AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

GCSE
PHYSICS

H

Higher Tier Paper 2

Friday 15 June 2018 Morning Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a scientific calculator
- the Physics Equation Sheet (enclosed).

Instructions
- Use black ink or black ball-point pen.
- Fill in the box at the top of this page.
- Answer **all** questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- 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.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

Do not write outside the box

0 1 A child drops a ball.

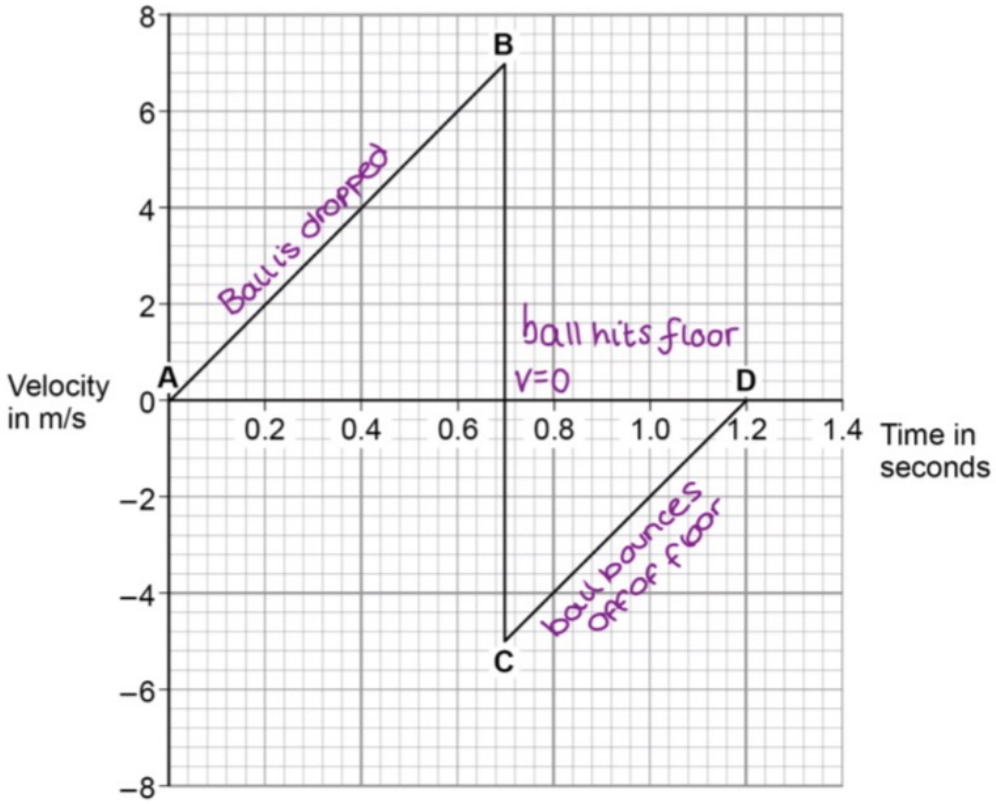
The ball hits the ground and bounces.

Figure 14 shows the velocity-time graph for the ball from when the ball is dropped until when the ball reaches the top of its first bounce.

Air resistance has been ignored.

A → B
Straight line with a constant gradient

Figure 14



0 1 . 1 Describe the motion of the ball between points **A** and **B** on **Figure 14**.

[2 marks]

gradient
m = acceleration $m = \frac{\Delta y}{\Delta x} = \frac{ms^{-1}}{s} = ms^{-2}$

uniform acceleration ← velocity is increasing at a constant rate
↑ constant – shown by straight line

0 1 . 2 What direction is the ball moving between points **C** and **D** on **Figure 14**?

[1 mark]

A→B
C→D
when ball hits floor

Upwards

The ball has a positive velocity when falling downwards (between A and B)

Do not write outside the box

0 1 . 3 The ball and the Earth form a system.

What is meant by 'a system'?

Tick **one** box.

[1 mark]

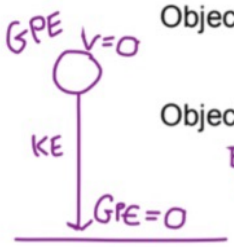
The objects in a system interact.
A group of objects that interact. ☑

Objects with big differences in mass. ☐

They do have a large difference in mass, but this doesn't determine whether or not the two are a system.

Objects with gravitational potential energy. ☐

Energy transfers do occur in systems, but again, this isn't the determining feature of a system.



0 1 . 4 When the ball hits the ground, energy is transferred from the ball to the Earth.

Explain how the data in **Figure 14** shows this energy transfer.

[4 marks]

Velocity just after bounce is less than velocity just before. (height at the top of the bounce is less than height dropped from). (1)

The ball has lost kinetic energy. (1) It will have a reduced maximum GPE after the bounce. (1)

The total energy of the ball and Earth is constant (1)
↑ energy is conserved

8

Turn over for the next question

Do not write outside the box

0 2 A student carried out an investigation to determine the spring constant of a spring.

Table 4 gives the data obtained by the student.

Table 4

Force in N	Extension in cm
0	0.0
2	3.5
4	8.0
6	12.5
8	16.0
10	20.0

force applied to spring (2N weights)

from rest position

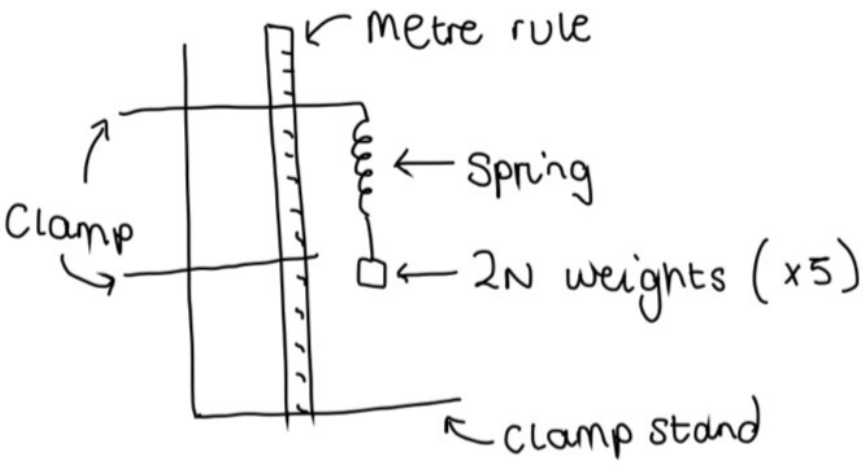
0 2 . 1 Describe a method the student could have used to obtain the data given in **Table 4**.

Your answer should include any cause of inaccuracy in the data.

Your answer may include a labelled diagram.

[6 marks]

logically arranged and detailed method required to obtain all marks here.



Set up the apparatus in the diagram above (spring hanging from clamp on a clamp stand with a ruler clamped beside it).

- Record the position of the bottom of the spring on the ruler ← rest / equilibrium position
- Hang the first 2N weight from the spring
- Measure the extension of the spring (new length − rest length)
- Add 2N weights, finding the extension (from the rest position) each time.

Do not write outside the box

These don't all need to be mentioned and could be included within the answer

Possible sources of inaccuracy:

- Holding the ruler as opposed to clamping it
- Not holding / clamping the ruler vertically
- Misjudging the position of the bottom of the spring
- Parallax error when reading measurements off of the ruler.

repeat measurements

0 2 . 2 The student measured the extension for five different forces rather than just measuring the extension for one force.

Suggest why.

[1 mark]

To identify any anomalous results

(to reduce the effect of random error – you could calculate an average from all of the reliable results).

