WJEC GCSE PHYSICS

PHYSICS



EXAM QUESTION PACK

UNIT P2 HIGHER TIER 4473 PAPERS

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4473/02

S16-4473-02

ADDITIONAL SCIENCE/PHYSICS

PHYSICS 2
HIGHER TIER

P.M. WEDNESDAY, 25 May 2016

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**11**	
2.	**13**	
3.	**9**	
4.	**6**	
5.	**7**	
6.	**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. Do not use gel pen or correction fluid.

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.

If you run out of space, use the continuation page at the back of the booklet, taking care to number the question(s) correctly.

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 **2***(a)* and **6***(b)*.

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Equations

power = voltage × current	$P = VI$
current = $\frac{\text{voltage}}{\text{resistance}}$	$I = \frac{V}{R}$
power = current^2 × resistance	$P = I^2R$
speed = $\frac{\text{distance}}{\text{time}}$	
acceleration [or deceleration] = $\frac{\text{change in velocity}}{\text{time}}$	$a = \frac{\Delta v}{t}$
acceleration = gradient of a velocity-time graph	
distance travelled = area under a velocity-time graph	
momentum = mass × velocity	$p = mv$
resultant force = mass × acceleration	$F = ma$
force = $\frac{\text{change in momentum}}{\text{time}}$	$F = \frac{\Delta p}{t}$
work = force × distance	$W = Fd$
kinetic energy = $\frac{\text{mass} \times \text{speed}^2}{2}$	$KE = \frac{1}{2}mv^2$
change in potential energy = mass × gravitational field strength × change in height	$PE = mgh$

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. The table shows the typical thinking and braking distances for a car at different speeds.

Speed in miles per hour (mph)	Thinking distance (m)	Braking distance (m)
20	6	6
30	9	14
40	12	24
50	.....	38
60	18	56
70	21	75

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

(ii) Calculate the overall stopping distance at 40 mph. [1]

stopping distance = ... m

(iii) Explain why the thinking distance changes as the speed increases. [2]

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(b) The data in the table applies to an alert driver on a dry day. Describe how the data would compare if the driver is tired. [2]

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To improve motorway safety, some motorways have chevron markers. The gap between one chevron marker and the next is 40 m. Drivers are instructed to keep at least **two chevron gaps** away from the car in front.



(c) Calculate how long it will take to travel 2 chevron gaps at the motorway speed limit of 31 m/s (70 mph) using the equation: [3]

$$\text{time} = \frac{\text{distance}}{\text{speed}}$$

time = ... s

(d) Explain why the data in the table opposite shows the two chevron rule may not keep motorists safe even if they are travelling in a car at the motorway speed limit. [2]

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11

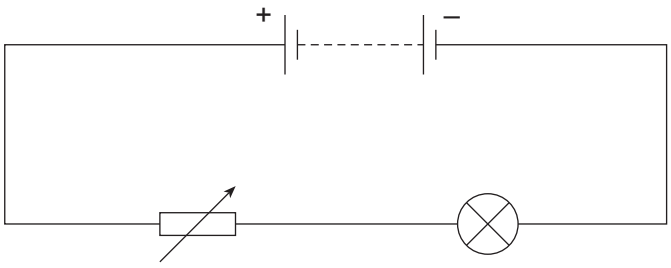
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2. The diagram shows a lamp connected to a battery and a variable resistor.



(a) Describe how the circuit can be used to obtain a **series of measurements** to show how the current through the lamp varies with the voltage across it. [6 QWC]

In your answer you should:

- include the names of the measuring instruments needed;
- **add these instruments** to the circuit diagram above;
- describe how a series of measurements is obtained.

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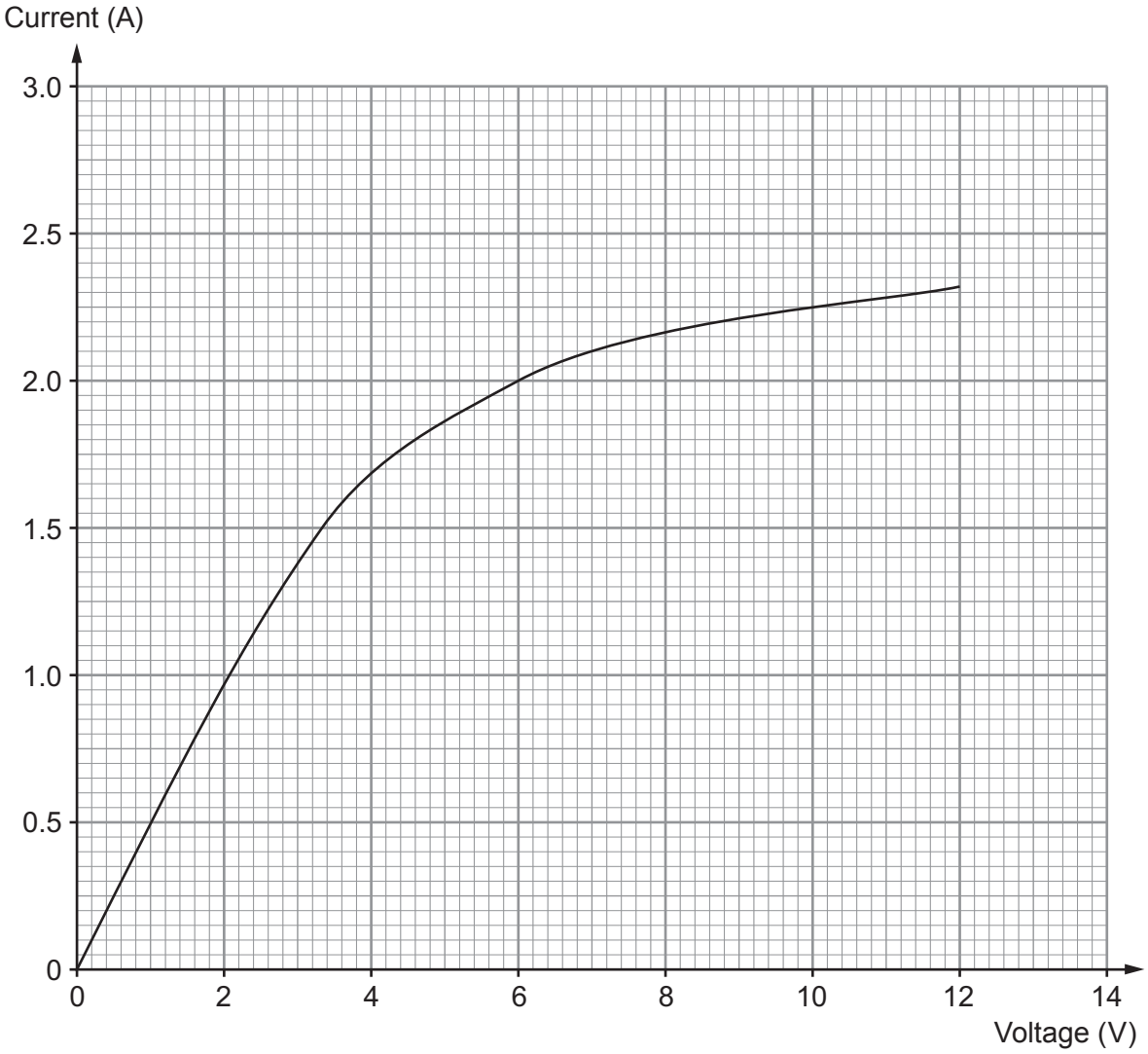
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(b) The current through the lamp was measured for voltages up to 12 V.
A graph of the results is shown on the grid below.



(i) Use the graph to find the current through the lamp when a voltage of 6 V is applied to it. [1]

current = ... A

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(ii) Use the equation:

$$\text{resistance} = \frac{\text{voltage}}{\text{current}}$$

to calculate the resistance of the lamp at 6 V. [2]

resistance = ... Ω

(iii) Use an equation from page 2 to calculate the power produced by the lamp at 6 V. [2]

power = ... W

(iv) The lamp is replaced by a resistor which remains at constant temperature. At 10 V the resistor and lamp have the same resistance. **Add a line** to the graph to show how the current through the resistor varies with voltage. [2]

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3. Nuclear medicine uses radioisotopes which emit radiation from within the body. One tracer uses iodine, which is injected into the body to treat the thyroid gland. The table shows four isotopes of iodine.

Form of iodine	Radiation emitted	Half-life
iodine-125	gamma	59.4 days
iodine-128	beta	25 minutes
iodine-129	beta and gamma	15 000 000 years
iodine-131	beta and gamma	8.4 days

(a) Iodine-129 emits both beta and gamma radiation. Describe the nature of these types of radiation. [2]

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(b) The table shows that the half-life of iodine-125 is 59.4 days. State what this means. [2]

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(c) (i) Use the data to explain why iodine-131 is the most suitable form of iodine for treating thyroid cancer.

[2]

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(ii) Patients are advised that after treatment with iodine-131, the radiation they are exposed to will not drop to the background value until 12 weeks after treatment. Calculate the fraction of radioactivity due to iodine-131 remaining after 12 weeks.
[3]

fraction remaining = ...

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4. Energy can be released in nuclear fission and nuclear fusion reactions.

(i) Explain how a sustainable, controlled chain reaction is achieved in a nuclear fission reactor containing uranium fuel rods, a moderator and control rods. [4]

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(ii) Explain why controlled nuclear fusion reactions are difficult to achieve on Earth. [2]

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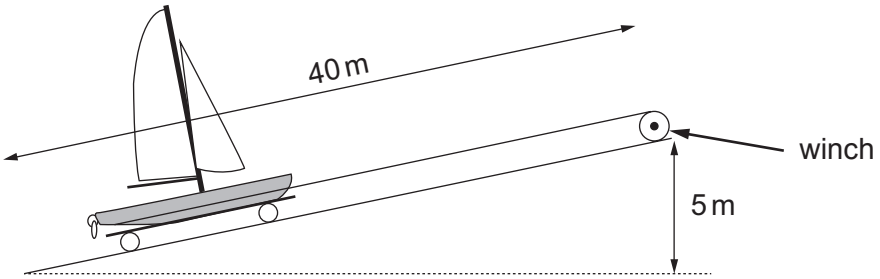
6

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5. The diagram shows a winch which is used to pull a boat 40 m up the slipway through a height of 5 m.



Use equations from page 2 to answer the following questions.

(i) Calculate the gain in potential energy of the boat when it is pulled up to the top of the slipway. (Mass of boat = 1 200 kg; gravitational field strength = 10 N/kg) [2]

gain in potential energy = ... J

(ii) A frictional force of 1 000 N acts against the boat as it is pulled up the slipway. Calculate the work done against this frictional force. [2]

work done = ... J

(iii) Calculate the force that must be applied by the winch in pulling the boat up the slipway. [3]

force applied by winch = ... N

7

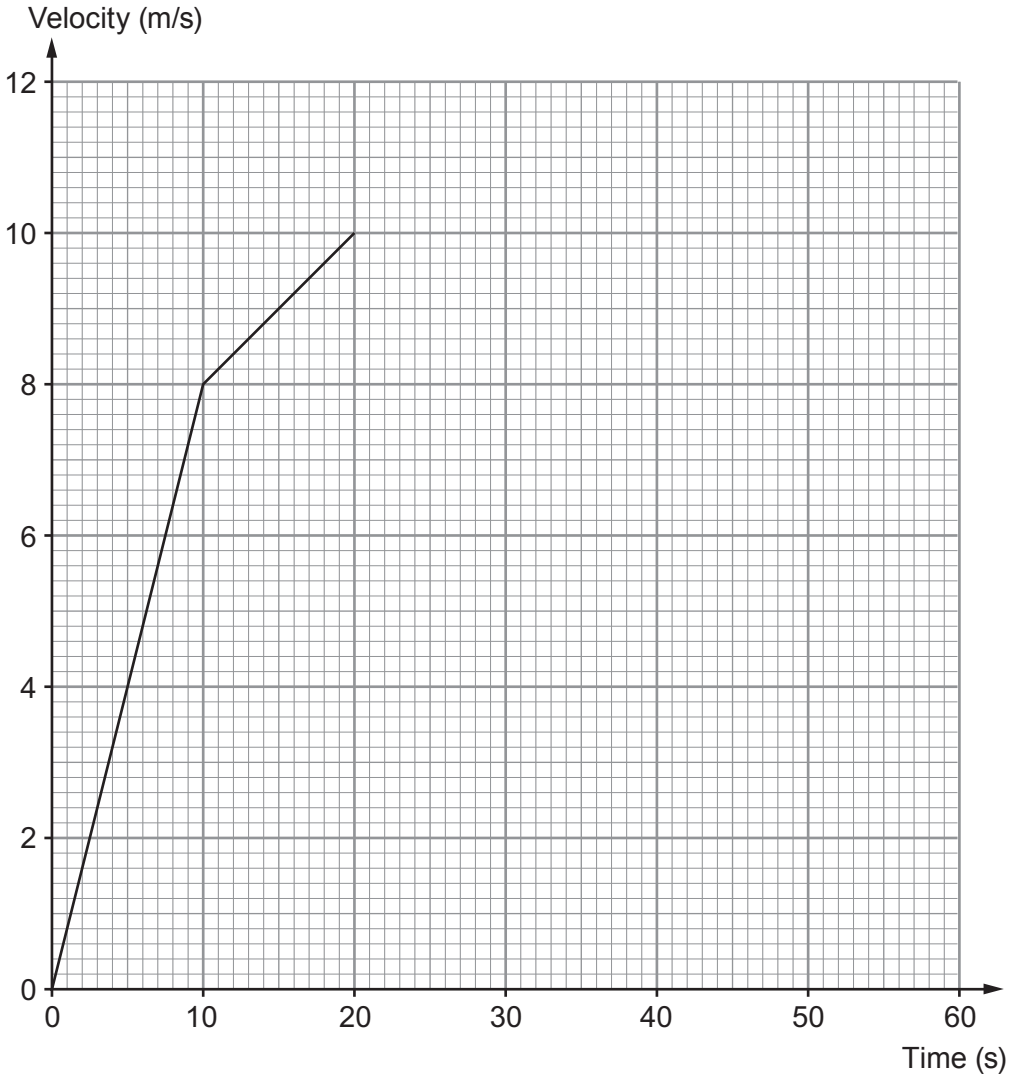
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6. Part of the journey of a cyclist is represented on the velocity-time graph below.



(a) (i) Select an equation from page 2 and use it to calculate the acceleration of the cyclist between 10 s and 20 s. [2]

acceleration = ... m/s^2

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(ii) Select an equation from page 2 and use it to calculate the distance the cyclist travels between 10 s and 20 s. [2]

distance = ... m

(iii) After 20 s the cyclist continues at constant velocity for 15 s and then decelerates to rest with constant deceleration of 0.5 m/s^2. Use this information along with an equation from page 2 **to complete the graph**. [4]
Space for calculations if needed.

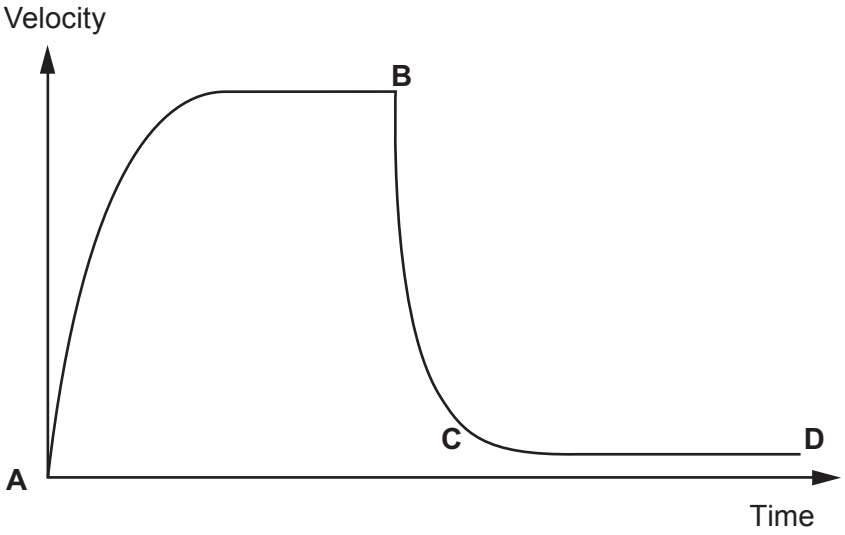
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(b) Another velocity-time graph is shown below. It represents the motion of a skydiver.



Describe and explain the motion of the skydiver in **terms of forces**. [6 QWC]

Include in your answer:

- the type of motion in each region, **AB**, **BC**, and **CD**;
- the forces acting in each region and how they compare.

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END OF PAPER

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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GCSE MARKING SCHEME

SUMMER 2016

SCIENCE - PHYSICS P2
4473/01/02

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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.

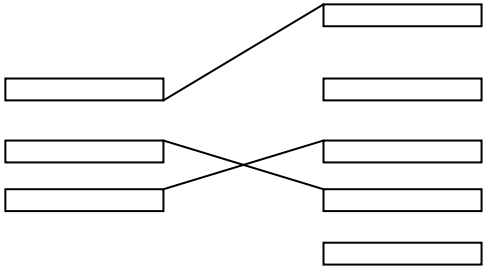
It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

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

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GCSE SCIENCE - PHYSICS P2

SUMMER 2016 MARK SCHEME

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
1		(a)			3	 All 3 correct - 3 marks 2 correct - 2 marks 1 correct - 1 mark More than one line from a box on the left loses that mark	Accept non straight lines		
		(b)	(i)		1	E			
			(ii)		1	H			
		Total			**5**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
2		(a)	(i)		2	$a = \frac{8}{10}$ (1-subs) = 0.8 (1-ans) [m/s^2]	$a = \frac{(8-0)}{10} = 0.8$ 0.8 on its own for both marks		$a = \frac{(0-8)}{10}$ Do not accept an answer of -0.8
			(ii)		2	Smaller acceleration [between B and C] (1) because the line is less steep / smaller velocity (speed) change [in the same time](1) **Alternative:** [Comparison of] accelerations of 0.8 [AB] with 0.2 [BC] / or using m/s^2 award 2 marks Acceleration along BC is 0.6 m/s^2 less award 2 marks **The 1st mark must be linked to the 2nd mark.**	Converse argument if clearly referring to A to B Slower acceleration (1) Slower rate (1) Award 1 mark for answer of 0.2		Doesn't travel so far The cyclist accelerates at a slower speed
			(iii)		2	$d = s \times t$ = 10 × 20 (1-subs) = 200 [m] (1)			
		(b)			2	Forward straight line down to the axis from D (1) terminating at coordinate (55,0) (1) no tolerance	Line drawn without a ruler if a good attempt has been made to make it straight.		
		Total			**8**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
3		(a)	(i)		1	(Making the gas) <u>very</u> hot / at a high temperature	Heats up a lot		"Make the particles hot". OR "Make them hot" or Increase temperature or High pressure
			(ii)		1	The container is in danger of melting / difficult to achieve such high temperatures / requires high energy	"The container melts" OR just "Containment" If pressure identified in (i) then accept leaking or bursting	Exploding	
		(b)	(i)		1	Hydrogen underlined			
			(ii)		1	Protons underlined			
			(iii)		1	Fusion underlined			
		(c)			2	**Any 2 × (1) from:** • Reactants are readily available from [water in] the oceans • Fossil fuels are likely to run out / are finite / it is a sustainable source of energy • [Producing electricity from it] does not <u>increase</u> global warming / add to acid rain • Releases a large amount of energy • Doesn't produce radioactive waste	Water / hydrogen / deuterium is readily available from the oceans	Reference to tritium	Other energy sources are running out / Cleaner energy supply / Reference to cost / reference to less pollution
		Total			**7**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
4		(a)	(i)	I	1	250 [cpm] ± 10			
				II	1	12 000 [years] (no tolerance)			
				III	1	6 000 [years] (no tolerance)			
			(ii)		1	**Answer must be the same as (a)(iii)** i.e. 6 000 [years]			
		(b)			3	14 - (1) 6 - (1) 8 - (1)			**ecfs** on 14 or 6
		Total			**7**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
5		(a)	(i)		2	work = 50 × 44 (1-subs) = 2 200 [J] (1-ans)			
			(ii)		1	3 200 + 2 200 (**ecf** from (a)(i)) = 5 400 [J] (1-ans)			
			(iii)		1	3 200 – 2 200 (**ecf** from (a)(i)) = 1 000 [J] (1-ans)			Negative answer
		(b)	(i)		2	Momentum change = 80 × 4 (1 for change of velocity value even if not multiplied by 80) = 320 [kg m/s] (1-ans) Answer of 320 [kg m/s] award 2 marks	Accept 80 × 5 = 400 or 80 × 1 = 80 for 1 mark Accept (5-1) for 1 mark even if not multiplied by a mass.		
			(ii)		2	$\frac{320(\ \textbf{ecf}\ \text{from(b)i})}{2}$ (1-subs) = 160 [N] (1-ans)			
			(iii)		1	**Answer must be the same as (b)(ii)** i.e. 160 [N]		Negative answer	800 N (weight of the boat)
		Total			**9**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
6	**1**	(a)	(i)		1	15			
			(ii)		1	36 [m]			
			(iii)		2	Increases [distance] (1) because it travels further in the <u>same time</u> (1) **The 1st mark must be linked to the 2nd mark.**	Thinking <u>time is the same</u> (1) so distance increases (1) / Thinking distance and overall stopping distance increase (1)		Takes you longer to think / Thinking distance and braking distance increase
		(b)			2	<u>Thinking</u> distance increases (1) <u>braking</u> distance unchanged (1)	Both distances increase / The data increases (1)	Stopping distance References to time Ignore any reasoning References to overall stopping distance	
		(c)			3	$2 \times 40 = 80$ (1) $\frac{80\text{ecf}}{31}$ (1) = 2.58 [s] or 2.6 [s] (1)	$\frac{40}{31} = 1.29$ (2) $\frac{80}{70}$ (1) [=1.14] Any number divided by 31 award 1 mark only 2.5 [s] on its own award 2 marks		$\frac{40}{70} = 0.57$
		(d)			2	Overall stopping distance <u>is 96 m</u> (1) which is <u>more than</u> 80 m / 16 m <u>more</u> / <u>more than</u> 2 gaps (1) **The 1st mark must be linked to the 2nd mark.**	which is more than 40 m / more than a gap (1)	Reference to braking distance	
		Total			**11**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
7	**2**	(a)			6	**Indicative content:** Voltmeter drawn in parallel with the lamp with correct symbol and ammeter drawn in series with lamp with correct symbol. The variable resistor is set [at highest / lowest resistance] and values of the current from the ammeter and voltage from the voltmeter are taken. The variable resistor is then altered and new readings taken. Repeating in this way, a series of values of current and voltage are recorded. **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)	(i)		1	2 [A] no tolerance			
			(ii)		2	$\frac{6}{2}$ (1) = 3 [Ω] (1) **ecf (b)(i)**			
			(iii)		2	6×2 (1) = 12 [W] (1) **ecf (b)(i)**	Use of $P = I^2R$ **ecf** on R		
			(iv)		2	Any line through (10, 2.25) (1) Straight line from origin (1) no tolerance		Ignore coordinate lines at (6,2)	More than one line e.g. a pair of coordinate lines
		Total			**13**				

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
	3	(a)			2	beta - <u>high energy/fast</u> moving electron (1) gamma - <u>electromagnetic</u> wave (1)	em wave One is a fast moving electron and one is an em wave – award 1 mark only Beta is an electron and gamma is a wave – award 1 mark only	Properties of beta and gamma	Beta is a particle and gamma is a wave
		(b)			2	The activity/mass/number of [unstable] nuclei (1) halves [in this time / in 59.4 days] (1)	<u>Count rate</u>		Atoms Molecules Radiation Radioactivity
		(c)	(i)		2	It has a <u>suitable half-life</u> / not <u>too long a</u> <u>half-life</u> / not <u>too short a</u> <u>half-life</u> (1) so it doesn't <u>decay</u> [too] quickly / so it doesn't <u>decay</u> [too] slowly (1) **OR** Emits beta (1) which is absorbed in tumour (1) **The 1st mark must be linked to the 2nd mark.**	Relatively short Relatively long	Half-life is 8.4 days	Gamma and beta Can't penetrate the tumour or ionises the tumour Kills cancer cells
			(ii)		3	12 weeks = 84 days (1) No. of half-lives = 10 (1) [award for method of calculating no. of half-lives] $\frac{1}{1024}$ or 0·09765% (1)	$1/2^{10}$ award 2 marks If no workings shown 10 on the answer line award 2 marks / $\frac{1}{10}$ award 1 mark Halving 131 ten times (0.1279) award 2 marks		
		Total			**9**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	4		(i)		4	Moderator slows down neutrons (1) so absorbed / captured by uranium nuclei / atoms (1) More than one neutron emitted [at fission] (1) but some absorbed /all but 1 neutron absorbed by control rods (1) **The 1st mark must be linked to the 2nd mark and the 3rd mark must be linked to the 4th mark.**		Collide with Causes fission Neutrons are introduced Raising or lowering the control rods	
			(ii)		2	Fusion requires high temperature **and** pressure (1) which is difficult to contain (1) **The 1st mark must be linked to the 2nd mark.**		References to stars	
		Total			**6**				

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Question Number					Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
	5		(i)		2	1 200 × 10 × 5 (1) = 60 000 [J] (1)			
			(ii)		2	1 000 × 40 (1) = 40 000 [J] (1)			
			(iii)		3	Total work done = 40 000 **ecf** + 60 000 **ecf** = 100 000 [J] (1) 100 000 **ecf** = $F \times 40$ (1) $F = \frac{100\,000}{40}$ = 2 500 [N] (1)	$\frac{40\,000\textbf{ecf}}{40}$ award 1 mark only $\frac{60\,000\textbf{ecf}}{40}$ award 1 mark only 100 000 anywhere award 1 mark 60 000 – 40 000 = 20 000, $\frac{20\,000}{40}$ = 500 award 2 marks		Substitution into force = change in momentum ÷ time
		Total			**7**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	6	(a)	(i)		2	$\frac{(10-8)}{10}$ (1 – substitution) = 0.2 [m/s^2] (1 – answer)			
			(ii)		2	(0.5 × 2 × 10) + (10 × 8) (1) = 90 [m] (1)	0.5(8 +10) × 10 (1) = 90 [m] (1)		
			(iii)		4	Horizontal line at 10 m/s to 35 s ± 1 small square tolerance (1) Time: $\frac{10}{0.5}$ (1) = 20 [s] (1) Straight line on graph to correct point (55,0) **ecf** from 20 s and horizontal line (1) no tolerance N.B. if diagonal line is not drawn scroll to bottom of page to look for the time calculation	Straight line on graph to correct point (55,0) award 3 marks <u>If no calculation shown</u> accept any forward diagonal line to x-axis - award 1 mark A diagonal line that ends at 55 s (**ecf**) but not on the x-axis award 2 marks		

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Question Number								
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
		(b)			6	**Indicative content:** Between A and B, when the skydiver first jumps, the only force acting is the weight force. As the skydiver speeds up air resistance increases, the resultant force decreases so the acceleration decreases, eventually reaching a terminal speed when both forces balance. At B the parachute opens, air resistance is now much larger than weight giving deceleration from B to C. As the skydiver slows down, the air resistance decreases, the resultant force decreases, and deceleration decreases. At C the skydiver has slowed down to a [lower] constant speed as the forces have balanced again. **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

4473/02

W16-4473-02

ADDITIONAL SCIENCE/PHYSICS

PHYSICS 2
HIGHER TIER

A.M. THURSDAY, 14 January 2016

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**12**	
2.	**14**	
3.	**5**	
4.	**12**	
5.	**11**	
6.	**6**	
Total	**60**	

4473 020001

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

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.

If you run out of space, use the continuation page at the back of the booklet, taking care to number the question(s) correctly.

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)* and **6**.

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Equations

power = voltage × current	$P = VI$
resistance = $\frac{\text{voltage}}{\text{current}}$	$R = \frac{V}{I}$
power = current^2 × resistance	$P = I^2R$
speed = $\frac{\text{distance}}{\text{time}}$	
acceleration [or deceleration] = $\frac{\text{change in velocity}}{\text{time}}$	$a = \frac{\Delta v}{t}$
acceleration = gradient of a velocity-time graph	
distance travelled = area under a velocity-time graph	
momentum = mass × velocity	$p = mv$
resultant force = mass × acceleration	$F = ma$
force = $\frac{\text{change in momentum}}{\text{time}}$	$F = \frac{\Delta p}{t}$
work = force × distance	$W = Fd$
kinetic energy = $\frac{\text{mass} \times \text{speed}^2}{2}$	$KE = \frac{1}{2}mv^2$
change in potential energy = mass × gravitational field strength × change in height	$PE = mgh$

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 student does an experiment with **dice** to investigate **radioactive decay**. The dice, which represent radioactive atoms, are thrown together onto the floor. Those that show a **six** are removed. These represent the atoms whose nuclei have decayed. The remaining dice (undecayed atoms) are thrown again and the process is repeated several times.

The student starts with **600** dice.

(a) (i) Predict how many of the dice would show a "six" on the first throw. [1]

.....

(ii) State why the student cannot predict **which** dice will show a "six". [1]

.....

.....

(b) The results of the experiment are shown in the table below.

Throw	Number of sixes	Number of dice remaining
0	0	600
1	95	505
2	85	420
3	.....	350
4	60	290
5	50	240
6	40	200
7	30	170
8	25	145

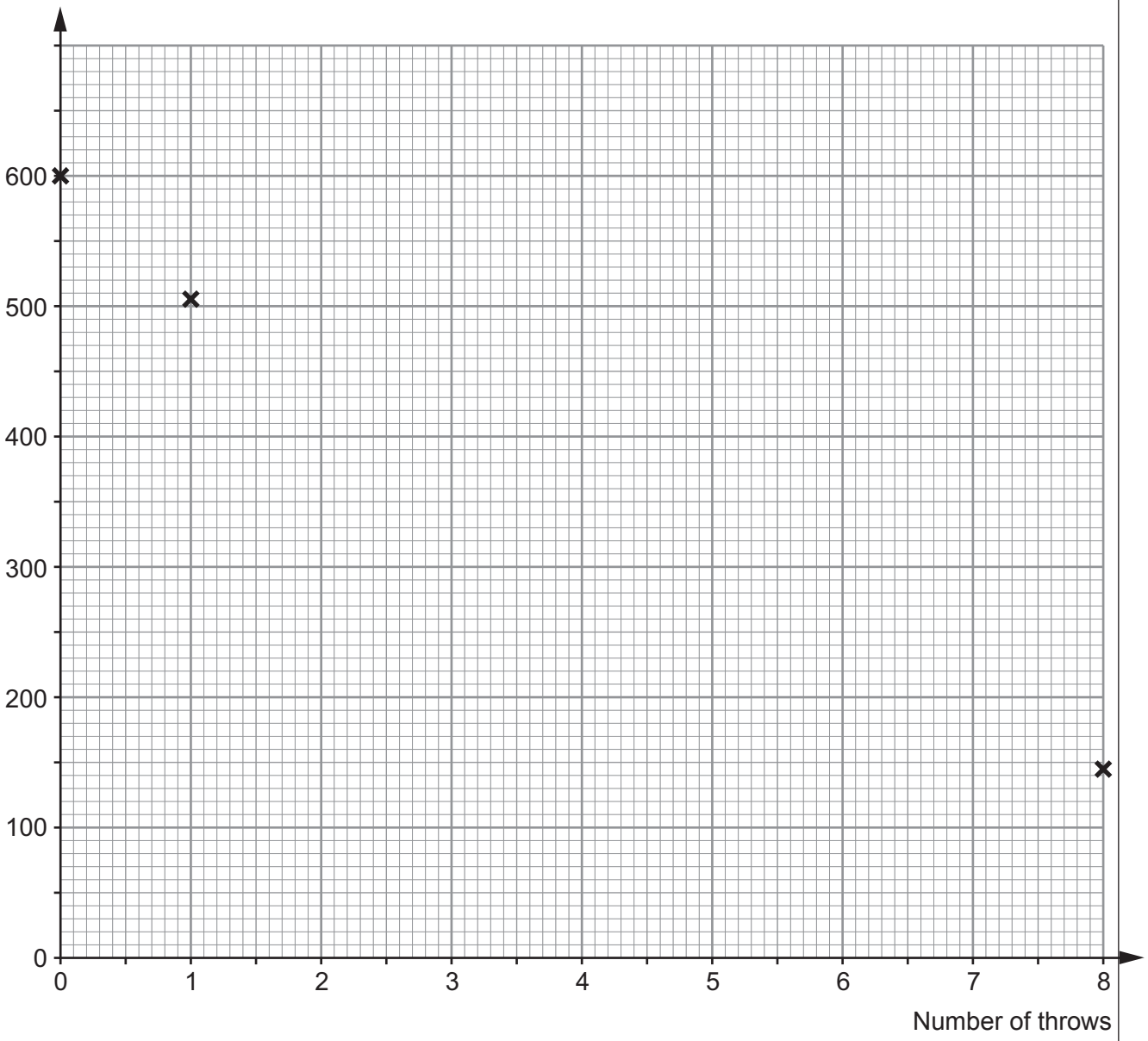
(i) **Fill in the gap** in the table above. [1]

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(ii) Plot the results on the grid below and draw a suitable line. [3]
Three points have been plotted for you.



