WJEC GCSE PHYSICS

PHYSICS



EXAM QUESTION PACK

UNIT P3 HIGHER TIER 4503 PAPERS

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4503/02

S16-4503-02

PHYSICS

PHYSICS 3
HIGHER TIER

P.M. WEDNESDAY, 25 May 2016

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**14**	
2.	**10**	
3.	**9**	
4.	**13**	
5.	**14**	
Total	**60**	

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ADDITIONAL MATERIALS

In addition to this paper you may require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.
You are reminded of the necessity for good English and orderly presentation in your answers.
A list of equations is printed on page 2. In calculations you should show all your working.
You are reminded that assessment will take into account the quality of written communication (QWC) used in your answer to question **2***(a)*(ii) and **5***(b)*.

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Equation

V_1 = voltage on the primary coil V_2 = voltage on the secondary coil N_1 = number of turns on the primary coil N_2 = number of turns on the secondary coil	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$
power = voltage × current	$P = VI$
speed = $\frac{\text{distance}}{\text{time}}$	
u = initial velocity v = final velocity t = time a = acceleration x = displacement	$v = u + at$ $v^2 = u^2 + 2ax$ $x = ut + \frac{1}{2}at^2$ $x = \frac{1}{2}(u + v)t$
momentum = mass × velocity	$p = mv$
kinetic energy = $\frac{\text{mass} \times \text{speed}^2}{2}$	$KE = \frac{1}{2}mv^2$
pressure = $\frac{\text{force}}{\text{area}}$	$p = \frac{F}{A}$
	T / K = θ / °C + 273
p = pressure V = volume T = kelvin temperature	$\frac{pV}{T}$ = constant
density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
	$E = mc^2$

SI multipliers

Prefix	Multiplier
p	10^{-12}
n	10^{-9}
μ	10^{-6}
m	10^{-3}

Prefix	Multiplier
k	10^{3}
M	10^{6}
G	10^{9}
T	10^{12}

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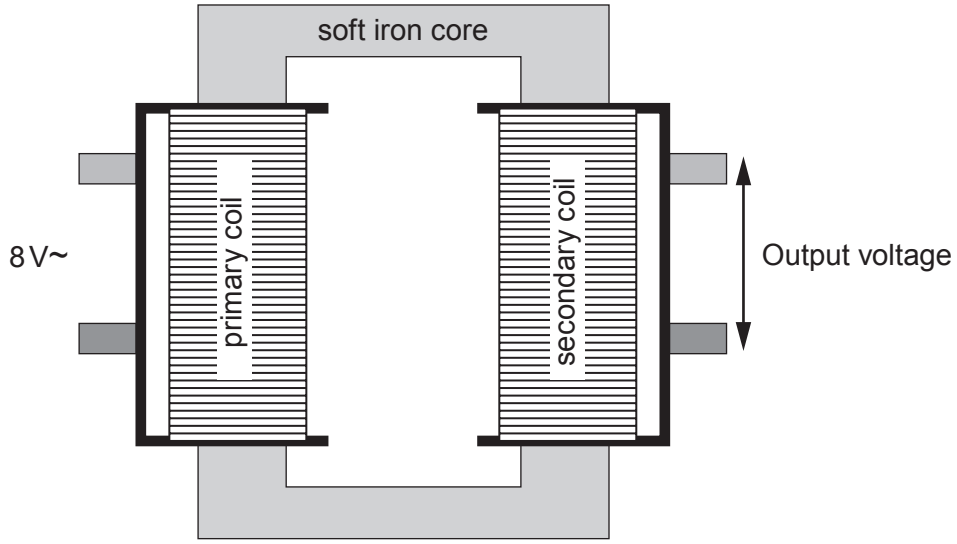
Answer **all** *questions.*

1. *(a)* State how the construction of a step-up transformer is different from a step-down transformer. [1]

.....

.....

The diagram shows a transformer that can be used for an investigation in a laboratory.



(b) Put a **tick (✓)** in the boxes next to the statements that would cause the output voltage to increase. [2]

Increasing the number of turns on the primary coil	☐
Decreasing the number of turns on the primary coil	☐
Decreasing the input voltage	☐
Increasing the number of turns on the secondary coil	☐
Decreasing the number of turns on the secondary coil	☐

(c) Explain why there must be an alternating input voltage for the transformer to work. [2]

.....

.....

.....

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Turn over.

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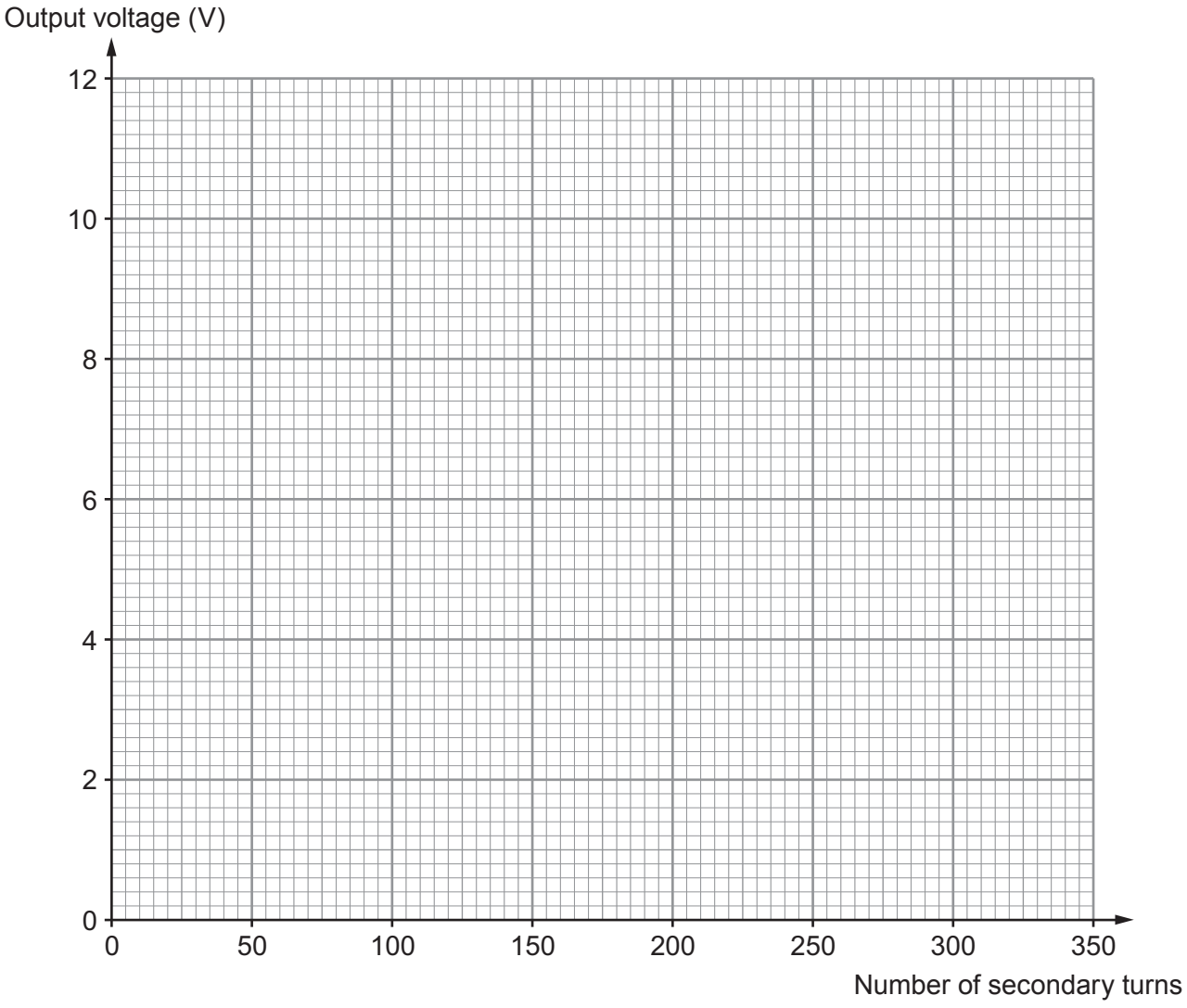
(d) An investigation is carried out to determine how the output voltage depends on the number of turns on the secondary coil. The input voltage (8 V) and the number of turns on the primary coil (200) are kept constant throughout the investigation.

The results of the investigation are recorded in the table below.

Input voltage (V)	Primary turns	Secondary turns	Output voltage (V)
8	200	50	2
8	200	.....	4
8	200	150	6
8	200	200	8
8	200	300	12

(i) **Complete the table.** [1]

(ii) Plot a graph of the output voltage against the number of secondary turns on the grid below and draw a suitable line. [3]



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(iii) Describe the relationship between the output voltage and the number of secondary turns. [2]

.....

.....

(iv) Use the graph to find the number of secondary turns required to give an output voltage of 5 V. [1]

number of turns = ...

(v) Explain how the graph would be different if the investigation were repeated with a primary coil containing 400 turns. [2]

.....

.....

.....

14

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2. *(a)* The diagrams below are drawings made by a student investigating how light rays pass through a semi-circular glass block.

Diagram A

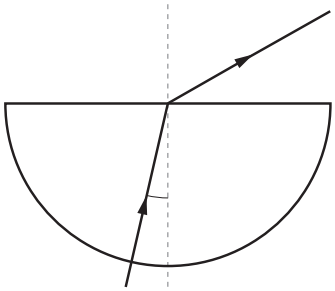


Diagram B

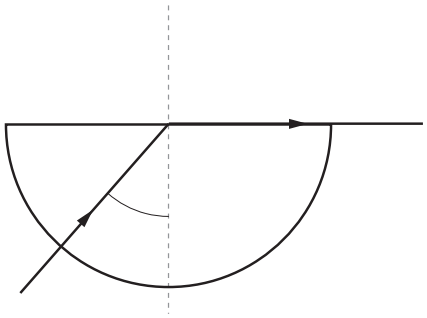
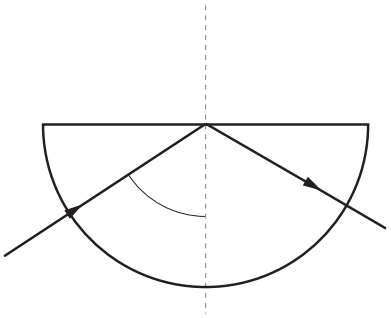


Diagram C



(i) **Label the critical angle (*c*)** on the appropriate diagram above. [1]

(ii) Describe and explain the observations shown in the drawings as fully as you can. [6 QWC]

You should:

- describe what happens to the light ray in each of the diagrams above;
- explain why the light ray follows the path shown in each diagram.

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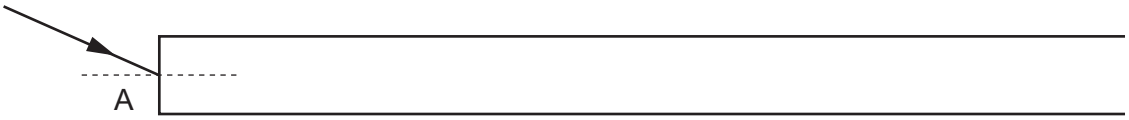
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.....

(b) Complete the diagram below to show how the light entering at A travels along the optical fibre. [3]



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3. *(a)* (i) Explain why our Sun remains the same size in the main sequence stage of its life. [2]

.....

.....

(ii) Name, in order, the next **two** stages in the life of our Sun. [2]

..... and .....

(iii) **Complete the nuclear equation below** which shows the nuclear fusion reaction occurring in the Sun. [2]

$$\text{.....}\,{}^{1}_{1}\text{H} \rightarrow {}^{4}_{2}\text{He} + \text{.....}\,{}^{0}_{1}\text{e}$$

(b) Each second, the Sun produces 3.9×10^{26} J of energy in the form of electromagnetic radiation. Use an equation from page 2 to calculate the mass loss of the Sun per second. (Speed of light, $c = 3 \times 10^{8}$ m/s) [3]

mass loss = ... kg

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4. A football of mass 0.3 kg is dropped from rest off a bridge and takes 2.8 seconds to reach the ground below.



The diagram is not drawn to scale

Use equations from page 2 to answer the questions below.
Assume the acceleration due to gravity = 10 m/s^2 and that air resistance is negligible.

(a) Calculate the height of the bridge. [2]

height = ... m

(b) Calculate the momentum of the ball just before it hits the ground. [3]

momentum = ... kg m/s

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(c) The ball rebounds from the ground with a speed of 14 m/s.

(i) Calculate the kinetic energy of the football as it leaves the ground. [2]

kinetic energy = ... J

(ii) Calculate the change in momentum of the ball due to the bounce. [2]

change in momentum = ... kg m/s

(iii) Explain how momentum is conserved when the ball rebounds from the Earth. [2]

.....

.....

.....

(d) Describe how Newton's third law of motion applies when the ball hits the ground. [2]

.....

.....

.....

13

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Turn over.

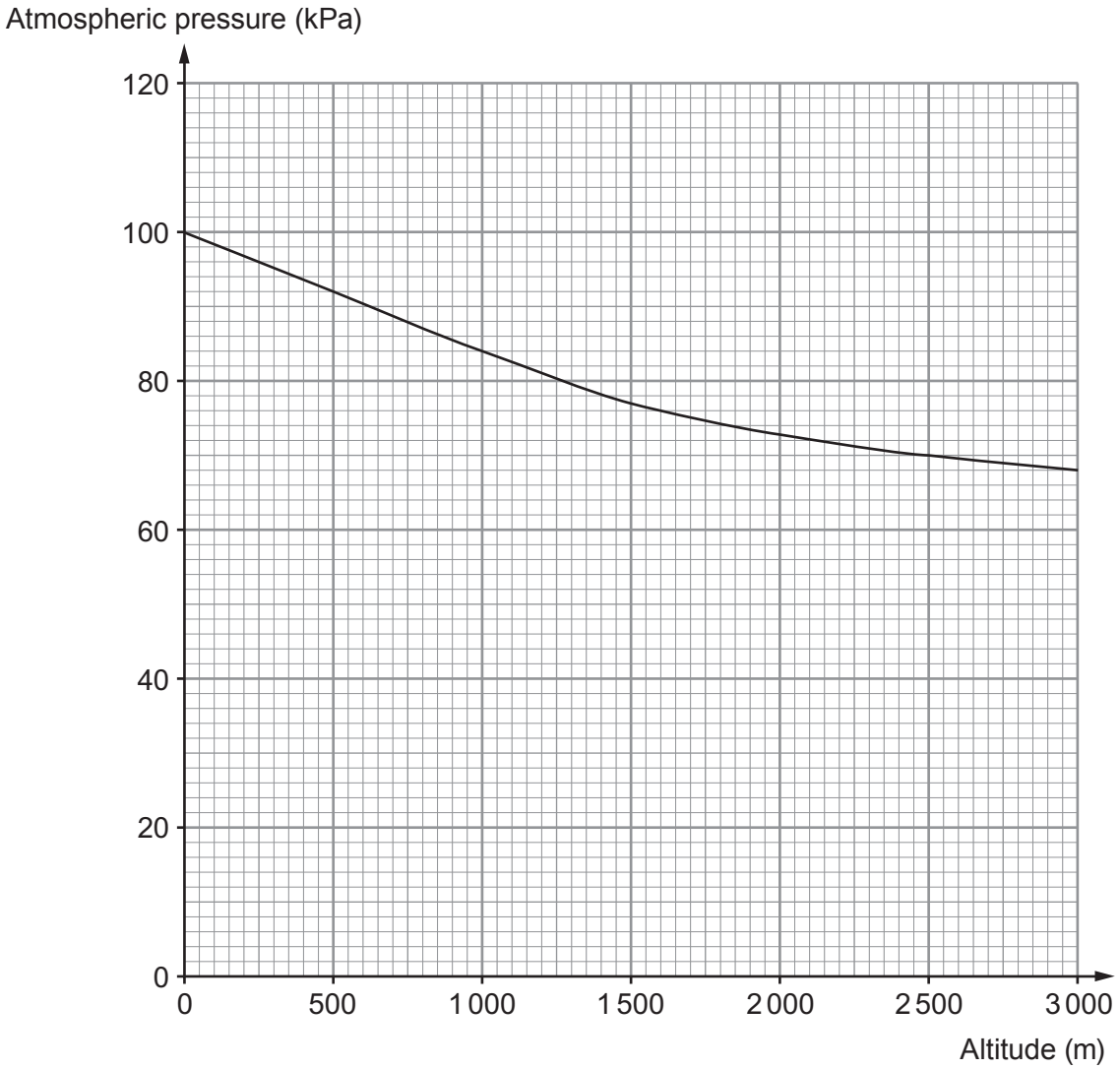
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5. Dan is on holiday in Denver USA. He packs a sealed plastic water bottle containing only air in his luggage. When he arrives home in Cardiff he notices that the water bottle appears crushed. He works out the volume of the bottle in both Denver and Cardiff.

The table below shows his results together with other relevant information.

Volume of bottle in Denver	$5.0 \times 10^{-4}\,m^3$
Volume of bottle in Cardiff	$3.8 \times 10^{-4}\,m^3$
Temperature in Cardiff	293 K
Temperature in Denver	293 K
Altitude of Cardiff	0 metres

The graph shows how atmospheric pressure changes with altitude (height above sea level).