Question 2 continues on the next page

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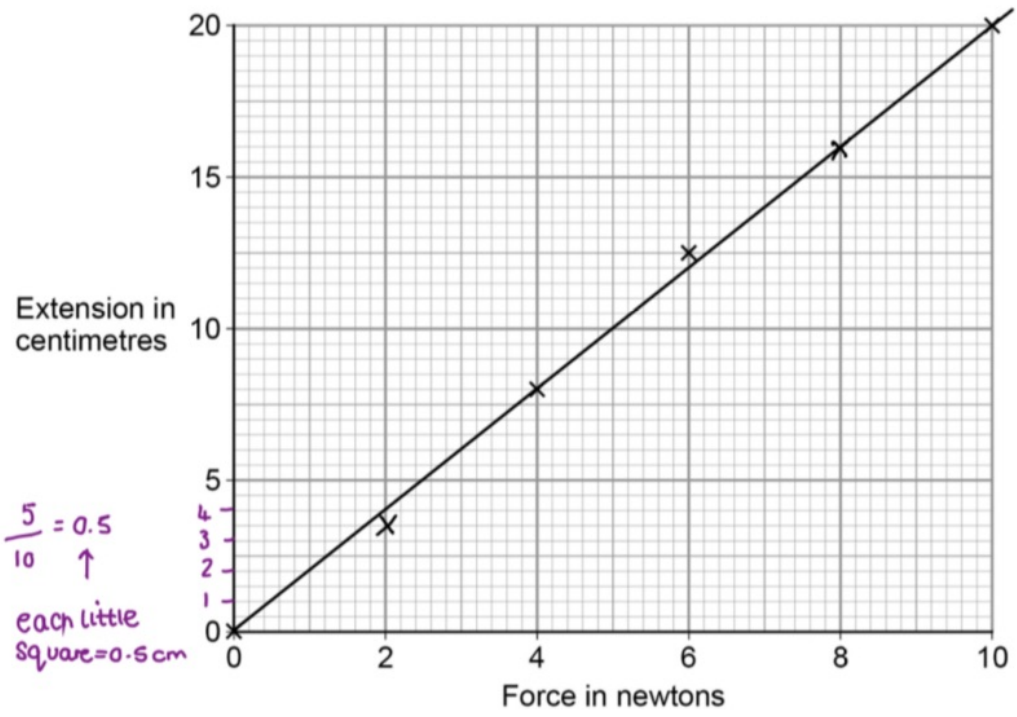
Figure 15 shows some of the data obtained by the student.

Figure 15



0 2 . 3 Complete **Figure 15** by plotting the missing data from **Table 4.**

Draw the line of best fit.

Table 4 is repeated here to help you answer this question.

[2 marks]

graph axis = x y

Table 4

Force in N	Extension in cm
0	0.0
2	3.5
4	8.0
6	12.5
8	16.0
10	20.0

Plot • (2, 3.5)

Plot • (8, 16.0)

ΔL F k

0 2 . 4 Write down the equation that links extension, force and spring constant.

[1 mark]

F ∝ L k

F = L k

Force = spring constant × extension

F = k ΔL

Do not write outside the box

0 2 . 5 Calculate the spring constant of the spring that the student used.

Give your answer in newtons per metre. Nm^{-1}

[4 marks]

$F = k\,\Delta L$ ← e

F / ΔL $\quad \frac{\Delta y}{\Delta x} = \frac{F}{\Delta L} = k$

$10 = k \times 20\text{cm}$ ← $\times 10^{-3}$ (1)

0.20m

$10\text{N} = 0.20\text{m} \times k$ (1)

$k = \frac{10\text{N}}{0.20\text{m}}$ (1) N/m

$k = 50$ (1)

Spring constant = 50 N/m

looking for a straight line graph which goes through the origin

0 2 . 6 Hooke's Law states that:

'The extension of an elastic object is directly proportional to the force applied, provided the limit of proportionality is not exceeded.'

ΔL / F $\quad F \propto \Delta L$

The student concluded that over the range of force used, the spring obeyed Hooke's Law.

Explain how the data supports the student's conclusion.

[2 marks]

the line is straight (1)

and passes through the origin (1)

16

Turn over for the next question

Do not write outside the box

0 3 P-waves and S-waves are two types of seismic wave caused by earthquakes.

P - longitudinal ↑ tran S ver Se ∿∿∿

0 3 . 1 Which **one** of the statements about P-waves and S-waves is correct?

P → has a long stem

Tick **one** box.

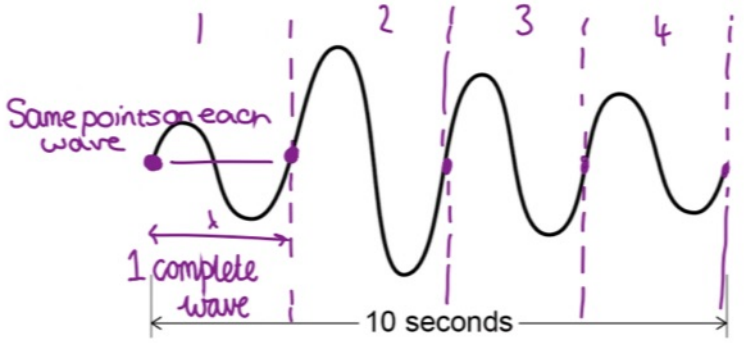
[1 mark]

- P-waves and S-waves are transverse. ☐
- P-waves and S-waves are longitudinal. ☐
- P-waves are transverse and S-waves are longitudinal. ☐
- P-waves are longitudinal and S-waves are transverse. ☑

Seismometers on the Earth's surface record the vibrations caused by seismic waves.

Figure 16 shows the vibration recorded by a seismometer for one P-wave.

Figure 16



number of waves to pass a fixed point each second

0 3 . 2 Calculate the frequency of the P-wave shown in **Figure 16**.

[1 mark]

4 waves = 10s

÷10 ↓ 4/10 = 1s ↓ ÷10 = 0.4

Frequency = 0.4 s^{-1} Hz

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0 3 . 3 Write down the equation which links frequency, wavelength and wave speed.

[1 mark]

$v = f\lambda$ Velocity = wavelength × frequency

Units (check) = $ms^{-1} = (Hz) \times m = ms^{-1}$ ($s^{-1} \times m = ms^{-1}$)

0 3 . 4 The P-wave shown in **Figure 16** is travelling at 7200 m/s.

Calculate the wavelength of the P-wave.

[3 marks]

$v = f\lambda$ ← from previous part of qu

$7200\ ms^{-1} = 0.4\ Hz \times \lambda$ (1)

÷0.4 ↓ ÷0.4

$\lambda = \frac{7200\ ms^{-1}}{0.4\ s^{-1}} = m$ (1) $\lambda = 18000$

Wavelength = 18000 (1) m

0 3 . 5 Explain why the study of seismic waves provides evidence for the structure of the Earth's core.

[2 marks]

Liquid (outer core) ↑ seismic waves are detected by seismometers around the Earth – data from these is analysed ↑ Produced by Earthquakes / explosions

Because S-waves cannot travel through a liquid (1) and S-waves do not travel through the Earth's outer core (1)

Question 3 continues on the next page

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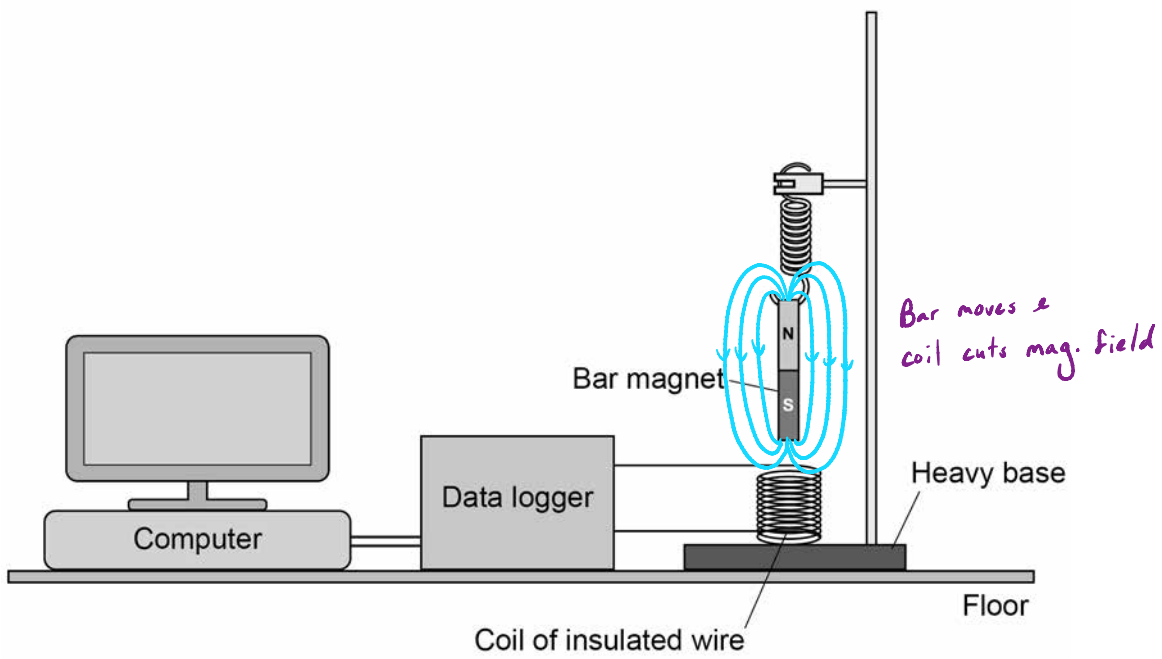
Figure 4 shows a simple seismometer made by a student.