(iii) **Draw lines on to your graph** to enable you to find the **half-life** of the dice. [2]

half-life of dice = ... throws

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(c) Americium-241 is a radioactive substance which is used in smoke alarms in houses. It decays by emitting alpha particles.

(i) State why Americium-241 is radioactive. [1]

.....

.....

(ii) What is an alpha particle? [1]

.....

(iii) Explain why the use of Americium-241 in house smoke alarms when in normal use, does not present a significant health risk to people living in the houses. [2]

.....

.....

.....

.....

12

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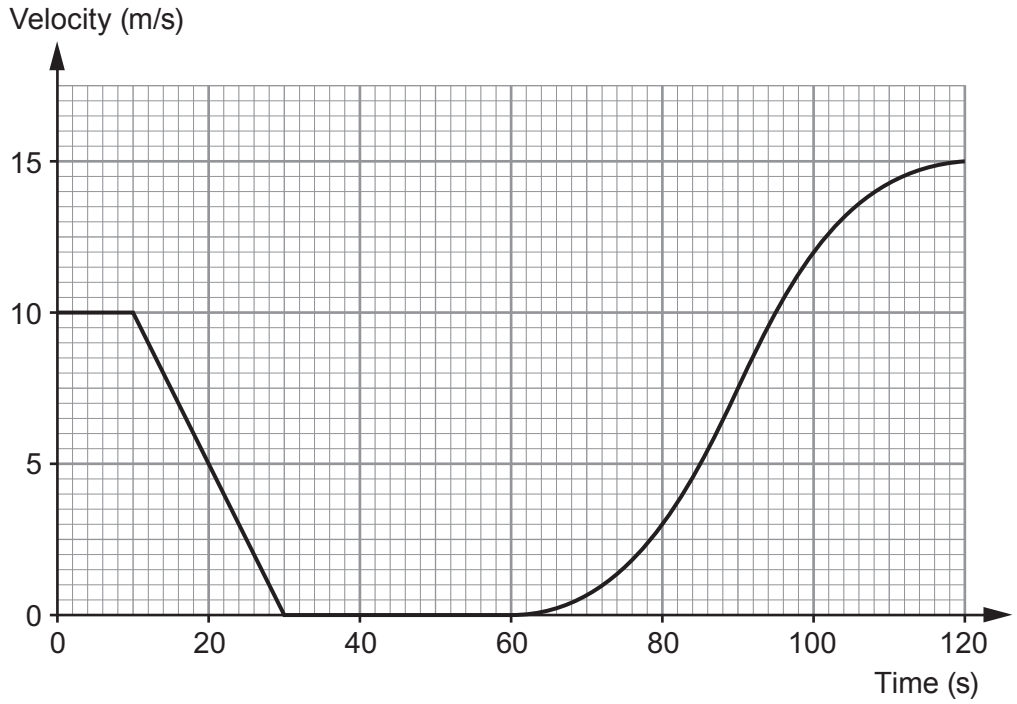
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2. The velocity-time graph below shows part of the journey of an underground train.



(a) Use the graph to find the total time that the train was travelling faster than 5 m/s. (Show your workings.) [2]

total time = ... s

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(b) Describe **fully** the motion of the train for the time shown. [6 QWC]

Your answer should include:

- data from the graph;
- appropriate calculations.

(Calculations of distance should not be given in your answer.)

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(c) (i) Use the equation: distance = speed × time

to calculate the distance travelled by the train in the **first 10 s** of the journey. [1]

distance = ... m

(ii) Between 10 s and 30 s, the train travels 100 m. Use an equation from page 2 to calculate the mean speed of the train between 0 s and 60 s. [3]

mean speed = ... m/s

(d) Use the graph to estimate (with a calculation) the distance travelled between 60 s and 120 s. [2]

distance = ... m

14

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3. *(a)* **Complete** the equation for the fission reaction shown below. [2]

$$^{235}_{92}\mathrm{U} \quad + \quad ^{1}_{0}\mathrm{n} \longrightarrow \quad ^{90}_{36}\mathrm{X} \quad + \quad ^{143}_{\ldots\ldots}\mathrm{Y} \quad + \quad ^{\ldots\ldots}_{0}\mathrm{n}$$

(b) What do the numbers 235 and 92 tell us about the particles inside the uranium nucleus? [2]

.....

.....

.....

(c) State how a fission reactor can be quickly shut down in the event of an accident. [1]

.....

.....

5

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4. Use equations from page 2 to answer the following questions about a swimmer.

(a) A swimmer of mass 60 kg steps off a diving board, and enters the water with a kinetic energy of 2 940 J.

(i) Assuming that no air resistance acts on the swimmer, calculate a value for the height of the diving board. [3]
(gravitational field strength, g = 10 N/kg)

height = ... m

(ii) In practise, air resistance acts on the swimmer as he falls. State how and explain why the actual height of the diving board is different from your calculated value. [3]

.....

.....

.....

.....

(b) (i) When swimming at constant speed, the kinetic energy of the swimmer is 7.5 J. Calculate the speed of the swimmer. [3]

speed = ... m/s

(ii) The swimmer then glides to a stop in 2 m. Calculate the mean drag force acting on the swimmer. [3]

drag force = ... N

12

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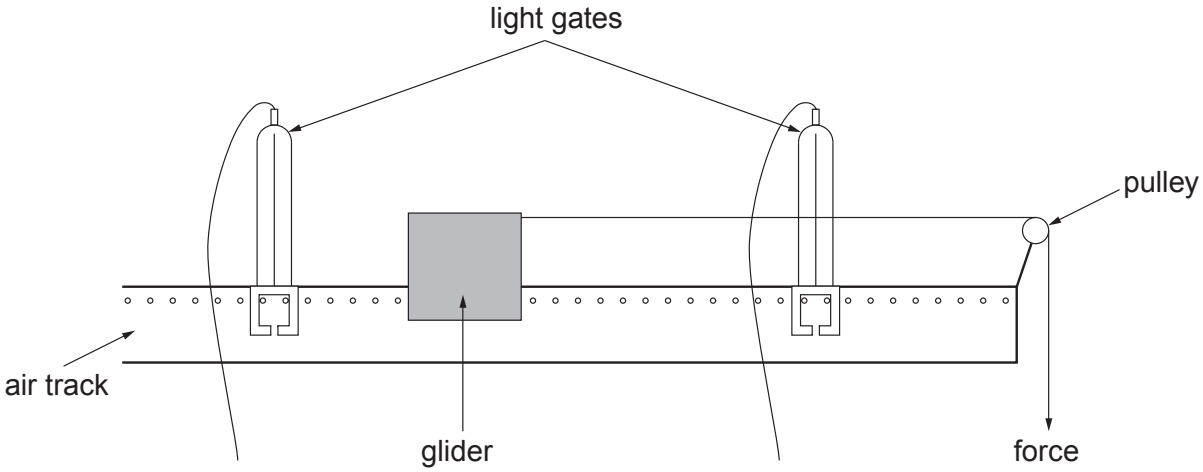
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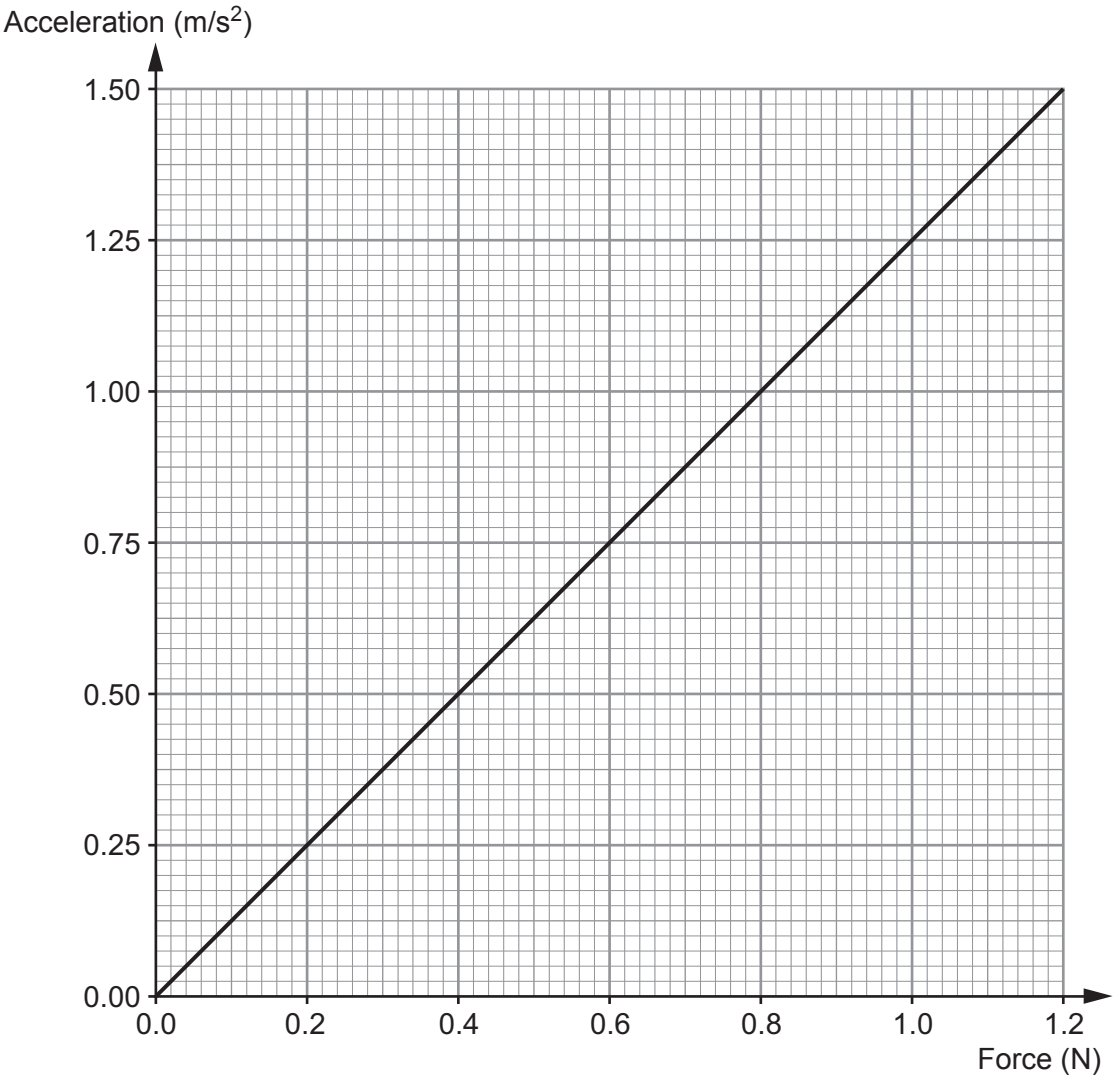
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5. A student sets up a glider on a frictionless air track. Light gates are set up to measure its acceleration. A frictionless pulley is attached to the end of the air track as shown, allowing a force to be applied to the glider.



From the results taken, a graph is plotted showing the relationship between the force and the acceleration of the glider.



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(a) (i) Use an equation from page 2 to calculate the mass of the glider. [2]

mass = ... kg

(ii) A force of 2.0 N is used to pull the glider from rest.

I. Determine the value of the acceleration. [1]

acceleration = ... m/s^2

II. The string snaps at 0.6 s. Use your value of acceleration and equations from page 2 to calculate the momentum of the glider at this time. [4]

momentum = ... kg m/s

III. Explain whether or not this momentum changes as the glider continues along the track, before reaching the end. [2]

.....

.....

.....

(b) The experiment is repeated with a glider of **3 times** the original mass. **Draw a line on** the original graph to show the results that you would expect. [2]

11

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6. A student investigated the changes in resistance of a 12 V filament lamp and wrote the following report of her experiment.

> A 12 V power supply was connected in series with an ammeter, the lamp and a variable resistor. A voltmeter was connected in parallel with the lamp.
>
> Initially the variable resistor was set on its highest setting and readings were taken from the ammeter and voltmeter. The setting on the variable resistor was changed 6 times and the readings were taken from the meters each time.

The student did not write anything more.

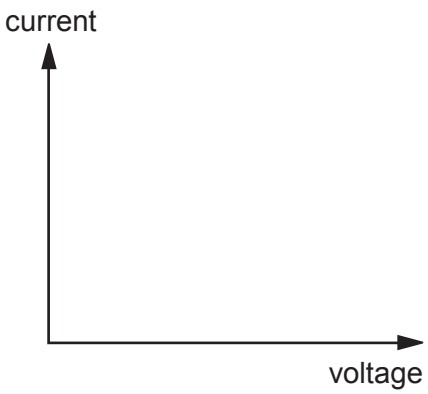
Your task is to complete the report. [6 QWC]

You should include the following points in your answer:

- a circuit diagram from the description given by the student;
- an explanation of how the results should be used to obtain resistance values;
- a sketch graph of how the current through the lamp would change with increasing voltage;
- a brief description of **how** the resistance of the lamp would change with increasing voltage (not **why** it changes).

Draw your circuit diagram below

Draw your graph below



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6

END OF PAPER

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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GCSE MARKING SCHEME

JANUARY 2016

SCIENCE – Physics 2
4473/01/02

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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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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
1		*(a)*		i	1	3			
				ii	3	92, 90, 92			
		(b)		i	1	moderator	graphite water		
				ii	1	control <u>rods</u>	boron <u>rods</u>		rods
		Total			**6**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
2		*(a)*			1	18 000 [N]			
		(b)	i		2	1 000 × 6 (1) substitution 6 000 [J] (1)			
			ii		1	No work is done / 0 [J]	1 000 × 0 = 0 [J]		0 × 6 = 0 [J]
			iii		1	Potential [energy] / gravitational potential [energy]			Gravity PE / GPE gravitational
		Total			**5**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
3		*(a)*	i		2	$\frac{5}{2.5}$ (1) = 2 [Ω] (1)			2.5 ÷ 5 = 2 [Ω]
			ii		2	5 × 2.5 (1) = 12.5 [W] (1)			
			iii		1	2.5 [A]			5 – 2.5 = 2.5 [A]
		(b)			3	Increase, stay the same, decrease.			
		(c)			1	Same voltage / switch separately / others stay on if one 'blows'	Converse about series	Lower risk of lamps going out Reference to brightness	
		Total			**9**				

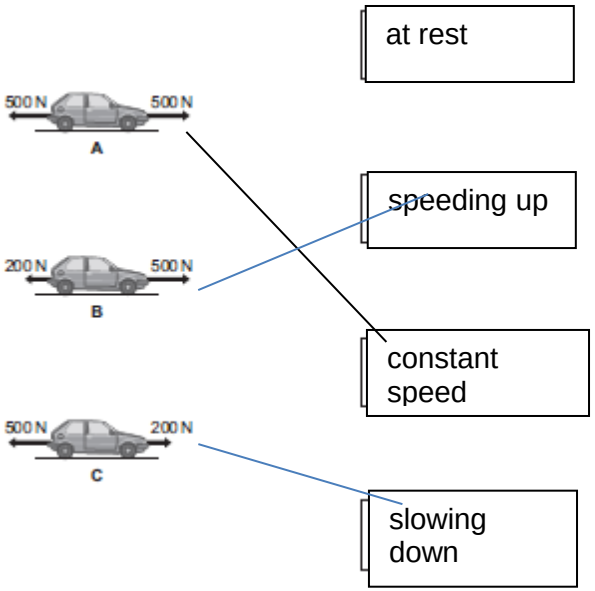
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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
4		*(a)*			1	<u>Braking distance</u>	<u>Breaking distance</u>		
		(b)	i		2	Thinking distance increases with speed (1) in proportion / uniformly / steadily (1)	As speed doubles thinking distance doubles (2) Speed increases with thinking distance (1)		Linear Constantly
			ii		1	Less steep straight line through origin ± 1 small square division			Any curves at all
		(c)	i		1	C			
			ii		1	A			
		Total			**6**				

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
5		*(a)*			3				2 lines originating from 1 car
		(b)			3	resultant force = 2 500 – 1 000 = 1 500 [N] (1) $a = \frac{F}{m} = \frac{1\ 500}{1\ 200}$ subs (1) **ecf on 1 500** 1.25 [m/s^2] answer (1)	$\frac{3\ 500}{1\ 200}$ = 2.92 [m/s^2] award 2 marks $\frac{2\ 500}{1\ 200}$ = 2.08 [m/s^2] award 2 marks		An ecf for any force other than 3 500 unless it is clearly shown that it is their resultant force
		(c)	i		1	N.B. the answer **must be half** of the answer in (b) [0.625 m/s^2]	0.63		0.62 or 0.6
			ii		1	It increases			
			iii		2	Drag **or** it equals driving force / forces are balanced / no ΣF (1) so a becomes zero / reaches a constant speed (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	Forces are the same Terminal velocity		Any reference to weight don't award 1st mark Reaches a maximum speed for the 2nd mark
		Total			**10**				

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Question Number					Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT	Sub-section							
6	**1**	*(a)*	i		1	100			$\frac{1}{6}$ or $\frac{100}{600}$
			ii		1	It is random	Decay is not regular / radioactive decay is random	A 1 in 6 chance	It is unpredictable / happens by chance / [throwing of] a dice is random
		(b)	i		1	70			
			ii		3	All points plotted within ± ½ small square division (2) -1 mark for each incorrect plot to a maximum of 2 marks Smooth curve of best fit ±1 small square division on each point between (2,420) and (7,170) (1)			Thick, wobbly, disjointed, wispy curves
			iii		2	[Horizontal and] <u>vertical</u> lines drawn on graph (1) Half-life taken from the intercept of their graph (around 4.0) (1)	Don't demand horizontal lines to be drawn when they are on the major grid lines. Allow answer close to 4 where no construction lines are drawn for the 2nd mark only Allow answer rounded to a whole number		Constructions and outcome that doesn't match the half-life
		(c)	i		1	Imbalance between protons and neutrons	Unstable <u>nucleus</u>		It is unstable. Unstable atom. Unstable nucleus with references to electrons. Too many neutrons. Unbalanced nucleus.

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	ii		1	Helium nucleus / 2 protons + 2 neutrons			helium helium atom helium ion $^{4}_{2}He$
	iii		2	Alpha particles have low penetrating power (1) so, cannot get through plastic or air to reach people (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	Alpha is highly ionising for the 1st mark Alpha can't travel far through air = 2 marks	Cannot get through the skin, paper	
Total			**12**				

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
7	**2**	*(a)*			2	20 ± 0 [s] **or** 35 ± 2 [s] (1 for either value) = 55 ± 2 [s] (1) Answer alone gets both marks	[120] – 65 ± 2 [s] (1) = 55 ± 2 [s] (1) **Or** 20 + 15 + 20 (1) = 55 ± 2 [s] (1)		
		(b)			6	**Indicative content:** In the first 10 s, the train travels at constant velocity at 10 m/s. It then decelerates uniformly to rest in 20 s. Its deceleration is 0.5 m/s^2. Having remained at rest for the next 30 s, it accelerates non-uniformly to a velocity of 15 m/s in the last 60 s. The acceleration increases between 60 and 90 s and then decreases again between 90 s and 120 s. The mean acceleration is 0.25 m/s^2. **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.	Accept "speed" instead of "velocity" in answer		

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
						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)	i		1	[Distance] = 10 × 10 = 100 [m]			
			ii		3	Mean speed $= \frac{(100+100)(1-\quad)}{60(1)}$ **ecf** 3.33 [m/s] (1)	3 or 3.3 Time = -60		3.0 or 3.30
		(d)			2	**HIGHER TIER only** Distance = 60 × 15 (1) ÷ 2 = 450 [m] (1 - answer)	No workings shown: 900 [m] = 1 mark Separate added area calculations that total 450 [m] = 2 marks 7.5 × 60 **or** 30 × 15 =1 mark		
		Total **FT** **HT**			**12** **14**				

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
	3	*(a)*			2	56, 3			
		(b)			2	92 gives the number of protons / is the proton number (1) 235 gives the number of protons and neutrons / is the nucleon number / it has 143 neutrons (1) N.B. Reference to electrons loses 1 mark		92 is the atomic number. 235 is the mass number	
		(c)			1	[Boron steel / cadmium] control rods are dropped <u>completely</u> [into the reactor] **Or** Control rods can be lowered to absorb <u>all</u> the neutrons	Ball bearings or boron steel dust is dropped [into the reactor]		Any reference to moderator
		Total			**5**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	4	*(a)*	i		3	KE = mgh (written or implied) (1) $h = \frac{2\,940}{(60 \times 10)}$ (1-manip or sub) h = 4.9 [m] (1-ans)	mgh = 2 940 for the first mark. $h = \frac{2\,940}{600}$ for the first 2 marks Answer of 49 or 490 = 1 mark		
			ii		3	Some energy has been lost [to air resistance] / heat is produced (1) So the diver would have had more than 2 940 J of PE when on the diving board (1) So the diving board would have been higher than 4.9 [m] (**ecf**) (1) **Alternative:** The acceleration would have been smaller (1) So the acceleration would have been over a greater distance (1) So the diving board would have been higher than 4.9 [m] (**ecf**) (1) **To award full marks the first two statements must be linked.**			
		(b)	i		3	½mv^2 = 7.5 (1) $v^2 = \frac{(2 \times 7.5)}{60}$ (1-manip and sub) v = 0.5 [m/s] (1)	$v^2 = \frac{15}{60}$ or 0.25 for the first 2 marks		

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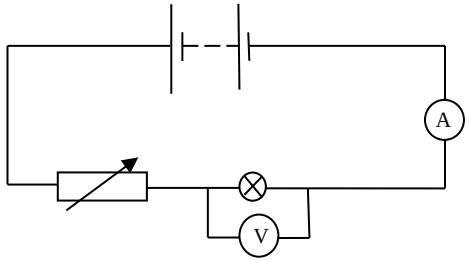
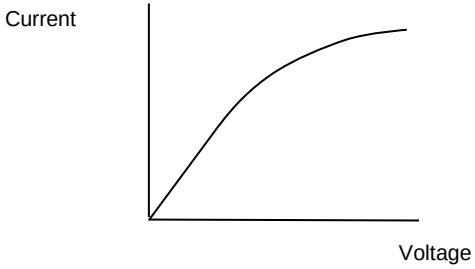
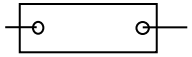
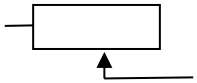
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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
		(b)	ii		3	Work = force × distance moved (written or implied) (1) $F = \frac{7.5}{2}$ (1-manip or sub) F = 3.75 [N] (1) **Alternative 1:** Mean speed = 0.25 [m/s] **ecf** Then time = $\frac{2}{0.25}$ = 8 [s] (1) Δp = 60 × 0.5 **ecf** = 30 (1) Force = $\frac{\Delta p}{t} = \frac{30\ \textbf{ecf}}{8\ \textbf{ecf}}$ = 3.75 [N] (1) **Alternative 2:** Mean speed = 0.25 [m/s] **ecf** Then time = $\frac{2}{0.25}$ = 8 [s] (1) $a = \frac{(v-u)}{t} = \frac{0.5\ \textbf{ecf}}{8\ \textbf{ecf}}$ = [-]0.0625 [m/s^2] (1) using $F = ma$ F = 60 × [-]0.0625 F = [-]3.75 [N](1)	$F \times d$ =7.5 for the first mark $F = \frac{7.5}{2}$ for the first 2 marks		
		Total			**12**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	5	*(a)*	i		2	Use of any pair of matching coordinates in the equation (1) e.g. 1.2 = $m \times 1.5$ m= 0.8 [kg] (1 – ans)	Any mathematical function of a matching pair award the 1st mark		
			ii	I	1	acceleration = $\frac{2.0}{0.8\ \textbf{ecf}}$ = 2.50 [m/s^2]			
				II	4	$a = \frac{(v-u)}{t}$ 2.5(**ecf**) $\frac{(v-0)}{0.6}$ v = 2.5 × 0.6 (1 – sub or manip) v = 1.5 [m/s] (1 – ans) momentum = 0.8 **(ecf)** × 1.5 (**ecf**) (1 – sub) = 1.2 [kg m/s] (1 – ans) **Alternative:** $\Delta p = F \times t = 2 \times 0.6 = 1.2$ [kg m/s] (4)	Accept error carried forward on mass from (b)(i) and from acceleration taken from graph.		
				III	2	The momentum / it does not change (1) as there is no [resultant] force acting on the trolley (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	momentum / it <u>decreases</u> (1) due to air resistance (1)		It changes as the slider slows down for the 1st mark
		(b)			2	Straight line drawn from origin ± ½ small square division and below the one given (1) **And** through point (1.2, 0.5) ± ½ small square division (1)			
		Total			**11**				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	6				6	**Indicative content:**  Resistance (in Ohms) is calculated each time by dividing the voltage (read from the voltmeter in volts) by the current (from the ammeter in amps). The results would show that as the voltage is increased, the resistance stays constant for low voltages and then increases as the voltage gets bigger and bigger. (The graph is initially straight and then curves showing a decreasing gradient.)  **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.	For power supply accept with or without box:  For variable resistor accept: 		Squares for ammeter, voltmeter or lamp $R = V \div C$

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
						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			**6**						

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4473/02

S15-4473-02

ADDITIONAL SCIENCE/PHYSICS

PHYSICS 2
HIGHER TIER

P.M. WEDNESDAY, 20 May 2015

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**11**	
2.	**7**	
3.	**6**	
4.	**14**	
5.	**13**	
6.	**9**	
Total	**60**	

4473 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. Do not use gel pen or correction fluid.

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.

If you run out of space, use the continuation page at the back of the booklet, taking care to number the question(s) correctly.

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

power = voltage × current	$P = VI$
current = $\frac{\text{voltage}}{\text{resistance}}$	$I = \frac{V}{R}$
power = current^2 × resistance	$P = I^2R$
speed = $\frac{\text{distance}}{\text{time}}$	
acceleration [or deceleration] = $\frac{\text{change in velocity}}{\text{time}}$	$a = \frac{\Delta v}{t}$
acceleration = gradient of a velocity-time graph	
distance travelled = area under a velocity-time graph	
momentum = mass × velocity	$p = mv$
resultant force = mass × acceleration	$F = ma$
force = $\frac{\text{change in momentum}}{\text{time}}$	$F = \frac{\Delta p}{t}$
work = force × distance	$W = Fd$
kinetic energy = $\frac{\text{mass} \times \text{speed}^2}{2}$	$KE = \frac{1}{2}mv^2$
change in potential energy = mass × gravitational field strength × change in height	$PE = mgh$

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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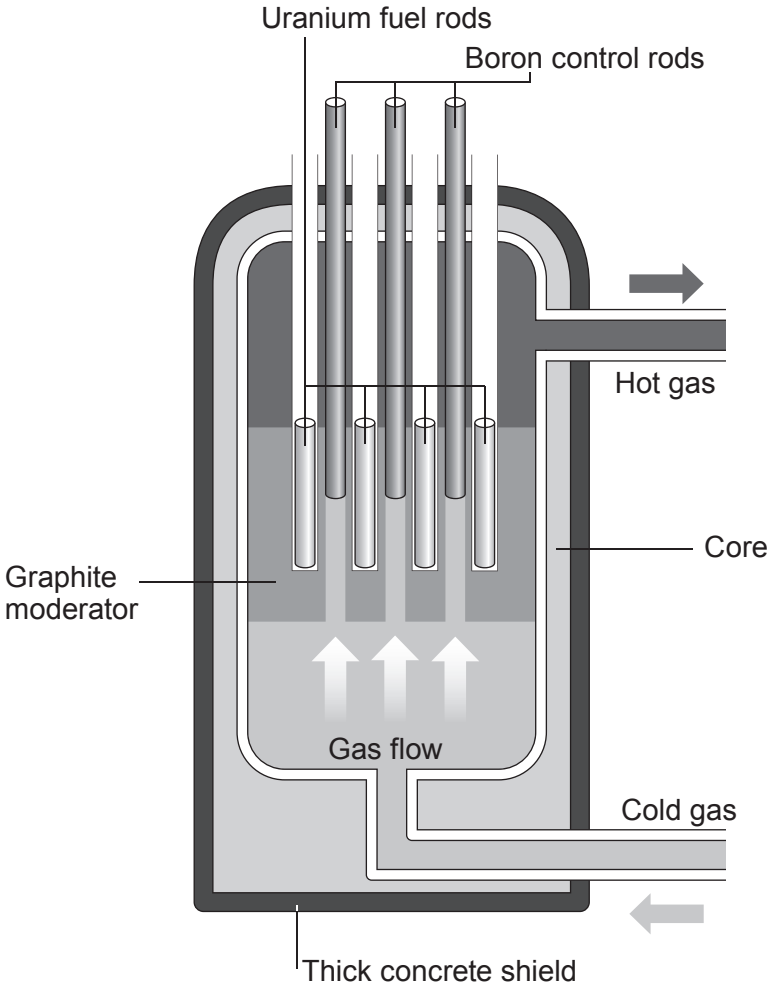
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Answer **all** *questions.*

1. Read the information in the passage and study the diagram before answering the questions that follow.

In the reactor, energy is released by fission and is the result of a controlled chain reaction. Fuel rods are made of uranium. The graphite moderator surrounds the fuel rods. The boron control rods can be raised and lowered.

The diagram shows the important parts in the core of a gas-cooled nuclear reactor.



(a) (i) Describe the process of fission of a single uranium nucleus in a gas-cooled reactor. [2]

.....

.....

.....

(ii) Explain the purpose of the graphite moderator. [2]

.....

.....

.....

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(iii) Explain why raising the boron control rods increases the energy released in the reactor. [2]

.....

.....

.....

(b) The table below shows different isotopes of uranium (U).

Isotope	Nuclear symbol
U-230	$^{230}_{92}U$
U-234	$^{234}_{92}U$
U-235	$^{235}_{92}U$
U-238	$^{238}_{92}U$

(i) Tick (✓) the boxes next to **three** correct statements about the isotopes shown in the table. [3]

All the isotopes have nuclei which contain 92 neutrons ☐

A nucleus of U-230 contains the least number of neutrons ☐

A nucleus of U-235 contains 143 neutrons ☐

A nucleus of U-234 contains 92 protons ☐

A nucleus of U-238 contains 238 protons ☐

(ii) Complete the following nuclear equations which show the decay of two of the uranium isotopes listed in the table above. [2]

$$^{238}_{92}U \rightarrow {}^{4}_{2}He + {}^{.....}_{90}Th$$

$$..... \rightarrow {}^{4}_{2}He + {}^{230}_{90}Th$$

11

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2. The table below shows information about some radioisotopes.