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(a) (i) Use the graph to write down the air pressure in Cardiff in Pa. [1]

pressure = ... Pa

(ii) Use the information opposite together with equations from page 2 to answer the following questions.

(I) Calculate the atmospheric pressure in Denver and use your answer to find the altitude of Denver. [4]

atmospheric pressure = ...

altitude = ... m

(II) Calculate the temperature required for the bottle in Cardiff to have the same volume as in Denver. Give your answer in °C. [3]

temperature = ... °C

TURN OVER FOR THE LAST PART OF THE QUESTION

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(b) Explain, in terms of the motion of molecules, how the behaviour of gases leads to the idea of absolute zero and an absolute scale of temperature. [6 QWC]

END OF PAPER

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GCSE MARKING SCHEME

SUMMER 2016

SCIENCE - PHYSICS P3
4503/01/02

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INTRODUCTION

This marking scheme was used by WJEC for the 2016 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

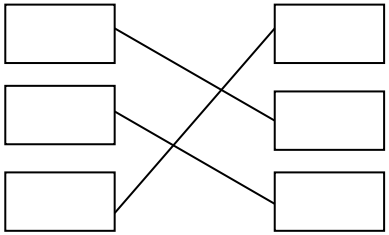
It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

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GCSE SCIENCE - PHYSICS P3

SUMMER 2016 MARK SCHEME

Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
1		(a)			2	 All 3 lines correct – 2 marks 1 or 2 lines correct – 1 mark More than one line drawn from or to a box – loses 1 mark	Accept curved lines joining boxes		
		(b)			3	All 4 labels in correct places – 3 marks 2 or 3 labels correct – 2 marks 1 label correct – 1 mark Accept complete terms only			
		(c)			1	Magnetic field left to right across the diagram Arrow can be drawn anywhere	Not having a label		Curved line
		(d)			2	**Any 2 × (1) from**: • weaker magnet, • fewer turns on coil, • smaller current / lower voltage [cell or battery], • smaller [area] coil	Fewer coils /shorter coil / move magnets further apart / add a resistor / less field lines / smaller or decrease magnetic field		Smaller magnets / remove wires
		(e)			1	**Any 1 from:** • reversing the magnetic field / swap N + S [poles around] or magnets • reversing the cell/battery / change polarity of battery • reversing the current			Reversing cell <u>and</u> magnetic field / change the current
		Total			**9**				

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
2		(a)			1	75 [%]			
		(b)	(i)		1	4			
			(ii)		1	4			
			(iii)		1	Positron	positive electron / anti electron		
		(c)	(i)		2	Gravity / gravitation (1) [Radiation / gas] pressure (1)			Radiation on its own / expanding force
			(ii)		1	Our Sun is not big enough / not massive or heavy enough	It is too small / only supernovae produce uranium / only very big stars produce uranium		Any answer that doesn't refer to size e.g. only produces elements up to iron
		Total			**7**				

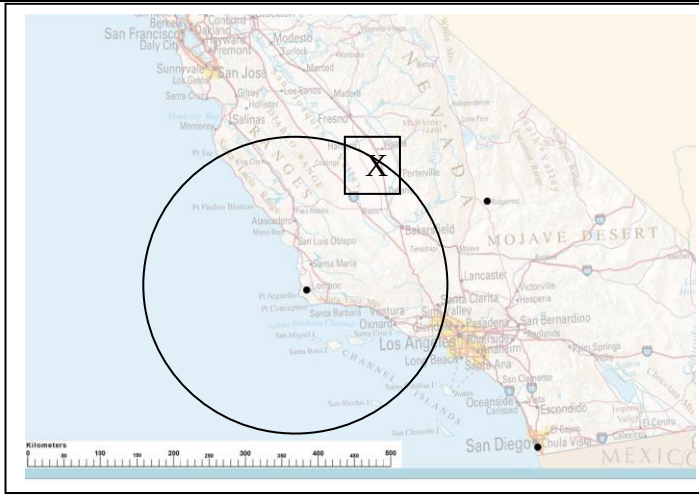
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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
3		(i)			2	momentum = 50 000 × -2 (1-subs) = -100 000 [kg m/s] (1 –ans)	100 000 to the left gets 2 marks. NB1:50 000 × 2 = 100 000 gets 1 mark. NB2: 50 000 × -2 = 100 000 gets 1 mark NB3: 50 000 × 2 = -100 000 **gets 1 mark** NB4: 50 000 × 2 = 100 000 to the left **gets 1 mark**		50 000 + -2 = ±100 000
		(ii)			1	The negative of answer in (i) i.e. 100 000 [kg m/s] **ecf**			
		(iii)			2	Answer from part (ii) ÷ 80 000 (1-subs) = 1.25 [m/s] or correct answer for their substitution (1)	If no answer in part (ii) and answer from part (i) used to get a correct answer award 1 mark only		
		Total			**5**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
4		(a)	(i)		2	distance = 6 × 25 (1-subs) = 150 [km] (1-ans)	Use of scale – 3 × 50 = 150 [km]		
			(ii)		1	 The circle should be crossed in the position of the X marked above i.e. on the N, A or T of "NATIONAL"			
		(b)	(i)		1	P waves travel faster than S waves or converse		Reference to surface waves in addition to S waves	They set out later / surface waves are slower than P waves / S waves take longer to travel
			(ii)		1	6 hours [0]1 minute 42 seconds			01 min 42 secs or just 42 secs
		Total			**5**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
5		(a)			2	Temperature = 0 [K] - 1 mark Pressure = 12 [N/cm^2] – 1 mark			
		(b)			2	The molecules travel faster / have more energy (1) More frequent / harder collisions / collide more often [with the container] (1)		More frequent / harder collisions with each other	They collide more / there is more energy / increased number of collisions
		Total			**4**				

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
6		(a)			1	The speeds are bigger [between 2 and 4 seconds]	The speed is bigger / moving faster / it is accelerating		
		(b)	(i)		2	$a = \frac{(40-10)}{(4-1)}$ using any matching speeds and times (1) = 10 [m/s^2] (1-ans)	Errors in expression e.g. (40 – 10) = $\frac{30}{3}$ = 10 [m/s^2] award 2 marks		Confusion between u and v values
			(ii)		2	$x = \frac{1}{2}(20+40) \times 2$ (1-sub) = 60 [m] (1-ans)			
		(c)			1	Air resistance has a bigger effect [on the feather than on the stone.]	Because the feather is lighter / smaller mass		More air resistance acts on the feather / smaller terminal velocity / feather is less dense / less momentum / reference to surface area
		Total			**6**				

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
7	**1**	(a)			1	It has more <u>secondary</u> or <u>output</u> turns or coils [than primary turns] or converse	A <u>step-down</u> transformer has more <u>primary or input</u> turns or coils [than secondary turns]		Reference to left and right
		(b)			2	Ticks in the 2nd i.e. Decreasing the number of turns on the primary coil (1) and 4th boxes i.e. Increasing the number of turns on the secondary coil (1) If 3 boxes ticked a maximum of 1 mark can be awarded			
		(c)			2	An a.c. creates a changing [magnetic] field (1) which creates / induces a voltage / current in the <u>secondary or output</u> coil (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	Changing flux	Reference to linkage	Moving magnetic field / cutting flux / core flips
		(d)	(i)		1	100			
			(ii)		3	All plots correct (2) (-1 for each incorrect plot – no tolerance allowed) **ecf from (i)** Straight line through the points from 50 – 300 turns (1)		Line extended back to origin	Thick, wobbly, disjointed, wispy lines
			(iii)		2	Output voltage increases as number of secondary turns increase (1) proportionally / uniformly / constant rate (1) **OR** output voltage is proportional to number of secondary turns (2)	Voltage doubles as turns double (2) Positive correlation (1)		
			(iv)		1	125 – no tolerance	Reading from their line		
			(v)		2	Less steep line / smaller gradient (1) because each output or voltage would be less [halved] (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	Voltages would be smaller (1)	Line would be different	Graph increases less
		Total			**14**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
8	**2**	(a)	(i)		1	*c* shown in correct position on middle drawing i.e. drawn between the normal and the ray	Labelling using the words critical angle or 42^{o}		
			(ii)		6	**Indicative content:** When the angle of incidence is less than the critical angle the light is refracted away from the normal as it passes into the air (A). This happens because light travels faster in air than in glass **or** the light is travelling into an optically less dense medium. When the angle of incidence is equal to the critical angle the light just escapes from the glass and travels along the glass-air boundary (B). If the angle of incidence is greater than the critical angle then total internal reflection occurs (C). TIR occurs when light is travelling from a more dense towards a less dense medium at an angle bigger than the critical angle. **5-6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3-4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1-2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.			
		(b)			3	Correct refraction at A i.e. refracted towards the normal (1) TIR shown - at the glass sides with straight lines (1) reflections show $i = r$ by eye (1)			
		Total			**10**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	3	(a)	(i)		2	Forces due to gravity / gravitation **and** [gas/radiation] pressure named (1) Which are balanced / equal and opposite (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	Cancels each other out		Equal only / one force counters the other / radiation energy
			(ii)		2	Red giant (1) White dwarf (1) Need the correct order			Red supergiant Planetary nebula
			(iii)		2	4 (1) 2 (1)			
		(b)			3	$3.9 \times 10^{26} = m \times (3 \times 10^{8})^{2}$ (1) Manipulation (1) Answer = 4.33×10^{9} [kg] (1)	If no substitution shown: $\frac{3.9 \times 10^{26}}{3 \times 10^{8}} =$ 1.3×10^{18} award the manipulation mark only		Use of KE equation
		Total			**9**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	4	(a)			2	Substitution into $x = ut + ½ at^2$ i.e. $x = [0 +] (½ \times 10 \times 2.8^2)$ (1) Answer = 39.2 [m] (1)	Combinations of equations of motion – find the mean speed (14 m/s) (1) and use of distance = speed × time = 39.2 [m] (1)		2.8 × 28 = 78.4 [m]
		(b)			3	Substitution into $v = u + at$ i.e. $v = [0] + 10 \times 2.8$ (1) $v = 28$ [m/s] (1) Momentum = mv = 0.3 × 28 (**ecf**) = 8.4 [kg m/s] (1)	Use of energy argument to get value for v i.e. PE = 117.6 J (**ecf**) (1) use KE to find v = 28 [m/s] (1) Substitution into $v^2 = u^2 + 2ax$ **ecf** on x (1) v = 28 [m/s] (1)		
		(c)	(i)		2	Substitution into KE = $½ mv^2$ i.e. KE = $½ \times 0.3 \times 14^2$ (1) Answer = 29.4 [J] (1)			KE = ½ × 0.3 × 14
			(ii)		2	Momentum after bounce = [-] 4.2 (1) Change in momentum = - 4.2 - 8.4 **ecf** = [-]12.6 [kg m/s] (1)	Change in momentum = 8.4 **ecf** + answer for momentum after bounce – award 2 marks		
			(iii)		2	Change in momentum of the ball (1) is equal [and opposite] to the change in momentum of the Earth (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**			Statement of principle of conservation of momentum
		(d)			2	Force on Earth / ground from the ball (1) equal and opposite force on ball from Earth / ground (1)	Force on Earth from the ball = force on ball from Earth (1)		Statement of N3rd Law
		Total			**13**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	5	(a)	(i)		1	100 000	100 with a k added in front of the Pa		
			(ii)	I	4	Use of pV = constant i.e. $100\,000 \times 3.8 \times 10^{-4} = 38$ (1) So $p_D = \frac{38}{V_D} = \frac{38}{5 \times 10^{-4}}$ (1) = 76 000 Pa (1) **answer + unit** Use of graph to find altitude = 1 600 (± 50) (1) **ecf** on p	Correct substitution into $p_1V_1 = p_2V_2$ award 2 marks $\frac{pV}{T}$ = 0.1297 (1) $p_D = \left(\frac{0.1297}{5 \times 10^{-4}}\right) \times 293$ (1) = 76 000 Pa (1) **answer + unit** Allow calculations in kPa		
				II	3	Use of $\frac{p}{T}$ = a constant $\frac{76\,000}{293} = \frac{100\,000}{T}$ (1) T = 385.5 K (1) So: 385.5 (**ecf**) – 273 = 112.5 [^oC] (1)	Use of $\frac{pV}{T}$ = constant i.e. $\frac{(76\,000 \times 5 \times 10^{-4})}{293} = \frac{38}{293}$ = 0.1297 (1) $100\,000 \times 5 \times 10^{-4} = T \times 0.1297$ T = 385.5 K (1) So: 385.5 (**ecf**) – 273 = 112.5 [^oC] (1) Allow calculations in kPa Accept a ratio of 1.3 – 1 mark		

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
		(b)			6	**Indicative content:** Gas molecules move slower / have lower energy at lower temperature. The separation of molecules is less at lower temperatures and they collide with the walls less frequently. The volume and pressure of a gas are proportional to the absolute temperature measured in Kelvin. Absolute zero is the temperature at which the energy / speed of molecules would be zero as would the pressure and volume. The absolute temperature scale (measured in K) uses the properties whereby zero volume and zero pressure coincide with 0 K. **5-6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3-4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1-2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.			
		Total			**14**				

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4503/02

S15-4503-02

PHYSICS

PHYSICS 3
HIGHER TIER

P.M. WEDNESDAY, 20 May 2015

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**14**	
2.	**11**	
3.	**6**	
4.	**10**	
5.	**9**	
6.	**10**	
Total	**60**	

4503 020001

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.
You are reminded of the necessity for good English and orderly presentation in your answers.
A list of equations is printed on page 2. In calculations you should show all your working.
You are reminded that assessment will take into account the quality of written communication (QWC) used in your answers to questions **3** and **6***(b)*.

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Equations

V_1 = voltage on the primary coil V_2 = voltage on the secondary coil N_1 = number of turns on the primary coil N_2 = number of turns on the secondary coil	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$
power = voltage × current	$P = VI$
speed = $\frac{\text{distance}}{\text{time}}$	
u = initial velocity v = final velocity t = time a = acceleration x = displacement	$v = u + at$ $v^2 = u^2 + 2ax$ $x = ut + \frac{1}{2}at^2$ $x = \frac{1}{2}(u + v)t$
momentum = mass × velocity	$p = mv$
kinetic energy = $\frac{\text{mass} \times \text{speed}^2}{2}$	$KE = \frac{1}{2}mv^2$
pressure = $\frac{\text{force}}{\text{area}}$	$p = \frac{F}{A}$
	T / K = θ / °C + 273
p = pressure V = volume T = kelvin temperature	$\frac{pV}{T}$ = constant
density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
	$E = mc^2$

SI multipliers

Prefix	Multiplier
p	10^{-12}
n	10^{-9}
μ	10^{-6}
m	10^{-3}

Prefix	Multiplier
k	10^{3}
M	10^{6}
G	10^{9}
T	10^{12}

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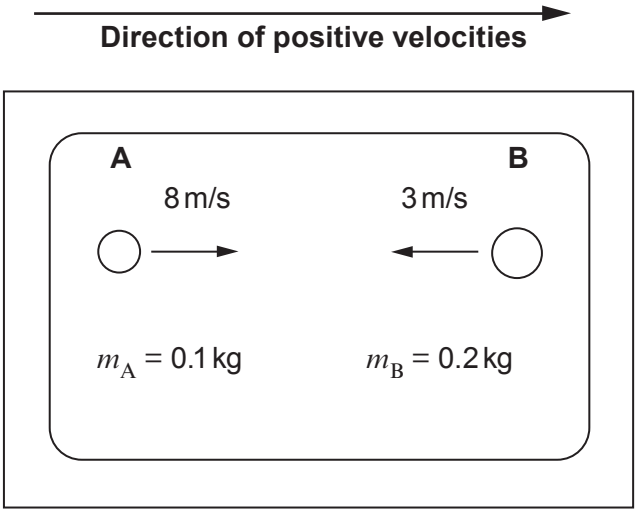
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Answer **all** *questions.*

1. *(a)* A sliding disc **A** of mass (m_A) 0.1 kg travelling with a velocity of +8 m/s on a frictionless table hits another disc **B** of mass (m_B) 0.2 kg travelling with a velocity of –3 m/s.



(i) Use an equation from page 2 to calculate the initial momentum of disc **A**. [2]

momentum = ... kg m/s

(ii) Calculate the initial momentum of disc **B**. [1]

momentum = ... kg m/s

(iii) Calculate the **total** momentum before the collision. [1]

total momentum = ... kg m/s

(iv) Write down the **total** momentum after the collision. [1]

total momentum = ... kg m/s

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(v) After the collision, disc **A** stops moving.

Use the equation:

$$\text{velocity} = \frac{\text{total momentum}}{\text{mass}}$$

to calculate the velocity of disc **B** after the collision. [2]

velocity of disc **B** = ... m/s

(b) Disc **A** decelerates at 160 m/s^2 during the collision.

(i) Use the equation:

$$t = \frac{(v - u)}{a}$$

to calculate how long the collision takes. [2]

time = ... s

(ii) Disc **A** applies a mean force of 1.6 N to disc **B** during the impact. Write down the **size** and **direction** of the mean force applied to disc **A** by disc **B** in the collision. [2]

.....