Figure 4



To test that the seismometer works, the student pushes the bar magnet into the coil and then releases the bar magnet.

0 3 . 6 Why does the movement of the bar magnet induce a potential difference across the coil?

[1 mark]

The magnetic field around the coil changes.
OR The coils cut through the magnetic field.

0 3 . 7 Why is the induced potential difference across the coil alternating?

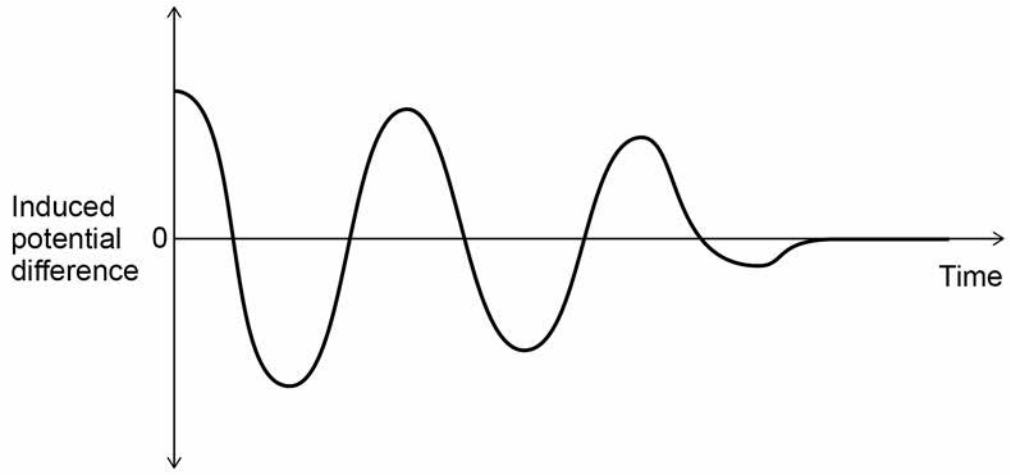
[1 mark]

Because the magnet changes direction.
↳ current induced in opposite direction when bar moves up than when it moves down.

Do not write outside the box

0 3 . 8 **Figure 5** shows how the potential difference induced across the coil varies after the bar magnet has been released.

Figure 5



Which statement describes the movement of the magnet when the induced potential difference is zero?

Tick **one** box.

[1 mark]

Accelerating upwards. ☐

Constant speed upwards. ☐

Decelerating downwards. ☐

Stationary. ☑

0 3 . 9 The seismometer cannot detect small vibrations.

Suggest **two** changes to the design of the seismometer that would make it more sensitive to small vibrations.

[2 marks]

1 Stronger magnetic field.

2 More turns on the coil.

OR: • turns pushed closer together • spring with a lower spring constant.

13

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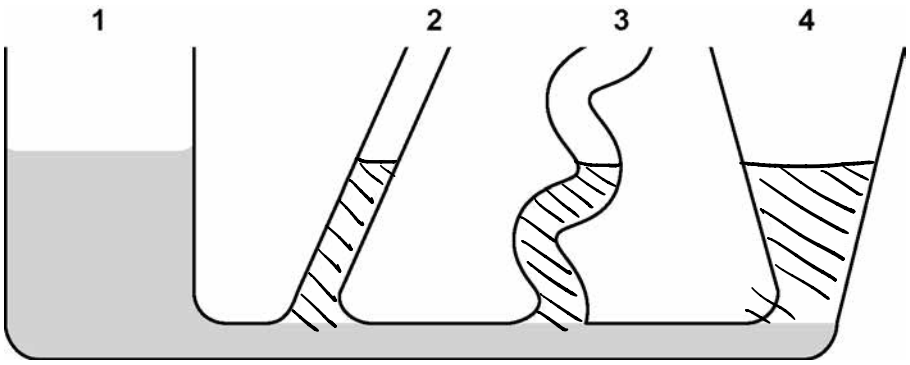
0 4 **Figure 6** shows an unusually shaped container.

The container has four vertical tubes of different shape and size.

Figure 6



↳all same container so will fill up to same level throughout

Water is poured into the container up to the level shown in tube **1**.

0 4 . 1 Complete **Figure 6** to show the height of the water in tubes **2**, **3** and **4**.

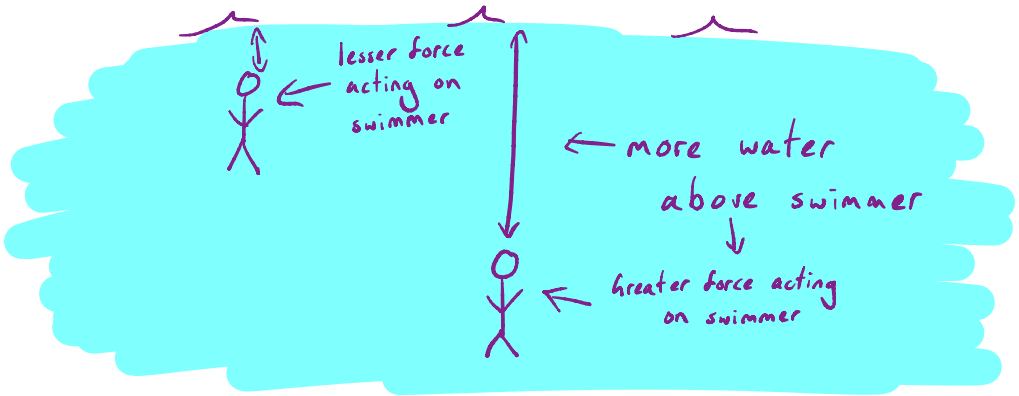
[1 mark]

0 4 . 2 The further a swimmer dives below the surface of the sea, the greater the pressure on the swimmer.

Explain why.

[2 marks]

The volume of water above the swimmer increases and so the weight of the water acting on the swimmer also increases.



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0 4 . 3 A person swims from a depth of 0.50 m to a depth of 1.70 m below the surface of the sea.

↳height of column

density of the sea water = 1030 kg/m^3

gravitational field strength = 9.8 N/kg

Calculate the increase in pressure on the swimmer.

Give the unit.

Use an equation from the Physics Equation Sheet.

[4 marks]

('rho')

$p = h\rho g$ $\quad \Delta h = 1.70 - 0.50 = 1.20\text{ m}$

$p = 1.20 \times 1030 \times 9.8 = 12112.8$

Increase in pressure = 12112.8 Unit Pa

N/m^2

7

→ pressure due to a column of liquid = height of column × density of liquid × gravitational field strength (g)

Turn over ►

Do not write outside the box

0 5 **Figure 7** shows the apparatus a student used to investigate the reflection of light by a plane mirror.

The student drew four ray diagrams for each angle of incidence.

The student measured the angle of reflection from each diagram.

Table 2 gives the student's results.

