2024

Name_____

Triple Science

Foundation

Physics: Paper 2

Physics Equations Sheet

GCSE Combined Science: Trilogy (8464) and GCSE Combined Science: Synergy (8465)

FOR USE IN JUNE 2024 ONLY

HT = Higher Tier only equations

kinetic energy = 0.5 × mass × (speed)^2	$E_k = \frac{1}{2} m v^2$
elastic potential energy = 0.5 × spring constant × (extension)^2	$E_e = \frac{1}{2} k e^2$
gravitational potential energy = mass × gravitational field strength × height	$E_p = m g h$
change in thermal energy = mass × specific heat capacity × temperature change	$\Delta E = m c \Delta\theta$
power = $\frac{\text{energy transferred}}{\text{time}}$	$P = \frac{E}{t}$
power = $\frac{\text{work done}}{\text{time}}$	$P = \frac{W}{t}$
efficiency = $\frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$	
efficiency = $\frac{\text{useful power output}}{\text{total power input}}$	
charge flow = current × time	$Q = I t$
potential difference = current × resistance	$V = I R$
power = potential difference × current	$P = V I$
power = (current)^2 × resistance	$P = I^2 R$
energy transferred = power × time	$E = P t$

	energy transferred = charge flow × potential difference	$E = Q\ V$
HT	**potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil**	$\boldsymbol{V_p\ I_p = V_s\ I_s}$
	density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
	thermal energy for a change of state = mass × specific latent heat	$E = m\ L$
	weight = mass × gravitational field strength	$W = m\ g$
	work done = force × distance (along the line of action of the force)	$W = F\ s$
	force = spring constant × extension	$F = k\ e$
	distance travelled = speed × time	$s = v\ t$
	acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$	$a = \frac{\Delta v}{t}$
	(final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance	$v^2 - u^2 = 2\ a\ s$
	resultant force = mass × acceleration	$F = m\ a$
HT	**momentum = mass × velocity**	$\boldsymbol{p = m\ v}$
	period = $\frac{1}{\text{frequency}}$	$T = \frac{1}{f}$
	wave speed = frequency × wavelength	$v = f\ \lambda$
HT	**force on a conductor (at right angles to a magnetic field) carrying a current = magnetic flux density × current × length**	$\boldsymbol{F = B\ I\ l}$

AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

GCSE PHYSICS

F

Foundation Tier Paper 2

Friday 14 June 2019 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.
- Fill in the box 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.
- 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	

There are no questions printed on this page

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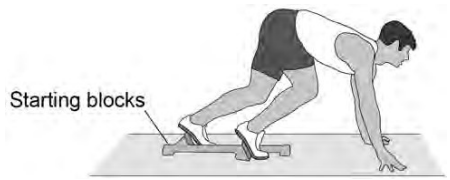
DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

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

Do not write outside the box

0 1 **Figure 1** shows an athlete on starting blocks waiting to start a 100 metre race.

Figure 1



0 1 . 1 Complete the sentence.

Choose the answer from the box.

[1 mark]

equal to	**greater than**	**less than**

The force from the athlete pushing backwards on the starting blocks

is _____ the force from the starting

blocks pushing forwards on the athlete.

Question 1 continues on the next page

Turn over ►

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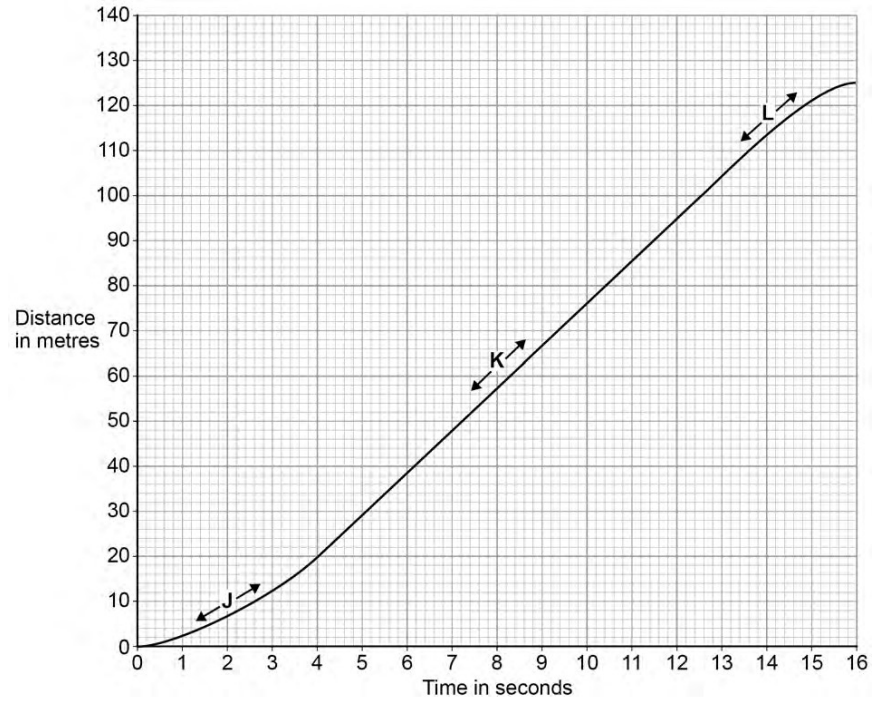
Figure 2 shows a distance-time graph for the athlete from the moment the race starts.

Figure 2



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0 1 . 2 Three parts of the distance-time graph are labelled **J**, **K** and **L**.

Draw **one** line from **each** of the labels to the correct description of the athlete's motion for that part of the graph.

[2 marks]

Labels	Description of motion
J	not moving
K	constant speed
L	decreasing speed
	increasing speed

0 1 . 3 What distance does the athlete travel after the end of the race before stopping?

[1 mark]

Distance = _____ m

0 1 . 4 Calculate the average speed of the athlete between the start and finish of the 100 metre race.

Use the equation:

$$\text{average speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

[2 marks]

_____

_____

_____

Average speed = _____ m/s

Turn over ►

Do not write outside the box

0 1 . 5 The athlete runs faster than a typical person.

What is the average running speed of a typical person in metres per second?

[1 mark]

Tick (✓) **one** box.

- 1.5 ☐
- 3.0 ☐
- 4.5 ☐
- 6.0 ☐

7

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 2 Most galaxies are moving away from the Earth. Scientists can determine the speed of a galaxy by observing the light from the galaxy.

0 2 . 1 Complete the sentence.

Choose the answer from the box.

[1 mark]

frequency	**speed**	**wavelength**

When scientists observe the light from distant galaxies, they observe an increase in the _____ of light from those galaxies.

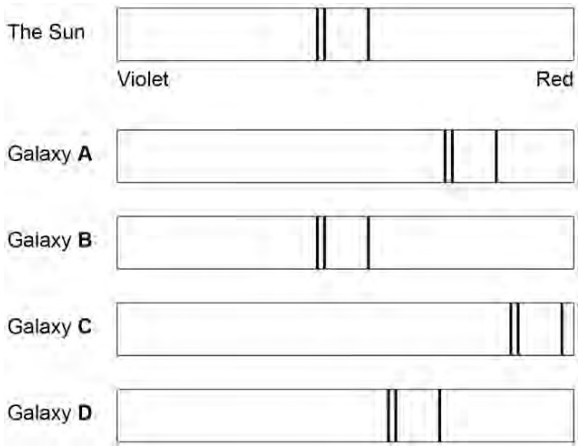
Do not write outside the box

The light spectra from stars and galaxies include dark lines.

The lines have the same pattern.

Figure 3 shows the light spectrum from the Sun and from four galaxies.

Figure 3



0 2 . 2 Which galaxy is moving the fastest away from the Earth?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 2 . 3 Which galaxy is the furthest away from the Earth?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

Turn over ►

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0 2 . 4 The Big Bang theory is one way to explain the origin of the universe.

How does the Big Bang theory describe the universe when it began?

[1 mark]

Tick (✓) **one** box.

Very big and very dense ☐

Very big and extremely hot ☐

Very dense and extremely hot ☐

Very small and extremely cold ☐

0 2 . 5 Which statement about the Big Bang theory is correct?

[1 mark]

Tick (✓) **one** box.

Scientists have proved that the theory is correct. ☐

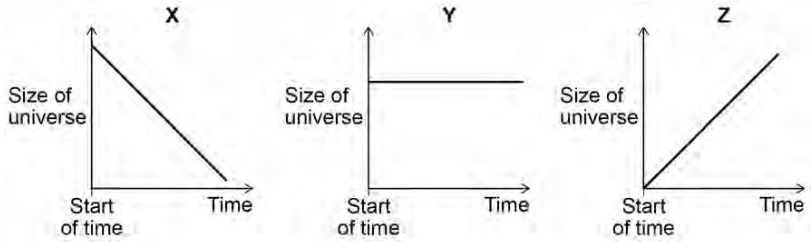
Scientific evidence supports the theory. ☐

There is no other way to explain the origin of the universe. ☐

Do not write outside the box

0 2 . 6 **Figure 4** shows three ways that the size of the universe may have changed with time.

Figure 4



Which graph would the Big Bang theory suggest is correct?

[2 marks]

Tick (✓) **one** box.

X ☐ **Y** ☐ **Z** ☐

Give a reason for your answer.

_____

_____

7

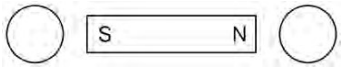
Turn over for the next question

Do not write outside the box

0 3 . 1 **Figure 5** shows a bar magnet.

Each circle represents a compass.

Figure 5



Draw an arrow inside each circle to show the direction that each compass would point.

[1 mark]

0 3 . 2 **Figure 6** shows part of a coat.

The coat has two magnets hidden inside the material.

Figure 7 shows how the magnets are used to fasten the coat.

Figure 6

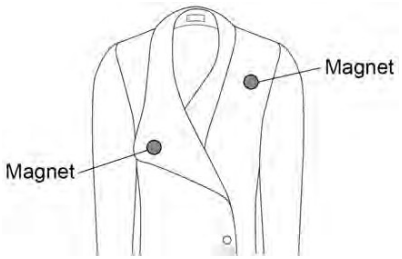


Figure 7

Explain why the magnets inside the coat must **not** have two south poles facing each other.

[2 marks]

_____

_____

_____

_____

A coil of wire is connected to a battery.

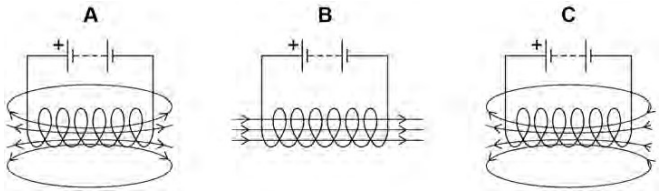
The current in the coil produces a magnetic field.

0 3 . 3 Which diagram in **Figure 8** shows the magnetic field produced by the current in the coil?

[1 mark]

Tick (✓) **one** box.

Figure 8



A ☐ B ☐ C ☐

0 3 . 4 A solid rod is placed inside the coil.

Which type of rod would make the magnetic field of the coil stronger?

[1 mark]

Tick (✓) **one** box.

Glass rod ☐

Plastic rod ☐

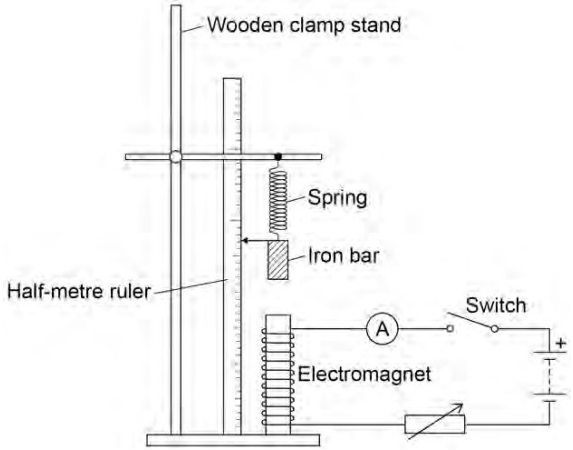
Steel rod ☐

Wooden rod ☐

A student investigated how the strength of an electromagnet varies with the current in the coil of the electromagnet.

Figure 9 shows the equipment the student used.

Figure 9



0 3 . 5 Why does the spring get longer when the electromagnet is switched on?

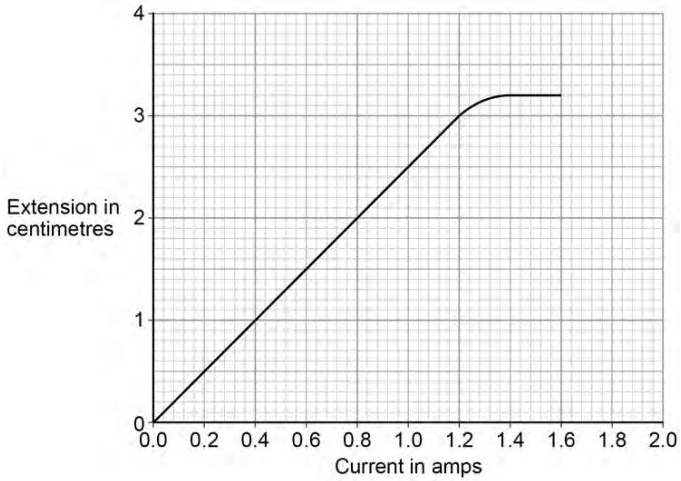
[1 mark]

Do not write outside the box

The student measured how much further the spring extended with different values of current in the coil.

Figure 10 shows the results.

Figure 10



0 3 . 6 The current in the coil is increased from 0.6 A to 1.2 A

Determine the increase in the extension of the spring.

[1 mark]

Increase in the extension = _____ cm

0 3 . 7 Calculate the increase in the force on the spring when the current in the coil increased from 0.6 A to 1.2 A

Spring constant = 0.18 N/cm

Use the equation:

force = spring constant × extension

[2 marks]

Increase in the force = _____ N

Turn over ►

Do not write outside the box

0 3 . 8 Describe what happened to the strength of the electromagnet as the current in the coil increased from 1.2 A to 1.6 A

[2 marks]

11

Do not write outside the box

0 4 . 1 **Figure 11** shows the position of three types of wave in the electromagnetic spectrum.

Figure 11

A	Microwaves	**B**	Visible light	**C**	**D**	Gamma rays

Which letter represents infrared in the electromagnetic spectrum?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 4 . 2 What is infrared used for?

[1 mark]

Tick (✓) **one** box.

Electrical heating ☐

Energy efficient lamps ☐

Satellite communications ☐

Sun tanning ☐

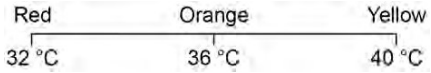
Question 4 continues on the next page

Do not write outside the box

An infrared camera produces a colour image. Different colours show different temperatures.

People emit infrared radiation. **Figure 12** shows how the colour of the image of a person on an infrared camera depends on the person's body temperature.

Figure 12



0 4 . 3 Complete the sentence.

Choose the answer from the box.

[1 mark]

orange	**red**	**yellow**

The image produced by an infrared camera of a person with a body temperature of 37 °C is mainly _____ .

0 4 . 4 Rescue workers use infrared cameras to search for people trapped under rubble after an earthquake.

How does the image of a trapped person change if the person's body temperature drops from 37 °C to 33 °C?

