



Surname _____

Forename(s) _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

**GCSE
PHYSICS**

F

Foundation Tier Paper 2

8463/2F

Friday 16 June 2023

Morning

Time allowed: 1 hour 45 minutes

[Turn over]



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At the front of this book, write your surname and forename(s), your centre number, your candidate number and add your signature.

MATERIALS

For this paper you must have:

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

[Turn over]



INSTRUCTIONS

- **Use black ink or black ball-point pen. Pencil should only be used for drawing.**
- **Answer ALL questions in the spaces provided.**
- **Do not write 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 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.**

DO NOT TURN OVER UNTIL TOLD TO DO SO



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Answer ALL questions in the spaces provided.

0	1
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A student carried out an investigation to determine the spring constant of a spring.

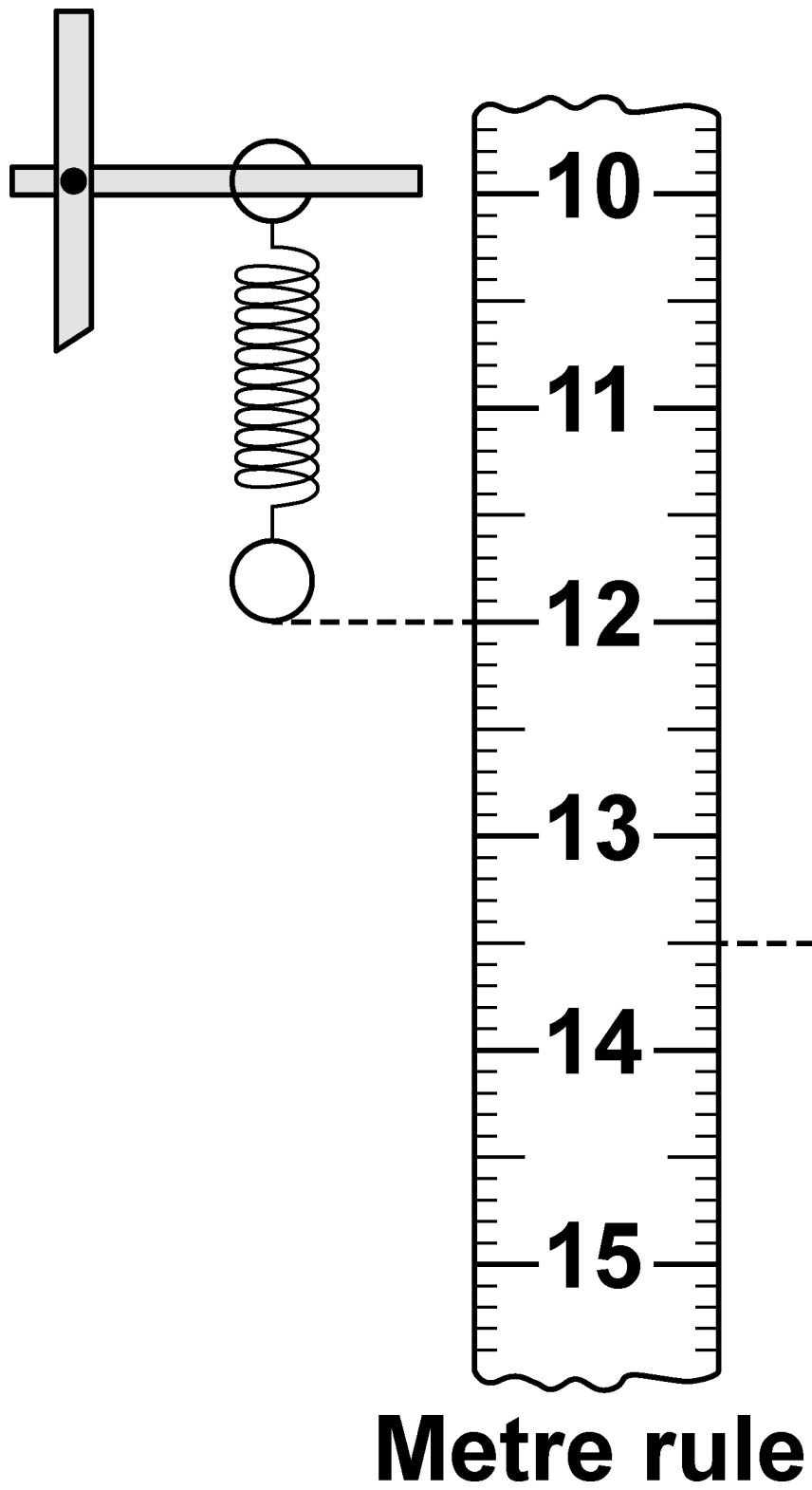
FIGURE 1, on page 8, shows the spring before and after a mass was hung from the end of the spring.

[Turn over]

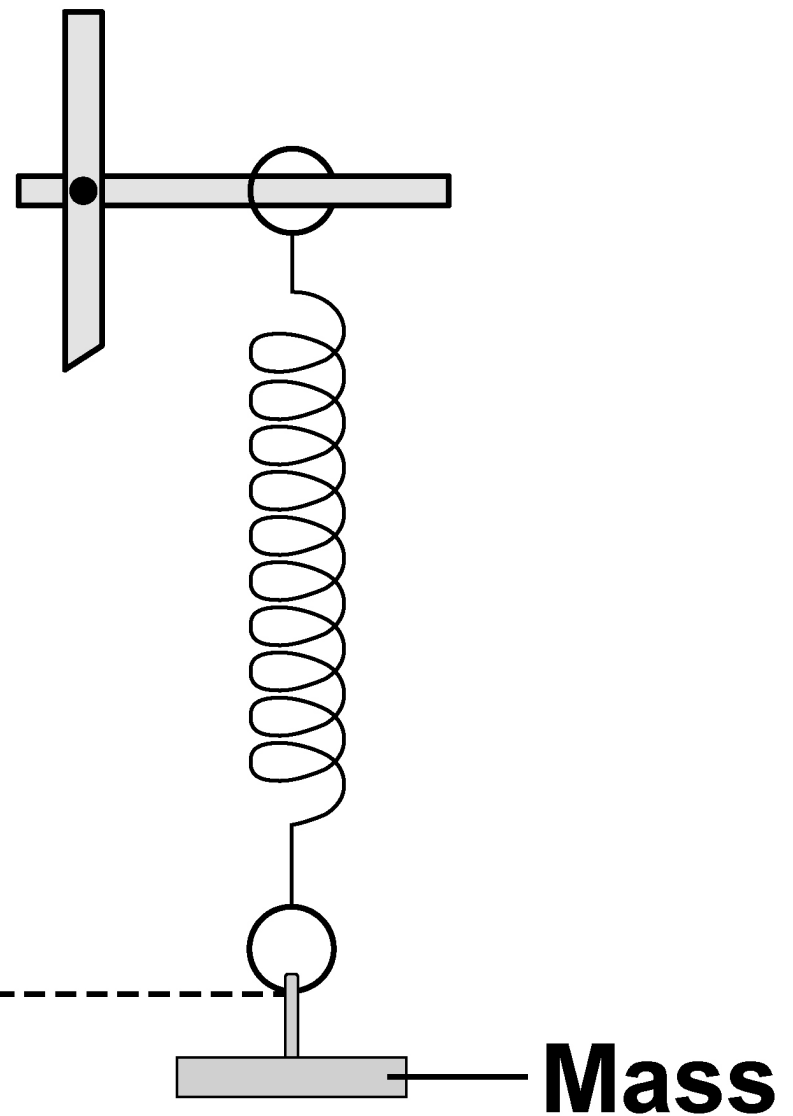


FIGURE 1

BEFORE



AFTER



0	1	.	1
---	---	---	---

**What is the extension of the spring in
FIGURE 1? [1 mark]**

Tick (✓) ONE box.

☐

1.5 cm

☐

3.5 cm

☐

13.5 cm

[Turn over]



0	1	.	2
---	---	---	---

Give ONE safety precaution the student should have taken during this investigation. [1 mark]



0	1	.	3
---	---	---	---

The student hung a mass of 0.050 kg from the spring.

gravitational field strength = 9.8 N/kg

Calculate the weight of the 0.050 kg mass.

Use the equation:

weight = mass \times gravitational field strength

[2 marks]

Weight = _____ N

[Turn over]



0	1	.	4
---	---	---	---

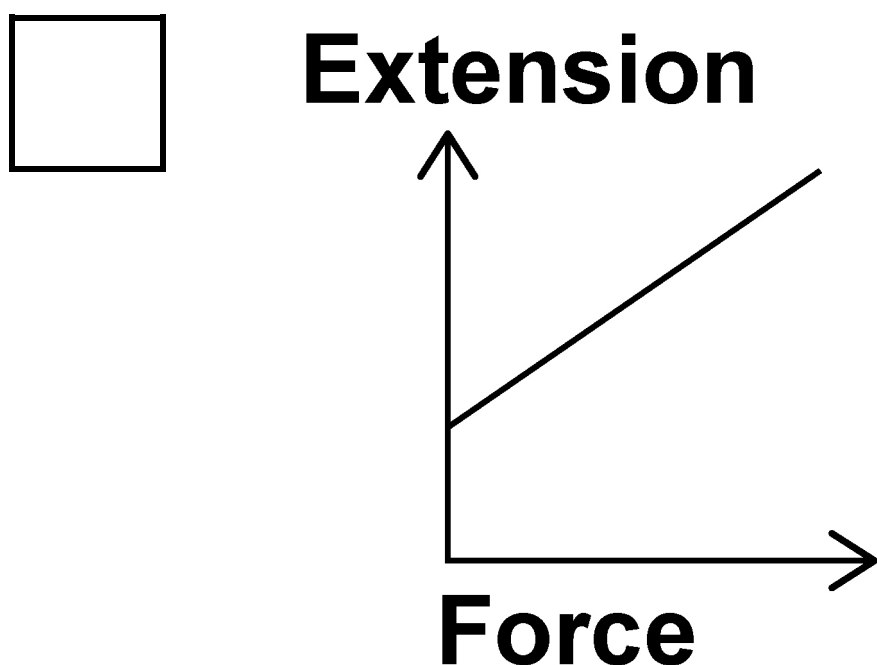
The weight of the mass applies a force to the spring.

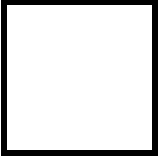
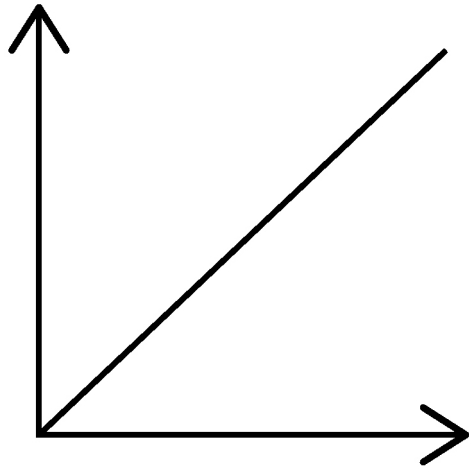
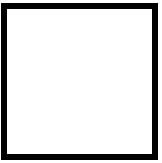
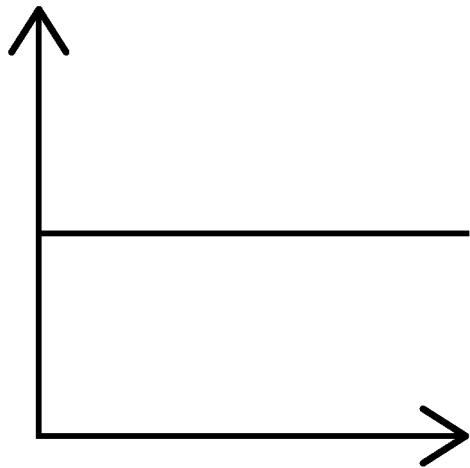
The student added more masses and recorded the extension of the spring.

Which graph in FIGURE 2, below and on the opposite page, shows the relationship between the force applied to the spring and the extension of the spring? [1 mark]

Tick (✓) ONE box.

FIGURE 2



**Extension****Force****Extension****Force****[Turn over]**

0	1	.	5
---	---	---	---

A force of 2.0 N was applied to a different spring.

The extension of the spring was 0.080 m.

Calculate the spring constant of the spring.

Use the equation:

$$\text{spring constant} = \frac{\text{force}}{\text{extension}}$$

[2 marks]

Spring constant = _____ N/m

7



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[Turn over]



0	2
---	---

The stopping distance of a car is the braking distance added to the thinking distance.

0	2	.	1
---	---	---	---

Complete the sentences.

Choose answers from the list.

- **chemical**
- **electrostatic**
- **kinetic**
- **nuclear**
- **thermal**

[2 marks]



A driver applies the brakes to a moving car.

As the car slows down, there is a decrease in the _____ energy of the car.

The work done by friction causes an increase in the _____ energy store of the brakes.