Figure 7

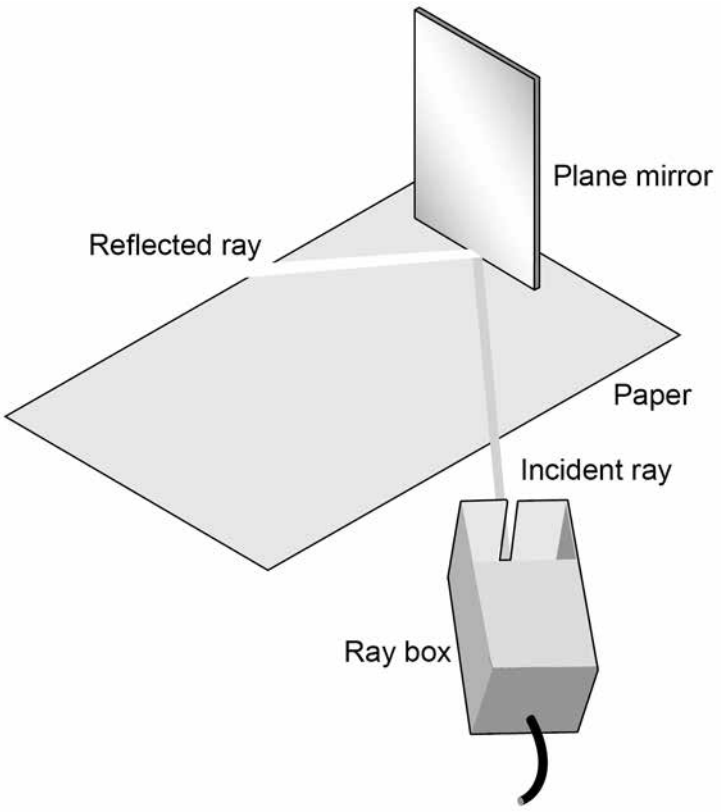

Table 2

	Angle of reflection			
Angle of incidence	**Test 1**	**Test 2**	**Test 3**	**Test 4**
20°	19°	22°	20°	19°
30°	31°	28°	32°	30°
40°	42°	40°	43°	41°
50°	56°	49°	53°	46°

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0 5 . 1 For each angle of incidence, the angle of reflection has a range of values.

This is caused by an error.

What type of error will have caused each angle of reflection to have a range of values?

[1 mark]

random error

0 5 . 2 Suggest what the student may have done during the investigation to cause each angle of reflection to have a range of values.

[1 mark]

Misjudging the centre of the ray.
OR not placing the mirror/ray box in the same position each time.

0 5 . 3 Estimate the uncertainty in the angle of reflection when the angle of incidence is 50°.

Show how you determine your estimate.

[2 marks]

Largest - smallest

Uncertainty = $\frac{\text{range}}{2}$ Range = 56 − 46 = 10°

$= \frac{10°}{2} = 5°$

Uncertainty = ± 5 °

0 5 . 4 The student concluded that for a plane mirror, the angle of incidence is equal to the angle of reflection.

Explain whether you agree with this conclusion.

Use examples from the results in **Table 2** in your answer.

[2 marks]

The values for angles of incidence & reflection are the same within experimental accuracy. ✓
For 20°, 30° & 40° at least one value is the same. ✓

OR The angle of incidence & angle of reflection are usually different. For 50° there are big differences.

Do not write outside the box

0 5 . 5 What extra evidence could be collected to support the student's conclusion?

[1 mark]

Measure different angles of incidence.

0 5 . 6 State **one** change the student should make to the apparatus if he wants to use the same method to investigate diffuse reflection.

[1 mark]

Replace the mirror with an irregular reflecting surface.

8

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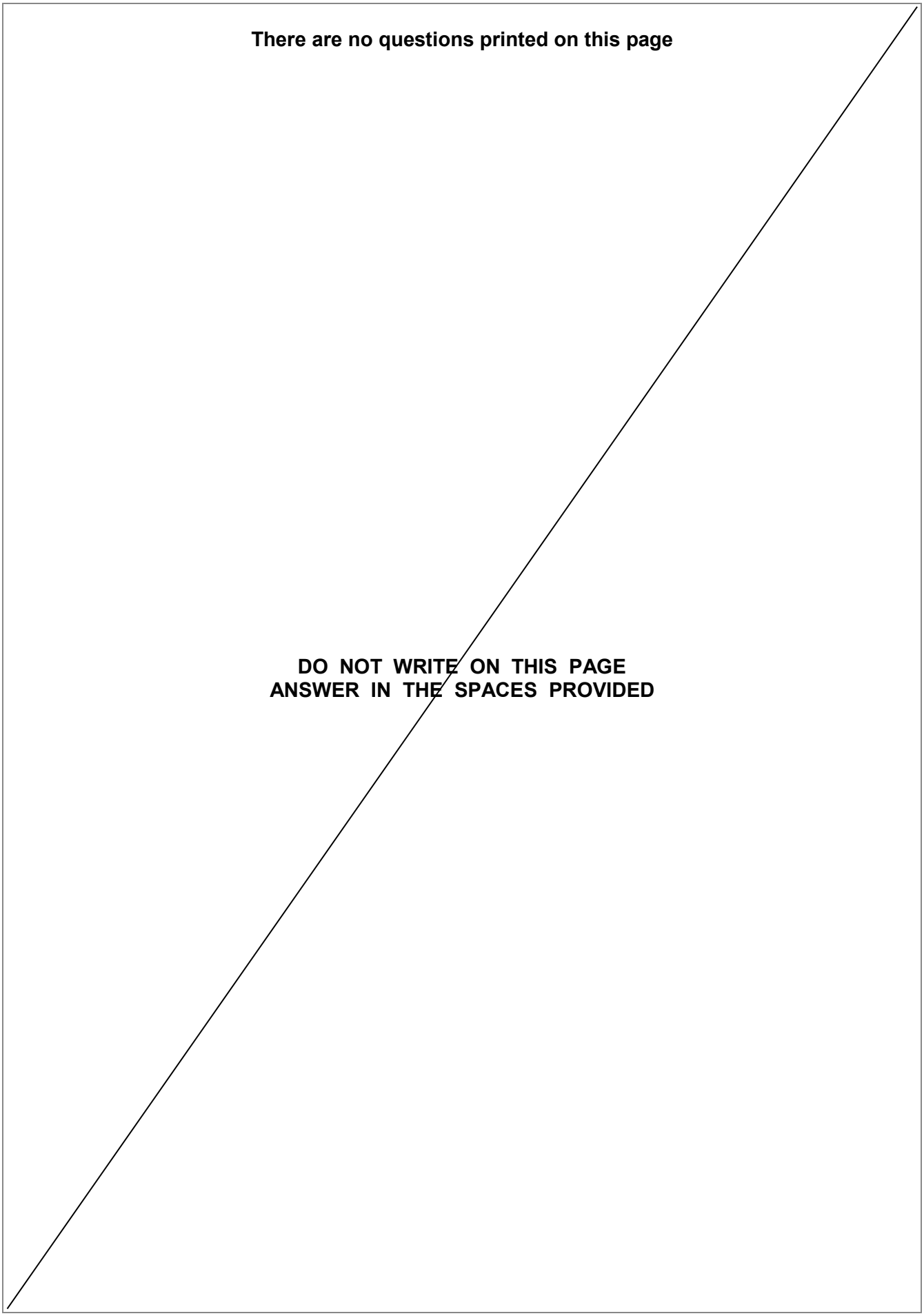
ANSWER IN THE SPACES PROVIDED



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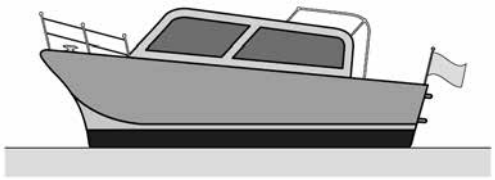
0 6 **Figure 8** shows a boat floating on the sea. The boat is stationary.