[1 mark]

_____

_____

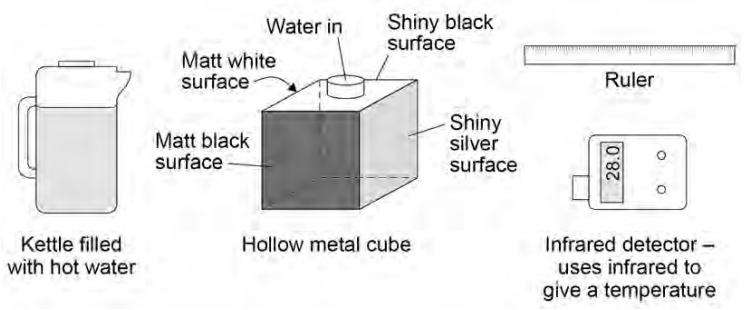
_____

Do not write outside the box

A student investigated how the type of surface affects the amount of infrared the surface radiates.

Figure 13 shows the equipment used.

Figure 13



0 4 . 5 Complete the sentence.

Choose the answer from the box.

[1 mark]

a control	**the dependent**	**the independent**

In this investigation the type of surface is _____ variable.

0 4 . 6 Describe how the equipment shown in **Figure 13** would be used to compare the infrared radiation emitted from the vertical surfaces of the cube.

[3 marks]

Do not write outside the box

Table 1 shows the results.

Table 1

Type of surface	Temperature in °C
Matt black	68.0
Matt white	65.5
Shiny black	66.3
Shiny silver	28.0

0 4 . 7 What is the resolution of the infrared detector?

[1 mark]

Tick (✓) **one** box.

0.1 °C ☐

1.0 °C ☐

1.7 °C ☐

68.0 °C ☐

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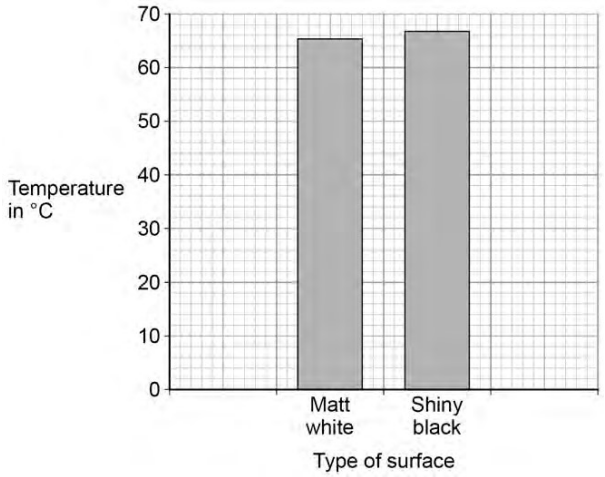
The bar chart in **Figure 14** shows two of the results.

Figure 14



0 4 . 8 Complete the bar chart to show all of the results.

[3 marks]

0 4 . 9 Give **one** conclusion that can be made from the results.

[1 mark]

_____

_____

_____

13

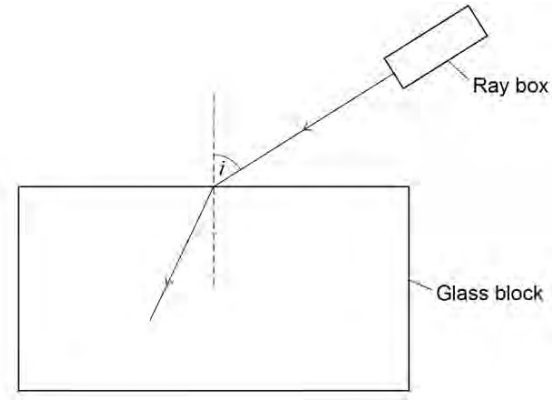
Turn over for the next question

Do not write outside the box

0 5 A student used a ray box and glass block to investigate refraction of light.

Figure 15 shows a ray of light entering the glass block.

Figure 15



0 5 . 1 In **Figure 15**, the angle of incidence is labelled with the letter ***i***.

Label the angle of refraction in **Figure 15** with the letter ***r***.

[1 mark]

0 5 . 2 Measure the angle of incidence in **Figure 15**.

[1 mark]

Angle of incidence = _____ °

0 5 . 3 Complete **Figure 15** to show the path taken by the ray of light through the glass block and out into the air.

[3 marks]

Do not write outside the box

0 5 . 4 Complete the sentence.

Choose an answer from the box.

[1 mark]

random	**systematic**	**zero**

The student repeated the measurement three times and calculated the mean to reduce the effect of _____ errors.

Table 2 shows the student's values for the angles of incidence and the mean angles of refraction.

Table 2

Angle of incidence in degrees	Mean angle of refraction in degrees
20	13
30	19
40	**X**
50	31

0 5 . 5 For an angle of incidence of 40° the three measurements for the angle of refraction were:

23° 27° 25°

Calculate the value of **X** in **Table 2.**

[1 mark]

_____

_____

X = _____ °

Turn over ►

Do not write outside the box

0 5 . 6 Complete the sentence.

Choose the answer from the box.

[1 mark]

equal to	**greater than**	**less than**

The student used the data in **Table 2** and correctly concluded that the angle of refraction is _____ the angle of incidence used.

0 5 . 7 Why is the student's conclusion only valid for angles of incidence between 20° and 50°?

[1 mark]

_____

_____

_____

0 5 . 8 The student repeated the investigation using a transparent plastic block.

Why did the student use a transparent block and not an opaque block?

[1 mark]

_____

_____

_____

Do not write outside the box

0 5 . 9 The student wanted to compare the refraction caused by the plastic with the refraction caused by the glass.

What must the student keep the same for both the plastic block and the glass block?

[1 mark]

Tick (✓) **one** box.

- The angles of incidence tested ☐
- The angles of refraction tested ☐
- The number of results recorded ☐
- The size of the two blocks ☐

11

Turn over for the next question

Do not write outside the box

0 6 The following statements describe parts of a short train journey between two railway stations.

Part A: The train accelerates at a constant rate from 0 m/s to 20 m/s in 40 s

Part B: The train travels at a constant velocity for 260 s

Part C: The train decelerates at a constant rate coming to a stop in 60 s

0 6 . 1 During which part of the journey is the resultant force on the train zero?

[1 mark]

Tick (✓) **one** box.

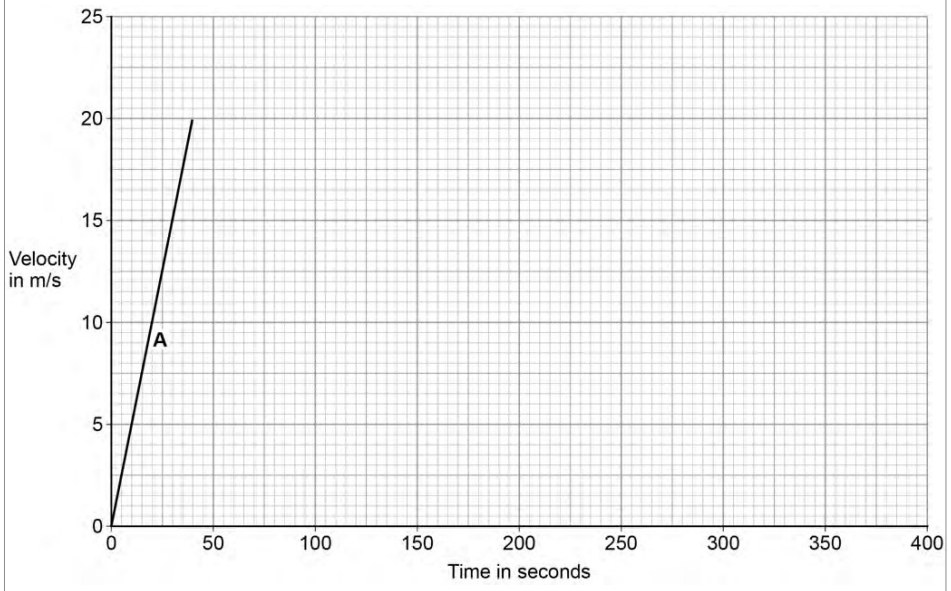
A ☐ **B** ☐ **C** ☐

0 6 . 2 **Figure 16** shows part of the velocity-time graph for the train journey.

Complete **Figure 16** showing part **B** and part **C** of the train journey.

[3 marks]

Figure 16



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0 6 . 3 Write down the equation which links acceleration, change in velocity and time taken.

[1 mark]

0 6 . 4 Another train accelerated at 1.15 m/s^2 for 22.0 s

Calculate the increase in velocity of the train.

[3 marks]

Increase in velocity = _____ m/s

8

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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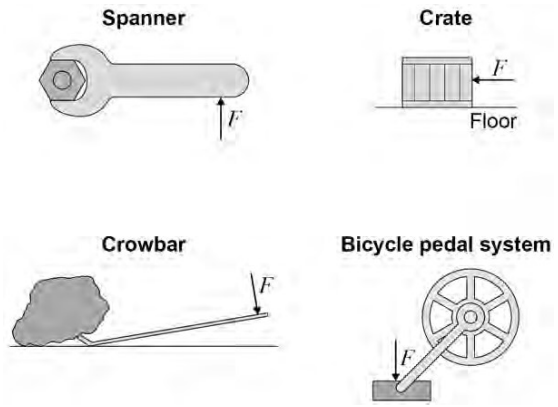
0 7 . 1 **Figure 17** shows four examples of a force causing an object to move.

Figure 17



Which object is **not** likely to rotate?

[1 mark]

Tick (✓) **one** box.

- Bicycle pedal system ☐
- Crate ☐
- Crowbar ☐
- Spanner ☐

Question 7 continues on the next page

Do not write outside the box

Figure 18 shows a simple device that can be used as a weighing scale.

Figure 19 shows the device being used to measure a quantity of rice.

The weight of the device is balanced by the weight of the rice and basket.

Figure 18

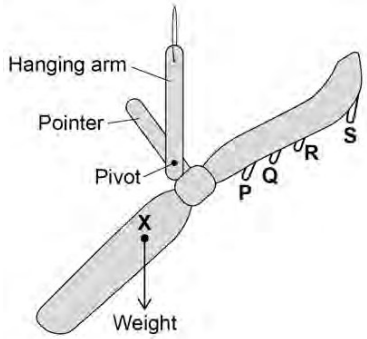
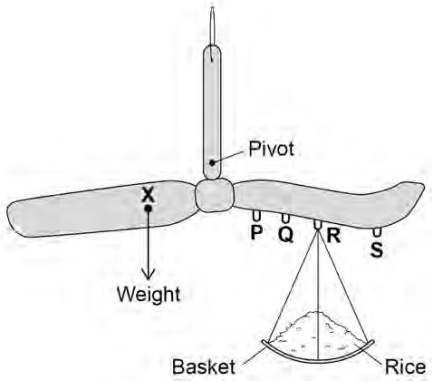


Figure 19



0 7 . 2 The weight of the device acts through the point labelled **X.**

What is point **X** called?

[1 mark]

Tick (✓) **one** box.

- Centre of balance ☐
- Centre of mass ☐
- Centre of weight ☐

Do not write outside the box

0 7 . 3 How does **Figure 19** show that the weight of the device is balanced by the weight of the rice and basket?

[1 mark]

0 7 . 4 The basket can hang from different points on the device.

Where should the basket hang to measure the largest quantity of rice?

[1 mark]

Tick (✓) **one** box.

P ☐ **Q** ☐ **R** ☐ **S** ☐

0 7 . 5 Write down the equation which links distance, force and moment of a force.

[1 mark]

0 7 . 6 In **Figure 19**, the weight of the device causes an anticlockwise moment of 0.15 Nm about the pivot.

The weight of the rice and basket acts 0.06 m from the pivot.

Calculate the weight of the rice and basket.

[3 marks]

Weight of rice and basket = _____ N

Turn over ►

Do not write outside the box

0 7 . 7 Write down the equation which links gravitational field strength, mass and weight.

[1 mark]

0 7 . 8 The basket has a mass of 0.04 kg

gravitational field strength = 9.8 N/kg

Calculate the mass of rice in the basket.

[3 marks]

Mass = _____ kg

12

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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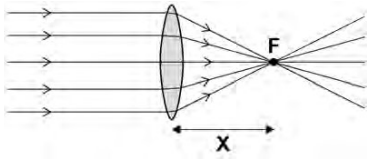
0 8 . 1 **Figure 20** shows parallel rays of light being refracted by a convex lens.

Figure 20



What is distance '**X**' called?

[1 mark]

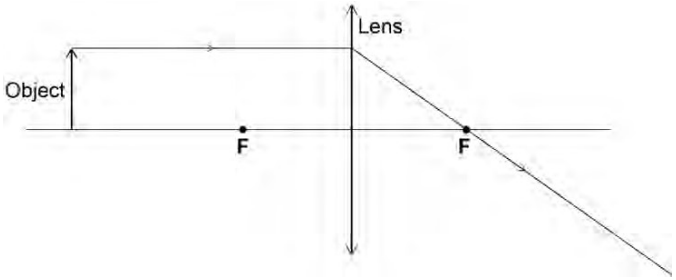
0 8 . 2 Lenses can be used to form the image of an object.

Complete the ray diagram in **Figure 21** to show how a **convex** lens forms the image of the object.

Use an arrow to represent the image.

[2 marks]

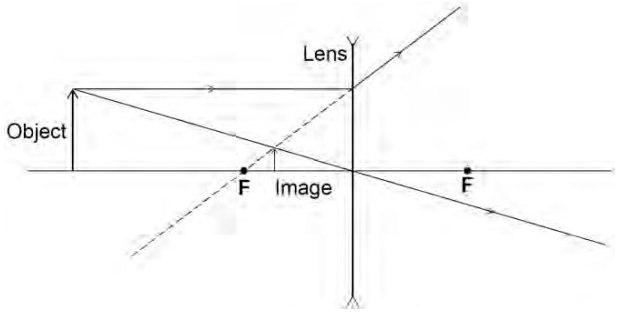
Figure 21



Do not write outside the box

Figure 22 shows how a **concave** lens forms the image of an object.

Figure 22



0 8 . 3 Give **one** similarity and **one** difference between the image formed by the convex lens and the image formed by the concave lens.

[2 marks]

Similarity _____

_____

Difference _____

_____

0 8 . 4 A person uses a lens to read the letters on the back of a coin.

The image height of the letters on the coin is 9.0 mm

The magnification produced by the lens is 6.0

Calculate the height of the letters on the coin.

Use the Physics Equations sheet.

[3 marks]

_____

_____

_____

_____

Height = _____ mm

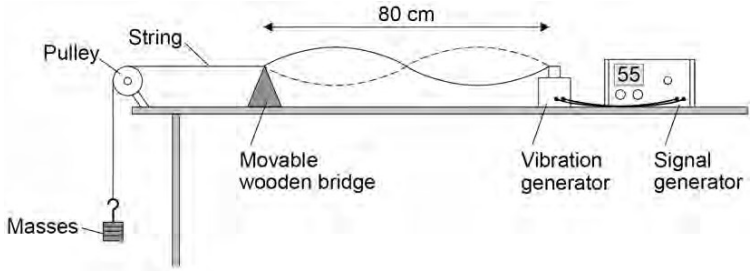
8

Turn over ►

Do not write outside the box

0 9 **Figure 23** shows the apparatus used to investigate the waves in a stretched string.

