GCSE MARKING SCHEME

SCIENCE - PHYSICS

JANUARY 2014

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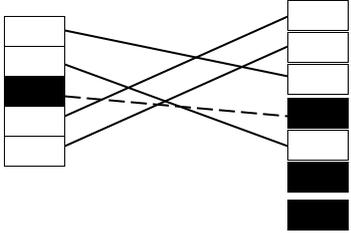
WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

GCSE Science - Physics 1 Mark Scheme

January 2014

FOUNDATION TIER

Question				Marking details	Marks
1.	(a)			 4 lines joined or words correct = 3 marks. 2 or 3 lines or words correct = 2 marks. 1 line or word correct = 1 mark. 0 lines or words correct = 0 mark. Deduct 1 mark for each additional line.	3
	(b)	(i)		<u>Bigger</u> than 30 / accept <u>bigger</u> than 0.3 <u>m</u> (provided cm deleted) / alternatives.	1
		(ii)		Travel through vacuum/travel in straight lines/same speed [in a vacuum] / transverse/[they both] carry energy /[they both] carry information / reflect / refract	1
				Question total	**[5]**
2.	(a)	(i)		Radioactive decay is random (more than one tick don't award the mark)	1
		(ii)		Dividing by 5 <u>**or**</u> total of 175 (1) mean = 35(1) (Answer alone gets both marks) (174/5 = 35 award 1 mark only)	2
		(iii)		Take the readings with no source (must be implied source is removed rather than distance increased)	1
	(b)	(i)	(I)	Nuclear industry	1
			(II)	50[%]	1
		(ii)		Different areas have different rocks in the ground / some areas have more uranium than others / more or less granite in the ground	1
				Question total	**[7]**

Question				Marking details	Marks
3.	(a)			230 (1), 50 [Hz] (1), 1 800 (accept 1.8 with kilo or k)(1)	3
	(b)			Microwave (1), infra-red (1) Don't accept microwave power or micro	2
	(c)	(i)		3.0 [kW] (Accept 3 000 only if the k is deleted in kW)	1
		(ii)		Units = (3.0 (**ecf from (i)**)) x 0.5) = 1.5 [kWh] Mark for the answer	1
		(iii)		Cost = (1.5 (**ecf from (ii)**)) x 14 p) = 21 [p] Mark for the answer Do not credit £ 21 p or £0.21 p	1
				Question total	**[8]**
4.	(a)	(i)		<u>National Grid</u>	1
		(ii)		A - 50 000 [V], B - 400 000 [V], C – 230 [V] [2 marks for all 3 correct, 1 mark for 1 or 2 correct]	2
		(iii)		<u>Step-down transformer</u>	1
	(b)	(i)		06:00 (Accept 6 am)	1
		(ii)		45 000 [MW]	1
		(iii)		[pumped storage] hydroelectric - accept solar	1
		(iv)		45 000 **or** 2 400 (1) 42 600 (1) (Answer alone gets 2 marks) Unit – MW (1) Can be written alongside power value. Don't accept mW.	3
				Question total	**[10]**
5.		(i)		Helium indicated as correct (in any manner) (more than one tick don't award the mark)	1
		(ii)		Absorbed	1
		(iii)		B on answer line or selected on diagram	1
		(iv)		<u>Galaxies </u>are moving away from us / moving apart **or** the Universe is expanding. Don't accept red shifted.	1
		(v)		It is expanding / started at one point	1
		(vi)		<u>Big Bang</u>	1
				Question total	**[6]**

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Question				Marking details	Marks
6.	(a)	(i)		Any 2 x (1) from: • produces a lot of energy <u>for a small mass</u> of fuel or is a concentrated energy source (accept amount for mass) • it is reliable or it can generate all of the time • produces no pollutant <u>gases</u> / doesn't contribute to global warming (accept named gas or greenhouse gases) (do not accept no pollution) • produces only a small volume of (solid) waste (accept amount for volume) • less dependence on fossil fuels / conserves fossil fuels • provides energy security	2
		(ii)		Any (1) from: • [radioactive waste] may <u>leak</u> [into the ground / environment] (don't accept radiation leaking) • geological changes (accept earthquakes etc.) • radioactive material may get into the food chain • [over time if location not correctly recorded] it may be excavated Do **not** accept answers in terms of property prices or damages the environment or cost or terrorism.	1
	(b)			Does not add to / cause global warming or greenhouse effect (1) because carbon dioxide released during burning = carbon dioxide used during growing/overall add no carbon dioxide to the environment (1) (Accept they are carbon neutral <u>or</u> they <u>just</u> release CO_2 <u>back</u> into the air) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
	(c)	(i)		Grass (1) low<u>est</u> crop yield (accept <u>only</u> 5 tonnes ... (1) low<u>est</u> energy content (accept <u>only</u> 16 .....(1)	3
		(ii)	(I)	$\dfrac{50000}{10} = 5\,000\,[\text{km}^2]$ Mark for the answer	1
			(II)	$50\,000 \times 20 = 1\,000\,000$ [units] Mark for the answer	1
		(iii)		Less land / space used (1) so less destruction of habitats / so more land available for food production (1) (Don't credit references to CO_2 or SO_2.) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
				Question total	**[12]**