no resultant force

Figure 8

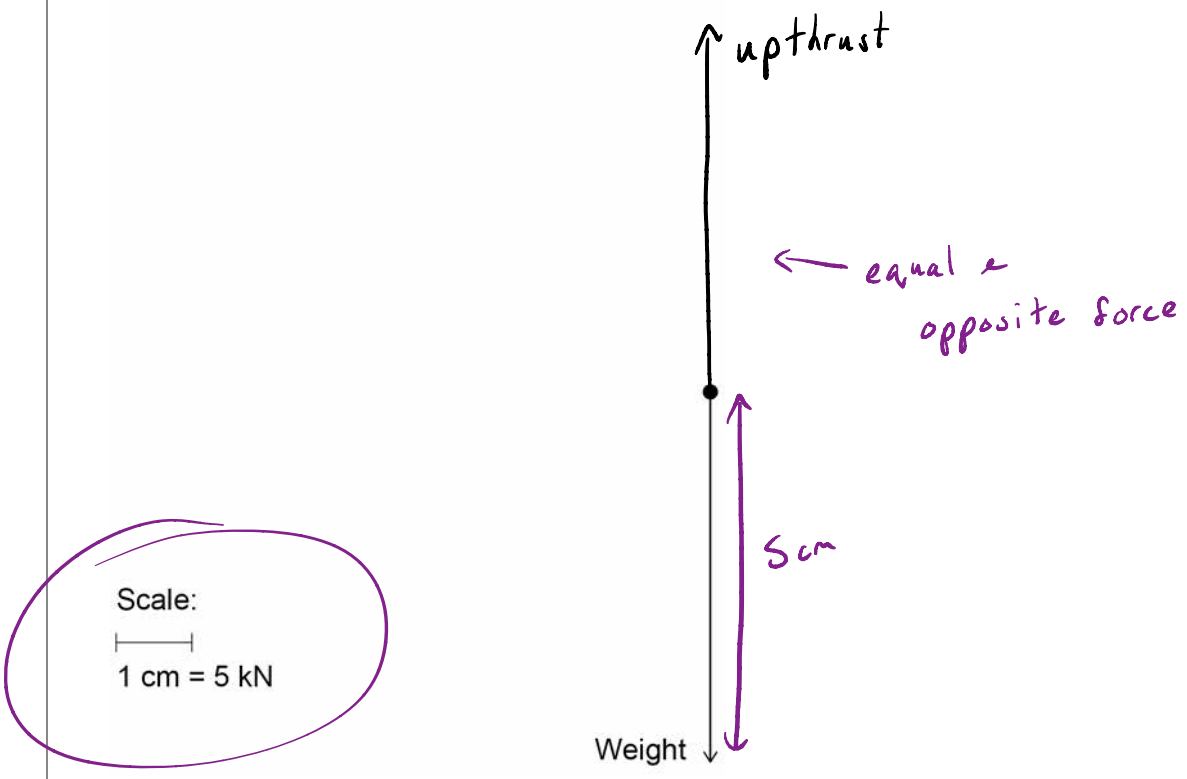


0 6 . 1 **Figure 9** shows part of the free body diagram for the boat.

Complete the free body diagram for the boat.

[2 marks]

Figure 9



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0 6 . 2 Calculate the mass of the boat.

F = m x a
W = m x g

Use the information given in **Figure 9**.

gravitational field strength = 9.8 N/kg ← m/s²

Give your answer to **two** significant figures.

h ← 1000

[4 marks]

5cm 1cm = 5kN 5cm = 5 x 5kN = 25kN ← Weight

= 25000N

W = mg → m = W/g = 25000/9.8 = 2551

≈ 2600

Mass = 2600 kg

0 6 . 3 When the boat propeller pushes water backwards, the boat moves forwards.
The force on the water causes an equal and opposite force to act on the boat.

Which law is this an example of?

[1 mark]

Newton's 3rd law

N's 1st law: if there is no resultant force acting on an object, it will remain stationary or moving at a constant velocity.

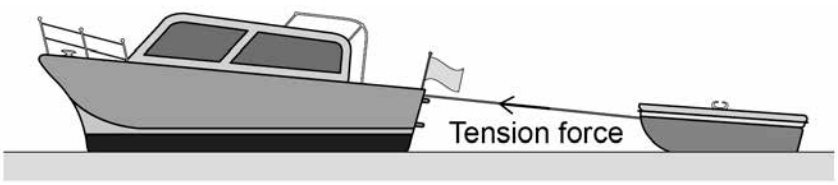
N's 2nd law: F = ma

N's 3rd law: every action has an equal & opposite reaction.

Do not write outside the box

0 6 . 4 **Figure 10** shows the boat towing a small dinghy.

Figure 10



The tension force in the tow rope causes a horizontal force forwards and a vertical force upwards on the dinghy.

horizontal force forwards = 150 N
vertical force upwards = 50 N

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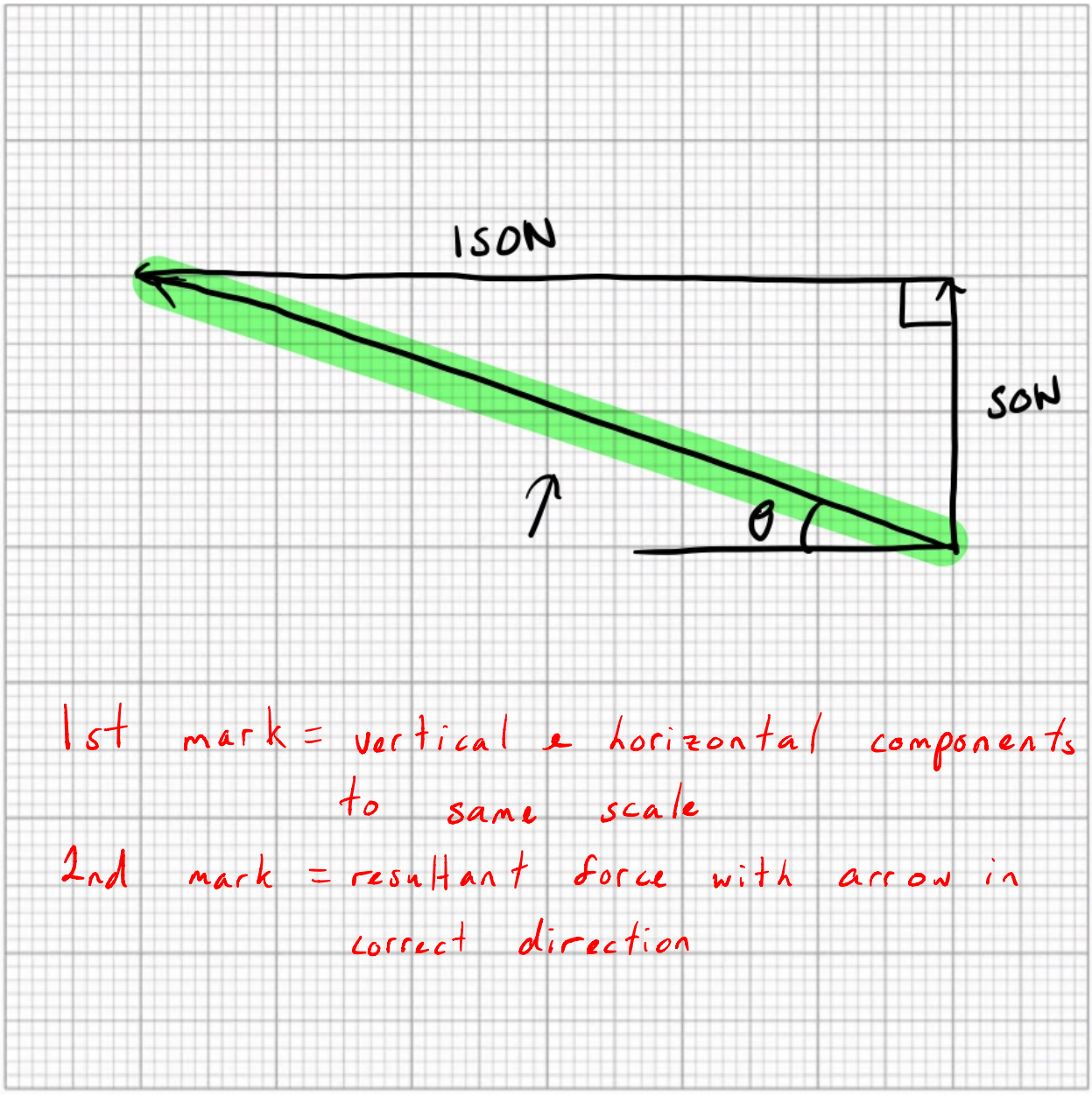
Figure 11 shows a grid.

Draw a vector diagram to determine the magnitude of the tension force in the tow rope and the direction of the force this causes on the dinghy.