Figure 23



The frequency of the signal generator is adjusted so that the wave shown in **Figure 23** is seen.

At this frequency the string vibrates between the two positions shown in **Figure 23.**

0 9 . 1 The wavelength of the wave shown in **Figure 23** was measured as 80 cm

What piece of apparatus would have been suitable for measuring this wavelength?

[1 mark]

_____

0 9 . 2 Write down the equation which links frequency, wavelength and wave speed.

[1 mark]

_____

0 9 . 3 The string in **Figure 23** vibrates at 55 Hz

Calculate the wave speed of the wave shown in **Figure 23.**

Use data given in **Figure 23.**

[3 marks]

_____

_____

_____

Wave speed = _____ m/s

0 9 . 4 The frequency of the signal generator is increased.

This makes the wavelength of the wave change.

The wave speed stays the same.

Describe how the apparatus could be adjusted to show one complete wave without reducing the frequency.

[2 marks]

Do not write outside the box

0 9 . 5 A student wants to investigate how the speed of a wave on a stretched string depends on the tension in the string.

The student uses the apparatus in **Figure 23**.

Describe a method the student could use for this investigation.

[4 marks]

11

1 0 . 1 The driver of a vehicle sees a hazard on the road.

The driver uses the brakes to stop the vehicle.

Explain the factors that affect the distance needed to stop a vehicle in an emergency.

[6 marks]

Do not write outside the box

Do not write outside the box

1 0 . 2 Write down the equation which links distance, force and work done.

[1 mark]

1 0 . 3 The work done by the braking force to stop a vehicle was 900 000 J

The braking force was 60 000 N

Calculate the braking distance of the vehicle.

[3 marks]

Braking distance = _____ m

1 0 . 4 The greater the braking force, the greater the deceleration of a vehicle.

Explain the possible dangers caused by a vehicle having a large deceleration when it is braking.

[2 marks]

12

END OF QUESTIONS

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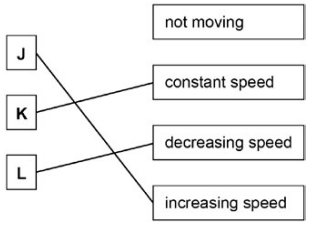
ANSWER IN THE SPACES PROVIDED

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1.1	equal to	allow the symbol = allow a correct answer indicated in the box provided the answer space is blank	1	AO1/1 4.5.6.2.3 WS 1.2
1.2	J -------- increasing speed K--------- constant speed L --------- decreasing speed	all three lines correct allow **1** mark for **1** line correct more than three lines are drawn scores **0**  	2	AO1/1 4.5.6.1.4
1.3	25 (m)		1	AO2/2 4.5.6.1.4
1.4	av speed = $\frac{100}{12.5}$ av speed = 8(.0) (m/s) OR av speed = $\frac{100}{12.6}$ av speed = 7.93… (m/s)	an answer of 8(.0) (m/s) scores **2** marks allow 7.9 or 7.94	1 1	AO2/1 4.5.6.1.2
1.5	3.0		1	AO1/1 4.5.6.1.2
Total			**7**	

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Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2.1	wavelength	allow a correct answer indicated in the box provided the answer space is blank	1	AO1/1 4.8.2 iso
2.2	C		1	AO3/1a 4.8.2
2.3	C		1	AO3/1a 4.8.2
2.4	Very dense and extremely hot		1	AO1/1 4.8.2 iso
2.5	Scientific evidence supports the theory		1	AO1/1 4.8.2 WS1.2
2.6	Z any **one** from • (only one) shows the universe is expanding • (only one) shows the universe began (very) small	 only scores if Z is chosen	1 1	AO3/1b 4.8.2
Total			**7**	

Question 3

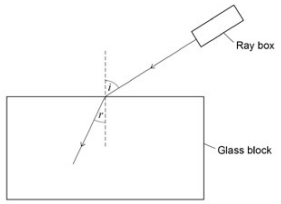
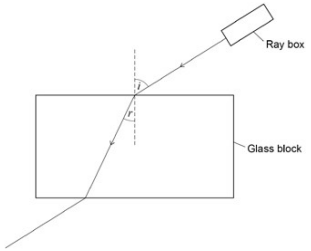
Question	Answers	Extra information	Mark	AO / Spec. Ref.
3.1	both arrows pointing horizontally and to the right	judged by eye	1	AO1/1 4.7.1.2
3.2	(two south) poles would repel so the coat would not be held together	allow magnets would repel allow so the coat would not fasten	1 1	AO1/1 AO2/1 4.7.1.1
3.3	C		1	AO1/1 4.7.2.1
3.4	steel rod		1	AO1/1 4.7.2.1
3.5	electromagnet exerts a downwards force on the iron bar	allow electromagnet pulls the iron (bar) down(wards) allow electromagnet attracts the iron (bar)	1	AO1/1 4.7.2.1
3.6	1.5 (cm)		1	AO2/2 4.5.3
3.7	 F = 0.18 × 1.5 OR F = 0.18 × their 3.6 F = 0.27 (N)	an answer 0.27 (N) scores **2** marks allow 0.18 × their 3.6 correctly calculated	 1 1	AO2/1 4.5.3
3.8	it increases and reaches a maximum	 allow and then does not change any change other than current causing strength to increase scores **0**	1 1	AO3/1a 4.7.2.1 WS3.5
Total			**11**	

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4.1	B		1	AO1/1 4.6.2.1
4.2	electrical heating		1	AO1/1 4.6.2.4
4.3	orange	allow a correct answer indicated in the box provided the answer space is blank	1	AO3/1a 4.6.2.4 WS3.5
4.4	becomes (more) red	allow changes from mainly orange to mainly red	1	AO3/2a 4.6.2.4 WS3.5
4.5	the independent	allow a correct answer indicated in the box provided the answer space is blank	1	AO2/2 4.6.2.2 WS2.2
4.6	pour (hot) water into the (hollow metal) cube point the IR detector at each / a side and take a reading keep the detector the same distance from each surface	 allow point the IR detector at the cube and take a reading allow IR detector touching the surface and take a reading allow take the temperature for take a reading	1 1 1	AO1/2 4.6.2.2 WS2.2
4.7	0.1°C		1	AO2/2 4.6.2.2 WS2.3
4.8	one bar drawn to 68.0 (°C) one bar drawn to 28.0 (°C) tallest bar labelled Matt black and shortest bar labelled Shiny silver	ignore the position of the bars on the x-axis	1 1 1	AO2/2 4.6.2.2 WS3.1

4.9	any **one** from: • (matt) black is the best emitter • shiny silver is the worst emitter	allow matt white and shiny black are (almost) the same at emitting allow black is a good emitter allow silver is a poor emitter allow an answer in terms of highest / lowest temperature ignore any reference to absorption / reflection	1	AO3/2b 4.6.2.2 WS3.5
Total			**13**	

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5.1	correct angle labelled	answer must indicate the angle, the letter **r** on it's own is insufficient  	1	AO1/1 4.6.2.2
5.2	58 (degrees)	allow 57 to 59 inclusive	1	AO2/2 4.6.2.2
5.3	ray continues in a straight line to the edge of the block ray refracts away from the normal both rays in the air should be parallel	 judge by eye	1 1 1	AO1/1 4.6.2.2
5.4	random	allow a correct answer indicated in the box provided the answer space is blank	1	AO3/2a 4.6.1.3 WS3.7
5.5	25		1	AO2/2 4.6.1.3
5.6	less than	allow a correct answer indicated in the box provided the answer space is blank	1	AO3/2b 4.6.1.3 WS3.5
5.7	there is no data/results outside of that range	allow that is all the student measured	1	AO3/1b 4.6.1.3 WS2.7

5.8	light would not pass through an opaque block **or** light will pass through a transparent block	an answer which does not refer to either transparent or opaque should be taken as referring to transparent	1	AO1/1 4.6.2.6
5.9	The angles of incidence tested		1	AO3/3b 4.6.1.3 WS2.7
Total			**11**	

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
6.1	B		1	AO1/1 4.5.6.2.1
6.2	horizontal line drawn from (40, 20) to (300, 20) straight line drawn from the point where line B finishes to 0 m/s finishing on the x-axis at 360 s	 allow a straight line showing time to decelerate as 60s	1 1 1	AO2/2 4.5.6.1.5
6.3	acceleration = $\frac{\text{(change in) velocity}}{\text{time (taken)}}$	allow a = $\frac{(\Delta)v}{t}$	1	AO1/1 4.5.6.1.5 iso
6.4	$1.15 = \frac{\Delta v}{22}$ $\Delta v = 1.15 \times 22$ $\Delta v = 25.3$ (m/s)	an answer 25.3 scores **3** marks	1 1 1	AO2/1 4.5.6.1.5
Total			**8**	

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
7.1	crate		1	AO1/1 4.5.4
7.2	centre of mass		1	AO1/1 4.5.1.3
7.3	the pointer is vertical	allow unable to see the pointer allow the bar is horizontal	1	AO3/1a 4.5.4
7.4	P		1	AO2/1 4.5.4
7.5	moment (of a force) = force x distance	allow M = F d	1	AO1/1 4.5.4
7.6	 0.15 = W × 0.06 $W = \frac{0.15}{0.06}$ W = 2.5 (N)	an answer 2.5 (N) scores **3** marks 	 1 1 1	AO2/1 4.5.4
7.7	weight = mass × gravitational field strength	allow W = m g	1	AO1/1 4.5.1.3
7.8	 2.5 = m × 9.8 m = 2.5 / 9.8 mass rice = 0.215 (kg)	an answer 0.215 or 0.22 (kg) scores **3** marks allow ecf from 07.6 an answer of 0.255 or 0.26 (kg) scores **2** marks	 1 1 1	AO2/1 4.5.1.3
Total			**12**	

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Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
8.1	focal length	this answer only	1	AO1/1 4.6.2.5
8.2	one correct line drawn from the top of the object, passing through the lens and crossing or meeting given line inverted image drawn at the correct position and length	ignore any arrow drawn on the line if two lines are drawn, both must be correct arrowhead required	1 1	AO2/2 4.6.2.5
8.3	similarity (both are) diminished difference concave is <u>virtual</u> and convex is <u>real</u> **or** concave is upright and convex is inverted	 allow smaller for diminished a comparison must be made ignore reference to positions of images	1 1	AO3/2a 4.6.2.5
8.4	 $6.0 = \frac{9.0}{\text{object height}}$ $\text{object height} = \frac{9.0}{6.0}$ object height = 1.5 (mm)	an answer of 1.5 (mm) scores **3** marks provided working can be seen, an attempt to convert 9.0 mm to cm or m with all other steps correct scores **2** marks	 1 1 1	AO2/1 4.6.2.5
Total			**8**	

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
9.1	metre rule	allow metre ruler allow tape measure do not accept ruler do not accept metre stick	1	AO1/2 4.6.1.2 RPA8
9.2	(wave) speed = frequency × wavelength	allow v = f λ	1	AO1/1 4.6.1.2 RPA8
9.3	 80cm = 0.8m v = 55 × 0.8 v = 44 (m/s)	an answer of 44 (m/s) scores **3** marks this mark may be awarded if wavelength is incorrectly or not converted allow correct calculation using an incorrectly or not converted wavelength an answer of 4400 (m/s) scores **2** marks	 1 1 1	AO2/1 4.6.1.2 RPA8
9.4	move the (wooden) bridge to the right OR change the mass/weight (on the string) scores **1** mark add more masses/weights (to the string) scores both marks	 dependent on 1st mp being scored	1 1	AO2/2 4.6.1.2 RPA8

9.5	**Level 2:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	3–4	AO3/3a 4.6.1.2 RPA8
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content add or take away masses from the string (ignore any stated values) adjust frequency using the signal generator and/or move the wooden bridge observe a steady / stationary pattern measure the wavelength calculate wave speed from frequency and wavelength a Level 1 answer should include a way of changing tension a complete Level 2 answer would include either changing frequency and/or moving the bridge		
Total		**11**	

Question 10

Question	Answers	Mark	AO/ Spec. Ref
10.1	**Level 3**: Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1/1 AO2/1 4.5.6.3.2 4.5.6.3.3
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content • reaction time explained in terms of longer reaction times increase thinking distance (from a given speed) • taking drugs • drinking alcohol • tiredness • age • distractions explained in terms of effect on driver's reaction time • speed explained in terms of the faster the vehicle the greater the distance travelled in the driver's reaction time (or converse) **OR** explained in terms of increased speed increases KE so increases work done to stop the vehicle • condition of the tyres • condition of road surface • wet/icy roads explained in terms of condition of tyres and road surface (including weather considerations) affecting <u>friction</u> (between tyres and road) • condition of brakes explained in terms of effect on braking force (applied to the wheels) or reduced <u>friction</u>		

	• mass / weight of vehicle explained in terms of deceleration force or kinetic energy or change in momentum answers do not need to reference thinking / braking distance a Level 1 answer would list factors only **or** one factor with one linked explanation a Level 2 answer lists at least three factors with one linked explanation **or** two factors with two linked but different explanations a Level 3 answer lists at least three factors with at least two linked but different explanations			
10.2	work (done) = force × distance	allow W = F s	1	AO1/1 4.5.2
10.3	900 000 = 60 000 × distance distance = $\frac{900\,000}{60\,000}$ distance = 15 (m)	an answer 15 (m) scores **3** marks	1 1 1	AO2/1 4.5.2
10.4	brakes overheating **or** brakes locking (causing) loss of control **or** (causing) a skid	allow brake fade allow wheels locking allow increasing the stopping / braking distance **ONLY** if the first marking point scored ignore any effects on passengers or possible accidents	1 1	AO1/1 4.5.6.3.4
Total			**12**	

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

F

Foundation 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.
- 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).
- 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	
TOTAL	

Do not write outside the box

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

0 1 **Figure 1** shows a water wave.

Figure 1

0 1 . 1 What type of wave is a water wave?

[1 mark]

Tick (✓) **one** box.

Electromagnetic ☐

Longitudinal ☐

Transverse ☐

0 1 . 2 Which statement describes the movement of the water at point **X**?

[1 mark]

Tick (✓) **one** box.

The water at point **X** does **not** move. ☐

The water at point **X** moves to the left and right. ☐

The water at point **X** moves up and down. ☐

Do not write outside the box

0 1 . 3 The wave has a frequency of 2.0 hertz.

The wavelength is 0.032 metres.

Calculate the wave speed.

Use the equation:

wave speed = frequency × wavelength

Choose the unit from the box.

[3 marks]

m^2/s	m/s	s^2

Wave speed = _____ Unit _____

0 1 . 4 What is transferred by all waves?

[1 mark]

Tick (✓) **one** box.

- Energy ☐
- Information ☐
- Water ☐

Question 1 continues on the next page

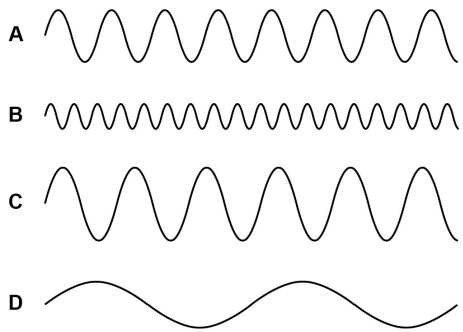
Do not write outside the box

Figure 2 shows four water waves.