Radioisotope	Half-life	Method of decay
Tellurium-133	12 minutes	beta
Astatine-211	7.2 hours	alpha
Cobalt-60	5 years	beta and gamma
Caesium-137	30 years	beta
Americium-241	432 years	alpha

(a) Using the information in the table, select the most suitable radioisotope for the tasks below, and give reasons for your choice. [4]

(i) Treating cancer by injecting the radioisotope directly into the tumour.

Name of radioisotope: .....

Reasons:

I. .....

.....

II. .....

.....

(ii) To sterilise packaged surgical instruments.

Name of radioisotope: .....

Reasons:

I. .....

.....

II. .....

.....

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(b) A sample of tellurium-133 has an initial activity of 288 Bq.

(i) How many half-lives occur in 1 hour? ..... [1]

(ii) Calculate the activity of the sample after 1 hour. [2]

activity = ... Bq

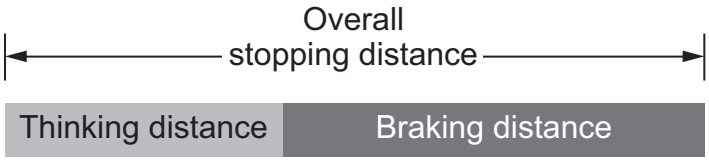
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3. The Highway Code provides information about stopping distances.



The **overall stopping distance** is divided into two parts, **thinking distance** and **braking distance.**

Some of the factors which affect the **overall stopping distance** are shown in the table below.

Column A	Column B	Column C
speed of the vehicle	condition of the brakes **or** road surface conditions	alcohol **or** tiredness

Choose **one factor** from **each column** of the table and describe fully how **the chosen factors** affect the distances described above. [6 QWC]

In your answer, include the following:

- the **three** factors you have chosen;
- for **each** factor refer to the thinking distance, braking distance and overall stopping distance;
- describe clearly whether these distances are **increased, decreased** or **unaffected** by the factor.

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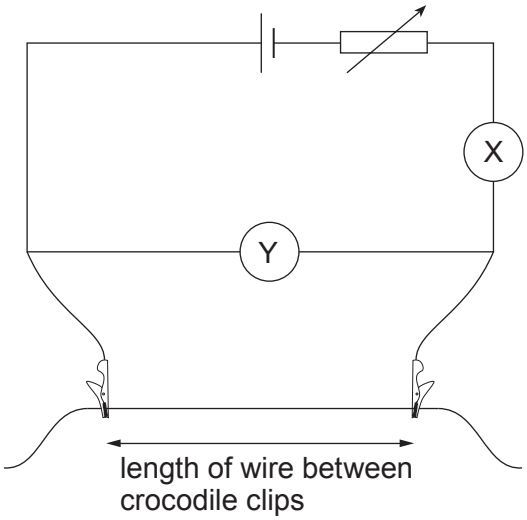
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4. The circuit shown is used to investigate how the current changes for different lengths of a wire. Each wire has the same thickness and is made from the same material.



The results from the experiment are displayed.

Length of wire (cm)	Voltage (V)	Current (A)
10	1.80	0.90
20	1.80	0.45
30	1.80	0.30
50	1.80	0.18
60	1.80	0.15
75	1.80	0.12

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(i) The student carrying out the experiment **cannot** say if these results are repeatable. Explain what she should do to enable her to judge the repeatability of her data. [2]

.....

.....

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(ii) The student **correctly** suggests that the **resistance** of the wire is directly proportional to its **length**. Explain how the results in the table agree with this statement. [3]

.....

.....

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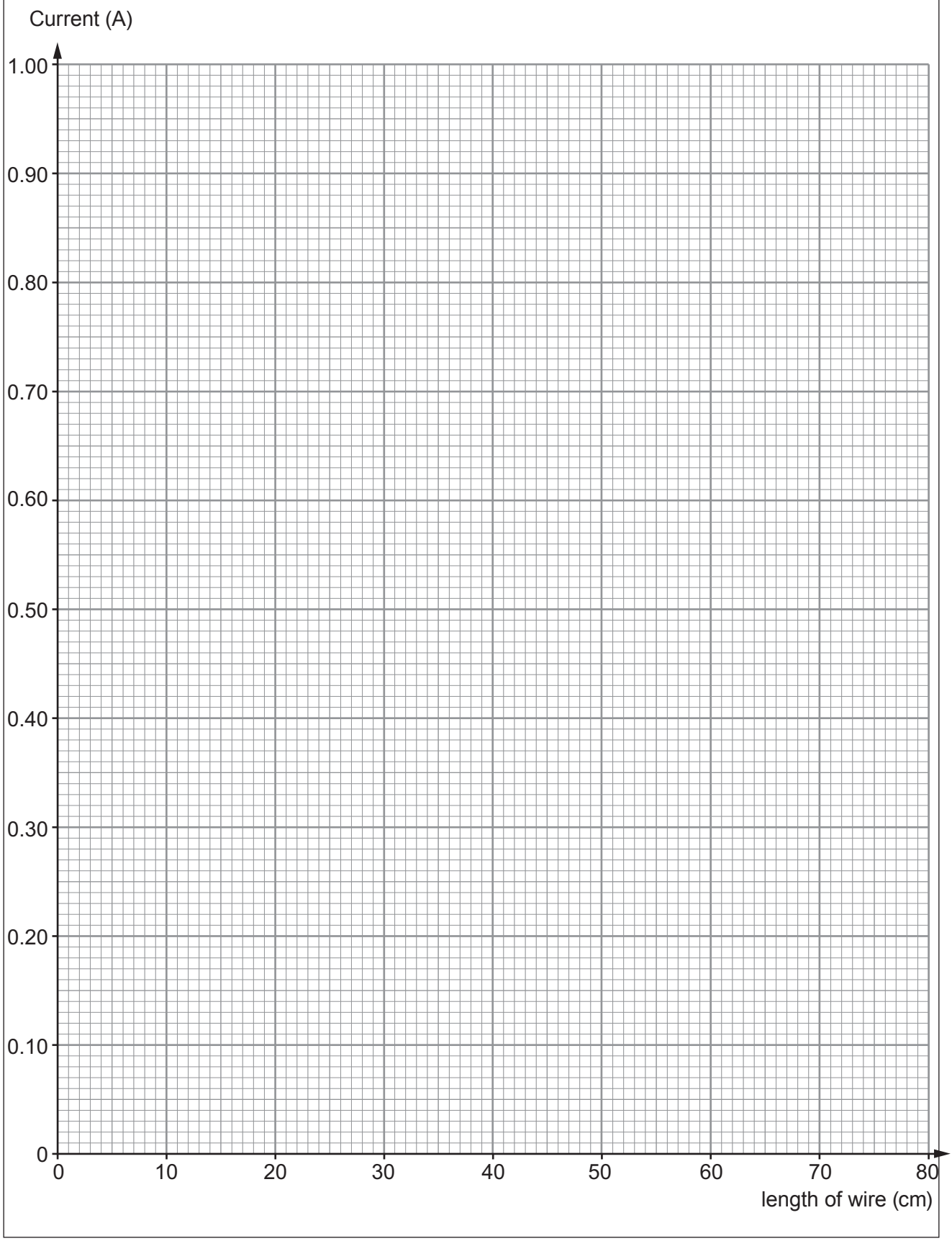
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(iii) Plot the data on the grid below and draw a suitable line. [3]



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(iv) Describe the relationship between the **length** of the wire and the **current**. [2]

.....

.....

.....

(v) The wire used in the experiment had been labelled by the science technician as $0.2\,\Omega$/cm.
Using your graph and the equation $V = IR$, explain if your results for a 45 cm length of wire agree with the information on the label. [4]

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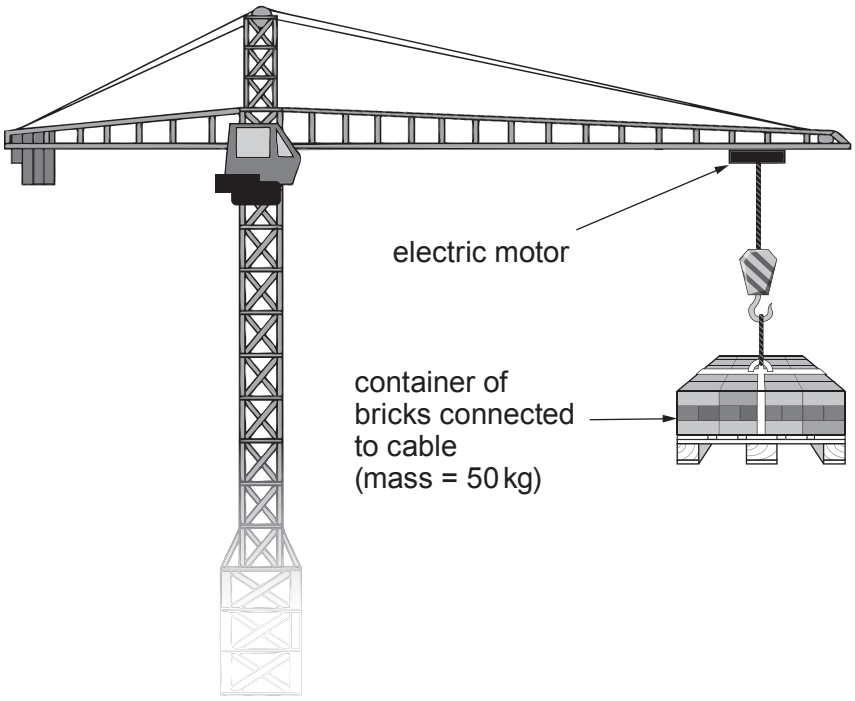
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5. A crane is used on a building site to vertically lift building materials. It uses an electric motor to winch a cable that is connected to a container full of bricks of mass 50 kg.



(a) (i) To lift the container of bricks the electric motor is supplied with a voltage of 120 V and a current of 5 A. Using an equation from page 2, calculate the power developed by the motor. [2]

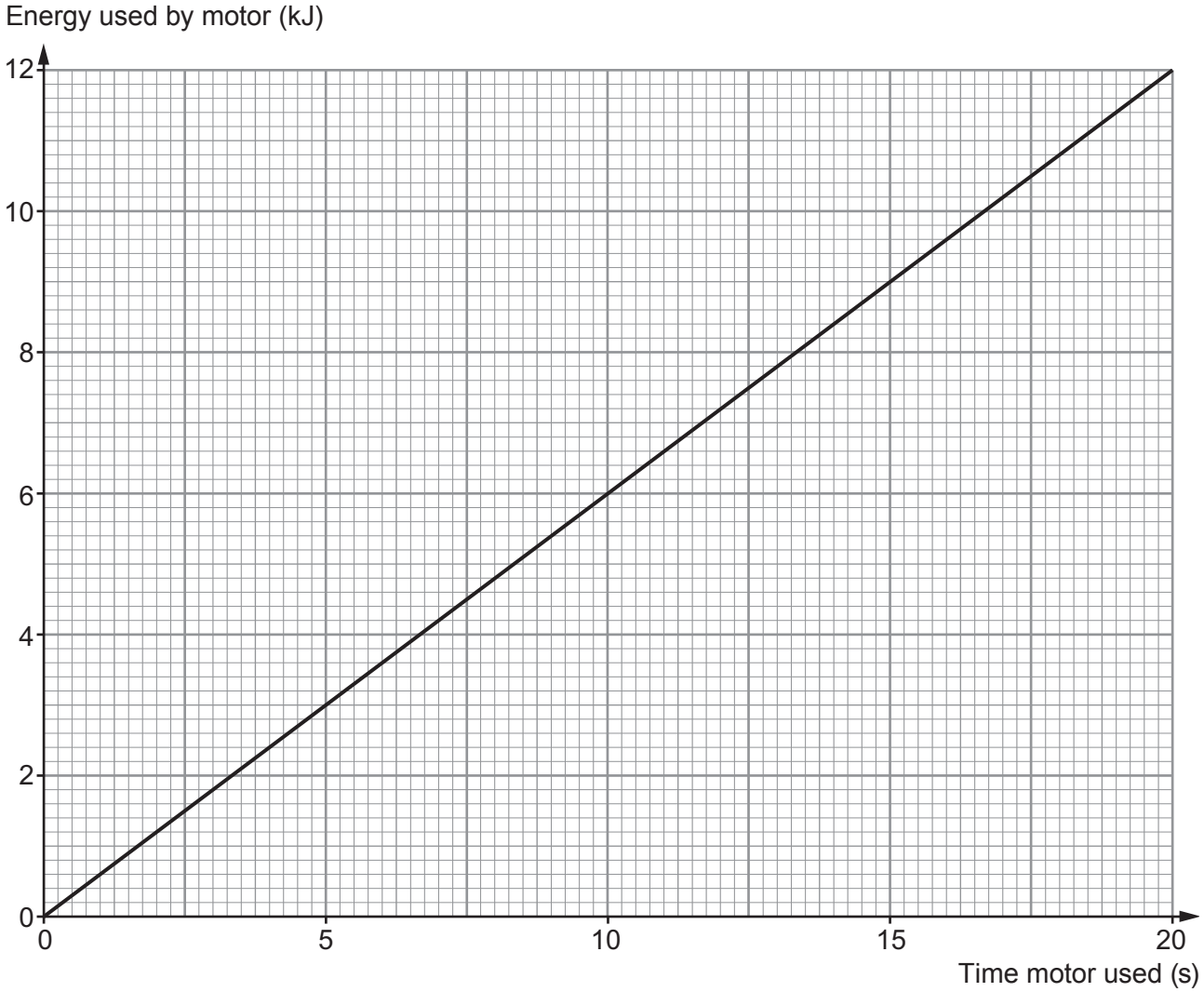
power = ... W

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(ii) The energy used by the motor increases with time as shown in the graph below.



The motor is used for 15 seconds to lift the container of bricks. State the amount of energy **(in J)** used by the motor to lift the container of bricks. [1]

energy = ... J

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(iii) The container of bricks is lifted through a height of 14 m. Using an equation from page 2, calculate the gain in gravitational potential energy whilst using the electric motor to lift the container of bricks. (g = 10 N/kg) [2]

potential energy gain = ... J

(iv) State why the answers to parts (ii) and (iii) are different. [1]

.....

.....

(b) The motor is stopped when the container of bricks reaches a height of 14 m. It is held stationary above the ground.

(i) Calculate the force in the cable. (g = 10 N/kg) [2]

force = ... N

(ii) The cable snaps. Using Newton's laws, explain the motion of the container of bricks. [2]

.....

.....

.....

(iii) Using your answer to *(a)*(iii) and an equation from page 2, calculate the **maximum** impact velocity of the container of bricks as they hit the ground. [3]

impact velocity = ... m/s

13

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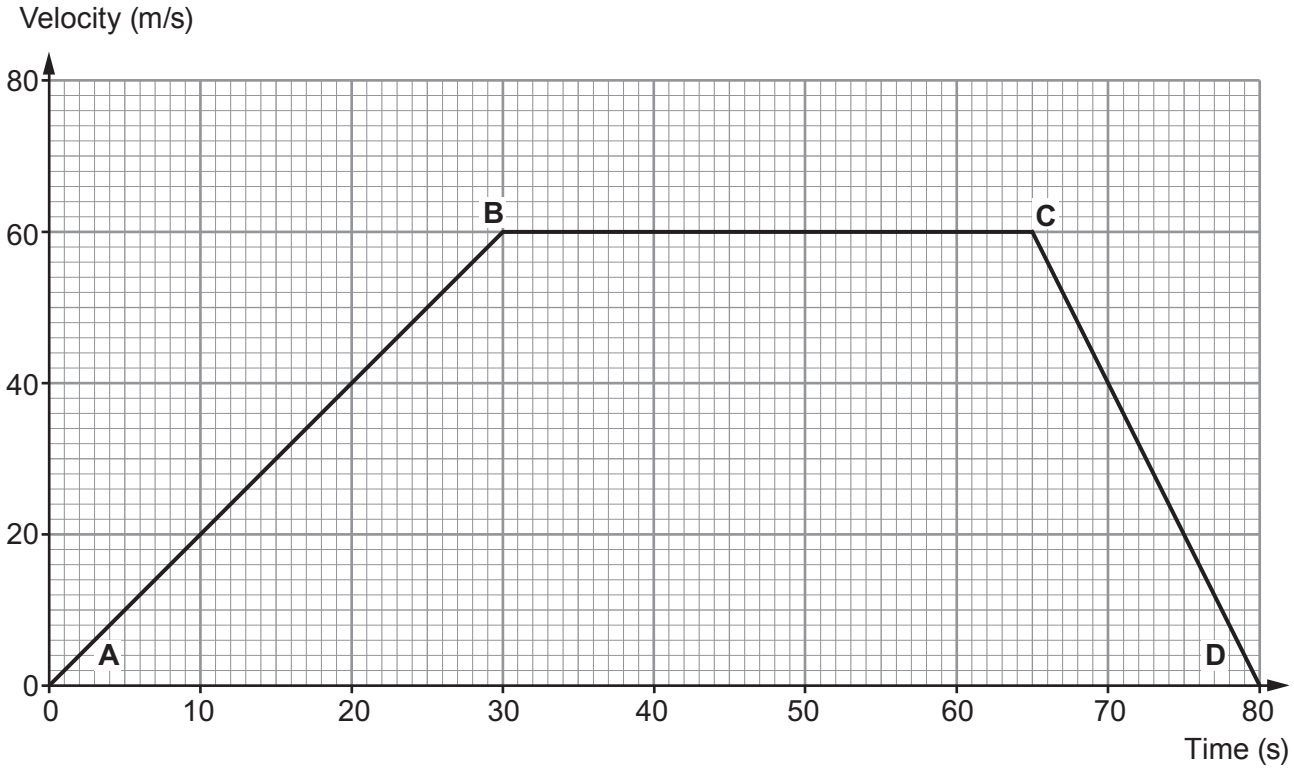
TURN OVER FOR THE LAST QUESTION

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6. Part of the journey of a car is shown by the graph below.



(a) Use information from page 2 to calculate the total distance travelled by the car. [3]

distance = ... m

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(b) A passenger in the car has a mass of 70 kg. Discuss how the **resultant force** on the passenger changes throughout the 80 s of the journey. [6 QWC]

Include in your answer:

- calculations to show the resultant force on the passenger at different stages in the journey;
- an explanation of how the resultant force affects the motion of the passenger at all stages.

9

END OF PAPER

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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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 2 Summer 2015
Foundation Tier

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
1		(a)			3	deceleration → m/s mean speed → m/s^2 time → m distance → s All 4 correct – 3 marks 2 or 3 correct – 2 marks 1 correct only – 1 mark	Squiggly lines		2 lines to one box (award no mark) 2 lines from any box (award no marks)
		(b)	(i)		1	5 [s] **and** 65 [s] (both answers required for 1 mark)			
			(ii)		2	acceleration = $\frac{40}{10}$ (1-sub), = 4 [m/s^2] (1-ans)	$\frac{10}{2.5}$ = 4 or any correct gradient calculation		
		(c)	(i)		2	momentum = 1 200 × 40 (1-sub) = 48 000 [kg m/s] (1-ans)			
			(ii)		2	$F = \frac{(0 - 48\,000)}{30}$ (ecf on 48 800) (1-for 30 shown anywhere) = [-] 1 600 [N] (1)	(48 000 – 0) or 48 000 in the numerator		30 on answer line
		Total Mark			10				

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Question Number								
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
2		(a)			2	Ticks in boxes 3 and 4 (2)	Crosses in boxes		Extra crosses in other boxes (minus 1 for each)
		(b)	(i)		1	400 [counts/min]			
			(ii)		1	100 [days]			
			(iii)		1	Same answer as (ii)			
			(iv)		1	Line drawn below the curve from (0,800) Allow ± one small square tolerance on (0,800) plot	Line that curves upwards at the end Line that does not extend all the way to 400		A straight line. A line that crosses / touches the one given / touches the time axis. Line on previous grid.
		Total Mark			6				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
3		(a)			2	$\frac{1.8}{6.0}$ (1-sub) = 0.3 (1-ans)	0.3 anywhere		$\frac{6.0}{1.8}$ = 0.3
		(b)			1	Current			Amps
		(c)	(i)		3	Points plotted within ± ½ small square division (2) (-1 mark for each incorrect plot to a maximum of 2 marks) Straight line of best fit ± ½ small square division on each point within the range of values plotted (i.e. 10 - 75 cm) (1)			Line joined dot to dot, whispy lines, double lines
			(ii)		2	As length increases resistance increases (1) In a uniform way / steady rate (1)	Bigger wire / In a linear way / In proportion. Resistance is [directly] proportional to length **gets 2 marks.** It is proportional **gets 2 marks.** For <u>every</u> 10 cm resistance increases by 2 Ω **gets 2 marks.** Length is equal to 5 times the resistance **gets 2 marks.** 10 cm has 2 Ω resistance and 20 cm has 4 Ω resistance **gets 1 mark.** As length increases resistance increases equally **gets 1 mark**		Stronger resistance. Graph is proportional

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
		(d)			2	The resistance of 100 cm would be 20 Ω / 30 Ω requires a 150 cm length (1) therefore the statement is not true (1) **ecf** it must be consistent with the first mark **The 2nd mark can only be awarded if it is linked to the 1st mark.**	10 cm has 2 Ω so 100 cm is not 30 Ω **gets 1 mark only**		
		(e)			1	Yes - To check repeatability **or** No- Results all lie on a straight line / there are no anomalous results	To check if the results match.	Any reference to reliability or accuracy.	To make it more repeatable. Make sure they're right / ok
		Total Mark			11				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
4		(a)			2	P = 120 × 5 (1 - substitution) = 600 [W] (1)			
		(b)	(i)		2	Mass is a measure of inertia of the bricks (1) Weight is [a measure of the force of] gravity acting on the bricks (1)	Mass is the amount of material (stuff) / matter / particles in an object. Mass is in kg and weight is in N **gets 1 mark**		Number of particles. Weight is how heavy it is.
			(ii)		1	mass = $\frac{5\,000}{10}$ = 500 [kg]			
		(c)	(i)		2	5 000 and 400 used in addition or subtraction (1) 5 400 [N] (1)	Answer only of 4 600 **gets 1 mark**		
			(ii)	I	1	"bigger than"			
				II	1	"equal to"			
		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	Uranium [nucleus] / it absorbs neutron[s] (1) splits into 2 [smaller] nuclei and neutrons [are released] (1)	Atoms Neutron capture Named elements		Force of impact shatters nucleus. Don't accept collides.
			(ii)		2	Slows down the neutrons (1) **so** they can be absorbed / captured by uranium [nuclei] (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	For 2nd mark: Split uranium nuclei **or** they cause fission of uranium **or** the reaction of uranium		
			(iii)		2	Fewer or no neutrons absorbed (1) **so** increase [in rate of] fission [of uranium nuclei] (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	For 1st mark: So more neutrons available for fission		Taken out / removed / more energy released
		(b)	(i)		3	Ticks in the 2nd, 3rd and 4th boxes A nucleus of U-230 least number of neutrons (1) ✓ A nucleus of U-235 contains 143 neutrons (1) ✓ A nucleus of U-234 contains 92 protons (1) ✓			Extra tick attracts -1
			(ii)		2	234 (1) $^{234}_{92}U$ (1) as shown here			
		Total Mark			11				

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
6		(a)	(i)		2	**No credit is given for just naming the radioisotope** **Astatine** Alpha particles highly ionising **or** easily absorbed [by cancer cells] **or** would not penetrate beyond the tumour [to affect healthy cells] (1) It decays [to a safe level] quickly or equivalent (1) **<u>Alternative solution:</u>** **Tellurium** Beta penetrates all of the tumour (1) It decays [to a safe level] quickly or equivalent (1)	Alpha is not able to spread far [The source] won't last long in the body		**Answers for any other radioisotope** Attacks / kills the cancer cells the best. It is highly ionising. Any statement implying that it leaves the body quickly / the half-life is short.
			(ii)		2	**Cobalt / Caesium** Beta / gamma will penetrate the <u>packaging/box</u> **or** kills bacteria (1) It won't need replacing for a long time / it lasts a long time (1)			It has a long half-life
		(b)	(i)		1	5			
			(ii)		2	288 – 144 – 72 – 36 – 18 - 9 Process of halving from 288 (1) 5 times to arrive at 9 (1) **ecf**	Answer only of 9 **gets 2 marks**		An incorrect answer with no workings shown <u>e.g. 18</u> except for 4 half-lives in (b)(i) which gets 2 marks
		Total Mark			7				

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Question Number								
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
7					6	**Indicative content:** If the vehicle is travelling faster then the thinking distance is increased and the braking distance is also increased. This means that the overall stopping distance is greater (or the converse for a vehicle travelling more slowly). If the brakes are worn (or poor road surface conditions) the thinking distance is unaffected but the braking distance is increased. This again leads to an increased stopping distance (or the converse for new brakes). If the driver has drunk alcohol or is tired the reaction time is bigger and so the thinking distance is greater. Although the braking distance is unaffected the overall stopping distance is greater. **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 2 Summer 2015
Higher Tier

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	1	(a)	(i)		2	Uranium [nucleus] / it absorbs neutron[s] (1) splits into 2 [smaller] nuclei and neutrons [are released] (1)	Atoms Neutron capture Named elements		Force of impact shatters nucleus. Don't accept collides.
			(ii)		2	Slows down the neutrons (1) **so** they can be absorbed / captured by uranium [nuclei] (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	For 2nd mark: Split uranium nuclei **or** they cause fission of uranium **or** the reaction of uranium		
			(iii)		2	Fewer or no neutrons absorbed (1) **so** increase [in rate of] fission [of uranium nuclei] (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	For 1st mark: So more neutrons available for fission		Taken out / removed / more energy released
		(b)	(i)		3	Ticks in the 2nd, 3rd and 4th boxes A nucleus of U-230 least number of neutrons (1) ✓ A nucleus of U-235 contains 143 neutrons (1) ✓ A nucleus of U-234 contains 92 protons (1) ✓			Extra tick attracts -1
			(ii)		2	234 (1) $^{234}_{92}U$ (1) as shown here			
		Total Mark			11				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	2	(a)	(i)		2	**No credit is given for just naming the radioisotope** **Astatine** Alpha particles highly ionising **or** easily absorbed [by cancer cells] **or** would not penetrate beyond the tumour [to affect healthy cells] (1) It decays [to a safe level] quickly or equivalent (1) **Alternative solution:** **Tellurium** Beta penetrates all of the tumour (1) It decays [to a safe level] quickly or equivalent (1)	Alpha is not able to spread far [The source] won't last long in the body		**Answers for any other radioisotope** Attacks / kills the cancer cells the best. It is highly ionising. Any statement implying that it leaves the body quickly / the half-life is short.
			(ii)		2	**Cobalt / Caesium** Beta / gamma will penetrate the packaging/box **or** kills bacteria (1) It won't need replacing for a long time / it lasts a long time (1)			It has a long half-life
		(b)	(i)		1	5			
			(ii)		2	288 – 144 – 72 – 36 – 18 - 9 Process of halving from 288 (1) 5 times to arrive at 9 (1) **ecf**	Answer only of 9 **gets 2 marks**		An incorrect answer with no workings shown e.g. 18 except for 4 half-lives in (b)(i) which gets 2 marks
		Total Mark			7				

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Question Number								
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	3				6	**Indicative content:** If the vehicle is travelling faster then the thinking distance is increased and the braking distance is also increased. This means that the overall stopping distance is greater (or the converse for a vehicle travelling more slowly). If the brakes are worn (or poor road surface conditions) the thinking distance is unaffected but the braking distance is increased. This again leads to an increased stopping distance (or the converse for new brakes). If the driver has drunk alcohol or is tired the reaction time is bigger and so the thinking distance is greater. Although the braking distance is unaffected the overall stopping distance is greater. **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		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
	4		(i)		2	Repeat <u>the</u> experiment / gather more data (1) and if the current values or results are <u>close to the first set</u> of readings [the results are repeatable] (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	Or opposite comment		
			(ii)		3	As the length doubles the current is halved (1) V is constant (1) so the resistance doubles (1) **Alternative solution:** For a length of e.g. 10 cm, R = 2 Ω and for a length of e.g. 30 cm, R = 6 Ω (2) therefore tripling l, triples R (1) **For 2 marks, the first and third statements need to be linked**	When the length doubles the current is halved (1) since resistance is inversely proportional to current this agrees with the statement (1)		As length increases, current decreases so resistance increases
			(iii)		3	Points plotted within ± ½ small square division (2) (-1 mark for each incorrect plot to a maximum of 2 marks) Curved line of best fit ± one small square division of each point within the range 20 - 75 cm (1)			Line joined dot to dot, whispy lines, double lines
			(iv)		2	Award 2 marks for <u>inversely</u> proportional Award 1 mark for as the length increases current decreases	If length doubles, current is halved **gets 2 marks** Decreases at a decreasing rate **gets 1 mark**		Directly proportional. In a non-linear way for the 2nd mark

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Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
			(v)		4	0.2 A identified from the graph (1) will be dependent on their graph line $R = \frac{V}{I} = \frac{1.8}{0.2}$ = 9 [Ω] (1) **ecf** on 0.2 A So $\frac{9}{45}$ = 0.2 Ω/cm (1) **ecf** on 9 [Ω] Yes or No must be consistent with their answer (1) **Alternative solution:** V = 0.2 (1) × 0.2 = 0.04 V cm^{-1} (1) 0.04 × 45 cm = 1.8 V (1) So correct V (1) **Alternative solution:** R = 0.2 (1) × 45 = 9 Ω (1) $I = \frac{V}{R} = \frac{1.8}{9}$ = 0.2 A (1) So correct value for I (1)	0.2 A identified from the graph (1) will be dependent on their graph line Resistance = 0.2 × 45 = 9 Ω (1) $V = IR$ = 0.2 × 9 = 1.8 V (1) Yes because that was the voltage used (1)		$V = IR$ = 0.2 × 45 = 9 Ω
		Total Mark			14				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	5	(a)	(i)		2	$P = VI$ = 120 × 5 (1) = 600 [W] (1)			
			(ii)		1	9 000 [J]	9 if k placed before J		9 kJ if given J not crossed out
			(iii)		2	GPE = mgh = 50 × 10 × 14 (1) = 7 000 [J] (1)			
			(iv)		1	Lost as heat / due to friction / energy to lift blocks and hook			Lost to atmosphere / energy wasted / energy lost / air resistance
		(b)	(i)		2	50 (1) × 10 = 500 [N] (1)	$F = \frac{W}{d}$ $= \frac{7\,000(1)}{14}$ = 500 [N] (1)		$\frac{9\,000}{14}$ Substitution of 50 into the PE equation
			(ii)		2	Resultant / unbalanced force (1) so velocity increases / object accelerates (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**			Statements of Newton's laws Reference to air resistance
			(iii)		3	Change in GPE = gain in KE (1) KE = ½ mv^2 => v^2 = $\frac{2KE}{m}$ (1 rearranged) **ecf** from (a)(iii) $\frac{2 \times 7\,000}{50}$ = 280 [m^2/s^2] => v = 16.7 [m/s] (1)	Answer of 17 [m/s]		7 000 substituted into any equation other than an energy one
		Total Mark			13				

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Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	6	(a)			3	Area: (½ × (60 × 30)) + (60 × 35) + (½ × (60 × 15)) So: (900 + 450) (1) - triangles + 2 100 (1) - rectangle = 3 450 [m] (1) **Alternative solution:** Area of a trapezium = ½ × (80 + 35) (1) × 60 (1) = 3 450 [m] (1)			
		(b)			6	**Indicative content:** In the first 30 s there is a resultant force acting in the forward direction which makes the passenger accelerate. Calculations to show the acceleration is 2 m/s^2 and the force is 140 N. Between 30 and 65 s the speed is constant so the resultant force is zero. For the last 15 s the there is a resultant force opposite/backward causing the passenger to decelerate to zero. Calculations to show the deceleration is 4 m/s^2 so the force is 280 N. **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			9				

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4473/02

W15-4473-02

ADDITIONAL SCIENCE/PHYSICS

PHYSICS 2
HIGHER TIER

P.M. THURSDAY, 15 January 2015

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**15**	
2.	**12**	
3.	**11**	
4.	**9**	
5.	**7**	
6.	**6**	
Total	**60**	

4473
020001

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

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.