.....

(c) Use an equation from page 2 to calculate the loss of kinetic energy in the collision. [3]

energy lost = ... J

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2. The Sun is in a stable state in the main sequence stage of its "life".

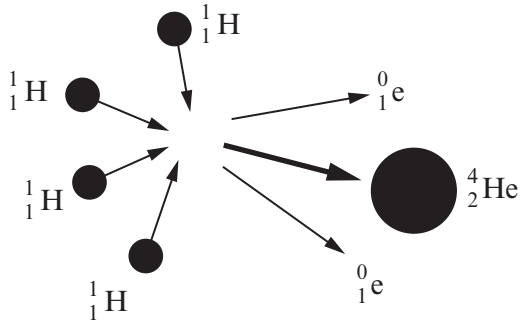
(a) (i) Name the forces acting on the Sun. [1]

.....

(ii) State why the Sun is in a stable state at present. [1]

.....

(b) The Sun generates most of its energy by the nuclear reaction shown in the diagram.



(i) Write the nuclear equation for this reaction. [1]

$\longrightarrow$

(ii) Describe this reaction, naming the particles involved. [3]

.....

.....

.....

.....

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(iii) Use the information below and an equation from page 2 to calculate the energy produced by this reaction. [4]

mass of a proton ($^{1}_{1}\mathrm{H}$ nucleus) = 1.00728 u

nuclear mass of $^{4}_{2}\mathrm{He}$ = 4.00151 u

1 u = 1.66×10^{-27} kg

$c = 3 \times 10^{8}$ m/s

ignore the mass of $^{0}_{1}\mathrm{e}$

energy = ... J

(c) State what happens when a particle $^{0}_{1}\mathrm{e}$ collides with a particle $^{0}_{-1}\mathrm{e}$. [1]

.....

11

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Turn over.

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3. Use your knowledge of the kinetic theory of matter to explain how heat energy is transferred by conduction in **metals** and by convection in **gases**. [6 QWC]

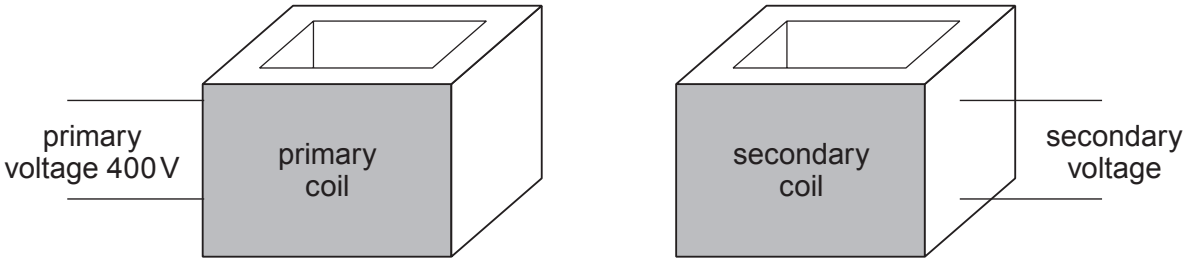
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4. The diagram shows parts of a transformer. The diagram is incomplete.



(a) **Draw** and **label** the missing part in the correct position on the diagram above and state its function. [2]

.....

.....

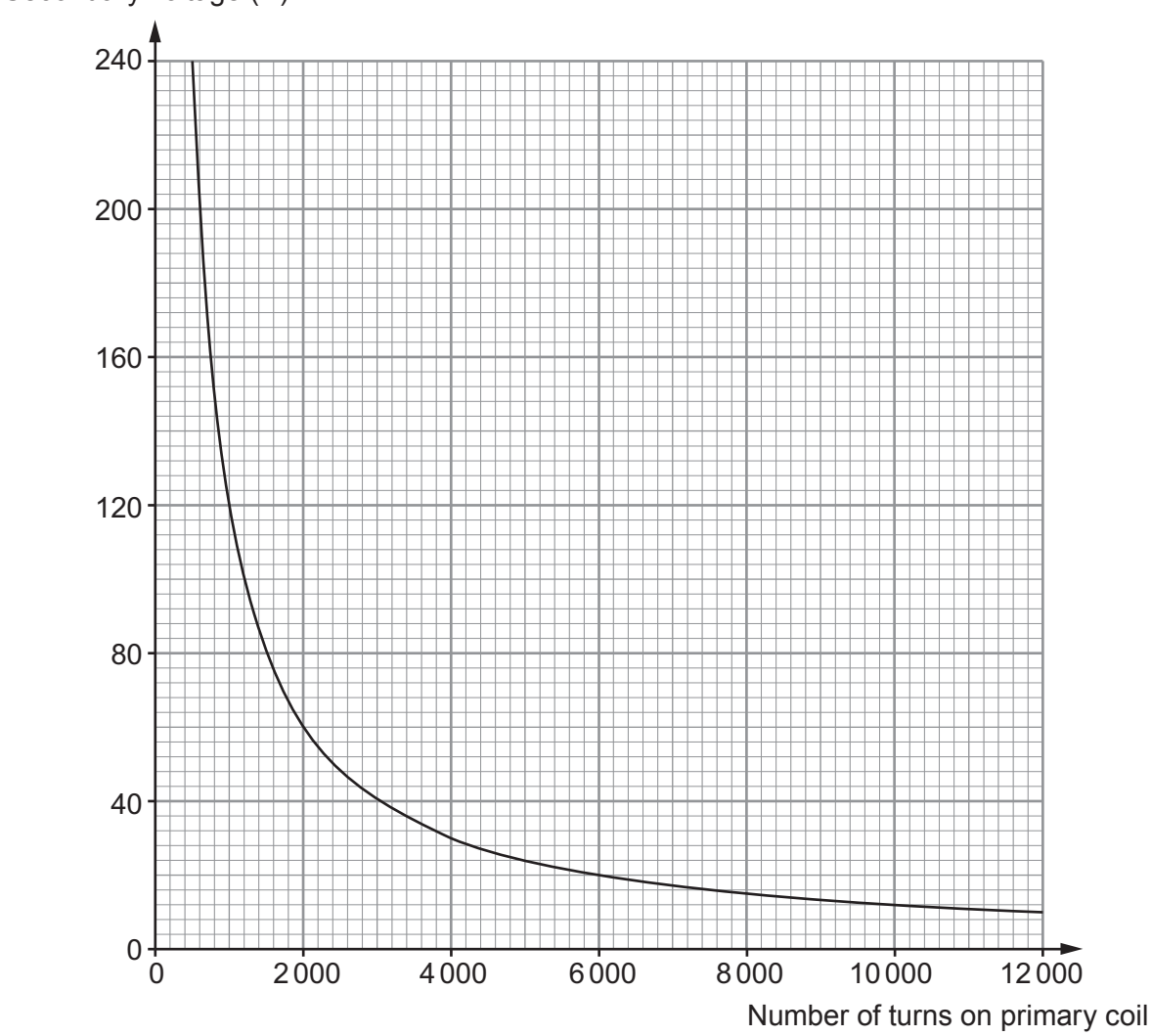
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(b) This transformer has a **fixed** number of turns on its **secondary coil**. The number of turns on its **primary coil** can be changed. This affects the **secondary voltage** in the way shown on the graph below.



(i) Describe how the secondary voltage changes as the number of turns on the primary coil is increased. [2]

.....

.....

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(ii) The voltage on the primary coil is 400 V. Use an equation from page 2 and a pair of readings from the graph to calculate the number of turns on the **secondary coil**. [2]

number of turns = ...

(iii) When the primary coil has 1 000 turns, it is used to power a 480 W heater that is connected to the secondary coil. Use the graph and an equation from page 2 to calculate the current in the secondary coil. [3]

current = ... A

(iv) **Draw a line** on the grid opposite, to show how the secondary voltage would change with the number of turns on the primary coil if this transformer had fewer turns on its secondary coil. [1]

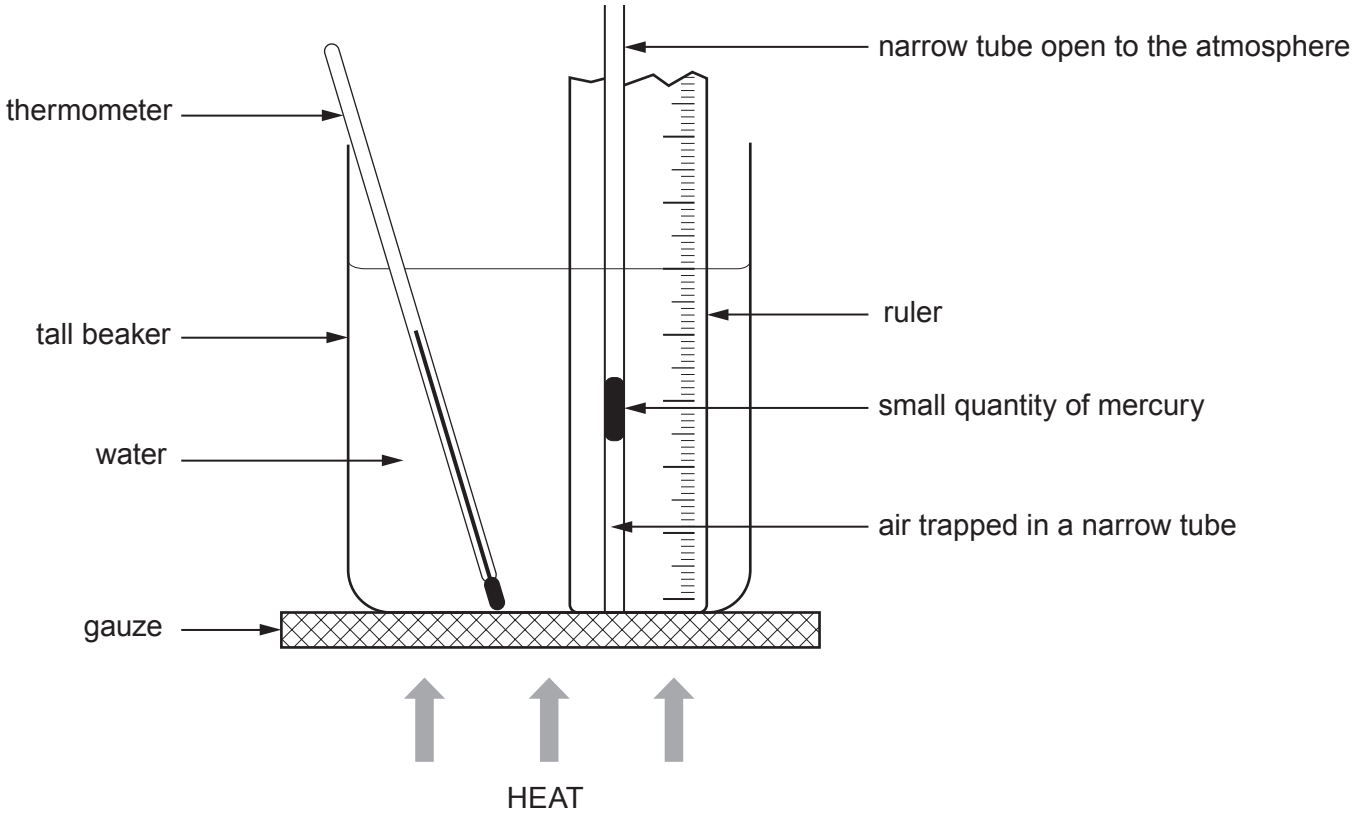
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5.



(a) In a class experiment the volume of a mass of air changed when it was heated. The air is shown contained in a narrow tube which is open to the atmosphere. The length of trapped air in the tube (which indicates its volume) was measured as the temperature of the water was changed. The results are shown in the table below.

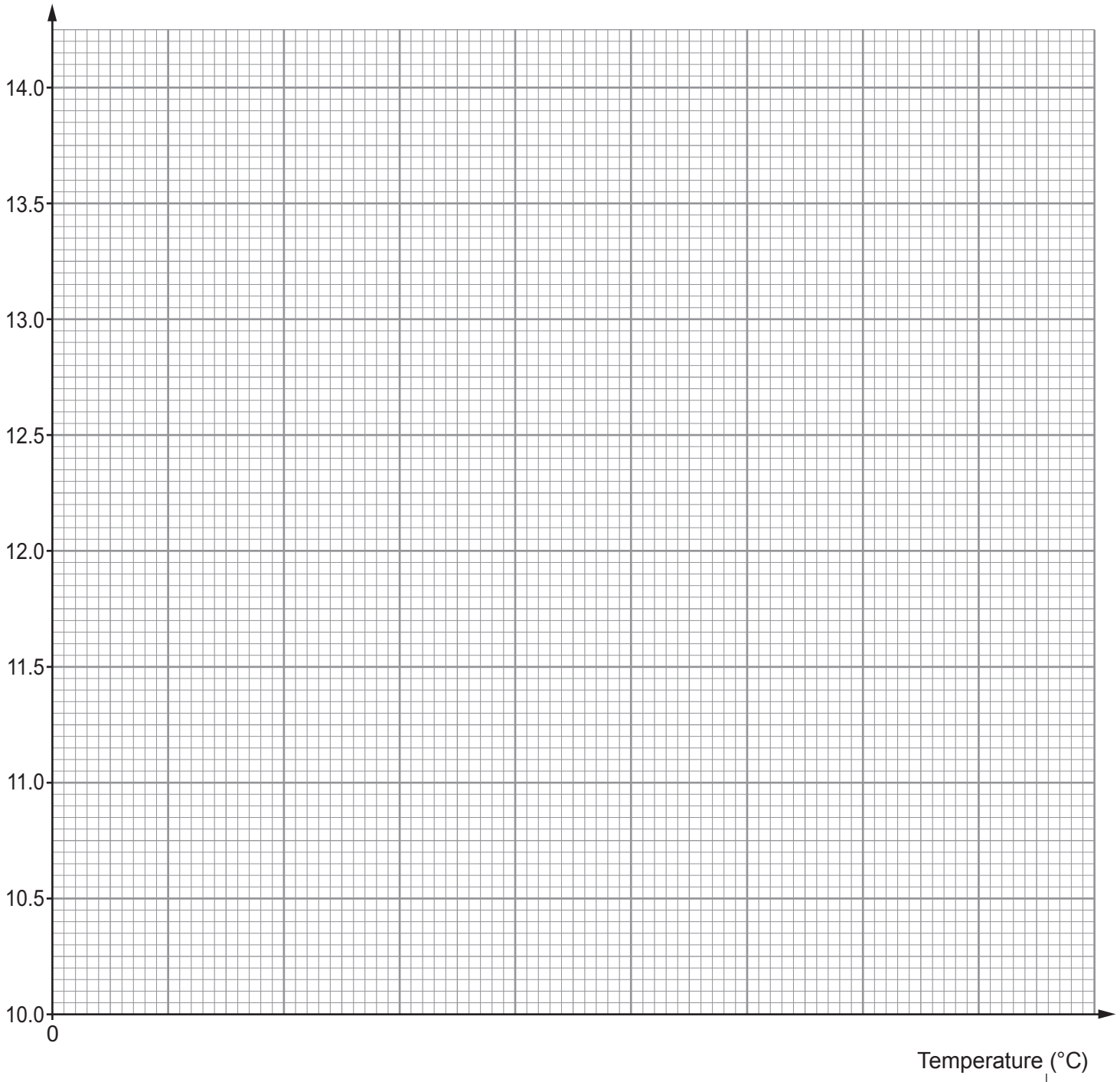
Temperature (°C)	Length of trapped air (cm)
10	10.7
25	11.2
40	11.8
55	12.4
70	12.9
85	13.5

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(i) Plot these results on the grid below and draw a suitable line. [3]
(Note that the scale on the length of trapped air axis does not start at zero.)



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(ii) How does the value of the kinetic energy of the gas particles change as the temperature decreases? [1]

.....

.....