The waves are all drawn to the same scale.

The waves all travel at the same speed.

Figure 2



0 1 . 5 Which wave has the longest wavelength?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 1 . 6 Which wave has the highest frequency?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

8

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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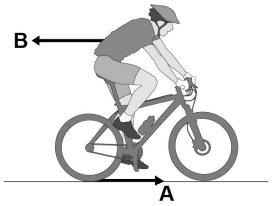
Do not write outside the box

0 2 **Figure 3** shows a cyclist on a bicycle.

The cyclist is moving at a constant velocity.

Arrows **A** and **B** represent the horizontal forces acting on the bicycle and cyclist.

Figure 3



0 2 . 1 What is force **A**?

[1 mark]

Tick (✓) **one** box.

- Air resistance ☐
- Friction ☐
- Tension ☐
- Upthrust ☐

0 2 . 2 What is force **B**?

[1 mark]

Tick (✓) **one** box.

- Air resistance ☐
- Magnetic ☐
- Tension ☐
- Upthrust ☐

0 2 . 3 What is the relationship between force **A** and force **B** when the cyclist travels at a constant velocity?

[1 mark]

Tick (✓) **one** box.

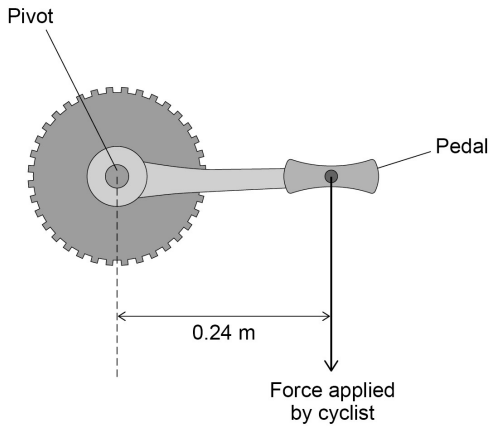
- **A** = **B** ☐
- **A** > **B** ☐
- **A** < **B** ☐

Question 2 continues on the next page

0 2 . 4 The cyclist applies a force of 150 N to one of the bicycle pedals.

Figure 4 shows the distance between the force applied and the pivot.

Figure 4



Calculate the moment about the pivot caused by the force applied to the pedal in **Figure 4.**

Use the equation:

moment of a force = force × distance

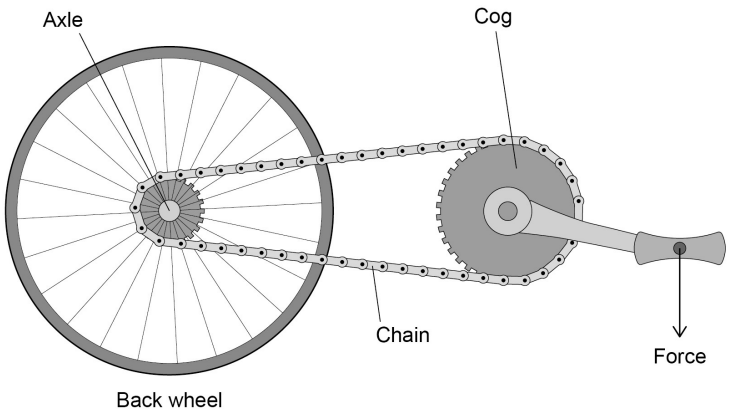
[2 marks]

Moment = _____ N m

Do not write outside the box

0 2 . 5 **Figure 5** shows how the pedal is connected to the back wheel of the bicycle.

Figure 5



Complete the sentence.

Choose the answer from the box.

[1 mark]

axle	**chain**	**cog**

The force from the cyclist pushing down on the pedal is transmitted to the back wheel by the _____ .

Question 2 continues on the next page

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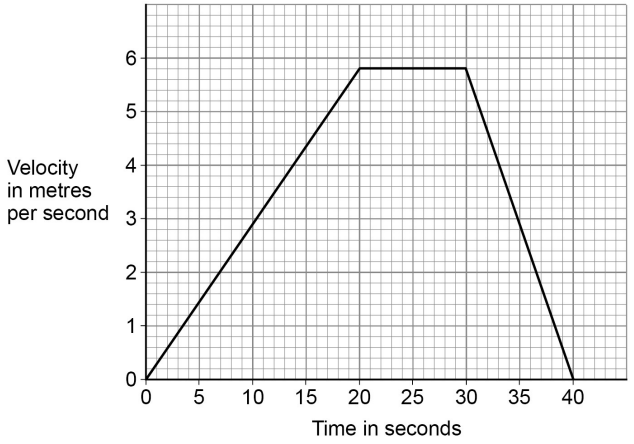
Figure 6 shows how the velocity of the cyclist changes during a journey.

Figure 6



0 2 . 6 What is the change in velocity of the cyclist in the first 20 seconds of the journey?

[1 mark]

Tick (✓) **one** box.

5.2 m/s ☐

5.4 m/s ☐

5.6 m/s ☐

5.8 m/s ☐

Do not write outside the box

0 2 . 7 Determine the acceleration of the cyclist during the first 20 seconds of the journey.

Use your answer from Question **02.6**

Use the equation:

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

[2 marks]

Acceleration of the cyclist = _____ m/s^2

0 2 . 8 Complete the sentence.

Choose the answer from the box.

[1 mark]

deceleration	**speed**	**velocity**

Between 30 and 40 seconds the cyclist moves with

a constant _____ .

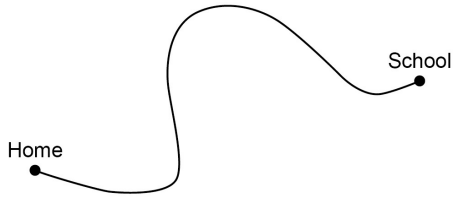
Question 2 continues on the next page

Do not write outside the box

0 2 . 9 The cyclist travels from home to school.

Figure 7 shows the route the cyclist followed.

Figure 7



Draw an arrow on **Figure 7** to show the displacement of the cyclist.

[1 mark]

11

0 3 There are different groups of waves in the electromagnetic spectrum.

0 3 . 1 **Figure 8** shows the position of three groups of the waves.

Figure 8

A	Microwaves	**B**	Visible light	**C**	**D**	Gamma rays

Which letter shows the position of infrared?

[1 mark]

Tick (✓) **one** box.

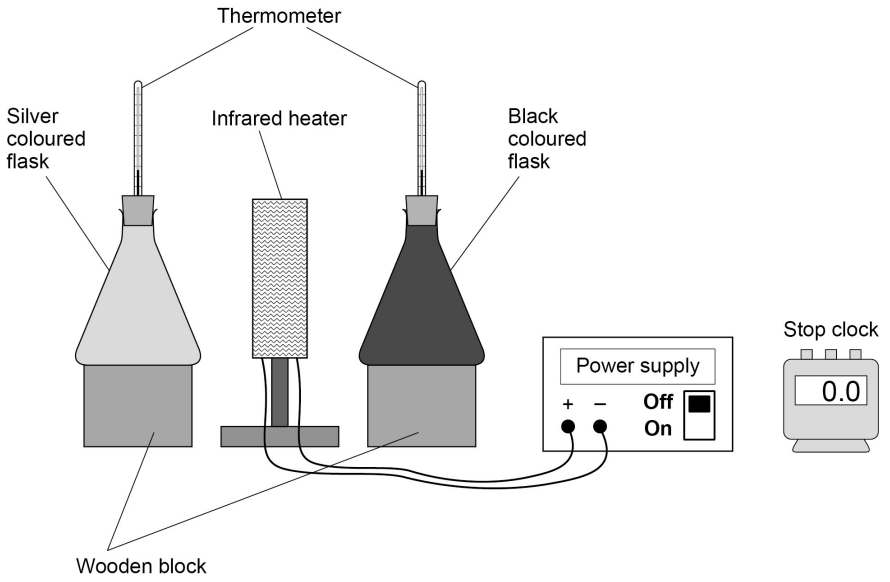
A ☐ **B** ☐ **C** ☐ **D** ☐

Question 3 continues on the next page

A student investigated how the colour of a surface affects the amount of infrared the surface absorbs.

Figure 9 shows the equipment used.

Figure 9



Do not write outside the box

0 3 . 2 Complete the sentence.

Choose the answer from the box.

[1 mark]

a control	**the dependent**	**the independent**

In this investigation the distance between each flask and the infrared heater

is _____ variable.

0 3 . 3 The student wrote the hypothesis:

'Surface colour of the flask affects the amount of infrared absorbed when the heater is switched on for five minutes.'

Describe how the equipment in **Figure 9** could be used to test this hypothesis.

[4 marks]

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Question 3 continues on the next page

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Table 1 shows the results.

Table 1

Colour of flask	**Temperature increase in °C**		
	Test 1	**Test 2**	**Test 3**
Black	19	17	27
Silver	10	12	11

0 3 . 4 Which **one** of the results for the black flask is anomalous?

[1 mark]

_____

0 3 . 5 The anomalous result was caused by reading the thermometer incorrectly.

What should the student do with the anomalous result?

[1 mark]

_____

_____

0 3 . 6 Calculate the mean temperature increase for the silver flask.

[1 mark]

_____

_____

Mean temperature increase = _____ °C

Do not write outside the box

0 3 . 7 What conclusion can be made from **Table 1?**

[1 mark]

Tick (✓) **one** box.

Both flasks absorbed the same amount of infrared during the five minutes. ☐

The black flask absorbed the most infrared during the five minutes. ☐

The silver flask absorbed the most infrared during the five minutes. ☐

10

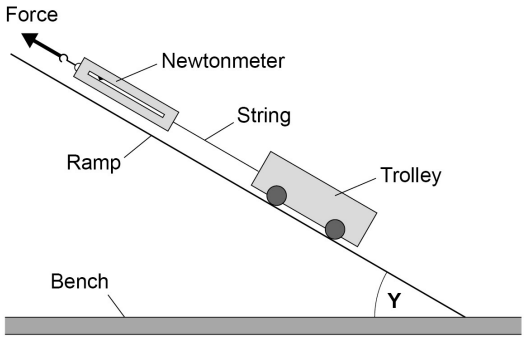
Turn over for the next question

Do not write outside the box

0 4 A student investigated how the angle of a ramp affects the force required to hold a trolley stationary on the ramp.

Figure 10 shows the equipment used.

Figure 10



0 4 . 1 Measure the angle **Y** in **Figure 10**

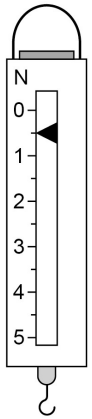
[1 mark]

Angle **Y** = _____ degrees

Do not write outside the box

Figure 11 shows the newtonmeter before the investigation started.

Figure 11



0 4 . 2 What type of error is shown on the newtonmeter in **Figure 11**?

[1 mark]

Tick (✓) **one** box.

Human error ☐

Random error ☐

Zero error ☐

0 4 . 3 How can this error be corrected after the measurements have been taken?

[1 mark]

Tick (✓) **one** box.

Add 0.5 N to each measurement ☐

Multiply each measurement by 0.5 N ☐

Subtract 0.5 N from each measurement ☐

Turn over ►

Do not write outside the box

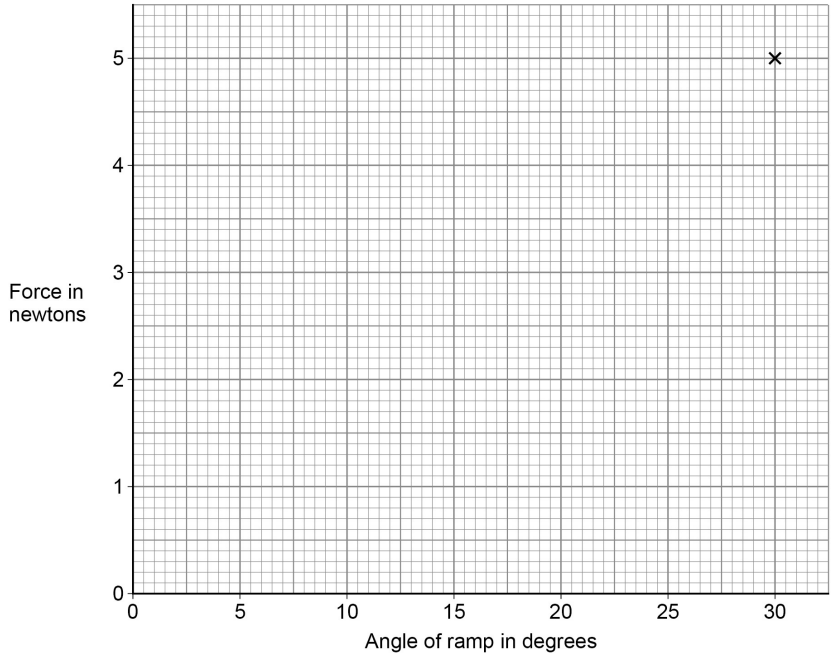
Table 2 shows the corrected results.

Table 2

Angle of ramp in degrees	Force in newtons
5	0.9
10	1.7
15	2.6
20	3.4
25	4.2
30	5.0

Figure 12 is an incomplete graph of the results

Figure 12



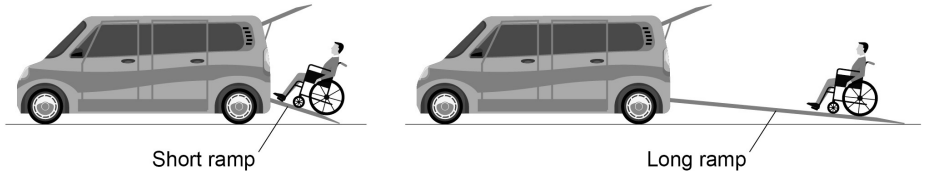
Do not write outside the box

0 4 . 4 Plot the missing results from **Table 2** on **Figure 12**.

[2 marks]

0 4 . 5 **Figure 13** shows a person in a wheelchair using two different ramps to enter a van.

Figure 13



The ramps are at different angles to the ground.

Explain **one** advantage of using the long ramp compared with using the short ramp.

[2 marks]

0 4 . 6 A force of 160 N is used to move the wheelchair up the long ramp.

The ramp is 2.5 m long.

Calculate the work done to move the wheelchair up the ramp.

Use the equation:

work done = force × distance

[2 marks]

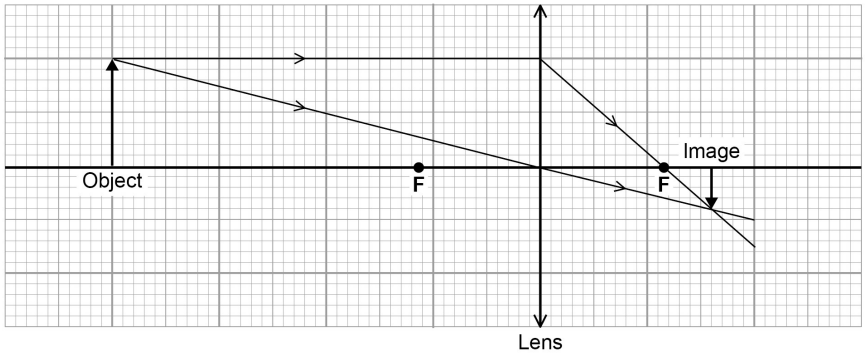
Work done = _____ J

9

Do not write outside the box

0 5 **Figure 14** shows how a lens forms an image of an object.

