2024

Name_____

Triple Science

Higher

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

H

Higher 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.

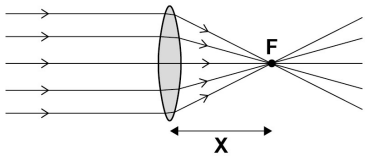
For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

Do not write outside the box

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

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

Figure 1



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

[1 mark]

_____

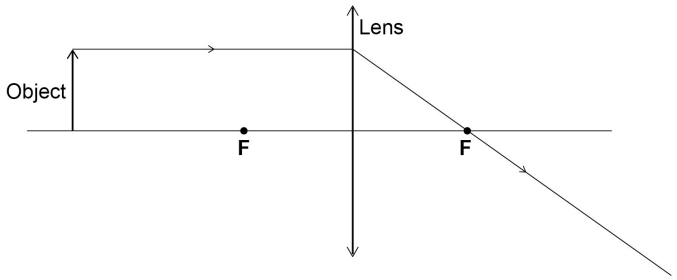
0 1 . 2 Lenses can be used to form the image of an object.

Complete the ray diagram in **Figure 2** to show how a **convex** lens forms the image of the object.

Use an arrow to represent the image.

[2 marks]

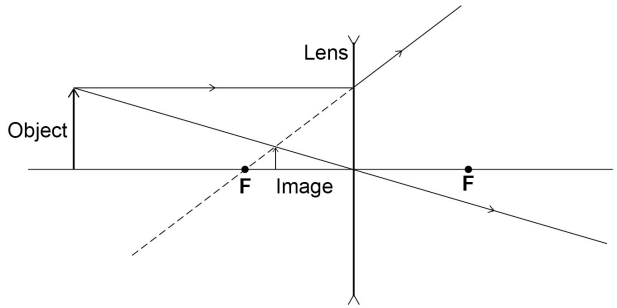
Figure 2



Do not write outside the box

Figure 3 shows how a **concave** lens forms the image of an object.

Figure 3



0 1 . 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 1 . 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

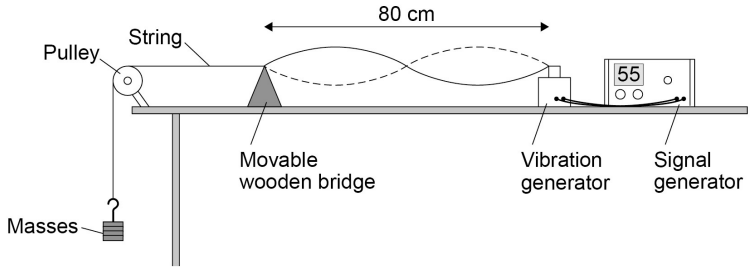
8

Turn over ►

Do not write outside the box

0 2 **Figure 4** shows the apparatus used to investigate the waves in a stretched string.

Figure 4



The frequency of the signal generator is adjusted so that the wave shown in **Figure 4** is seen.

At this frequency the string vibrates between the two positions shown in **Figure 4.**

0 2 . 1 The wavelength of the wave shown in **Figure 4** was measured as 80 cm

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

[1 mark]

_____

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

[1 mark]

_____

0 2 . 3 The string in **Figure 4** vibrates at 55 Hz

Calculate the wave speed of the wave shown in **Figure 4.**

Use data given in **Figure 4.**

[3 marks]

_____

_____

_____

Wave speed = _____ m/s

Do not write outside the box

0 2 . 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]

0 2 . 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 4**.

Describe a method the student could use for this investigation.

[4 marks]

11

Turn over ►

Do not write outside the box

0 3 . 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

0 3 . 2 Write down the equation which links distance, force and work done.

[1 mark]

0 3 . 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

0 3 . 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

Turn over for the next question

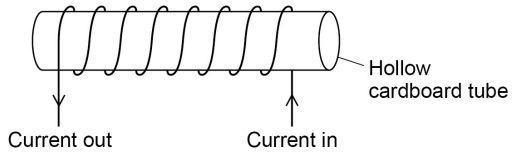
Do not write outside the box

0 4 . 1 **Figure 5** shows a solenoid.

Draw the magnetic field of the solenoid on **Figure 5**.

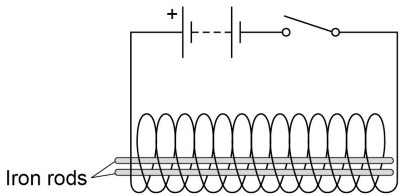
[2 marks]

Figure 5



0 4 . 2 **Figure 6** shows two iron rods placed inside a solenoid.

Figure 6



Explain why the iron rods move apart when the switch is closed.

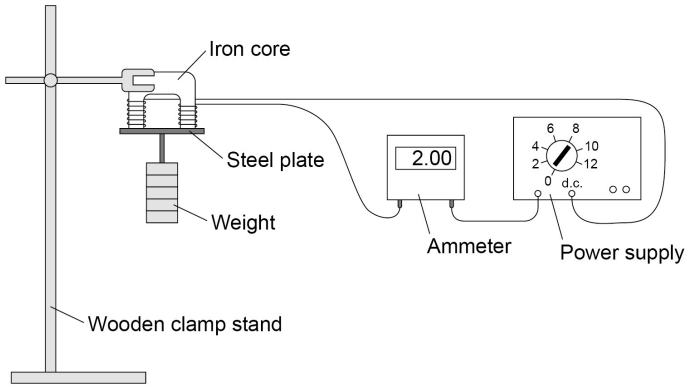
[2 marks]

A student investigated the strength of an electromagnet.

The student investigated how the strength depended on:
- the current in the wire
- the number of turns of wire around the iron core.

Figure 7 shows the equipment used.

Figure 7



The student measured the strength of the electromagnet as the maximum weight the electromagnet could hold.

0 4 . 3 **Table 1** shows the results.

Table 1

Current in amps	Number of turns of wire	Maximum weight in newtons
1.0	30	6.5
1.5	20	6.4
2.0	10	3.7

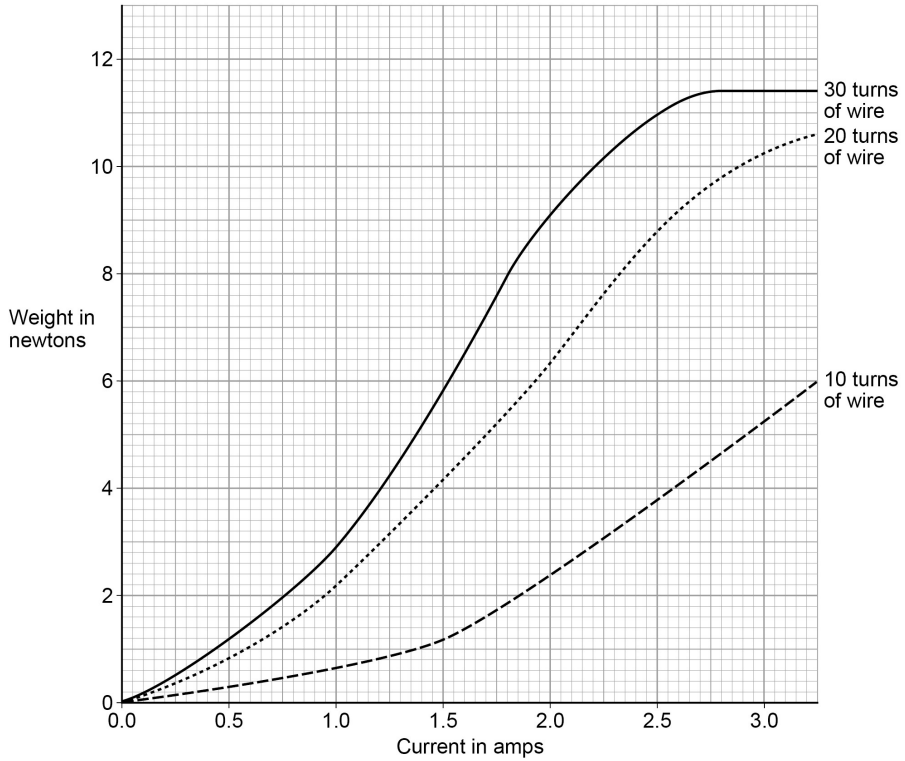
Explain why the method used by the student is **not** valid for this investigation.

[2 marks]

A second student repeated the investigation using the same equipment.

Figure 8 shows the second student's results.

Figure 8



0 4 . 4 How does increasing the current in the wire affect the strength of the electromagnet, when the electromagnet has 30 turns of wire?

[1 mark]

Do not write outside the box

0 4 . 5 How does increasing the number of turns of wire from 10 to 20 affect the strength of the electromagnet, compared to increasing the number of turns of wire from 20 to 30?

[1 mark]

8

Turn over for the next question

Do not write outside the box

0 5 . 1 The light from distant galaxies shows red-shift.

Complete the sentence.

[1 mark]

The term red-shift describes the observed increase

in the _____ of the light from a distant galaxy.

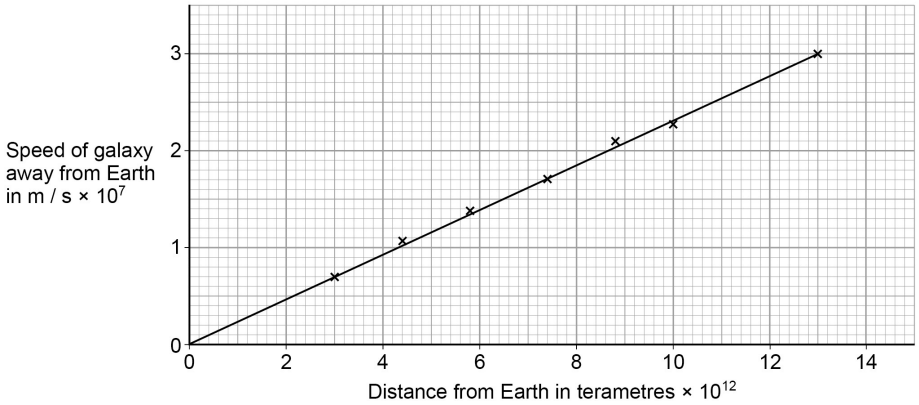
0 5 . 2 The Big Bang theory is one model used to explain the origin of the universe.

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

[1 mark]

Figure 9 shows data scientists have calculated from measurements of red-shift.

Figure 9



Do not write outside the box

0 5 . 3 Describe the relationship between the speed of a galaxy and the distance the galaxy is from the Earth.

[1 mark]

0 5 . 4 Which of the following is the same as 6×10^{12} terametres?

[1 mark]

Tick (✓) **one** box.

6×10^{15} m ☐

6×10^{18} m ☐

6×10^{21} m ☐

6×10^{24} m ☐

0 5 . 5 Explain how the data in **Figure 9** supports the suggestion that the universe began from a very small region.

[2 marks]

Question 5 continues on the next page

Do not write outside the box

0 5 . 6 The Big Bang theory suggested that gravity would slow the rate at which galaxies move away from the Earth.

New observations suggest that distant galaxies are moving away from the Earth at an increasingly fast rate.

What do the new observations suggest is happening to the universe?

[1 mark]

0 5 . 7 New observations and data that do not fit existing theories should undergo peer review.

Give **one** reason why peer review is an important process.

[1 mark]

0 5 . 8 The Andromeda galaxy is moving towards the Earth.

Describe how the wavelength and frequency of the light from Andromeda seem to have changed when viewed from the Earth.

[2 marks]

10

Do not write outside the box

0 6 . 1 An adult of mass 80 kg has more inertia than a child of mass 40 kg

What is inertia?

[1 mark]

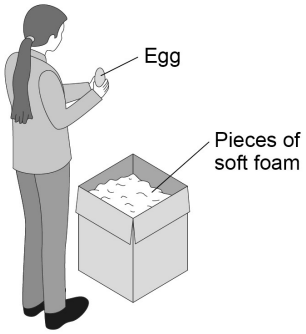
0 6 . 2 A teacher demonstrated the idea of a safety surface.

She dropped a raw egg into a box filled with pieces of soft foam.

The egg did not break.

Figure 10 shows the demonstration.