If you run out of space, use the continuation pages at the back of the booklet, taking care to number the question(s) correctly.

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 **2***(b)*(i) and **6**.

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Equations

power = voltage × current	$P = VI$
resistance = $\frac{\text{voltage}}{\text{current}}$	$R = \frac{V}{I}$
power = current^2 × resistance	$P = I^2R$
speed = $\frac{\text{distance}}{\text{time}}$	
acceleration [or deceleration] = $\frac{\text{change in velocity}}{\text{time}}$	$a = \frac{\Delta v}{t}$
acceleration = gradient of a velocity-time graph	
distance travelled = area under a velocity-time graph	
momentum = mass × velocity	$p = mv$
resultant force = mass × acceleration	$F = ma$
force = $\frac{\text{change in momentum}}{\text{time}}$	$F = \frac{\Delta p}{t}$
work = force × distance	$W = Fd$
kinetic energy = $\frac{\text{mass} \times \text{speed}^2}{2}$	$KE = \frac{1}{2}mv^2$
change in potential energy = mass × gravitational field strength × change in height	$PE = mgh$

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 class of students were using dice to model radioactive decay.

- There were 8 groups of students.
- Each group of students had 50 dice.
- The 50 dice were rolled.
- Any that landed with a 6 facing upwards were removed.
- The remaining dice were counted.
- The remaining dice were rolled again and again, taking away the 6's each time.
- The table shows the results from one group and from the whole class.

Roll number	Number of dice remaining	
	One group's results	Class results
0	50	400
1	42	330
2	37	280
3	28	230
4	26	190
5	22	160
6	18	130
7	13	110
8	5	90

(a) Each group's results were added together to give the class results. Give **one** reason why the bigger sample size makes the data more repeatable. [1]

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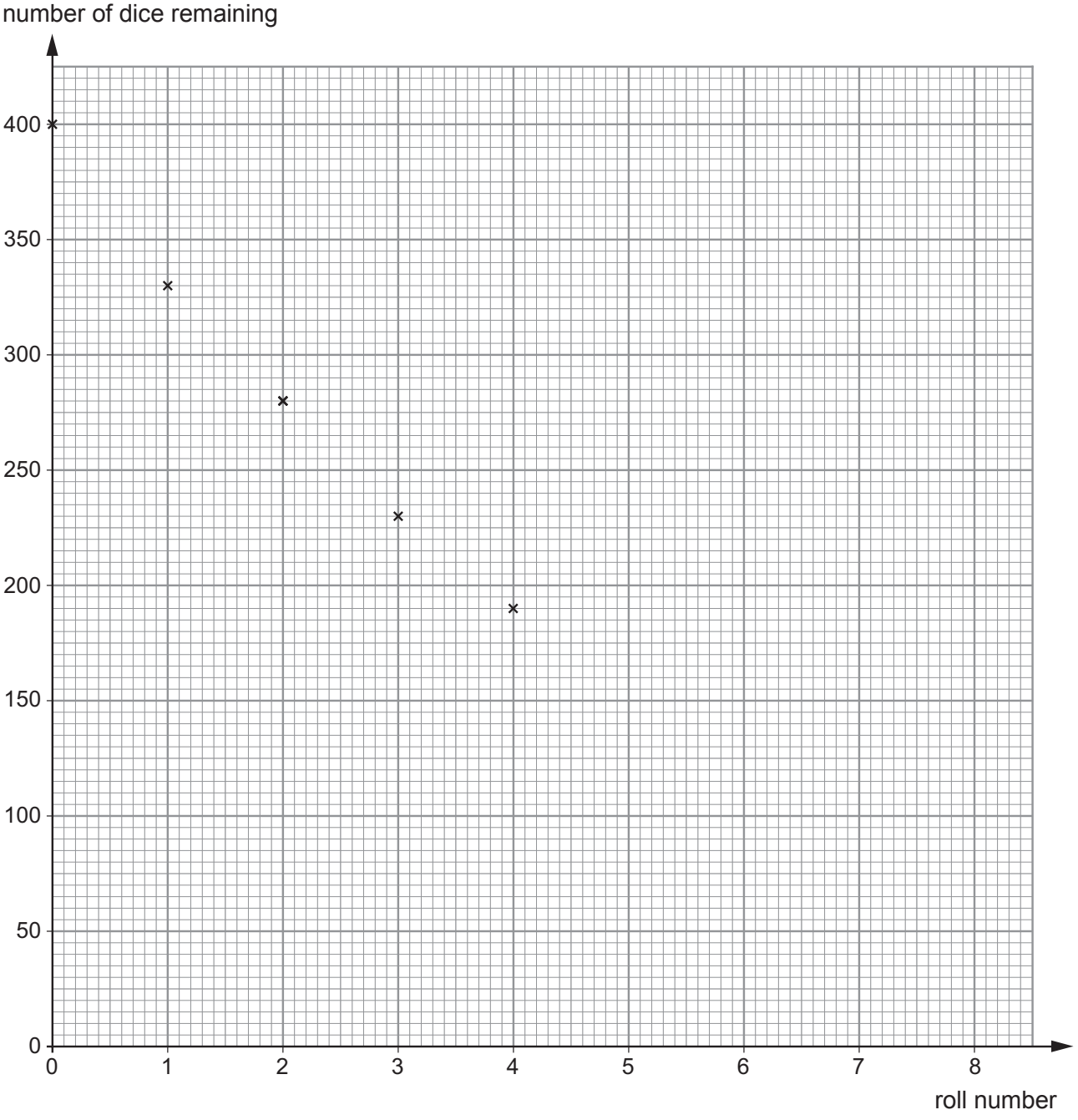
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(b) The graph shows part of the data from the whole class.
Plot the remaining data and draw a suitable line. [3]



(c) The "half-life" for this modelled decay is the number of rolls needed for the number of dice to halve. *(The number of rolls will include fractions.)*

(i) Use the class results in the table on page 4 to estimate the half-life. [1]

half-life = ... rolls

(ii) Now use the graph to find the half-life. Show the method you use on the graph. [2]

half-life = ... rolls

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(iii) Suggest why it is better to use the graph than the table to estimate the half-life. [1]

.....

.....

(iv) Use the graph to find how many rolls it took for the number of dice to fall to $\frac{1}{4}$ of the original value. Comment on your answer. [2]

number of rolls = ...

.....

.....

(d) An experiment was carried out to obtain similar data using the radioactive isotope, protactinium 234, which is a beta emitter. The **initial count** rate was measured to be 80 counts per second. After 210 s the count rate had dropped to 10 counts per second.

(i) Find the half-life of protactinium 234. [2]

half-life = ... s

(ii) Calculate how long it would take for the count rate to drop from 80 to 2.5 counts per second. [2]

time taken = ... s

(iii) State the unit of activity of a radioactive source. [1]

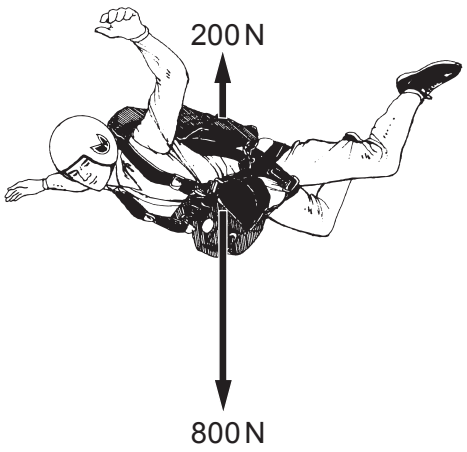
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2. *(a)* A skydiver of mass 80 kg weighs 800 N.



Use the equation:

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

to calculate the acceleration of a skydiver of mass 80 kg when the air resistance force is 200 N. [3]

acceleration = ... m/s^2

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(b) When a skydiver opens a parachute, he decelerates until he reaches a small terminal speed of about 3 m/s for landing.



(i) Discuss the above statement. Include in your answer the following points:

- An explanation in terms of forces – why a skydiver decelerates when the parachute is opened.
- An explanation of how a small terminal speed is achieved for landing. [6 QWC]

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(ii) The correct size of parachute is important to give a small terminal speed. A heavy person needs to have a different size parachute from a lighter person.

Explain why a heavier person needs a different area parachute from a lighter person to achieve the same small landing speed. [3]

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12

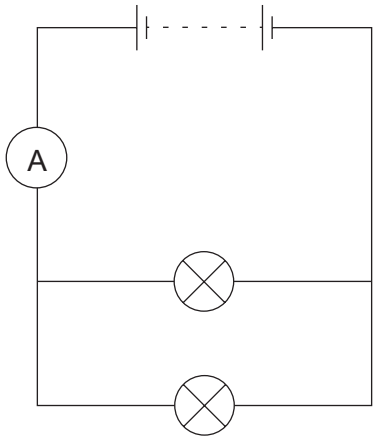
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3. Two identical lamps, each having a constant resistance of 8 Ω are connected as shown. In this circuit the lamps each have a power output of 18 W.



(a) (i) Use an equation from page 2 to calculate the current through each lamp. [3]

current = ... A

(ii) Write down the reading on the ammeter. [1]

..... A

(iii) Use the equation $V = IR$ to calculate the voltage of the battery. [2]

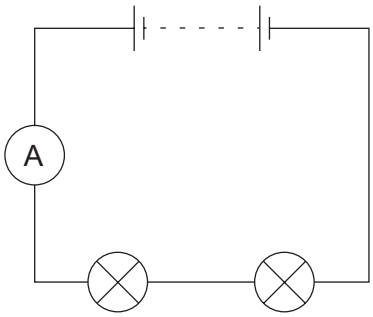
voltage = ... V

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(b) The same two lamps are now connected in series with the same battery.



(i) Explain why the ammeter reading has decreased. [2]

.....

.....

.....

(ii) Calculate the power dissipated by each lamp in **this** circuit, given that the current is 0.75 A. [2]

power = ... W

(iii) Give a reason why lamps are connected in parallel rather than in series in domestic circuits. [1]

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11

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Turn over.

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4. *(a)* State Newton's third law of motion. [2]

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.....

.....

(b) A bean bag of mass 0.5 kg is dropped from rest and takes 0.8 s to fall to the floor, which it hits without rebounding. (g = 10 N/kg = 10 m/s^2)

(i) While the bean bag is falling, the Earth's gravity is pulling it towards the centre of the Earth. Write down the size of the force exerted **by the bean bag on the Earth** and give its direction. [2]



force = ... N

direction = ...

(ii) Use an equation from page 2 to calculate the velocity with which the bean bag hits the ground. (Ignore air resistance.) [2]

velocity = ... m/s

(iii) The bean bag is stopped in 0.2 s.
Use an equation from page 2 and your answer from part (ii) to calculate the resultant force exerted to stop the bean bag. [3]

resultant force = ... N

9

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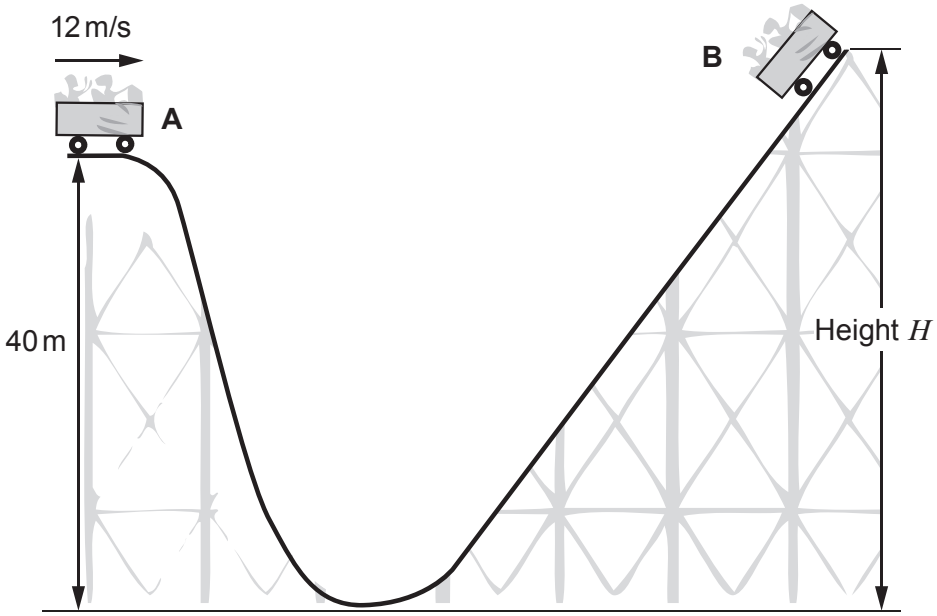
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5. A roller coaster car has no engine. The car and its passengers have a total mass of 1 500 kg. The car is shown as it passes over a peak of the ride which is 40 m high at point **A**. It has a speed of 12 m/s at this point. It then rolls down the track to ground level before moving up to point **B** where it comes to rest before rolling backwards again.



(i) Calculate the **total** energy of the car at **A**. (g = 10 m/s^2 = 10 N/kg) [3]

energy = ... J

(ii) For the car moving at 12 m/s at **A**, calculate the maximum height H that the car reaches before stopping at point **B**. [2]

height = ... m

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(iii) Explain why the car would not actually reach the height you have calculated in part (ii). [2]

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7

TURN OVER FOR QUESTION 6

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6. In nuclear reactors, uranium $^{235}_{92}\mathrm{U}$ undergoes fission when a neutron ($^{1}_{0}\mathrm{n}$) is absorbed. Products of this include krypton (Kr) and barium (Ba). The particles in the nuclei of these substances are shown below.

Element	Number of protons in the nucleus	Number of neutrons in the nucleus
Uranium	92	143
Krypton	36	54
Barium	56	88

Write a balanced **nuclear equation** for this reaction and explain how a controlled chain reaction is achieved inside the nuclear reactor. [6 QWC]

Equation:



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END OF PAPER

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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GCSE MARKING SCHEME

SCIENCE- PHYSICS

JANUARY 2015

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INTRODUCTION

The marking schemes which follow were those used by WJEC for the January 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
Physics 1 (Higher Tier)	6
Physics 2 (Foundation Tier)	11
Physics 2 (Higher Tier)	15

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GCSE Science - Physics 2 Mark Scheme

January 2015

FOUNDATION TIER

Question			Marking details	Marks
1.	(a)		increases (1) decreases (1) no change (1)	3
	(b)	(i)	$\frac{18}{30(1)}$ = 0.6 [s] (1) First mark is for dividing by 30	2
		(ii)	1 200 × 75 (1) = 90 000 [J] (1)	2
		(iii)	$\frac{30}{5}$ (1) = 6 [m/s^2] (1)	2
			Question total	**[9]**
2.	(a)	(i)	current	
		(ii)	current	
		(iii)	voltage	3
	(b)	(i)	subs $\frac{12}{8}$ (1) = 1.5 [A] (1)	2
		(ii)	3 [A] **ecf - answer must be double the answer to (b)(i)**	1
		(iii)	12 (1) × 1.5 (1)(**ecf must be 12 × answer to (b)(i)**) = 18 [W] (1)	3
	(c)		reduces current (1) by factor of 4 / to 0.75 A (1) **Don't accept** slows down current	2
			Question total	**[11]**

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Question			Marking details	Marks
3.	(a)	(i)	15 [m/s] (1)	1
		(ii)	900 [kg m/s] (1) **ecf**	1
		(iii)	$\frac{900(\text{ecf})}{6}$ = 150 (1) N **or** kg m/s^2 **or** Newtons (1)	2
	(b)		The same change in momentum happens in a shorter time / change in momentum per second is greater / increased deceleration (1) so force increases / is greater (1) **The 2nd mark must be linked to the 1st mark.**	2
	(c)		**Any 2 × (1) from:** Air bag, crumple zone, head rest, passenger cage, ABS (anti-locking) brakes, laminated windscreen, collapsible steering-wheel / side impact bars / child safety seat **Do not accept** flexible bumper / crumble zone / crash zone / head support	2
			Question total	**[8]**
4.	(a)		[He] 2 (1) [Fe] 56 (1)	2
	(b)		H or hydrogen	1
	(c)	(i)	$^{207}_{82}Pb$	1
		(ii)	$^{90}_{36}Kr + {}^{144}_{56}Ba$ (1) $2{}^{1}_{0}n$ (1) **Do not accept** krypton and barium written in full **Do not accept** Kr^{90}_{36} or Ba^{144}_{56}	2
	(d)	(i)	slows down	
		(ii)	absorb	2
			Question total	**[8]**

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Question			Marking details	Marks
5.	(a)		To smooth out random fluctuations in data / even out variations / reduces [the effect of] anomalies **Accept** less anomalies / odd results / closer estimate **Do not accept** prevents anomalies / more reliable / more accurate	1
	(b)		Plots (allow ± ½ small square division) (2) -1 for each error to a maximum of 2. Smooth curve of best fit drawn from last given point (4 rolls) onwards but must encompass all points (1)	3
	(c)	(i)	About 4 [rolls]. Accept any x where $4 > x > 3.6$ inclusive	1
		(ii)	Method shown on grid (1)[line across or down probably at 200] ~3.8 [rolls] (1-value taken from their graph ± 0.1)	2
		(iii)	Allows (more) <u>precise / accurate</u> value to be obtained / to nearest 0.1 of a roll **Accept** graph is more accurate **Don't accept** exact value / more reliable value	1
		(iv)	7.6 (1-value taken from graph ± 0.1) value is approximately 2 half-lives (1) **Don't accept** ¼ of original value	2
	(d)	(i)	Identifying 3 half-lives (1) $\frac{210}{3}$ = 70 [s] (1-ans) **Don't accept** 80→40→20→10 without any qualification	2
		(ii)	5 half-lives required (1) 5 × 70(**ecf**) = 350 [s] (1)	2
		(iii)	becquerel, **accept** bq, Bq, any reasonable spelling	1
			Question total	**[15]**

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Question			Marking details	Marks
6.	(a)		$\frac{(800\text{-}200)(1)}{80(1)}$ =7.5 (1-ans) [m/s^2] **Award 1 mark** for 600 anywhere	3
	(b)		**Indicative content:** When the parachute is opened, a big air resistance force is produced that acts upwards. This is bigger than the person's weight (downwards), the resultant force is upwards and so the person decelerates. As the speed decreases, the air resistance (or resultant force) decreases and the deceleration decreases. Eventually the speed becomes so low that the air resistance and weight become equal and the person falls at a (low) constant speed. **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 **[9]**
			FOUNDATION TIER PAPER TOTAL	**[60]**

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HIGHER TIER

Question			Marking details	Marks
1.	(a)		To smooth out random fluctuations in data / even out variations / reduces [the effect of] anomalies **Accept** less anomalies / odd results / closer estimate **Do not accept** prevents anomalies / more reliable / more accurate	1
	(b)		Plots (allow ± ½ small square division) (2) -1 for each error to a maximum of 2. Smooth curve of best fit drawn from last given point (4 rolls) onwards but must encompass all points (1)	3
	(c)	(i)	About 4 [rolls]. Accept any x where $4 > x > 3.6$ inclusive	1
		(ii)	Method shown on grid (1)[line across or down probably at 200] ~3.8 [rolls] (1-value taken from their graph ± 0.1)	2
		(iii)	Allows (more) <u>precise / accurate</u> value to be obtained / to nearest 0.1 of a roll **Accept** graph is more accurate **Don't accept** exact value / more reliable value	1
		(iv)	7.6 (1-value taken from graph ± 0.1) value is approximately 2 half-lives (1) **Don't accept** ¼ of original value	2
	(d)	(i)	Identifying 3 half-lives (1) $\frac{210}{3}$ = 70 [s] (1-ans) **Don't accept** 80→40→20→10 without any qualification	2
		(ii)	5 half-lives required (1) 5 × 70(**ecf**) = 350 [s] (1)	2
		(iii)	becquerel, **accept** bq, Bq, any reasonable spelling	1
			Question total	**[15]**

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Question			Marking details	Marks
2.	(a)		$\frac{(800-200)(1)}{80(1)}$ =7.5 (1-ans) [m/s^2] **Award 1 mark** for 600 anywhere	3
	(b)	(i)	**Indicative content:** When the parachute is opened, a big air resistance force is produced that acts upwards. This is bigger than the person's weight (downwards), the resultant force is upwards and so the person decelerates. As the speed decreases, the air resistance (or resultant force) decreases and the deceleration decreases. Eventually the speed becomes so low that the air resistance and weight become equal and the person falls at a (low) constant speed. **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)	Bigger parachute / surface area (1) To give a bigger air resistance / upward force (1) To equal the [bigger] weight (1) **Either the 2nd mark must be linked to the 1st mark or the 3rd mark must be linked to the 2nd mark.**	3
			Question total	**[12]**

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Question			Marking details	Marks
3.	(a)	(i)	$P = I^2R$ 18 = $I^2$8 (1-sub), $I^2 = \frac{18}{8}$ (1-manip), I = 1.5 [A] (1-answer) **Award 2 marks** for an answer of 2.25 [A] **Award 1 mark** if substitution precedes manipulation.	3
		(ii)	3 [A] **ecf - answer must be double the answer to (i)**	1
		(iii)	Either $V = IR$ V = 1.5 **(ecf)** × 8 (1-sub), = 12 [V] (1) **ecf must be 8 × answer to (i)** **Or** accept $P = VI$ so $V = \frac{18}{1.5}$ **(ecf)** (1-sub+manip) = 12 [V] (1) **ecf applies to 1.5 the value used must be the answer to (i)**	2
	(b)	(i)	**Either:** Supply voltage is unchanged / **current** (**don't accept** amps) has decreased (1) so the circuit resistance must have increased. (1) **The 2nd mark must be linked to the 1st mark.** **OR** voltage across each bulb has decreased (1) and so the **current** (**don't accept** amps) has decreased / but the resistance of each bulb has not changed (1) **The 2nd mark must be linked to the 1st mark.**	2
		(ii)	$P = I^2R$ = 0.75^2 × 8 (1 – sub) = 4.5 [W] (1) **Or** accept $P = VI$ = 6 (**ecf** from (a)(iii)) × 0.75 (1 – sub) = 4.5 [W] (1) **Or** accept $P = V^2 / R$ = 6^2 (**ecf** from (a)(iii)) / 8 (1 – sub) = 4.5 [W] (1)	2
		(iii)	Lamps are more powerful (brighter) [in parallel] / if one fails then the others will still work / they can be switched independently **Accept** they have the supply voltage across them	1
			Question total	**[11]**

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Question			Marking details	Marks
4.	(a)		Equal and opposite forces (1) acting on different objects (1) Equal and opposite forces acting on the same object – **award 1 mark** **Award 2 marks** for action and reaction are equal and opposite	2
	(b)	(i)	Force = 5 [N](1) **accept** 4.9 [N] upwards (1)	2
		(ii)	$\Delta v = a \times t$ =10 × 0.8 (1-sub+manip) =8 [m/s](1-ans)	2
		(iii)	**EITHER:** $a = \frac{(8(\mathbf{ecf}))}{0.2} = 40\ [\mathrm{m/s^2}](1)$ $F = ma$ = 0.5 × 40 **(ecf)** (1) = 20 [N] (1) **OR:** $F = \frac{\Delta p}{t} = \frac{[0-]0.5x8(\mathbf{ecf})(1)}{0.2(1)} = 20$ [N](1) **OR:** Momentum [change] = 0.5 × 8 (**ecf**)(1) = 4 $F = \frac{4}{0.2}(1) = 20$ [N] (1)	3
			Question total	**[9]**
5.		(i)	$(\frac{1}{2}x1500x12^2) + (1500x10x40)$ =108 000 (1) + 600 000 (1) = 708 000 [J] (1- ans) **ecf** from PE or KE	3
		(ii)	**EITHER :** $h = \frac{708\ 000\ (\mathbf{ecf})}{1\ 500\ x\ 10}(1 - \mathbf{sub+manip}) = 47.2$ [m] (1-ans) **OR :** $mgh = \frac{1}{2}x1500x12^2$ so h = 7.2 [m] (1) Total h = 40 + 7.2 = 47.2 [m] (1) i.e. when applying **ecf** the following answers are produced: 108 000 [J] used → h = 7.2 [m] 600 000 [J] used → h = 40 [m]	2
		(iii)	Work done / energy lost / heat produced (1) Against friction / air resistance / resistive forces (1)	2
			Question total	**[7]**

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Question			Marking details	Marks
6.			$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{90}_{36}Kr + {}^{144}_{56}Ba + 2{}^{1}_{0}n$ **Indicative content:** This nuclear reaction only occurs with slow neutrons and so it is the job of the moderator, usually graphite or water, to slow down the neutrons that cause the reaction and those that are released. A controlled chain reaction is achieved by using control rods, usually of boron steel, being used to absorb some of the neutrons that are released in the reaction. Other neutrons are allowed to go on to fission other uranium nuclei. **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 **[6]**
			HIGHER TIER PAPER TOTAL	**[60]**

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4473/02

ADDITIONAL SCIENCE/PHYSICS

PHYSICS 2
HIGHER TIER

P.M. MONDAY, 19 May 2014

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**12**	
2.	**12**	
3.	**10**	
4.	**12**	
5.	**14**	
Total	**60**	

4473
020001

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

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.

If you run out of space, use the continuation page at the back of the booklet, taking care to number the question(s) correctly.

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 **2***(c)* and **5***(a)*.

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Equations

power = voltage × current	$P = VI$
current = $\frac{\text{voltage}}{\text{resistance}}$	$I = \frac{V}{R}$
power = current^2 × resistance	$P = I^2R$
speed = $\frac{\text{distance}}{\text{time}}$	
acceleration [or deceleration] = $\frac{\text{change in velocity}}{\text{time}}$	$a = \frac{\Delta v}{t}$
acceleration = gradient of a velocity-time graph	
distance travelled = area under a velocity-time graph	
momentum = mass × velocity	$p = mv$
resultant force = mass × acceleration	$F = ma$
force = $\frac{\text{change in momentum}}{\text{time}}$	$F = \frac{\Delta p}{t}$
work = force × distance	$W = Fd$
kinetic energy = $\frac{\text{mass} \times \text{speed}^2}{2}$	$KE = \frac{1}{2}mv^2$
change in potential energy = mass × gravitational field strength × change in height	$PE = mgh$

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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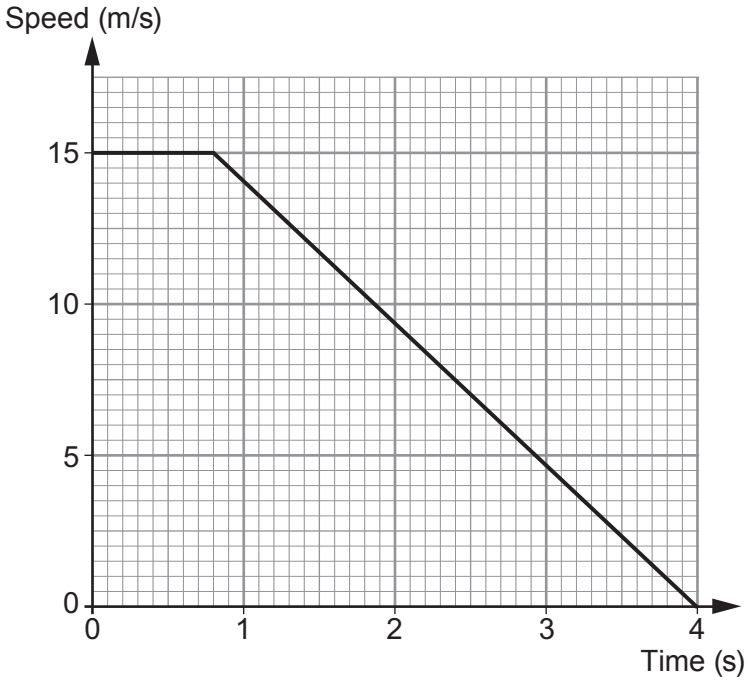
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Answer **all** *questions.*

1. A car is moving at a speed of 15 m/s. A child runs out into the road causing the driver to make an emergency stop.

(a) The graph shows how the speed of the car changes from the moment the driver sees the child.



(i) What was the reaction time of the driver? [1]

..... s

(ii) How long did it take the car to stop once the brakes were applied? [1]

..... s

(iii) Use an equation from page 2 to calculate the deceleration of the car. [2]

deceleration = ... m/s^2

(iv) Explain how the graph would be different for a driver who had drunk alcohol. [2]

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(v) Explain how the graph would be different if it had been a wet day. [2]

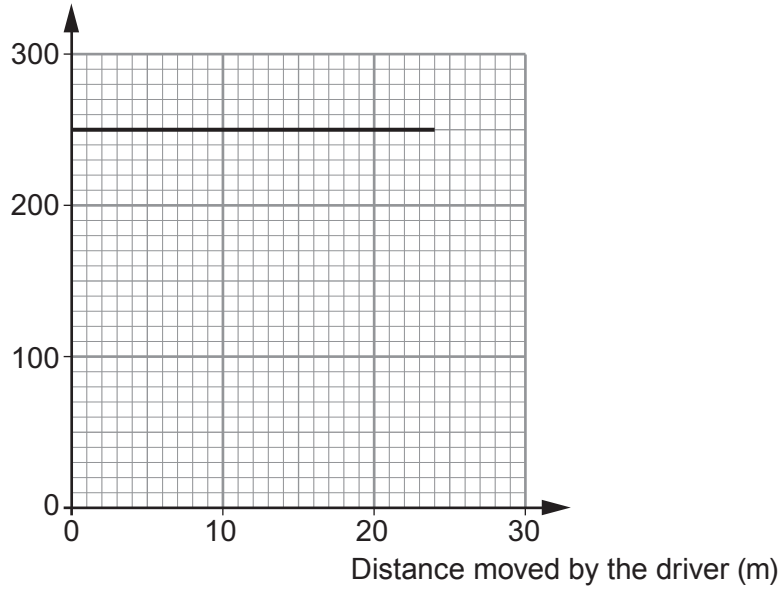
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(b) In an emergency stop, the driver in the car moves forward before being stopped by the seat belt.

The graph shows the force exerted by the seat belt on the driver during the emergency stop.



(i) Use an equation from page 2 to calculate the work done to stop the driver. [3]

work done = ... J

(ii) How much energy is transferred from the driver during the emergency stop? [1]

..... J

12

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2. Nuclear fission and nuclear fusion are examples of nuclear reactions. Typical nuclear fission and nuclear fusion reactions are shown below.

(a) (i) Complete the equation for the first reaction. [2]

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{90}_{\ldots\ldots}\mathrm{Sr} + {}^{144}_{54}\mathrm{Xe} + \ldots\ldots\ {}^{1}_{0}\mathrm{n}$$

$$^{2}_{1}\mathrm{H} + {}^{3}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n}$$

(ii) Explain how the first reaction could lead to an uncontrolled chain reaction. [2]

.....

.....

.....

(b) $^{2}_{1}\mathrm{H}$ and $^{3}_{1}\mathrm{H}$ are both isotopes of hydrogen.

Compare the structure of the **nuclei** of these two isotopes. [2]

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(c) Nuclear fission and nuclear fusion both produce heat energy. Describe and compare nuclear fission and nuclear fusion reactions. [6 QWC]

Include in your answer:

- what happens in each of the reactions;
- the problems associated with each reaction.

(You are **not** required to include any detail on moderators or control rods.)

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3. Living animals take in small amounts of radioactive carbon-14. After death, the amount of carbon-14 in their bodies decreases, because the carbon-14 atoms decay. The amount of carbon-14 remaining in the bones of an animal's skeleton can be used to estimate its age.

Carbon-14 is a beta emitter, with a half-life of 5 720 years.

(a) State what is meant by the following statements: [3]

(i) carbon-14 is a beta emitter;

.....

.....