(iii) State the value of the kinetic energy of the gas particles at –273 °C (absolute zero). [1]

kinetic energy = ... J

(b) A butane gas cylinder is kept in a garage where, in the winter, it is at a temperature of – 3 °C. The pressure in the cylinder is 3.0×10^6 N/m^2. In a hot summer, the temperature increases to 42 °C, whilst the **volume** of the gas remains constant.
Use an equation from page 2 to find whether the cylinder is in danger of exploding in the hot summer if the maximum pressure that the container can withstand is 4.0×10^6 N/m^2.
Comment on your answer. [4]

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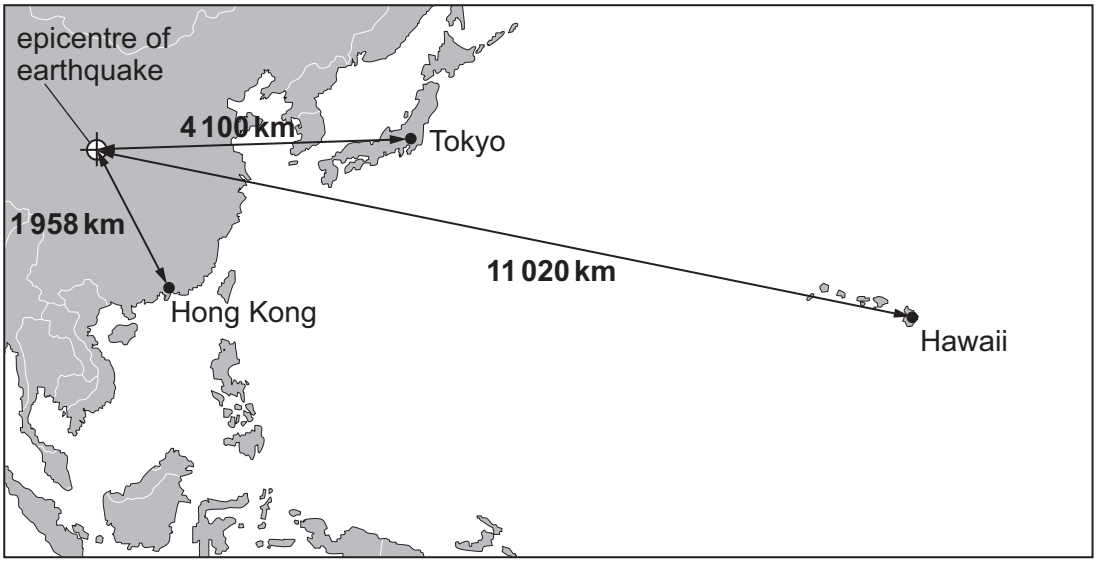
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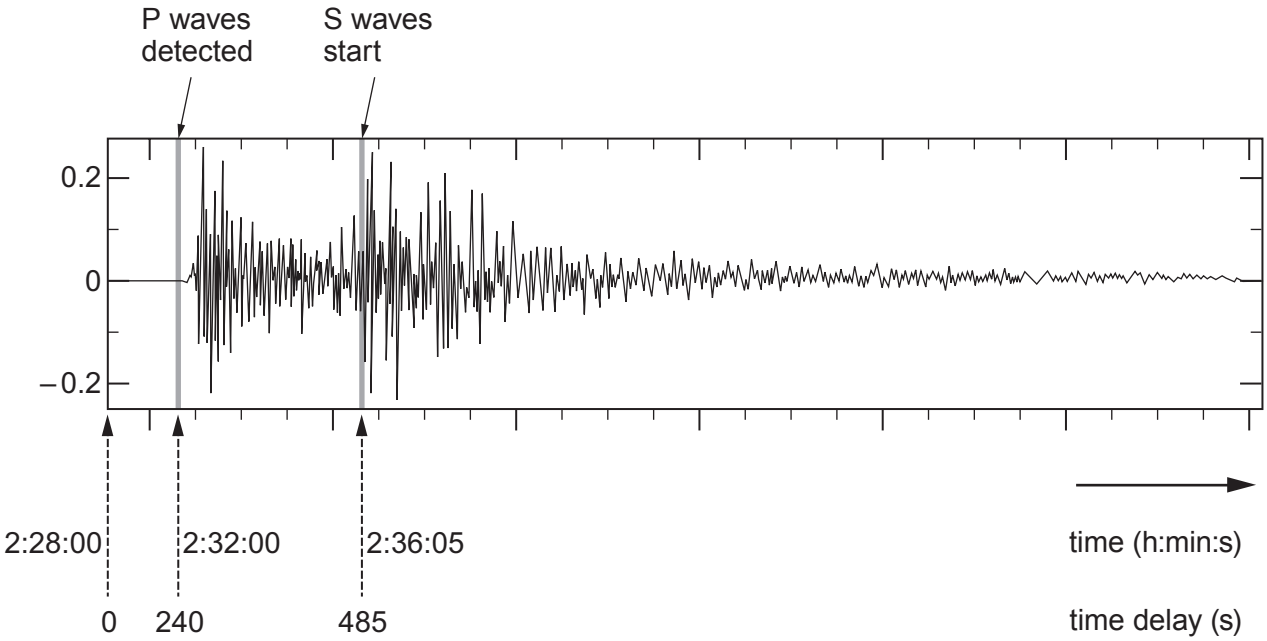
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6. The map below shows the epicentre of an earthquake which occurred in China at exactly 2:28 p.m. on 16 December 2013. The positions of seismic recording stations in Tokyo, Hawaii and Hong Kong are also shown. The trace produced by the Hong Kong station is shown below the map.



Hong Kong station trace



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Use information from the map and the Hong Kong station trace, to answer the following questions.

(a) Use an equation from page 2 to calculate the speed of the P waves travelling from the epicentre to Hong Kong. Give your answer in km/s. [3]

speed = ... km/s

(b) Explain what similarities and differences you would expect between the Hong Kong, Hawaii and Tokyo station traces. [6 QWC]

Include in your answer:

- statements describing how the traces would be different;
- statements describing how the traces would be similar;
- calculations showing how the greater distances affect parts of the traces.

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TURN OVER FOR THE LAST PART OF THE QUESTION

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(c) A student calculates the speed of P waves for another earthquake in the San Francisco area and finds that it is different. Suggest a reason why this might be the case. [1]

.....

.....

10

END OF PAPER

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GCSE MARKING SCHEME

SCIENCE - PHYSICS

SUMMER 2015

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INTRODUCTION

The marking schemes which follow were those used by WJEC for the Summer 2015 examination in GCSE SCIENCE - PHYSICS. They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conferences was to ensure that the marking schemes were interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

		Page
Physics 1	Foundation Tier	1
	Higher Tier	7
Physics 2	Foundation Tier	14
	Higher Tier	22
Physics 3	Foundation Tier	29
	Higher Tier	36

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PHYSICS 3 Summer 2015
Foundation Tier

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
1		(a)			2	Hydrogen (1) Helium (1)	H He		h HE he
		(b)			4	LHS: red giant (1), white dwarf (1) RHS: supernova (1), black hole (1)			Any words not in box
		Total Mark			6				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
2		(a)			2	Appropriate field lines on both sides (at least 2 above and 2 below) (1) Direction arrows (north → south) (1)	Lines that touch / cross at the poles		Crossing or touching lines above and/or below Lines that don't start at either pole
		(b)	(i)		3	1 mark for each one correct. Upwards moving wire – points to +2 Other 2 diagrams – points to 0			
			(ii)		2	Move the metal rod faster / quicker (1) Make the magnets stronger / stronger magnetic field (1)	Move magnets closer together / more conductive metal bar / wider magnet / thicker metal bar / shorter metal bar		Use a coil of wire, bigger magnet, longer metal bar / more metal bars / curved magnets
		(c)	(i)		1	Alternates between + and -			The ammeter needle keeps moving back and fore / up and down / it will change
			(ii)		2	The wire moves up through the field and then down/changes its direction of travel through the field (1) So current is <u>induced / generated</u> one way and then the other (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	Wire cuts field to induce a current (1)		
		Total Mark			10				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
3		(a)	(i)		2	27 (1) 350 (1)			
			(ii)		3	Plots (2) no tolerance allow **ecf** on 350 K Straight line joining plotted points (1) ± ½ small square tolerance	A curve if **ecf** applied for the last point		
			(iii)		2	Show the line extended backwards **to the origin** (1) Reading of pressure consistent with their intercept (1)	1 mark if answer of 0 with no extrapolated line shown		Answer of 0 if extrapolated line does not go through 0
			(iv)		2	Pressure increases with temperature / positive correlation (1) In a uniform way (1)	Award 2 marks: [Directly] proportional / as one doubles the other doubles too		
		(b)			2	12 (1) × 80 = 960 [N] (1)			
		Total Mark			11				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
4		(a)			2	Ticks in bottom 2 boxes Lose 1 mark for each extra tick			
		(b)			3	Any number of TIR shown (1) **or** 3 TIR shown (2) Straight line joining outgoing ray (1)			
		(c)			4	Refract (1) Travel along the boundary (1) Totally internally reflect / TIR (1) Totally internally reflect / TIR (1)			
		Total Mark			9				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
5		(a)	(i)		2	0.1 × 8 (1) 0.8 [kg m/s] (1)			
			(ii)		1	- 0.6 [kg m/s]			+0.6
			(iii)		1	Total momentum before collision = + 0.2 [kg m/s] (**ecf** from parts (i) &(ii) probably giving an answer of +1.4)			
			(iv)		1	Same answer as (iii)			
			(v)		2	$v_B = \frac{0.2}{0.2}$ 1 mark for the numerator (**ecf** from (iv)) 1 mark for the denominator (i.e. 0.2)	If no workings shown: Award 2 marks for an answer of 1 [m/s] Award 2 marks for an answer of 7 [m/s] when **ecf** applied		
		(b)	(i)		2	$t = \frac{(0-8)}{-160}$ 1 mark for the numerator of (0 - 8) **or** (8 - 0) 1 mark for the denominator of -160 **or** 160 respectively	If no workings shown: Award 2 marks for an answer of 0.05 Award 1 mark for an answer of -0.05		
			(ii)		2	Force = 1.6 [N] (1) To the left / opposite [direction to force applied to B] (1)	In the negative vector / velocity direction (for second mark) Accept = -1.6 [N] for both marks Award 1 mark for: force on A is equal and opposite / same size and opposite		Force is backwards / same size
		Total Mark			11				

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
6		(a)	(i)		1	Gravity **and** radiation / pressure			
			(ii)		1	Forces are balanced / they are balanced	Equal and opposite / forces cancel each other out		The same / equal / because it has a supply of hydrogen / its balanced
		(b)	(i)		1	$^{1}_{1}\mathrm{H} + {}^{1}_{1}\mathrm{H} + {}^{1}_{1}\mathrm{H} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{0}_{1}\mathrm{e} + {}^{0}_{1}\mathrm{e}$	$4\,{}^{1}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + 2\,{}^{0}_{1}\mathrm{e}$		
			(ii)		3	<u>Four</u> hydrogen [nuclei] / protons <u>join / fuse</u> (1) to form a helium [nucleus] (1) and <u>two</u> positrons (1)	Antielectron instead of positron		Positive electron / react / bond / collide / alpha particle
		(c)			1	Energy / gamma is released	They annihilate / destroy each other / cancel each other out	An explosion takes place	They neutralise each other
		Total Mark			7				

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Question Number				
FT	HT	Sub-section	Mark	Answer
7			6	**Indicative content:** Conduction in solids occurs because the atoms are regularly positioned and are close together. The atoms in the hot part of the solid vibrate faster than those elsewhere. They pass on their energy to their neighbours by collisions and so the energy travels through the solid. In metals this is improved by free electrons which move at speed from the hot region, colliding with metal ions in the lattice, transferring their energy in the process. Convection occurs in gases because the particles in the hotter region have more energy and push each other further apart in violent collisions. This region becomes less dense and rises above the cooler region setting up a circulating current, transferring thermal energy to all parts of the gas. **5-6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3-4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1-2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.
		Total Mark	6	

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PHYSICS 3 Summer 2015
Higher Tier

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	1	(a)	(i)		2	0.1 × 8 (1) 0.8 [kg m/s] (1)			
			(ii)		1	- 0.6 [kg m/s]			+0.6
			(iii)		1	Total momentum before collision = + 0.2 [kg m/s] (**ecf** from parts (i) &(ii) probably giving an answer of +1.4)			
			(iv)		1	Same answer as (iii)			
			(v)		2	$v_B = \frac{0.2}{0.2}$ 2 mark for the numerator (**ecf** from (iv)) 1 mark for the denominator (i.e. 0.2)	If no workings shown: Award 2 marks for an answer of 1 [m/s] Award 2 marks for an answer of 7 [m/s] when **ecf** applied		
		(b)	(i)		2	$t = \frac{(0-8)}{-160}$ 1 mark for the numerator of (0 - 8) **or** (8 - 0) 1 mark for the denominator of -160 **or** 160 respectively	If no workings shown: Award 2 marks for an answer of 0.05 Award 1 mark for an answer of -0.05		
			(ii)		2	Force = 1.6 [N] (1) To the left / opposite [direction to force applied to B] (1)	In the negative vector / velocity direction (for second mark) Accept = -1.6 [N] for both marks Award 1 mark for: force on A is equal and opposite / same size and opposite		Force is backwards / same size
		(c)			3	Before KE = ($\frac{1}{2}$ × 0.1 (8^2)) +($\frac{1}{2}$ × 0.2 (3^2)) = 3.2 + 0.9 = 4.1 [J] (1) After KE = 0 +($\frac{1}{2}$ × 0.2 (1^2)) = 0.1 [J] (1) **ecf** from (a)(v) KE lost = 4.1 – 0.1 = 4.0 [J](1) N.B. **ecf** from (a)(v) gives KE = 0 +($\frac{1}{2}$ × 0.2 (7^2)) = 4.9 [J] and energy loss = -0.8 [J]	Award mark for correct subtraction where energies are wrong		Final answer of 0.8 from **ecf**s (Award 2 max for KE calculations)
		Total Mark			14				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	2	(a)	(i)		1	Gravity **and** radiation / pressure			
			(ii)		1	Forces are balanced / they are balanced	Equal and opposite / forces cancel each other out		The same / equal / because it has a supply of hydrogen / its balanced
		(b)	(i)		1	$^{1}_{1}\mathrm{H} + {}^{1}_{1}\mathrm{H} + {}^{1}_{1}\mathrm{H} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{0}_{1}\mathrm{e} + {}^{0}_{1}\mathrm{e}$	$4\,{}^{1}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + 2\,{}^{0}_{1}\mathrm{e}$		
			(ii)		3	Four hydrogen [nuclei] / protons join / fuse (1) to form a helium [nucleus] (1) and two positrons (1)	Antielectron instead of positron		Positive electron / react / bond / collide / alpha particle
			(iii)		3	Mass on left hand side = $4 \times 1.00728 = 4.02912$ (1) [Mass on right hand side = 4.00151] Mass defect = 4.02912 **ecf** – 4.00151 = 0.02761 [u] (1) $E = mc^2$ =0.02761 **ecf** $\times 1.66 \times 10^{-27}$ $= 4.58326 \times 10^{-29}$ [kg] (1) $\times (3 \times 10^{8})^2 = 4.12 \times 10^{-12}$ [J] (1) **Alternative solution:** LHS: $4 \times 1.00728 = 4.02912$ (1) 4.02912 **ecf** $\times 1.66 \times 10^{-27} = 6.6883392 \times 10^{-27}$ [kg] **and** RHS: $4.00151 \times 1.66 \times 10^{-27} = 6.6425066 \times 10^{-27}$ [kg] (1) LHS: 6.6883392 **ecf** $\times (3 \times 10^{8})^2 = 6.01950528 \times 10^{-10}$ [J] **and** RHS: $6.6425066 \times (3 \times 10^{8})^2 = 5.97825594 \times 10^{-10}$ [J] (1) Energy loss = (6.01950528 - 5.97825594) $\times 10^{-10}$ J $= 4.12 \times 10^{-12}$ [J] (1)			
		(c)			1	Energy / gamma is released	They annihilate / destroy each other / cancel each other out	An explosion takes place	They neutralise each other
		Total Mark			11				

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Question Number				
FT	HT	Sub-section	Mark	Answer
	3		6	**Indicative content:** Conduction in solids occurs because the atoms are regularly positioned and are close together. The atoms in the hot part of the solid vibrate faster than those elsewhere. They pass on their energy to their neighbours by collisions and so the energy travels through the solid. In metals this is improved by free electrons which move at speed from the hot region, colliding with metal ions in the lattice, transferring their energy in the process. Convection occurs in gases because the particles in the hotter region have more energy and push each other further apart in violent collisions. This region becomes less dense and rises above the cooler region setting up a circulating current, transferring thermal energy to all parts of the gas. **5-6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3-4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1-2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.
		Total Mark	6	

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	4	(a)			2	Full core drawn so as to pass inside both coils and labelled IRON CORE (1) Function is to take the magnetic field [from the primary coil] into the secondary coil / linking the magnetic field of primary and secondary coils (1)	To increase the field strength through the secondary coil		A half core drawn or a single line drawn Links the two coils for the 2nd mark
		(b)	(i)		2	As the number of turns on the input coil increases, the output voltage decreases (1) at a decreasing rate (1)	Award 1 mark for negative correlation Award 2 marks for inversely proportional		….in a non-linear way / non-uniform way / reference to the gradient
			(ii)		2	$\frac{400}{60} = \frac{2\,000}{N_2}$ (e.g. using paired values from graph) (1-subs) $N_2 = 2\,000 \times \frac{60}{400} = 300$ (1-ans)			
			(iii)		3	(1-for 120 from graph) $P = VI$ so $I = \frac{480}{120}$ (1-substitution) $I = 4$ [A] (1-manipulation and answer)	$480 = 120 \times I$ gets first 2 marks Use of voltage value between 0 – 230 V		
			(iv)		1	Line drawn to the left and always below the line that is given in the question			Any touching of the original line
		Total Mark			10				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	5	(a)	(i)		3	Scale added to temperature axis in 10 °C intervals (1) Points ± ½ small square division (1) Best fit straight line with some points either side (1)			
			(ii)		1	Decreases			0 K
			(iii)		1	0 [J]			
		(b)			4	$T_1 = 270$ K, $T_2 = 315$ K $p_1 = 3 \times 10^6$, $p_2 = ?$ $p_2 = p_1 \times \frac{T_2}{T_1} = 3 \times 10^6 \times \frac{315}{270}$ (1 – temp conversions) (1 – substitution) $p_2 = 3.5 \times 10^6$ (1- manipulation and answer) Comment which is dependent on their calculation (1) e.g. if correct answer – no danger of explosion stated	$\frac{p_1}{T_1} = \frac{p_2}{T_2}$ $\frac{3 \times 10^6}{-3} = \frac{p_2}{42}$ $p_2 = -42 \times 10^6$ [Pa] No danger of explosion Award: 0 for Kelvin conversion 1 for substitution of - 3 °C 1 for answer **with** negative sign 1 for correct comment based on their answer		
		Total Mark			9				

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Question Number								
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	6	(a)			3	Speed = $\frac{1958\mathbf{(1)}}{240\mathbf{(1)}}$ = 8.1583 / 8.16 [km/s] (1)	8.2 [km/s]		8.15 [km/s]
		(b)			6	**Indicative content:** Similarities: • P and S waves will both arrive at Tokyo and Hawaii. • P waves will always arrive before S waves. Differences: • Tokyo and Hawaii traces will start later than Hong Kong because they have further to travel. Tokyo calculation for arrival of P waves: Time = $\frac{4\,100}{8.16}$ **ecf** = 502.6 s (8.4 min) [so trace starts at 2:36:24] Hawaii Calculation: Time = $\frac{11020}{8.16}$ **ecf** = 1351 s (22.5min) [so trace starts at 2:50:31] • Tokyo trace to have a greater gap (than Hong Kong trace) between P and S waves arriving. Hawaii trace to have an even longer gap between P and S waves arriving. <u>Delay Calculations</u>: From Hong Kong data: Speed of S wave: $\frac{1958}{485}$ = 4.04 km/s Tokyo time for S waves: $\frac{4\,100}{4.04}$ = 1 015.6 [s] [So Tokyo lag time: 1 015.6 – 502.6 = 513 [s]] Hawaii time for S waves: $\frac{11020}{4.04}$ = 2 729 [s] [So Hawaii lag time: 2 729 – 1 351 = 1 378 [s]] Amplitude at Tokyo less than Hong Kong and less still at Hawaii (These figures are within a range of 30 s depending on rounding off.)			