[4 marks]

Figure 11



1st mark = vertical & horizontal components to same scale

2nd mark = resultant force with arrow in correct direction

Magnitude of the tension force in the tow rope = 158 N

3rd mark

Direction of the force on the dinghy caused by the tension force in the tow rope = 19° above the horizontal

4th mark

11

Turn over ►

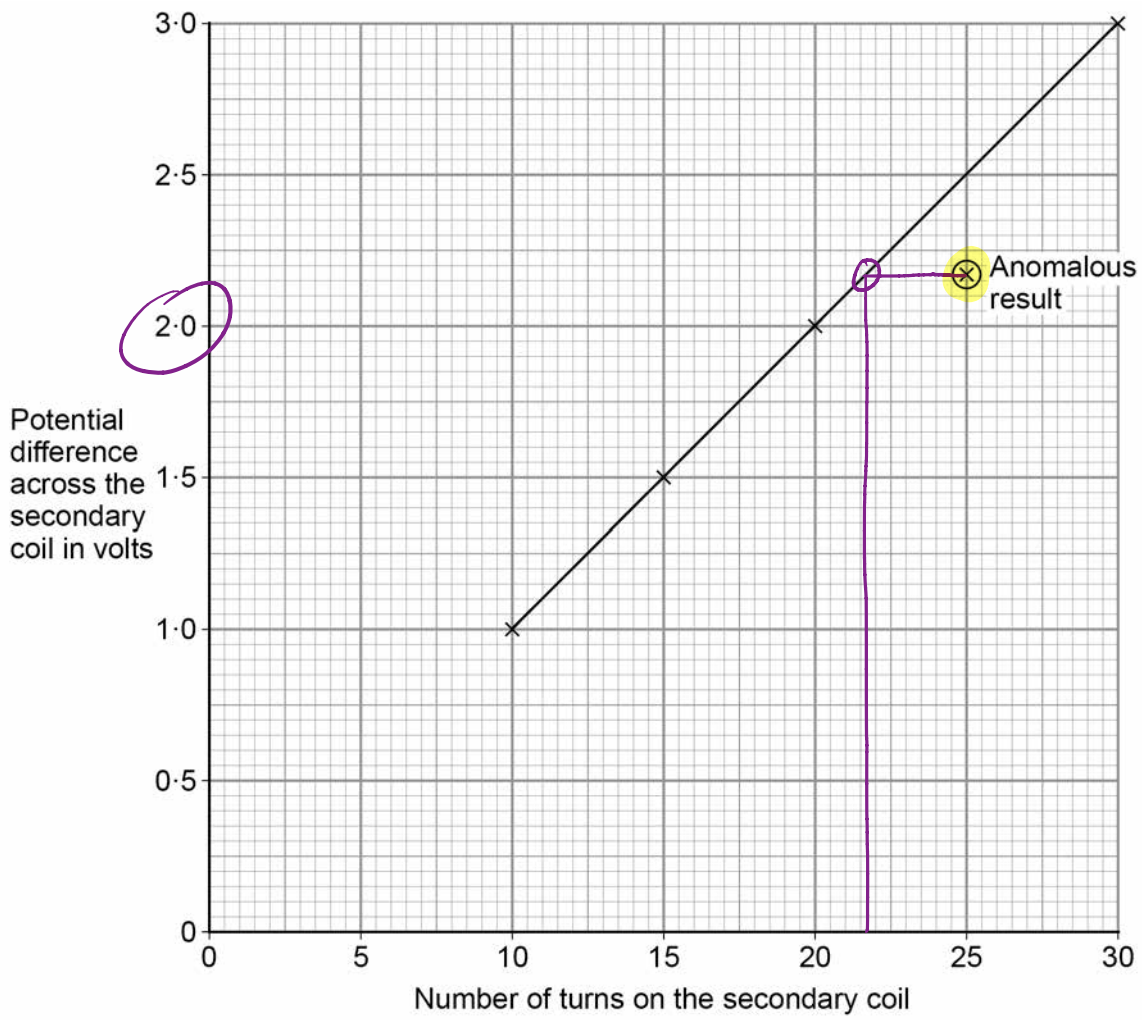
Do not write outside the box

0 7 A student used a simple transformer to investigate how the number of turns on the secondary coil affects the potential difference (p.d.) across the secondary coil.

The student kept the p.d. across the primary coil fixed at 2V.

Figure 12 shows the results collected by the student.

Figure 12

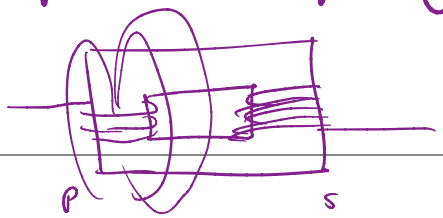


0 7 . 1 **Figure 12** contains one anomalous result.

Suggest **one** possible reason why this anomalous result occurred.

[1 mark]

Too few turns / coils on secondary coil.
OR reduced p.d across primary coil.



Do not write outside the box

0 7 . 2 The transformer changes from being a step-down to a step-up transformer.

How can you tell from **Figure 12** that this happens?

[1 mark]

The p.d across the secondary coil goes above 2V.

Step-down transformer → p.d in primary coil > p.d in secondary coil

Step-up transformer → p.d in primary coil < p.d in secondary coil

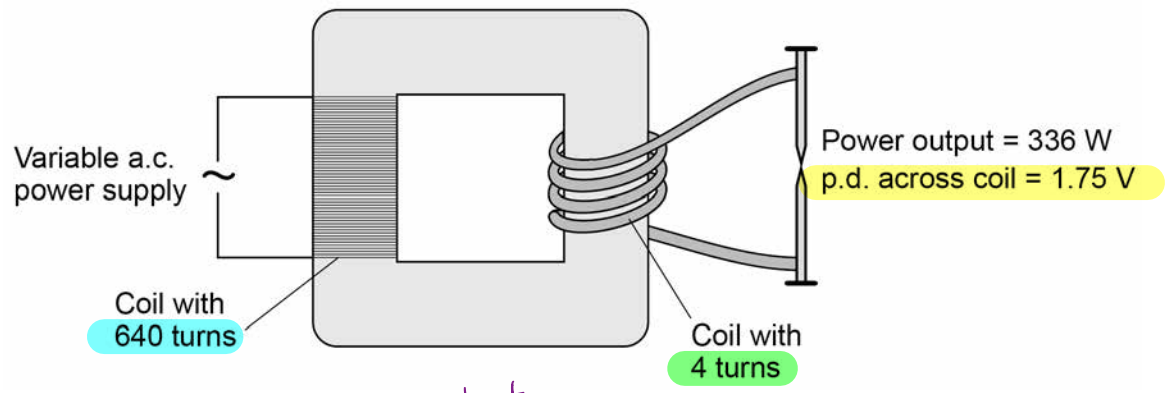
Do not write outside the box

A spot-welder is a device that uses a transformer to produce a large current to join sheets of metal together.

Figure 13 shows a transformer demonstrating how a large current can heat and join two nails together.

$\frac{V_p}{V_s} = \frac{N_p}{N_s}$

Figure 13



heat ← it melts so heat increases

0 7 . 3 How does the amount of infrared radiation emitted by the nails change when the power supply is switched on?

[1 mark]

It increases

0 7 . 4 Calculate the current from the power supply needed to provide a power output of 336 W. ↳ in primary coil

Use the data in **Figure 13**.

The transformer is 100% efficient.