[Turn over]



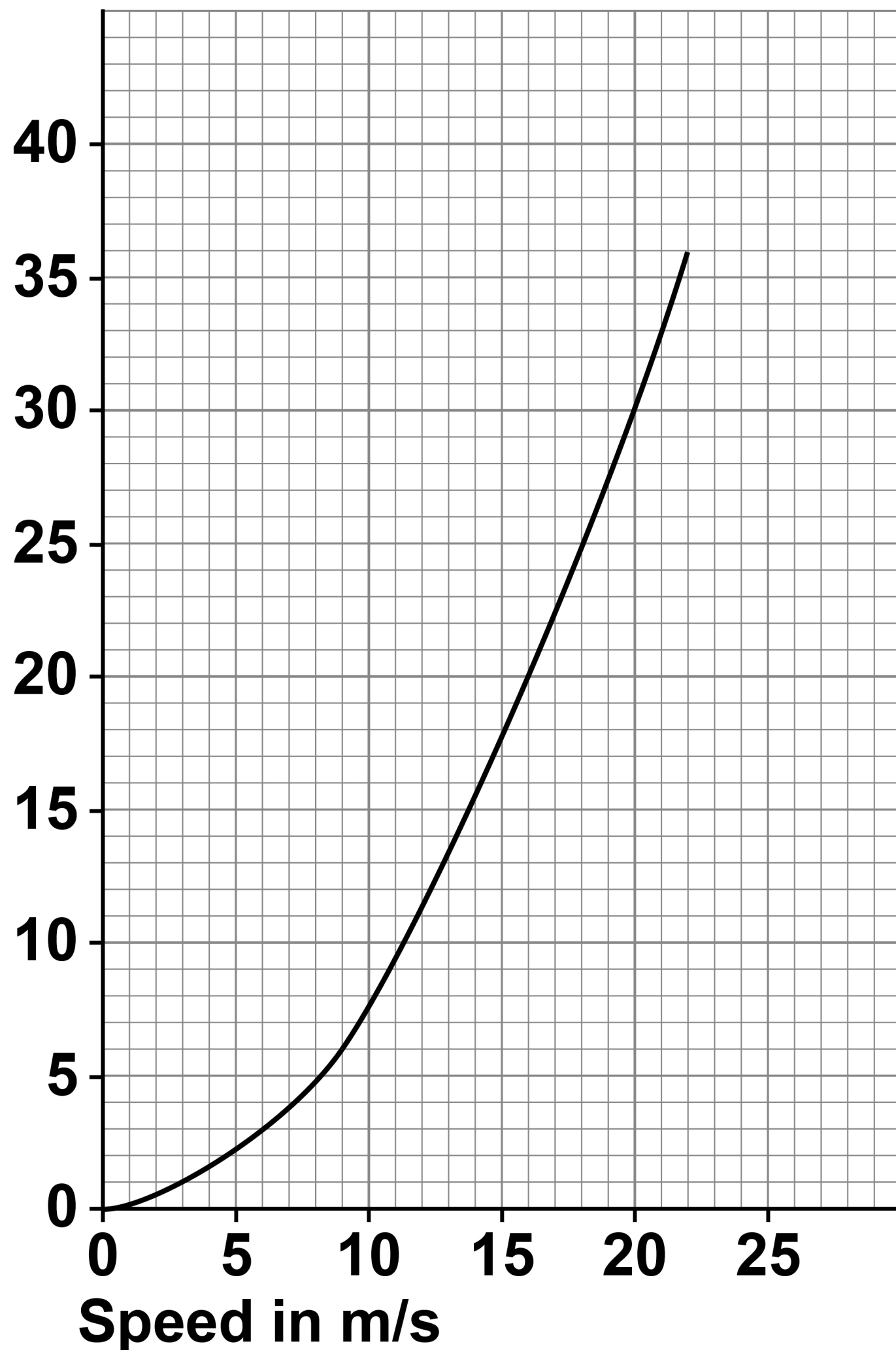
0	2	.	2
---	---	---	---

FIGURE 3, on the opposite page, shows how the speed of the car affects the minimum braking distance of the car.

Describe the relationship between the speed of the car and the minimum braking distance of the car. [1 mark]

FIGURE 3

**Minimum braking
distance in metres**



[Turn over]



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0	2	.	3
---	---	---	---

Complete the sentence.

Choose the answer from the list.

- **decreases**
- **stays the same**
- **increases**

[1 mark]

When the road becomes icy, the braking distance _____.

[Turn over]



A car driver applies the brakes to decelerate the car as it approaches a road junction.

The car decelerates at 0.25 m/s^2 .

mass of the car = 1600 kg

0 2 . 4

Calculate the time taken for the velocity of the car to decrease from 12.5 m/s to 5.0 m/s .

Use the equation:

$$\text{time taken} = \frac{\text{change in velocity}}{\text{deceleration}}$$

[3 marks]



Time taken = _____ s

[Turn over]



0	2	.	5
---	---	---	---

Calculate the resultant force causing the car to decelerate.

Use the equation:

resultant force = mass \times deceleration

[2 marks]

Resultant force = _____ N



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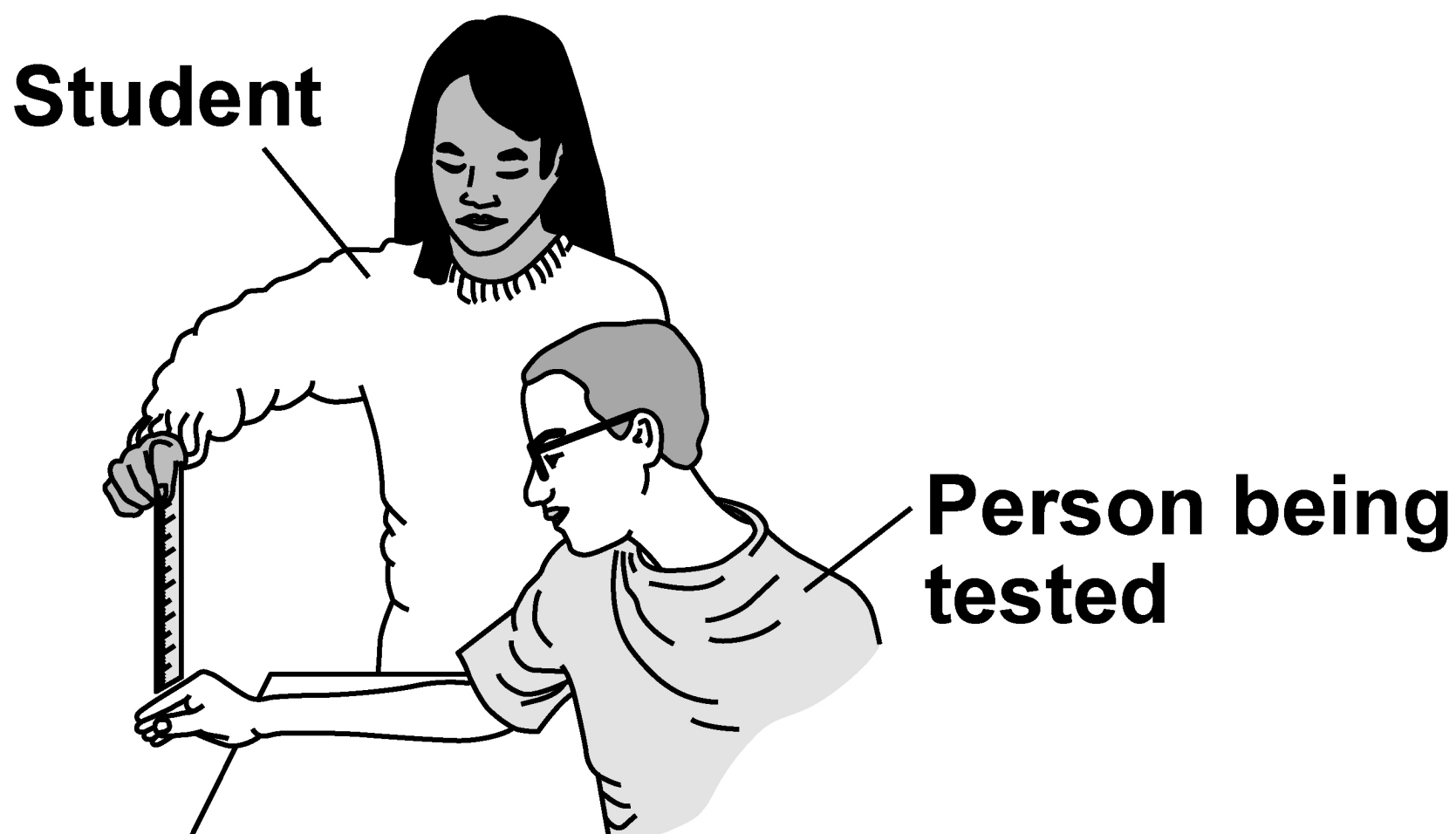
[Turn over]



Thinking distance is affected by the reaction time of the driver.

FIGURE 4 shows how a student tested a person's reaction time.

FIGURE 4



The student held a ruler and then released it.

The person being tested closed his hand to catch the ruler as quickly as possible.

The further the ruler fell the greater the person's reaction time.

0 2 . 6

The student wanted to test the reaction time of the people in her class.

Which of the following could have been a control variable in this investigation?

[1 mark]

Tick (✓) ONE box.

☐

Distance fallen by the ruler before being caught

☐

Initial height of the ruler above the person's hand

☐

Reaction time of the person being tested

[Turn over]



0	2	.	7
---	---	---	---

The student tested three people in her class.

The mean distance that the ruler fell before being caught was 18.2 cm.

If all of the people in her class were tested, the mean distance may not be 18.2 cm.

Suggest why. [1 mark]

0	2	.	8
---	---	---	---

Describe how this investigation could be changed to find out how listening to music affects reaction time. [2 marks]

[Turn over]

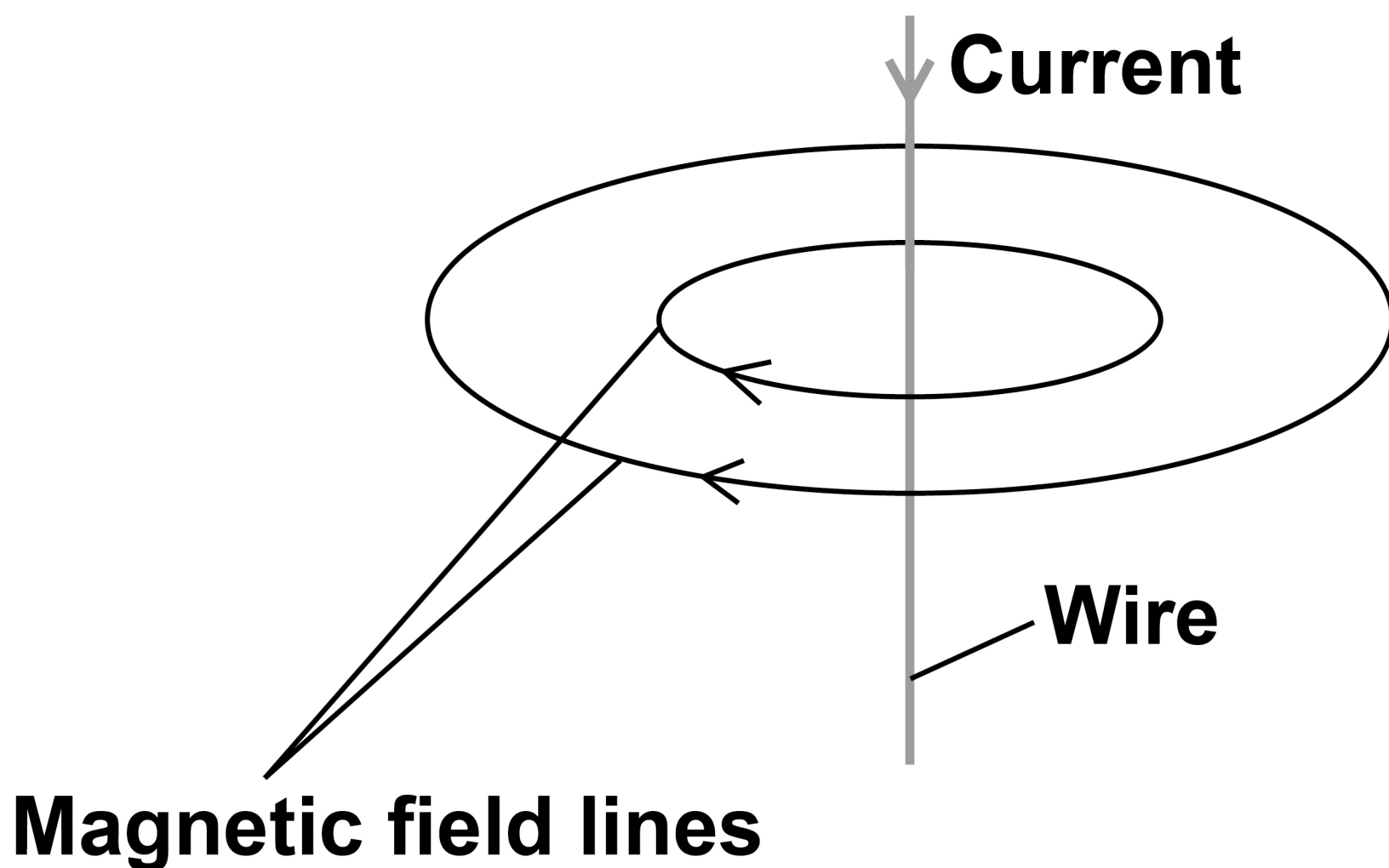
13



0	3
---	---

FIGURE 5 shows the magnetic field pattern produced when there is a current in a wire.

FIGURE 5



0	3	.	1
---	---	---	---

What do the arrows on the magnetic field lines represent? [1 mark]

[Turn over]



0	3	.	2
---	---	---	---

How could the strength of the magnetic field be increased? [1 mark]

Tick (✓) ONE box.

☐

Change the direction of the current in the wire

☐

Increase the current in the wire

☐

Increase the temperature of the wire



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[Turn over]



0	3	.	3
---	---	---	---

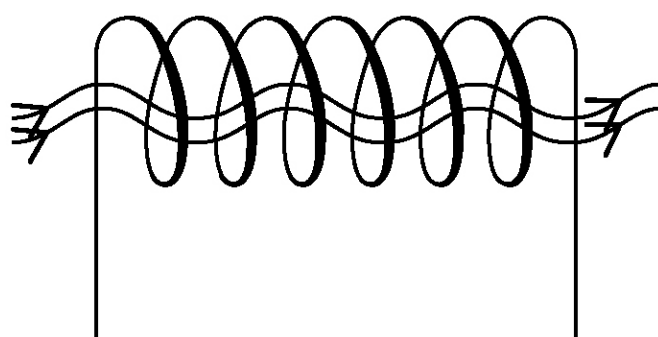
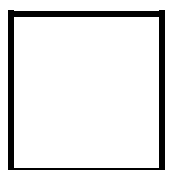
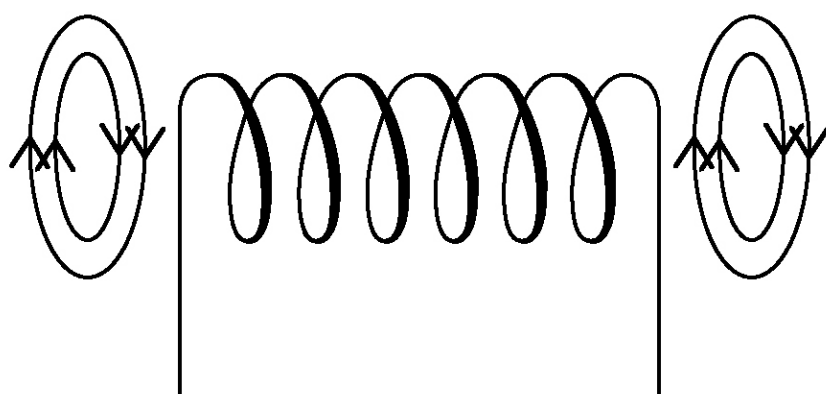
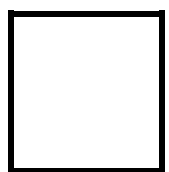
The wire is coiled to make a solenoid.