Figure 14



0 5 . 1 What type of lens is represented in **Figure 14**?

[1 mark]

Tick (✓) **one** box.

Concave ☐

Convex ☐

Diverging ☐

0 5 . 2 Measure the image height and the object height in **Figure 14**.

[1 mark]

Image height = _____ cm

Object height = _____ cm

Do not write outside the box

0 5 . 3 Calculate the magnification produced by the lens.

Use the equation:

$$\text{magnification} = \frac{\text{image height}}{\text{object height}}$$

[2 marks]

Magnification = _____

0 5 . 4 Which **two** words describe the image in **Figure 14**?

[2 marks]

Tick (✓) **two** boxes.

- Enlarged ☐
- Inverted ☐
- Real ☐
- Upright ☐
- Virtual ☐

Question 5 continues on the next page

Do not write outside the box

0 5 . 5 The object was blue.

A student looked at the blue object through a green filter.

Complete the sentences.

Choose answers from the box.

[2 marks]

black	**blue**	**green**	**red**	**white**

Looking at the blue object through a green filter makes the object appear

_____ .

This is because the green filter only transmits the light that is _____ .

8

Do not write outside the box

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 6 The Sun is the closest star to the Earth.

0 6 . 1 A 2.5 kg mass would have a weight of 750 N at the surface of the Sun.

Calculate the gravitational field strength at the surface of the Sun.

Use the equation:

$$\text{gravitational field strength} = \frac{\text{weight}}{\text{mass}}$$

[2 marks]

Gravitational field strength = _____ N/kg

0 6 . 2 Gravity is a non-contact force.

Which of the following is also a non-contact force?

[1 mark]

Tick (✓) **one** box.

- Air resistance ☐
- Electrostatic ☐
- Friction ☐
- Tension ☐

Do not write outside the box

0 6 . 3 All stars have a life cycle.

Figure 15 shows part of the life cycle of a star that becomes a black dwarf.

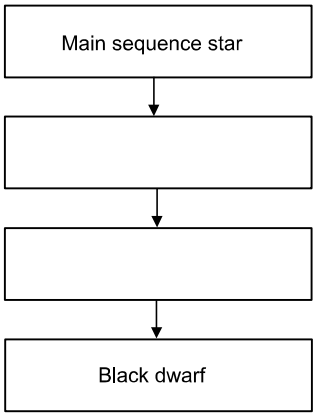
Complete **Figure 15**.

Choose answers from the box.

[2 marks]

Black hole		**Neutron star**
Red giant	**Supernova**	**White dwarf**

Figure 15



Question 6 continues on the next page

Do not write outside the box

Table 3 gives the mass of three stars compared to the mass of the Sun.

Table 3

Star	Mass compared to the mass of the Sun
X	× 25.0
Y	× 15.0
Z	× 0.9

0 6 . 4 Which letter represents the star most likely to become a black dwarf?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

X ☐ **Y** ☐ **Z** ☐

Reason _____

_____

_____

0 6 . 5 In which stage of the life cycle of a star are elements heavier than iron produced?

[1 mark]

Tick (✓) **one** box.

Nebula ☐

Protostar ☐

Supernova ☐

8

Turn over for the next question

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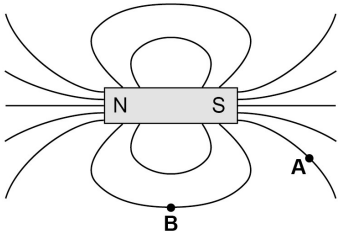
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 7 **Figure 16** shows the magnetic field pattern around a bar magnet.

Figure 16



0 7 . 1 Draw an arrow at point **A** and point **B** to show the direction of the magnetic field at each point.

[1 mark]

0 7 . 2 A bar magnet produces its own magnetic field.

Complete the sentence.

Choose the answer from the box.

[1 mark]

an electromagnet	**an induced magnet**	**a permanent magnet**

A bar magnet is an example of _____ .

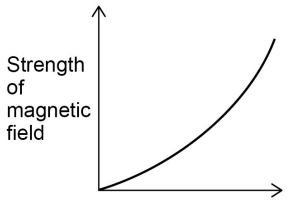
Do not write outside the box

0 7 . 3 Which graph shows how the strength of the magnetic field varies with distance from the bar magnet?

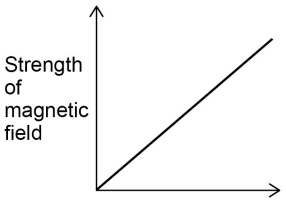
Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.



☐



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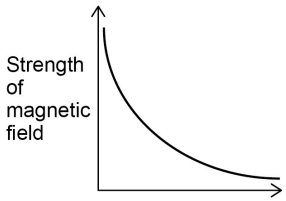


☐

Reason _____

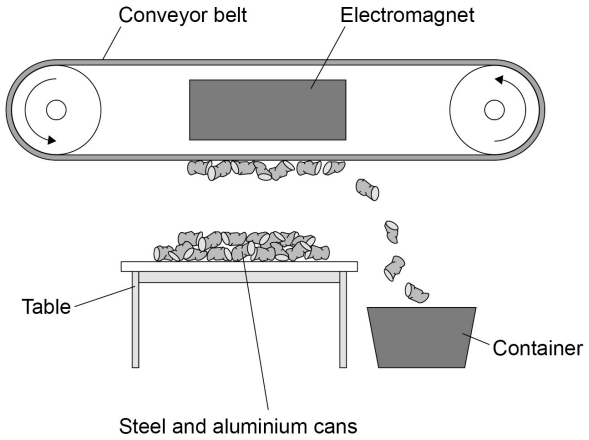
_____

Question 7 continues on the next page

Do not write outside the box

Figure 17 shows an electromagnet being used to separate aluminium cans from steel cans.

Figure 17



0 7 . 4 Explain how the electromagnet and conveyor belt are used to separate the steel cans from the aluminium cans.

[2 marks]

_____

_____

_____

_____

Do not write outside the box

0 7 . 5 At the top of the table the strength of the magnetic field is only just enough to pick the cans up.

Describe **two** ways to increase the strength of magnetic field at the top of the table.

[2 marks]

1 _____

_____

2 _____

_____

0 7 . 6 Write down the equation which links distance travelled (s), speed (v) and time (t).

[1 mark]

_____

0 7 . 7 The conveyor belt moves a can at a speed of 1.7 m/s.

Calculate the time taken to move the can 3.3 m at this speed.

Give your answer to 2 significant figures.

[4 marks]

_____

_____

_____

_____

_____

Time taken (2 significant figures) = _____ s

13

Turn over for the next question

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DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

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0 8 The thinking distance and braking distance for a car vary with the speed of the car.

0 8 . 1 Explain the effect of **two** other factors on the **braking** distance of a car.

Do **not** refer to speed in your answer.

[4 marks]

Question 8 continues on the next page

Do not write outside the box

0 8 . 2 Which equation links acceleration (a), mass (m) and resultant force (F).

[1 mark]

Tick (✓) **one** box.

resultant force = mass × acceleration ☐

resultant force = mass × acceleration^2 ☐

resultant force = $\frac{\text{mass}}{\text{acceleration}^2}$ ☐

resultant force = $\frac{\text{mass}}{\text{acceleration}}$ ☐

0 8 . 3 The mean braking force on a car is 7200 N.

The car has a mass of 1600 kg.

Calculate the deceleration of the car.

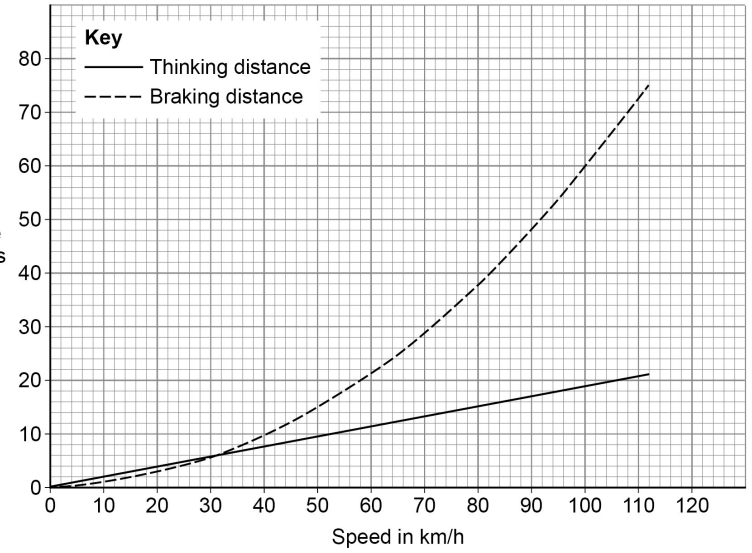
[3 marks]

Deceleration = _____ m/s^2

Do not write outside the box

0 8 . 4 **Figure 18** shows how the thinking distance and braking distance for a car vary with the speed of the car.

Figure 18



Determine the stopping distance when the car is travelling at 80 km/h.

[2 marks]

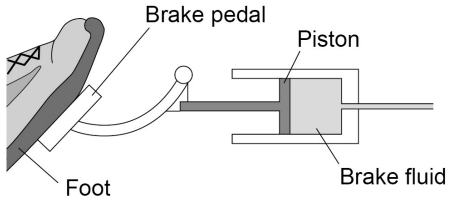
Stopping distance = _____ m

Question 8 continues on the next page

Do not write outside the box

Figure 19 shows part of the braking system for a car.

Figure 19



0 8 . 5 Which equation links area of a surface (A), the force normal to that surface (F) and pressure (p)?

[1 mark]

Tick (✓) **one** box.

$p = F \times A$ ☐

$p = F \times A^2$ ☐

$p = \frac{F}{A}$ ☐

$p = \frac{A}{F}$ ☐

Do not write outside the box

0 8 . 6 When the brake pedal is pressed, a force of 60 N is applied to the piston.

The pressure in the brake fluid is 120 000 Pa.

Calculate the surface area of the piston.

Give your answer in standard form.

Give the unit.

[5 marks]

Surface area (in standard form) = _____ Unit _____

16

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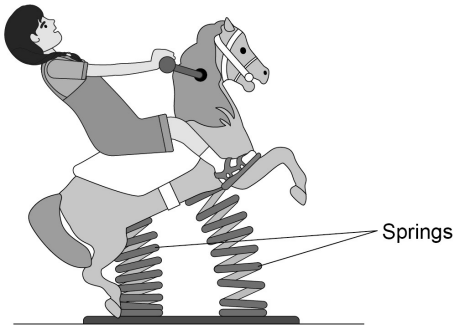
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 9 **Figure 20** shows a child on a playground toy.

Figure 20



0 9 . 1 The springs have been elastically deformed.

Explain what is meant by 'elastically deformed'.

[2 marks]

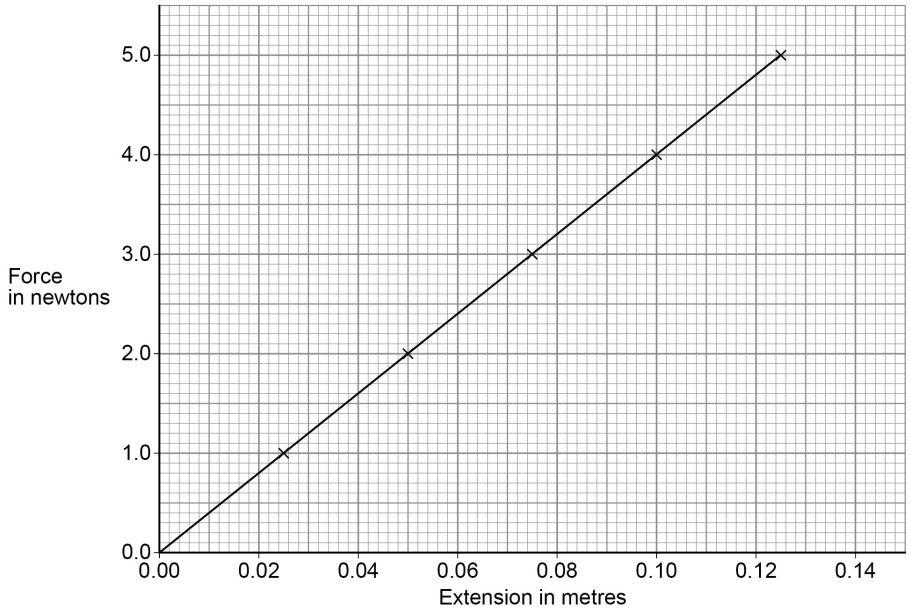
Question 9 continues on the next page

Do not write outside the box

A student investigated the relationship between the force applied to a spring and the extension of the spring.

Figure 21 shows the results.

Figure 21



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0 9 . 2 Describe a method the student could use to obtain the results given in **Figure 21**.

You should include a risk assessment for **one** hazard in the investigation.

Your answer may include a diagram.

[6 marks]

Question 9 continues on the next page

Do not write outside the box

0 9 . 3 Which equation links extension (e), force (F) and spring constant (k).

[1 mark]

Tick (✓) **one** box.

force = spring constant × (extension)^2 ☐

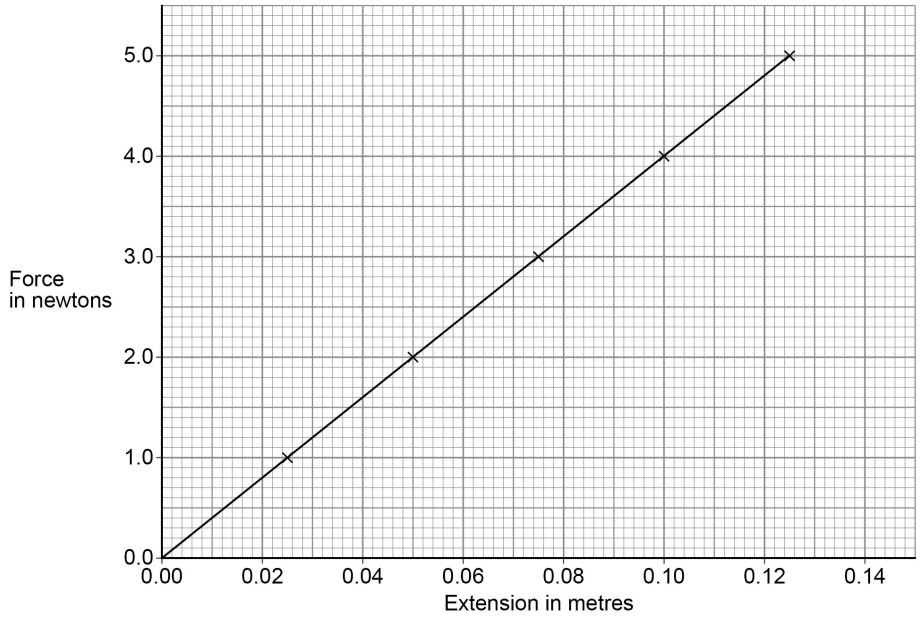
force = spring constant × extension ☐

$\text{force} = \dfrac{\text{extension}}{\text{spring constant}}$ ☐

$\text{force} = \dfrac{\text{spring constant}}{\text{extension}}$ ☐

Figure 21 is repeated below.