(ii) carbon-14 has a half-life of 5 720 years.

.....

.....

.....

(b) Complete the decay equation for carbon-14 shown below. [3]

$$^{14}_{6}C \rightarrow \begin{matrix}\cdots\cdots\\ \cdots\cdots\end{matrix} N + \begin{matrix}\cdots\cdots\\ \cdots\cdots\end{matrix} e$$

(c) (i) A bone taken from a skeleton, found at an archaeological site, contains 10 units of carbon-14. An identical bone in a living animal contains 160 units of carbon-14. Use your understanding of half-life to calculate the age of the skeleton. [2]

age = ... years

(ii) Explain why this method of calculating the age of bones is unreliable for skeletons believed to be less than 100 years old. [2]

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4. On 14 October 2012 Felix Baumgartner created a new world record when he jumped from a stationary balloon at a height of 39 km above the surface of the Earth. At 42 s of free fall he reached a terminal velocity of 373 m/s, which was greater than the speed of sound. The total mass of Felix and his suit was 118 kg.

(a) Explain in terms of weight and air resistance how terminal velocity is reached. [3]

.....

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(b) (i) Use an equation from page 2 to calculate Felix's change in momentum in the first 42 s of his fall. [2]

change in momentum = ... kg m/s

(ii) Use an equation from page 2 to calculate the mean resultant force acting on him during the first 42 s. [2]

mean resultant force = ... N

(iii) Calculate the mean value of the air resistance force during the first 42 s. [3]

mean air resistance force = ... N

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(c) At 39 km the air particles are very far apart. Explain how jumping from this height allowed Felix to reach such a high terminal velocity. [2]

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12

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5. *(a)* Describe how you would investigate how the resistance of a filament lamp changes with the voltage. [6 QWC]

Include in your answer:

- a labelled circuit diagram;
- how you would obtain a range of results;
- how you would analyse the data.

TURN OVER FOR THE REST OF THE QUESTION.

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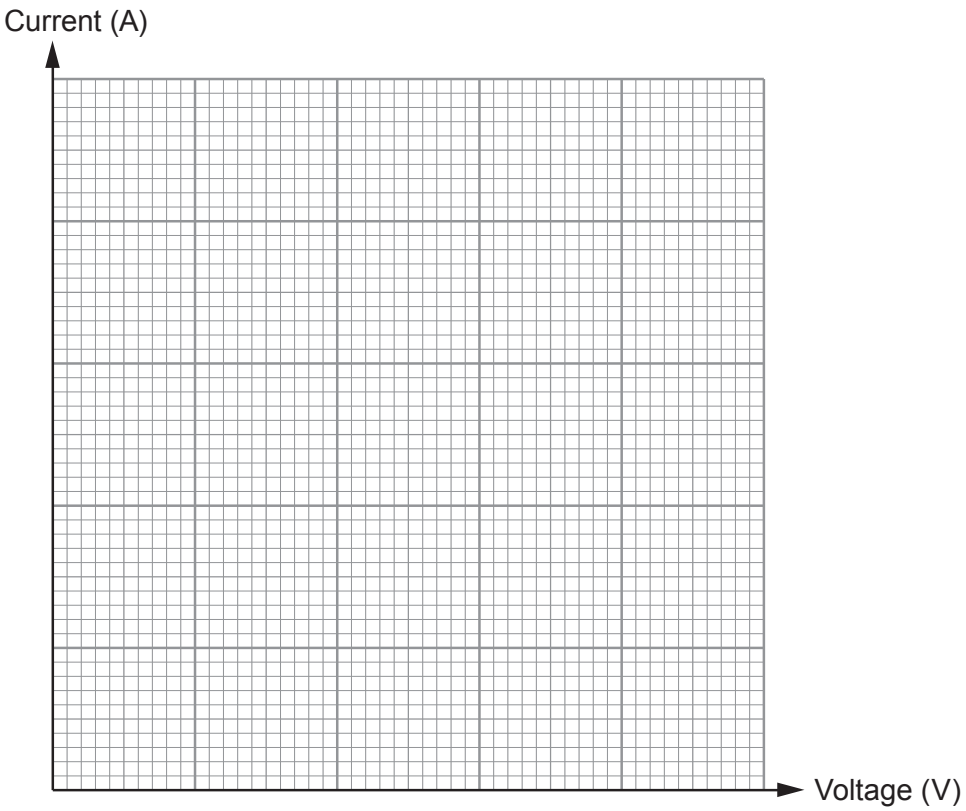
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(b) A table of results for a similar investigation is shown below.

Voltage (V)	Current (A)
0	0
2.0	1.0
4.0	1.4
6.0	1.7
8.0	1.9
10.0	2.0

(i) Plot the data on the grid below and draw a suitable line. [3]



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(ii) Use the graph and an equation from page 2 to calculate the resistance of the lamp at 5 V. [3]

resistance = ... Ω

(iii) Use the graph to explain how the resistance of the lamp changes as the voltage increases. [2]

.....

.....

.....

14

END OF PAPER

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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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 2

Marking Scheme - Summer 2014

FOUNDATION TIER

Question				Marking details	Marks
1.	(a)	(i)		ammeter (1) series (1)	2
		(ii)		same as	1
		(iii)		variable resistor	1
	(b)	(i)		plots (2) -1 for each error. (allow ± ½ small square division) line (1) allow ± ½ small square division. Don't allow wispy, wobbly, thick lines	3
		(ii)		(1-sub of any corresponding values from graph) e.g. $R = \frac{5}{2.5} = 2$ [Ω](1) **ecf**	2
				Question total	**[9]**
2.	(a)			Ticks in boxes 2, 4 and 6 (3). Lose a mark for any extra tick.	3
	(b)			Momentum = 100 × 373 (1-sub) = 37 300 [kg m/s] (1-ans)	2
	(c)			$F = \frac{37300}{42}$ (allow **ecf** from (*b*)) (1) = 888.095 [N] (**ecf**) (1) Accept 888 or 888.1 or 890 but not 888.09 (i.e. correct rounding off is required)	2
				Question total	**[7]**
3.	(a)	(i)		4 (half-lives) (1)	1
		(ii)		2 or 120 (allow **ecf** from (i) above) (1). Hours or minutes (1). **Unit must complement the answer.** Accept min or h but not m for unit. If the unit is given with the answer, the unit given must agree with it.	2
		(iii)		4 [grams] (allow **ecf** from (i) above) If answer of 16 in (i) then award **no mark** here for 64/16	1
	(b)			Emits gamma (1) so it would not ionise [cells] much / radiation can be detected outside of the body / can get out of the body (1) **Don't accept** doesn't harm. Only gamma passes through the skin **award 1 mark** only **OR** Has a short half-life / has a half-life of only 30 mins (1) but doesn't last for long in the body / decays quicker (1). **Accept** safe after a short time. **Don't accept** escape quickly. **To award both marks both statements must be linked.**	2
				Question total	**[6]**

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Question				Marking details	Marks
4.	(a)	(i)		9 [m]	1
		(ii)		2 [s]	1
	(b)			Speed = $\frac{9}{2}$ = 4.5 (**ecf** on (i) or (ii) above) [m/s] (1-ans)	1
	(c)			The distance**s** get / are bigger / balls get further apart. **Don't accept** further away.	1
	(d)			Distances between the ball positions would be less / the balls would be closer together.	1
				Question total	**[5]**
5.	(a)	(i)		Mass is the amount of inertia or material (accept "stuff" (1), whereas weight is the pull of gravity on the car (1). **Do not accept** that mass is measured in kg, weight is measured in Newtons.	2
		(ii)		weight = 800 × 10 = 8 000 [N] (1-ans)	1
	(b)	(i)		3 000 [N]	1
		(ii)		1 200 [N]	1
		(iii)		$a = \frac{1200(\text{ecf})(\text{ii})}{800}$ (1-sub) = 1.5 [m/s^2] (1-ans)	2
		(iv)		The [horizontal] forces become balanced (accept match / equal / level out) (1) because the air resistance (or drag) increases [with speed] (1) **To award both marks both statements must be linked.**	2
				Question total	**[9]**
6.	(a)	(i)		0.8 [s]	1
		(ii)		3.2 [s] (allow **ecf** from (i)) If answer is 3.2 in (i) then **don't accept** 0.8 as **ecf** in this part.	1
		(iii)		subs $\frac{15}{3.2(\text{ecf})}$ (1) = 4.69 or 4.7 or 4.6875 [m/s^2] (1) Ignore the signs. **Don't accept** 4.68 or 4.687. A common **ecf** is $\frac{15}{4.2}$ = 3.57 or 3.6	2
		(iv)		Horizontal line would be longer (1) because the reaction (or thinking) time (or distance) would be longer / would travel further [at constant speed] / slower reactions (1) **Don't accept** slower reaction time **To award both marks both statements must be linked.**	2

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Question				Marking details	Marks
		(v)		Less steep graph / sloping line is longer (1) because braking distance (or time) increases / takes longer to stop / smaller deceleration / less friction or grip (1) **Don't accept** not as fast to mean a greater braking distance. **Accept** slippery road. **To award both marks both statements must be linked.**	2
	(b)	(i)		250 **and** 24 from graph (1) subs 250 × 24 (1) = 6 000 [J] (1)	3
		(ii)		6 000 [J] (**ecf**)	1
				Question total	**[12]**
7.	(a)	(i)		38 (1) 2 (1)	2
		(ii)		Neutrons produced [go on to] cause more reactions **or** collisions **or** bombards (1), number of neutrons doubles (accept increase / multiply / triple) [each time] (1) Treat reference to fast neutrons as neutral. N.B. reference to 3 neutrons could arise from the equation above. **To award both marks both statements must be linked.**	2
	(b)			They contain same number of protons / 1 proton (1) but different number of neutrons / 1 neutron and the other has 2 neutrons (1) Reference to electrons loses 1 mark. **Don't accept** nucleons / mass number / atomic number	2
	(c)			**Indicative content:** In fission a heavy element such as [U 235] absorbs a neutron and splits into lighter nuclei [releasing energy]. In fusion, light elements [such as hydrogen isotopes] collide [in high energy collisions and join together] to produce a heavier element, [also releasing energy]. The main problem with nuclear fission is that it produces waste products which are highly radioactive for a long time. The main problem with nuclear fusion is that it requires very high temperatures and pressures which need lots of energy so it is not yet easily contained. **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.	6

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Question				Marking details	Marks
				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**	**[12]**
				Foundation tier paper total	**[60]**

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GCSE Science - Physics 2

Marking Scheme - Summer 2014

HIGHER TIER

Question				Marking details	Marks
1.	(a)	(i)		0.8 [s]	1
		(ii)		3.2 [s] (allow **ecf** from (i)) If answer is 3.2 in (i) then **don't accept** 0.8 as **ecf** in this part.	1
		(iii)		subs $\frac{15}{3.2(\text{ecf})}$ (1) = 4.69 or 4.7 or 4.6875 [m/s^2] (1) Ignore the signs. **Don't accept** 4.68 or 4.687. A common **ecf** is $\frac{15}{4.2}$ = 3.57 or 3.6	2
		(iv)		Horizontal line would be longer (1) because the reaction (or thinking) time (or distance) would be longer / would travel further [at constant speed] / slower reactions (1) **Don't accept** slower reaction time **To award both marks both statements must be linked.**	2
		(v)		Less steep graph / sloping line is longer (1) because braking distance (or time) increases / takes longer to stop / smaller deceleration / less friction or grip (1) **Don't accept** not as fast to mean a greater braking distance. **Accept** slippery road. **To award both marks both statements must be linked.**	2
	(b)	(i)		250 **and** 24 from graph (1) subs 250 × 24 (1) = 6 000 [J] (1)	3
		(ii)		6 000 [J] (**ecf**)	1
				Question total	**[12]**

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Question				Marking details	Marks
2.	(a)	(i)		38 (1) 2 (1)	2
		(ii)		Neutrons produced [go on to] cause more reactions **or** collisions **or** bombards (1), number of neutrons doubles (accept increase / multiply / triple) [each time] (1) Treat reference to fast neutrons as neutral. N.B. reference to 3 neutrons could arise from the equation above. **To award both marks both statements must be linked.**	2
	(b)			They contain same number of protons / 1 proton (1) but different number of neutrons / 1 neutron and the other has 2 neutrons (1) Reference to electrons loses 1 mark. **Don't accept** nucleons / mass number / atomic number	2
	(c)			**Indicative content:** In fission a heavy element such as [U 235] absorbs a neutron and splits into lighter nuclei [releasing energy]. In fusion, light elements [such as hydrogen isotopes] collide [in high energy collisions and join together] to produce a heavier element, [also releasing energy]. The main problem with nuclear fission is that it produces waste products which are highly radioactive for a long time. The main problem with nuclear fusion is that it requires very high temperatures and pressures which need lots of energy so it is not yet easily contained. **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]**

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Question				Marking details	Marks
3.	(a)	(i)		Emits an electron	1
		(ii)		It is the time taken to halve / it takes 5 720 years to halve(1) the number of C-14 nuclei (or atoms) / the mass (or amount) of C-14 / the activity / count rate (1) Treat radioactivity as neutral.	2
	(b)			$^{14}_{7}N$ (2) $^{0}_{-1}e$ (1) beware of missing minus sign	3
	(c)	(i)		It takes 4 half-lives (1) so time = 4 × 5 720 = 22 880 [years] (1)	2
		(ii)		100 years is only a [small] fraction or $\frac{1}{57}$ of a half-life (1) so difference in C-14 readings will be small / won't have decayed by very much (1) **To award both marks both statements must be linked.**	2
				Question total	**[10]**
4.	(a)			Initially weight is greater than air resistance [so he accelerates] (1) as he goes faster air resistance increases (1) eventually the forces balance (1) **To award all 3 marks the third statement written down must be linked to one of the previous two statements.**	3
	(b)	(i)		Change in momentum = 118 × 373 (1) = 44 014 [kg m/s] (1)	2
		(ii)		Resultant force = $\frac{44014}{42}$ (1) = 1 048 [N] (1) **ecf** from (i) OR use of $F = ma$ = 118 × 8.9 (1) = 1 050 [N] (1)	2
		(iii)		W = 118 × 10 = 1 180 N (1) Air resistance = W – resultant force or 1 180 – 1 048 (1) = 132 [N] (1) **ecf** from (ii) & on weight N.B. **Answer mark awarded only** if correct sign present e.g. 118 – 1 048 (1) = - 930 [N]	3
	(c)			Air resistance force small (1) because in contact with small number of air particles [per second] / so need to go very quickly for air resistance to balance weight / so need to go very quickly to reach terminal velocity (1) **To award both marks both statements must be linked.**	2
				Question total	**[12]**

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Question				Marking details	Marks
5.	(a)			**Indicative content:** Diagram showing the lamp connected in series with an ammeter, a variable power supply **or** a power supply with a variable resistor. A voltmeter is connected in parallel across the lamp. A pair of readings is taken from the ammeter and voltmeter. The variable resistor is adjusted [to vary the voltage across the lamp] and another pair of readings is taken. This is repeated. Results are plotted on a graph and the variation in resistance can be determined by how the slope changes **OR** the resistance of the lamp is calculated for each set of readings by using $V=IR$. **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
	(b)	(i)		Scales (at least ½ of each axis used) (1) plots (allow ± ½ small square division) (1) smooth curve allow ± ½ small square division (1) allow straight line between 0 and 2 and between 2 and 6 but expect a curve between 6 and 10. **Don't allow** wispy, wobbly, thick lines	3
		(ii)		Current from their graph (i.e. 1.6 A) (1), substitution (1), answer = 3.1 [Ω] (1) **ecf**	3
		(iii)		*R* must be increasing (1) Graph becomes less steep / as voltage increases, current increases less and less / an alternative method would be calculating another value of *R* (1) **To award both marks both statements must be linked.**	2
				Question total	**[14]**
				Higher tier paper total	**[60]**

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4473/02

ADDITIONAL SCIENCE/PHYSICS

PHYSICS 2
HIGHER TIER

P.M. THURSDAY, 16 January 2014

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**6**	
2.	**12**	
3.	**6**	
4.	**12**	
5.	**11**	
6.	**13**	
Total	**60**	

4473
020001

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use a gel pen. Do not use correction fluid.

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. If you run out of space, use the continuation pages at the back of the booklet, taking care to number the question(s) correctly.

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)*(i).

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Equations

power = voltage × current	$P = VI$
resistance = $\frac{\text{voltage}}{\text{current}}$	$R = \frac{V}{I}$
power = current^2 × resistance	$P = I^2R$
speed = $\frac{\text{distance}}{\text{time}}$	
acceleration [or deceleration] = $\frac{\text{change in velocity}}{\text{time}}$	$a = \frac{\Delta v}{t}$
acceleration = gradient of a velocity-time graph	
distance travelled = area under a velocity-time graph	
momentum = mass × velocity	$p = mv$
resultant force = mass × acceleration	$F = ma$
force = $\frac{\text{change in momentum}}{\text{time}}$	$F = \frac{\Delta p}{t}$
work = force × distance	$W = Fd$
kinetic energy = $\frac{\text{mass} \times \text{speed}^2}{2}$	$KE = \frac{1}{2}mv^2$
change in potential energy = mass × gravitational field strength × change in height	$PE = mgh$

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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4473
020003

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

1. A car is travelling at 15 m/s and decelerates to 0 m/s in 5 s on a dry road.

(i) Use an equation from page 2 to calculate the deceleration of the car. [2]

deceleration = ... m/s^2

(ii) (I) Use the equation:

$$\text{mean speed} = \frac{(\text{initial speed} + \text{final speed})}{2}$$

to calculate the mean speed of the car as it decelerates. [2]

mean speed = ... m/s

(II) Explain how the mean speed of the decelerating car travelling at 15 m/s would have changed (if at all) if the road had been icy instead of dry. [2]

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2. Isotopes of iodine can be used to study the thyroid gland in the body.

A small amount of the radioactive isotope is injected into a patient and the radiation is detected outside the body. Two isotopes that could be used are $^{123}_{53}\mathrm{I}$ and $^{131}_{53}\mathrm{I}$.

(a) Answer the following questions in terms of the numbers of particles.

(i) State **one** similarity between the nuclei of $^{123}_{53}\mathrm{I}$ and $^{131}_{53}\mathrm{I}$. [1]

.....

.....

(ii) State **one** difference between the nuclei of $^{123}_{53}\mathrm{I}$ and $^{131}_{53}\mathrm{I}$. [1]

.....

.....

(b) The nucleus of $^{131}_{53}\mathrm{I}$ decays into xenon (Xe) by giving out beta (β) and gamma (γ) radiation.

(i) What is beta radiation? [1]

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(ii) Complete the equation below to show the decay of Iodine-131 (I-131). [2]

$$^{131}_{53}\mathrm{I} \longrightarrow {}^{\ldots\ldots}_{54}\mathrm{Xe} + {}^{0}_{\ldots\ldots}\beta + \gamma$$

(c) The isotope $^{123}_{53}\mathrm{I}$ decays by gamma emission. Explain why it is better to use $^{123}_{53}\mathrm{I}$ than $^{131}_{53}\mathrm{I}$ as a medical tracer. [2]

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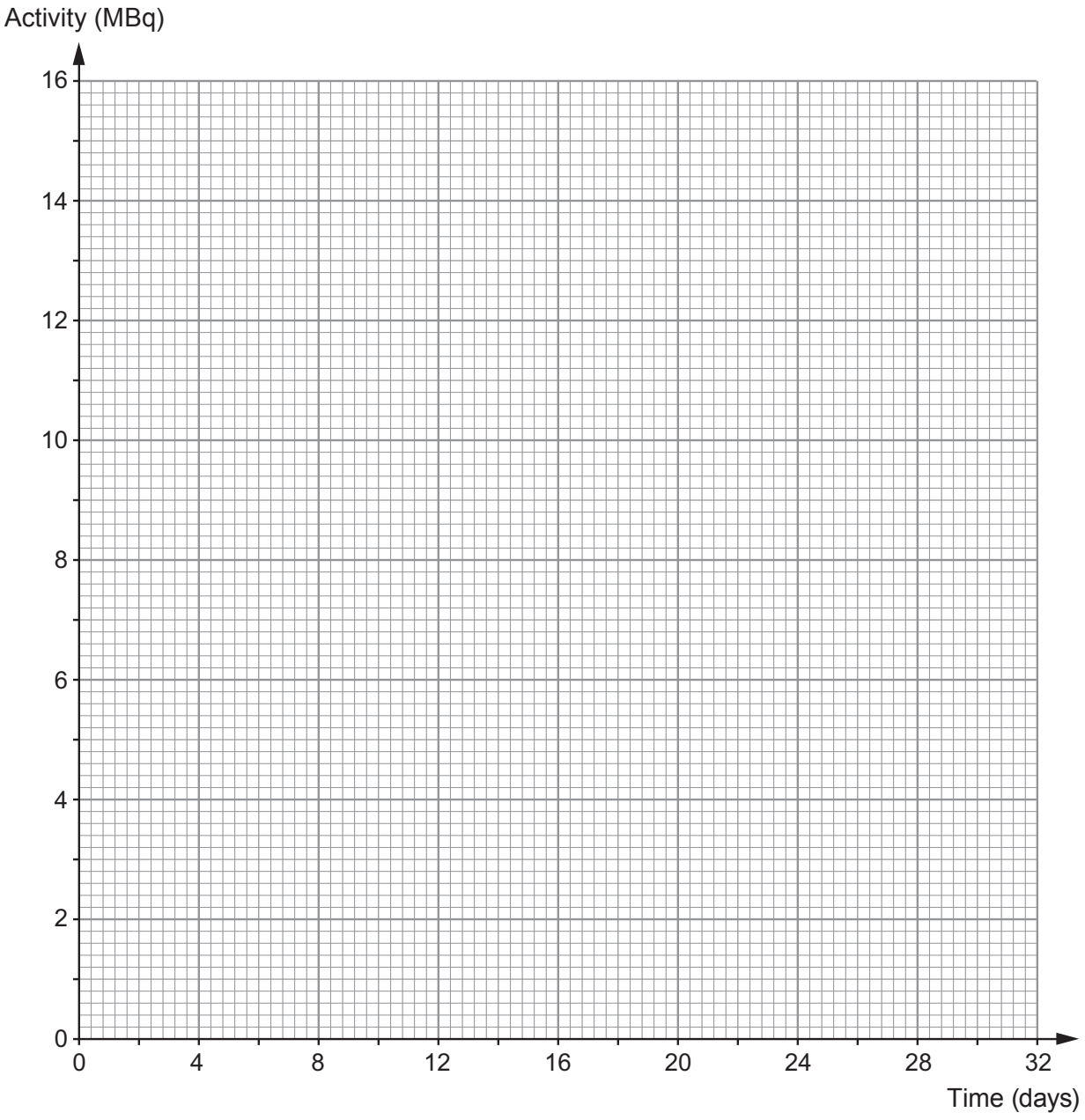
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(d) (i) Iodine-131 has a half-life of 8 days. A sample has an initial activity of 16 MBq. Plot the data on the grid and draw a suitable line to show how the activity changes over 32 days. [3]

Time (days)	0	8	16	24	32
Activity (MBq)	16	8	4	2	1



(ii) **Draw lines** on the graph to find the time it takes for the activity to fall from 12 MBq to 3 MBq. Comment on your answer. [2]

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3. A number of safety features appear in modern cars to protect the people in the car in a head-on collision. A passenger safety cage and a collapsible steering column are two safety features. Name **one** *other* safety feature and explain the physics behind its design.

Your answer should include:

- the name of **one** *other* safety feature;
- a description of what it does in a collision;
- an explanation of how it works in terms of either forces or energy. [6 QWC]

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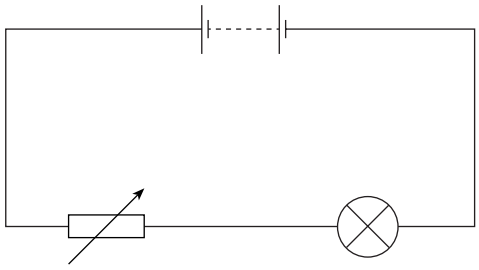
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4. The diagram shows a lamp connected to a battery and a variable resistor.



(a) (i) Describe how the circuit is used to obtain a **series of measurements** of the voltage across the lamp and the current through it. **You should add symbols to the circuit** of any additional components you would use. [4]

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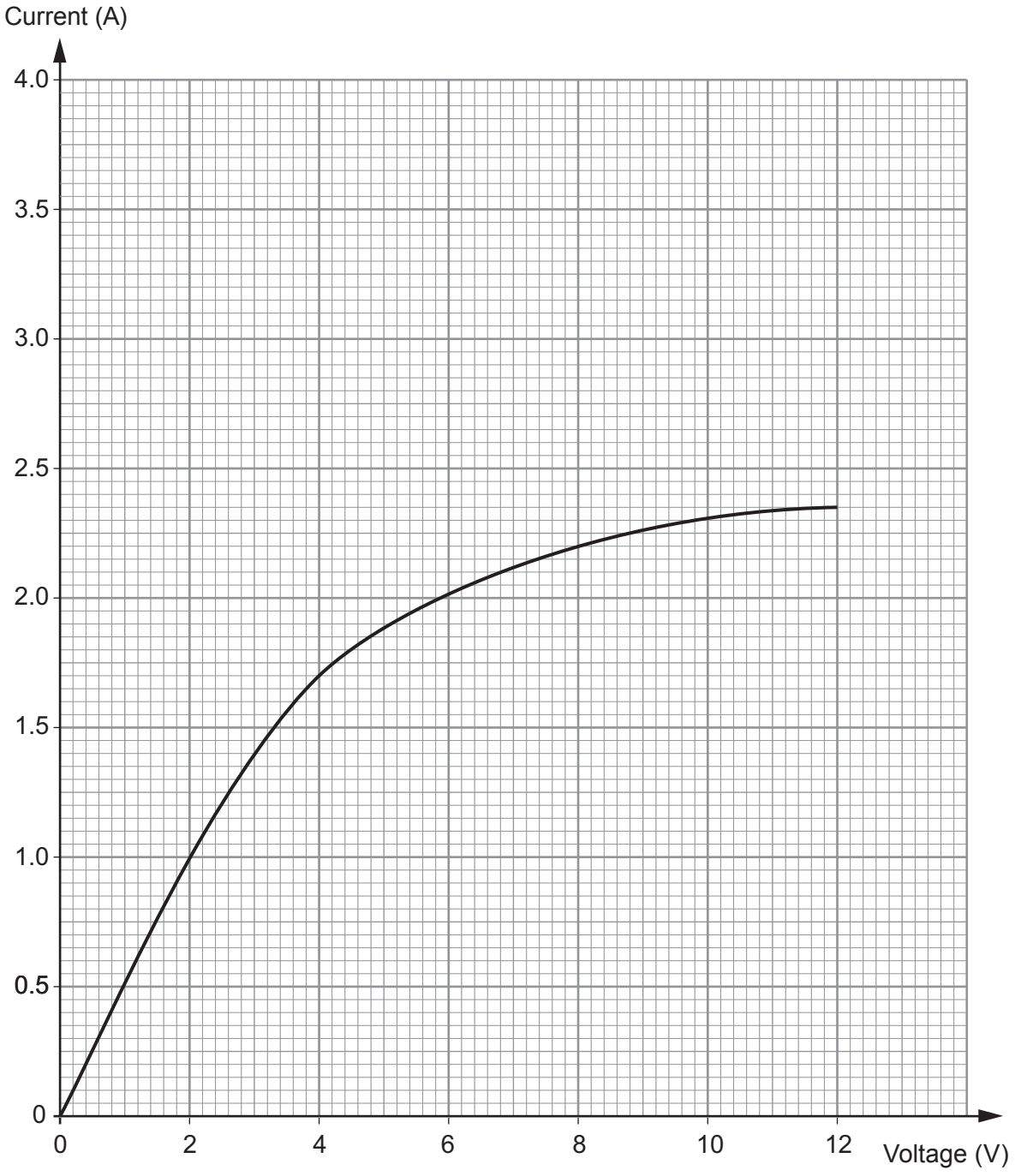
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(ii) The results for the lamp are shown on the graph below.



A **resistor** has a resistance of 4 Ω. **Draw a line** on the graph above to show the current through it and the voltage across it up to 12 V. [3]

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(b) (i) Use the graph and an equation from page 2 to find the power of the lamp when it has the same resistance as the resistor. [3]

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(ii) Compare the resistances of the lamp and resistor when a voltage of 12 V is applied to each. Give a reason for your answer. [2]

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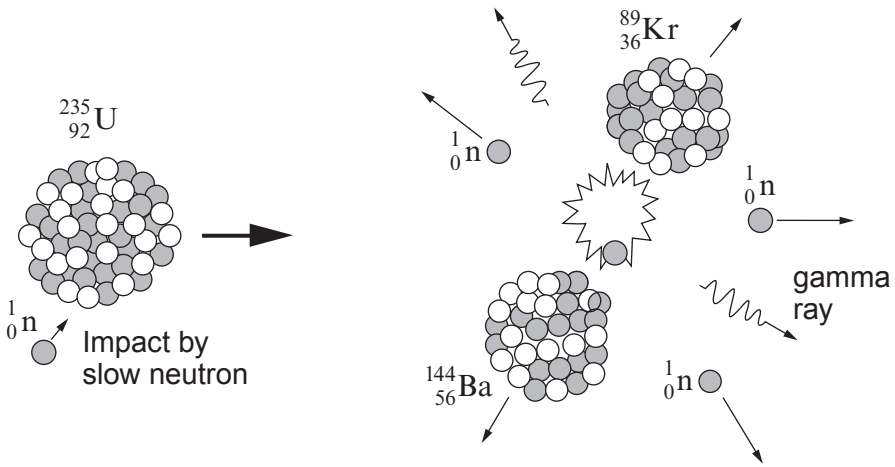
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5. The diagram below shows an example of a nuclear fission reaction in which a neutron strikes an atom of $^{235}_{92}U$.



The neutrons that are released in the reaction (3 in this case) have high energies and move very fast.

(a) State which part of the nuclear reactor core is designed to reduce the neutrons' high energies and explain why the reduction in energy is **necessary**. [3]

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(b) (i) Only 1 of the 3 neutrons that are released is needed to maintain a controlled chain reaction. Describe how the others are stopped inside the reactor. [2]

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(ii) Describe how the fission reactions inside a nuclear reactor can be shut down completely. [2]

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(c) (i) Write a balanced nuclear equation for the reaction shown opposite. [2]



(ii) If the barium nucleus in the diagram opposite is released with the same **kinetic energy** as a neutron, explain why the size of its velocity would only be **one twelfth ($\frac{1}{12}$)** of the velocity of a neutron. [2]

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6. *(a)* Describe how Newton's 3rd law applies to a rocket on take-off. [2]

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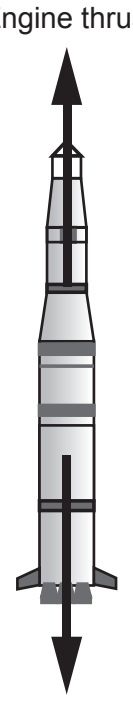
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(b) The Cassini spacecraft with its Huygens probe was launched by rocket in 1997 to study one of Saturn's moons. On 14 January 2005 the Huygens probe landed on the moon, Titan, and was slowed down by a parachute which opened 120 km above the surface.