Figure 10



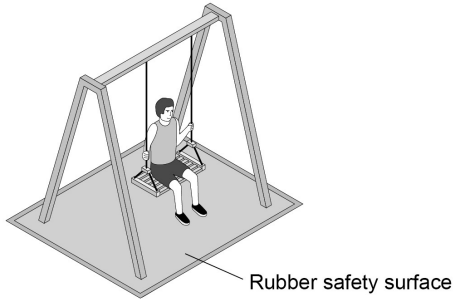
Explain why the egg is less likely to break when dropped onto soft foam rather than onto a concrete floor.

[3 marks]

Do not write outside the box

0 6 . 3 **Figure 11** shows a child on a playground swing. The playground has a rubber safety surface.

Figure 11



A child of mass 32 kg jumped from the swing.

When the child reached the ground she took 180 milliseconds to slow down and stop.

During this time an average force of 800 N was exerted on her by the ground.

Calculate the velocity of the child when she first touched the ground.

Use the Physics Equations Sheet.

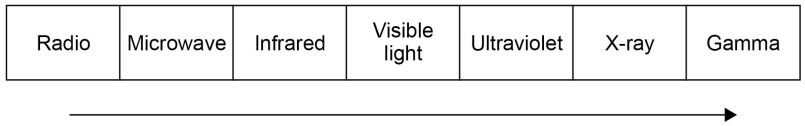
[4 marks]

Velocity = _____ m/s

8

0 7 . 1 **Figure 12** shows the electromagnetic spectrum.

Figure 12



Which statement is correct for the direction of the arrow in **Figure 12**?

[1 mark]

Tick (✓) **one** box.

- The wavelength decreases and the wave speed in air increases. ☐
- The frequency increases and the wavelength increases. ☐
- The frequency increases and the wave speed in air stays the same. ☐
- The wavelength increases and the wave speed in air increases. ☐

0 7 . 2 Explain how the properties of X-rays make them suitable for the medical imaging of bones.

[2 marks]

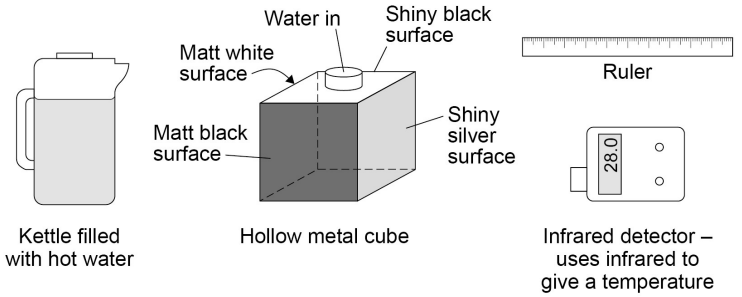
Question 7 continues on the next page

A student investigated the infrared radiation emitted from the sides of a hollow metal cube.

The sides of the cube are different colours or textures.

Figure 13 shows the equipment used.

Figure 13



Boiling water was poured into the cube. The amount of infrared radiation emitted from each vertical surface was then measured.

0 7 . 3 Boiling water is a hazard in this investigation.

Suggest how the risk of harm could be reduced in this investigation.

[1 mark]

0 7 . 4 What is the control variable in this investigation?

[1 mark]

Do not write outside the box

Table 2 shows the results.

Table 2

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

0 7 . 5 The four temperature values in **Table 2** cannot be used to show that the infrared detector gives precise readings.

Give the reason why.

[1 mark]

0 7 . 6 The student looked at the data in **Table 2** and concluded:

'A black surface always emits more infrared radiation than a white surface.'

Explain how using an infrared detector with a resolution of 1 °C would have affected the student's conclusion.

[2 marks]

Turn over ►

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Albedo is a measure of the amount of solar radiation reflected by an object compared to the total solar radiation incident on the object.

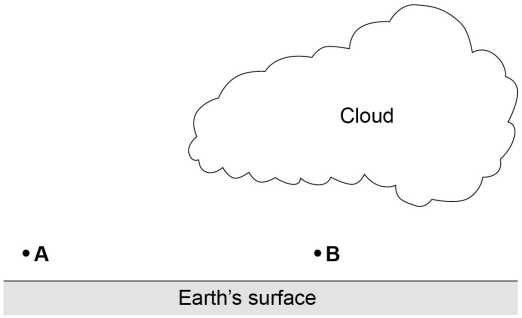
A perfect reflector has an Albedo value of 1.0
A perfect absorber has an Albedo value of 0.0

0 7 . 7 What is the Albedo value of a perfect black body?

[1 mark]

0 7 . 8 **Figure 14** shows two points, **A** and **B**, just above the Earth's surface.

Figure 14



The average Albedo value of the Earth's surface is 0.3
The Albedo value of thick cloud varies between 0.6 and 0.9

At night the air at point **A** cools faster than the air at point **B**.

Explain why.

[3 marks]

12

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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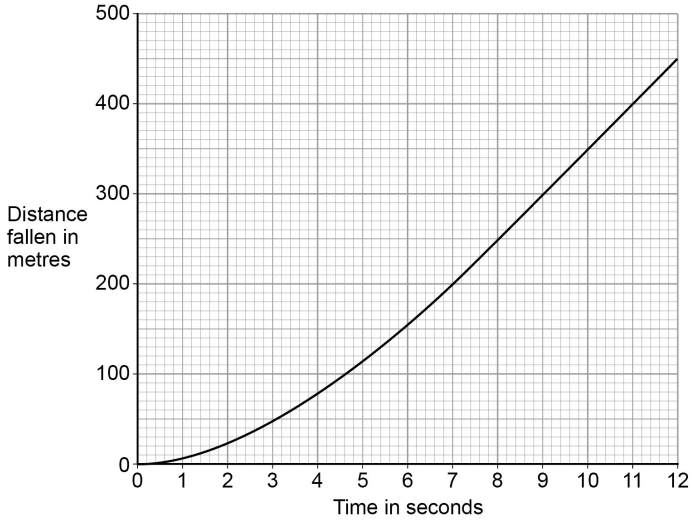
0 8 An aeroplane is 4000 m above the Earth's surface.

A skydiver jumps from the aeroplane and falls vertically.

Figure 15 shows the distance the skydiver falls during the first 12 seconds after jumping.

Figure 15

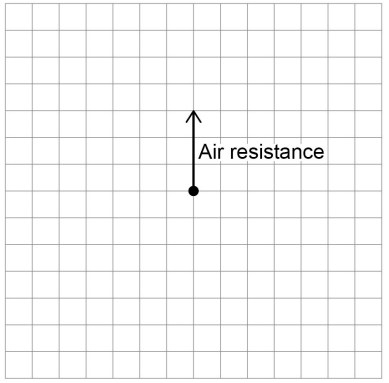


0 8 . 1 **Figure 16** shows part of the free body diagram for the skydiver three seconds after jumping.

Complete the free body diagram for the skydiver.

[2 marks]

Figure 16



Do not write outside the box

0 8 . 2 Explain the changing motion of the skydiver in terms of the forces acting on the skydiver.

[4 marks]

0 8 . 3 Use **Figure 15** to determine the speed of the skydiver between 7 seconds and 12 seconds.

[3 marks]

Speed = _____ m/s

Question 8 continues on the next page

Do not write outside the box

0 8 . 4 In 2012 a skydiver jumped from a helium balloon 39 000 metres above the Earth's surface. The skydiver reached a maximum speed of 377 m/s

Jumping from 39 000 metres allowed the skydiver to reach a much higher speed than a skydiver jumping from 4000 metres.

Explain why.

[3 marks]

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 9 . 1 **Table 3** gives the frequencies in the hearing ranges of five different animals.

Table 3

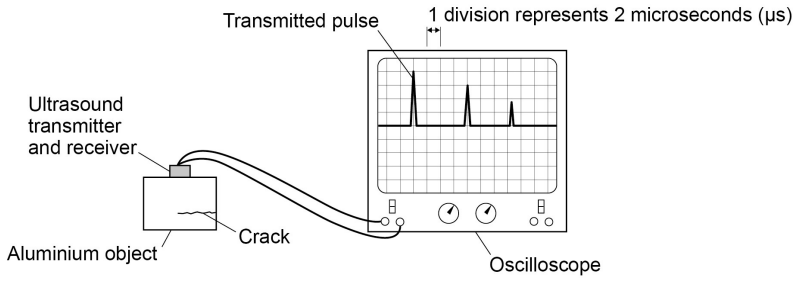
Animal	Frequencies of hearing range
Cat	55 Hz to 77 kHz
Chicken	125 Hz to 2 kHz
Dog	20 Hz to 30 kHz
Gerbil	56 Hz to 60 kHz
Horse	55 Hz to 33 kHz

Which **one** of the animals from **Table 3** would not be able to hear ultrasound?

[1 mark]

Figure 17 shows ultrasound being used to detect a hidden crack in a solid aluminium object. The transmitted and reflected pulses of ultrasound are shown on the screen.

Figure 17



Do not write outside the box

0 9 . 2 Which of the following is the same as 2 microseconds?

[1 mark]

Tick (✓) **one** box.

2×10^{3} s ☐

2×10^{-3} s ☐

2×10^{-6} s ☐

2×10^{-9} s ☐

0 9 . 3 Ultrasound travels at 6300 m/s in aluminium.

Determine the depth of the crack below the top surface of the aluminium.

Use information from **Figure 17**.

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

[4 marks]

Depth = _____ m

Question 9 continues on the next page

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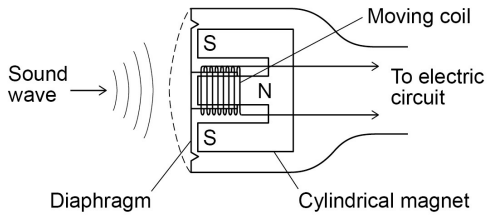
Figure 18 shows the parts of a moving-coil microphone.

Figure 18



0 9 . 4 What is the function of a microphone?

[1 mark]

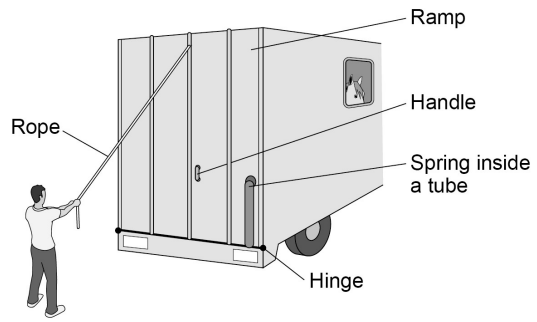
0 9 . 5 Explain how a moving-coil microphone works.

[4 marks]

11

1 0 **Figure 19** shows the back of a lorry. The lorry is used to carry horses.

Figure 19



The ramp is lowered by pulling on the rope or by pulling on the handle.

The hinge acts as a pivot.

1 0 . 1 Explain why it is easier to lower the ramp by pulling on the rope rather than pulling on the handle.

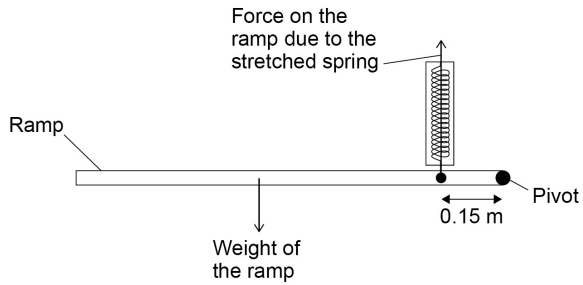
[2 marks]

Question 10 continues on the next page

When the ramp is lowered, work is done to stretch a spring on the side of the ramp. Elastic potential energy is stored in the stretched spring.

Figure 20 shows the ramp part way down in a balanced horizontal position.

Figure 20



1 0 . 2 With the ramp horizontal:

the moment caused by the weight of the ramp = 924 Nm

the spring is stretched by 0.250 m

Calculate the elastic potential energy stored in the stretched spring.