Figure 21



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0 9 . 4 Determine the spring constant of the spring.

Use **Figure 21**.

[3 marks]

Spring constant = _____ N/m

0 9 . 5 The student concluded:

'The extension of the spring is directly proportional to the force applied to the spring.'

Describe how **Figure 21** supports the student's conclusion.

[2 marks]

Question 9 continues on the next page

Do not write outside the box

0 9 . 6 The student repeated the investigation using a different spring with a spring constant of 13 N/m.

Calculate the elastic potential energy of the spring when the extension of the spring was 20 cm.

Use the Physics Equations Sheet.

[3 marks]

Elastic potential energy = _____ J

17

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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

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ANSWER IN THE SPACES PROVIDED

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	transverse		1	AO1 4.6.1.1
01.2	the water at point **X** moves up and down		1	AO2 4.6.1.1
01.3	*v* = 2.0 × 0.032 *v* = 0.064 (m/s) m/s		1 1 1	AO2 AO2 AO1 4.6.1.2
01.4	energy		1	AO1 4.6
01.5	**D**		1	AO1 4.6.1.2
01.6	**B**		1	AO1 4.6.1.2
Total			**8**	

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Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	friction		1	AO1 4.5.1.2
02.2	air resistance		1	AO1 4.5.1.2
02.3	**A = B**		1	AO1 4.5.6.2.2
02.4	*M* = 150 × 0.24 *M* = 36 (Nm)		1 1	AO2 4.5.4
02.5	chain		1	AO2 4.5.4
02.6	5.8 m/s		1	AO2 4.5.6.1.5
02.7	$a = \frac{5.8}{20}$ *a* = 0.29 (m/s^2)	allow their *v* from question **02.6** allow a correctly calculated value using their *v* from question **02.6**	1 1	AO2 4.5.6.1.5
02.8	Deceleration		1	AO3 4.5.6.1.5
02.9	straight arrow drawn between home and school pointing towards school.		1	AO1 4.5.6.1.1
Total			**11**	

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	**B**		1	AO1 4.6.2.1
03.2	a control		1	AO1 4.6.2.2 RPA10
03.3	record the initial temperature of the two thermometers in each flask	allow initial temperature is a control variable **or** ensure initial temperature is the same in both flasks	1	AO1 4.6.2.2 RPA10
	switch the infrared heater on and start the stop clock (at the same time)	allow switch on the power supply for switch on the heater	1	
	after five minutes record the (final) temperature from both flasks	allow calculate the temperature increase / change after five minutes	1	
	see / check if the temperature inside the flasks had increased by different amounts		1	
03.4	27 (°C)	allow 27 (°C) identified on the table allow test 3	1	AO3 4.6.2.2 RPA10
03.5	ignore (the result)	allow repeat (the result)	1	AO1 4.6.2.2 RPA10
03.6	(33/3 =) 11		1	AO2 4.6.2.2 RPA10
03.7	the black flask absorbed the most infrared during the five minutes		1	AO3 4.6.2.2 RPA10
Total			**10**	

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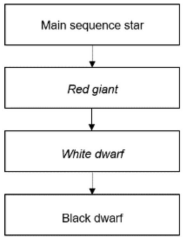
Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	30 (°)		1	AO2 4.5.2
04.2	zero error		1	AO3 4.5.2
04.3	subtract 0.5 N from each measurement		1	AO3 4.5.2
04.4	points plotted correctly	allow 5 correctly plotted for **2** marks, 2–4 correctly plotted for **1** mark allow ± half a square ignore any attempt at a line of best fit	2	AO2 4.5.2
04.5	the long ramp has a smaller angle (so) less force is needed (to hold the wheelchair stationary on the ramp)	allow description (eg shallower gradient / less steep) allow (so) less force is needed to move the wheelchair up the ramp	1 1	AO3 4.5.2
04.6	$W = 160 \times 2.5$ $W = 400$ (J)		1 1	AO2 4.5.2
Total			**9**	

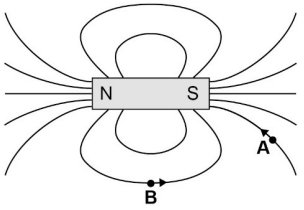
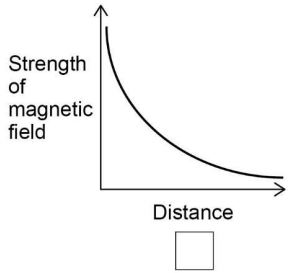
Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	convex		1	AO1 4.6.2.5
05.2	image height = 0.8 (cm) **and** object height = 2 (.0 cm)	both correct for **1** mark	1	AO2 4.6.2.5
05.3	magnification = $\frac{0.8 \text{ (cm)}}{2 \text{ (.0 cm)}}$ magnification = 0.4(0)	allow their measured object and image heights from question **05.2**	1 1	AO2 4.6.2.5
05.4	inverted real		1 1	AO3 4.6.2.5
05.5	black green	this order only	1 1	AO1 4.6.2.6
Total			**8**	

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	$g = \frac{750}{2.5}$ g = 300.0 (N/kg)		1 1	AO2 4.5.1.3
06.2	electrostatic		1	AO1 4.5.1.2
06.3	red giant white dwarf	this order only 	1 1	AO1 4.8.1.2
06.4	Z only stars about the same/smaller size/mass as the Sun become Black dwarfs	reason only scores if Z chosen allow converse	1 1	AO3 4.8.1.2
06.5	supernova		1	AO1 4.8.1.2
Total			**8**	

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	both arrows correct		1	AO1 4.7.1.2
07.2	a permanent magnet		1	AO1 4.7.1.1
07.3	third box ticked any **one** from • (the only graph) that shows the magnetic field getting weaker (as distance increases) • both other graphs show the magnetic field getting stronger (as the distance increases)	 only scores if correct box is chosen	1 1	AO3 4.7.1.2
07.4	steel cans are attracted to the electromagnet and are transferred to the container (by the conveyor belt) aluminium cans are not attracted to the electromagnet		1 1	AO1 4.7.1.2

	and are left behind on the table	If no other mark scored: Steel cans are attracted (to the electromagnet) but aluminium cans are not – scores one mark		
07.5	raise the height of the table	allow longer legs on the table allow put a (non-magnetic) box on top of the table allow lower the electromagnet	1	AO3 4.7.2.1
	use a larger potential difference / current **or** use a stronger electromagnet	allow more turns on the coil (of the electromagnet) do **not** accept insert a (soft) iron core	1	
07.6	distance travelled = speed × time **or** $s = v\,t$		1	AO1 4.5.6.1.2
07.7	$3.3 = 1.7 \times t$		1	AO2 4.5.6.1.2
	$t = \frac{3.3}{1.7}$		1	
	$t = 1.941$ (s)		1	
	$t = 1.9$ (s)	allow a calculation using the given data incorrectly but correctly rounded to 2 sig figs	1	
Total			**13**	

Question 8

Question	Answers	Mark	AO/ Spec. Ref
08.1	**Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	3–4	AO1 4.5.6.3.3 4.5.6.3.4 4.1.1.2
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content Factors • poor condition of tyres • poor road surface • wet or icy road • poor/worn brakes Explanation • because of decreased friction Factors • increased mass of car/passengers Explanation • increases kinetic energy of car • more work needs to be done to stop car • increases momentum of the car Factor • road slopes downhill Explanation • (a component of) gravity opposes the braking force • resultant (braking) force is reduced allow answers in terms of reducing braking distance throughout A single factor with no related explanation is insufficient to score a mark		

08.2	resultant force = mass × acceleration		1	AO1 4.5.6.2.2
08.3	7200 = 1600 × *a* *a* = $\frac{7200}{1600}$ *a* = 4.5 (m/s^2)	ignore negatives throughout	1 1 1	AO2 4.5.6.2.2
08.4	15 (m) 38 (m) = 53 (m)	two correct values identified allow the correct addition of a misread braking distance and /or a misread thinking distance taken from the graph	1 1	AO3 4.5.6.3.1
08.5	$p = \frac{F}{A}$		1	AO1 4.5.5.1.1
08.6	120 000 = $\frac{60}{A}$ *A* = $\frac{60}{120\,000}$ *A* = 0.0005 *A* = 5 (.0) × 10^{-4} m^2	 allow an answer given to 2 sig figs from an incorrect calculation using the given data	1 1 1 1 1	AO2 AO2 AO2 AO2 AO1 4.5.5.1.1
Total			**16**	

Question 9

Question	Answers	Extra information	Mark	AO/ Spec. Ref
09.1	will return to its original shape/length when the force is removed	 allow (when) the child gets off the second mark is dependent on scoring the first mark	1 1	AO2 4.5.3
09.2	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.		5–6	AO1 4.5.3
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.		3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.		1–2	
	No relevant content		0	
	Indicative content • set up a clamp stand with a clamp • hang the spring from the clamp • use a second clamp and boss to fix a (half) metre rule alongside the spring • record the ruler reading that is level with the bottom of the spring • hang a 1 N / a known weight from the bottom of the spring • record the new position of the bottom of the spring • calculate the extension of the spring • measure the extension of the spring • add further weights to the spring so the force increases 1 N at a time up to 5 N • for each new force record the position of the bottom of the spring and calculate / measure the extension Indicative content continues on the next page…			

	Risk Assessment Hazard: Clamp (stand, boss and masses) might fall off desk Risk: injury to feet Precaution: Use clamp to fix apparatus to the bench **or** Ensure that the slotted masses hang over the base/foot of the stand **or** Ensure that the boss is screwed tightly into the stand and clamp **or** Put (heavy) masses on the base/foot of the stand **or** Stand up so that you can move out of the way Hazard: Spring could break / come loose Risk: damage eye Precaution: Wear safety goggles If a risk assessment / hazard is not given, the answer can still reach level 3, but not full marks. Full marks may be awarded for alternative feasible methods.		

09.3	force = spring constant × extension		1	AO1 4.5.3

09.4	5.00 0.125 $k = \frac{5.00}{0.125}$ k = 40 (N/m)	allow any correct pair of values from the graph allow a misread value(s) from the graph allow a correct calculation using their incorrect value(s)	1 1 1	AO2 4.5.3

09.5	the line is straight and passes through the origin	allow the line does not curve allow a constant gradient	1 1	AO3 4.5.3

09.6	e = 0.20 m $E_e = 0.5 \times 13 \times 0.20^2$ E_e = 0.26 (J)	 allow an incorrectly / not converted value of e use of two incorrectly/not converted values scores a máximum of 1 mark	1 1 1	AO2 4.5.3

Total			**17**

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

F

Foundation 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.

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.

Do not write outside the box

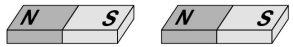
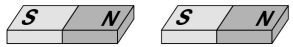
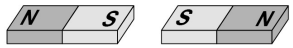
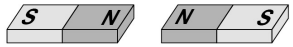
Answer **all** questions in the spaces provided.

0 1 When two magnets are close together they exert a force on each other.

0 1 . 1 Complete **Table 1** to show if the magnets would attract or repel. **[2 marks]**

Tick (✓) **one** box in **each** row.

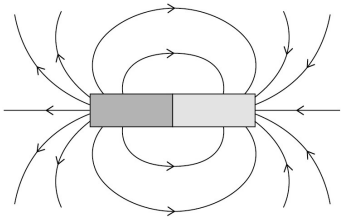
Table 1

	Attract	Repel
		
		
		
		

Do not write outside the box

0 1 . 2 **Figure 1** shows the magnetic field around a bar magnet.

Figure 1



Which statements are true for the magnetic field shown in **Figure 1**?

[2 marks]

Tick (✓) **two** boxes.

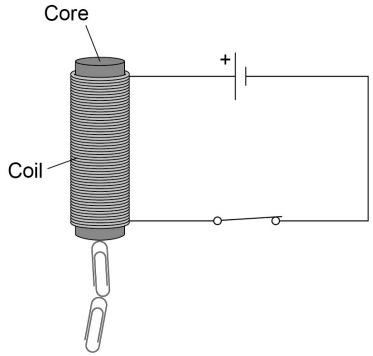
- The magnetic field gets weaker further from the magnet. ☐
- The magnetic field is strongest at the poles. ☐
- The magnetic field is uniform away from the poles. ☐
- The magnetic field lines all meet at a single point. ☐
- The magnetic field lines point from south to north. ☐

Question 1 continues on the next page

Do not write outside the box

Figure 2 includes an electromagnet.

Figure 2



0 1 . 3 Which metal is used to make the core of the electromagnet?

[1 mark]

Tick (✓) **one** box.

- Aluminium ☐
- Copper ☐
- Iron ☐
- Magnesium ☐

0 1 . 4 Complete the sentence.

Choose the answer from the box.

[1 mark]

coil	**metal core**	**paper clip**

The switch is closed. There is a current in the _____.

Do not write outside the box

0 1 . 5 The number of turns on the coil is increased. The current remains the same.

How does this affect the strength of the magnetic field around the electromagnet?

[1 mark]

Tick (✓) **one** box.

- The magnetic field would be stronger. ☐
- The magnetic field would stay the same. ☐
- The magnetic field would be weaker. ☐

0 1 . 6 The metal core was removed. The current remains the same.

How does this affect the strength of the magnetic field around the electromagnet?

[1 mark]

Tick (✓) **one** box.

- The magnetic field would be stronger. ☐
- The magnetic field would stay the same. ☐
- The magnetic field would be weaker. ☐

Turn over for the next question

8

Do not write outside the box

0 2 Hailstones are small balls of ice. Hailstones form in clouds and fall to the ground.

Figure 3 shows different-sized hailstones.

Figure 3

0 2 . 1 Which force causes the hailstones to fall to the ground?

[1 mark]

Tick (✓) **one** box.

- Air resistance ☐
- Gravitational force ☐
- Magnetic force ☐
- Tension ☐

Do not write outside the box

0 2 . 2 As the hailstones begin to fall they accelerate.

Which force increases as the hailstones accelerate?

[1 mark]

Tick (✓) **one** box.

- Air resistance ☐
- Gravitational force ☐
- Magnetic force ☐
- Tension ☐

0 2 . 3 After a short time hailstones fall at terminal velocity.

Which of the following statements is true at terminal velocity?

[1 mark]

Tick (✓) **one** box.

- The hailstones begin to slow down. ☐
- The mass of the hailstones increases. ☐
- The resultant force on the hailstones is zero. ☐

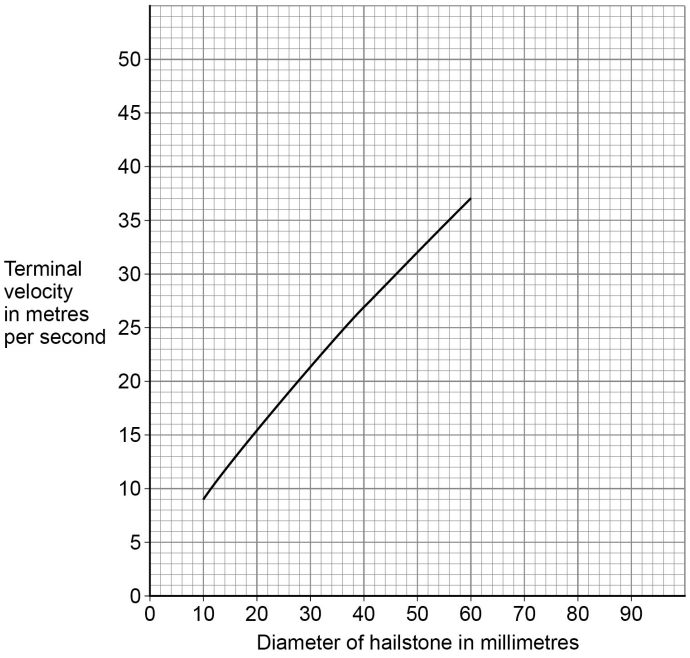
Question 2 continues on the next page

Do not write outside the box

A scientist investigated how the terminal velocity of hailstones varies with their diameter.