Take-off mass of rocket, spacecraft and probe = $9{\cdot}5 \times 10^5$ kg
Engine thrust of rocket on take-off = $1{\cdot}5 \times 10^7$ N
Gravitational field strength on Earth = 10 N / kg
Gravitational field strength on Titan = 1·35 N / kg
Mass of Huygens probe = 320 kg

(i) Discuss the acceleration of the rocket at its launch. Include in your answer:

- A calculation of the initial acceleration. (Hint: consider the weight of the rocket.)
- An explanation of the way the acceleration changes as the rocket rises. (Hint: ignore the effects of air resistance.) [6 QWC]



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initial acceleration = ... m/s^2

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TURN OVER FOR THE REST OF THE QUESTION

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(ii) Calculate the loss in gravitational potential energy of the Huygens probe during its descent by parachute to the surface of Titan. [3]

change in potential energy = ... J

(iii) Explain what has happened to this potential energy as the probe falls to the surface of Titan. [2]

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13

END OF PAPER

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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GCSE MARKING SCHEME

SCIENCE - PHYSICS

JANUARY 2014

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INTRODUCTION

The marking schemes which follow were those used by WJEC for the January 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
P1 - 4463 (01/02)	1
P2 - 4473 (01/02)	10

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GCSE Science – Physics P2 Mark Scheme

January 2014

FOUNDATION TIER

Question			Marking details	Marks
1.	(a)	(i)	Second box ticked	1
		(ii)	Second box ticked	1
	(b)		Arrow pointing up (can be anywhere)	1
	(c)	(i)	20 – 5 = 15 [N]	1
		(ii)	$\frac{15(\text{ecf})}{0.5}(1) = 30[\text{m/s}^2]$ (1)	2
			Question total	**[6]**
2.			slow neutrons (1) fission (1) moderator (1) neutrons (1) control rods (1)	5
			Question total	**[5]**
3.	(a)	(i)	D	
		(ii)	C	
		(iii)	C	
		(iv)	D	4
	(b)		50 x 70 (1 – substitution) = 3 500 [kg m/s] (1) **ALTERNATIVE:** 55 x 70 = 3 850 **and** 5 x 70 = 350 (1) 3 500 [kg m/s] (1)	2
			Question total	**[6]**

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Question			Marking details	Marks
4.	(a)	(i)	$\frac{4}{2}$ (1) = 2 [Ω] (1)	2
		(ii)	2 x 4 (1) = 8 [W] (1)	2
		(iii)	2 [A]	1
	(b)	(i)	Decreases (1) stays the same (1)	2
		(ii)	Increase	1
	(c)		Bulbs can be switched separately / don't go out if one breaks (1) bulbs stay bright [when more added] / same voltage / current doesn't decrease or resistance doesn't increase (1) **OR** converse arguments about series circuits	2
			Question total	**[10]**
5.	(a)		Braking [distance]	1
	(b)	(i)	[Thinking distance] increases with speed (1) in proportion / in a linear manner / uniformly (1)	2
		(ii)	Increase it (no reference to time)	1
		(iii)	Steeper line shown through the origin (accept a curve provided always above the given line)	1
	(c)	(i)	13 [m/s]	1
		(ii)	8 [s] accept 6.8 [s]	1
		(iii)	B (1) because time is shortest / area under graph smallest / biggest deceleration / steepest line (accept steeper than others) / biggest gradient / stops in only 5 s (1) Neutral – longest or shortest gradient Don't accept – stops at 5 s or steeper rate	2
			Question total	**[9]**

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Question				Marking details	Marks
6.		(i)		$a = \frac{(0-15)}{5}$ OR $a = \frac{(15-0)}{5}$ (1 – subs) = -3(1 – ans) [m/s^2] Answer does not require a negative sign.	2
		(ii)	(I)	Mean speed = $\frac{(15+0)}{2} = 7.5$ (1 – subs), (1 – ans) [m/s]	2
			(II)	EITHER: Mean speed would have remained the same (1) because it is the sum of two values that will not have changed (divided by two) (1). OR: The distance taken to stop would have increased but the time taken would have also increased (1) so it is difficult to conclude how the mean speed would have changed. (1) OR: Mean speed would remain the same (1) because distance and time increase. (1) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
				Question total	**[6]**
7.	(a)	(i)		[Same] number (accept amount) of protons / 53 protons / [same] proton number / Don't accept: same number of protons and electrons or same atomic number or 53 or reference to the mass number being equal to 53.	1
		(ii)		[Different] number of neutrons / nucleons Accept [different] number of protons and neutrons / one has 70 neutrons and the other has 78 neutrons. Don't accept different mass numbers or 123 and 131.	1
	(b)	(i)		[fast moving / high energy] electron (accept slow electron) Don't accept positive electron.	1
		(ii)		$I \rightarrow {}^{131(1)}Xe + {}_{-1(1)}\beta + \gamma$	2
	(c)			Gamma is less ionising (1) so is easily detected outside of the body / penetrates the body or skin well / is less harmful (1). OR because beta would be more ionising (1) so is less penetrating / less likely to get out of the body / more harmful (1). OR Iodine-123 has a shorter half-life [13 hours] (1) so it decays quicker (1) don't accept escapes quicker **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
	(d)	(i)		Plots (2) allow ± ½ small square division (deduct 1 mark for each incorrect plot) smooth curve (1) allow **ecf** Don't accept double lines /whispy / thick / disjointed / wobbly lines.	3
		(ii)		Lines/points on grid from 12 and 3 to the curve or down to time axis (1) time interval of 16 [days] ± 1 [day] / equal to two half-lives (1). Apply **ecf** for the graph.	2
				Question total	**[12]**

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Question			Marking details	Marks
8.			**Indicative content:** Name of air bag, seat belt, head rest or crumple zone. **Explanation in terms of forces:** The seat belt is slightly stretchy, the air bag is soft and can be pushed in. The front crumple zone is designed to collapse in a head-on collision. They all increase the time taken for the occupant to come to rest in a collision. This reduces the force acting on an occupant since the force acting to stop a person is inversely proportional to the time taken, given that the final speed is zero in all cases. Smaller force implies less chance of an injury. $\{F = \frac{m(v-u)}{t}$ or $a = \frac{(v-u)}{t}\}$ (**For head rest answer only**) It squashes to provide a forward force to prevent recoil of the head. The force of the head rest on the head decelerates its backward motion. **Explanation in terms of energy:** All 3 aspects of car safety increase the distance that the occupant travels before coming to rest. The kinetic energy of the occupant is reduced to zero by work being done on the person. Work is the product of force and distance, so by increasing the stopping distance, the force acting is reduced, resulting in less chance of an injury. ($W=F$ x d) **(For head rest answer only)** The recoil distance travelled by the head is small, so head rest is strong enough to apply sufficient force to reduce the kinetic energy of the head to zero through its work done. **Explanation in terms of momentum:** All three aspects of car safety increase the time taken to bring the occupant to rest. That means that the rate of change of momentum is reduced, which in turn reduces the force on the occupant ($F = \frac{\Delta p}{t}$) **(For head rest answer only)** Head's momentum is brought to zero in a small time so head rest must be strong enough to do this. **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 **[6]**
			FOUNDATION TIER PAPER TOTAL	**[60]**

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HIGHER TIER

Question				Marking details	Marks
1.		(i)		$a = \frac{(0-15)}{5}$ OR $a = \frac{(15-0)}{5}$ [1 – subs] = -3 [1 – ans] [m/s^2] Answer does not require a negative sign.	2
		(ii)	(I)	Mean speed = $\frac{(15+0)}{2} = 7.5$ [1 – subs], [1 – ans] [m/s]	2
			(II)	EITHER: Mean speed would have remained the same (1) because it is the sum of two values that will not have changed (divided by two) (1). OR: The distance taken to stop would have increased but so would the time taken have increased (1) so it is difficult to conclude how the mean speed would have changed. (1) OR: Mean speed would remain the same (1) because distance and time increase. (1) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
				Question total	**[6]**
2.	(a)	(i)		[Same] number (accept amount) of protons / 53 protons / [same] proton number / Don't accept: same number of protons and electrons or same atomic number or 53 or reference to the mass number being equal to 53.	1
		(ii)		[Different] number of neutrons / nucleons Accept [different] number of protons and neutrons / one has 70 neutrons and the other has 78 neutrons. Don't accept different mass numbers or 123 and 131.	1
	(b)	(i)		[fast moving / high energy] electron (accept slow electron) Don't accept positive electron.	1
		(ii)		$I \rightarrow {}^{131(1)}Xe + {}_{-1(1)}\beta + \gamma$	2
	(c)			Gamma is less ionising (1) so is easily detected outside of the body / penetrates the body or skin well / is less harmful (1). OR because beta would be more ionising (1) so is less penetrating / less likely to get out of the body / more harmful (1). OR Iodine-123 has a shorter half-life [13 hours] (1) so it decays quicker or loses its radioactivity quicker (1) don't accept escapes quicker. **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
	(d)	(i)		Plots (2) allow ± ½ small square division (deduct 1 mark for each incorrect plot) smooth curve (1) allow **ecf** Don't accept double lines / whispy /thick/ disjointed / wobbly lines.	3
		(ii)		Lines on grid from 12 and 3 [to the curve and] down to time axis (1) time interval of 16 [days] ± 1 [day] / equal to two half-lives (1). Apply **ecf** for the graph.	2
				Question total	**[12]**

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Question			Marking details	Marks
3.			**Indicative content:** Name of air bag, seat belt, head rest or crumple zone. **Explanation in terms of forces:** The seat belt is slightly stretchy, the air bag is soft and can be pushed in. The front crumple zone is designed to collapse in a head-on collision. They all increase the time taken for the occupant to come to rest in a collision. This reduces the force acting on an occupant since the force acting to stop a person is inversely proportional to the time taken, given that the final speed is zero in all cases. Smaller force implies less chance of an injury. $\{F = \frac{m(v-u)}{t}$ or $a = \frac{(v-u)}{t}\}$ (**For head rest answer only**) It squashes to provide a forward force to prevent recoil of the head. The force of the head rest on the head decelerates its backward motion. **Explanation in terms of energy:** All 3 aspects of car safety increase the distance that the occupant travels before coming to rest. The kinetic energy of the occupant is reduced to zero by work being done on the person. Work is the product of force and distance, so by increasing the stopping distance, the force acting is reduced, resulting in less chance of an injury. (*W=F* x *d)* **(For head rest answer only)** The recoil distance travelled by the head is small, so head rest is strong enough to apply sufficient force to reduce the kinetic energy of the head to zero through its work done. **Explanation in terms of momentum:** All three aspects of car safety increase the time taken to bring the occupant to rest. That means that the rate of change of momentum is reduced, which in turn reduces the force on the occupant ($F = \frac{\Delta p}{t}$) **(For head rest answer only)** Head's momentum is brought to zero in a small time so head rest must be strong enough to do this. **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 **[6]**

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Question			Marking details	Marks
4.	(a)	(i)	Voltmeter drawn with correct symbol in parallel with the lamp (allow a line through the voltmeter and allow other voltmeters across other components) (1) Ammeter drawn with correct symbol in series with the resistor (1) The [variable] resistor is altered / changes the resistance / resistor changes the current / resistor changes the voltage (1) Take readings <u>each time</u> (1).	4
		(ii)	Any diagonally upwards straight line from origin [as for a resistor] (1) Diagonal line of correct gradient from origin award 2 marks. Calculation of I = 3 A (at foot of page) (1) Point (12, 3) plotted (1) (Point at (12, 3) implies 2nd mark so can be awarded).	3
	(b)	(i)	$P = IV$ or $P = I^2R$ (1) or implied with correct substitution Substitution (1) Answer = 20.25 [W] (1) to be taken from their graph Expected values are: 9 V(± 0.2) , I = 2.25 A (± 0.1)	3
		(ii)	Lamp has greater resistance (1) because it has the smaller current through it / allow calculations of 5.1 Ω [and 4 Ω] (1) Accept converse argument for resistor. (Any reference to power treat as being neutral.)	2
			Question total	**[12]**
5.	(a)		Moderator / water / graphite (1) slows down the neutrons (1) so to allow capture by <u>uranium</u> / absorption by <u>uranium</u> / fission or split of <u>uranium</u> (1) Do not accept (for 3rd mark) reacts with uranium or impacts with uranium. **The second and third marks can be awarded even if the first mark is withheld.**	3
	(b)	(i)	Control rods (1) [completely] absorb the [other] neutrons (1)	2
		(ii)	Dropping / putting / letting in [all of] the control rods [into the reactor] (1) absorbs <u>all</u> (1) neutrons.	2
	(c)	(i)	$^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{89}_{36}\text{Kr} + {}^{144}_{56}\text{Ba} + 3{}^{1}_{0}\text{n}$ (+ γ treat as neutral) (1 for symbol equation correct, 1 for 3 neutrons on RHS)	2
		(ii)	Since $(\frac{1}{2}mv^2)\text{Ba} = (\frac{1}{2}mv^2)\text{n}$ (1) (or by implication) Then $144v^2(\text{Ba}) = 1v^2(\text{n})$ $v_{\text{Ba}} = \frac{1}{12}v_{\text{n}}$ (1) Accept $m_{\text{Ba}} = 144\ m_{\text{n}}$ OR that Ba has a bigger mass, so needs less speed for <u>the same kinetic energy</u> [as the neutron] OR recognition of square root for the 1st mark. **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
			Question total	**[11]**

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Question			Marking details	Marks
6.	(a)		Rocket exerts force on exhaust gases (1) which exert [equal but opposite] force on rocket causing it to take-off (1) Do not credit a statement of N's 3rd law out of context.	2
	(b)	(i)	**Indicative content**: [Ignore changes to *g*] Using $F = ma$, $(1.5 \times 10^7 - 9.5 \times 10^6) = 9.5 \times 10^5 \times a$ so $a = 5.789$ [m/s^2]. The acceleration increases because the weight decreases as fuel is used up, thus increasing the resultant upward force (thrust remains constant). The acceleration is directly proportional to the resultant force. The acceleration also increases because the mass decreases (acceleration is inversely proportional to mass). **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)	$mg\Delta h = 320 \text{x} 1.35 \text{x} 120000$ [= 51 840 000 J] Correct value for *m* (320 kg)(1), correct value for *g* x1.35(1), correct value for Δh x120 000) (1). No mark for answer. Award 3 marks for 51 840 000 Award 2 marks for 51 840 or 1.54×10^{11} or 1.14×10^{12} Award 1 mark for 384 000 or 1.54×10^8 or 1.14×10^9	3
		(iii)	Energy is converted / transferred / changed (1) (not lost, but accept lost and changes) to work being done against friction [in the atmosphere] / increasing the heat energy or temperature of the atmosphere and/or probe or parachute (1) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
			Question total	**[13]**
			HIGHER TIER PAPER TOTAL	**[60]**

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Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4473/02

ADDITIONAL SCIENCE/PHYSICS

PHYSICS 2
HIGHER TIER

A.M. THURSDAY, 23 May 2013

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**12**	
2.	**12**	
3.	**6**	
4.	**7**	
5.	**8**	
6.	**15**	
Total	**60**	

4473
020001

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

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.

If you run out of space, use the continuation pages at the back of the booklet, taking care to number the question(s) correctly.

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 **2**(i) and **6***(a)*.

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Equations

power = voltage × current	$P = VI$
$\text{current} = \frac{\text{voltage}}{\text{resistance}}$	$I = \frac{V}{R}$
power = current^2 × resistance	$P = I^2R$
$\text{speed} = \frac{\text{distance}}{\text{time}}$	
$\text{acceleration [or deceleration]} = \frac{\text{change in velocity}}{\text{time}}$	$a = \frac{\Delta v}{t}$
acceleration = gradient of a velocity-time graph	
distance travelled = area under a velocity-time graph	
momentum = mass × velocity	$p = mv$
resultant force = mass × acceleration	$F = ma$
$\text{force} = \frac{\text{change in momentum}}{\text{time}}$	$F = \frac{\Delta p}{t}$
work = force × distance	$W = Fd$
$\text{kinetic energy} = \frac{\text{mass} \times \text{speed}^2}{2}$	$KE = \frac{1}{2}mv^2$
change in potential energy = mass × gravitational field strength × change in height	$PE = mgh$

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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4473
020003

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Answer **all** *questions.*

1. All living material takes in carbon-14 (C-14) which is radioactive and decays by beta emission. It has a half-life of 6000 years and is used in carbon dating which tells us the age of some old fossils. The age of things that died more than **10 half-lives** in the past cannot be accurately measured as the amount of C-14 present is too small.

(a) (i) State what you understand by the statement "the half-life of carbon-14 is 6000 years". [1]

.....

.....

(ii) Explain how carbon-14 decays by beta emission. [2]

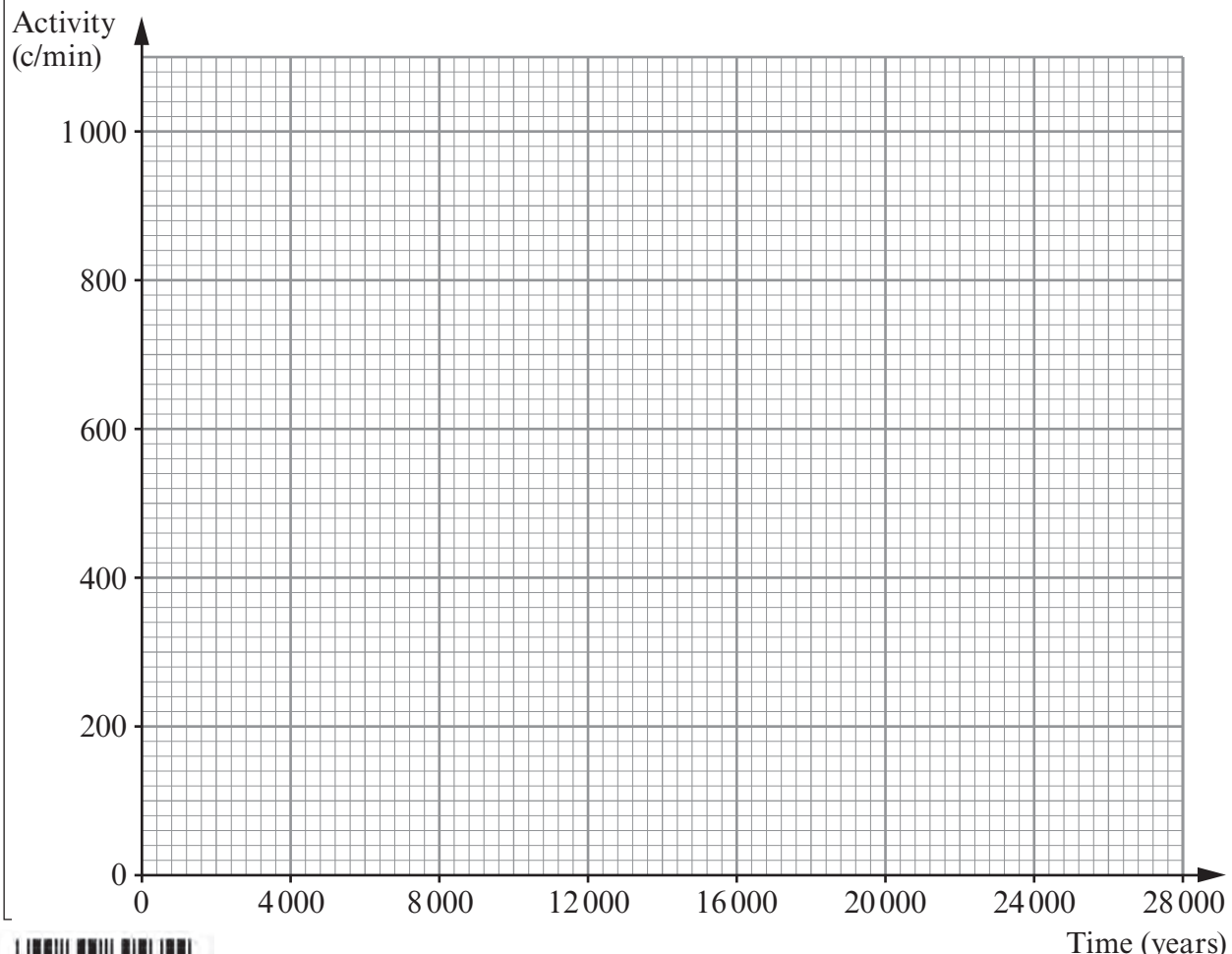
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(b) The activity of an amount of carbon-14 reduces with time in the way shown in the table below. (All values have been adjusted for background radiation.)

Time (years)	0	6000	12000	18000	24000
Activity (c/min)	800	400	200	100	50

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



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(ii) Use the graph to give the activity from the carbon at 16000 years. [1]

Activity = ... c/min

(iii) Calculate the number of years after which carbon dating proves to be impossible. [2]

Number of years = ...

(c) (i) A sample of bone taken from a skeleton at an archaeological site gave a reading of 32 c/min. An identical mass of bone in a living animal gives a reading of 80 c/min. Use the graph to find the age of the skeleton. [1]

Age = ... years

(ii) State the method you used to arrive at your answer and show it on the graph. [2]

.....

.....

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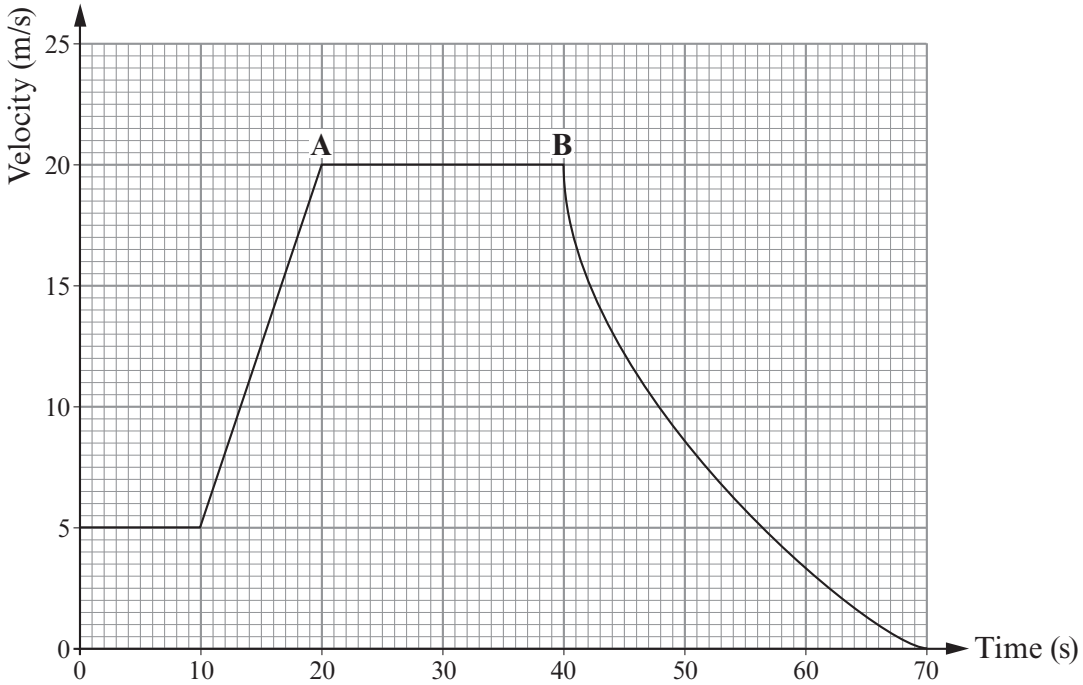
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2. The velocity-time graph for part of a journey of a bus is shown below.



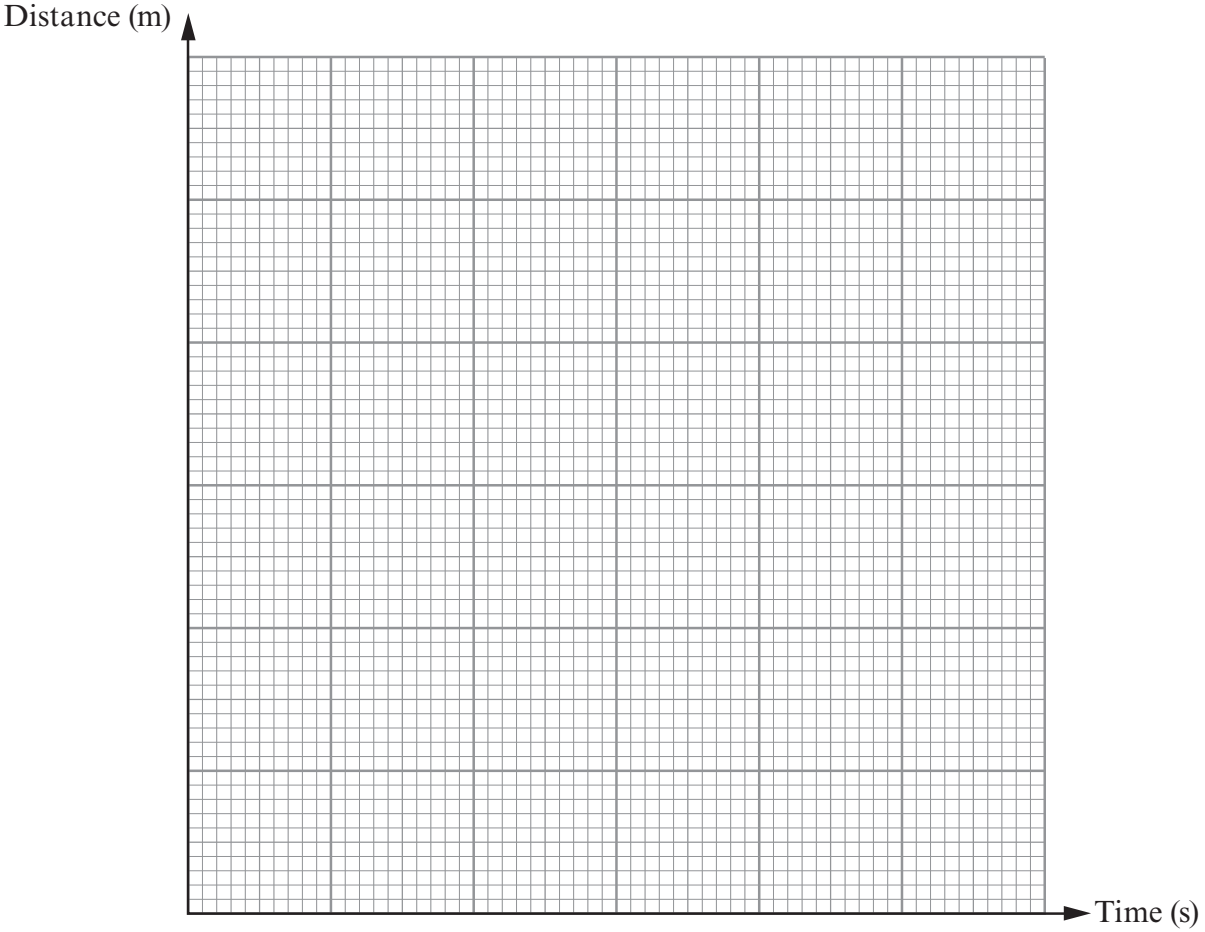
(i) Using data from the graph, describe the motion of the bus during the 70 s shown. [6 QWC]

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(ii) During the first 10 s, the bus travels 50 m. Use this information to construct a distance-time graph for the **first 10 s only** on the grid below. [3]



(iii) Use the equation:

$$\text{distance} = \text{speed} \times \text{time}$$

to calculate the distance travelled by the bus between **A** and **B** on the graph opposite. [3]

Distance travelled = ... m

12

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3. *(a)* State Newton's first law of motion. [2]

.....

.....

.....

(b) (i) A car experiences an accelerating force of 2 250 N for 8 seconds. Use an equation from page 2 to calculate its change in momentum. [2]

Change in momentum = ... kg m/s

(ii) If the car was initially travelling at 5 m/s and has a mass of 900 kg, use an equation from page 2 to calculate its final velocity. [2]

Final velocity = ... m/s

6

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4. The table below shows information about different nuclei involved in the process of nuclear fission.

Nucleus	Symbol	Number of protons	Number of neutrons
Plutonium	Pu	94	145
Yttrium	Y	39	50
Caesium	Cs	55	93

(a) A nucleus of plutonium undergoes fission when bombarded with a **slow moving** neutron (n) splitting into the daughter nuclei yttrium and caesium.

(i) How are slow moving neutrons achieved in a nuclear reactor? [1]

.....

(ii) Produce the balanced nuclear equation for this fission reaction. [4]

..... + ... ⟶ ..... + ... + ...

(b) Caesium has 40 known isotopes. Describe how these isotopes are similar to and different from each other. [2]

.....

.....

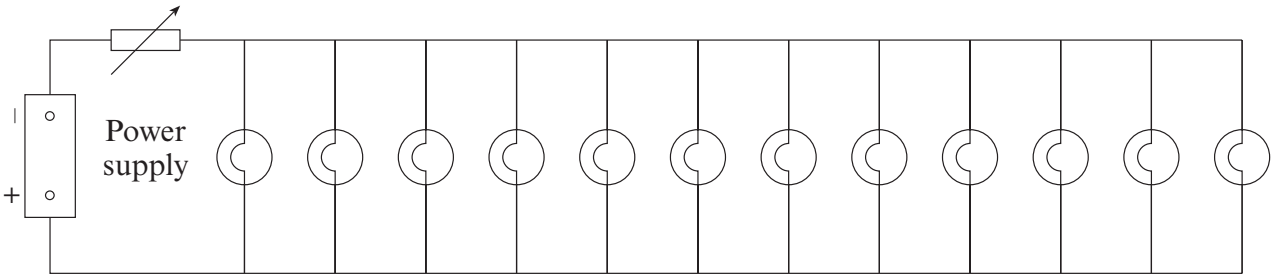
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5. A light fitting consists of twelve 40 W lamps connected in parallel. They are connected to the 230 V mains in a circuit in series with a single dimmer switch.



(a) Use an equation from page 2 to calculate the current through each lamp, when all the lamps are operating at normal brightness. [2]

Current = ... A

(b) The lamps are dimmed. At one dimmer switch setting, the resistance of the dimmer switch is 82 Ω and the power loss in the dimmer switch is 118 W.

(i) Use an equation from page 2 to calculate the current through the dimmer switch. [3]

Current = ... A

(ii) Calculate the power produced by each lamp at this dimmer switch setting. [3]

Power = ... W

8

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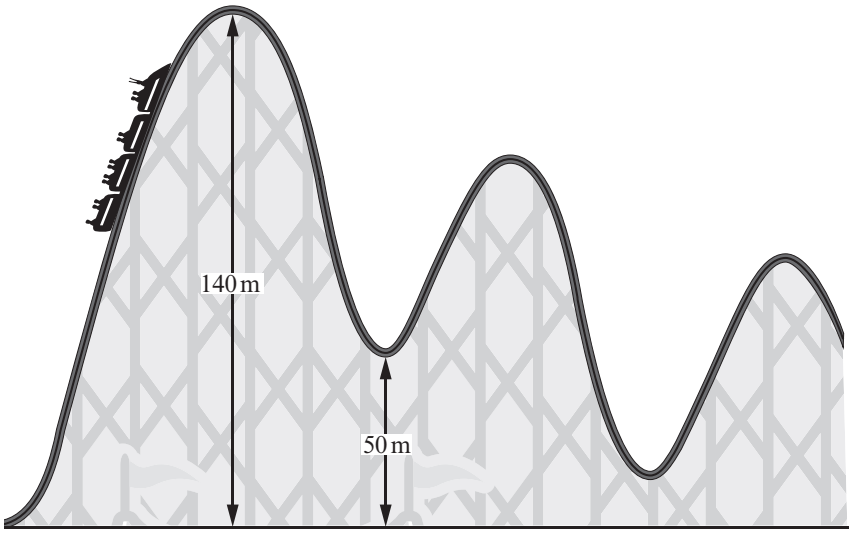
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6. A rollercoaster car has no engine. The car is pulled to the top of the first peak at the beginning of the ride, but after that the car must complete the ride on its own. Every peak on a rollercoaster must be lower than the one before it.



(a) Explain in terms of energy transfers how the car is able to complete the ride after being pulled to the top of the first peak and why each peak must be lower than the one before it. [6 QWC]

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(b) One of the world's tallest rollercoasters has an initial peak of height 140 m. After reaching the top, the car first falls to a height 50 m above the ground before it continues on its journey.

The mass of the car and passengers is 1 200 kg.

(i) Use equations from page 2 to calculate the theoretical maximum velocity of the car after this first fall. (g = 10 m/s^2) [4]

Maximum velocity = ... m/s

(ii) Discuss whether or not this theoretical maximum velocity depends on the mass of the passengers. [2]

.....