Use data from **Figure 20.**

[6 marks]

Elastic potential energy = _____ J

8

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1.1	focal length	this answer only	1	AO1/1 4.6.2.5
1.2	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
1.3	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 1	AO3/2a 4.6.2.5
1.4	 $6.0 = \frac{9.0}{\text{object height}}$ $\text{object height} = \frac{9.0}{6.0}$ 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	Answers	Extra information	Mark	AO / Spec. Ref.
2.1	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
2.2	(wave) speed = frequency × wavelength	allow v = f λ	1	AO1/1 4.6.1.2 RPA8
2.3	 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
2.4	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

Question 2

MARK SCHEME – GCSE PHYSICS – 8463/2H – JUNE 2019

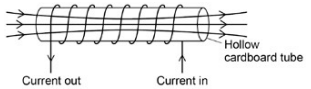
2.5	**Level 2:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	3–4	AO3/3a 4.6.1.2 RPA8
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant 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 3

Question	Answers	Mark	AO/ Spec. Ref
3.1	**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 the 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			
3.2	work (done) = force x distance	allow W = F s	1	AO1/1 4.5.2
3.3	 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
3.4	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 is scored ignore any effects on passengers or possible accidents	1 1	AO1/1 4.5.6.3.4
Total			**12**	

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4.1	field lines going in, (through) and out of the solenoid arrow(s) in correct direction	 allow field lines only visible outside the cardboard tube allow a bar magnet shaped field with lines above and below the solenoid	1 1	AO1/1 4.7.2.1
4.2	the rods become (induced) magnets with the same polarity (at each end)	allow the rods are (temporarily) magnetised ignore rods repel do not accept rods become charged	1 1	AO1/1 4.7.1.1
4.3	changed two (independent) variables (at the same time) so it is not possible to know the effect of one (independent) variable or the other	allow need to keep current or number of turns constant allow should only change one variable (at a time) allow current and number of turns both changed ignore fair test	1 1	AO3/1b 4.7.2.1 WS2.7
4.4	(increasing the current) increases the strength until the strength reaches a maximum value	allow weight (held) for strength of electromagnet ignore a given current value for when maximum strength happens	1	AO3/2b 4.7.2.1 WS3.5
4.5	increasing the number of turns from 10 to 20 increases the strength more than increasing from 20 to 30	a general trend is required	1	AO3/2b 4.7.2.1 WS3.5
Total			**8**	

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5.1	wavelength	this answer only	1	AO1 4.8.2 iso
5.2	(extremely) hot and dense	ignore very small	1	AO1/1 4.8.2 iso
5.3	(directly) proportional	allow a correct description of direct proportionality ignore positive correlation	1	AO3/2b 4.8.2
5.4	6×10^{24}		1	AO2/2 4.8.2 WS4.4
5.5	the furthest galaxies are moving the fastest (this suggests) the universe is expanding (from a very small region)		1 1	AO1/1 4.8.2
5.6	expanding at (an ever) greater rate	allow expanding faster	1	AO3/1a 4.8.2
5.7	any **one** from: • detects false claims • detects inaccurate data • detects bias • verifies new data • provides a consensus (of opinion)	 allow provides credibility allow detects mistakes allow removes bias allow checks validity ignore shows data is accurate ignore proves a theory	1	AO1/1 4.8.2 WS 1.6
5.8	wavelength (seems to have) decreased frequency (seems to have) increased		1 1	AO2/1 4.8.2
Total			**10**	

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Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
6.1	the tendency of an object to continue in its state of rest or motion	allow how difficult it is to change the velocity of an object	1	AO1/1 4.5.6.2.1 iso
6.2	(soft foam) increases the time taken to stop or increases the time taken to decrease momentum decreases the rate of change in momentum reducing the force (on the egg)	allow increases impact/contact time allow increases the time of the collision do not accept slows down time allow reduces acceleration/deceleration reduces momentum is insufficient allow increases the time to reduce the momentum to zero for **2** marks allow impact for force	1 1 1	AO1/1 4.5.7.3

6.3	180 ms = 0.18 s $800 = \frac{32 \times v}{0.18}$ $v = \frac{800 \times 0.18}{32}$ v = 4.5 (m/s) Alternative method 180 ms = 0.18 s (1) ∆mv = 144 (kgm/s) (1) ∆v = 144 ÷ 32 (1) v = 4.5 (m/s) (1) Alternative method 180 ms = 0.18 s (1) a = 25 (m/s^2) (1) 25 = ∆v ÷ 0.18 (1) v = 4.5 (m/s) (1)	an answer 4.5 (m/s) scores **4** marks an answer 4500 scores **3** marks if incorrectly or not converted, subsequent marks may still be awarded for correct method and calculations	1 1 1 1	AO2/1 4.5.7.3
Total			**8**	

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
7.1	The frequency increases and the wave speed in air stays the same		1	AO1/1 4.6.2.1 iso
7.2	pass through soft tissue (but) absorbed by bone	allow penetrate for pass through allow skin/muscle/etc… for soft tissue pass through tissue is insufficient allow do not pass through bone do not accept reflected by bone	1 1	AO1/1 4.6.2.4
7.3	accept a sensible practical suggestion eg • complete the investigation standing up • use (slightly) cooler water • do not touch the hot cube	do not accept use cold water pour water in carefully is insufficient ignore wear safety goggles or gloves	1	AO2/2 4.6.2.2 WS2.4
7.4	distance between each side (of the cube) and the (infrared) detector	allow distance between cube and detector	1	AO1/2 4.6.2.2 WS2.2
7.5	measurements (for each surface) have not been repeated (to show that they cluster closely)	do not accept any answer for measurement should be repeated for any reason other than to show they cluster eg to show accuracy / average / anomalies would be wrong	1	AO3/3b 4.6.2.2 WS3.7
7.6	(the student) could not conclude that black surfaces always emit more (infrared) than a white surface (as) the reading for the matt white and shiny black would both be 66 (°C)	a (matt) white surface (appears to) emit(s) the same amount (of infrared) as a (shiny) black surface the conclusion is wrong is insufficient allow (as) the reading for the matt white and shiny black would be the same	1 1	AO3/1a/2b 4.6.2.2 WS2.2
7.7	0.0	allow 0 allow zero	1	AO1/1 4.6.3.1

7.8	at night, more radiation is emitted from the Earth than absorbed from space cloud reflects radiation (towards the Earth) at A, (there is no cloud cover so) a larger proportion of radiation will be emitted into space	 allow solar radiation for radiation 	1 1 1	AO1/1 4.6.3.2
Total			**12**	

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
8.1	longer arrow pointing vertically downwards	one arrow only	1	AO2/1 4.5.1.4 4.5.6.1.5
	labelled weight	allow (force of) gravity	1	AO1/1 4.5.6.1.5
8.2	initially air resistance is less than weight / gravity so the skydiver accelerates acceleration causes the air resistance to increase resultant force decreases to zero so the skydiver falls at terminal velocity	allow drag for air resistance allow increased velocity / speed for accelerates acceleration **or** increased velocity / speed is not required here if given in the first mark point allow air resistance becomes equal to weight / gravity allow constant velocity/speed for terminal velocity ignore any mention of subsequent motion and use of parachute	1 1 1 1	AO3/1a AO1/1 AO2/1 4.5.6.1.4 4.5.6.1.5 4.5.6.2.1
8.3	 distance at 7s = 200 (m) distance at 12s = 450 (m) speed = $\frac{450 - 200}{12 - 7}$ **or** $\frac{250}{5}$ 50 (m/s)	an answer of 50 (m/s) scores **3** marks **both** distances required allow correct use of their two distances divided by 5 allow an answer consistent with their two distances	 1 1 1	AO2 4.5.6.1.4

8.4	The higher the altitude the less dense the air so the air resistance on the skydiver (falling from 39000m) was less (at the same speed) so the skydiver was able to accelerate for longer before reaching (a higher) terminal velocity **or** so the skydiver was able to accelerate for longer before air resistance = weight / gravity	 allow constant velocity/speed for terminal velocity	1 1 1	AO1/1 4.5.5.2 AO1/1 AO2/1
Total			**12**	

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
9.1	chicken	allow a correct answer indicated in Table 3 provided the answer space in blank	1	AO3
9.2	2×10^{-6}		1	AO1/1 4.5.6.1.2 WS4.4
9.3	 time = 8μs = 8×10^{-6} (s) or 4 × their answer to 9.2 distance = ½ × 6300 × 8×10^{-6} distance = 0.0252 (m) distance = 0.025 (m)	an answer 0.025 (m) scores **4** marks subsequent marks may be scored if the number of squares is miscounted or t = 2μs is used allow 8×10^{3} or 8×10^{-3} or 8×10^{-9} for 8×10^{-6} allow a correctly calculated answer using 8×10^{3} or 8×10^{-3} or 8×10^{-9} allow a calculated value correctly rounded to 2 sig figs an answer 0.050 (m) scores **3** marks an answer 0.05 or 0.0504 (m) scores **2** marks	 1 1 1 1	AO2/1 4.6.1.5 4.5.6.1.2
9.4	to convert (the pressure variations in) sound (waves) into variations in current / p.d	allow electrical signal for variations in current / p.d. do not accept amplifies sound	1	AO1/1 4.7.3.3

9.5	sound (waves) cause the diaphragm to vibrate the diaphragm causes the coil / wire to vibrate the coil / wire moves through the magnetic field **or** the coil / wire cuts magnetic field lines a potential difference is induced (across the ends of the coil / wire)	diaphragm moves is insufficient do not accept moves the coil / wire up and down if m.p.1 and m.p.2 do not score, allow sound (waves) cause the coil / wire to vibrate for **1** mark allow induced current for induced p.d.	1 1 1 1	AO1/1 4.7.3.3
Total			**11**	

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	the (perpendicular) distance from the pivot / hinge to (the line of action of) the force is greater so a smaller force is required	allow distance from the rope to the pivot / hinge is greater (than distance between handle and pivot / hinge) this mark is dependent on scoring the 1st mark an answer a smaller force is required at the rope to produce the same moment scores **2** marks	1 1	AO2/1 4.5.4
10.2	$924 = F \times 0.15$ F = 6160 (N) $6160 = k \times 0.25$ $k = \frac{6160}{0.25}$ **or** k = 24640 (N/m) $E = \frac{½ \times 6160 \times 0.25 \times 0.25}{0.25}$ E = 770 (J)	an answer of 770 scores **6** marks allow use of $E = ½ F e$ instead of $k = F \div e$ and $E = ½ \times k \times e^2$ allow their calculated $F = k \times 0.25$ allow a value for k calculated using their calculated F allow $E = ½ \times$ their calc. $k \times 0.25^2$ allow an answer consistent with their calculated k	1 1 1 1 1 1	AO2/1 4.5.4 4.5.3
Total			**8**	

AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE
PHYSICS

H

Higher Tier Paper 2

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	

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ANSWER IN THE SPACES PROVIDED

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

Do not write outside the box

0 1 The thinking distance and braking distance for a car vary with the speed of the car.

0 1 . 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 1 continues on the next page

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0 1 . 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 1 . 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.

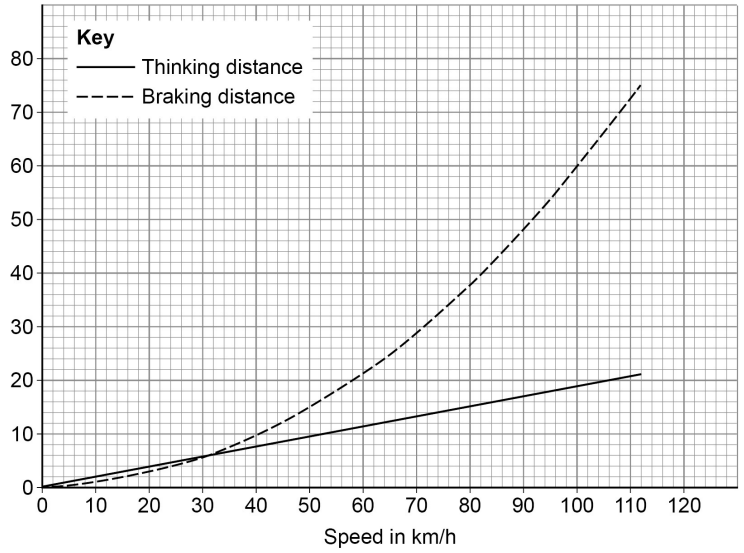
[3 marks]

Deceleration = _____ m/s^2

Do not write outside the box

0 1 . 4 **Figure 1** shows how the thinking distance and braking distance for a car vary with the speed of the car.