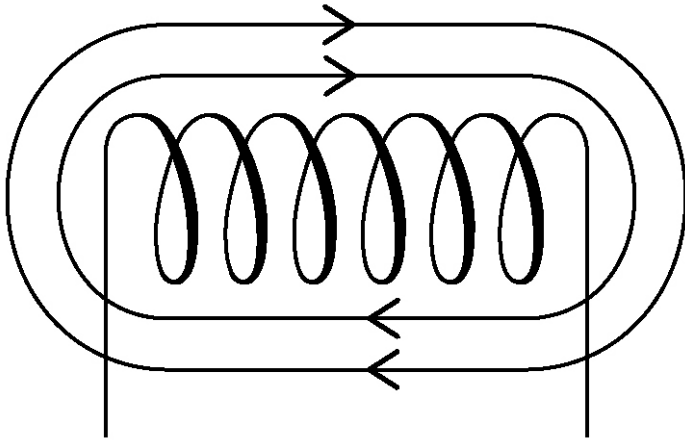
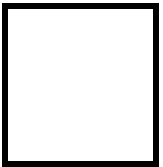
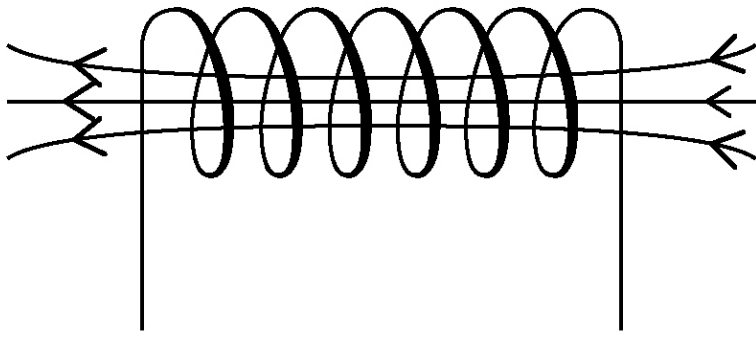
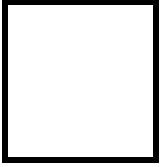
Which diagram in FIGURE 6, below and on the opposite page, shows the magnetic field pattern produced when there is a current in the solenoid?

[1 mark]

Tick (✓) ONE box.

FIGURE 6



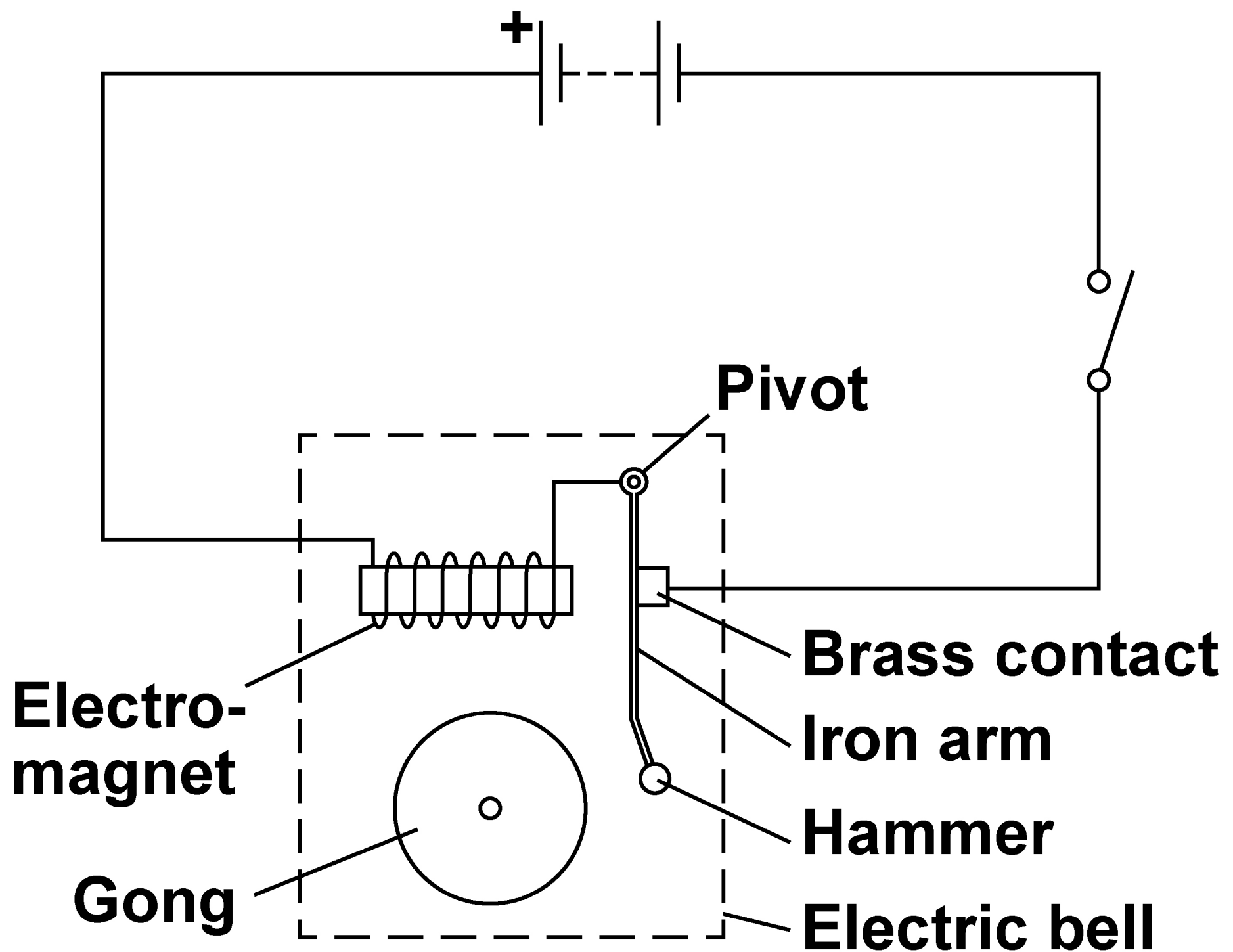


[Turn over]



FIGURE 7 shows the parts of an electric bell.

FIGURE 7



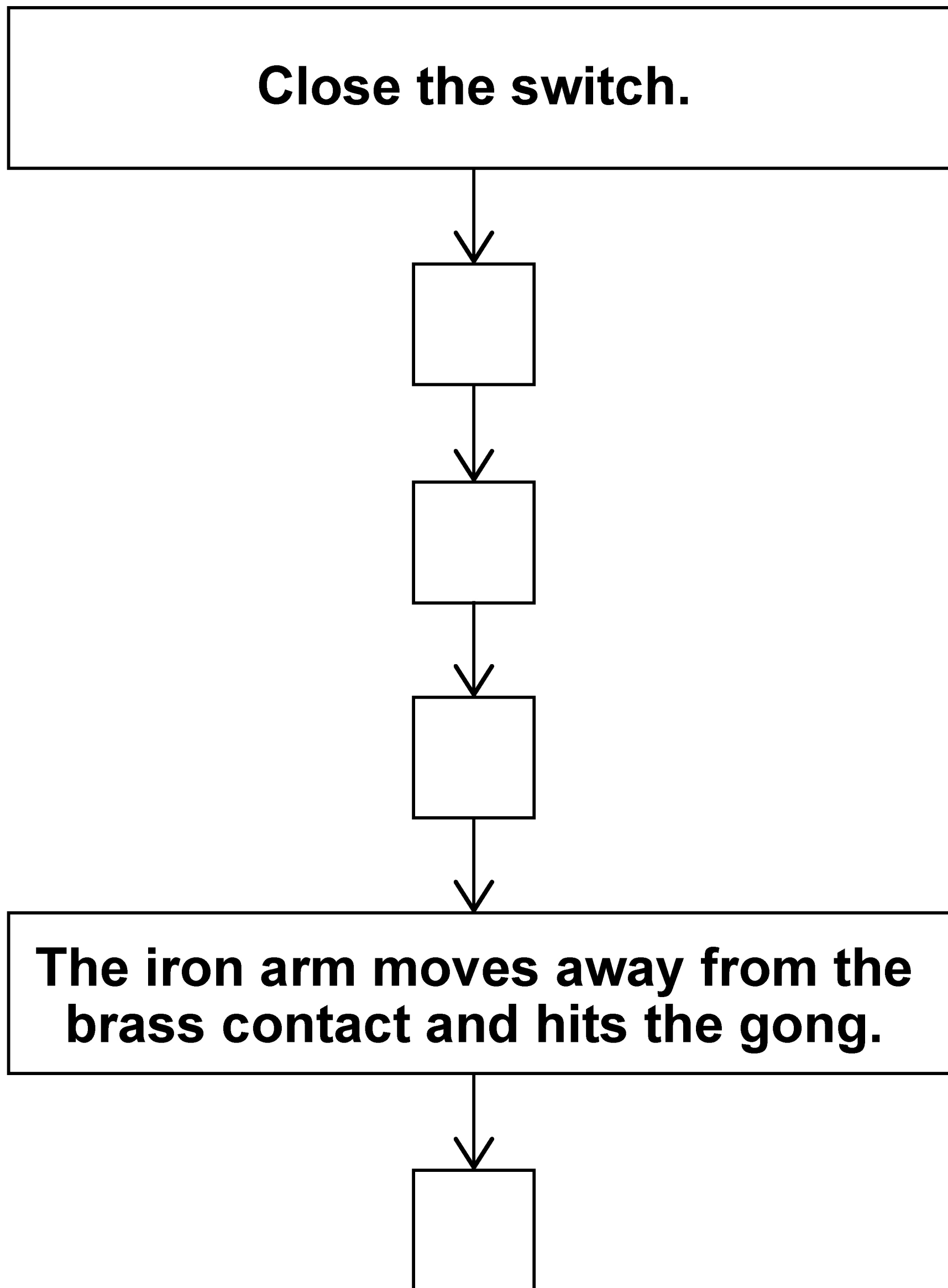
0	3	.	4
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FIGURE 8, on page 38, shows an incomplete sequence of how the bell works.

[Turn over]



FIGURE 8



On the opposite page, write ONE letter in each box to show the correct sequence.

Use each letter once. [2 marks]

- A A magnetic field is created around the electromagnet.**
- B A resultant force acts on the iron arm causing it to move towards the electromagnet.**
- C The iron arm returns to its original position.**
- D There is a current in the circuit.**

[Turn over]



0	3	.	5
---	---	---	---

Which of the following would increase the resultant force on the iron arm?
[1 mark]

Tick (✓) ONE box.

☐

Decrease the distance between the electromagnet and the iron arm

☐

Decrease the number of cells in the circuit

☐

Decrease the number of turns on the electromagnet

0	3	.	6
---	---	---	---

The iron arm of the bell vibrates with a frequency of 6.25 Hz.

Calculate the period of the iron arm.

Use the equation:

$$\text{period} = \frac{1}{\text{frequency}}$$

[2 marks]

Period = _____ s

[Turn over]

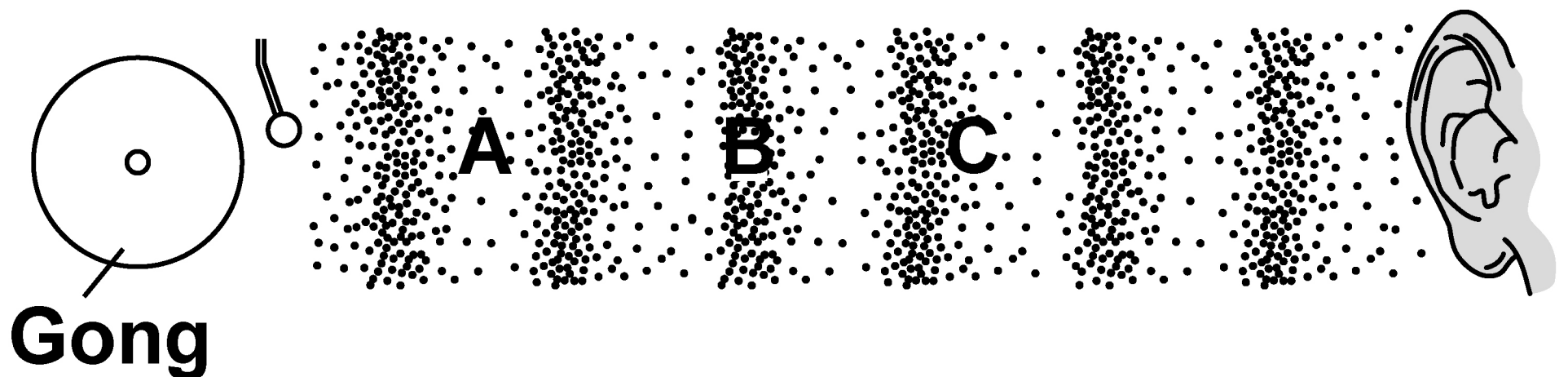


0	3	.	7
---	---	---	---

The sound waves produced by the bell are longitudinal waves.

FIGURE 9 shows the position of the air particles at one point in time as the sound waves travel through the air.

FIGURE 9



Which letter represents an area of compression? [1 mark]

Tick (✓) ONE box.

☐

A

☐

B

☐

C

[Turn over]

9

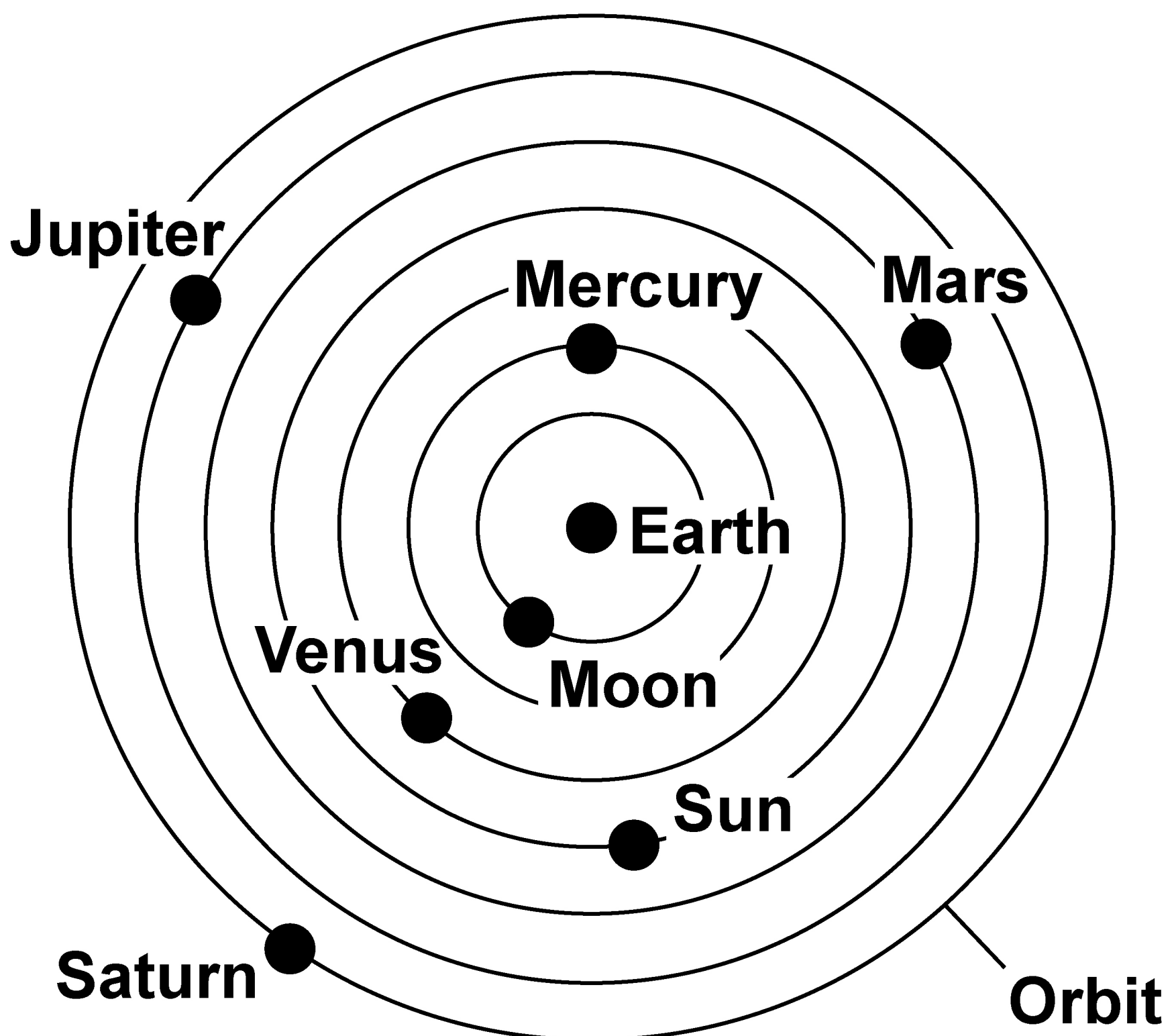


0	4
---	---

FIGURE 10 shows an old scientific model of the solar system that has now been replaced.