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	6					**5-6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3-4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1-2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.			
		(c)			1	The earth in San Francisco may have a different stiffness or different density.	Incorrect change in velocity for a correct property. Waves travel faster in some rocks than others.		Different materials
		Total Mark			10				

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4503/02

PHYSICS

PHYSICS 3
HIGHER TIER

P.M. MONDAY, 19 May 2014

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**12**	
2.	**6**	
3.	**11**	
4.	**11**	
5.	**8**	
6.	**12**	
Total	**60**	

4503
020001

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.
You are reminded of the necessity for good English and orderly presentation in your answers.
A list of equations is printed on page 2. In calculations you should show all your working.
You are reminded that assessment will take into account the quality of written communication (QWC) used in your answers to questions **3***(a)* and **6***(c)*.

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Equations

V_1 = voltage on the primary coil V_2 = voltage on the secondary coil N_1 = number of turns on the primary coil N_2 = number of turns on the secondary coil	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$
power = voltage × current	$P = VI$
speed = $\frac{\text{distance}}{\text{time}}$	
u = initial velocity v = final velocity t = time a = acceleration x = displacement	$v = u + at$ $v^2 = u^2 + 2ax$ $x = ut + \frac{1}{2}at^2$ $x = \frac{1}{2}(u + v)t$
momentum = mass × velocity	$p = mv$
kinetic energy = $\frac{\text{mass} \times \text{speed}^2}{2}$	$KE = \frac{1}{2}mv^2$
pressure = $\frac{\text{force}}{\text{area}}$	$p = \frac{F}{A}$
	$T / \text{K} = \theta / ^\circ\text{C} + 273$
p = pressure V = volume T = kelvin temperature	$\frac{pV}{T}$ = constant
density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
	$E = mc^2$

SI multipliers

Prefix	Multiplier
p	10^{-12}
n	10^{-9}
μ	10^{-6}
m	10^{-3}

Prefix	Multiplier
k	10^{3}
M	10^{6}
G	10^{9}
T	10^{12}

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Answer **all** *questions.*

1. A balloon is filled with 2.0 m^3 of helium and released. The following table shows data for the balloon as it rises.

Height of balloon above the ground (km)	Volume of balloon (V) (m^3)	Helium pressure (p) (kN/m^2)	pV (kN m)
0	2.0	100	200
2	2.4	80	.....
4	3.0	60	180
6	3.6	50	180
8	4.4	40	176
10	5.8	30	174
12	8.1	.....	162

(a) (i) **Complete** the table. [2]

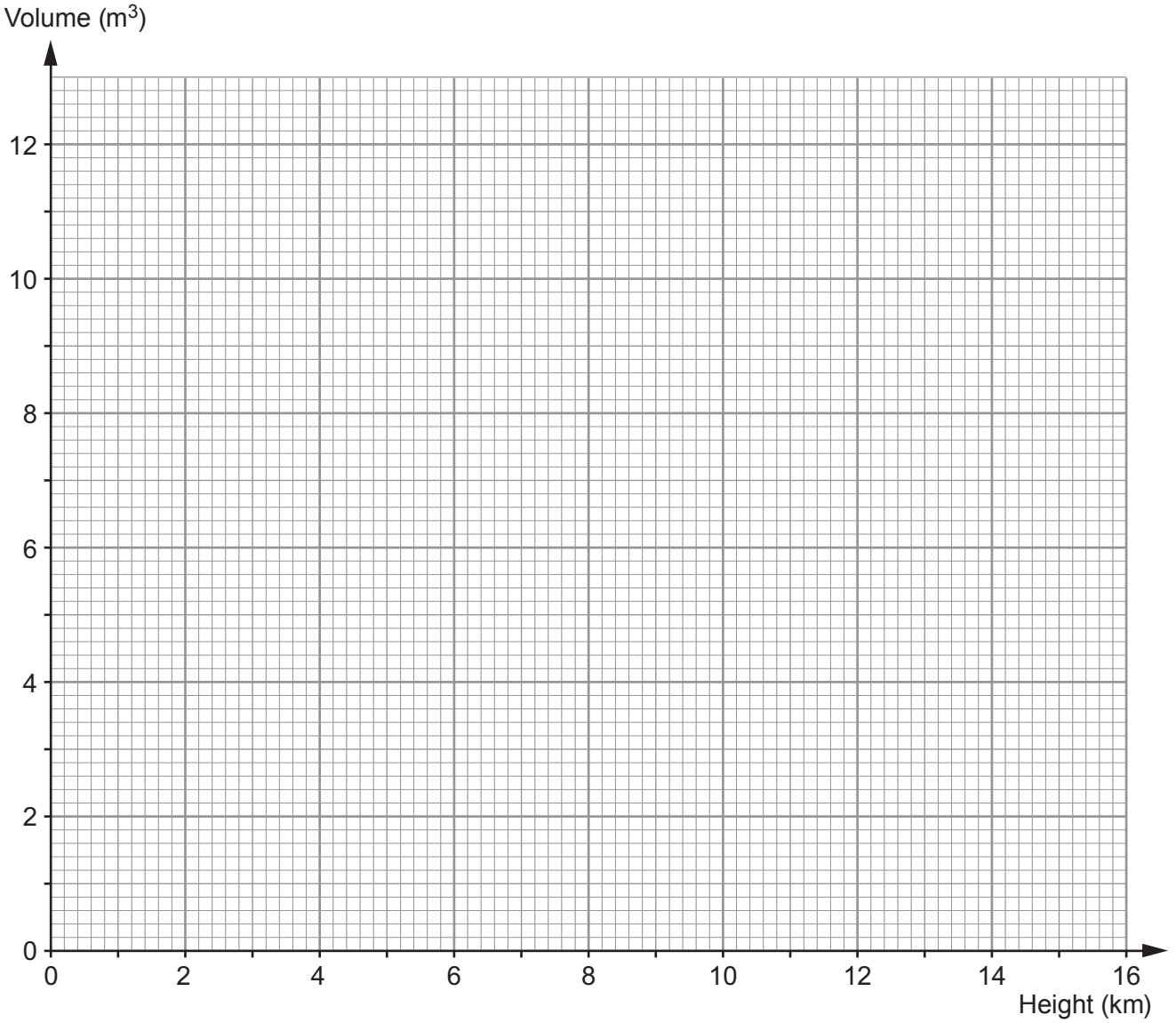
(ii) Use the data in the table to plot a graph of **volume** against **height** of the balloon on the grid opposite. [3]

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(b) (i) Use your graph to describe how the **volume** of the balloon changes as the **height** increases. [2]

.....

.....

.....

(ii) Use the information in the table to give a reason why this volume change occurs. [1]

.....

.....

(iii) The balloon bursts when its volume reaches 12 m^3. **Continue** your graph to estimate at what height this happens. [2]

height = ... km

Turn over.

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(c) The volume of the balloon is also affected by changes in temperature.

(i) State how a decrease in temperature affects the volume of the balloon. [1]

.....

(ii) Give a reason for your answer in terms of molecules. [1]

.....

.....

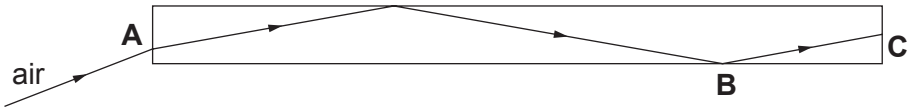
12

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2. The diagram shows the path of a signal through a glass fibre.



(a) State the name given to the change in direction of the signal: [2]

(i) at **A**; .....

(ii) at **B.** .....

(b) (i) Give a reason why the signal changes direction at **A**. [1]

.....

.....

(ii) State the **two** conditions needed for the signal to change direction at **B**. [2]

1. .....

2. .....

(c) **Add** a line to the diagram to show how the signal leaves the glass fibre at **C**. [1]

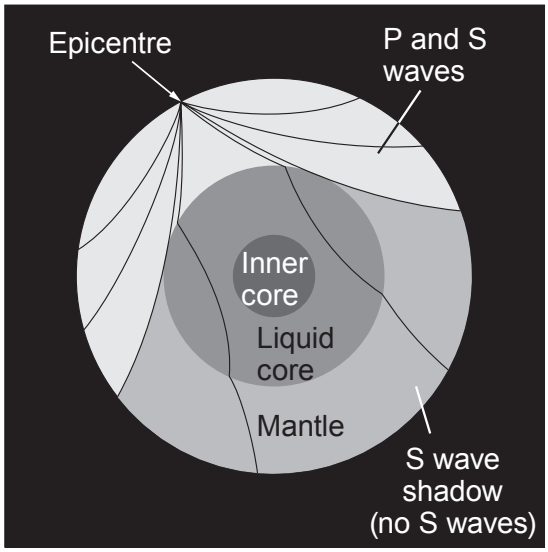
6

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3. *(a)* Use the diagram below **and** your knowledge to compare the properties of seismic P waves, S waves and surface waves. [6 QWC]



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(b) By looking at the seismograms from different monitoring stations we can find out their distances from the epicentre of the earthquake. The signals arriving at 3 stations named as STN 1, STN 2 and STN 3 are shown below. (STN = station.)

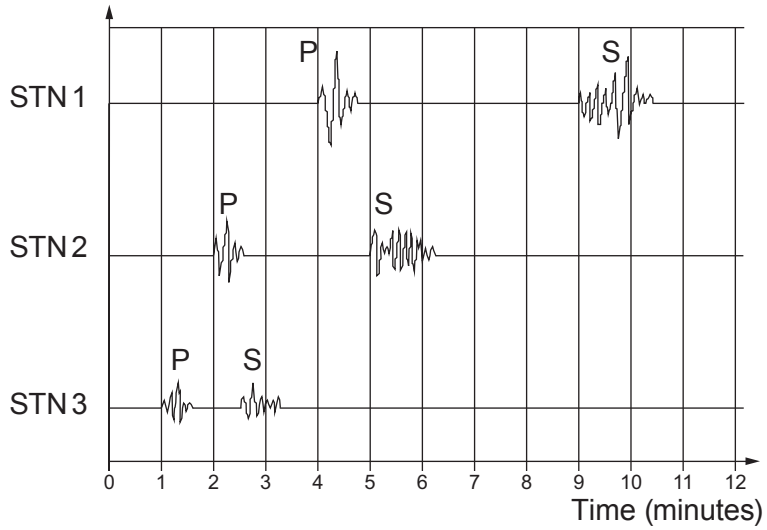
(i) Use the information in the diagram and graph below to find the distance from the STN 2 monitoring station to the epicentre of the earthquake, describing how you arrive at your answer. [2]

.....

.....

STN 2 distance from epicentre = ... km

Plot of arrival of P and S waves at the three different monitoring stations



Distance from epicentre (km)



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(ii) **Describe** how you would determine the position of the epicentre of the earthquake using your answer in *(b)*(i) and the information below. **Show** its position on the diagram below. [3]

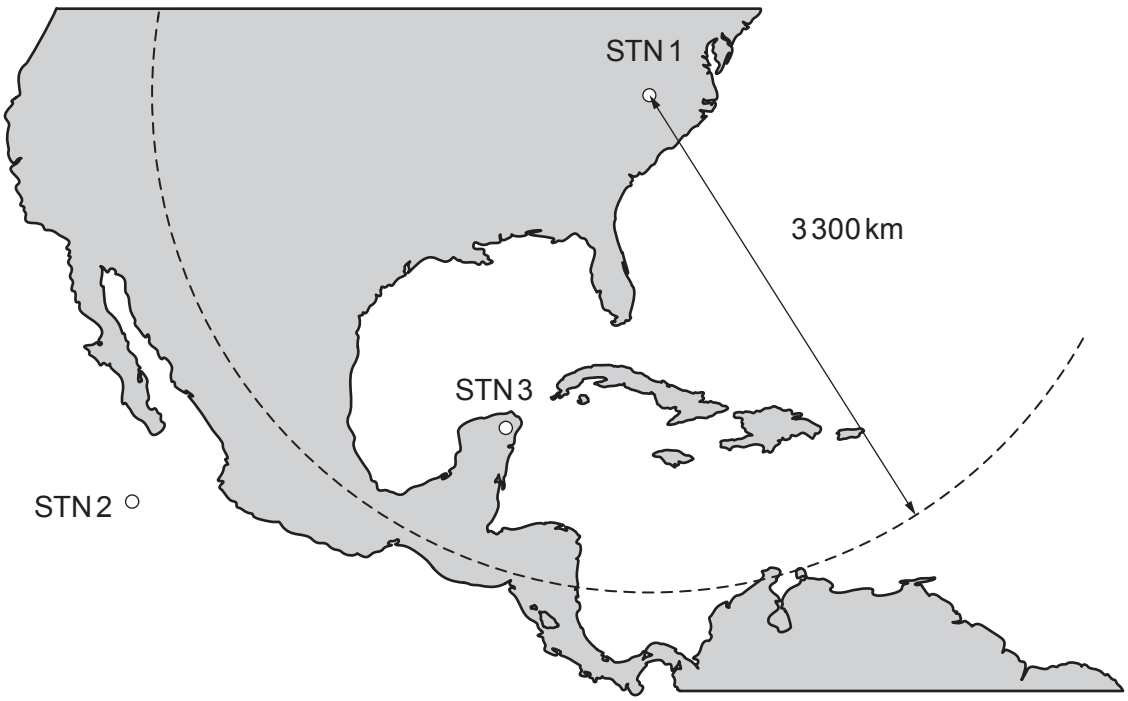
STN 1 distance from epicentre = 3 300 km

STN 3 distance from epicentre = 900 km

.....

.....

.....



Scale: 1 cm to 500 km

11

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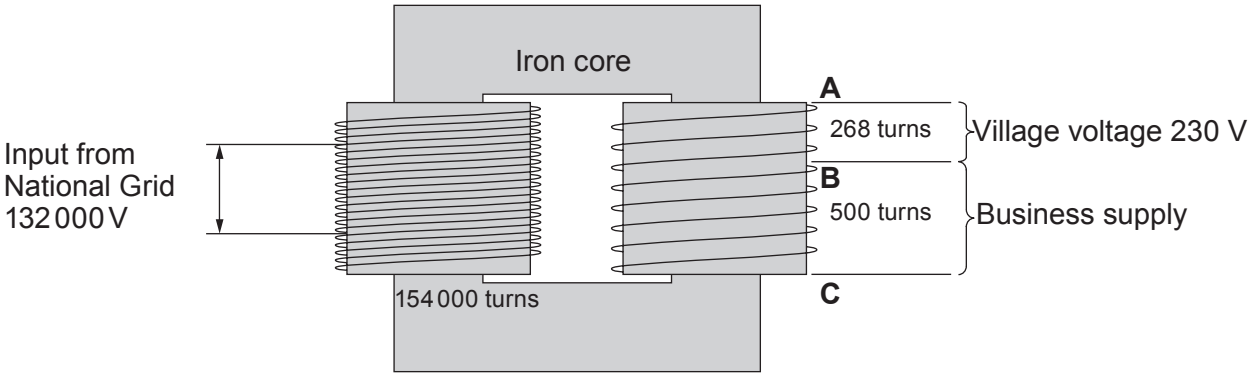
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4. A transformer supplies both a village and a business with electricity from the National Grid. The business and the village need electricity at different voltages so they are connected to different numbers of secondary turns on the iron core of the transformer.