Figure 1



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

[2 marks]

Stopping distance = _____ m

Question 1 continues on the next page

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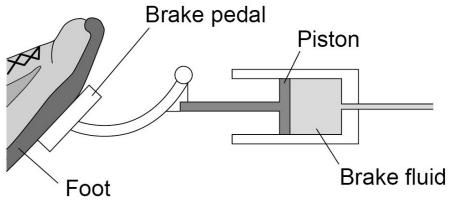
Figure 2 shows part of the braking system for a car.

Figure 2



0 1 . 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 1 . 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

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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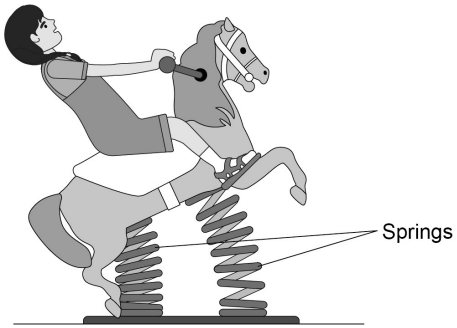
0 2 **Figure 3** shows a child on a playground toy.

Figure 3



0 2 . 1 The springs have been elastically deformed.

Explain what is meant by 'elastically deformed'.

[2 marks]

Question 2 continues on the next page

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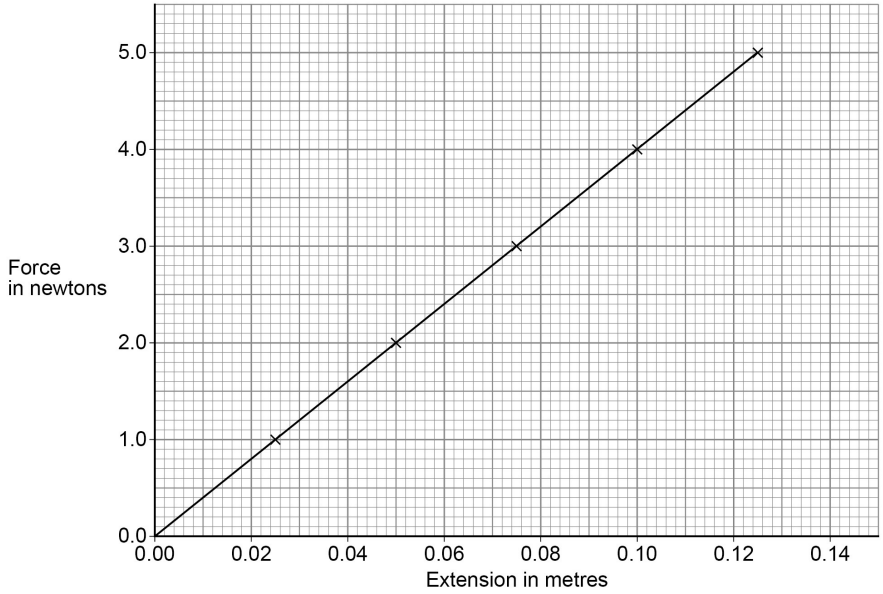
A student investigated the relationship between the force applied to a spring and the extension of the spring.

Figure 4 shows the results.

Figure 4



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0 2 . 2 Describe a method the student could use to obtain the results given in **Figure 4**.

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

Your answer may include a diagram.

[6 marks]

Question 2 continues on the next page

Do not write outside the box

0 2 . 3 Which equation links extension (e), force (F) and spring constant (k).

[1 mark]

Tick (✓) **one** box.

force = spring constant × (extension)^2 ☐

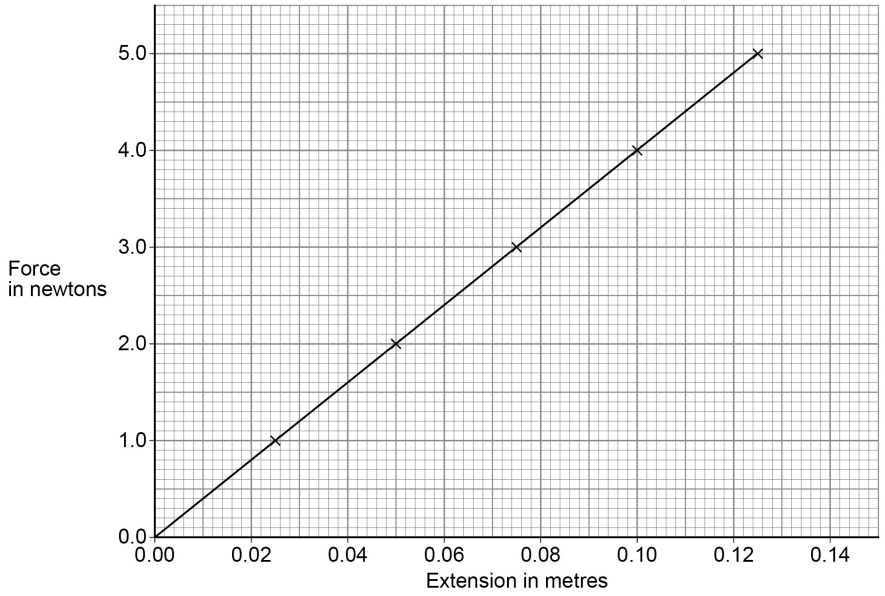
force = spring constant × extension ☐

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

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

Figure 4 is repeated below.

Figure 4



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0 2 . 4 Determine the spring constant of the spring.

Use **Figure 4.**

[3 marks]

Spring constant = _____ N/m

0 2 . 5 The student concluded:

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

Describe how **Figure 4** supports the student's conclusion.

[2 marks]

Question 2 continues on the next page

Do not write outside the box

0 2 . 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

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 3 A main sequence star in a distant galaxy is the same size and mass as the Sun.

0 3 . 1 Explain why the star is stable while it is in the main sequence stage of its life cycle.

[2 marks]

0 3 . 2 Describe what will happen to the star between the main sequence stage and the end of the star's life cycle.

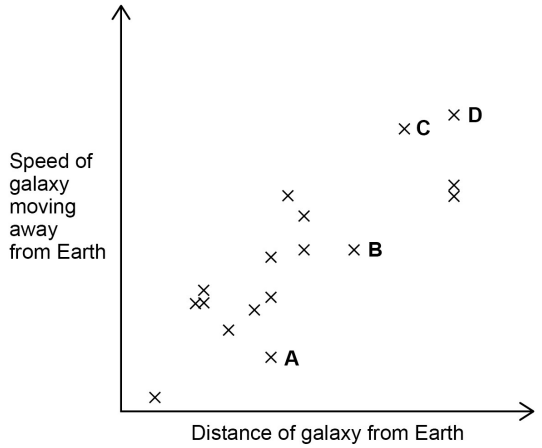
You should include the names of the stages in the life cycle of the star.

[3 marks]

Do not write outside the box

0 3 . 3 **Figure 5** shows how the speed of galaxies moving away from Earth varies with the distance of the galaxies from Earth.

Figure 5



Which galaxy would show the smallest observed change in the wavelength of visible light?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

Reason _____

_____

7

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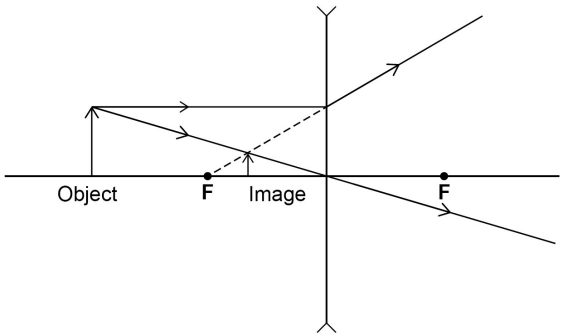
0 4 Lenses are used to form images of objects.

0 4 . 1 **Figure 6** shows how a concave lens forms an image of an object.

Figure 6



The image of the object in **Figure 6** is upright.

Give **two** other words that describe the image.

[1 mark]

1 _____

2 _____

Do not write outside the box

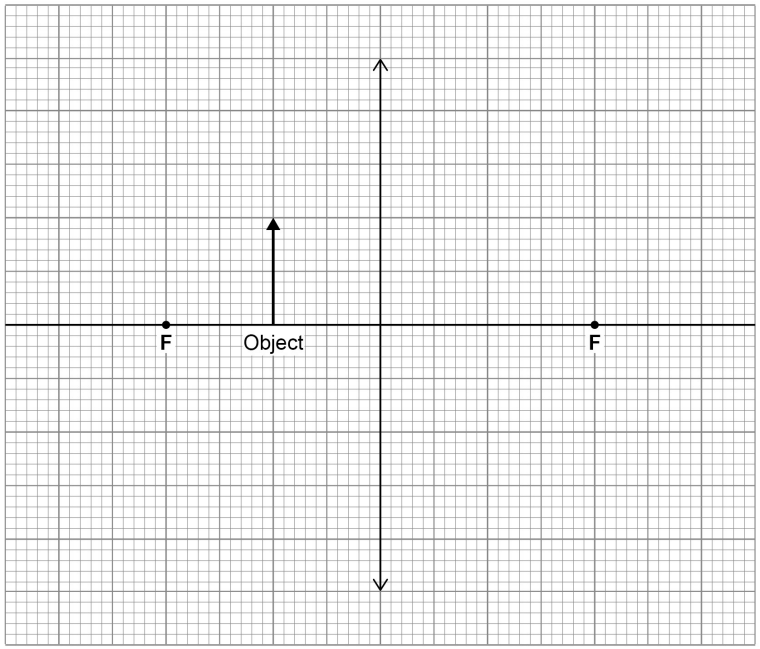
0 4 . 2 **Figure 7** shows an object near to a **convex** lens.

Complete the ray diagram to show how the image is formed.

Use an arrow to represent the image.

[3 marks]

Figure 7



Question 4 continues on the next page

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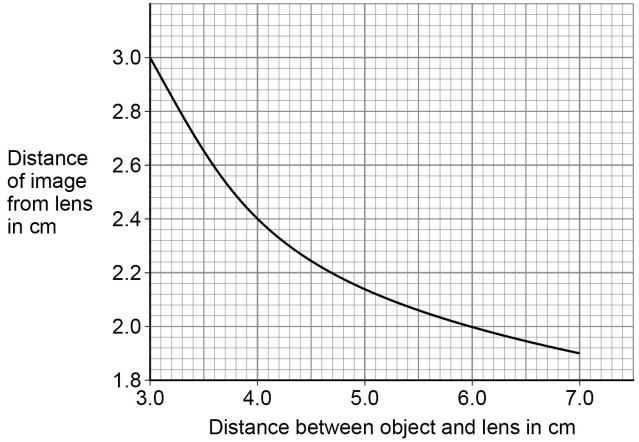
The position of an image formed by a convex lens varies with the distance between the object and the lens.

Figure 8 shows the results of a student's investigation using a convex lens.

Figure 8



0 4 . 3 Describe how the distance of the image from the lens decreases as the distance between the object and the lens increases.

[1 mark]

Do not write outside the box

0 4 . 4 The student measured the distance from the image to the lens four times.

The distance between the object and the lens did not change.

The 4 measurements from the image to the lens were:

1.9 cm 1.7 cm 2.2 cm 1.4 cm

Calculate the uncertainty in the measurements.

[2 marks]

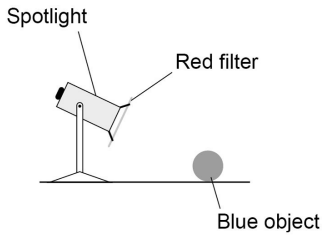
Uncertainty = ± _____ cm

0 4 . 5 **Figure 9** shows a spotlight containing a convex lens.

A red filter is placed in front of the spotlight.

The spotlight is directed at a blue object.

Figure 9



Explain why the blue object appears black.

[3 marks]

10

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0 5 Ultraviolet is a type of electromagnetic wave.

0 5 . 1 Give **one** use of ultraviolet.

[1 mark]

0 5 . 2 An ultraviolet wave has a wavelength of 300 nanometres.

