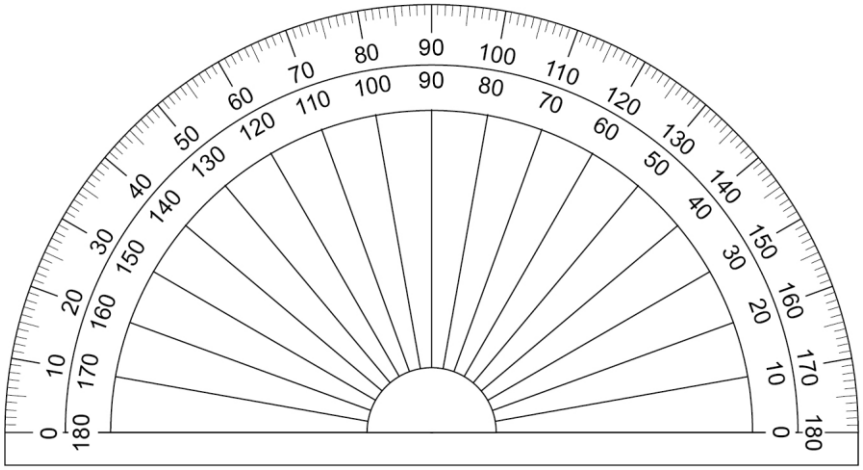
**0 7 . 5** The student measured the angle of refraction for different angles of incidence.

**Figure 19** shows the protractor used.

**Figure 19**




When the angle of incidence was 10° the student measured the angle of refraction four times.

The student recorded the measurements as:

6.0° 6.3° 6.4° 5.8°

Explain why the student should **not** have recorded these results when using the protractor in **Figure 19** to make the measurements.

**[2 marks]**

the resolution (of the protractor) is 1° so could not be used to measure the difference between the results

**Question 7 continues on the next page**

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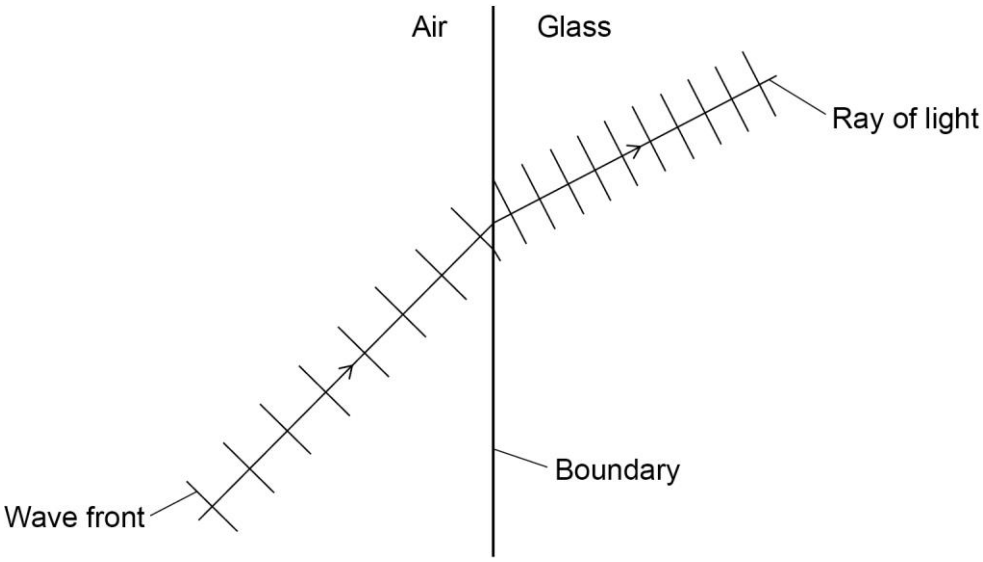
**0 7 . 6** **Figure 20** shows what happens to wave fronts as they pass across the boundary between air and glass.

**Figure 20**




Explain in terms of the wave fronts, why refraction happens at the boundary between air and glass.

**[3 marks]**

different parts of the wavefront enter the glass at different times the velocity / speed (of light) is less in glass so one part of the wave front changes speed before other parts

10

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**Turn over for the next question**

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**ANSWER IN THE SPACES PROVIDED**

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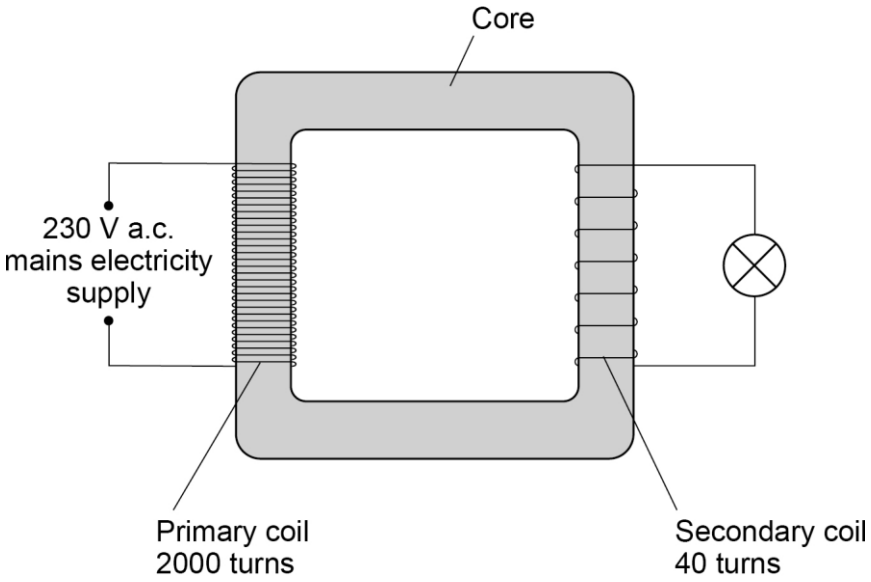
**0 8** **Figure 21** shows a transformer used to power a lamp using the mains electricity supply.