.....

.....

(iii) In practice, the car reaches a velocity of 37 m/s after this first fall. The length of track on the fall is 100 m. Use equations from page 2 to calculate the mean resistive force on the car. [3]

Mean resistive force = ... N

15

END OF PAPER

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

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

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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.

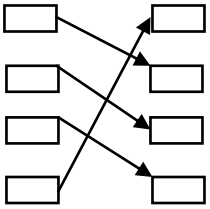
	Page
Physics 1 - Foundation Tier	1
Physics 1 - Higher Tier	5
Physics 2 - Foundation Tier	9
Physics 2 - Higher Tier	13
Physics 3 - Foundation Tier	17
Physics 3 - Higher Tier	20

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GCSE SCIENCE - PHYSICS 2

FOUNDATION TIER

Question			Marking details	Mark
1.	(a)		All correct - 3 marks 2 or 3 correct – 2 marks 1 correct – 1 mark 	3
	(b)	(i)	fission OR chain [reaction]	1
		(ii)	krypton or barium (accept Kr or Ba)	1
	(c)		Any 2 x (1): - they have <u>long half- lives</u> - <u>highly/very</u> <u>radioactive</u> - prevents leaks / getting into the environment or food chain or water supply - <u>harmful/poisonous/toxic/dangerous to living things</u> or <u>ionises cells / mutates cells</u> or <u>risk to health/cancer</u> - prevent theft/use as weapons/use by terrorists If 2 correct answers given on 1 line only then award 2 marks. If 2 correct answers given on 1 line and then on the 2nd line an incorrect answer is given award 1 mark only. If 1 correct answer and 1 incorrect answer are given on the same line then no mark awarded.	2
			Question total	**[7]**
2.	(a)	(i)	3 [A]	1
		(ii)	Point at coordinates (9, 3) ± ½ small square division (ignore any other points that are plotted.	1
		(iii)	Straight(ish) line from origin through (9,3) ± ½ small square division (allow **ecf**)	1
	(b)	(i)	$\frac{9}{3}$ (1) = 3 (1) Ohms or Ω (1) If 3/9 written no marks for substitution and answer can be awarded.	3
		(ii)	9 x 3 (1) = 27 (1) Watts or W or J/s (1)	3
			Question total	**[9]**

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Question			Marking details	Mark
3.	(a)		$^{12}_{6}C$	1
	(b)		14 (1), 1 (1) N.B. must look like a subscript	2
	(c)		6 (1), 8 (1), 0 (1)	3
			Question total	**[6]**
4.	(a)	(i)	15 [m/s]	1
		(ii)	16 [m] **ecf** must be applied from (i)	1
	(b)	(i)	$\frac{15(1)}{25}$ = 0.6 [s] (1)	2
		(ii)	50(1)**+ 15(1)** = [65 m] If 65 only award 2 marks. Do not accept 50 or 15 on the answer line.	2
		(iii)	any factor that reduces the braking distance of the car e.g. - improved/good tread on tyres, - rougher road surface, - good/better brakes, - good/better weather conditions, - correct tyre pressure, - good/better/newer tyres etc. Accept converse arguments if explained.	1
			Question total	**[7]**
5.	(a)	(i)	0.15 x 20 (1 for substitution) = 3 [kg m/s] (1)	2
		(ii)	$\frac{3}{0.5}$ (1) allow **ecf** from (i) = 6 [N] (1)	2
		(iii)	3 [N] allow **ecf** from (i) which gives the same answer as in (i) **or** allow **ecf** from (ii) which gives half the answer to (ii)	1
	(b)	(i) (ii)	e.g. car crash / emergency stop / sudden braking / landing on ground Stretchy seat belt / air bag / crumple zone to achieve it/ bending legs on landing **Mark parts (i) and (ii) together.**	2
			Question total	**[7]**

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Question			Marking details	Mark
6.	(a)	(i)	The time/how long it takes/it takes 6 000 years for half of the undecayed atoms/mass/amount/activity/count rate to fall by half.	1
		(ii)	The **nucleus** emits/loses (1) an **electron** (1) OR identifies the nucleus (1) in which neutron splits into proton and electron (1) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
	(b)	(i)	plots correct (2) [lose 1 for each incorrect plot allow ± ½ small square division up to a maximum of 2 marks] reasonable curve through the points (1)	3
		(ii)	Value to be taken from candidate's graph ±10 [About 130]. Credit an answer of between 120-140 when no line is drawn.	1
		(iii)	10 (1) **x 6 000** (1) = [60 000 years]	2
	(c)	(i)	7 400 years (value to be taken from candidate's graph)	1
		(ii)	reduce activities from the graph by a factor of 10 (1), line from 320 on graph to find time (1) or converse, (or reference to) lines drawn on graph at 320 (and down to the time axis). **Alternative** - for an extended graph and lines drawn at 80 (1) and "32" drawn on an extended line (1), award both marks for method either explained or drawn. N.B. **No marks can be awarded for the age** because of the uncertainty in this method.	2
			Question total	**[12]**

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Question			Marking details	Mark
7.		(i)	Indicative content: The initial velocity of the bus is 5 m/s. It continues at this velocity for 10 s. Then it accelerates at a constant rate of 1.5 m/s^2 for 10 s to 20 m/s. It travels at a constant velocity of 20 m/s for 20 s. At 40 s, it decelerates at a decreasing rate until it comes to a rest at 70 s. The mean deceleration is 0.67 m/s^2. **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)	Scales using at least half of each axis [at least one intermediate point required and a sensible scale] (1) point (10,50) [point may not be clear but award if line ends at this point. Ignore intermediate points]. (1) Straight(ish) line to that point and **mus**t be from (0,0) [Do not award this mark for an obvious curve] (1). Any line that goes past (10,50) is penalised 1 mark. Straight line to wrongly plotted point gets the line mark.	3
		(iii)	20 (1) <u>x 20</u> (1) = 400 [m] (1) Repeated multiplications e.g. **20** x 20, **20** x 40, **20** x 5 [1 only]	3
			Question total	**[12]**
			Foundation Tier Paper Total	**[60]**

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HIGHER TIER

Question			Marking details	Mark
1.	(a)	(i)	The time/how long it takes/it takes 6 000 years for half of the undecayed atoms/mass/amount/activity/count rate to fall by half.	1
		(ii)	The **nucleus** emits/loses (1) an **electron** (1) OR identifies the nucleus (1) in which neutron splits into proton and electron (1) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
	(b)	(i)	plots correct (2) [lose 1 for each incorrect plot allow ± ½ small square division up to a maximum of 2 marks] reasonable curve through the points (1)	3
		(ii)	Value to be taken from candidate's graph ±10 [About 130]. Credit an answer of between 120-140 when no line is drawn.	1
		(iii)	10 (1) **x 6 000** (1) = [60 000 years]	2
	(c)	(i)	7 400 years (value to be taken from candidate's graph)(1)	1
		(ii)	reduce activities from the graph by a factor of 10 (1), line from 320 on graph to find time (1) or converse, (or reference to) lines drawn on graph at 320 (and down to the time axis). **Alternative** - for an extended graph and lines drawn at 80 (1) and "32" drawn on an extended line (1), award both marks for method either explained or drawn. N.B. **No marks can be awarded for the age** because of the uncertainty in this method.	2
			Question total	**[12]**

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Question			Marking details	Mark
2.		(i)	Indicative content: The initial velocity of the bus is 5 m/s. It continues at this velocity for 10 s. Then it accelerates at a constant rate of 1.5 m/s^2 for 10 s to 20 m/s. It travels at a constant velocity of 20 m/s for 20 s. At 40 s, it decelerates at a decreasing rate until it comes to a rest at 70 s. The mean deceleration is 0.67 m/s^2. **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)	Scales using at least half of each axis [at least one intermediate point required and a sensible scale] (1) point (10,50) [point may not be clear but award if line ends at this point. Ignore intermediate points]. (1) Straight(ish) line to that point and **mus**t be from (0,0) [Do not award this mark for an obvious curve] (1). Any line that goes past (10,50) is penalised 1 mark. Straight line to wrongly plotted point gets the line mark.	3
		(iii)	20 (1) <u>x 20</u> (1) = 400 [m] (1) Repeated multiplications e.g. **20** x 20, **20** x 40, **20** x 5 [1 only]	3
			Question total	**[12]**

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Question			Marking details	Mark
3.	(a)		Object continues in its state of rest/inertia/motion/constant speed [in a straight line] (1) unless acted upon by an [external/unbalanced] force (1)	2
	(b)	(i)	2 250 x 8 (1 for substitution) = 18 000 [kg m/s](1) [Answer mark must be number on answer line]	2
		(ii)	(1 for subs + manip) $\frac{18000}{900}$ = 20 (allow **ecf** from (i)) final velocity = 20 (**ecf**) + 5 = 25 [m/s] (1) **OR** Final momentum = 4 500 + 18 000 = 22 500 (1) v = 25 [m/s] (1) **OR** Momentum ratio = velocity ratio e.g. 18 000:4 500 = 4 so arrive at a [change in] velocity of 20 [m/s] (1) v = 25 [m/s] (1)	2
			Question total	**[6]**
4.	(a)	(i)	By using a moderator / graphite / water. Accept graphite rods / graphite monitor. BUT moderator + control rods (0) graphite and boron (0).	1
		(ii)	$^{239}_{94}Pu + {}^{1}_{0}n \rightarrow {}^{89}_{39}Y + {}^{148}_{55}Cs + 3\ {}^{1}_{0}n$ LHS: Correct symbol for a neutron $^{1}_{0}n$ NOT N (1), correct nuclear symbol for plutonium $^{239}_{94}Pu$ (1), RHS: correct nuclear symbols for Yttrium $^{89}_{39}Y$ and Caesium $^{148}_{55}Cs$ (1), 3 neutrons $\underline{3}\ {}^{1}_{0}n$ (1). Accept Y^{89}_{39} Accept $\underline{3}\ {}^{1}_{0}N$ or $\underline{3}n$	4
	(b)		Same/equal number (accept amount) of protons/atomic number/$\underline{55}$ protons (1) different number (accept amount) of neutrons/mass number/nucleon number (1) Electrons are not awarded but regard as neutral. HOWEVER 'same number of electrons in neutral atoms' (1).	2
			Question total	**[7]**
5.	(a)		Subs+manip 40/230 (1) I = 0.17[4] [A] (1) [Do not accept 0.173 but accept 0.2]	2
	(b)	(i)	Subs+manip $I^2 = \frac{118}{82}$ (1) = 1.44 (1), I = 1.2 [A] (1) If 1.44 on the answer line then award 2 marks. If 1.43 used, no penalty for rounding I will = 1.19 [A] N.B. $\sqrt{1.4}$ = 1.18	3
		(ii)	current through each lamp = $\frac{1.2(ecf)}{12}$ = 0.1 [A] (1) **Either** pd across dimmer = 1.2 x 82 = 98[.4] (1) pd across lamps = 230 – 98.4 **ecf** = 131.6 (accept 132) power = 131.6 **ecf** x 0.1**ecf** = 13.16 [W] (accept 13.2) (1) **OR** resistance of each lamp = $\frac{230}{0.174}$ = 1 322 (1) **ecf** for 0.174 Power = 0.1^2 **ecf** x 1 322 **ecf** = 13.22 [W] (1)	3
			Question total	**[8]**

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Question			Marking details	Mark
6.	(a)		Indicative content: As the car is pulled to the top of the hill it gains potential energy. Since this is the highest point of its journey, this will be the maximum potential energy that the car will gain. As the car runs down the other side of the hill, potential energy will be converted to kinetic energy. As the car begins to rise at the next hill, the kinetic energy is then converted back into potential energy and so on. However due to resistive forces, some of the energy is dissipated as heat so during the ride the total energy possessed by the car decreases. This explains why each successive hill must be lower than the previous one. **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
	(b)	(i)	Calculation of PE using *mgh* or by implication (1): 1 200 x 10 x 90 (1) = [1 080 000 J] If 1 200 x 10 x 50 **or** 1 200 x 10 x 140 used this implies use of *mgh* so award 1 mark. 1 080 000 **ecf** = ½ mv^2 **or** 1 080 000 **ecf** = KE (1) = 600 v^2 v = 42.4 [m/s] **ecf** (1) **Alternatives:** If PE = KE stated anywhere award 1 mark If show ½ mv^2 = mgh anywhere award 2 marks	4
		(ii)	No (1), because ½ mv^2 = mgh **or** m cancels out (1) Actual KE at bottom = ½ 1 200 x 37^2 = 821 400 [J] (1)	2
		(iii)	Energy loss = 1 080 000 **ecf** – 821 400 **ecf** = 258 600 [J] (1) mean resistive force = WD **ecf** /distance = 2 586 [N] (1)	3
			Question total	**[15]**
			Higher Tier Paper Total	**[60]**

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Surname	Centre Number	Candidate Number
Other Names		0

New GCSE

4473/02

ADDITIONAL SCIENCE
HIGHER TIER
PHYSICS 2

P.M. THURSDAY, 17 January 2013

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**8**	
2.	**12**	
3.	**6**	
4.	**7**	
5.	**15**	
6.	**8**	
7.	**4**	
Total	**60**	

4473
020001

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use a gel pen. Do not use correction fluid.

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. If you run out of space, use the continuation page at the back of the booklet, taking care to number the question(s) correctly.

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)*.

JAN134473020 1

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Equations

power = voltage × current	$P = VI$
$\text{resistance} = \frac{\text{voltage}}{\text{current}}$	$R = \frac{V}{I}$
power = current^2 × resistance	$P = I^2R$
$\text{speed} = \frac{\text{distance}}{\text{time}}$	
$\text{acceleration [or deceleration]} = \frac{\text{change in velocity}}{\text{time}}$	$a = \frac{\Delta v}{t}$
acceleration = gradient of a velocity-time graph	
distance travelled = area under a velocity-time graph	
momentum = mass × velocity	$p = mv$
resultant force = mass × acceleration	$F = ma$
$\text{force} = \frac{\text{change in momentum}}{\text{time}}$	$F = \frac{\Delta p}{t}$
work = force × distance	$W = Fd$
$\text{kinetic energy} = \frac{\text{mass} \times \text{speed}^2}{2}$	$\text{KE} = \frac{1}{2}mv^2$
change in potential energy = mass × gravitational field strength × change in height	PE = mgh

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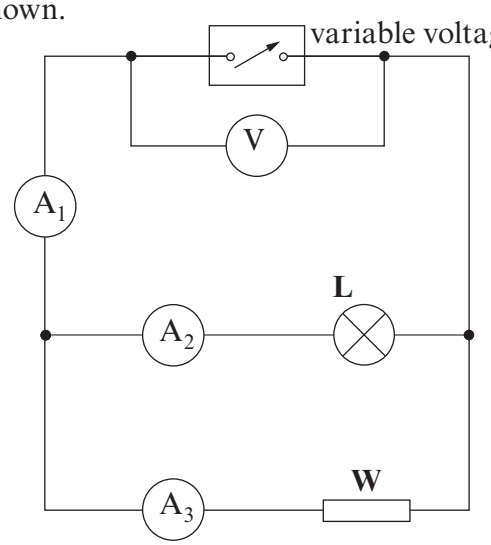
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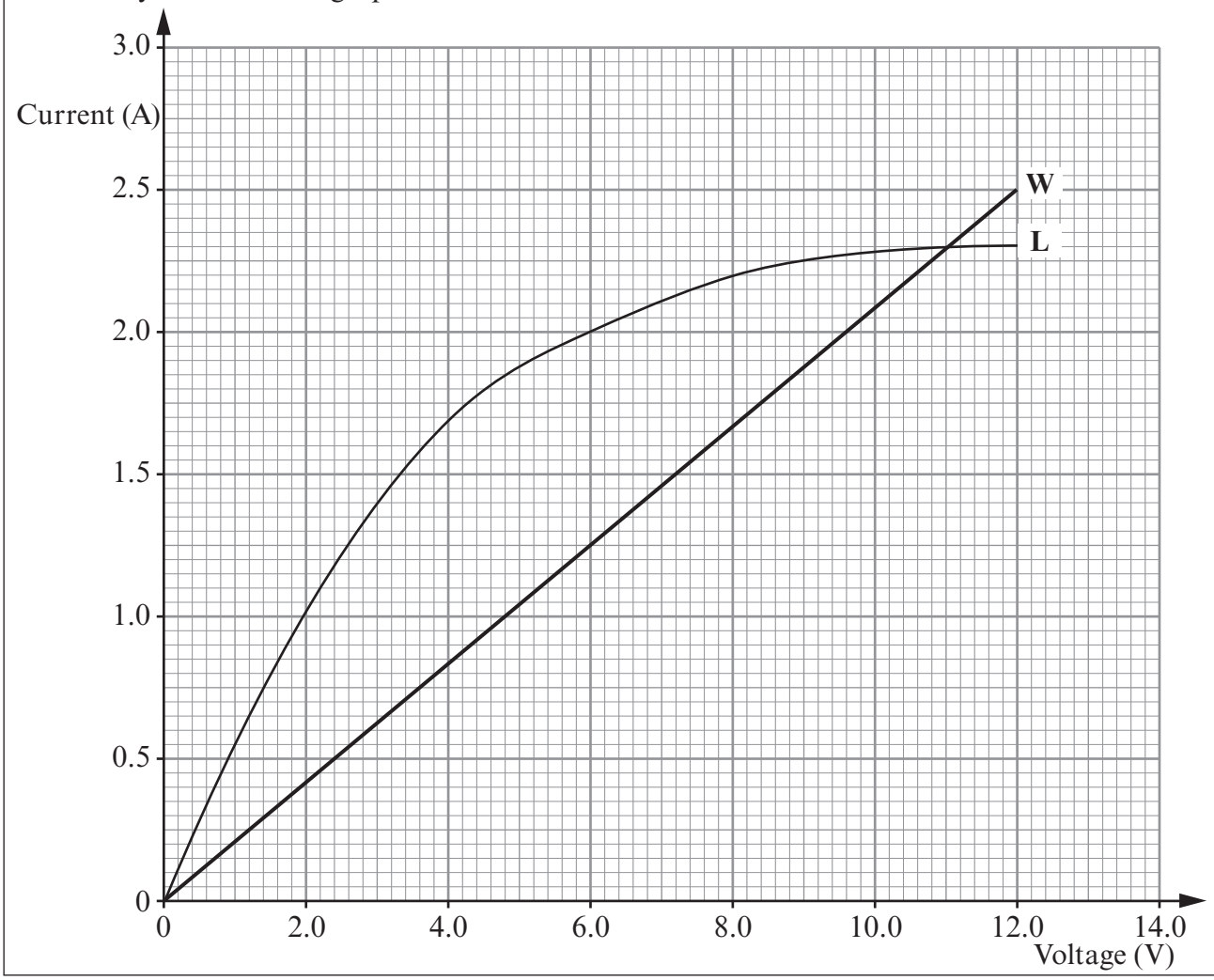
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*Answer **all** questions in the spaces provided.*

1. The diagram shows a circuit used to investigate currents in a parallel circuit when the voltage is varied. A lamp **L** and a wire **W** are connected in parallel with a variable voltage supply. The circuit has 3 ammeters A_1, A_2 and A_3 as shown.



The currents through the lamp, **L**, and the wire, **W**, depend on the voltage applied to them in the way shown on the graph below.



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(a) (i) Use the graph to find the current through the lamp when the voltmeter reading is 6 V. [1]

Current = ... A

(ii) Using an equation from page 2, calculate the resistance of the lamp at 6 V. [2]

Resistance = ... Ω

(iii) Find the current through ammeter A_1 at 6 V. [1]

Current = ... A

(b) The voltage supply in the diagram is increased from 6 V to 12 V.

(i) Compare the resistances of the lamp and wire at 12 V. [1]

.....

(ii) Give a reason for your answer. [1]

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(c) "As the voltage is increased from 0 V to 12 V, the power of the wire is not always less than the power of the lamp."
Explain why this statement is true. [2]

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8

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2. A smoke detector works as follows:

- It uses a radioactive source that emits alpha particles.
- The alpha particles ionise the air inside the detector causing an electric current.
- Any smoke getting into the detector absorbs the alpha particles and changes the current.
- The change in current sets off the alarm.

(a) (i) What is an alpha particle? ..... [1]

(ii) Explain why the detector would not work if the radioactive source emitted gamma rays only. [2]

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(iii) Explain why, in normal use, the radioactive source in the detector is not a risk to human health. [2]

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(b) Americium-241 has a half-life of 432 years. Curium-242 has a half-life of 160 days. Both isotopes are alpha emitters.

(i) Explain why Americium-241 is more suitable for use in the smoke detector than Curium-242. [2]

.....

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(ii) An average smoke detector contains about 0.4 micrograms (μg) of Americium-241 which has an initial activity of 52 000 units.

(I) Name the unit of activity. ..... [1]

(II) Calculate how long it will take for the activity to drop to 26 000 units. [2]

Time = ... years

(III) Calculate the mass of Americium-241 remaining after 864 years. [2]

Mass remaining = ... μg

12

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3. The government is considering increasing the motorway speed limit from 70 miles per hour (mph) to 80 mph.
Standard thinking distances and braking distances for a variety of speeds are given in the table below. They apply to an alert driver on a dry day.

Speed (mph)	Thinking Distance (m)	Braking Distance (m)	Total Stopping Distance (m)
60	18	55	73
70	21	75	
80	24	97.5	

Discuss the advantages and disadvantages for taking a journey of 280 miles at 80 mph compared with 70 mph.
Include in your answer information from the table above and your knowledge on the topic.
You should use the equation: time = $\frac{\text{distance}}{\text{speed}}$ to help in part of your answer.
[6 QWC]

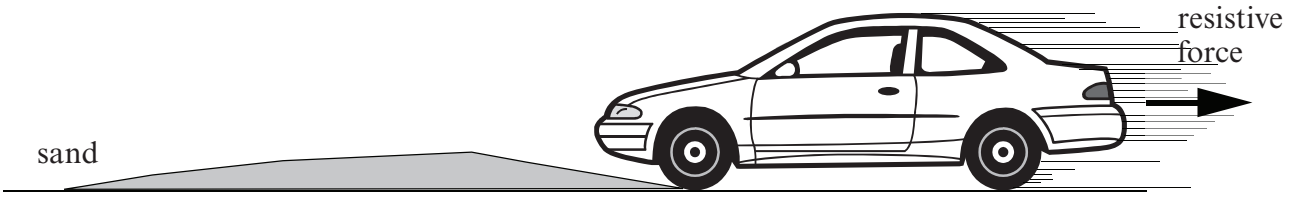
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4. A car of mass 1 500 kg, travelling at 15 m/s has its speed reduced to 5 m/s when it travels 7.5 m through a pile of sand in the road.



(a) Use an equation from page 2 to calculate the loss of kinetic energy of the car. [3]

Loss in kinetic energy = ...

(b) Use your answer to part *(a)* along with an equation from page 2 to find the (mean) resistive force produced by the sand during the collision. [3]

Resistive force = ... N

(c) Write down the value of the horizontal force that acts on the **sand** in this collision. [1]

Force on the sand = ... N

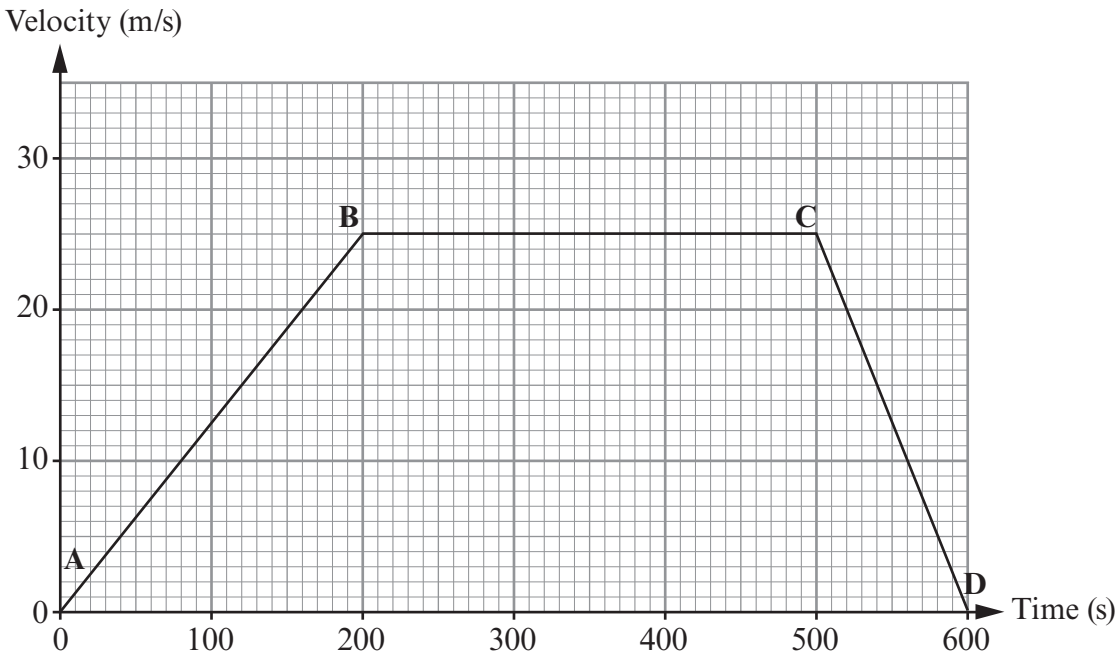
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5. A train of mass 80 000 kg leaves a station **A** and arrives at another station **D**. Its journey is shown on the velocity-time graph below.



(a) Describe the motion from **A** to **D** giving as much detail as possible. [3]

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(b) (i) Use the graph and equations from page 2 to calculate the resultant force acting on the train when it was accelerating. [3]

Resultant force = ... N

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(ii) Explain how the size of the resultant force acting on the train during its deceleration compares to your answer in *(b)*(i). [3]

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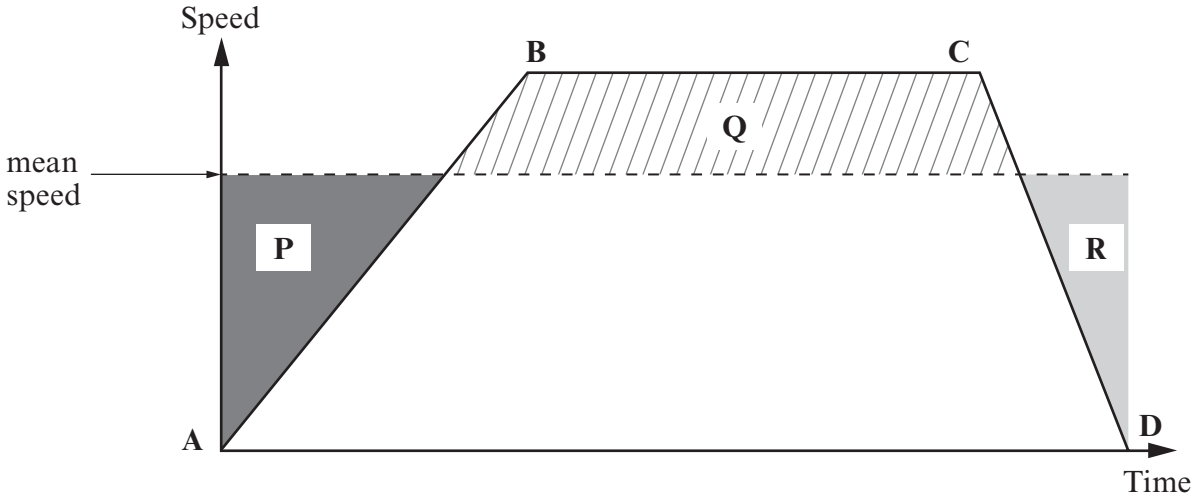
(c) (i) Use the graph and equation from page 2 to calculate the distance from station **A** to station **D**. [3]

Distance from **A** to **D** = ... m

(ii) Use your answer to *(c)*(i) and an equation from page 2 to calculate the mean speed of the train. [2]

Mean speed = ... m/s

(iii) The mean speed for the journey is shown as a dotted line on the graph below.



Write down how the three shaded areas **P**, **Q** and **R** are related mathematically. [1]

.....

.....

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6. *(a)* Deuterium, $^{2}_{1}H$, is an isotope of hydrogen.
Explain what the term "isotope" means. [2]

(b) A fusion reaction can occur when two deuterium nuclei, $^{2}_{1}H$, collide at high speed to produce a helium nucleus (He) and release a neutron.

Explain the importance of this reaction along with its benefits and the difficulties in achieving it in a controlled manner. Your answer should include a balanced nuclear equation. [6 QWC]

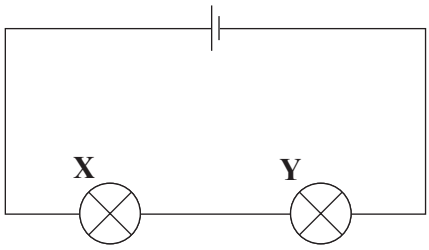
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7. Two filament lamps, **X** and **Y**, are connected in series. Lamp **Y** is brighter than lamp **X**.



Choose and write down an equation from page 2 to explain why lamp **Y** is brighter than lamp **X**. [Hint: consider power] [4]

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4

END OF PAPER

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

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GCSE MARKING SCHEME

SCIENCE - PHYSICS (NEW)

JANUARY 2013

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INTRODUCTION

The marking schemes which follow were those used by WJEC for the January 2013 examination in GCSE SCIENCE - PHYSICS (NEW). 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.