(a) Using an equation from page 2 and information from the diagram calculate the voltage supplied to the business. [3]

business supply voltage = ... V

(b) During a severe storm the connections from the transformer are altered by a falling tree. The **village is now connected to A and C**.

(i) Explain what effect, if any, this would have on the voltage supplied to the village. [2]

.....

.....

.....

(ii) State the effect, if any, you would expect this to have on the village. [1]

.....

(iii) Explain what effect, if any, this would have on the business. [2]

.....

.....

.....

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(c) Describe how a transformer works. [3]

.....

.....

.....

.....

.....

11

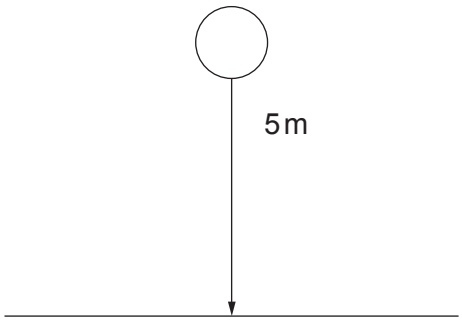
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5. A ball of mass 0.2 kg, initially at rest, is dropped from a height of 5 m.



Use equations from page 2 to answer the following questions.
Assume acceleration due to gravity = 10 m/s^2 and that air resistance is negligible.

(i) Calculate the speed with which the ball hits the ground. [3]

speed = ... m/s

(ii) As the ball rebounds it loses **half of its kinetic energy**. Calculate the rebound speed. [2]

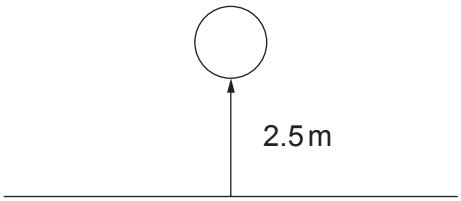
speed = ... m/s

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(iii) The ball rebounds to a maximum height of 2.5 m. Calculate how long it takes to reach this height after it rebounds. [3]



time = ... s

8

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6. *(a)* The Sun produces energy by nuclear fusion. One of the nuclear fusion reactions that takes place in the Sun is shown in the equation below. Complete the equation. [2]

$$\underset{\cdots\cdots}{\overset{\cdots\cdots}{\cdots}}\mathrm{H} + \underset{\cdots\cdots}{\overset{\cdots\cdots}{\cdots}}\mathrm{H} \longrightarrow {}^{3}_{2}\mathrm{He} + \gamma$$

(b) Another nuclear fusion reaction in the Sun is shown below.

$${}^{3}_{2}\mathrm{He} + {}^{3}_{2}\mathrm{He} \longrightarrow {}^{4}_{2}\mathrm{He} + 2\,{}^{1}_{1}\mathrm{p}$$

(i) Use the information below to calculate the difference between the mass of the products and the reactants (i.e. the mass lost in the reaction in atomic mass units u). [2]

Nuclear mass of ${}^{3}_{2}\mathrm{He}$ = 3.014932 u

Nuclear mass of ${}^{4}_{2}\mathrm{He}$ = 4.00151 u

Mass of a proton = 1.00728 u

mass loss = ... u

(ii) Use an equation from page 2 and your answer to (i) to calculate the energy released in this reaction. [2]

1 u = 1.66×10^{-27} kg

$c = 3 \times 10^{8}$ m/s

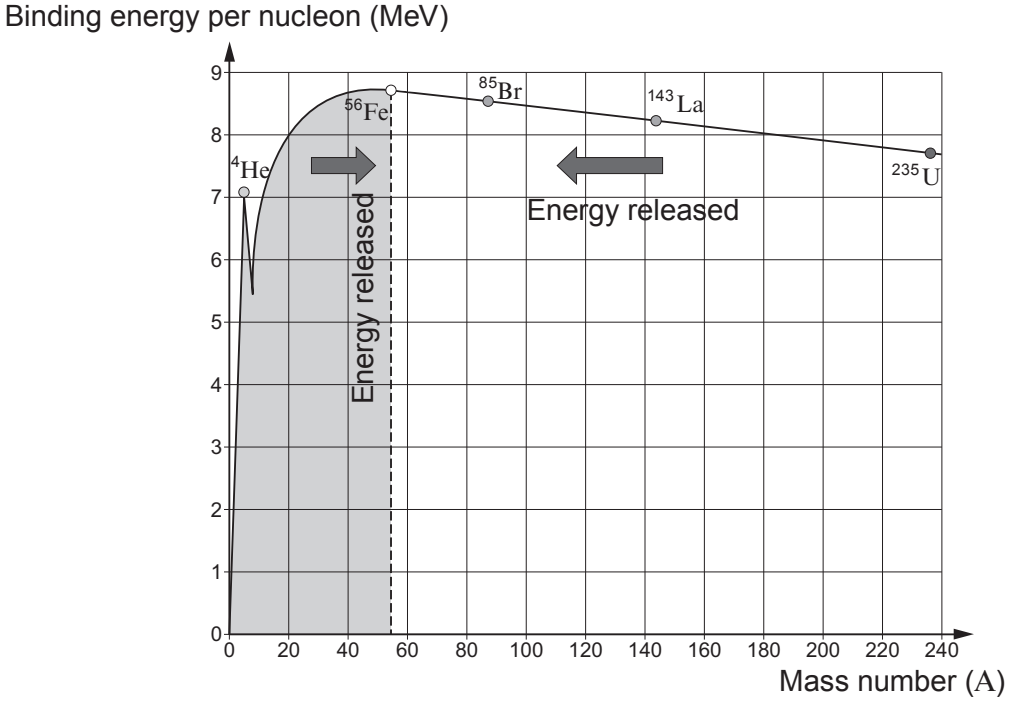
energy released = ... J

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(c) Use the graph below to explain why energy is released in both nuclear fission **and** nuclear fusion. [6 QWC]



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GCSE MARKING SCHEME

SCIENCE - PHYSICS

SUMMER 2014

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INTRODUCTION

The marking schemes which follow were those used by WJEC for the Summer 2014 examination in GCSE SCIENCE - PHYSICS. They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conferences was to ensure that the marking schemes were interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

	Page
Physics 1 - Foundation Tier	1
Physics 1 - Higher Tier	5
Physics 2 - Foundation Tier	11
Physics 2 - Higher Tier	15
Physics 3 - Foundation Tier	19
Physics 3 - Higher Tier	23

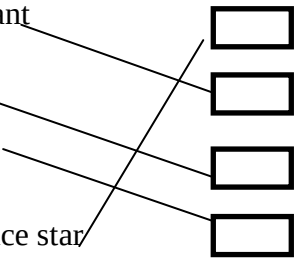
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GCSE Science - Physics 3

Mark Scheme - Summer 2014

FOUNDATION TIER

Question			Marking details	Mark
1.	(a)		circles accept concentric (on its own) or rings. **don't accept** oval or clockwise	1
	(b)		reverses [direction] accept changes direction / anticlockwise / opposite direction. Treat as neutral references to N & S.	1
	(c)		no magnetic field / field disappears / field stops **don't accept** less field	1
			Question total	**[3]**
2.	(a)		red super giant supernova black hole main sequence star  3 marks for all correct 2 marks for 2 or 3 correct 1 mark for 1 correct double lines from or to any box earns no credit	3
	(b)		radiation pressure / gas pressure / pressure / force due to fusion	1
	(c)		fusion (1) helium (1) uranium (1) iron (1)	4
			Question total	**[8]**
3.	(a)	(i)	steps-down	1
		(ii)	440	1
		(iii)	has a changing magnetic field	1
	(b)		**Any 2 ×(1):** changing magnetic field (1) which links (or cuts) the secondary coil / passes through the secondary coil (1) induces a current or voltage (1) **To award both marks both statements must be linked.**	2
			Question total	**[5]**

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Question			Marking details	Mark
4.	(a)		1	1
	(b)		positron / antiparticle of electron / antielectron	1
	(c)		it is negative (accept different charge or opposite charge) **don't accept** it is positive	1
	(d)		annihilate / cancel each other out / destroy each other (1) **don't accept** fuse or neutralise and release energy / creates heat (1) any reference to 2 electrons don't award the 1st mark	2
			Question total	**[5]**
5.	(a)	(i)	momentum = 50 000 × 6 (1-sub) = 300 000 [kg m/s] (1-ans)	2
		(ii)	mass = $\frac{300000}{4}$ (1-sub) mass = 75 000 [kg](1-ans) **ecf from (i)**	2
		(iii)	mass of B = 25 000 [kg] (1-ans) **ecf from (ii)**	1
	(b)	(i)	loss of momentum = 50 000 × 6 – 50 000 × 4 (1-sub) = 100 000 [kg m/s] (1-ans) **Accept** correct calculation for the momentum gain of B.	2
		(ii)	momentum gain = 100 000 [kg m/s] **ecf from (b)(i)**	1
			Question total	**[8]**
6.	(a)		As time increases, velocity increases (**accept** positive correlation) (1) at a uniform rate / uniformly / linearly (1) **don't accept** at a constant speed N.B. "velocity is directly proportional to time" gets 2 marks	2
	(b)	(i)	e.g. $a = \frac{50}{5}$ (Use of paired points for substitution – 1) = 10 [m/s^2](1) If paired points chosen should produce an answer of -10 [m/s^2] **award 1 mark only**	2
		(ii)	$x = \frac{1}{2}(0+40)4$ (1-sub) = 80 [m](1)	2
	(c)		Can't ignore air resistance **or** friction **or** drag / acceleration isn't constant	1
			Question total	**[7]**

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Question			Marking details	Mark
7.	(a)	(i)	192 (1) 20 (1)	2
		(ii)	Correct points plotted – allow ± ½ small square divison on volume axis (2) -1 for each error. Curve of best fit **up to (12,8)** allow ± ½ small square division (1) **don't allow** wispy, wobbly, thick or point to point lines	3
	(b)	(i)	Volume increases as height increases (1) description of curved relationship e.g. increases at an increasing rate **or** gradient increases (1) **Don't accept** non-uniformly / non-linearly / non-proportional	2
		(ii)	[Air] pressure is decreasing	1
		(iii)	Best fit line extrapolated (put tick on graph) (1) Answer consistent with graph (1)	2
	(c)	(i)	[The balloon's volume would] decrease (treat reference to pressure as neutral)	1
		(ii)	As the helium molecules are moving more slowly **or** have less [kinetic] energy / taking longer between collisions / less force applied in each collision / less collisions <u>per second</u> **Don't accept** closer together	1
			Question total	**[12]**
8.	(a)	(i)	Refraction	1
		(ii)	<u>Total internal reflection / TIR</u>	1
	(b)	(i)	Change of speed [at boundary] / change of density **Don't accept** speeds up or lower density	1
		(ii)	Hits the edge at an angle <u>greater than the critical angle **or** greater than 42^o</u> (accept between $41^o - 45^o$) (1) must be travelling [from more dense] to less dense medium (1)	2
	(c)		Emergent straight line should be drawn steeper (put tick or cross on the diagram)	1
			Question total	**[6]**

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Question			Marking details	Mark
9.			**Indicative content:** A surface seismic wave travels across the surface of the Earth as opposed to through it. Surface waves usually have larger amplitudes and longer wavelengths than body waves, and they travel more slowly than body waves do. A P wave is a seismic body wave [that shakes the ground back and forth in the same direction and the opposite direction as the direction the wave to moving]/longitudinal wave. An S wave is a seismic body wave [that shakes the ground back and forth perpendicular to the direction the wave is moving]/transverse wave. S waves do not travel through fluids, [so do not exist in Earth's outer core [or molten rock (magma)]]. S waves travel slower than P waves in a solid and, therefore, arrive after the P wave. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit. **Question total**	6 **[11]**
			Foundation tier paper total	**[60]**

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GCSE Science - Physics 3

Mark Scheme - Summer 2014

HIGHER TIER

Question			Marking details	Mark
1.	(a)	(i)	192 (1) 20 (1)	2
		(ii)	Correct points plotted – allow ± ½ small square divison on volume axis (2) -1 for each error. Curve of best fit **up to (12,8)** (1) allow ± ½ small square divison (1) **don't allow** wispy, wobbly, thick or point to point lines	3
	(b)	(i)	Volume increases as height increases (1) description of curved relationship e.g. increases at an increasing rate **or** gradient increases (1) **Don't accept** non-uniformly / non-linearly / non-proportional	2
		(ii)	[Air] pressure is decreasing	1
		(iii)	Best fit line extrapolated (put tick on graph) (1) Answer consistent with graph (1)	2
	(c)	(i)	[The balloon's volume would] decrease (treat reference to pressure as neutral)	1
		(ii)	As the helium molecules are moving more slowly **or** have less [kinetic] energy / taking longer between collisions / less force applied in each collision / less collisions <u>per second</u> **Don't accept** closer together	1
			Question total	**[12]**
2.	(a)	(i)	Refraction	1
		(ii)	<u>Total internal reflection / TIR</u>	1
	(b)	(i)	Change of speed [at boundary] / change of density **Don't accept** speeds up or lower density	1
		(ii)	Hits the edge at an angle <u>greater than the critical angle **or** greater than 42^{o}</u> (accept between $41^{o} – 45^{o}$) (1) must be travelling [from more dense] to less dense medium (1)	2
	(c)		Emergent straight line should be drawn steeper (put tick or cross on the diagram)	1
			Question total	**[6]**

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Question			Marking details	Mark
3.	(a)		**Indicative content:** A surface seismic wave travels across the surface of the Earth as opposed to through it. Surface waves usually have larger amplitudes and longer wavelengths than body waves, and they travel more slowly than body waves do. A P wave is a seismic body wave [that shakes the ground back and forth in the same direction and the opposite direction to the direction the wave is moving]/longitudinal wave. An S wave is a seismic body wave [that shakes the ground back and forth perpendicular to the direction the wave is moving]/transverse wave. S waves do not travel through fluids, [so do not exist in Earth's outer core [or molten rock (magma)]. S waves travel slower than P waves in a solid and, therefore, arrive after the P wave. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	6

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Question			Marking details	Mark
	(b)	(i)	Describe use of trace to find time delay of 3 mins (1) **Accept** 5 – 2 = 3 mins STN2 distance from epicentre = 2 000 [km] (1) **ecf** from their lag time e.g. lag time of 2.5 mins (0) distance 1 650 [km] (1) If no description present **or** indications on the diagrams only **award 1 mark** maximum.	2
		(ii)	To locate the **earthquake** candidate stated "draw arcs of the appropriate (scaled) radius from the monitoring stations" **or** shown calculations that generate answers of 1.8 cm and 4.0 cm **(ecf) or** these arcs **shown** on the diagram (1) and locate the epicentre where the three circles intersect **or** point of intersection shown on the diagram (1). Reasonable attempt at finding epicentre with 2 (rough) arcs drawn **or** scale lines that cross circle given. (1) N.B. Point only indicated **award 1 mark** only 1 arc shown for STN3 and point indicated **award 2 marks** only	3
			Question total	**[11]**
4.	(a)		Correct substitution into $\frac{V_1}{V_2} = \frac{N_1}{N_2} \rightarrow \frac{132\,000}{V_2} = \frac{154\,000}{50}$ (1) Rearrangement i.e. $V_2 = \frac{132\,000 \times 50}{154\,000}$ (1) 429 [V] (1) accept 428 [V] or 430 [V] **Alternative method:** Substitution of 768 turns (1) Rearrangement to give 659 [V] (1) Subtraction of 230 [V] to give 429 [V] (1)	3
	(b)	(i)	Increased voltage (1) Because of increased number of [secondary] turns (1) **To award both marks both statements must be linked.**	2
		(ii)	Failure of electrical equipment / Overheating of equipment / Fire / fuse blows **ecf from (i)**	1
		(iii)	No effect. (1) Because the ratio of primary to secondary turns for the business remains the same / still connected to B and C (1) **Alternative:** The businesses lose their supply / the voltage falls to 0 (1) because B joins to C (1). **To award both marks both statements must be linked.**	2
	(c)		Alternating input current or voltage (1) creates changing magnetic field (1) links (or cuts) with output coil / induces an [alternating] current / induces an [alternating] voltage (1)	3
			Question total	**[11]**

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Question			Marking details	Mark
5.		(i)	Substitution into $v^2 = u^2 + 2ax$ (1) $u = 0$ (1) $v = 10$ m/s (1) **Alternative method:** t calculated first **OR another alternative method:** PE = $mgh = 0.2 \times 10 \times 5 = 10$ [J] (1) ½ $mv^2 = 10$ [J] (1) then $v = 10$ [m/s] (1)	3
		(ii)	Recognition that v^2 halves i.e. to 50 (1) Therefore new $v = \sqrt{50} = 7[.07]$ [m/s] (1) **Alternative method:** Initial KE = 10 [J] **ecf** so rebound KE = 5 [J] (1) Calculation of $v = 7[.07]$ [m/s] (1)	2
		(iii)	Substitution into $x = ½ (u+v)t$ (1) rearrange so $t = \frac{2.5}{3.5(\text{ecf})}$ (1) Answer = 0.7[1] s (1) Award same format of marks if $x = ut + \ldots$ is used	3
			Question total	**[8]**

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Question			Marking details	Mark
6.	(a)		$^{2}_{1}H$ (1) $^{1}_{1}H$ (1)	2
	(b)	(i)	mass of reactants = (2 × 3.014932) = 6.029864 [u] (1) mass of products = 4.00151 u + (2 × 1.00728) = 6.01607 [u] (1) [mass difference = 0.013794 u] N.B. for 1 proton: mass of products = 5.00879 [u] and [mass difference = 1.021074 u]	2
		(ii)	conversion to kg = 0.013794 (**ecf**) × 1.66 × 10^{-27} = 2.29 × 10^{-29} kg(1) energy calculation to give answer = 2.06 × 10^{-12} [J] (1) N.B. for 1 proton: conversion to kg = 1.69498 × 10^{-27} kg energy = 1.52548 × 10^{-10} [J]	2
	(c)		**Indicative content:** The relationship $E = mc^2$ states the equivalence of mass and energy. Binding energy is the energy equivalent of the mass difference between a whole nucleus and its individual constituent protons and neutrons. As the graph above shows, fusion of light nuclei into heavier nuclei causes an increase in binding energy per nucleon. The product is more stable. In fission heavy nuclei split into lighter nuclei with a higher binding energy per nucleon. The fragments are more stable. In a fusion/fission reaction, the mass difference is converted to energy. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit. **Question total**	6 **[12]**
			Higher tier paper total	**[60]**

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4503/02

PHYSICS

PHYSICS 3
HIGHER TIER

A.M. THURSDAY, 23 May 2013

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**14**	
2.	**13**	
3.	**5**	
4.	**7**	
5.	**6**	
6.	**7**	
7.	**8**	
Total	**60**	

4503
020001

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

You are reminded of the necessity for good English and orderly presentation in your answers.