FIGURE 10

OLD SCIENTIFIC MODEL



0	4	.	1
---	---	---	---

Which statement is a reason for replacing an old scientific model with a newer scientific model? [1 mark]

Tick (✓) ONE box.

☐

The old model cannot explain new observations.

☐

The old model has been used by scientists for a long time.

☐

The old model is too simple.

[Turn over]



0	4	.	2
---	---	---	---

Compare the model of the solar system used now with the old model of the solar system shown in FIGURE 10, on page 44. [4 marks]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[Turn over]



TABLE 1 shows data about four planets.

TABLE 1

PLANET	Mean distance from the Sun in millions of kilometres	Time taken for one orbit in Earth years
Mercury	58	0.25
Venus	108	0.60
Earth	150	1.00
Mars	228	1.90

0	4	.	3
---	---	---	---

How does the time taken for one orbit change as the mean distance from the Sun increases? [1 mark]

[Turn over]

REPEAT OF TABLE 1

PLANET	Mean distance from the Sun in millions of kilometres	Time taken for one orbit in Earth years
Mercury	58	0.25
Venus	108	0.60
Earth	150	1.00
Mars	228	1.90

04.4

The bar chart in FIGURE 11, on the opposite page, shows some of the data from TABLE 1.

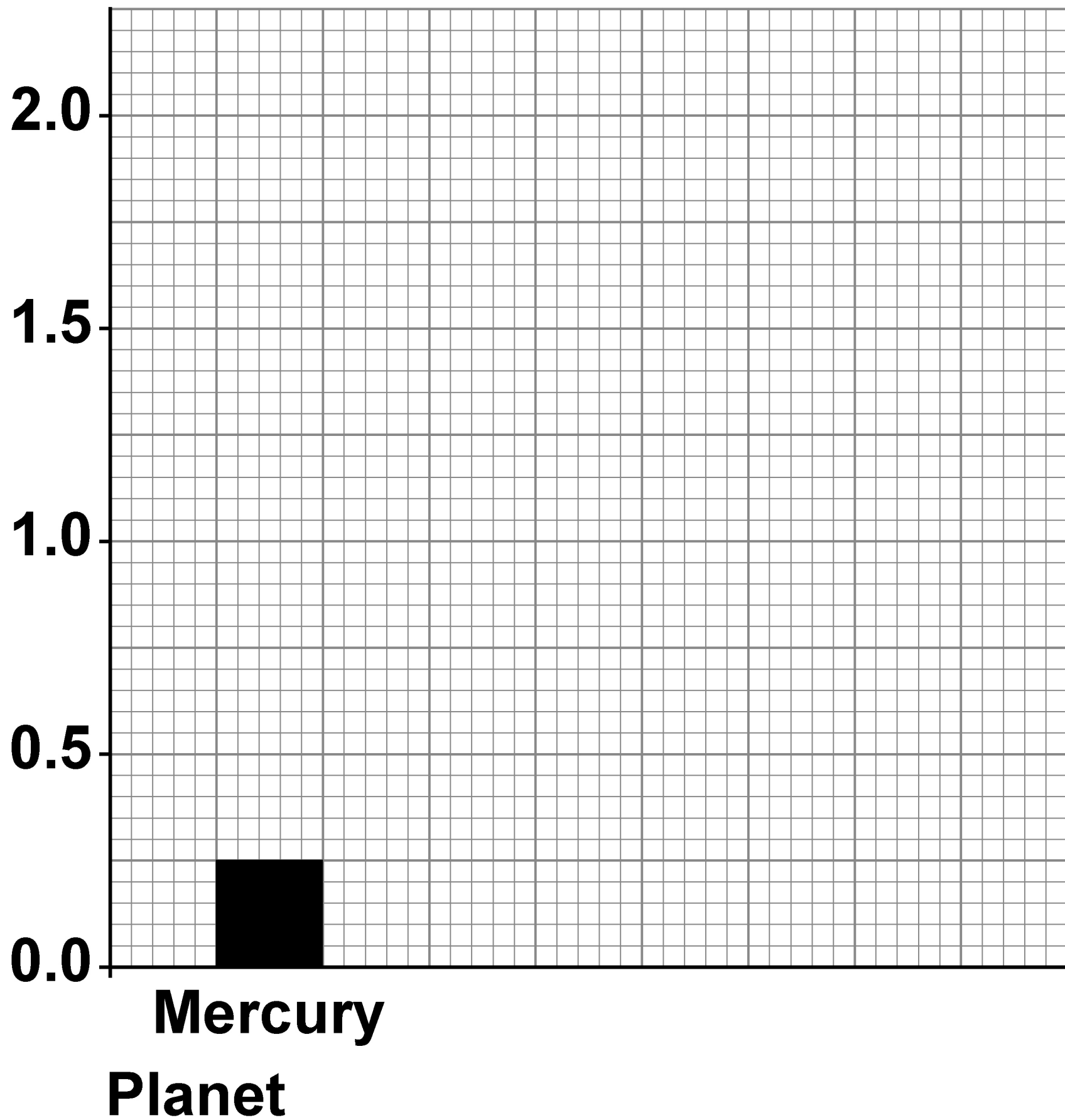
Complete the bar chart.

Use data from TABLE 1. [2 marks]



FIGURE 11

**Time taken for one orbit
in Earth years**



[Turn over]



0	4	.	5
---	---	---	---

All stars have a life cycle.

A, B and C in FIGURE 12, on the opposite page, represent three stages in the life cycle of the Sun.

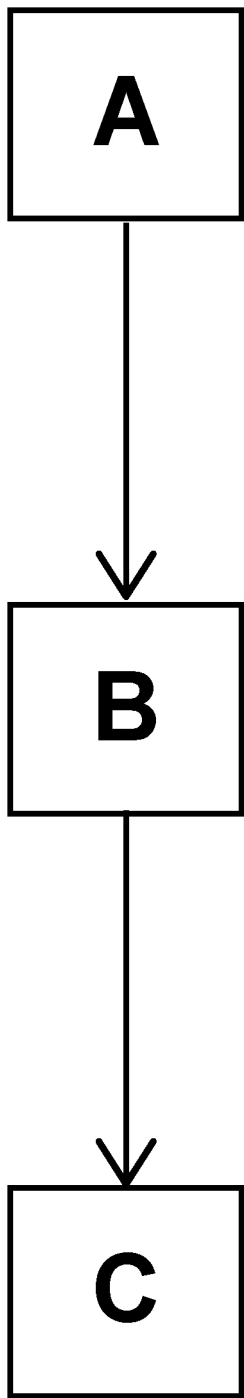
The stages are in the correct order.

On the opposite page, draw ONE line from each stage to the name of the stage. [2 marks]

FIGURE 12

STAGE

NAME OF THE STAGE



Main sequence

Red giant

Supernova

White dwarf

[Turn over]



0	4	.	6
---	---	---	---

Stars act like black bodies.

Which statement is true for perfect black bodies? [1 mark]

Tick (✓) ONE box.

☐

They are good reflectors of radiation.

☐

They are the best emitters of radiation.

☐

They easily transmit radiation.

<hr/>
11



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[Turn over]

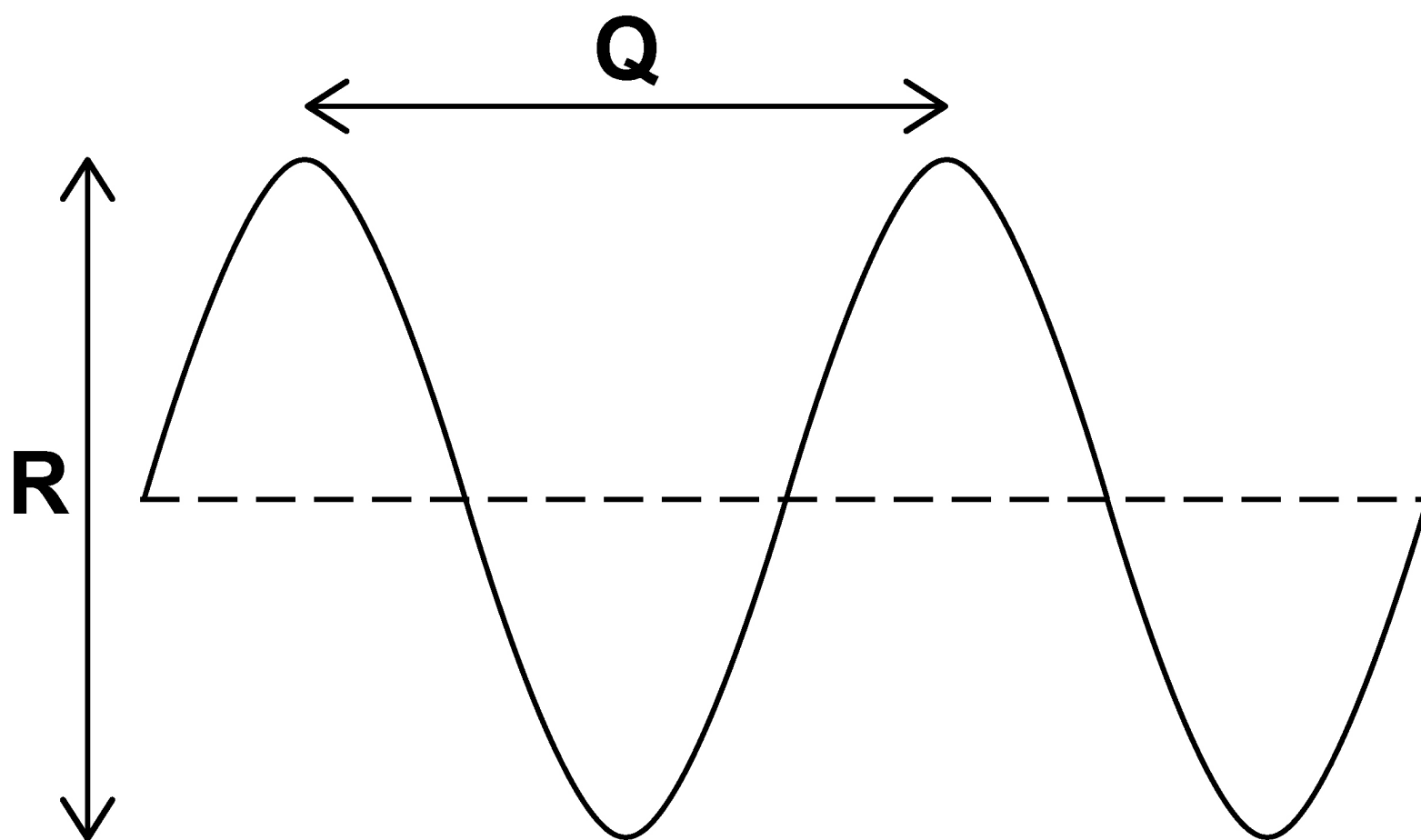


0	5
---	---

Electromagnetic waves are transverse.

FIGURE 13 represents a transverse wave.

FIGURE 13



0	5	.	1
---	---	---	---

Which of the following gives the wavelength of the transverse wave?
[1 mark]

Tick (✓) ONE box.

<input type="checkbox"/>	wavelength = $\frac{Q}{2}$
--------------------------	--

<input type="checkbox"/>	wavelength = Q
--------------------------	-----------------------

<input type="checkbox"/>	wavelength = 2 Q
--------------------------	-------------------------

[Turn over]



0	5	.	2
---	---	---	---

Which of the following gives the amplitude of the transverse wave?
[1 mark]

Tick (✓) ONE box.

☐ amplitude = $\frac{R}{2}$

☐ amplitude = R

☐ amplitude = 2 R

0	5	.	3
---	---	---	---

Microwaves are electromagnetic waves used for mobile phone communications.

**Which other type of electromagnetic wave is also used for communications?
[1 mark]**

Tick (✓) ONE box.

☐

Radio waves

☐

Ultraviolet

☐

X-rays

[Turn over]



0	5	.	4
---	---	---	---

Microwaves from a mobile phone take 0.000 009 s to reach a mobile phone mast.

speed of microwaves = 300 000 000 m/s

Calculate the distance between the mobile phone and the mobile phone mast.

Use the equation:

distance = speed \times time

[2 marks]

Distance = _____ m



0	5	.	5
---	---	---	---

Mobile phone communications is only one of the uses for microwaves.

Give ONE other use of microwaves.
[1 mark]

[Turn over]

<hr/>
6



0	6
---	---

A student investigated the refraction of light through a glass block.

FIGURE 14, on the opposite page, shows the ray box used.

The student aimed the beam of light from the ray box towards a glass block.

The student measured the angle of incidence at the point where the light entered the glass block.

FIGURE 14

**Wide beam
of light**

[Turn over]

BLANK PAGE



0	6	.	1
---	---	---	---

Why is using a wide beam of light less likely to give accurate results than using a narrow beam? [1 mark]

Tick (✓) ONE box.

☐

It will be harder to judge where the centre of the beam is.

☐

It will cause a smaller uncertainty in the measurements.