Figure 4 shows the results.

Figure 4



0 2 . 4 Estimate the terminal velocity for a hailstone with a diameter of 80 mm.

Show how you obtain your answer.

[2 marks]

Terminal velocity = _____ m/s

Do not write outside the box

0 2 . 5 Give **one** reason why a hailstone with a large diameter has a greater terminal velocity than a hailstone with a smaller diameter.

[1 mark]

Tick (✓) **one** box.

It has a greater power. ☐

It has a greater pressure. ☐

It has a greater temperature. ☐

It has a greater weight. ☐

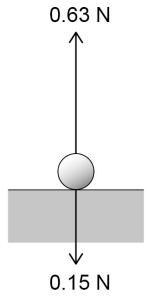
Question 2 continues on the next page

Do not write outside the box

After falling, the hailstone hits the ground.

Figure 5 shows the forces acting on the hailstone at the moment it hits the ground.

Figure 5



0 2 . 6 What is the magnitude of the resultant force on the hailstone in **Figure 5**?

[1 mark]

Tick (✓) **one** box.

0.15 N ☐

0.48 N ☐

0.63 N ☐

0.78 N ☐

0 2 . 7 What is the direction of the resultant force on the hailstone in **Figure 5**?

[1 mark]

_____

8

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 3 The Sun is at the centre of our solar system.

0 3 . 1 What type of object is the Sun?

[1 mark]

0 3 . 2 What is the name of the galaxy our solar system is part of?

[1 mark]

Tick (✓) **one** box.

- Andromeda ☐
- Milky Way ☐
- Sombrero ☐
- Tadpole ☐

Table 2 gives information about some of the moons in our solar system.

Table 2

Moon	Radius in kilometres
Ganymede	2630
Titan	2570
Europa	1560
Charon	606

0 3 . 3 What is a moon?

[1 mark]

_____

0 3 . 4 A student researched the radius of some planets in the solar system.

radius of largest dwarf planet = 1190 km
radius of smallest planet = 2440 km

The student made the following conclusions:

1. dwarf planets are always smaller than moons
2. planets are always bigger than moons.

Give **one** reason why each of the student's conclusions is wrong.

Use the data given above and in **Table 2**.

[2 marks]

1 _____

_____

2 _____

_____

Question 3 continues on the next page

The Earth's Moon and the International Space Station both orbit the Earth.

0 3 . 5 Give **one other** similarity and **one** difference between the orbit of the Earth's Moon and the orbit of the International Space Station.

[2 marks]

Similarity _____

_____

Difference _____

_____

0 3 . 6 Very few people have been to the International Space Station.

Suggest **one** reason why very few people have been to the International Space Station.

[1 mark]

_____

_____

_____

8

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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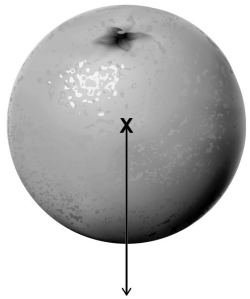
Do not write outside the box

0 4 **Figure 6** shows the weight of an orange acting from a point labelled **X.**

Figure 6



0 4 . 1 What name is given to point **X** in **Figure 6**?

[1 mark]

Tick (✓) **one** box.

- Centre of force ☐
- Centre of mass ☐
- Centre of balance ☐
- Centre of weight ☐

0 4 . 2 Weight and mass are not the same.

The relationship between weight and mass for an object can be written as:

$$\text{weight} \propto \text{mass}$$

Which sentence describes the relationship between weight and mass?

[1 mark]

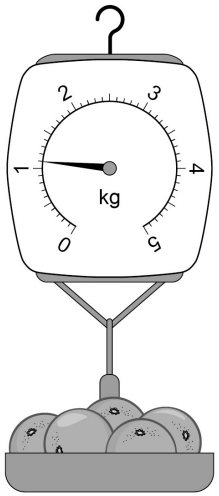
Tick (✓) **one** box.

- Weight is approximately equal to mass. ☐
- Weight is directly proportional to mass. ☐
- Weight is less than mass. ☐

Do not write outside the box

Figure 7 shows a balance used to measure the mass of 5 oranges.

Figure 7



0 4 . 3 All 5 of the oranges have the same mass.

Determine the mass of 1 orange.

[2 marks]

Mass = _____ kg

0 4 . 4 Calculate the weight of 1 orange.

gravitational field strength = 9.8 N/kg

Use the equation:

weight = mass × gravitational field strength

[2 marks]

Weight = _____ N

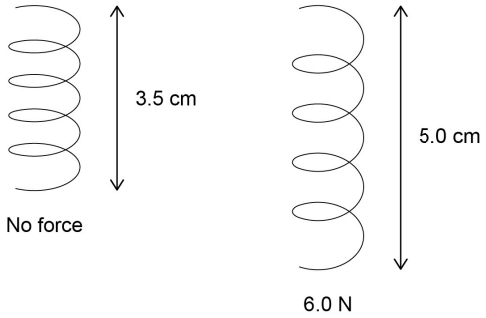
Turn over ►

Do not write outside the box

The balance shown in **Figure 7** contains a spring.

Figure 8 shows the spring with no force acting on it and with a force of 6.0 N acting on it.

Figure 8



0 4 . 5 What is the extension of the spring when a force of 6.0 N acts on it?

[1 mark]

Tick (✓) **one** box.

- 0.015 m ☐
- 0.035 m ☐
- 0.050 m ☐
- 0.085 m ☐

0 4 . 6 Calculate the spring constant of the spring.

Use the equation:

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

[2 marks]

Spring constant = _____ N/m

Do not write outside the box

0 4 . 7 What will happen to the spring when the force is removed?

[1 mark]

10

Turn over for the next question

Do not write outside the box

0 5 Ultraviolet and visible light are both parts of the electromagnetic spectrum.

0 5 . 1 How does the speed of ultraviolet in a vacuum compare to the speed of visible light in a vacuum?

[1 mark]

Tick (✓) **one** box.

Ultraviolet travels at a faster speed than visible light. ☐

Ultraviolet travels at a slower speed than visible light. ☐

Ultraviolet travels at the same speed as visible light. ☐

0 5 . 2 **Figure 9** shows parts of the electromagnetic spectrum.

Figure 9

Radio waves	A	B	C	D	X-rays	Gamma rays

Which letters represent the positions of ultraviolet and visible light in the electromagnetic spectrum?

[2 marks]

Ultraviolet _____

Visible light _____

Do not write outside the box

0 5 . 3 **Table 3** shows the range of wavelengths for different types of ultraviolet.

Table 3

Type	Range of wavelength in nanometres
Ultraviolet **A** (UVA)	315–400
Ultraviolet **B** (UVB)	280–315
Ultraviolet **C** (UVC)	100–280

Determine which type of ultraviolet shown in **Table 3** has the largest range of wavelengths.

To gain full marks you must calculate the range of wavelengths for each type of ultraviolet.

[3 marks]

Type of ultraviolet with the largest range of wavelengths _____

Question 5 continues on the next page

Do not write outside the box

Figure 10 shows how different types of ultraviolet are absorbed by the ozone layer in the Earth's atmosphere.

Table 4 shows the relative ionising power from each type of ultraviolet.

Figure 10

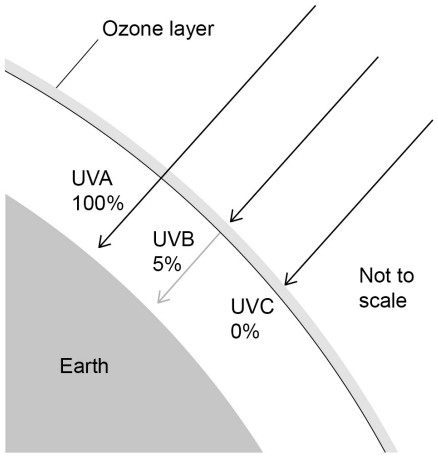


Table 4

Type	Relative ionising power
UVA	Low
UVB	Medium
UVC	High

0 5 . 4 Explain the importance of the ozone layer in reducing the risk to people from all types of ultraviolet.

Use **Figure 10** and **Table 4**.

[4 marks]

Do not write outside the box

0 5 . 5 The Sun emits visible light.

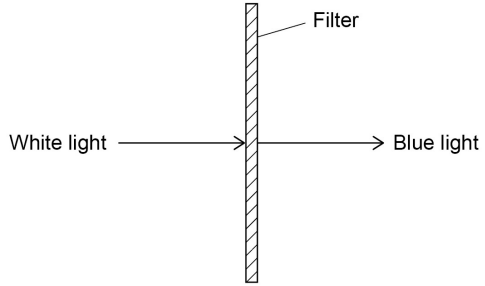
A student concludes that visible light is **not** absorbed by the ozone layer.

Give **one** piece of evidence that shows the student's conclusion is correct.

[1 mark]

0 5 . 6 **Figure 11** shows white light incident on a colour filter.

Figure 11



Complete the sentence.

Choose the answers from the box.

[2 marks]

absorbed	**radiated**	**reflected**	**refracted**	**transmitted**

When white light is incident on the filter, only blue light is _____

and all other colours of light are _____ .

13

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There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 6 The Earth is surrounded by an atmosphere.

0 6 . 1 The radius of the Earth is 6400 km.

Which of the following could be an approximate depth of the Earth's atmosphere?

[1 mark]

Tick (✓) **one** box.

100 km ☐

6400 km ☐

100 000 km ☐

640 000 km ☐

0 6 . 2 What state of matter is most of the Earth's atmosphere?

[1 mark]

Tick (✓) **one** box.

Gas ☐

Liquid ☐

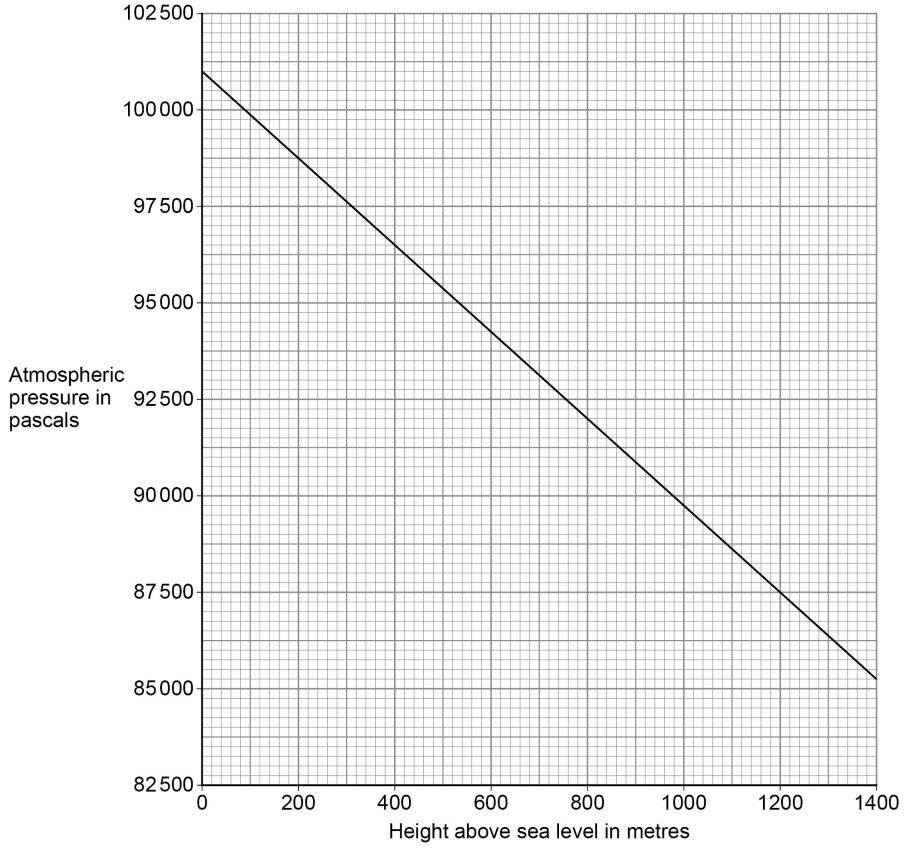
Solid ☐

Question 6 continues on the next page

Do not write outside the box

Figure 12 shows how atmospheric pressure varies with height above sea level.

Figure 12



Do not write outside the box

0 6 . 3 The highest point above sea level in England is the top of a mountain called Scafell Pike.

The height above sea level of Scafell Pike is 978 m.

Determine the atmospheric pressure at the top of Scafell Pike.

Use **Figure 12.**

[1 mark]

Atmospheric pressure = _____ Pa

0 6 . 4 Determine the difference between the atmospheric pressure at sea level and at the top of Scafell Pike.

Use **Figure 12** and your answer from Question **06.3**

[1 mark]

Difference in atmospheric pressure = _____ Pa

0 6 . 5 A student climbs Scafell Pike.

Why does the atmospheric pressure decrease as the student climbs higher?

[2 marks]

Tick (✓) **two** boxes.

- The air exerts a greater force on the student. ☐
- The density of the air decreases. ☐
- The mass of air above the student decreases. ☐
- The temperature of the air increases. ☐
- The volume of air above the student increases. ☐

Question 6 continues on the next page

Do not write outside the box

0 6 . 6 **Figure 13** shows a mountain lake.

Figure 13

The lake has a surface area of 2000 m^2.

Atmospheric pressure exerts a force of 188 000 000 N on the surface of the lake.

Calculate the atmospheric pressure at the surface of the lake.

Use the equation:

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

[2 marks]

Atmospheric pressure = _____ Pa

8

Do not write outside the box

0 7 Sound travels as longitudinal waves.

0 7 . 1 Complete the sentences.

Choose the answers from the box.

[2 marks]

amplitude	frequency	speed	wavelength

The distance between the centre of one compression of a sound wave and the centre of the next compression is called the _____ .

The number of waves passing a point each second is called the _____ .

0 7 . 2 Complete the sentence.

Choose the answer from the box.

[1 mark]

opposite	perpendicular	parallel

In a longitudinal wave, the oscillations are _____ to the direction of energy transfer.

Question 7 continues on the next page

Do not write outside the box

0 7 . 3 A sound wave has a frequency of 8.0 kHz.

Which of the following is the same as 8.0 kHz?

[1 mark]

Tick (✓) **one** box.

0.0080 Hz ☐

8.0 Hz ☐

8000 Hz ☐

800 000 Hz ☐

0 7 . 4 Calculate the period of a sound wave with a frequency of 8.0 kHz.

Use the Physics Equations Sheet.

[2 marks]

Period = _____ s

Do not write outside the box

0 7 . 5 Calculate the wavelength of a sound wave with a frequency of 6600 Hz.

speed of sound = 330 m/s

Use the equation:

$$\text{wavelength} = \frac{\text{speed}}{\text{frequency}}$$

Choose the unit from the box.