A list of equations is printed on page 2. In calculations you should show all your working.

You are reminded that assessment will take into account the quality of written communication (QWC) used in your answer to questions **2***(b)*(i) and **7***(b)*.

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Equations

V_1 = voltage on the primary coil V_2 = voltage on the secondary coil N_1 = number of turns on the primary coil N_2 = number of turns on the secondary coil	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$
power = voltage × current	$P = VI$
$\text{speed} = \frac{\text{distance}}{\text{time}}$	
u = initial velocity v = final velocity t = time a = acceleration x = displacement	$v = u + at$ $v^2 = u^2 + 2ax$ $x = ut + \frac{1}{2}at^2$ $x = \frac{1}{2}(u + v)t$
momentum = mass × velocity	$p = mv$
$\text{kinetic energy} = \frac{\text{mass} \times \text{speed}^2}{2}$	$KE = \frac{1}{2}mv^2$
$\text{pressure} = \frac{\text{force}}{\text{area}}$	$p = \frac{F}{A}$
	$T / \text{K} = \theta / ^\circ\text{C} + 273$
p = pressure V = volume T = kelvin temperature	$\frac{pV}{T} = \text{constant}$
$\text{density} = \frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{v}$
	$E = mc^2$

SI multipliers

Prefix	Multiplier
p	10^{-12}
n	10^{-9}
μ	10^{-6}
m	10^{-3}

Prefix	Multiplier
k	10^{3}
M	10^{6}
G	10^{9}
T	10^{12}

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Answer **all** *questions.*

1. *(a)* Complete the sentence below. [2]

The law of conservation of momentum states that in a collision or explosion .....

.....

.....

(b) (i) Two cars of equal mass, 800 kg, collide. Before the collision, car **B** is at rest while car **A** has a constant velocity of 15 m/s. In the questions that follow, ignore the effects of friction.

Before collision

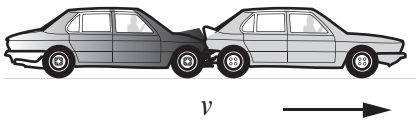


Use an equation from page 2 to calculate the momentum of car **A** before the collision. [2]

Momentum = ... kg m/s

(ii) After the collision, the two cars are stuck together.

After collision



Use the equation:

$$\text{velocity} = \frac{\text{momentum}}{\text{mass}}$$

to calculate the velocity v of the cars after the collision. [3]

Velocity = ... m/s

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(iii) During the collision, car **A** exerts a force of 16000 N to the right on car **B**. What force does car **B** exert on car **A** during the collision? [2]

.....

(c) Use an equation from page 2 to calculate the loss of kinetic energy in the original collision. [2]

Loss of kinetic energy = ... J

(d) Suppose both cars had been travelling towards each other at the same speed.

(i) What would their velocity be after a head-on collision if they stuck together on impact? [1]

.....

(ii) Explain your answer. [2]

.....

.....

14

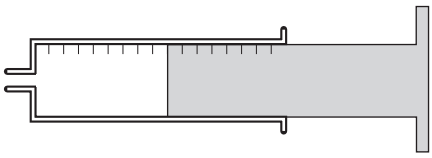
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Turn over.

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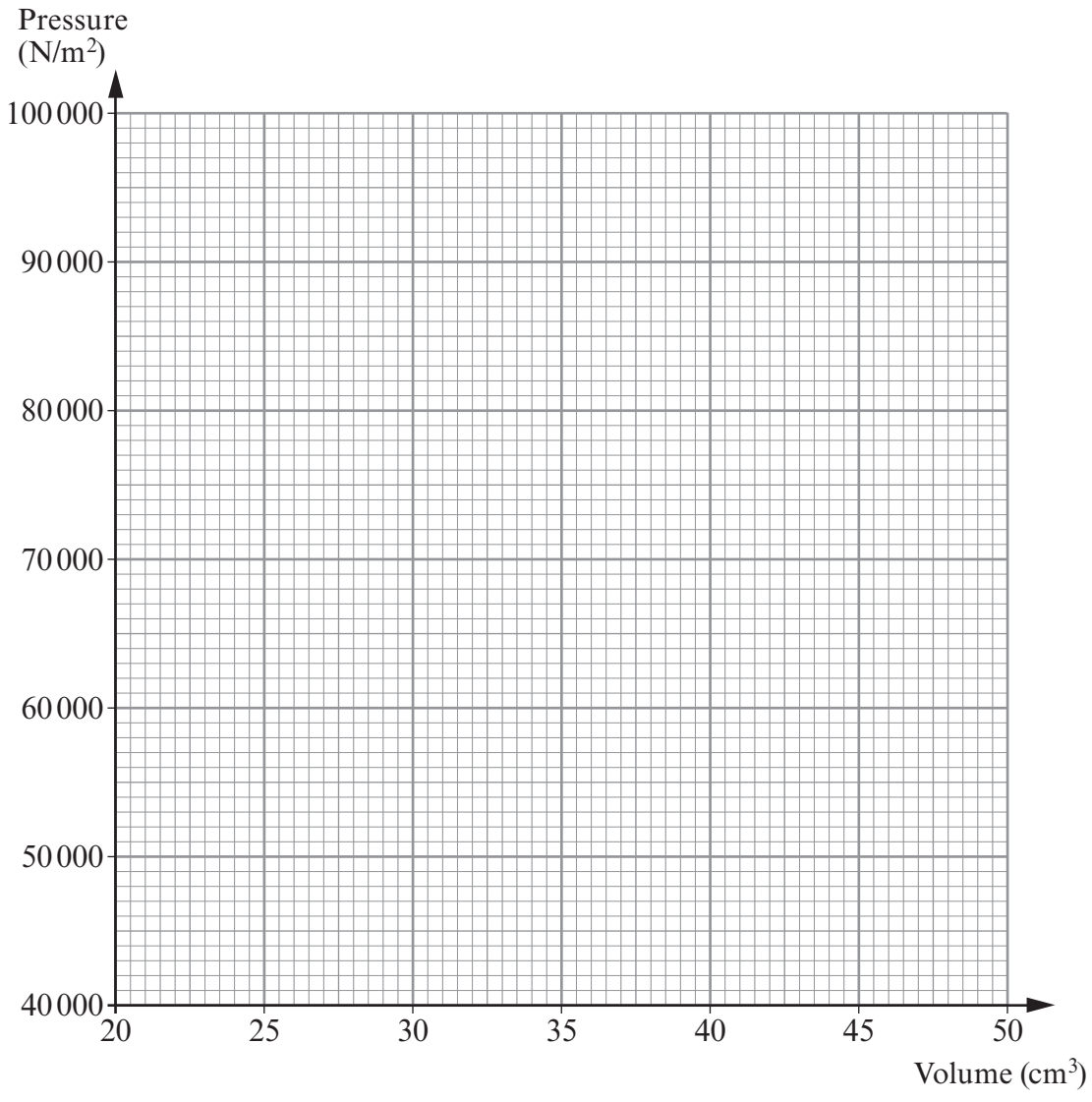
2. A fixed mass of gas is kept at constant temperature in a syringe as shown below.



The gas in the syringe is expanded (made larger) by slowly pulling the plunger out. The table shows the pressure exerted by the gas at different volumes.

Volume (cm^3)	20	25	35	40	50
Pressure (N/m^2)	100 000	80 000	57 000	50 000	40 000

(a) (i) Use the information in the table to **plot a graph** on the grid below. [3]



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(ii) Describe the relationship between the volume and pressure of the gas. [2]

.....

.....

(iii) Use your graph to write down the pressure of the gas when its volume is 30 cm^3. [1]

..... N/m^2

(b) (i) The gas is at constant temperature. Explain in terms of molecular motion and collisions why the pressure changes in the way it does when the volume is increased. (You may want to refer to the diagram on the previous page in your answer.) [6 QWC]

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(ii) State how the motion of a gas molecule would be affected if the temperature of the gas is increased. [1]

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4503 020007

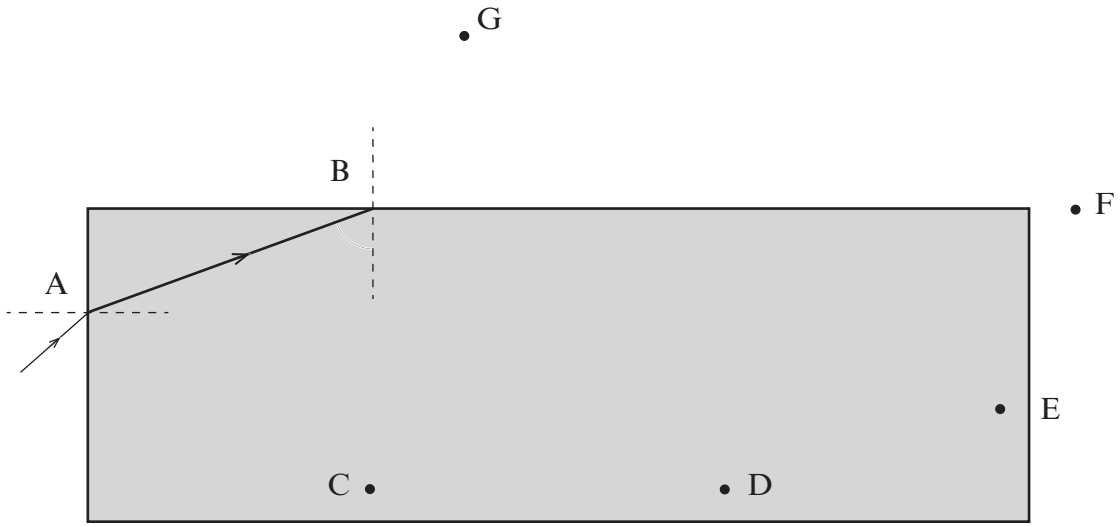
13

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3. The diagram shows a ray of light passing from air, and then into a glass block. The critical angle for glass is 42°.



(a) The ray of light enters the glass block at A in the diagram. Write the name for this change of direction **and** state why the ray follows the path shown. [2]

.....

.....

(b) (i) At point B the ray strikes the glass surface at an angle of 70°. After striking the surface, it goes on to **one of** the points C, D, E, F or G. **Draw the correct ray on the diagram**. [1]

(ii) Give **two** reasons why the ray changes direction in the way you have chosen at B. [2]

.....

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5

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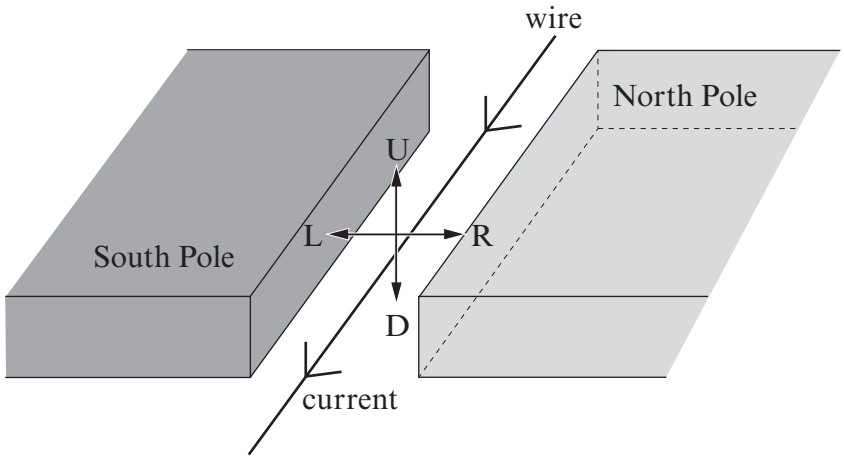
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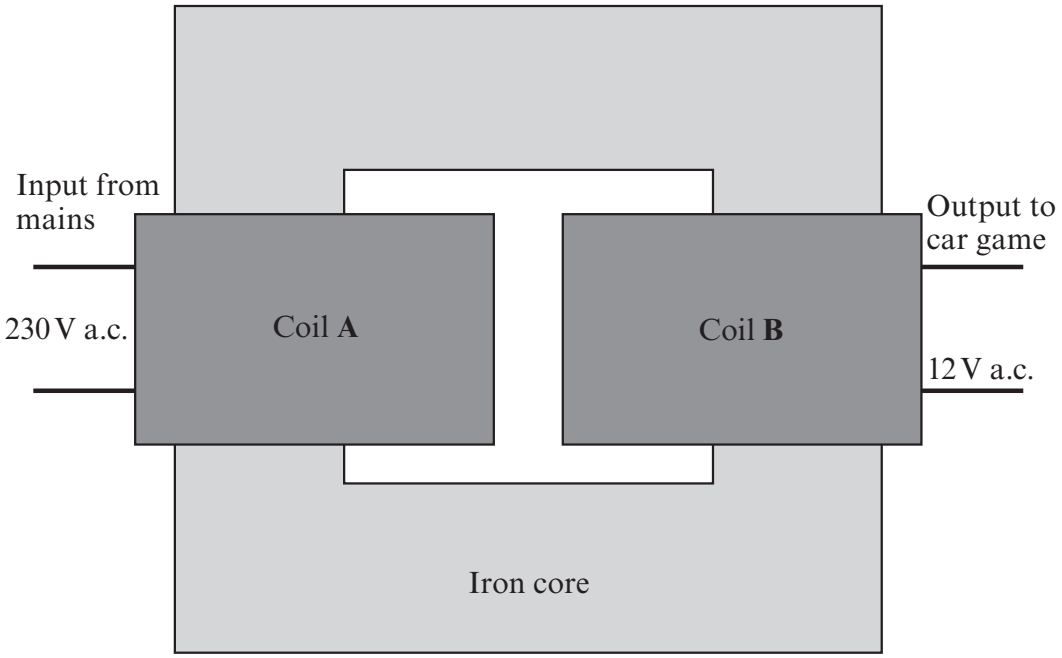
4. The diagram shows a wire being moved in a magnetic field between two permanent magnets.



(a) By using one of the letters on the diagram, state the direction in which the wire needs to move so that the current is induced in it in the direction shown. [1]

.....

(b) A model racing car game uses a transformer. It changes a 230 V input to a 12 V output by using two coils **A** and **B**.



(i) Which coil, **A** or **B** should have the bigger number of turns? Give a reason for your answer. [1]

.....

.....

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(ii) State why the input voltage has to be alternating for the transformer to work. [1]

.....

.....

(iii) One function of the iron core is to increase the strength of the magnetic field inside the primary coil. State **one** other function that it has. [1]

.....

.....

(iv) Briefly state why an output voltage is produced by the transformer. [1]

.....

.....

(v) Coil **A** has 18 400 turns. Use an equation from page 2 to calculate the number of turns in coil **B**. [2]

Number of turns = ...