Which of the following is equal to 300 nanometres?

[1 mark]

Tick (✓) **one** box.

3×10^{7} m ☐

3×10^{-7} m ☐

3×10^{9} m ☐

3×10^{-9} m ☐

0 5 . 3 The speed of ultraviolet waves is 3×10^{8} m/s.

Calculate the frequency of the ultraviolet wave.

Use your answer to Question **05.2**

[3 marks]

Frequency = _____ Hz

Do not write outside the box

0 5 . 4 **Table 1** gives the wavelength of an ultraviolet wave and three other electromagnetic waves.

Table 1

	Ultraviolet	Wave E	Wave F	Wave G
Wavelength in nanometres	300	0.1	600	100 000

Draw **one** line from each wave to the name of the wave.

[1 mark]

Wave	Name
Wave E	Infrared
Wave F	Visible light
Wave G	X-rays

0 5 . 5 Electromagnetic waves are transverse.

Some other types of wave are longitudinal.

Describe the difference between transverse and longitudinal waves.

[2 marks]

8

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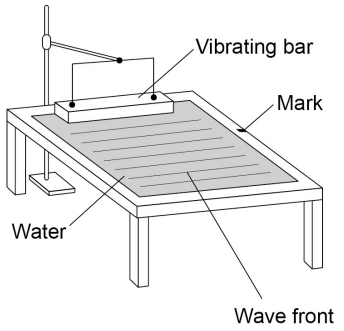
0 6 A teacher demonstrated some features of waves using a ripple tank.

Figure 10 shows the ripple tank.

Figure 10



0 6 . 1 The teacher measured the time taken for 10 wave fronts to pass the mark.

The teacher repeated this measurement three times and calculated the mean.

What is the advantage of repeating measurements and calculating a mean?

[1 mark]

Do not write outside the box

0 6 . 2 The teacher's measurements for the time taken for 10 wave fronts to pass the mark were:

8.4 s 7.8 s 8.1 s

Calculate the mean frequency of the wave.

Give your answer to 2 significant figures.

[5 marks]

Mean frequency (2 significant figures) = _____ Hz

0 6 . 3 In a different investigation, the teacher wanted to determine the speed of water waves in the ripple tank.

The teacher did **not** measure the wavelength of the wave.

Explain how the teacher could determine the speed of the wave.

[3 marks]

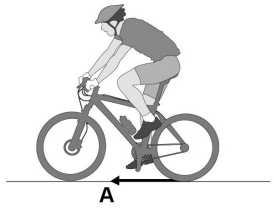
9

Do not write outside the box

0 7 **Figure 11** shows a cyclist riding a bicycle.

Force **A** causes the bicycle to accelerate forwards.

Figure 11

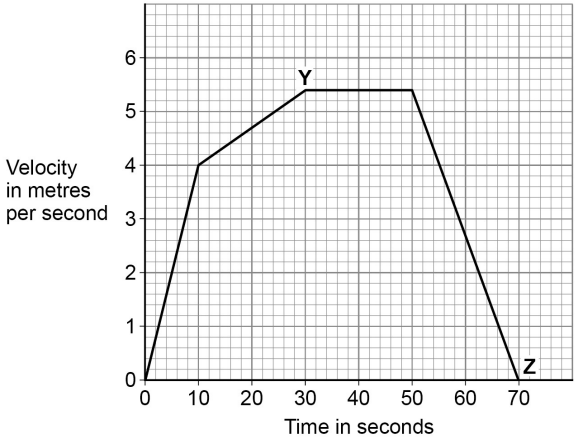


0 7 . 1 What name is given to force **A**?

[1 mark]

Figure 12 shows how the velocity of the cyclist changes during a short journey.

Figure 12



Do not write outside the box

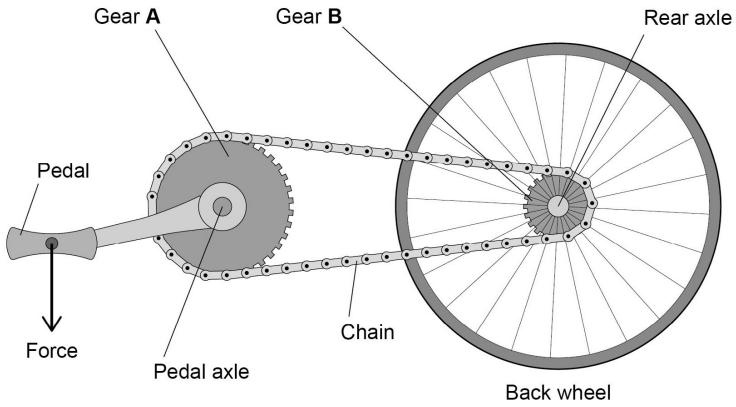
0 7 . 2 Determine the distance travelled by the cyclist between **Y** and **Z**.

[3 marks]

Distance travelled by the cyclist between **Y** and **Z** = _____ m

0 7 . 3 **Figure 13** shows the gears on the bicycle.

Figure 13



Describe how the force on the pedal causes a moment about the rear axle.

[2 marks]

Question 7 continues on the next page

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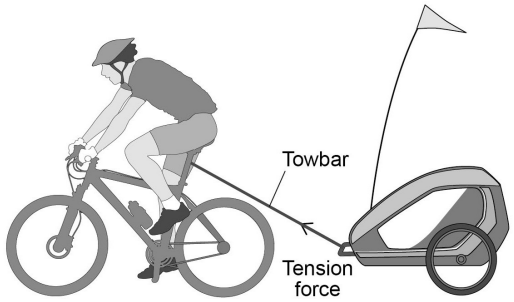
Figure 14 shows a different cyclist towing a trailer.

Figure 14



0 7 . 4 The speed of the cyclist and trailer increased uniformly from 0 m/s to 2.4 m/s.

The cyclist travelled 0.018 km while accelerating.

Calculate the initial acceleration of the cyclist.

[3 marks]

Acceleration = _____ m/s^2

Do not write outside the box

0 7 . 5 The resultant force of the towbar on the trailer has a horizontal component and a vertical component.

horizontal force = 200 N

vertical force = 75 N

Determine the magnitude and direction of the resultant force of the towbar on the trailer by drawing a vector diagram.

[4 marks]

Magnitude of force = _____ N

Direction of force = _____ degrees

13

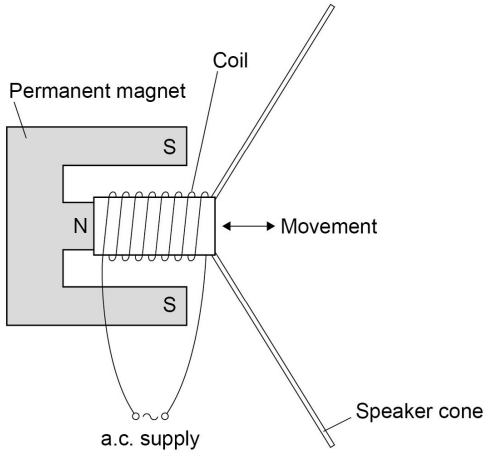
Turn over for the next question

Do not write outside the box

0 8 A student made a moving-coil loudspeaker.

Figure 15 shows a diagram of the loudspeaker.

Figure 15



0 8 . 1 What is the name of the effect used by the moving-coil loudspeaker to produce sound waves?

[1 mark]

_____

Do not write outside the box

0 8 . 2 Explain how a moving-coil loudspeaker produces a sound wave.

[4 marks]

Question 8 continues on the next page

Do not write outside the box

0 8 . 3 A student investigated how the loudness of sound from the loudspeaker depends on:

- the number of turns on the coil
- the frequency of the supply.

Table 2 shows the results.

Table 2

Number of turns	Frequency of supply in Hz	Loudness of sound in arbitrary units
100	200	32
200	400	47
300	600	63

Explain why the results **cannot** be used to make a valid conclusion.

[2 marks]

7

Do not write outside the box

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

Do not write outside the box

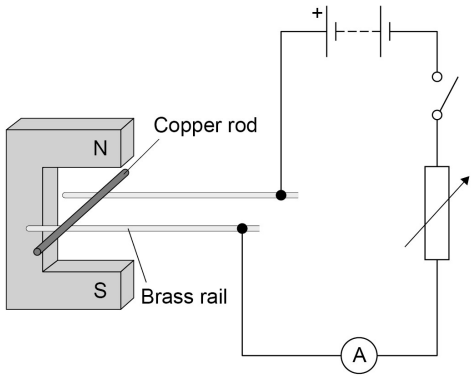
0 9 A teacher demonstrated how a magnetic field can cause a copper rod to accelerate.

The teacher placed the copper rod on two brass rails in a magnetic field.

The copper rod was able to move.

Figure 16 shows the equipment used.

Figure 16



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0 9 . 1 The teacher closes the switch and the copper rod accelerates.

Explain how Fleming's left hand rule can be used to predict the direction in which the copper rod will move.

[5 marks]

0 9 . 2 Suggest **two** changes to the equipment that would increase the force on the copper rod.

[2 marks]

1 _____

_____

2 _____

_____

Question 9 continues on the next page

Do not write outside the box

0 9 . 3 The teacher closed the switch and the copper rod accelerated uniformly from rest for 0.15 s.

The current in the copper rod was 1.7 A.

mass of copper rod = 4.0 g

length of copper rod in the magnetic field = 0.050 m

magnetic flux density = 0.30 T

Calculate the maximum possible velocity of the copper rod when it left the magnetic field.

[6 marks]

Maximum velocity = _____ m/s

13

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.**

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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	**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: Point 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			

01.2	resultant force = mass × acceleration		1	AO1 4.5.6.2.2
01.3	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
01.4	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
01.5	$p = \frac{F}{A}$		1	AO1 4.5.5.1.1
01.6	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 2

Question	Answers	Extra information	Mark	AO/ Spec. Ref
02.1	will return to its original shape/length		1	AO2 4.5.3
	when the force is removed	allow (when) the child gets off the second mark is dependent on scoring the first mark	1	
02.2	**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…			

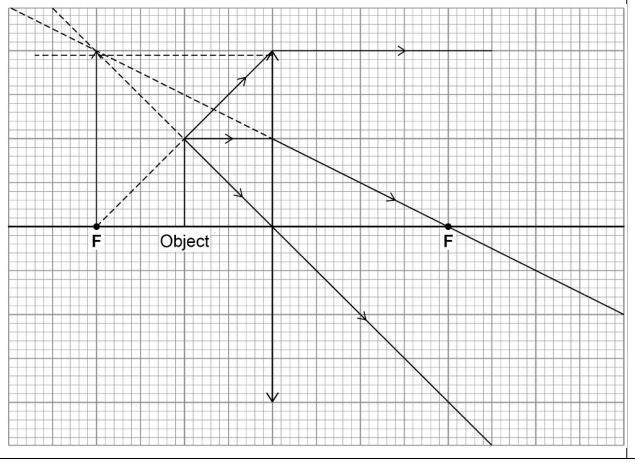
	Risk Assessment Hazard: Clamp (stand, boss and masses) might fall off desk Risk: injury to feet Precaution: Use clamp to fix apparatus to the bench **or** Ensure that the slotted masses hang over the base/foot of the stand **or** Ensure that the boss is screwed tightly into the stand and clamp **or** 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.			
02.3	force = spring constant × extension		1	AO1 4.5.3
02.4	5.00 0.125	allow any correct pair of values from the graph	1	AO2 4.5.3
	$k = \frac{5.00}{0.125}$	allow a misread value(s) from the graph	1	
	k = 40 (N/m)	allow a correct calculation using their incorrect value(s)	1	
02.5	the line is straight	allow the line does not curve allow a constant gradient	1	AO3 4.5.3
	and passes through the origin		1	

02.6	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 maximum of 1 mark	1 1 1	AO2 4.5.3
Total			**17**	