[3 marks]

kg	m	N

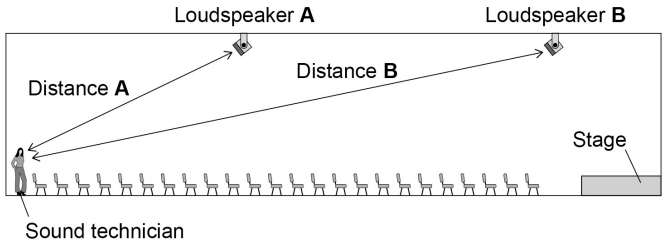
Wavelength = _____ Unit _____

Question 7 continues on the next page

Do not write outside the box

Figure 14 shows the arrangement of two loudspeakers at a concert venue.

Figure 14



The loudspeakers in **Figure 14** are tested by playing the same song through both loudspeakers.

A sound technician listens to the song.

Use the Physics Equations Sheet to answer questions **07.6** and **07.7**.

0 7 . 6 Write down the equation which links distance (*s*), speed (*v*) and time (*t*).

[1 mark]

0 7 . 7 Distance **A** on **Figure 14** is 13.2 m.

speed of sound = 330 m/s

Calculate the time taken for the sound to travel from loudspeaker **A** to the technician.

[3 marks]

Time taken = _____ s

Do not write outside the box

0 7 . 8 The sound from each loudspeaker travels at the same speed.

For the sound technician to hear the song clearly, the sound from loudspeaker **B** should be emitted slightly before the sound from loudspeaker **A**.

Explain why.

[3 marks]

16

Turn over for the next question

Do not write outside the box

0 8 **Figure 15** shows an electric super-car.

Figure 15

0 8 . 1 The battery in an electric car needs to be recharged.

Suggest **two** factors that affect the distance an electric car can travel before the battery needs to be recharged.

[2 marks]

1 _____

2 _____

Do not write outside the box

Use the Physics Equations Sheet to answer questions **08.2** and **08.3**.

0 8 . 2 Write down the equation which links acceleration (a), change in velocity (Δv) and time taken (t).

[1 mark]

0 8 . 3 The maximum acceleration of the car is 20 m/s^2.

Calculate the time taken for the speed of the car to change from 0 m/s to 28 m/s at its maximum acceleration.

[3 marks]

Time taken = _____ s

Question 8 continues on the next page

Do not write outside the box

0 8 . 4 In a trial run, the car accelerates at 10 m/s^2 until it reaches its final velocity.

distance travelled by the car = 605 m

initial velocity of the car = 0 m/s

Calculate the final velocity of the car.

Use the Physics Equations Sheet.

[3 marks]

Final velocity = _____ m/s

Do not write outside the box

Use the Physics Equations Sheet to answer questions **08.5** and **08.6**.

0 8 . 5 Write down the equation which links distance (*s*), force (*F*) and work done (*W*).

[1 mark]

0 8 . 6 When travelling at its maximum speed the air resistance acting on the car is 4000 N.

Calculate the work done against air resistance when the car travels a distance of 7.5 km at its maximum speed.

[3 marks]

Work done = _____ J

13

Turn over for the next question

Do not write outside the box

0 9 A student used a ray box to shine a ray of light through air into a glass block.

The student investigated how the angle of refraction varied with the angle of incidence.

Table 5 shows the results.

Table 5

Angle of incidence in degrees	Angle of refraction in degrees
10	5
20	10
30	14
40	19
50	23
60	26
70	28
80	29

0 9 . 1 Describe a method the student could have used to obtain the results in **Table 5**.

Your answer may include a labelled diagram.

[6 marks]

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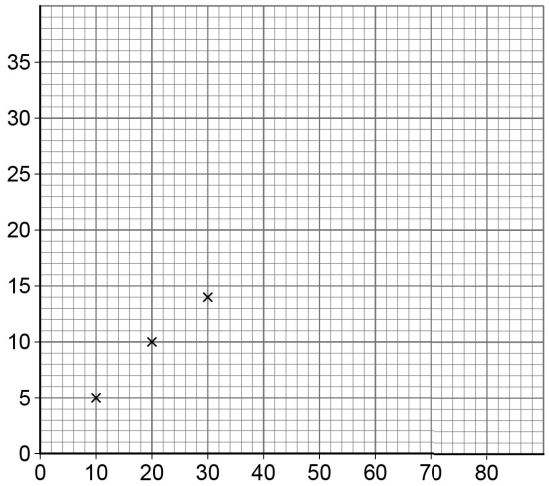
0 9 . 2 **Figure 16** is an incomplete graph of the results.

Figure 16



Complete **Figure 16** using data from **Table 5**.

- Label the axes.
- Plot the remaining data.
- Draw a line of best fit.

[4 marks]

Question 9 continues on the next page

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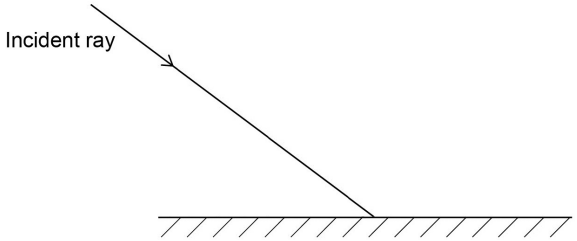
0 9 . 3 Complete the ray diagram in **Figure 17** to show the reflection of light from the surface of a plane mirror.

You should:

- draw the normal line
- draw the reflected ray.

[2 marks]

Figure 17



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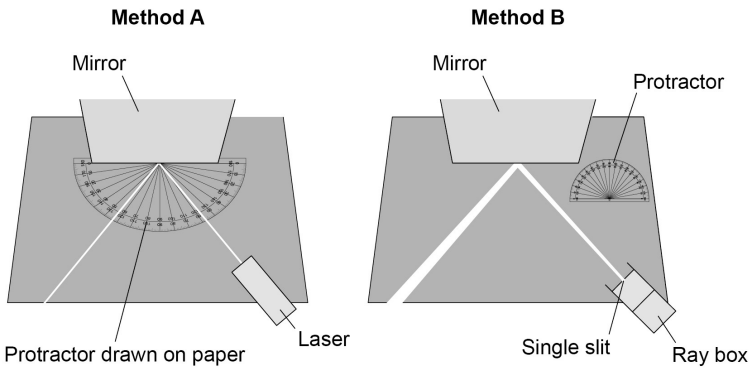
0 9 . 4 Two students investigated the reflection of light by a plane mirror.

Figure 18 shows the different equipment the students used.

Figure 18



Explain **two** ways that **Method A** is better than **Method B.**

[4 marks]

1 _____

_____

_____

_____

2 _____

_____

_____

_____

16

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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

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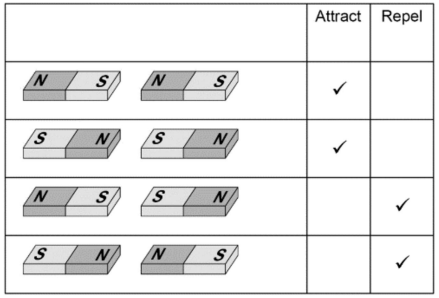
Question number	**Additional page, if required. Write the question numbers in the left-hand margin.**

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	all ticks correct  allow **1** mark for 3 correct ticks		2	AO2 4.7.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	the magnetic field gets weaker further from the magnet the magnetic field is strongest at the poles		1 1	AO1 4.7.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	iron		1	AO1 4.7.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	coil		1	AO1 4.7.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	the magnetic field would be stronger		1	AO1 4.7.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	the magnetic field would be weaker		1	AO1 4.7.2.1

Total Question 1		**8**

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	gravitational force		1	AO1 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	air resistance		1	AO1 4.5.6.15

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	the resultant force on the hailstones is zero		1	AO1 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	line extrapolated to 80 mm 46 (m/s)	allow a straight line allow 44 – 48 but not if inconsistent with their extrapolated line	1 1	AO3 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	it has a greater weight		1	AO3 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	0.48 (N)		1	AO2 4.5.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.7	upwards	allow up ignore north	1	AO2 4.5.1.4

Total Question 2		**8**

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	a star		1	AO1 4.8.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	Milky Way		1	AO1 4.8.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	natural satellite (that orbits a planet)		1	AO1 4.8.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	Charon is smaller than the (largest) dwarf planet Ganymede / Titan is larger than the (smallest) planet	 allow **1** mark for some are bigger than the smallest planet **or** some are smaller than dwarf planets	1 1	AO3 4.8.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	similarity: circular (orbit) difference: (orbital) period **or** (orbital) height	 allow (orbital) speed	 1 1	AO1 4.8.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	expensive **or** dangerous	 allow difficult to get to allow few opportunities allow only trained astronauts can go	1	AO3 4.8.1.3

Total Question 3		8

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	centre of mass		1	AO1 4.5.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	weight is directly proportional to mass		1	AO1 4.5.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	reading from balance = 1.1 kg mass = $\frac{1.1}{5}$ = 0.22 kg	 allow correct calculation using incorrectly read value from the balance	1 1	AO2 4.5.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	weight = 0.22 × 9.8 2.156 (N)	allow ecf from question **04.3** allow correct answer to 2 or 3 sig figs	1 1	AO2 4.5.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	0.015 m		1	AO2 4.5.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	spring constant = $\frac{6.0}{0.015}$ 400 (N/m)	allow ecf from question **04.5**	1 1	AO2 4.5.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	returns to its original length/shape	allow returns to 3.5 cm	1	AO3 4.5.3

Total Question 4		**10**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	ultraviolet travels at the same speed as visible light		1	AO1 4.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	D C	this order only	1 1	AO1 4.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	A 400 – 315 = 85 (nm) B 315 – 280 = 35 (nm) C 280 – 100 = 180 (nm) (ultraviolet) C (UVC)	three calculations correct 2 marks one or two calculations correct 1 mark mark dependent on all three calculations being made	2 1	AO2 4.6.2.1

Question	Answers	Mark	AO / Spec. Ref.
05.4	**Level 2:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	3–4	AO3 4.6.2.3
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content.	0	
	Indicative content: • ozone absorbs all of the UVC • UVC is the most dangerous • ozone absorbs nearly all (95%) of the UVB • UVB has a medium risk • ozone does not absorb any UVA • ozone does not reduce risk from UVA • UVA is the least dangerous • the greater the ionising power the greater the absorption by ozone • the greater the ionising power the greater the risk • UV damages skin cells • can lead to skin cancer • can cause sunburn • UV can damage eyes • leads to problems with eyesight		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	our eyes detect visible light	allow it would be dark all the time allow specific effect ie plants couldn't grow	1	AO1 4.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	transmitted absorbed	this order only	1 1	AO1 4.6.2.6

Total Question 5		**13**

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	100 km		1	AO3 4.5.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	gas		1	AO1 4.5.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	90 000 (Pa)	allow 89 500 to 90 500	1	AO2 4.5.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	101 000 – 90 000 = 11 000 (Pa)	allow ecf from question **06.3**	1	AO2 4.5.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	the density of the air decreases the mass of air above the student decreases		1 1	AO2 4.5.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.6	$P = \frac{188\ 000\ 000}{2000}$ 94 000 (Pa)		1 1	AO2 4.5.5.1.1

Total Question 6		**8**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	wavelength frequency	this order only	1 1	AO1 4.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	parallel		1	AO1 4.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	8000 Hz		1	AO2 4.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	period = $\frac{1}{8000}$ 0.000125 (s)	allow ecf from question **07.3**	1 1	AO2 4.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	$\lambda = \frac{330}{6600}$		1	AO2
	$\lambda = 0.050$	allow 0.05	1	AO2
	m		1	AO1 4.5.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	distance (travelled) = speed × time **or** $s = vt$	allow any correct rearrangement	1	AO2 4.5.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.7	$13.2 = 330 \times t$		1	AO2 4.5.6.1.2
	$t = \frac{13.2}{330}$		1	
	$t = 0.04$ (s)	allow 0.040 (s)	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.8	loudspeaker **B** is further from the technician (than speaker **A**)	'it' means speaker **B**	1	AO3 4.6.1.2
	so the sound would take more time to travel (to the technician)		1	
	so the sound from each speaker arrives at the technician at the same time		1	

Total Question 7		**16**

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	any **two** from: • capacity of the battery • speed • mass / weight • uphill / downhill • stopping at traffic lights • condition of the road • (air) temperature • (incorrect) tyre pressure • streamlining of the car	allow energy/charge stored in battery allow efficiency of battery ignore size of the battery allow terrain ignore 'the road' only ignore 'weather' only allow efficiency of engine allow anything that would use charge from the battery **or** anything that will reduce the energy stored	2	AO3 4.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	acceleration = change in velocity/time (taken) **or** $a = \frac{\Delta v}{t}$	allow any correct rearrangement allow $a = \frac{v - u}{t}$ do **not** accept $a = \frac{v}{t}$	1	AO1 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	$20 = \frac{28}{t}$ $t = \frac{28}{20}$ 1.4 (s)		1 1 1	AO2 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	$v^2 - 0^2 = 2 \times 10 \times 605$ $v^2 = 12\,100$ $v = 110$ (m/s)		1 1 1	AO2 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5	work done = force × distance **or** $W = Fs$	allow any correct rearrangement	1	AO1 4.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.6	*s* = 7500 (m)		1	AO2 4.5.2
	W = 4000 × 7500	allow correct substitution using incorrectly / not converted value of s	1	
	W = 30 000 000 (J)	allow correct calculation using incorrectly / not converted value of s	1	

Total Question 8		**13**

Question 9

Question	Answers	Mark	AO / Spec. Ref.
09.1	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 4.6.1.3
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content Some indicative content could be indicated within a labelled diagram • place a glass block on a piece of paper • draw around the glass block • use the ray box to shine a ray of light through the glass block • mark the ray of light entering the glass block • mark the ray of light emerging from the glass block • join the points to show the path of the complete ray through the block • and draw a normal line at 90 degrees to the surface • use a protractor to measure the angle of incidence • use a protractor to measure the angle of refraction • use a ray box to shine a ray of light at a range of different angles (of incidence) • increase the angle of incidence in 10 degree intervals • from an angle of incidence of 10 degrees to an angle of incidence of 80 degrees Methods involving mirrors and reflection score zero		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	angle of incidence in degrees / ° on *x*-axis **and** angle of refraction in degrees / ° on *y*-axis		1	AO2 4.6.1.3
	all points plotted correctly	allow **1** mark if 3 or 4 points plotted correctly allow tolerance of half a small square	2	
	curved line of best fit	allow line of best fit from their incorrectly plotted points	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	normal drawn at 90° at the point where the incident ray strikes the mirror		1	AO2 4.6.1.3
	straight line drawn with a ruler **and** angle of incidence = angle of reflection	ignore any arrows	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	(the protractor drawn on the paper means you) do not have to move the mirror (to measure the angles)	allow do not have to mark the position of the rays of light allow protractor does not need to be repositioned	1	AO3 4.6.1.3
	(so) more likely to record the correct angle of incidence and/or reflection	allow reducing random error allow more accurate	1	
	ray in method A does not diverge	allow the ray in method A is thin(ner)	1	
	(making it) easier to judge the centre (position) of the ray	allow more accurate if not already awarded allow converse answers in terms of method B being worse than method A	1	

Total Question 9		**16**