[5 marks]

$\frac{V_p}{V_s} = \frac{N_p}{N_s}$ $\frac{V_p}{1.75} = \frac{640}{4}$ (×1.75)

p.d in primary coil

$V_p = \frac{640 \times 1.75}{4} = 280\text{V}$

$P = VI$

$I = \frac{P}{V} = \frac{336}{280} = 1.2$

Current = 1.2 A

current in primary coil

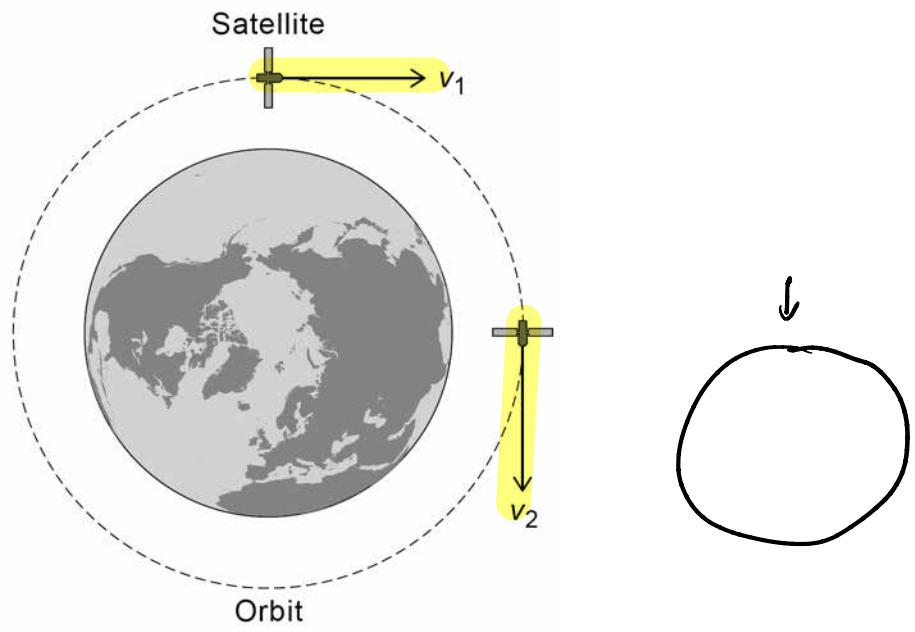
8

Do not write outside the box

0 8 A satellite is in a circular orbit around the Earth.

Figure 14 shows the velocity of the satellite at two different positions in the orbit.

Figure 14



0 8 . 1 Explain why the velocity of the satellite changes as it orbits the Earth.

[3 marks]

Gravity causes the satellite to accelerate towards Earth. The acceleration causes the satellite to change direction. Direction is changing so velocity is also changing.

Question 8 continues on the next page

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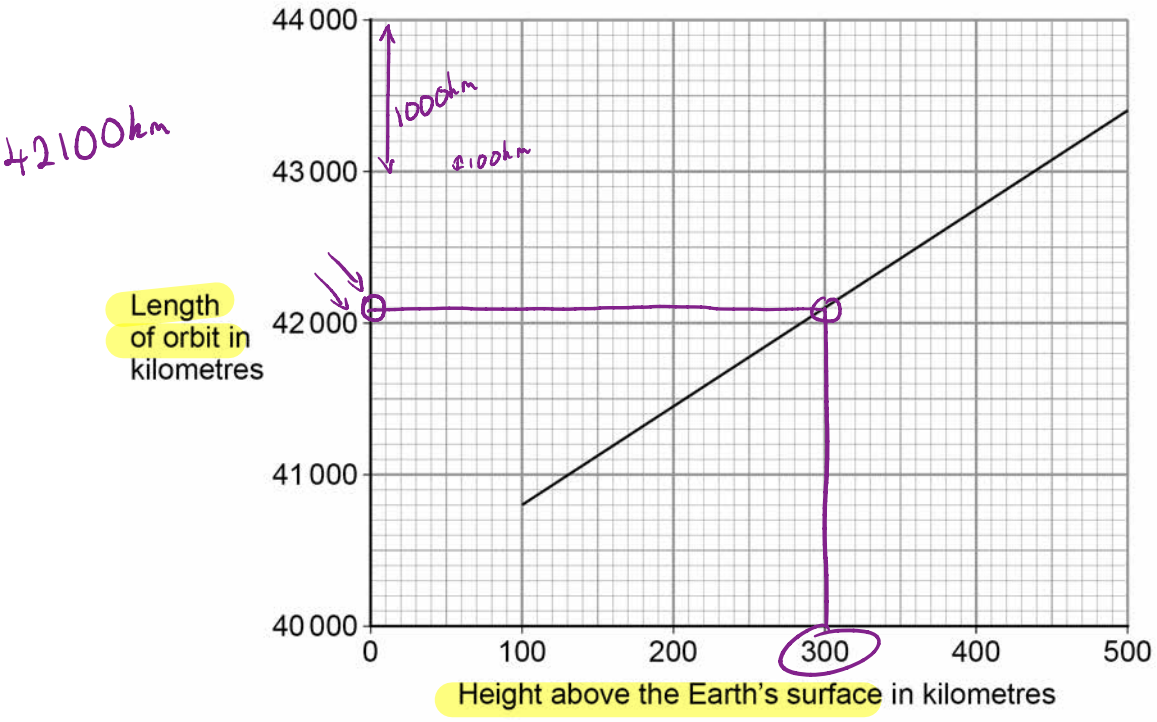
0 8 . 2 **Figure 15** shows how the length of a satellite orbit depends on the height of the satellite above the Earth's surface.

Figure 15



A satellite orbits 300 km above the Earth's surface at a speed of 7.73 km/s.

Calculate how many complete orbits of the Earth the satellite will make in 24 hours.

[5 marks]

Length of orbit = 42100 km

distance = speed × time

time = $\frac{\text{distance}}{\text{speed}} = \frac{42100}{7.73} = \frac{42100 \times 1000}{7.73 \times 1000}$

$= 5446.31$ s

24 hrs = 24 × 60 × 60 = 86400 s

Number of complete orbits = 15

$\frac{86400}{5446} = 15.86$ orbits

$\approx$ 15 orbits

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In 1772, an astronomer called J Bode developed an equation to predict the orbital radii of the planets around the Sun.

Table 3 shows Bode's predicted orbital radii and the actual orbital radii for the planets that were known in 1772.

Table 3

Planet	Predicted orbital radius in millions of kilometres	Actual orbital radius in millions of kilometres
Mercury	60	58
Venus	105	108
Earth	150	150
Mars	240	228
Jupiter	780	778
Saturn	1500	1430

0 8 . 3 The predicted data can be considered to be accurate.

Give the reason why.

[1 mark]

The predicted data is very close to the actual data.

0 8 . 4 J Bode used his equation to predict the existence of a planet with an orbital radius of 2940 million kilometres.

The planet Uranus was discovered in 1781.

Uranus has an orbital radius of 2875 million kilometres.

Explain why the discovery of Uranus was important.

[2 marks]

The discovery supported Bode's prediction which gave evidence that his equation was correct.

11

Turn over ►

Do not write outside the box

0 9 Light is usually described as a wave. Light can also be described as a stream of particles.

These are two different scientific models of light.

0 9 . 1 Which statement describes a scientific model?

Tick **one** box.

a model in everyday life e.g: a model starship

[1 mark]

A small scale version of a real object. ☐

A way of guessing what will happen. ☐

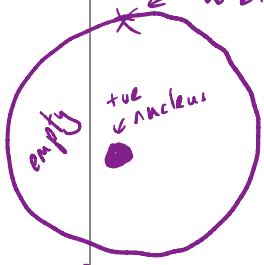
An idea used to explain observations and data. ☑

models can predict things but must be based on previous evidence

0 9 . 2 Why do scientists sometimes have different models like the wave and particle models of light?

[1 mark]

There is more than one explanation supported by experimental evidence.



Nuclear model

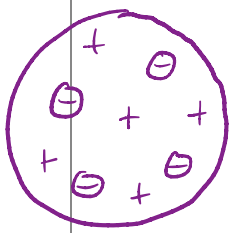
Sometimes an old scientific model is replaced by a new model.

Explain why scientists replace an old scientific model with a new model.

Include an example from Physics in your answer.

[4 marks]

New evidence cannot be explained by the existing model so a new model is made which can explain it. For example, the plum pudding model of the atom was replaced by the nuclear model after Rutherford's experiments.



Plum pudding model

Do not write outside the box

Some students used water waves in a ripple tank to model the behaviour of light waves.

0 9 . 4 **Figure 16** shows what happens to the wave fronts as they pass the boundary between deep water and shallower water.