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	gravitational force inwards and forces as a result of fusion reactions outwards are in equilibrium / balanced	allow fusion energy for fusion reactions outwards allow radiation pressure for fusion reactions outwards dependant on scoring 1st mark point allow for **1** mark forces are in equilibrium	1 1	AO1 4.8.1.1
03.2	(the star will) expand to become a red giant (the star will) collapse to become a white dwarf (the star will) cool to become a black dwarf	the answers must be in the correct sequence to score all **3** marks allowed outer layers ejected for collapsed if no other marks score, allow red giant, white dwarf, black dwarf in the correct order for **1** mark	1 1 1	AO1 4.8.1.2
03.3	**A** it is (moving away from Earth) the slowest or it is the closest (to the Earth)	 reason only scores if A is chosen	1 1	AO3 4.8.2
Total			**7**	

Question 4

Question	Answers	Extra information	Mark	AO/ Spec. Ref
04.1	**both** answers correct virtual diminished	answers may be in either order allow a description of diminished (eg smaller / reduced)	1	AO3 4.6.2.5
04.2	any **two** correct lines drawn from the top of the object, passing through the lens and traced backwards image drawn in the correct position and with the correct orientation  	allow construction lines that are not dashed allow 1 mark for **two** correct lines drawn from the top of the object, passing through the lens BUT not traced backwards mark only scores if first two marks score	2 1	AO2 4.6.2.5

04.3	(increasing the object distance) decreases the image distance more rapidly at small (object) distances / more gradually at larger (object) distances	do **not** accept inversely proportional	1	AO3 4.6.2.5
04.4	$\frac{(2.2 - 1.4)}{2}$ uncertainty = (±) 0.4 (cm)	 allow $\frac{1.9 + 1.7 + 2.2 + 1.4}{4} = 1.8$ (1) (2.2 – 1.8 =) (±) 0.4 (cm) (1)	1 1	AO3 4.6.2.5
04.5	only red is transmitted by the filter red is absorbed by the (blue) object (so) no light is reflected by the (blue) object		1 1 1	AO1 4.6.2.6
Total			**10**	

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	any **one** from: • (sun) tan • energy efficient lamps	allow • (invisible) security coding • detecting forged bank notes • kill microbes • attract insects • sterilise (surgical) equipment • cause the body to produce vitamin D • increasing the growth rate of plants • water purification	1	AO1 4.6.2.4
05.2	3×10^{-7} m		1	AO1 4.6.2.1
05.3	$3.0 \times 10^{8} = \text{frequency} \times 3 \times 10^{-7}$ $\text{frequency} = \frac{3.0 \times 10^{8}}{3 \times 10^{-7}}$ frequency = 1×10^{15} (Hz)	allow ecf from question **05.2**	1 1 1	AO2 4.6.1.2
05.4	**Wave** / **Name** Wave E – Infrared Wave F – Visible light Wave G – X-rays all three lines correct for **1** mark		1	AO3 4.6.2.1
05.5	in a transverse wave, the oscillations / vibrations are perpendicular to the direction of energy transfer in a longitudinal wave, the oscillations / vibrations are parallel to the direction of energy transfer	allow direction of wave travel for direction of energy transfer	1 1	AO1 4.6.1.1
Total			**8**	

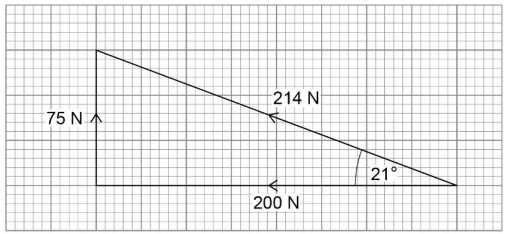
MARK SCHEME – GCSE PHYSICS – 8463/2H – JUNE 2021

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	to reduce the effect of random errors	allow gives a more accurate mean ignore reference to anomalous results ignore measurements are more accurate	1	AO1 4.6.1.2
06.2	$\frac{(8.4+7.8+8.1)}{3} = 8.1$ (s)		1	AO2 4.6.1.2
	$\frac{8.1}{10} = 0.81$ (s)		1	
	frequency = $\frac{1}{0.81}$	allow a correct substitution of an incorrectly calculated value for time	1	
	frequency = 1.2345…	this mark may be awarded if the time is incorrectly calculated	1	
	frequency = 1.2 (Hz)	allow a calculated value correctly rounded to 2 sig figs	1	
06.3	measure the distance travelled by a wave using a metre rule	allow measure the length of the (ripple) tank using a metre rule	1	AO1 4.6.1.2
	measure the time taken (for the wave to travel the measured distance) with a timer / stopwatch		1	
	divide the distance by the time	dependant on scoring the first two mark points	1	
Total			**9**	

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	friction		1	AO1 4.5.1.2
07.2	(area of rectangle =) 108 (m)		1	AO2 4.5.6.1.5
	(area of triangle =) 54 (m)		1	
	(total area / distance =) 162 (m)	allow a correctly calculated total area / distance from an incorrectly calculated area of rectangle and / or triangle	1	
07.3	(the force on the pedal) causes a moment about the pedal axle		1	AO1 4.5.4
	which causes a force on the chain (which causes a moment about the rear axle)	allow gear B for chain	1	
07.4	$2.4^2 (- 0^2) = 2 \times a \times 18$		1	AO2 4.5.6.1.5
	$a = \frac{2.4 \times 2.4}{36}$		1	
	$a = 0.16$ (m/s^2)		1	
	alternative method			
	t = 18 / 1.2 t = 15 (s) (1)			
	a = 2.4 / 15 (1)	this mark may be awarded if the time is incorrectly calculated		
	a = 0.16 (m/s^2) (1)	allow a correctly calculated acceleration from an incorrectly calculated time		

07.5	horizontal (200N) **and** vertical (75N) forces drawn to the same scale		1	AO2 4.5.1.4
	resultant force drawn in the correct direction	shown by an arrow head from bottom right to top left	1	
	resultant force with a value in the range 212 to 218 (N)	allow a calculated value of 213.6 **or** 214 (N)	1	
	direction in the range 20–22 (degrees from the horizontal)	allow 68–70 (degrees from the vertical) allow a bearing in the range 290–292 to gain full marks a vector diagram must have been drawn	1	
				
Total			**13**	

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	motor (effect)		1	AO1 4.7.2.4
08.2	current creates a magnetic field (around the coil)		1	AO1 4.7.2.4
	(which) interacts with the permanent magnet field		1	
	producing a (resultant) force causing the coil/cone to move		1	
	(when the) direction of the current reverses, the direction of the (resultant) force reverses (producing a sound wave)	allow coil/cone for force allow backwards for reverses	1	
08.3	the student changed two variables at the same time	allow only one variable should be changed at a time	1	AO3 4.6.1.2
	(so) it is not possible to know the effect of each variable		1	
Total			**7**	

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	hold thumb first finger and second finger (of left hand) at right angles to each other	allow first two fingers/index and middle for first and second finger throughout	1	AO1
	second finger represents the current pointing out of the paper		1	AO1
	first finger represents the field pointing downwards		1	AO3
	thumb points in the direction of the force / thrust / acceleration		1	AO3
	(therefore) the rod moves left to right	allow correct description (eg away from the magnet) dependent on scoring marking point 3 or 4	1	AO3 4.7.2.2
09.2	decrease the resistance of the variable resistor	allow increase the current/pd	1	AO3 4.7.2.2
	use a stronger magnet	allow use a magnet with a greater flux density	1	

09.3	F = 0.30 × 1.7 × 0.050		1	AO2 4.5.6.2.2
	F = 0.0255 (N)		1	4.5.6.1.5 4.7.2.2
	m = 0.004(0 kg)		1	
	0.0255 = 0.0040 × a	this mark may be awarded if *m* is incorrectly / not converted and / or *F* is incorrectly calculated	1	
	a = 0.0255 / 0.0040 **or** a = 6.375	this mark may be awarded if *m* is incorrectly / not converted and / or *F* is incorrectly calculated	1	
	Δv = 6.375 × 0.15 = 0.95625 (m/s)	allow a correct calculation using an incorrectly / not converted *m* and / or an incorrectly calculated *F* allow 0.96 **or** 0.956 (m/s)	1	
	<u>alternative method</u>			
	F = 0.30 × 1.7 × 0.050 (1)			
	F = 0.0255 (N) (1)			
	m = 0.004(0 kg) (1)			
	$0.0255 = \frac{0.0040 \times \Delta v}{0.15}$ (1)	this mark may be awarded if *m* is incorrectly / not converted and / or *F* is incorrectly calculated		
	$\Delta v = \frac{0.0255 \times 0.15}{0.0040}$ (1)	this mark may be awarded if *m* is incorrectly / not converted and / or *F* is incorrectly calculated		
	Δv = 0.95625 (m/s) (1)	allow a correct calculation using an incorrectly / not converted *m* and / or an incorrectly calculated *F* allow 0.96 **or** 0.956 (m/s)		

Total			**13**

AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE
PHYSICS

H

Higher Tier Paper 2

Time allowed: 1 hour 45 minutes

Materials

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

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

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

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

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

Do not write outside the box

0 1 **Figure 1** shows an electric super-car.

Figure 1

0 1 . 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 **01.2** and **01.3**.

0 1 . 2 Write down the equation which links acceleration (a), change in velocity (Δv) and time taken (t).

[1 mark]

0 1 . 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 1 continues on the next page

Do not write outside the box

0 1 . 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 **01.5** and **01.6**.

0 1 . 5 Write down the equation which links distance (*s*), force (*F*) and work done (*W*).

[1 mark]

0 1 . 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 2 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 1 shows the results.

Table 1

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 2 . 1 Describe a method the student could have used to obtain the results in **Table 1**.

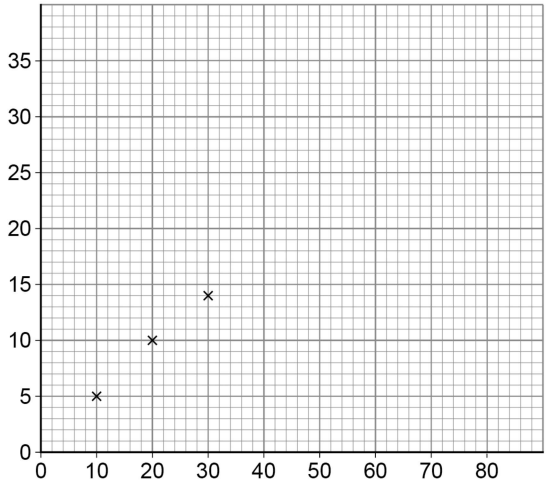
Your answer may include a labelled diagram.

[6 marks]

Do not write outside the box

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

Figure 2



Complete **Figure 2** using data from **Table 1**.

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

[4 marks]

Question 2 continues on the next page

Do not write outside the box

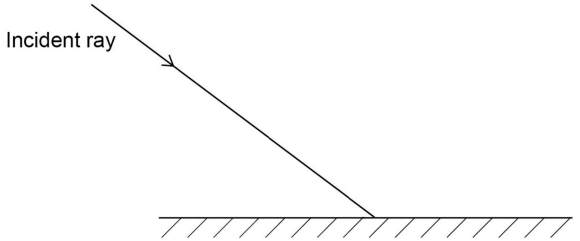
0 2 . 3 Complete the ray diagram in **Figure 3** to show the reflection of light from the surface of a plane mirror.

You should:

- draw the normal line
- draw the reflected ray.

[2 marks]

Figure 3

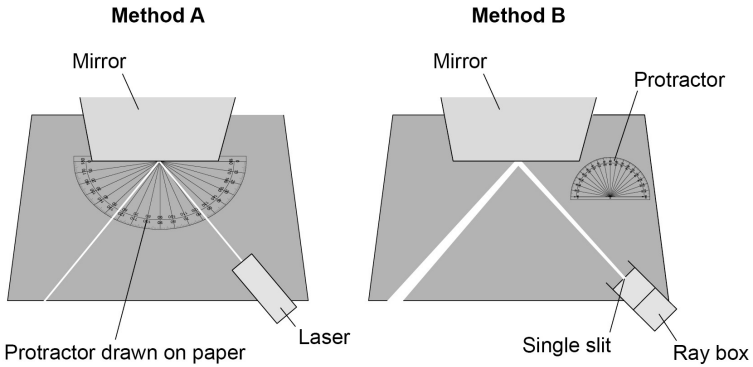


Do not write outside the box

0 2 . 4 Two students investigated the reflection of light by a plane mirror.