☐

The angle of refraction will be larger than it should be.

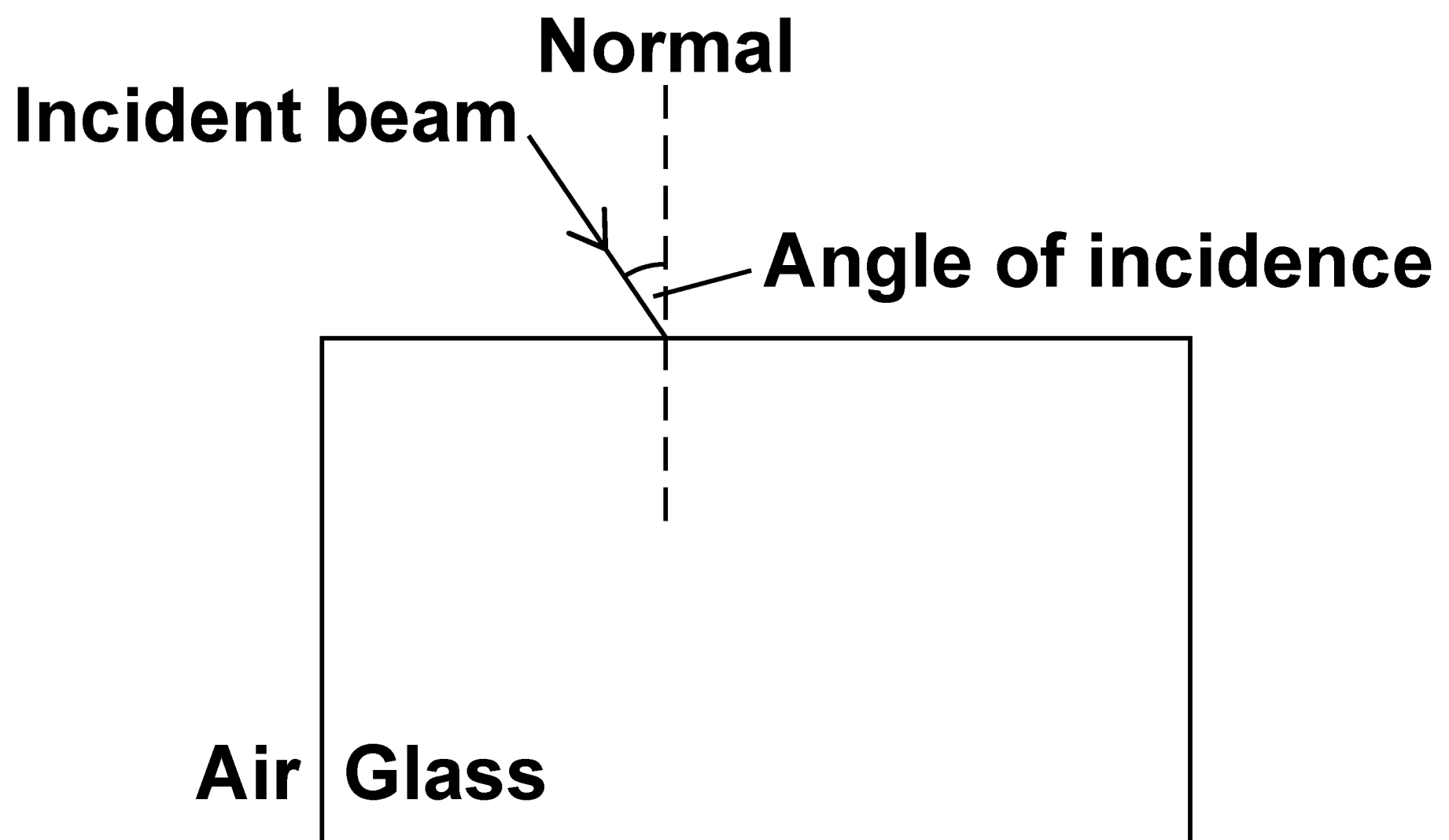
[Turn over]



0	6	.	2
---	---	---	---

FIGURE 15 shows the beam of light incident on the glass block.

FIGURE 15



Complete FIGURE 15, on the opposite page, to show the path taken by the beam of light through the glass block and back into the air.

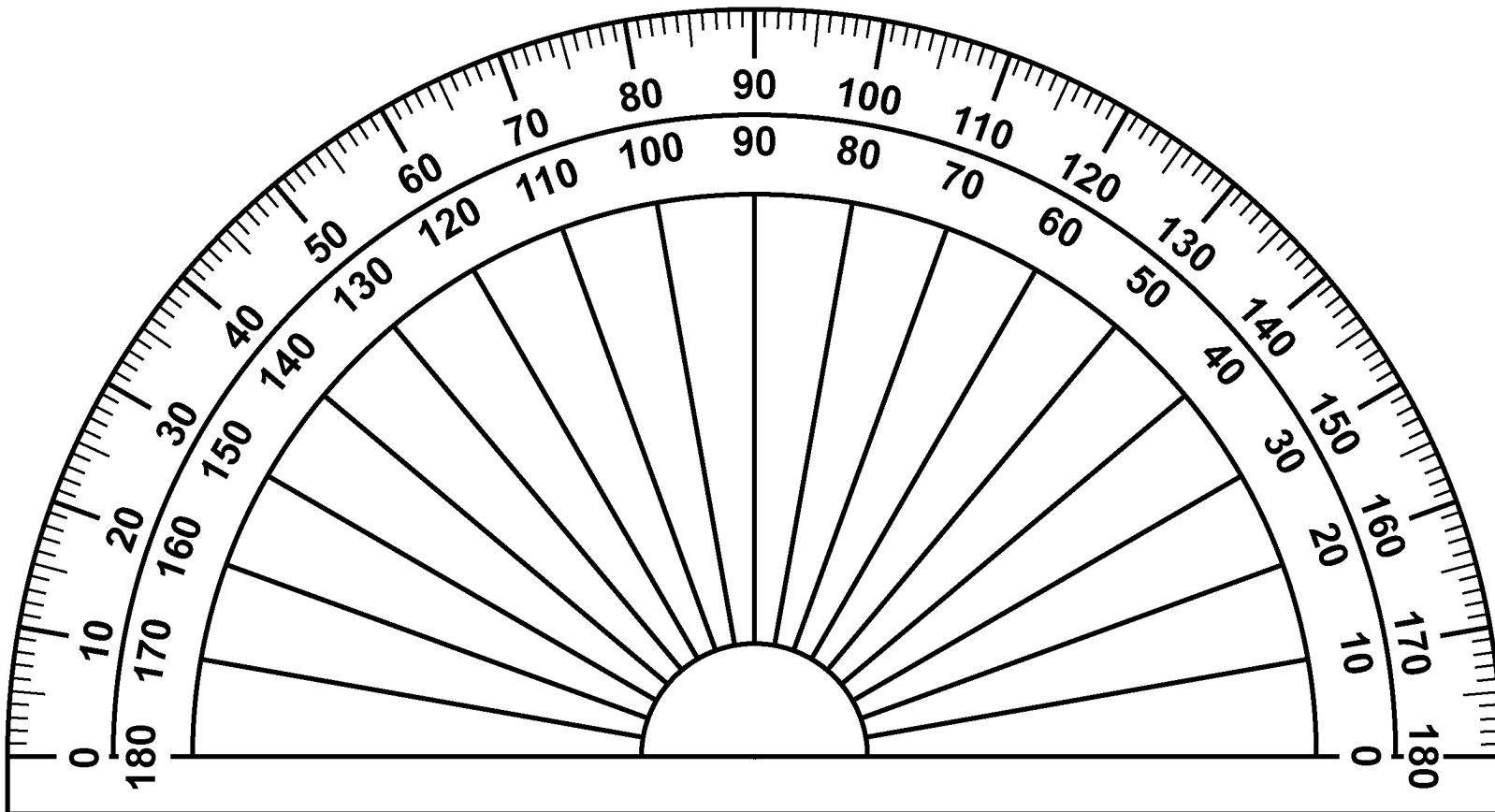
[3 marks]

[Turn over]



FIGURE 16 shows the protractor used by the student.

FIGURE 16



0	6	.	3
---	---	---	---

What is the resolution of the protractor?
[1 mark]

Tick (✓) ONE box.

☐

1 degree

☐

10 degrees

☐

180 degrees

[Turn over]



0	6	.	4
---	---	---	---

For one angle of incidence the student measured the angle of refraction three times.

The three measurements were:

35°

31°

33°

**Calculate the mean angle of refraction.
[1 mark]**

Mean angle of refraction = _____ $^\circ$



The student placed a red filter in front of the white beam of light.

Only red light passes through the filter.

06.5

Complete the sentence. [1 mark]

When white light is incident on the red filter, all colours except for red are _____ by the filter.

[Turn over]



Use the Physics Equations Sheet to answer questions 06.6 and 06.7.

06.6

Write down the equation which links frequency (f), wave speed (v) and wavelength (λ). [1 mark]



0	6	.	7
---	---	---	---

Light has a wave speed of 3.0×10^8 m/s in air.

The frequency of the red light is 4.0×10^{14} Hz.

Calculate the wavelength of the red light in air. [3 marks]

Wavelength = _____ m

[Turn over]

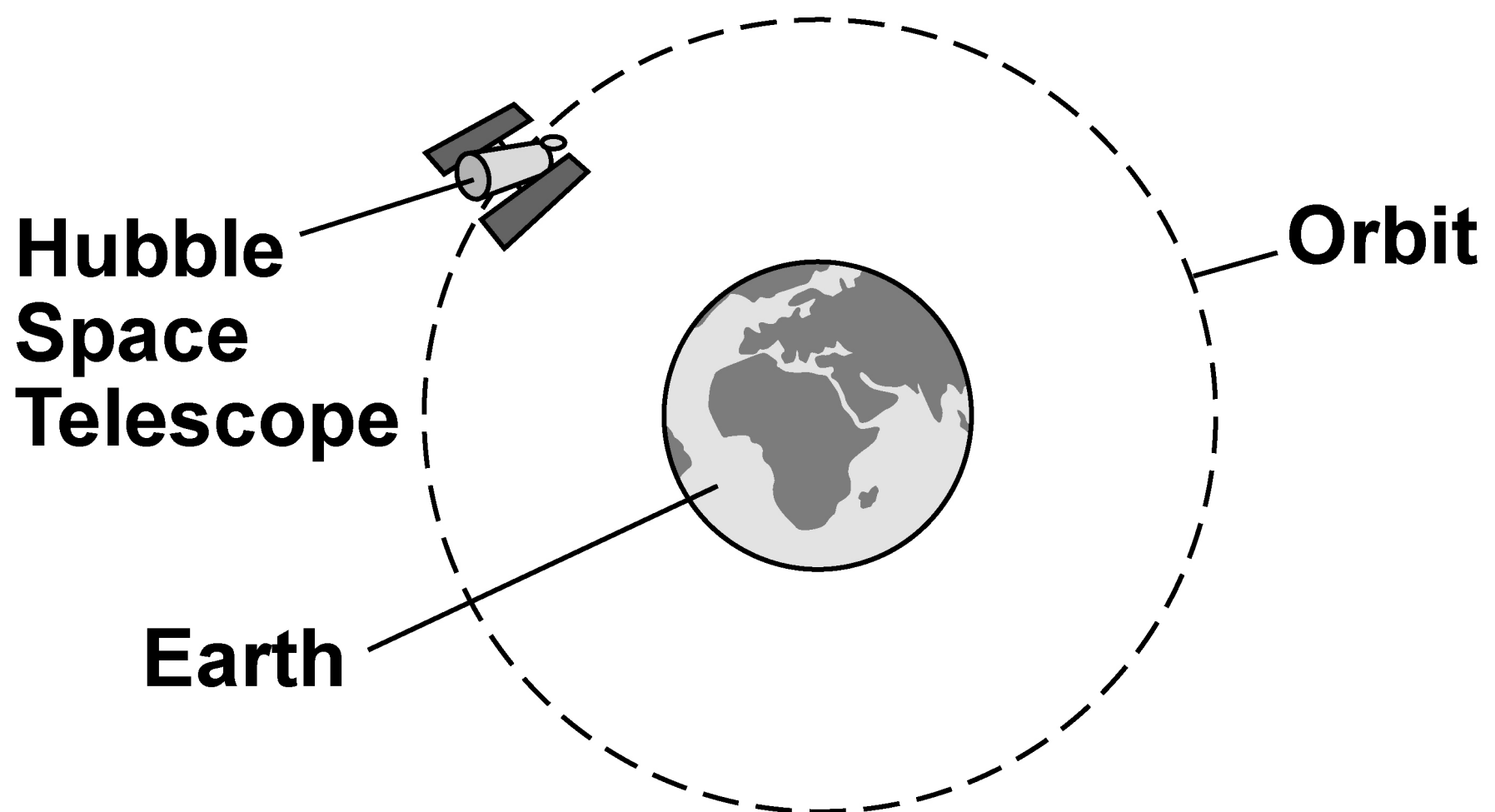
11



0	7
---	---

FIGURE 17 shows the Hubble Space Telescope orbiting the Earth.

FIGURE 17



07.1

What name is given to an object that orbits a planet? [1 mark]

Tick (✓) ONE box.

☐

A comet

☐

A satellite

☐

A star

07.2

The Earth exerts a gravitational force on the Hubble Space Telescope.