**Figure 21**




**0 8 . 1** What material is used to make the core of the transformer?

Give the reason for using this material.

**[2 marks]**

Material iron

Reason it is easily magnetised (and demagnetised)

Do not write outside the box

**0 8 . 2** Determine the current in the secondary coil when the power output of the transformer is 6.9 W.

The transformer is 100% efficient.

Use the Physics Equations Sheet.

**[5 marks]**

$V_s = 40/2000 \times 230$

$V_s = 4.6$ (V)

$4.6 \times I_s = 6.9$

$I_s = 1.5$ A

Current in the secondary coil = 1.5 A

7

**Turn over for the next question**

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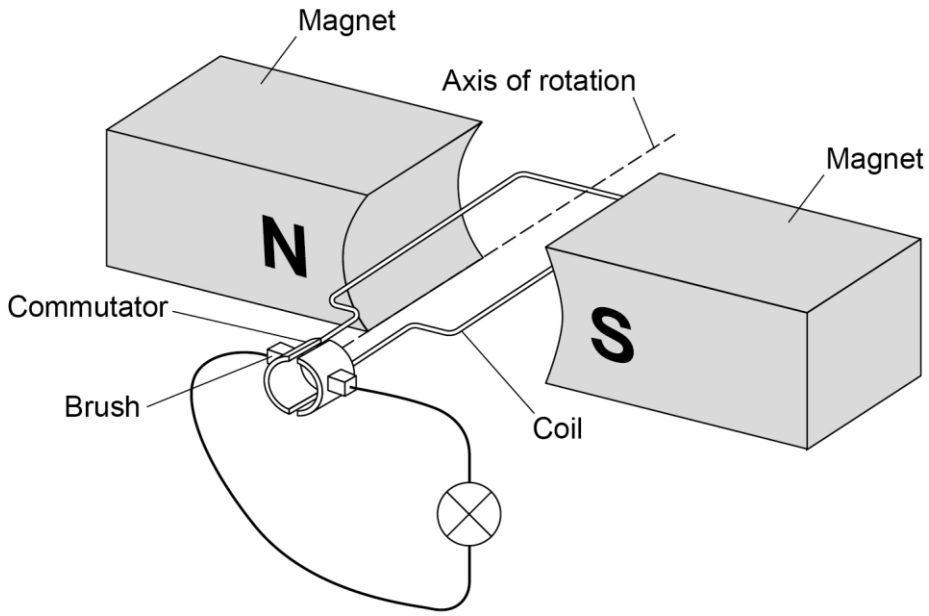
**0 9** A dynamo is used to generate an electric current.

**Figure 22** shows the inside parts of the dynamo connected to a lamp.

**Figure 22**




**0 9 . 1** The coil is rotated.

Explain why a direct current is induced in the coil.

**[5 marks]**

each half-revolution, (the two halves of) the commutator switch brushes / contacts so the direction of the (induced) current / potential difference does not reverse every half rotation

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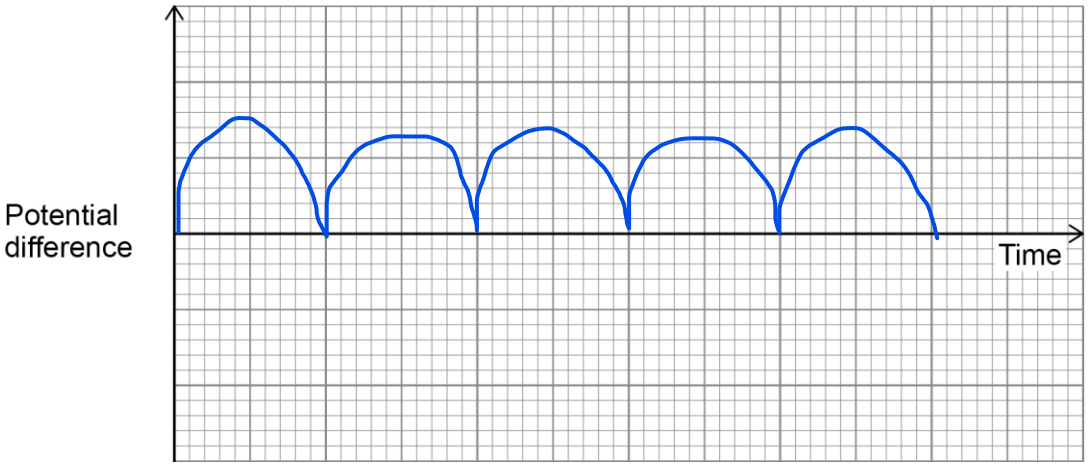
**0 9 . 2** Sketch a graph on **Figure 23** to show how the potential difference generated across the lamp varies for **two** complete revolutions of the dynamo coil.

**[1 mark]**

**Figure 23**




**0 9 . 3** The lamp is disconnected from the dynamo.

Explain why the dynamo becomes much easier to turn.

**[3 marks]**

(after disconnection) there is no (induced) current so no magnetic field (produced around / by the coil) to oppose the movement of the coil

9

**END OF QUESTIONS**

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