Figure 4 shows the different equipment the students used.

Figure 4



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

[4 marks]

1 _____

_____

_____

_____

2 _____

_____

_____

_____

16

Turn over for the next question

Do not write outside the box

0 3 Speed limits on roads increase safety.

0 3 . 1 The braking distance of a car increases as the speed of the car increases.

Give two **other** factors that **increase** the braking distance of a car.

[2 marks]

1 _____

2 _____

0 3 . 2 Explain why the driver's reaction time affects the thinking distance of a car.

[2 marks]

_____

_____

_____

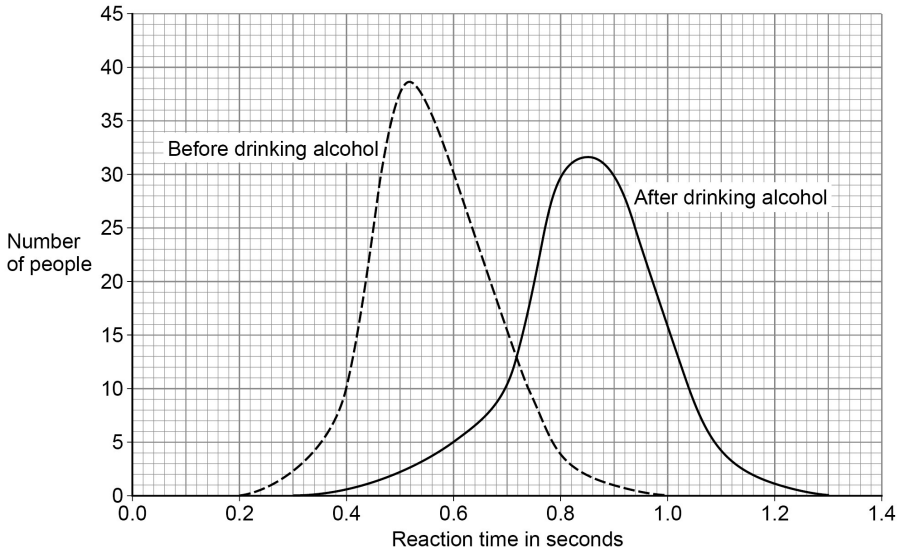
_____

Do not write outside the box

0 3 . 3 Scientists have investigated how drinking alcohol affects a person's reaction time.

Figure 5 shows the results of the investigation.

Figure 5



Which of the following conclusions can be made using **Figure 5**?

[2 marks]

Tick (✓) **two** boxes.

- Every person's reaction time increases after drinking alcohol. ☐
- Mean reaction time increases after drinking alcohol. ☐
- Some people's reaction time is not affected by drinking alcohol. ☐
- The change in reaction time is not the same for all people after drinking alcohol. ☐
- There is a smaller range of reaction times after drinking alcohol. ☐

Question 3 continues on the next page

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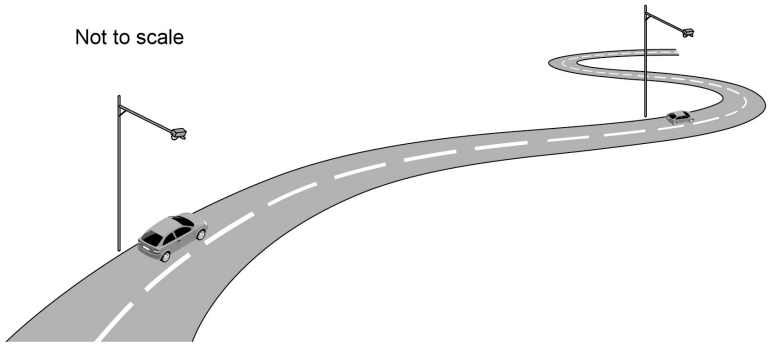
Figure 6 shows some speed cameras on a road.

The speed cameras determine the average speed of cars on the road.

Figure 6



0 3 . 4 The speed limit on the road in **Figure 6** is 20 m/s.

The cameras in **Figure 6** are 1.5 km apart.

Calculate the minimum time it takes to travel 1.5 km without breaking the speed limit.

Use the Physics Equations Sheet.

[4 marks]

Minimum time = _____ s

Do not write outside the box

0 3 . 5 The average speed of a car between the cameras and the average velocity of the car between the cameras are different.

Explain why.

[3 marks]

13

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ANSWER IN THE SPACES PROVIDED

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0 4 Hailstones are small balls of ice. Hailstones form in clouds and fall to the ground.

Figure 7 shows different-sized hailstones.

Figure 7

A hailstone falls from a cloud and accelerates.

0 4 . 1 Why does the hailstone accelerate?

[1 mark]

0 4 . 2 The hailstone stops accelerating and reaches terminal velocity.

Explain why the hailstone reaches terminal velocity.

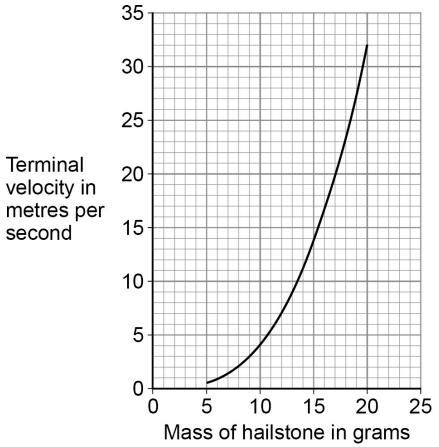
[3 marks]

Do not write outside the box

A scientist investigated how the mass of hailstones affects their terminal velocity.

Figure 8 shows the results.

Figure 8



0 4 . 3 Why does terminal velocity increase with mass?

[1 mark]

Tick (✓) **one** box.

As mass increases the cross-sectional surface area of a hailstone increases. ☐

As mass increases the volume of a hailstone increases. ☐

As mass increases the weight of a hailstone increases. ☐

Do not write outside the box

0 4 . 4 Explain the difference in the maximum kinetic energy of a hailstone with a mass of 10 g and a hailstone with a mass of 20 g.

[3 marks]

0 4 . 5 The kinetic energy of a hailstone is measured in joules.

Which of the following is the same as 1 joule?

[1 mark]

Tick (✓) **one** box.

1 N m ☐

1 N/m ☐

1 N/m^2 ☐

1 N m^2 ☐

Question 4 continues on the next page

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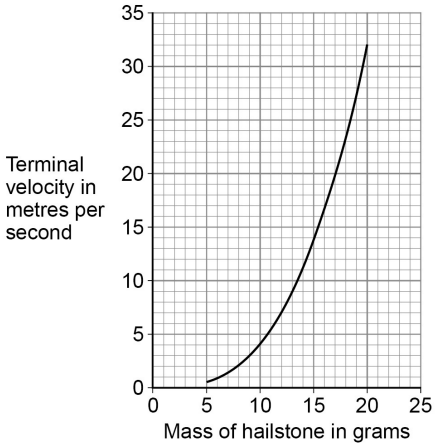
Figure 8 is repeated below.

Figure 8



0 4 . 6 A hailstone hit the ground at its terminal velocity of 25 m/s.

The hailstone took 0.060 s to stop moving.

Determine the average force on the hailstone as it hit the ground.

Use information from **Figure 8**.

Use the Physics Equations Sheet.

[3 marks]

Average force = _____ N

12

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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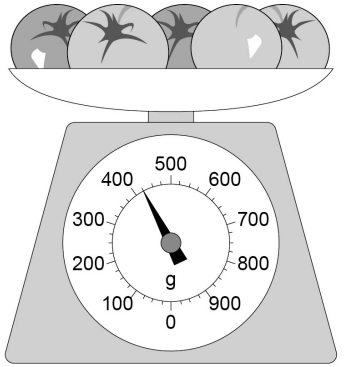
0 5 **Figure 9** shows a balance used to measure the mass of five tomatoes.

Figure 9



0 5 . 1 What is meant by 'centre of mass'?

[1 mark]

0 5 . 2 Calculate the mean weight of a tomato in **Figure 9.**

Use the Physics Equations Sheet.

gravitational field strength = 9.8 N/kg

[3 marks]

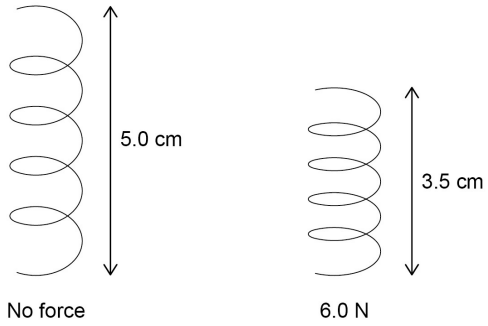
Weight = _____ N

Do not write outside the box

0 5 . 3 The balance in **Figure 9** contains a spring that compresses when the tomatoes are placed on the balance.

Figure 10 shows the spring with no force acting and with a 6.0 N force acting.

Figure 10



Determine the spring constant of the spring.

Use the Physics Equations Sheet.

[3 marks]

Spring constant = _____ N/m

0 5 . 4 Explain **one** property of the spring that makes it suitable for use in the balance.

[2 marks]

9

Do not write outside the box

0 6 Galaxies contain billions of stars.

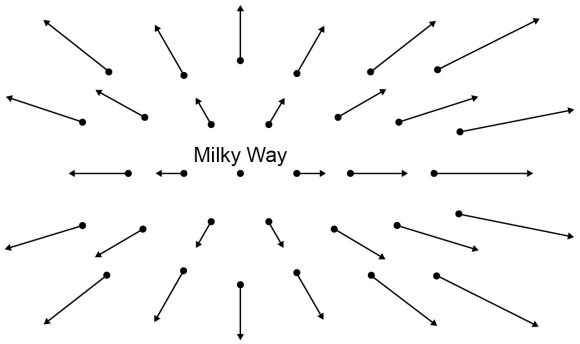
0 6 . 1 Compare the formation and life cycles of stars with a similar mass to the Sun to stars with a much greater mass than the Sun.

[6 marks]

Do not write outside the box

The points on **Figure 11** represent galaxies that are moving away from the Milky Way.

Figure 11



Each arrow represents the velocity of the galaxy relative to the Milky Way.

0 6 . 2 Light from all galaxies represented in **Figure 11** is red-shifted.

Describe what is meant by red-shift.

[2 marks]

0 6 . 3 Explain how **Figure 11** provides evidence for the Big Bang theory.

[2 marks]

0 6 . 4 Sometimes scientists have to change theories about the universe.

Give the reason why.

[1 mark]

11

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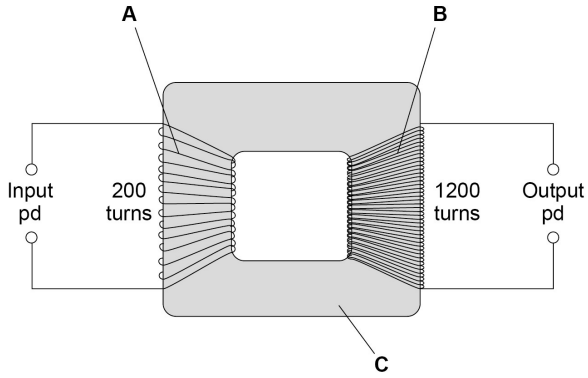
0 7 The National Grid uses transformers to change potential difference (pd).

Figure 12 shows a transformer.

Figure 12



0 7 . 1 Identify the parts of the transformer labelled in **Figure 12**.

[2 marks]

A _____

B _____

C _____

0 7 . 2 There is an alternating input pd of 230 V.

Determine the output pd.

Use the Physics Equations Sheet.

[3 marks]

Output pd = _____ V

0 7 . 3 The input pd causes an alternating current.

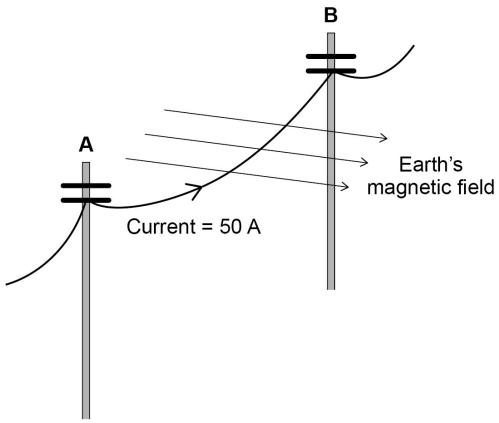
Explain why there is an alternating current in the output when the transformer is connected to a circuit.