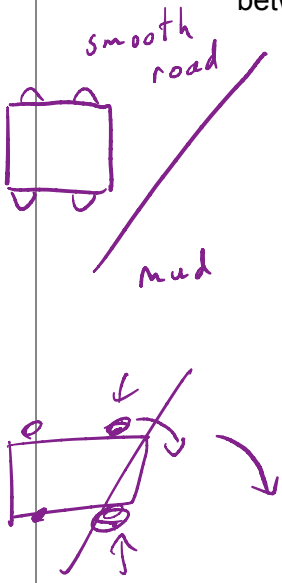
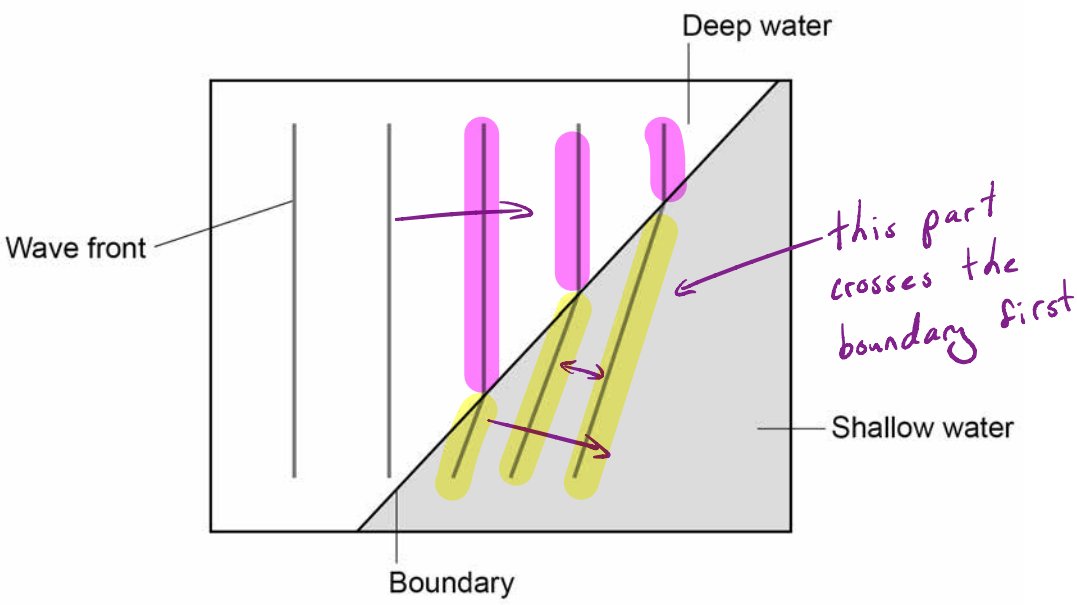


Figure 16



Explain why refraction happens at the boundary between the deep water and shallower water.

[3 marks]

The wave has a slower speed in shallower water ✓ so the edge of the wave entering the shallow water first slows down, ✓ while the other edge continues at the original speed ✓ causing a change in direction.

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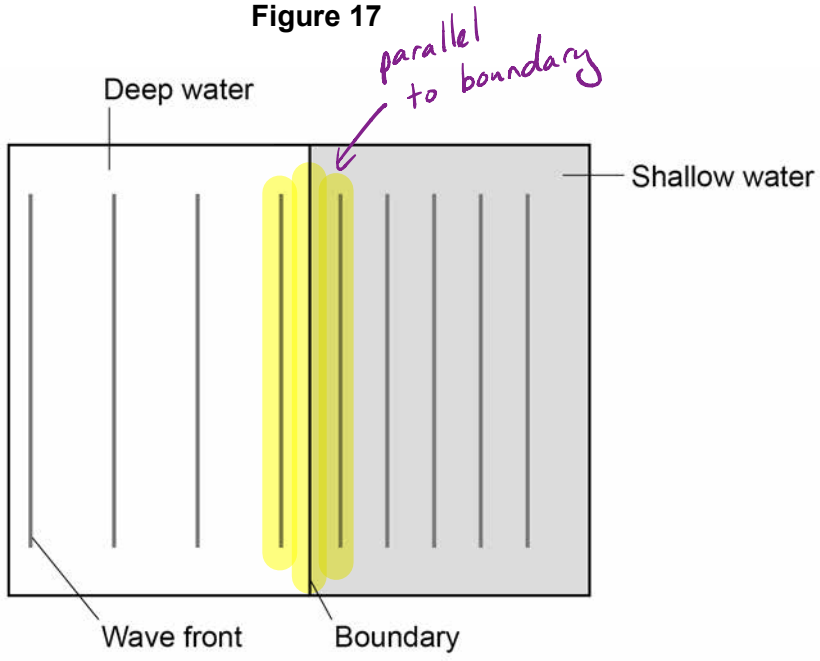
0 9 . 5 **Figure 17** shows the wave fronts travelling parallel to the boundary between deep water and shallower water.

Figure 17



Explain why the wave fronts in **Figure 17** do not refract at the boundary.

[2 marks]

Every point on the wave enters the shallow water at the same time, ✓ and hence slows down at the same time. ✓

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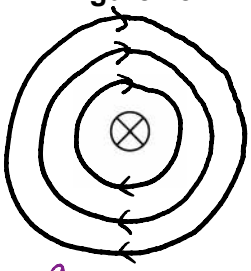
1 0 The circle in **Figure 18** represents a straight wire carrying a current. The cross shows that the current is into the plane of the paper.

into paper ⊗

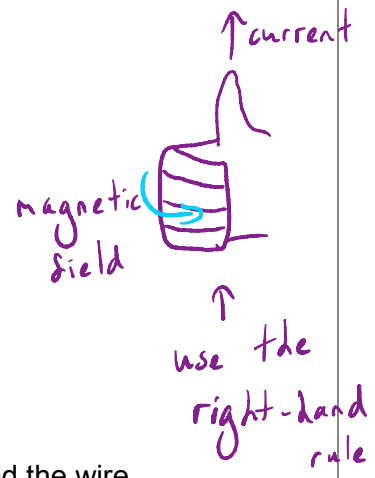
⊙ out of paper

thumb into paper, fingers curl clockwise

Figure 18



at least three circles



1 0 . 1 Complete **Figure 18** to show the magnetic field pattern around the wire.

[2 marks]

1 0 . 2 The magnetic flux density 10 cm from the wire is 4 microtesla.

Which of the following is the same as 4 microtesla?

Tick **one** box.

[1 mark]

4 x 10^{-2} T ☐

4 x 10^{-3} T ☐

4 x 10^{-6} T ☑

4 x 10^{-9} T ☐

Thank	Tera	$\times 10^{12}$
Goodness	Giga	$\times 10^{9}$
My	Mega	$\times 10^{6}$
Kids	kilo	$\times 10^{3}$
Can	Centi	$\times 10^{-2}$
Meet	Milli	$\times 10^{-3}$
My	Micro	$\times 10^{-6}$
New	Nano	$\times 10^{-9}$
Perfect	Pico	$\times 10^{-12}$
Friend	Femto	$\times 10^{-15}$

Question 10 continues on the next page

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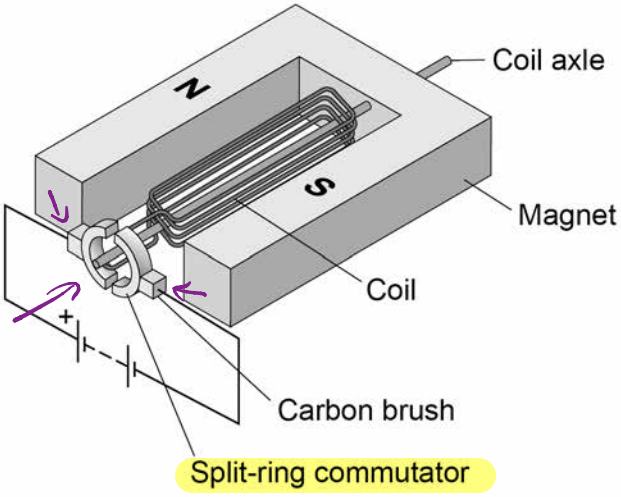
1 0 . 3 **Figure 19** shows a simple electric motor.

Figure 19

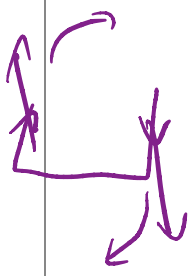


When there is a current in the coil, the coil rotates continuously.

this is due to the motor effect.

Explain why.

[4 marks]



The sides of the coil experience a force in opposite directions. The moments from the forces cause the coil to rotate. When the two halves of the commutator swap from one carbon brush to the other, the commutator reverses the current in the coil to keep the forces in the same direction and keep the coil rotating.

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END OF QUESTIONS