7

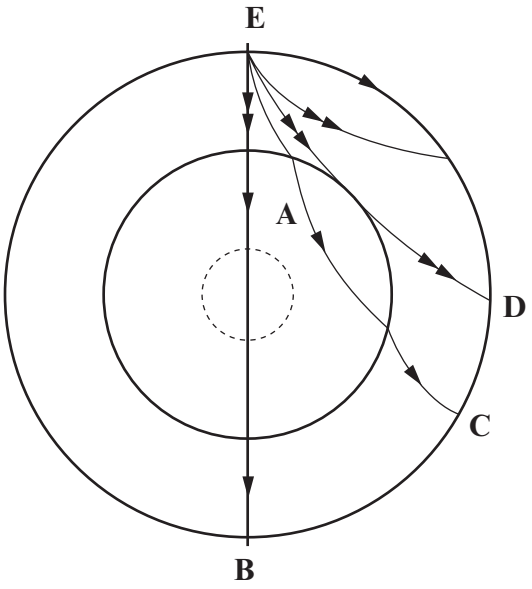
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Turn over.

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5. The diagram shows how seismic waves from an earthquake at point **E** travel through the Earth. These waves travel through the Earth and are detected by scientists elsewhere.



(a) State which seismic waves (if any) are detected:

(i) between points **B** and **C** [1]

.....

(ii) between points **C** and **D**. [1]

.....

(b) Explain how the Earth's structure affects the path of the seismic wave that passes from **E** to **A** on the diagram. [4]

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6

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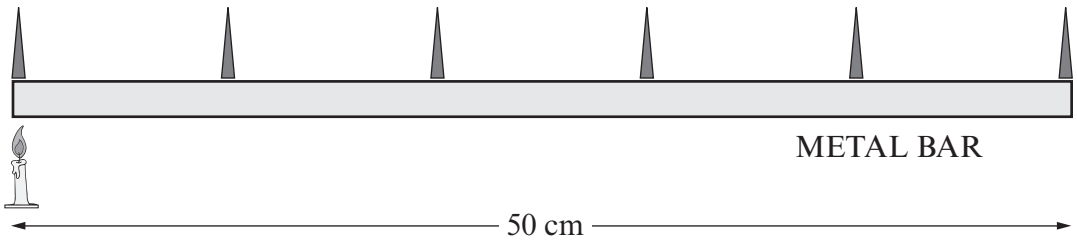
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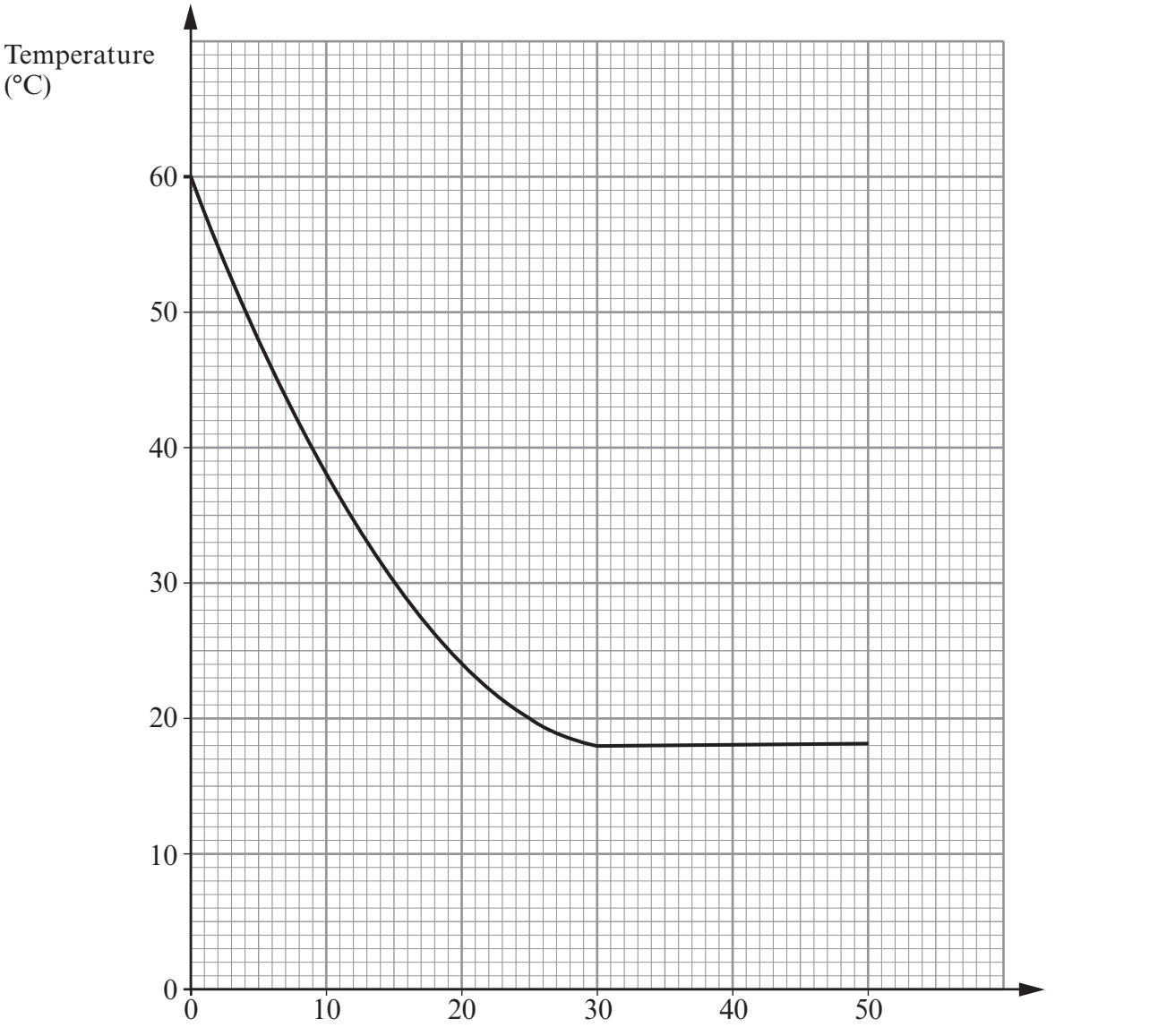
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6. The diagram shows a metal bar which is heated by a candle at one end and has temperature probes attached to it along its length.

Six temperature probes connected to a computer



The graph shows how the temperature falls with distance along the metal bar from the heated end.



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(a) (i) Use the graph to calculate the mean temperature drop per cm for the first 20 cm along the metal bar. [2]

..... °C/cm

(ii) The mean temperature drop per cm for the first 10 cm along the bar is 2.2 °C/cm. State how the temperature drop per cm **at the heated end** of the metal bar could be found from the graph. [1]

.....

.....

.....

(b) **Draw** on the graph a line to show how the temperature change along the bar would look for a metal bar which conducts less well. [2]

(c) Explain, in terms of particles, why metals are better conductors of heat than non-metals. [2]

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7

TURN OVER FOR QUESTION 7

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7. *(a)* The Sun is in the main sequence stage of its life. It derives its energy from the conversion of hydrogen to helium. The forces acting within it are balanced.
Each second, the energy released from the Sun is about 4×10^{26} J.

Use an equation from page 2 to calculate the mass of the Sun that is converted into energy each second. [speed of light = 3×10^8 m/s] [2]

Mass = ... kg

(b) Explain how the Sun will produce elements heavier than helium after it leaves the main sequence stage of its life. [6 QWC]

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8

END OF PAPER

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GCSE MARKING SCHEME

SCIENCE - PHYSICS

SUMMER 2013

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INTRODUCTION

The marking schemes which follow were those used by WJEC for the Summer 2013 examination in GCSE SCIENCE - PHYSICS. They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conferences was to ensure that the marking schemes were interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

	Page
Physics 1 - Foundation Tier	1
Physics 1 - Higher Tier	5
Physics 2 - Foundation Tier	9
Physics 2 - Higher Tier	13
Physics 3 - Foundation Tier	17
Physics 3 - Higher Tier	20

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GCSE SCIENCE - PHYSICS 3

FOUNDATION TIER

<table>
<tr><th colspan="3">Question</th><th>Marking details</th><th>Mark</th></tr>
<tr><td>1.</td><td>(a)</td><td></td><td>correct shape with no lines crossing & 2 lines minimum (1 on the top and 1 on the bottom ignore the middle) (1) direction (1)</td><td>2</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>stronger / accept more lines / bigger / increases</td><td>1</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>stronger / accept more lines / bigger / increases</td><td>1</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>reverses direction / opposite direction / goes the other way</td><td>1</td></tr>
<tr><td></td><td></td><td></td><td>Question total</td><td>[5]</td></tr>
<tr><td>2.</td><td>(a)</td><td></td><td>current, primary, magnetic, core / primary, secondary. [5 x 1]</td><td>5</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>100 turns</td><td>1</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>IC = 100 (1) OC = 1 000 (1) (allow 1 mark for any combination that increases voltage)</td><td>2</td></tr>
<tr><td></td><td></td><td></td><td>Question total</td><td>[8]</td></tr>
<tr><td>3.</td><td>(a)</td><td>(i)</td><td>Reasonably straight line joining to C (arrowhead not required)</td><td>1</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>X between incident ray and normal</td><td>1</td></tr>
<tr><td></td><td>(b)</td><td></td><td>
<table>
<tr><th></th><th>Medium 2</th><th>Angle of incidence</th><th>What happens to the ray of light at the boundary?</th></tr>
<tr><td></td><td>Air</td><td>35^o</td><td>Refracts (1)</td></tr>
<tr><td></td><td>Glass</td><td>42^o</td><td>Refracts (1)</td></tr>
<tr><td></td><td>Air</td><td>42^o</td><td>Travel along the boundary (1)</td></tr>
<tr><td></td><td>Air</td><td>45^o</td><td>TIR (1)</td></tr>
</table>
</td><td>4</td></tr>
<tr><td></td><td></td><td></td><td>Question total</td><td>[6]</td></tr>
<tr><td>4.</td><td>(a)</td><td>(i)</td><td>Surface waves travel on surface / P & S waves travel through Earth</td><td>1</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>particle vibrations / oscillations (1) parallel/same direction as travel for P wave and at right angles for S wave (1) (accept up and down / back and for)</td><td>2</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>3 (1) only P waves detected / no S waves accept longest time (1)</td><td>2</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>2 (1) Y is further away/greater distance to travel (1) so waves would arrive later (1) Either mark can be awarded on its own but only award 2 marks if they are linked. (Accept middle value distance and middle time.)</td><td>3</td></tr>
<tr><td></td><td></td><td></td><td>Question total</td><td>[8]</td></tr>
</table>

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Question			Marking details	Mark
5.	(a)	(i)	accept any value between 5 500 and 6 500 K inclusive	1
		(ii)	[ACB is] smaller/cooler or lower temperature/dimmer or converse if referring to Sun but must be clear referring to Sun [any 2 x 1]	2
		(iii)	Both main sequence stars (accept balanced forces)	1
	(b)	(i)	radiation pressure/outward force becomes greater than gravitational force / inward force N.B. must compare the both. Unbalanced forces must be qualified.	1
		(ii)	becomes larger / expands, brighter, cooler / redder [3 x 1] Award marks if appropriate values for the properties given.	3
	(c)		X marked near white dwarf section	1
			Question total	**[9]**
6.	(a)		If no external / outside force acts (1) the total momentum remains constant /stays the same / is conserved **or** momentum before [collison/explosion] equals momentum after (1)	2
	(b)	(i)	15 x 800 (1) = 12 000 [kg m/s] (1)	2
		(ii)	Subs 12 000 or **ecf (**1) subs 1 600 kg (1) ans = 7.5 [m/s] (1)	3
		(iii)	16 000 [N] (1) to the left (1) Award 2 marks for -16 000 **or** equal and opposite force	2
	(c)	(i)	0	1
		(ii)	equal and opposite momentum (1) so total momentum is zero (1) **Either mark can be awarded on its own but only award 2 marks if they are linked.** Award 1 mark only for momentum to the right cancels momentum to the left unless linked to 1 of the other marking points.	2
			Question total	**[12]**

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Question			Marking details	Mark
7.	(a)	(i)	Plots ± ½ small square division (2), curve (1)	3
		(ii)	As the volume increases, the pressure decreases (1) in a non-linear way / decreasing rate (1) (inversely proportional / as volume doubles the pressure is halved award both marks)	2
		(iii)	Around 67 000 (**take the value that occurs from their line** ± 500)	1
	(b)		Indicative content: As the volume increases, the molecules have further to travel between collisions with the container therefore they take a longer time to travel so the rate of change of momentum is reduced. This reduces the force from any one molecule when in collision with the walls. Since pressure = force / area, the decrease in the force gives a reason for a decrease in pressure / increase in area causes pressure. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	6
			Question total	**[12]**
			Foundation tier paper total	**[60]**

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HIGHER TIER

Question			Marking details	Mark
1.	(a)		If no external / outside force acts (1) the <u>total</u> momentum remains constant /stays the same / is conserved **<u>or</u>** momentum before [collison/explosion] equals momentum after (1)	2
	(b)	(i)	15 x 800 (1) = 12 000 [kg m/s] (1)	2
		(ii)	Subs 12 000 or **ecf (**1) subs 1 600 kg (1) ans = 7.5 [m/s] (1)	3
		(iii)	16 000 [N] (1) to the left (1) Award 2 marks for -16 000 **or** equal and opposite force	2
	(c)		KE before collision = ½ 800 x 15^2 = 90 000 [J] (1) KE after collision = ½ 1 600 x 7.5^2 = 45 000 [J] (1) **ecf from (b)(ii)** KE loss = 45 000 [J](1) **Award a maximum of 2 marks**	2
	(d)	(i)	0	1
		(ii)	equal and opposite momentum (1) so total momentum is zero (1) **Either mark can be awarded on its own but only award 2 marks if they are linked.** Award 1 mark only for momentum to the right cancels momentum to the left unless linked to 1 of the other marking points.	2
			Question total	**[14]**

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Question			Marking details	Mark
2.	(a)	(i)	Plots ± ½ small square division (2), curve (1)	3
		(ii)	As the volume increases, the pressure decreases (1) in a non-linear way / decreasing rate (1) (inversely proportional / as volume doubles the pressure is halved award both marks)	2
		(iii)	Around 67 000 (**take the value that occurs from their line** ± 500)	1
	(b)	(i)	Indicative content: As the volume increases, the molecules have further to travel between collisions with the container therefore they take a longer time to travel so the rate of change of momentum is reduced. This reduces the force from any one molecule when in collision with the walls. Since pressure = force / area, the decrease in the force gives a reason for a decrease in pressure / increase in area causes pressure. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	6
		(ii)	increased speed / faster / KE increases	1
			Question total	**[13]**
3.	(a)		Refraction (1). Passing from a less to a more dense medium or material / light slows down (1)	2
	(b)	(i)	point E	1
		(ii)	Award 2 x(1): strikes at an angle greater than the critical angle/42^{o} for glass (1) directed from a more to a less dense medium (1) angle of reflection is equal to the angle of incidence (1)	2
			Question total	**[5]**

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Question			Marking details	Mark
4.	(a)		U	1
	(b)	(i)	coil A because it has the bigger voltage of the two [both points required for the mark] or it's a step-down transformer or A has less current	1
		(ii)	to set up a changing magnetic field [in the iron core] don't accept moving	1
		(iii)	to transfer / link the <u>field</u> into coil <u>B</u>	1
		(iv)	The <u>changing magnetic field</u> induces a voltage in coil B (cutting is neutral)	1
		(v)	$\frac{230}{12} = \frac{18400}{N2}$ [1 sub] $N_2 = 18400 \times \frac{12}{230}$ $N_2 = 960$ (1)	2
			Question total	**[7]**
5.	(a)	(i)	[surface and] longitudinal / P waves [arrive between B and C]. (DO NOT ACCEPT "It is a shadow zone for S waves")	1
		(ii)	Surface waves / none [are detected between C and D]. (Accept it is in the shadow zones of S and P waves)	1
	(b)		Any 4 x (1): in the mantle stiffness increases with depth (1) so wave speed increases / refraction (1), solid mantle, liquid core (1) [entering the liquid core] the stiffness decreases / density increases (1) so the wave speed decreases / refracts the other way (1)	4
			Question total	**[6]**
6.	(a)	(i)	$\frac{36 \pm 0.5(1)}{20(1)} = 1.8$	2
		(ii)	Take a very small interval of length (e.g. 5 cm) / draw a tangent and find its gradient	1
	(b)		Line below the one drawn from 60 °C (1) down to, but never falling below room temp (1)	2
	(c)		Presence of free electrons (1) which [transfer energy when they] <u>collide</u> (1) Award 1 mark only for moving particles which transfer energy by collisions.	2
			Question total	**[7]**

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Question			Marking details	Mark
7.	(a)		Using $E=mc^2$, $4 \times 10^{26} = m \times (3 \times 10^8)^2$ (1) $m \sim 4.4 \times 10^9$ [kg] (1)	2
	(b)		Indicative content: At the end of the main sequence, hydrogen is exhausted and the balance between gravity and radiation pressure fails. Initially, radiation pressure drops and the core contracts, density increases and the temperature increases allowing heavier elements to fuse. This is the red giant stage. Meanwhile the lighter elements continue fusing in a shell around the nucleus. Stars like the Sun never reach sufficient temperatures to create elements as heavy as iron. Eventually, the core will run out of helium fuel, and in order to maintain equilibrium, the core will contract again to initiate the last type of fusion – carbon. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit. **Question total**	6 **[8]**
			Higher tier paper total	**[60]**

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