[3 marks]

Question 7 continues on the next page

Figure 13 shows a large cable supported by two wooden poles. The cable is connected to an electricity supply.

Figure 13



0 7 . 4 There is a force on the cable due to the Earth's magnetic field when the current is in the direction **A** to **B**.

What is the direction of this force?

[1 mark]

Tick (✓) **one** box.

- Down ☐
- Left ☐
- Right ☐
- Up ☐

Do not write outside the box

0 7 . 5 The cable experiences a force of 0.045 N due to the Earth's magnetic field.

magnetic flux density = 60 μT

current = 50 A

Calculate the length of the cable between **A** and **B**.

Use the Physics Equations Sheet.

[4 marks]

Length = _____ m

0 7 . 6 State **one** assumption you made in your calculation.

[1 mark]

14

Turn over for the next question

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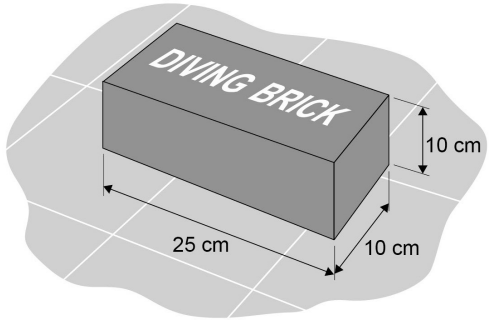
0 8 Diving bricks sink to the bottom of a swimming pool.

Figure 14 shows a diving brick.

Figure 14



Swimmers practise diving to the bottom of the swimming pool to pick up the diving brick.

0 8 . 1 Explain why the forces on the brick at the bottom of the pool cause the brick to be stationary.

[3 marks]

Do not write outside the box

0 8 . 2 When the brick from **Figure 14** is at the bottom of the pool, the top surface of the brick is 2.50 m below the surface of the water.

The force acting on the top surface of the brick due to the weight of the water is 637 N.

gravitational field strength = 9.8 N/kg

Calculate the density of the water in the swimming pool.

Use the Physics Equations Sheet.

[6 marks]

Density of water = _____ kg/m^3

Question 8 continues on the next page

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0 8 . 3 Professional divers are trained in a very deep swimming pool.

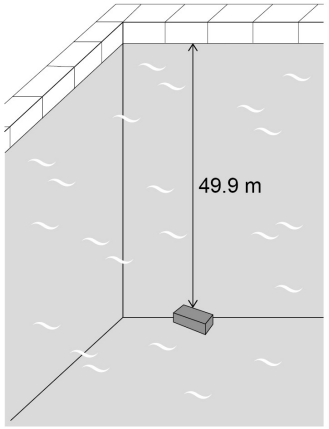
The density of the water in this pool is **not** the same as the density of the water in Question **08.2**

The diving brick was dropped into the very deep swimming pool.

When the brick was at a depth of 2.50 m, the force due to the weight of the water on the top surface of the brick was 618 N.

Figure 15 shows the diving brick at the bottom of the very deep swimming pool.

Figure 15



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Determine the force due to the weight of the water on the top surface of the brick in **Figure 15**.

Use the Physics Equations Sheet.

Give your answer to 3 significant figures.

[3 marks]

Force (3 significant figures) = _____ N

12

END OF QUESTIONS

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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	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 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.
01.2	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.
01.3	$20 = \frac{28}{t}$ $t = \frac{28}{20}$ 1.4 (s)		1 1 1	AO2 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	$v^2 (- 0^2) = 2 \times 10 \times 605$ $v^2 = 12\,100$ $v = 110$ (m/s)		1 1 1	AO2 4.5.6.1.5

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	*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 1		13

Question 2

Question	Answers	Mark	AO / Spec. Ref.
02.1	**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.
02.2	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.
02.3	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.
02.4	(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 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 2		**16**

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	any **two** from: • wet / icy road conditions • poor condition of brakes • poor condition of tyres • increased mass of car • negative gradient of the road	ignore weather allow weight for mass allow going downhill	2	AO1 4.5.6.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	distance = speed × time (so) longer reaction time = longer distance		1 1	AO1 4.5.6.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	mean reaction time increases after drinking alcohol the change in reaction time is not the same for all people after drinking alcohol		1 1	AO3 4.5.6.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	distance = 1500 (m) 1500 = 20 × t $t = \frac{1500}{20}$ 75 (s)	 allow a correct substitution using an incorrectly / not converted value of distance allow a correct rearrangement using an incorrectly / not converted value of distance allow a correctly calculated value using an incorrectly / not converted value of distance	1 1 1 1	AO2 4.5.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	velocity is a vector and speed is a scalar road is not straight therefore direction changes so the velocity changes	allow velocity includes direction (speed does not) allow driver may change lanes	1 1 1	AO3 4.5.6.1.2

Total Question 3		13

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	there is a resultant force acting	allow weight/gravity is greater than air resistance allow (initially) weight/gravity is the only force acting	1	AO1 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	as the velocity of the hailstone increases air resistance increases until air resistance becomes equal to the weight of the hailstone so the <u>resultant force</u> is (equal to) zero	allow speed for velocity	1 1 1	AO1 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	as mass increases the weight of a hailstone increases		1	AO3 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	kinetic energy depends on both mass and velocity as mass increases so does terminal / maximum velocity kinetic energy ∝ m and kinetic energy ∝ v^2 so as mass doubles kinetic energy more than doubles	allow $E_k = ½ mv^2$ a statement is required this mark can be scored by relevant calculations	1 1 1	AO1 AO1 AO3 4.1.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	1 N m		1	AO3 4.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	mass = 0.0185 (kg)	allow 0.018 to 0.019 inclusive	1	AO2 4.5.7.3
	$F = \frac{0.0185 \times 25}{0.060}$	allow a correct substitution using an incorrectly / not converted value of *m*	1	
	F = 7.708 (N)	allow 7.7 (N) allow correct calculation using an incorrectly / not converted value of *m* **if no other marks are awarded** a misreading of the scale giving a value between 15.6 and 15.7 inclusive that is then correctly converted giving an answer between 6.50 and 6.54 scores 2 marks a misreading of the scale giving a value between 15.6 and 15.7 inclusive that is then not converted giving an answer between 6500 and 6542 scores 1 mark	1	

Total Question 4		**12**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	the point from which weight may be considered to act **or** the point where the mass appears to be concentrated	allow the point through which the line of action of the weight acts allow the point at which the mass is concentrated	1	AO1 4.5.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	mass of 5 tomatoes = 0.425 (kg)		1	AO2 4.5.1.3
	mass of 1 tomato = 0.085 (kg)	allow an incorrect and / or not converted reading correctly divided by 5	1	
	W = (0.085 × 9.8) = 0.833 (N)	allow a correct calculation using their value of mass	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	6.0 = *k* × 0.015		1	AO2 4.5.3
	$k = \frac{6.0}{0.015}$	allow correct rearrangement using an incorrectly <u>calculated</u> value of *e*	1	
	k = 400 (N/m)	allow a correct calculation using an incorrectly <u>calculated</u> value of *e*	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	deforms elastically (so) will return to its original length / shape (after force is removed) **OR** compression is directly proportional to the force (applied) (1) (so) gives a linear scale (1)	 allow easy to calibrate	1 1	AO3 4.5.3

Total Question 5		**9**

Question 6

Question	Answers	Mark	AO / Spec. Ref.
06.1	**Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.	4–6	AO1 4.8.1.1 4.8.1.2
	Level 1: Relevant features are identified and differences noted.	1–3	
	No relevant content	0	
	Indicative content **all stars:** • form in a cloud of gas and dust (nebula) by gravity – mostly hydrogen • forms a protostar • fusion begins • fusion of small nuclei into larger nuclei (hydrogen into helium) • main sequence star – stable period where gravitational forces (inwards) balance forces (outwards) due to fusion processes **comparisons:** • stars about the same size as the Sun expand to become a red giant, stars much bigger than the Sun expand to become a red super giant • stars about the same size as the Sun contract (and temperature increases) to become a white dwarf, stars much bigger than the Sun explode in a supernova • stars about the same size as the Sun (cool to) become a black dwarf, stars much bigger than the Sun become either a neutron star or black hole		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	the (observed) increase in wavelength (of light from galaxies) as galaxies move away from us	ignore light waves are stretched	1 1	AO1 4.8.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	the furthest galaxies are moving away (from the Milky Way) the fastest (which suggests that) at some time all galaxies / matter started at the same point		1 1	AO3 4.8.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	there are new observations / evidence that does not fit into current theory / model	allow specific examples of new observations / theories such as dark matter or dark energy	1	AO1 4.8.2

Total Question 6		11

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	**A** primary coil **and** **B** secondary coil **C** iron core		1 1	AO1 4.7.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	$\frac{230}{V_s} = \frac{200}{1200}$ $V_s = \frac{1200 \times 230}{200}$ V_s = 1380 (V)		1 1 1	AO2 4.7.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	(the alternating current causes) a changing magnetic field around the primary (coil) creates magnetic field that changes direction in the core this induces an alternating potential difference across the secondary (coil causing an alternating current)	 allow creates a changing magnetic field in the core	1 1 1	AO2 4.7.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	down		1	AO2 4.7.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	$B = 60 \times 10^{-6}$ (T)		1	AO2 4.7.2.2
	$0.045 = 60 \times 10^{-6} \times 50 \times l$	allow correct substitution of incorrectly / not converted value of B	1	
	$l = \frac{0.045}{60 \times 10^{-6} \times 50}$	allow correct rearrangement using an incorrectly / not converted value of B	1	
	$l = 15$ (m)	allow a correct calculation using an incorrectly / not converted value of B	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	the wire / force is at right angles to the magnetic field	allow the current is constant allow the cable is straight allow the field is uniform allow the force is constant	1	AO3 4.7.2.2

Total Question 7		**14**

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	upthrust acts (upwards on the brick)		1	AO1 4.5.1.2 4.5.5.1.2
	normal contact force acts upwards (on the brick)		1	
	weight is equal to upthrust plus normal contact force	allow resultant force is equal to zero only if all three forces are given	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	$A = 0.25 \times 0.10 = 0.025$ (m^2)		1	AO2 4.5.5.1.1 4.5.5.1.2
	$P = \frac{637}{0.025}$	allow correct substitution of incorrectly calculated value of A	1	
	$P = 25\,480$ (Pa)	allow correct calculation using an incorrectly calculated value of A to gain further marks, $P = F/A$ or an incorrect rearrangement of $P = F/A$ must have been used with the given data	1	
	$25\,480 = \underline{2.5} \times \rho \times 9.8$	allow correct substitution of incorrectly calculated value of P	1	
	$\rho = \frac{25\,480}{9.8 \times 2.5}$	allow correct rearrangement using an incorrectly calculated value of P allow use of $h = 2.6$ (m)	1	
	$\rho = 1040$ (kg/m^3)	allow correct calculation using an incorrectly calculated value of P allow use of $h = 2.6$ (m)	1	
	Alternative method			
	$A = 0.25 \times 0.10 = 0.025$ (m^2)		1	
	volume of water column (V) $= 0.025 \times 2.5$	allow use of an incorrectly calculated value of A	1	
	$V = 0.0625$ (m^3)	allow use of an incorrectly calculated value of A	1	
	$m \left(= \frac{637}{9.8}\right) = 65$ (kg)		1	
	$\rho = \frac{65}{0.0625}$	allow use of an incorrectly calculated value of V	1	
	$\rho = 1040$ (kg/m^3)	allow use of an incorrectly calculated value of V	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	$F = 618 \times \frac{49.9}{2.5}$	allow calculation of density = 1008.979 (kg/m^3)	1	AO3 4.5.5.1.1 4.5.5.1.2
	$F = 12\,335.28$		1	
	$F = 12\,300$ (N)		1	
		allow correct rounding of an incorrectly calculated value of F		
		allow max of **2** marks if 50 m is used		

Total Question 8		**12**