Draw an arrow on FIGURE 17, on the opposite page, to show the gravitational force. [1 mark]

[Turn over]

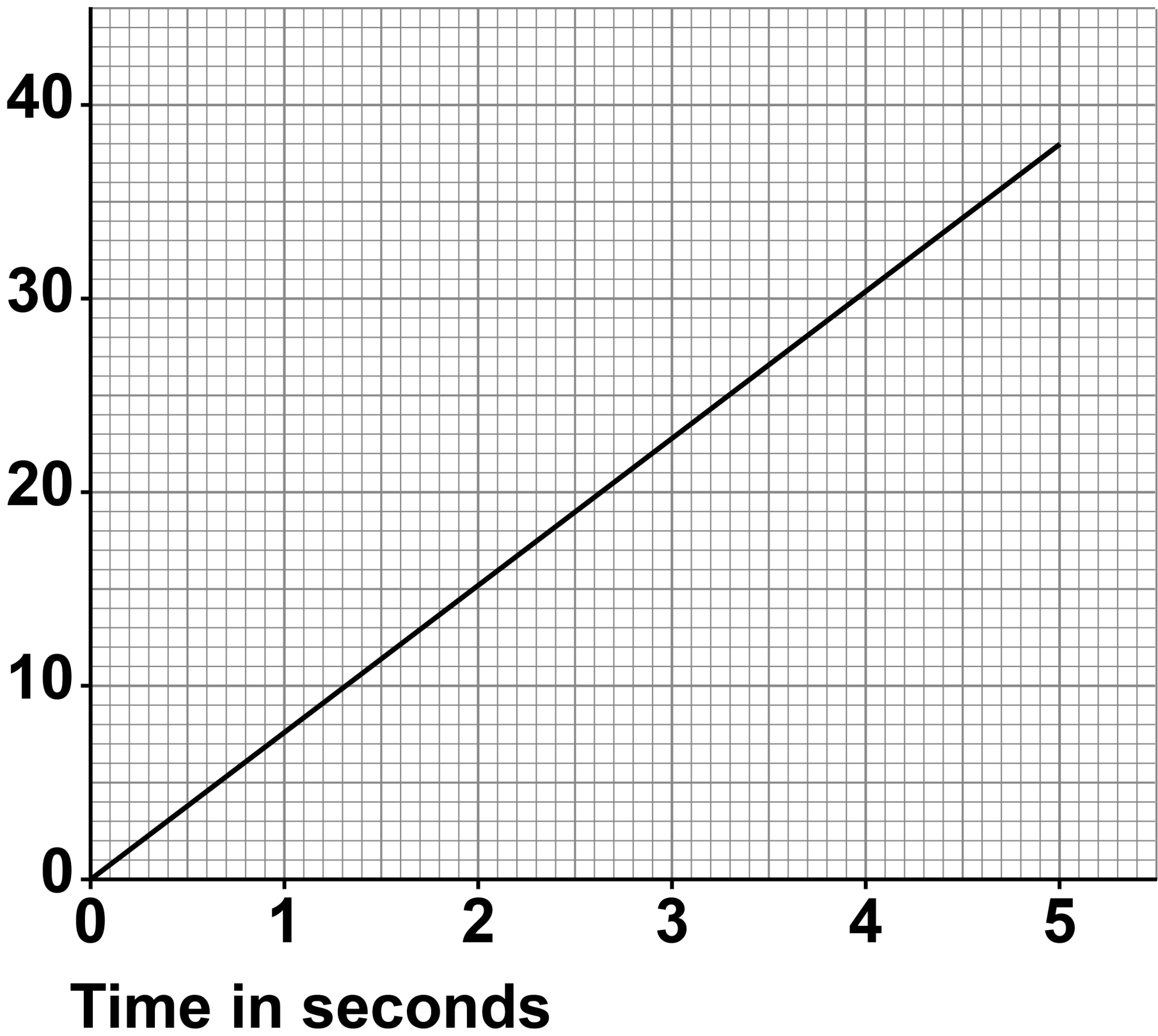


07.3

FIGURE 18 shows how the distance travelled by the Hubble Space Telescope during its orbit changes with time.

FIGURE 18

Distance in kilometres



The gradient of the line in FIGURE 18 gives the speed of the Hubble Space Telescope.

Determine the speed of the Hubble Space Telescope.

Give your answer in km/s. [3 marks]

Speed = _____ km/s

[Turn over]

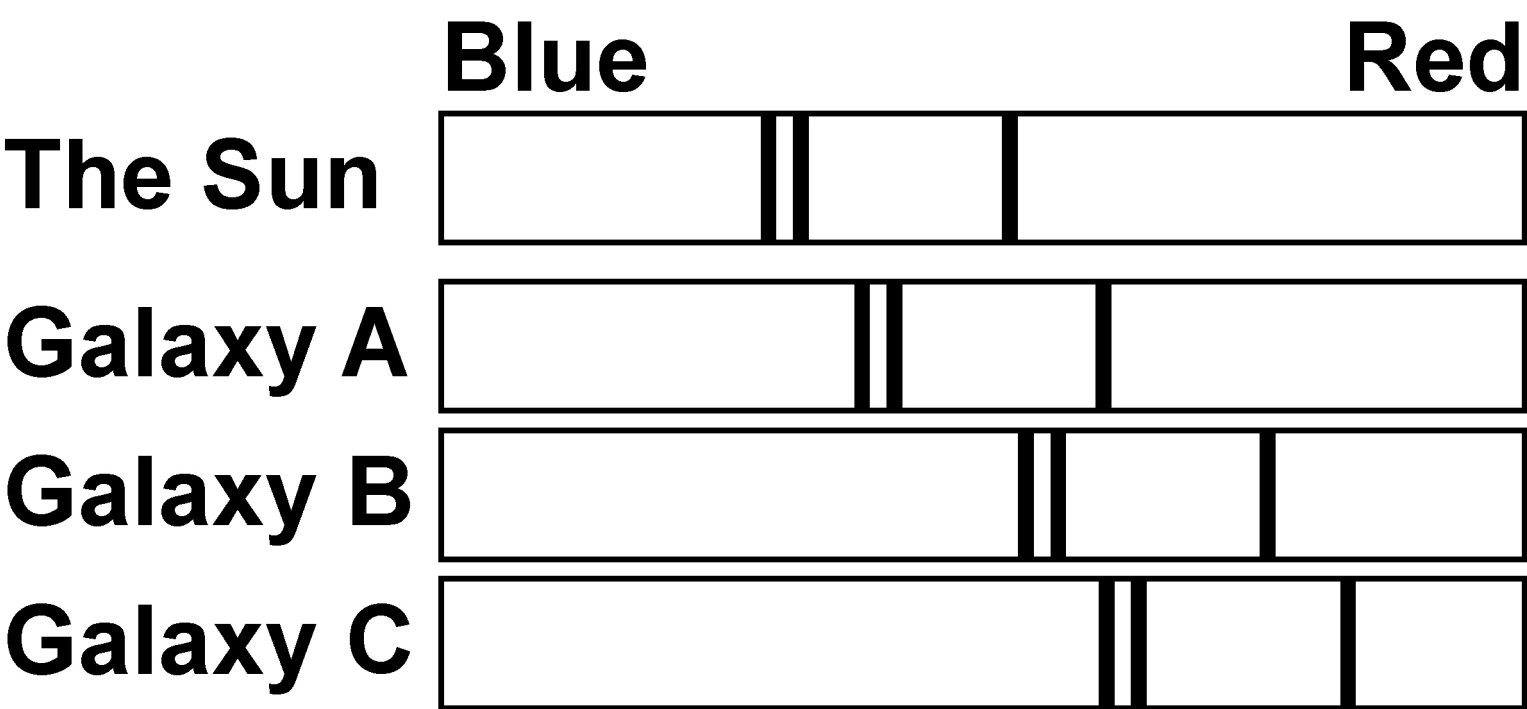


The Hubble Space Telescope can detect the visible light spectra from distant galaxies.

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

FIGURE 19 shows the visible light spectra from the Sun and three galaxies.

FIGURE 19



0	7	.	4
---	---	---	---

Which galaxy is moving away from the Earth the fastest? [1 mark]

Tick (✓) ONE box.

☐

Galaxy A

☐

Galaxy B

☐

Galaxy C

[Turn over]



0	7	.	5
---	---	---	---

Which galaxy is the furthest away from the Earth? [1 mark]

Tick (✓) ONE box.

☐

Galaxy A

☐

Galaxy B

☐

Galaxy C



07.6

New scientific observations indicate that many galaxies rotate too quickly for the known mass of the stars they contain.

Why is it important that new scientific observations are peer reviewed?

[1 mark]

Tick (✓) ONE box.

☐

To check the observations are correct

☐

To identify control variables

☐

To provide more proof

[Turn over]

<hr/>
8



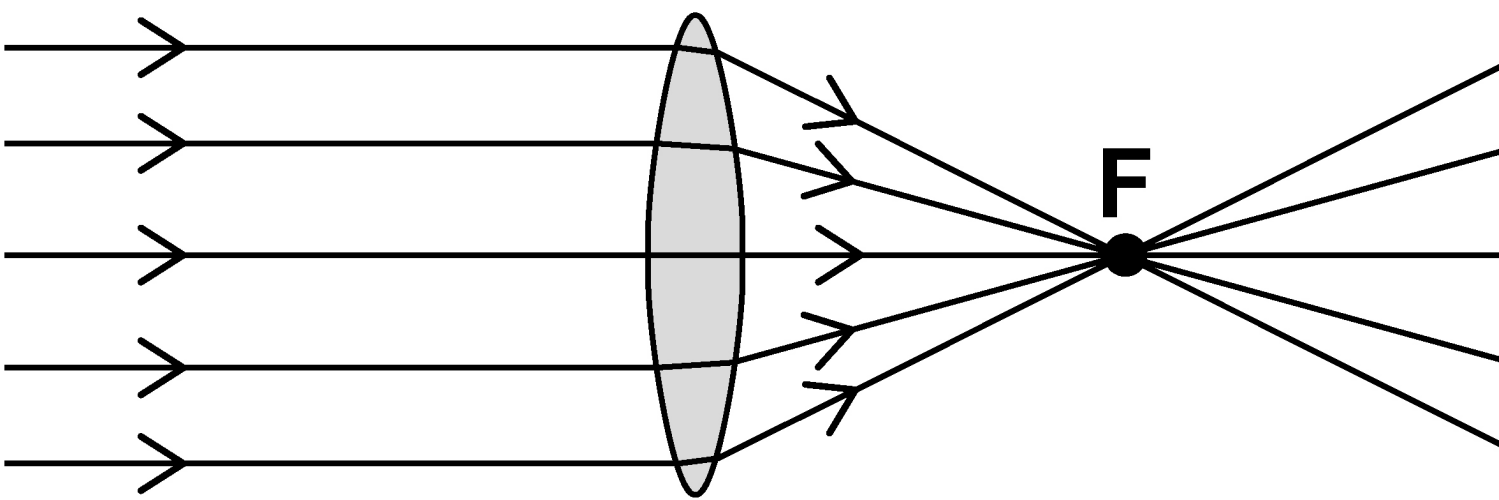
0	8
---	---

Lenses can be used to form an image of an object.

0	8	.	1
---	---	---	---

FIGURE 20 shows parallel rays of light being refracted by a CONVEX lens.

FIGURE 20



What is the position marked 'F' called?
[1 mark]

Tick (✓) ONE box.

☐

Focal length

☐

Focus point

☐

Principal focus

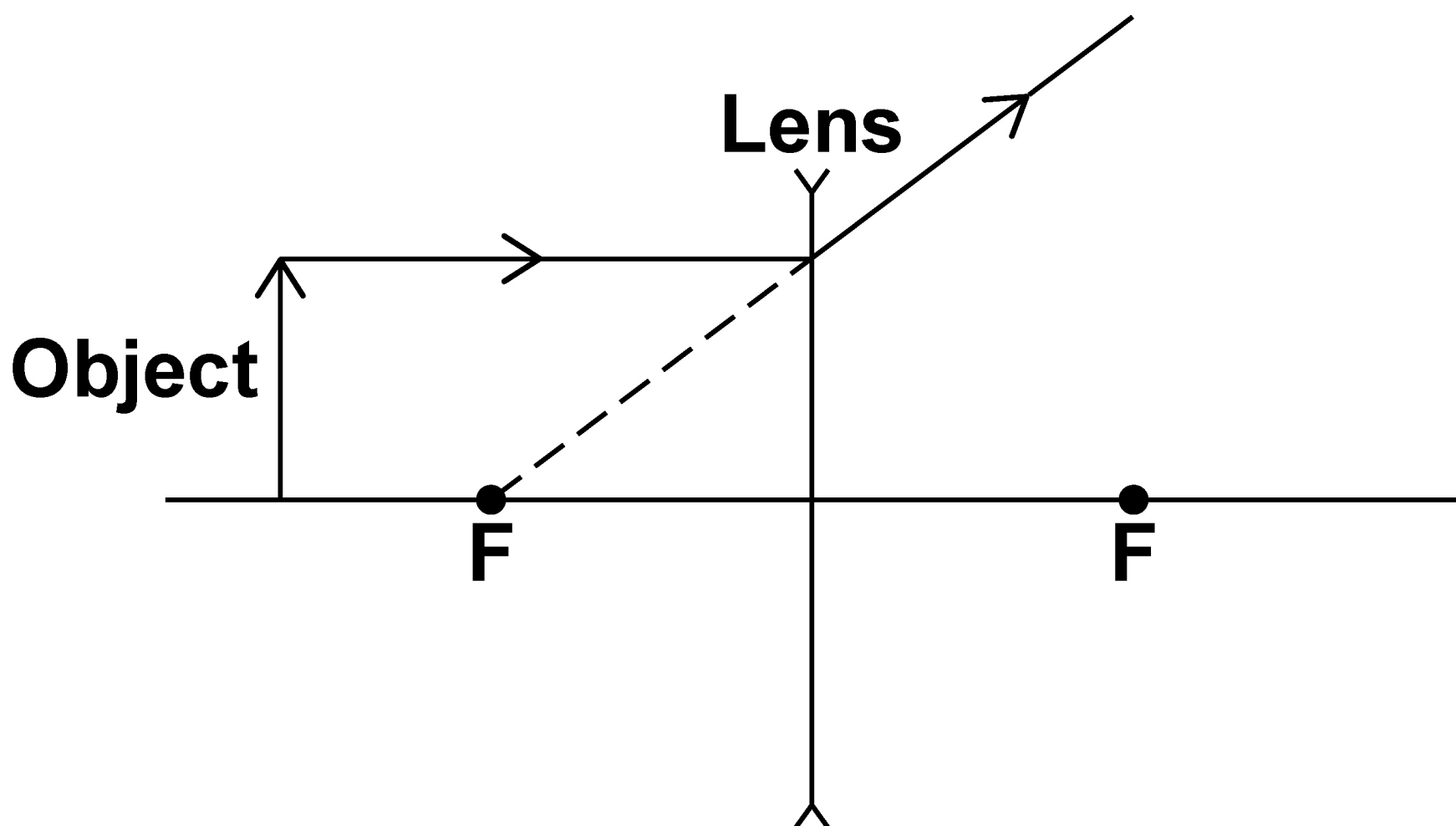
[Turn over]

0	8	.	2
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Complete the ray diagram in FIGURE 21 to show how a **CONCAVE lens forms the image of the object.**

Use an arrow to represent the image.
[2 marks]