Unit	Page
PHYSICS 1 - FOUNDATION TIER	1
PHYSICS 1 - HIGHER TIER	4
PHYSICS 2 - FOUNDATION TIER	7
PHYSICS 2 - HIGHER TIER	12

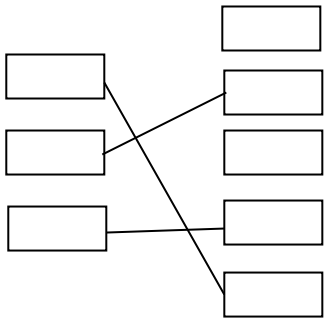
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GCSE Science - Physics 2 Mark Scheme

January 2013

FOUNDATION TIER

Question			Answer / Explanatory Notes	Marks Available
1.	*(a)*		Correct lines 3 × (1) – (-1) for additional lines 	3
	(b)		Acceleration = $\frac{30}{6}$ (1 – substitution) = 5 [m/s^2] (1) For $\frac{30}{6}$ = 0.2 award 1 mark (the substitution mark)	2
	(c)		Slows down (accept falls slower) (1) ….because air resistance increases/becomes more than weight (1) Don't accept slow increase in air resistance. Forces mark (1) e.g. increased surface area against air [particles] Motion mark (1) e.g. air resistance increases (1) parachute goes up (0) – **N.B. independent marking points.**	2
			Question total	**[7]**
2.	*(a)*		Plots ± ½ square (2) [–1 per error] Joined point to point (1) **ecf** for incorrect plots If line is correct assume points are correct even if they can't be seen. Ignore thickness of line but do not accept disjointed / whispy / double / curves	3
	(b)	(i)	Use of 200 m from graph (1) Speed = $\frac{200}{40}$ (1 – subst) = 5 [m/s] (1) Correct working of gradient (matching points) = 3 marks e.g. $\frac{100}{20} = 5$	3
		(ii)	60 [s] **ecf** from graph	1
	(c)	(i)	Faster speed in the last 40 seconds **or** 5 m/s compared with 10 m/s	1
		(ii)	Steeper line / has a larger gradient / same time [interval] but travelled further **or** 5 m/s compared with 10 m/s	1
			Question total	**[9]**

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Question			Answer / Explanatory Notes	Marks Available
3.	*(a)*		Momentum = 800 × 12 (1 – subst) = 9 600 [kg m/s] (1)	2
	(b)	(i)	0 (ignore units)	1
		(ii)	9 600 **ecf** for subtract *(a)* – *(b)*(i)	1
		(iii)	$\frac{9600(1)(\text{ecf})\text{from (b)(ii)}}{3(1)}$ [=3 200 N]	2
	(c)		Any 1 from: • worse weather conditions or implied • worn tyres / incorrect tyre pressure • poor brakes • worse road conditions • high speed / momentum / mass bigger NOT drink driving / tiredness References to reaction time are neutral	1
			Question total	**[7]**

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Question			Answer / Explanatory Notes	Marks Available
4.	*(a)*	(i)	graphite / moderator	1
		(ii)	to cause [fission / chain] reactions / if too quick, reaction won't work	1
	(b)	(i)	boron / control rods	1
		(ii)	to prevent an <u>uncontrolled</u> chain reaction / <u>control</u> the chain reaction / prevent overheating or meltdown / Don't accept "to stop fission" only must be qualified.	1
	(c)	(i)	235	1
		(ii)	36	1
		(iii)	[91 – 36] = 55 (No ecf for 91 – (ii))	1
	(d)		$^{136}_{56}$Ba circled	1
	(e)		37 (1) 0 (1)	2
			Question total	**[10]**
5.	*(a)*	(i)	2 [A]	1
		(ii)	$R = \frac{6}{2}$ (1 –substitution) = 3 [Ω] (1) **ecf** from (i) (If found for wire in (i) R = 4.8 Ω)	2
		(iii)	6 × 2 (1 – subst) = 12 [W] (1) **ecf** from (i) (If found for wire in (i) P = 7.5 W)	2
		(iv)	11 [V]	1
		(v)	3.25 [A]	1
	(b)	(i)	**<u>Lamp</u>** has bigger resistance or converse argument or values given W = 4.8 Ω and L = 5.2 Ω	1
		(ii)	Smaller current through it or converse argument **or** calculations shown (allow temperature increase)	1
			Question total	**[9]**

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Question			Answer / Explanatory Notes	Marks Available
6.	*(a)*	(i)	Helium <u>nucleus/nuclei</u> / 2 protons and 2 neutrons (accept 2p and 2n)	1
		(ii)	Gamma more penetrating [than alpha] / so would not be blocked by smoke / wouldn't change the current / weakly ionising. **<u>Any 2 x (1) due to all points being interlinked.</u>**	2
			Or gamma is more weakly ionising (1) so doesn't cause an electric current (1) (Don't accept gamma is not ionising.)	
		(iii)	Distance between detector / ceiling and the human body (1) so / hence alpha is easily absorbed by the air / case (1) (Answer must be relevant to this context so **don't accept alpha will be blocked by skin / paper**.)	2
	(b)	(i)	<u>Longer ½-life</u> (1) (don't accept longer to decay) so detector stays active / works longer or doesn't need replacing [as often] (1)	2
		(ii)	I. becquerel [accept [Becquerel!] / Bq / bq	1
			II. 26 000 is half of 52 000 (1 – method) so time is one ½-life = <u>432</u> [years] (1)	2
			(Accept $\frac{52000}{2}$ as recognition of half-life – don't allow any other value divided by 2).	
			III. $\frac{864}{432} = 2$ or 864 years is 2 ½-lives or implied (1) so ¼ of the mass remains = <u>0.1</u> [μg] (1)	2
			Question total	**[12]**

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Question			Answer / Explanatory Notes	Marks Available
7.			**Indicative content**: The advantage is that the time taken for the given journey is reduced from 4 h to 3.5 h with the increase in speed. The disadvantage is that in the event of an emergency stop being necessary, the total stopping distance is increased from 96 m to 121.5 m, increasing risk of serious injury or death. Relevant factors clearly explained, e.g. tiredness, related to time or speed / separation from vehicle in front. Increased momentum at higher speed related to increased force on vehicle and occupants in the event of a collision. 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	**[6]**
			Total for foundation tier paper	**[60]**

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HIGHER TIER

Question			Answer / Explanatory Notes	Marks Available
1.	*(a)*	(i)	2 [A]	1
		(ii)	$R = \frac{6}{2}$ (1 –substitution) = 3 [Ω] (1) **ecf** from (i) (If found for wire in (i) R = 4.8 Ω)	2
		(iii)	3.25 [A]	1
	(b)	(i)	**Lamp** has bigger resistance or converse argument or values given W = 4.8 Ω and L = 5.2 Ω	1
		(ii)	Smaller current through it **or** converse argument or calculations shown (allow temperature increase)	1
	(c)		Beyond about 11 V, W has the bigger current (1) hence W has the bigger power (1) **Or** power calculations at 12 V (1) this is because the current in W is now bigger than in L (1) **Or** at 11 V the powers are equal (1) because the currents are equal (1)	2
			Question total	**[8]**
2.	*(a)*	(i)	Helium nucleus/nuclei / 2 protons and 2 neutrons (accept 2p and 2n)	1
		(ii)	Gamma more penetrating than alpha / so would not be blocked by smoke / wouldn't change the current / weakly ionising. **Any 2 x (1) due to all points being interlinked.** **Or** gamma is more weakly ionising (1) so doesn't cause an electric current (1) (Don't accept gamma is not ionising.)	2
		(iii)	Distance between detector / ceiling and the human body (1) so / hence alpha is easily absorbed by the air / case (1) (Answer must be relevant to this context so **don't accept alpha will be blocked by skin**.)	2
	(b)	(i)	Longer ½-life (1) (don't accept longer to decay) so detector stays active / works longer or doesn't need replacing [as often] (1)	2
		(ii)	I. becquerel [accept [Becquerel!] / Bq / bq	1
			II. 26 000 is half of 52 000 (1 – method) so time is one ½-life = 432 [years] (1) (Accept $\frac{52000}{2}$ as recognition of half-life – don't allow any other value divided by 2).	2
			III. $\frac{864}{432}$ = 2 or 864 years is 2 ½-lives (1) so ¼ of the mass remains = 0.1 [μg] (1)	2
			Question total	**[12]**

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Question			Answer / Explanatory Notes	Marks Available
3.			**Indicative content**: The advantage is that the time taken for the given journey is reduced from 4 h to 3.5 h with the increase in speed. The disadvantage is that in the event of an emergency stop being necessary, the total stopping distance is increased from 96 m to 121.5 m, increasing risk of serious injury or death. Relevant factors clearly explained, e.g. tiredness, related to time or speed / separation from vehicle in front. Increased momentum at higher speed related to increased force on vehicle and occupants in the event of a collision. 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	**[6]**
4.	*(a)*		Initial K.E. = 0.5 x 1500 x 15^2 = 168 750 [J] (1) Final K.E. = 0.5 x 1500 x 5^2 = 18 750 [J] (1) Loss = 150 000 [J] (1) (award 1 mark for doing any subtraction but award no marks for use of $(15\text{-}5)^2$.)	3
	(b)		$F = \frac{150000(ecf)}{7.5}$ = 20 000 [N] (1) manip, (1) subst, (1) ans For candidates who present a momentum argument: $\frac{x}{t} = \frac{(u+v)}{2}$ to find time = 0.75 [s](1) momentum change = 15 000 [kg m/s](1) $F = \frac{15000(ecf)}{0.75(ecf)}$ = 20 000 [N] (1)	3
	(c)		F = 20 000 [N] ecf from *(b)*	1
			Question total	**[7]**

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Question			Answer / Explanatory Notes	Marks Available
5.	*(a)*		General description of 3 parts (1) Reference to all 3 times (1) Reference to 25 m/s value / value of acceleration (0.125) / deceleration (0.25) (1)	3
	(b)	(i)	Either: a = 0.125 (1) and $F = ma$ = 80 000 (1) x 0.125 (**ecf**) = 10 000 [N](1) **or** F= 80 000(1) x $\{\frac{(25-0)}{200}\}$(1) = 10 000 [N](1)	3
		(ii)	Force is bigger (1 mark only) but force is twice as big (2 marks only) because time is smaller / half as long / gradient is bigger or twice as big (1) (Calculated value for force of 20 000 N gets 2 marks but a statement the force is bigger because the time is halved (1) is still needed.)	3
	(c)	(i)	(300 + 600)(1) x (0.5 (1) x 25)(1) = [11 250 m] N.B. no mark for answer OR Area = (0.5 x 200 x 25)(1) + (300 x 25)(1) + (0.5 x 100 x 25)(1) = 2 500 + 7 500 + 1 250 = [11 250 m] N.B. no mark for answer	3
		(ii)	mean speed = $\frac{11250(ecf)}{600}$ = 18.75 [m/s] [1 for subs, 1 for answer]	2
		(iii)	Area P + area R = area Q [1] accept P + R = Q	1
			Question total	**[15]**

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6.	*(a)* *(b)*		The same atomic / proton number (1) but different mass / nucleon / neutron numbers (1) (Reference to electrons treat as neutral). Indicative content: $^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{3}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n}$ (LHS correct with He and n written on RHS, correct nucleon and proton numbers for He, correct nucleon and proton numbers for n.) The collision releases a large amount of energy. Containment is very difficult because of the high pressure needed and in maintaining high temperatures. Difficulty in keeping the plasma away from the container - can be achieved magnetically. Virtually unlimited availability of deuterium from water in the oceans. It releases a large amount of energy per unit mass and no radioactive waste. However the neutrons that are released interact with container causing radiation emissions. 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.	2 6
			Question total	**[8]**
7.			$P=I^2R$ quoted (1), common current (1), so bigger P [has larger R] (1), Y has bigger R (1) **OR** $P = V$ x I **and** $V = IR$ must be given (1) ($V = IR$ can be implied) Common current (1) Bigger voltage across Y than X (1) Hence bigger R for Y (1) (Do not credit if more than one equation is written unless it is clear that the appropriate equation is used for the argument.) **Question total**	4 **[4]**
			Total for higher tier paper	**[60]**

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Surname	Centre Number	Candidate Number
Other Names		0

New GCSE

4473/02

ADDITIONAL SCIENCE
HIGHER TIER
PHYSICS 2

A.M. THURSDAY, 24 May 2012

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**8**	
2.	**9**	
3.	**17**	
4.	**9**	
5.	**8**	
6.	**9**	
Total	**60**	

4473
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 pages 2 and 3 of the examination paper. 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 **1***(a)* and **4***(b)*.

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Equations and Units

Physics 1

power = voltage × current $P = VI$

energy transfer = power × time $E = Pt$

units used (kWh) = power (kW) × time (h)
cost = units used × cost per unit

$$\% \text{ efficiency} = \frac{\text{useful energy [or power] transfer}}{\text{total energy [or power] input}} \times 100$$

$$\text{density} = \frac{\text{mass}}{\text{volume}} \qquad \rho = \frac{m}{V}$$

wave speed = wavelength × frequency $v = \lambda f$

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

Physics 2

$$\text{current} = \frac{\text{voltage}}{\text{resistance}} \qquad I = \frac{V}{R}$$

power = current^2 × resistance $P = I^2R$

$$\text{acceleration [or deceleration]} = \frac{\text{change in velocity}}{\text{time}} \qquad a = \frac{\Delta v}{t}$$

distance travelled = area under a velocity – time graph

acceleration = gradient of a velocity – time graph

momentum = mass × velocity $p = mv$

resultant force = mass × acceleration $F = ma$

$$\text{force} = \frac{\text{change in momentum}}{\text{time}} \qquad F = \frac{\Delta p}{t}$$

work = force × distance $W = Fd$

$$\text{kinetic energy} = \frac{\text{mass} \times \text{speed}^2}{2} \qquad \text{KE} = \tfrac{1}{2}mv^2$$

$$\text{change in potential energy} = \text{mass} \times \text{gravitational field strength} \times \text{height} \qquad \text{PE} = mgh$$

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Physics 3

$$\frac{\text{primary coil voltage}}{\text{secondary coil voltage}} = \frac{\text{primary coil turns}}{\text{secondary coil turns}} \qquad \frac{V_1}{V_2} = \frac{N_1}{N_2}$$

$v = u + at$
$v^2 = u^2 + 2ax$
$x = ut + \frac{1}{2}at^2$
$x = \frac{1}{2}(u + v)t$

where u = initial velocity, v = final velocity, a = acceleration, x = displacement, t = time

$$\text{pressure} = \frac{\text{force}}{\text{area}} \qquad p = \frac{F}{A}$$

$\frac{pV}{T}$ = constant

$E = mc^2$

where p = pressure, V = volume, T = kelvin temperature

Units

1 kWh = 3.6 MJ
T / K = θ / °C + 273

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}

4473
020003

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Examiner only

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

1. *(a)* Describe how fission of $^{235}_{92}U$ is produced in a nuclear reactor and explain the role of moderators and control rods in the process. [6 QWC]

(b) Complete the equation for the fission reaction shown below.

$$^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{137}_{\ldots\ldots}Ba + {}^{\ldots\ldots}_{36}Kr + 2\,{}^{1}_{0}n$$

[2]

8

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Examiner only

2. Iodine-131 [$^{131}_{53}$I] is present in fission products of uranium. It is a beta (β) emitter with a half-life of 8 days. When absorbed into the body it concentrates in the thyroid gland increasing the risk of thyroid cancer. After the nuclear disaster in Japan, people living in the area were given non-radioactive iodine-127 [$^{127}_{53}$I] supplement tablets to reduce their intake of iodine-131 that leaked from the reactor.

(a) (i) What is a beta (β) particle? ..... [1]

(ii) Write down the symbol for a beta particle in the form $^{A}_{Z}X$. ..... [1]

(b) (i) Explain why iodine-131 increases the risk of thyroid cancer. [2]

.....

.....

.....

.....

(ii) Compare the nuclear structure of $^{131}_{53}$I and $^{127}_{53}$I. [3]

.....

.....

.....

.....

.....

.....

.....

(c) Calculate for how long people had to take the iodine supplement tablets until the activity of iodine-131 reduced to approximately 3% of its original value just after a leak. [2]

Time = ... days

4473 020005

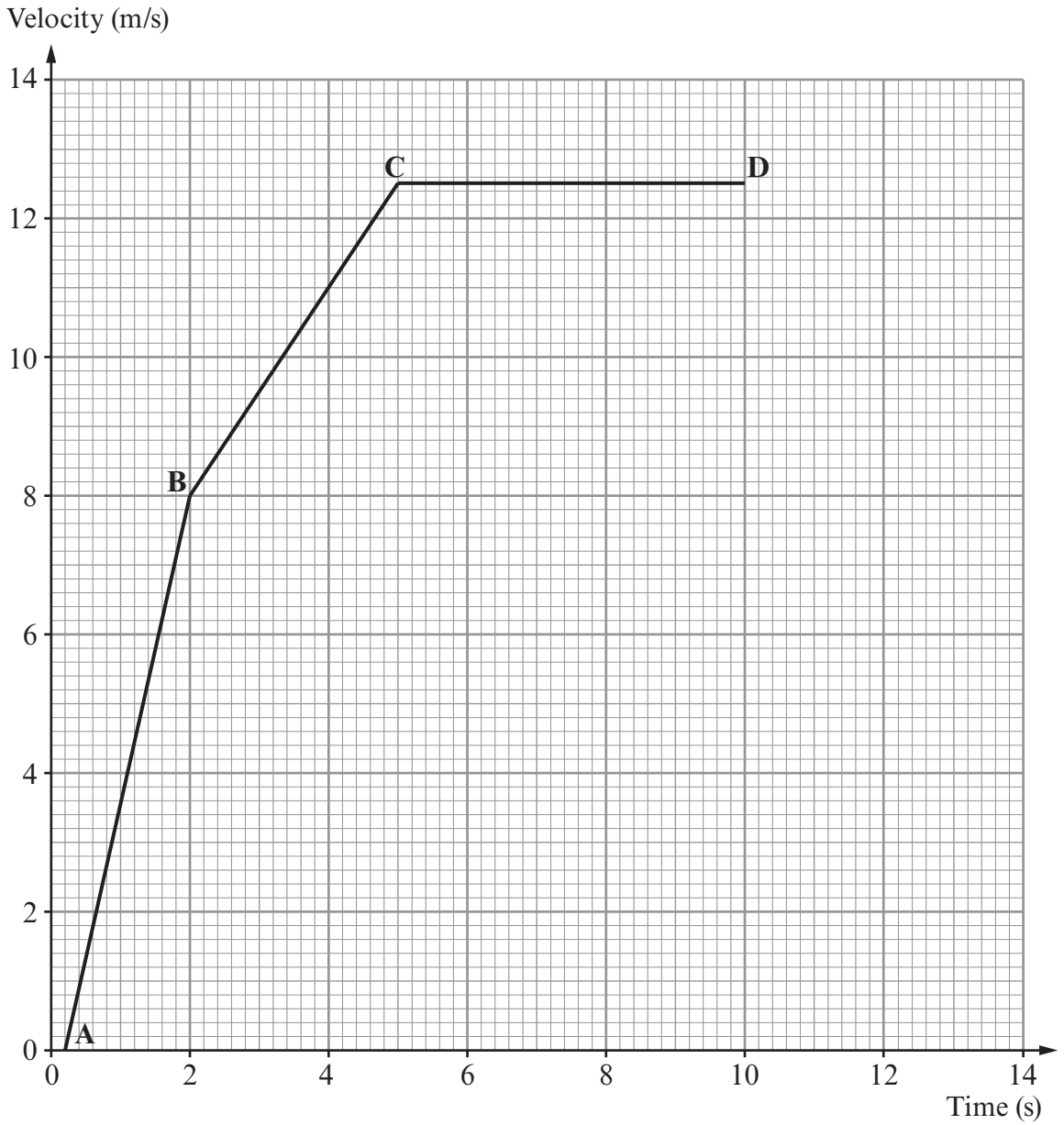
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Turn over.

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3. The simplified graph shows the velocity of a top athlete running a 100 m race. The gun is fired at 0 s to start the race.



(a) Use the graph to find the athlete's reaction time. ..... s [1]

(b) (i) The acceleration of the athlete is greatest between **A** and **B**.
State how the graph shows this. [1]

.....

.....

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(ii) Use the equation

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

to calculate the athlete's acceleration between **A** and **B** and give its unit. [3]

Acceleration = ... Unit .....

(iii) Use your answer to *(b)* (ii) and an equation from pages 2 and 3 to calculate the resultant force on the athlete, given that his mass is 94 kg. [2]

Resultant force = ... N

(c) (i) Use the graph to identify the part of the race (**AB**, **BC** or **CD**) in which the athlete travels the furthest. [1]

.....

(ii) Explain your answer. [2]

.....

.....

(d) At the end of the race the athlete takes 2.5 s to slow down uniformly to rest.
Complete the graph to show this. [2]

(e) (i) Use information from pages 2 and 3 to calculate the distance travelled by the athlete between points **B** and **D**. [3]

Distance travelled = ... m

(ii) Use an equation from pages 2 and 3 to calculate the mean velocity of the athlete between points **B** and **D**. [2]

Mean velocity = ... m/s

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Examiner only

4. *(a)* A skydiver has a mass of 75 kg.

(i) Calculate the weight of the skydiver. [g = 10 N/kg] [1]

Weight = ... N

(ii) After jumping from a plane, at one point in the fall the air resistance is 300 N. Use the equation

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

to calculate the acceleration of the skydiver at this point. [2]

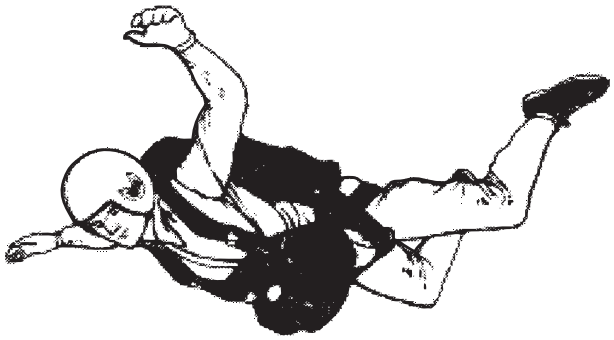
Acceleration = ...

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(b) Explain in terms of forces, why, after jumping from a plane, a skydiver reaches a terminal speed. [6 QWC]



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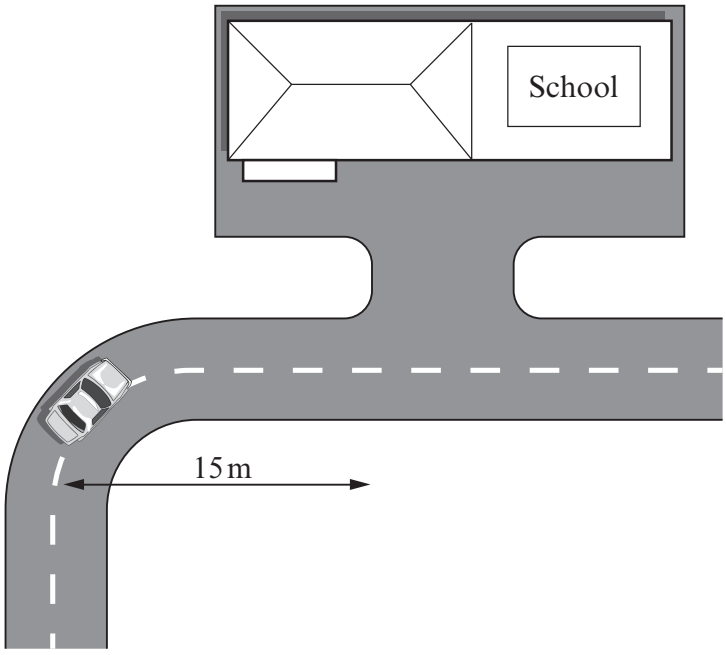
Examiner only

5. The speed limit outside a school is currently 18 m/s (40 mph). The thinking distance at **this speed** is 12 m.

(a) Using equations from pages 2 and 3, calculate the braking distance **and hence**, the overall stopping distance for a car of mass 1000 kg travelling at 18 m/s if the braking force is 6750 N. [Hint: consider kinetic energy and work done.] [5]

Overall stopping distance = ... m

(b) The entrance to the school is situated 15 m past a bend in the road.



Campaigners argue that the speed limit should be halved to 9 m/s (20 mph). **Explain how** this would decrease the chance of children getting knocked down as they crossed the road. [A numerical answer is required for full marks.] [3]

.....

.....

.....

.....

.....

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6. A lighting scheme is being planned for a new restaurant.
Information about the lights to be used is shown in the table below.

Position of lights	Number of lights	Description of lights
over tables	20	11 W compact fluorescent
toilets	6	18 W compact fluorescent
kitchen	6	50 W fluorescent

All the lights will be connected in parallel to one another and to the 230 V mains.

(a) Give a reason for connecting the lights in parallel. [1]

.....

.....

(b) (i) Use an equation from pages 2 and 3 to calculate the mains current flowing to the lighting circuit when all the lights are switched on. [3]

Total current = ... A

(ii) Regulations for this circuit mean that the power loss in the main supply cable should not exceed 19 W. Use an equation from pages 2 and 3 to calculate the maximum resistance of the cable that should be used in the circuit. [3]

Maximum resistance = ... Ω

(c) Calculate the resistance of each fluorescent light used in the kitchen. [2]

Resistance = ... Ω

THERE ARE NO MORE QUESTIONS IN THE EXAMINATION.

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GCSE MARKING SCHEME

SUMMER 2012

SCIENCE - PHYSICS

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INTRODUCTION

The marking schemes which follow were those used by WJEC for the Summer 2012 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.

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PHYSICS 2

FOUNDATION TIER

Question			Marking details	Marks Available
1.	*(a)*		Isotope	1
	(b)		4	1
	(c)		[Very] high temperatures are reached [inside the vessel] (1) [Very] high pressure [inside vessel] (1)	2
			Question total	**[4]**
2.	*(a)*		P = 230 x (10 (1)) = 2300 (1) W[atts] (1) accept 2.3 kW	3
	(b)		32 A	1
	(c)		230 [V]	1
			Question total	**[5]**
3.	*(a)*		The line is not straight	1
	(b)		Any 2 marks from 3: [Overall] stopping distance reduced / 20 [m] / 10 [m] (1) OR halved (2 marks)	2
	(c)	(i)	Overall stopping distance = 100 [m] (1) Speed = 30 [m/s] (1). (Allow **ecf** from stopping distance)	2
		(ii)	Mobile phone (1), drunk driver (1)	2
			Question total	**[7]**

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Question			Marking details	Marks Available
4.	*(a)*		$\frac{50000}{20}$ (substitution (1)) = 2 500 [m/s] (1)	2
	(b)		EITHER: Every object continues its motion in a straight line (1) unless acted upon by an (external) force (1) OR There is no air resistance / friction / gravity [in space] (1), so no force is needed to equal / overcome it (1) **The 2nd mark must be linked to the 1st mark.**	2
	(c)		Speed increases / force is produced (1) momentum = mass x speed / which causes a change in momentum (1) OR momentum given to burnt fuel (1) = momentum supplied to rocket (1) **The 2nd mark must be linked to the 1st mark.**	2
	(d)		$F = \frac{360000 - 200000}{8} =$ (substitution (1)) = 20 000 [N] (1)	2
			Question total	**[8]**

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Question			Marking details	Marks Available
5.	*(a)*		Imbalance between numbers of protons and neutrons	1
	(b)	(i)	5 [hours]	1
		(ii)	50 [counts per minute]	1
		(iii)	Yes (1), short [enough] half life [so decays from the body in a few days] (1) and [gamma emitter] so it can escape the body [for detection] (1)	3
			Question total	**[6]**
6.	*(a)*		0.6 A	1
	(b)		Symbol in parallel with the lamp (1) circle with V in anywhere (1)	2
	(c)		Answer = 15 [Ω]	1
		(i)	Increases	1
		(ii)	Decreases / halves	1
			Question total	**[6]**
7.			**Indicative content:** The absorption of slow neutrons can induce fission of Uranium-235 nuclei, releasing energy and the emission of neutrons from such fission can lead to a sustainable chain reaction. The moderator slows down the neutrons for fission to occur. The control rods control the rate of fission by absorbing a proportion of the neutrons. **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.	6

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Question			Marking details	Marks Available
7.			**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.	*(a)* *(b)* *(c)*		[High energy] / [fast moving] electron Beta absorbed / can't get out of the body (1) so damages / ionises cells (1) **The 2nd mark must be linked to the 1st mark.** Both nuclei contain the same number of (53) protons / proton number (1) different numbers of neutrons / mass number / nucleon number (1) 78 neutrons in I-131 & 74 in I-127 / difference of 4 neutrons (1) **Question Total**	1 2 3 **[6]**
9.	*(a)* *(b)* *(c)* *(d)*	 (i) (ii) (iii) (i) (ii)	0.2 [s] Line is steepest $a = \frac{8(1)}{(2-0.2)(1)}$ allow **ecf** from (a) = [4.44] (1) m/s ^{2} (1) Subs 4.44 x 94 (1) = 417.36 (accept 417 - 418) [N] (1) Allow **ecf** from (b)(ii) C to D because longest time (1) at highest velocity (1) OR area under graph (1) with the term "is greatest" or equivalent (1) **The 2nd mark must be linked to the 1st mark.** Straight line from D to axis (1) final coordinate (12.5, 0) (1) Allow ± ½ square. **Question Total**	1 1 3 2 1 2 2 **[12]**
			Foundation Tier Total	**60**

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PHYSICS 2

HIGHER TIER

Question			Marking details	Marks Available
1.	*(a)*		Indicative content: The absorption of slow neutrons can induce fission of Uranium-235 nuclei, releasing energy and the emission of neutrons from such fission can lead to a sustainable chain reaction. The moderator slows down the neutrons for fission to occur. The control rods control the rate of fission by absorbing a proportion of the neutrons **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
	(b)		97 added to Kr, 56 added to Ba	2
			Question total	**[8]**
2.	*(a)*	(i)	[High energy] / [fast moving] electron	1
		(ii)	$_{-1}^{0}\beta$ or $_{-1}^{0}e$	1
	(b)	(i)	Beta absorbed / can't get out of the body (1) so damages / ionises cells (1) **The 2nd mark must be linked to the 1st mark.**	2
		(ii)	Both nuclei contain the same number of (53) protons / proton number (1) different numbers of neutrons / mass number / nucleon number (1) 78 neutrons in I-131 & 74 in I-127 / difference of 4 neutrons (1)	3
	(c)		Calculation of number of half lives -5 (1) x 8 (1)	2
			Question total	**[9]**

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Question			Marking details	Marks Available
3.	*(a)*		0.2 [s]	1
	(b)	(i)	Line is steepest	1
		(ii)	$a = \frac{8(1)}{(2-0.2)(1)}$ allow **ecf** from (a) = [4.44] m/s^2 (1)	3
		(iii)	Subs 4.44 x 94 (1) = 417.36 (accept 417 - 418) [N] (1) Allow **ecf** from (b)(ii)	2
	(c)	(i)	C to D	1
		(ii)	because longest time (1) at highest velocity (1) OR area under graph (1) with the term "is greatest" or equivalent (1) **The 2nd mark must be linked to the 1st mark.**	2
	(d)		Straight line from D to axis (1) final coordinate (12.5, 0) (1) Allow ± ½ square.	2
	(e)	(i)	Calculation of area under BC – 30.75/30.8 [m] (1); calculation of area under CD – 62.5 [m]; (1) total = 93.3 [m] (1) OR area under AB = 7.2 (1) and 100 (1) – 7.2 = 92.8 [m] (1) Any attempt at area calculation = 1 mark only.	3
		(ii)	$\frac{(d)(i)(ecf)}{8}$ (1) = 11.66 - 11.8 [m/s] (1)	2
			Question Total	**[17]**
4.	*(a)*	(i)	750 [N]	1
		(ii)	Calculation of resultant force: 750 (**ecf**) – 300 = 450 [N] (1) $\frac{450}{75}$ = 6 [m/s^2] (1)	2
	(b)		**Indicative content:** During free fall, sky diver acted on by 2 forces; these are weight and air resistance; the weight remains constant throughout the fall; the air resistance increase with speed; eventually the air resistance becomes equal to the weight; the resultant force is zero; the skydiver stops accelerating. **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.	6

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Question			Marking details	Marks Available
4.			**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**	**[9]**
5.	*(a)*		Calculation of braking distance: Calculation of KE: use of $\frac{1}{2}mv^2$; (1) subs ½ x 1000 x 18^2; (1) answer of 162 000 [J]; use of W*D* = *F* x *s*; (1) answer for *s* of 24 [m]; (1) Alternatively, accept this method: First step find deceleration: use of $a = \frac{F}{m}$ (1), subs $\frac{6750}{1000} = 6.75[\ m/s^2\ ]$; (1) Now braking time: braking time = $\frac{18.6}{6.75} = 2.67/2.7$ [s]; (1) braking distance = mean speed x time = 9 x 2.67 = 24 [m]; (1) So overall stopping distance = 24 (**ecf**) + 12 = 36 [m] (1)	5
	(b)		Thinking distance halves / 6 [m]; (1) braking distance decreases to a quarter / 6 [m]; (1) overall stopping distance of 12 [m] is less than 15 [m] view of the school (1) **Question total**	3 **[8]**

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Question			Marking details	Marks Available
6.	*(a)*		Same voltage across each (Accept can be switched separately)	1
	(b)	(i)	Use of $P=VI$; (1) Method 1 : calculation of current through quantity of each type of lamp: 0.05 x 20, 0.08 x 6, 0.22 x 6 (1) for currents and (1) for multiples; Answer of 2.8 [A] gains 3 marks. Alternatively: total power = ((20 x 11) + (6 x 50) +(6 x 18))= 628 [W] (1); Current = $\frac{628}{230}$ = 2.73 or 2.80 [A] (1)	3
		(ii)	Use of $P=I^2R$; (1) $19 = 2.7^2$ x R; (1 mark – substitution, 1 mark – manipulation) R = [2.6 Ω] (answer of 83 Ω = 2 marks)	3
	(c)		Use of $P=I^2R$ (no credit); 50=0.048 (**ecf**) x R (1) so R = 1040 [Ω](1)	2
			Question total	**[9]**
			Higher Paper Total	**60**

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