FIGURE 21



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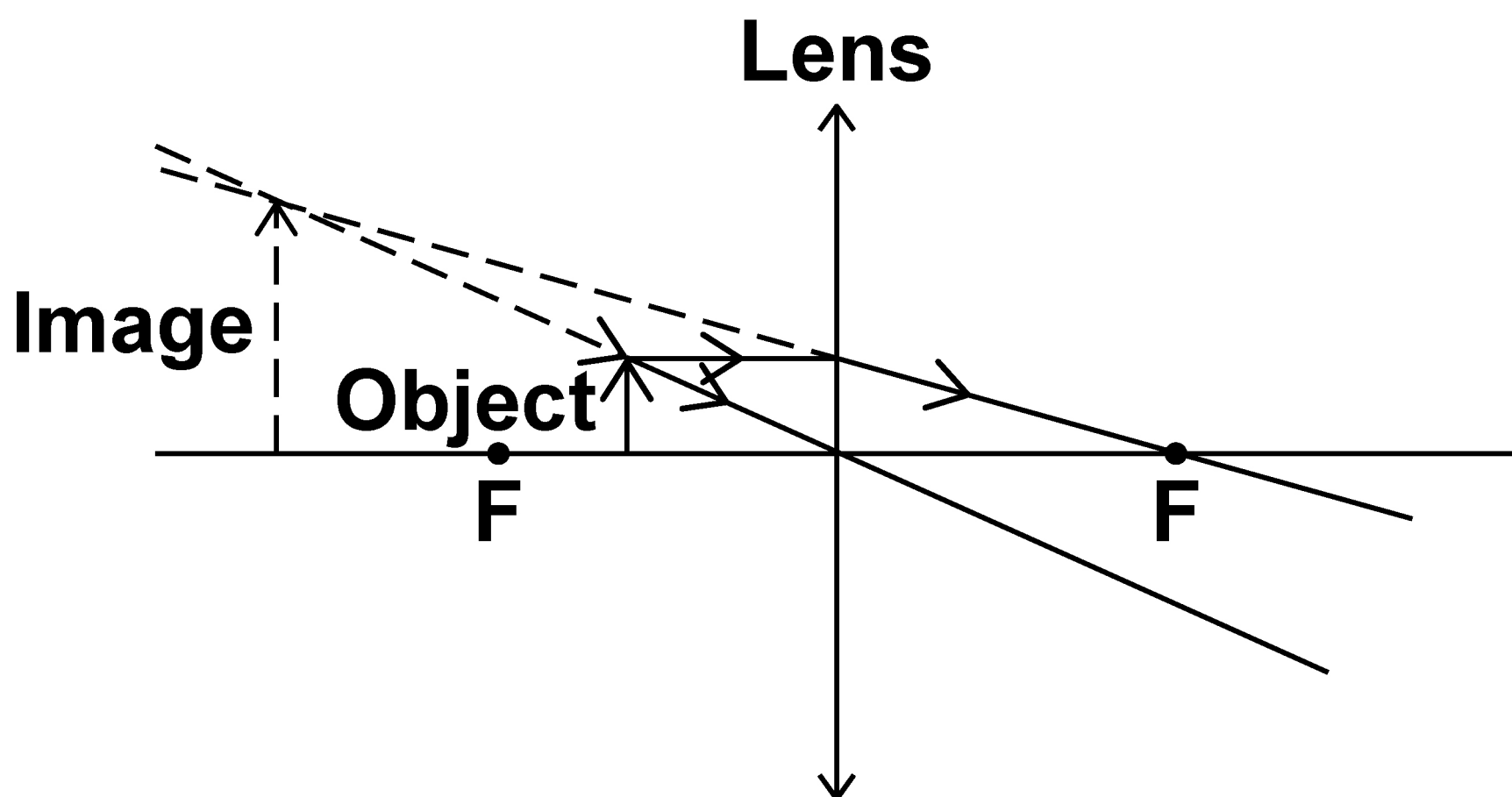
[Turn over]



0	8	.	3
---	---	---	---

FIGURE 22 shows how a **CONVEX** lens can be used to form a magnified image of an object.

FIGURE 22



Give TWO ways that the image formed by the convex lens in FIGURE 22, on the opposite page, is similar to the image formed by the concave lens. [2 marks]

1 _____

2 _____

[Turn over]



0	8	.	4
---	---	---	---

A convex lens is used as a magnifying glass to identify a symbol on the back of a silver spoon.

The symbol has an actual height of 1.6 mm.

The magnification produced by the lens is 3.5

Calculate the image height of the symbol when viewed through the magnifying glass.

**Use the Physics Equations Sheet.
[3 marks]**

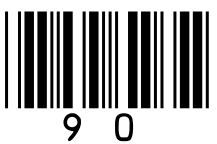


Image height = _____ mm

[Turn over]

8

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0	9
---	---

Infrared waves are transverse waves.

0	9	.	1
---	---	---	---

Complete the sentence. [1 mark]

In a transverse wave, the direction of oscillation is _____

to the direction of energy transfer by the wave.

[Turn over]

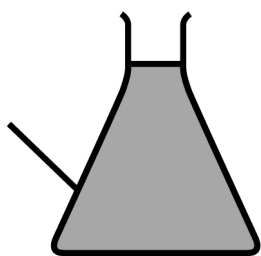


A student investigated how the colour of a surface affects the rate at which the surface emits infrared radiation.

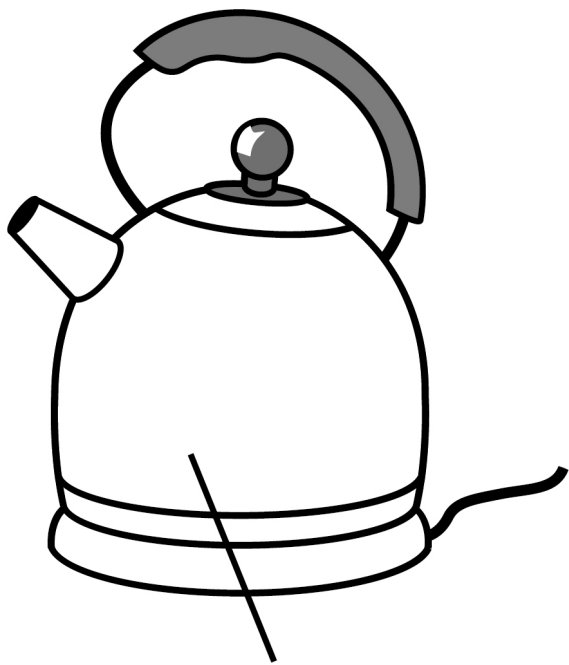
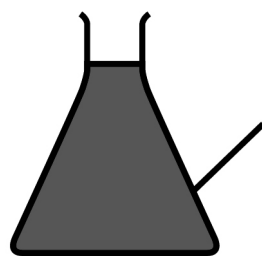
FIGURE 23 shows some of the equipment used.

FIGURE 23

**Silver-
coloured
flask**



**Black-
coloured
flask**



Kettle of cold water

0	9	.	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]

[Turn over]



[illegible]

[Turn over]



0	9	.	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 _____

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[Turn over]



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	9	.	4
---	---	---	---

What was the dependent variable in this investigation? [1 mark]

[Turn over]

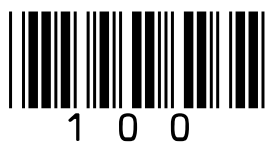


09.5

TABLE 2 shows the results.

TABLE 2

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 2. [2 marks]

1 _____

2 _____

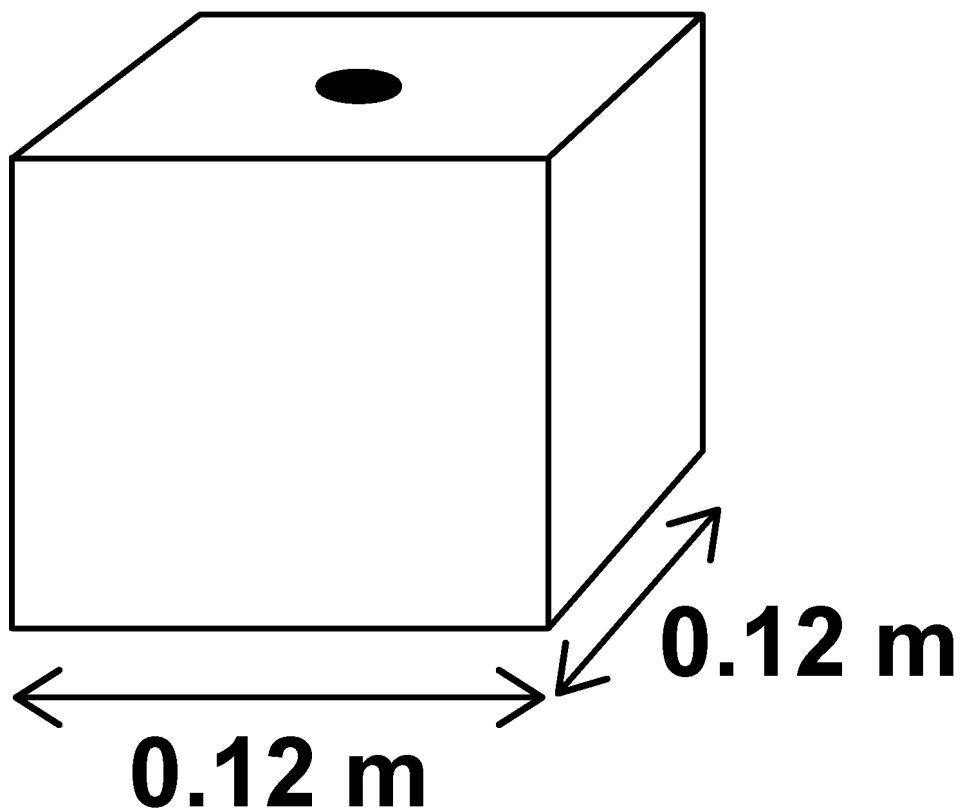
[Turn over]



FIGURE 24 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 24



Use the Physics Equations Sheet to answer questions 09.6 and 09.7.

09.6

Which equation correctly links area, force and pressure? [1 mark]

Tick (✓) ONE box.

☐

pressure = force \times area²

☐

pressure = force \times area

☐

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

☐

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

[Turn over]



0	9	.	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]

Force = _____ N

17



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[Turn over]



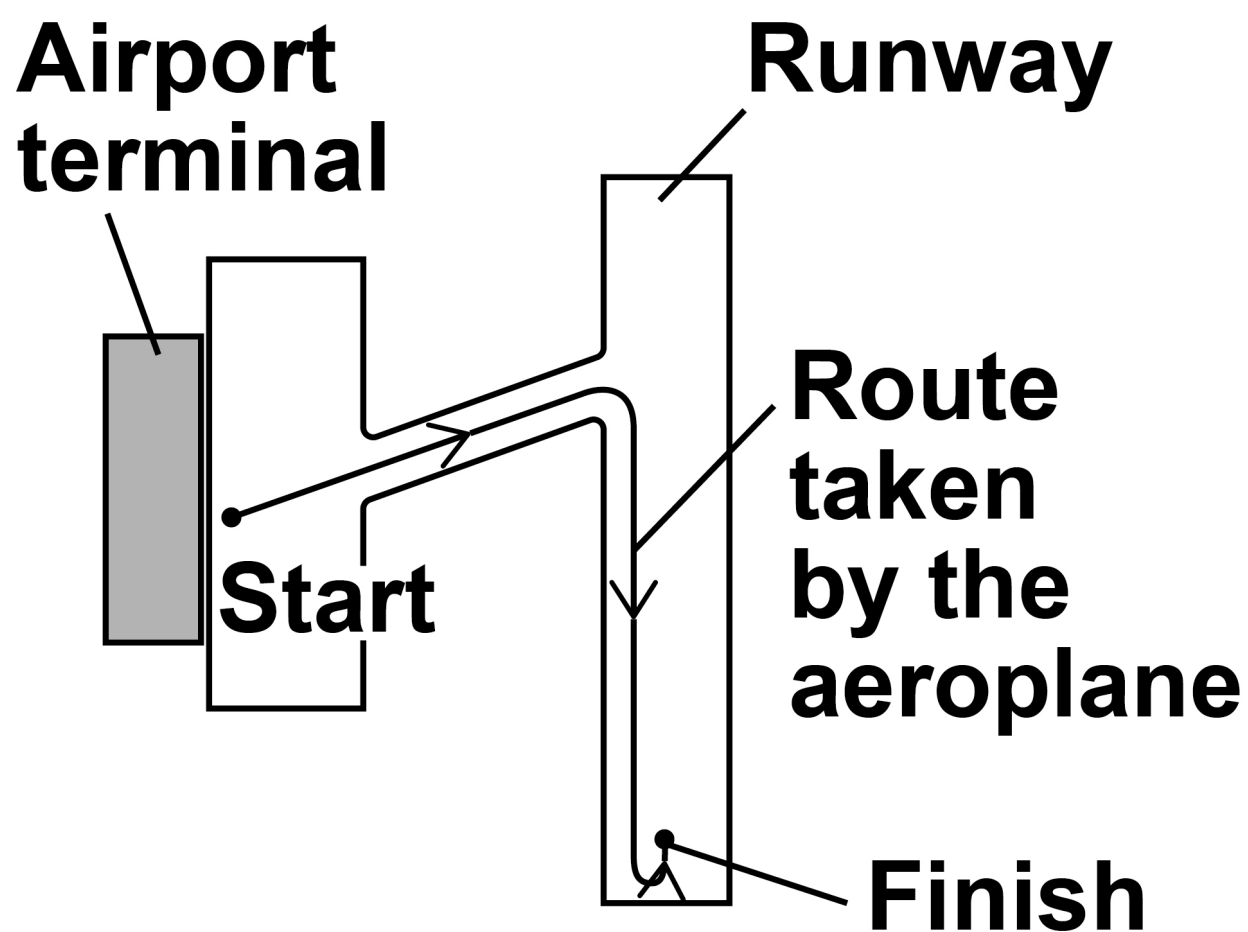
1	0
---	---

FIGURE 25 shows the route an aeroplane takes as it travels from an airport terminal to the runway.

FIGURE 25 has been drawn to scale.

FIGURE 25

Scale: 1 cm represents 70 m



1	0	.	1
---	---	---	---

Determine the magnitude of the aeroplane's displacement from the start point to the finish point on FIGURE 25.
[2 marks]

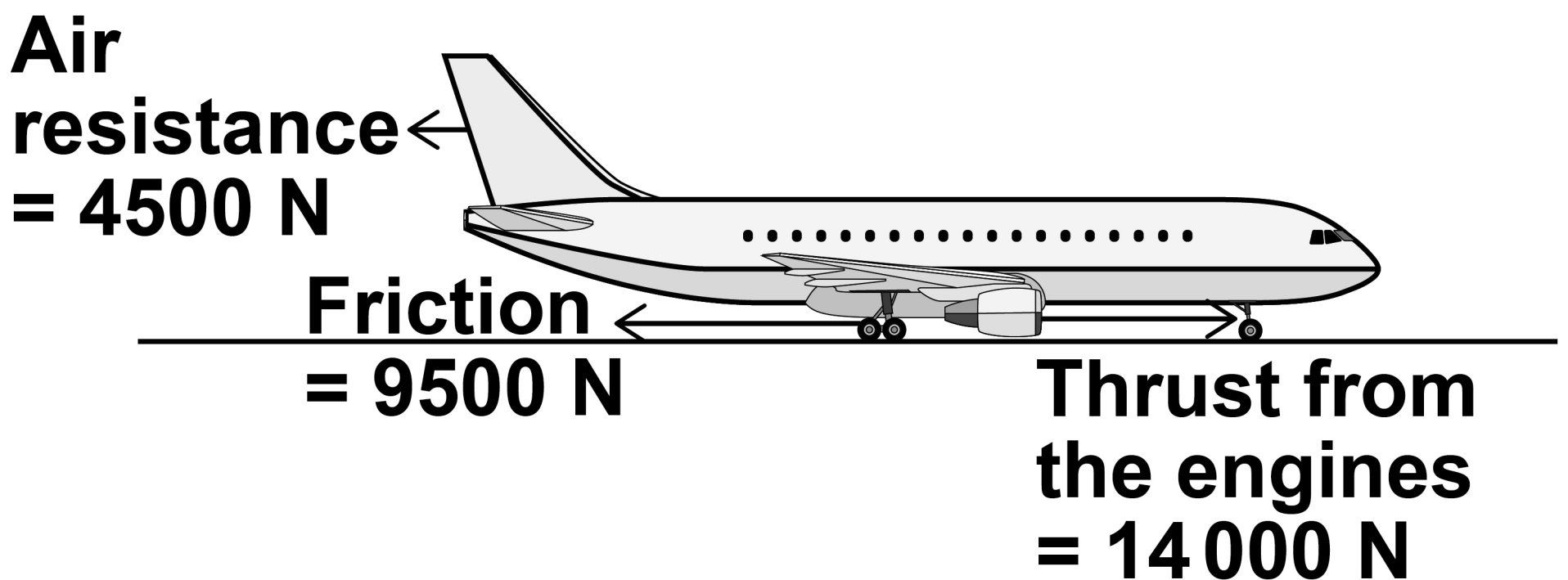
Displacement = _____ m

[Turn over]



FIGURE 26 shows the direction of the horizontal forces acting on the aeroplane as it moves in a straight line towards the runway.

FIGURE 26



1	0	.	2
---	---	---	---

Determine the magnitude of the resultant horizontal force on the aeroplane.

[1 mark]

Resultant horizontal force =

_____ N

[Turn over]



1	0	.	3
---	---	---	---

Describe the motion of the aeroplane as it moves towards the runway. [1 mark]

1	0	.	4
---	---	---	---

Air resistance and friction are contact forces.

Give ONE other example of a contact force. [1 mark]



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[Turn over]



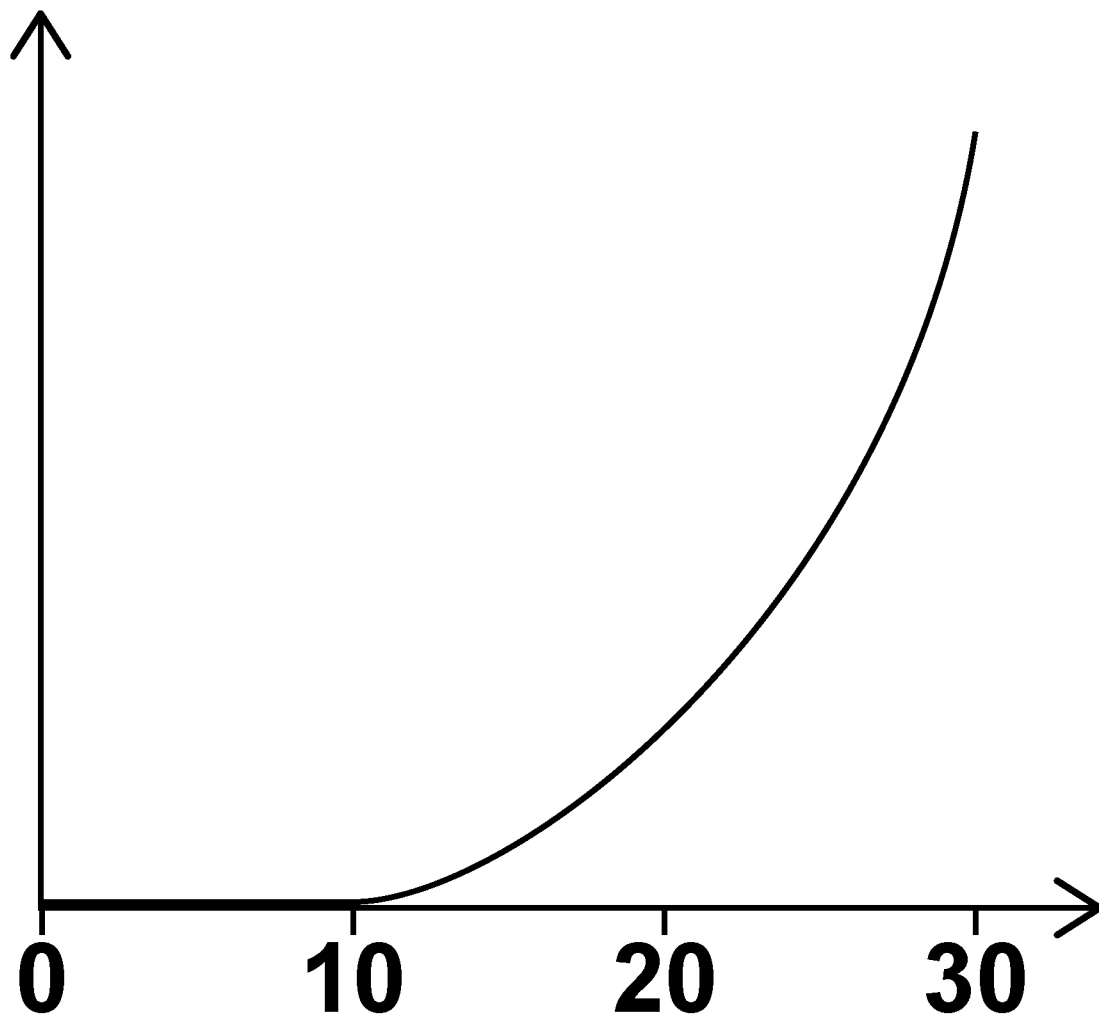
10.5

The aeroplane stops for a short time and then accelerates along the runway.

FIGURE 27 shows a distance–time sketch-graph for this stage of the journey.

FIGURE 27

Distance

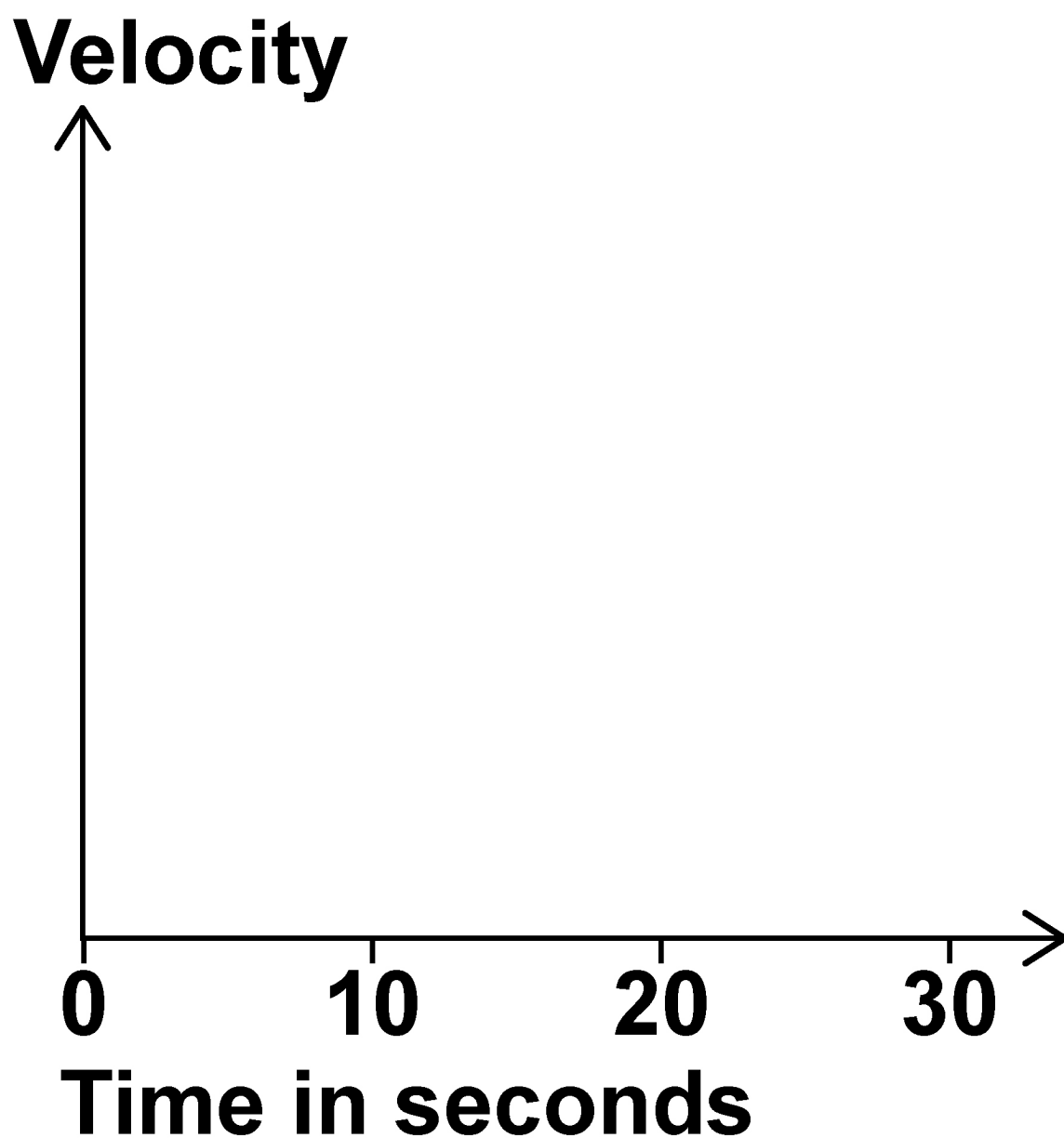


Time in seconds



Draw the velocity–time sketch-graph for this stage of the journey on FIGURE 28.
[2 marks]

FIGURE 28



[Turn over]



10.6

The aeroplane takes off from the runway, so its height above the ground increases.

FIGURE 29, on the opposite page, shows how atmospheric pressure varies with the height of the aeroplane above the ground.

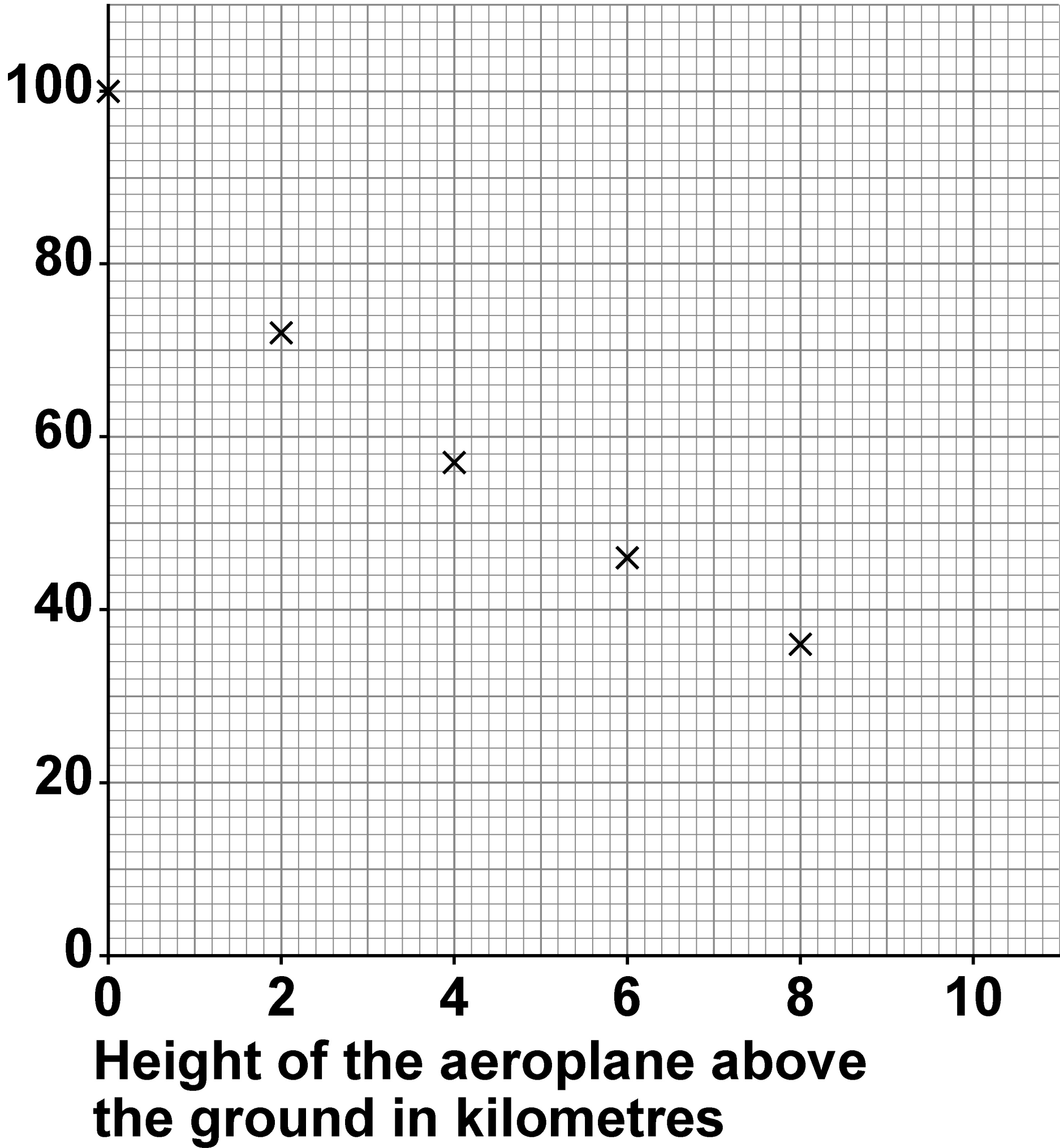
Estimate the atmospheric pressure when the height of the aeroplane above the ground is 10 km. [2 marks]

Atmospheric pressure = _____ kPa



FIGURE 29

Atmospheric pressure
in kilopascals



[Turn over]



1	0	.	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.

END OF QUESTIONS

<hr/>
10



Additional page, if required.
Write the question numbers in the left-hand margin.

Additional page, if required.

Write the question numbers in the left-hand margin.

This image shows a blank sheet of white paper with horizontal ruling lines. A single vertical line runs down the left side, creating a margin. There are 20 horizontal lines in total, evenly spaced across the page. The lines are thin and black.

Additional page, if required.

Write the question numbers in the left-hand margin.

[illegible]

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Question	Mark
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