Question				Marking details	Marks
7.	(a)			$\rho = \dfrac{104}{80}$ (1) = 1.3 (1) kg/m^3 (1) **Alternative:** $\rho = \dfrac{104000}{80000000}$ (1) = 0.0013 (1) g/cm^3 (1)	3
	(b)	(i)		A	1
		(ii)		A	1
		(iii)		Because <u>hot</u> air rises / expands (don't accept heat rises or least dense)	1
	(c)			**Indicative content** The silver sheet reflects infra-red radiation back into the radiator and reflects heat back into the room. The ridged panels / bubble wrap trap insulating pockets of air between the radiator and the wall, reducing heat lost through the wall by conduction. Plastic is also an insulator. The outside air temperature of the wall will be reduced by both factors above, so convection will be reduced. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	6
				Question total	**[12]**
				FOUNDATION TIER PAPER TOTAL	**[60]**

Question				Marking details	Marks
1.	(a)	(i)		Any 2 x (1) from: • produces a lot of energy <u>for a small mass</u> of fuel or is a concentrated energy source (accept amount for mass) • it is reliable or it can generate all of the time • produces no pollutant <u>gases</u> / doesn't contribute to global warming (accept named gas or greenhouse gases) (do not accept no pollution) • produces only a small volume of (solid) waste (accept amount for volume) • less dependence on fossil fuels / conserves fossil fuels • provides energy security	2
		(ii)		Any (1) from: • [radioactive waste] may <u>leak</u> [into the ground / environment] (don't accept radiation leaking) • geological changes (accept earthquakes etc.) • radioactive material may get into the food chain • [over time if location not correctly recorded] it may be excavated Do **not** accept answers in terms of property prices or damages the environment or cost or terrorism.	1
	(b)			Does not add to / cause global warming or greenhouse effect (1) because carbon dioxide released during burning = carbon dioxide used during growing / overall add no carbon dioxide to the environment (1) (Accept they are carbon neutral <u>or</u> they <u>just</u> release CO_2 <u>back</u> into the air) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
	(c)	(i)		Grass (1) low<u>est</u> crop yield (accept <u>only</u> 5 tonnes .... (1) low<u>est</u> energy content (accept <u>only</u> 16 ......) (1)	3
		(ii)	(I)	$\dfrac{50000}{10} = 5\,000\,[\text{km}^2]$ Mark for the answer	1
			(II)	$50\,000 \times 20 = 1\,000\,000$ [units] Mark for the answer	1
		(iii)		Less land / space used (1) so less destruction of habitats / so more land available for food production (1) (Don't credit references to CO_2 or SO_2.) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
				Question total	**[12]**

Question			Marking details	Marks
2.	(a)		$\rho = \dfrac{104}{80}$ (1) = 1.3 (1) kg/m³ (1) **Alternative:** $\rho = \dfrac{104000}{80000000}$ (1) = 0.0013 (1) g/cm³ (1)	3
	(b)	(i)	A	1
		(ii)	A	1
		(iii)	Because <u>hot</u> air rises / expands (don't accept heat rises or least dense)	1
	(c)		**Indicative content** The silver sheet reflects infra-red radiation back into the radiator and reflects heat back into the room. The ridged panels / bubble wrap trap insulating pockets of air between the radiator and the wall, reducing heat lost through the wall by conduction. Plastic is also an insulator. The outside air temperature of the wall will be reduced by both factors above, so convection will be reduced. **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]**

Question				Marking details	Marks
3.	(a)			1.3 [seconds]	1
	(b)	(i)		Scales on both axes more than ½ of the grid used (1). All Points correct (no tolerance allowed) (1) best fit curved line drawn passing through (0,0) (1) allow **ecf.** Don't accept double lines / whispy / disjointed / wobbly lines.	3
		(ii)		Wave speed increases (1) at a decreasing rate (don't accept non-linearly) (1) allow **ecf** from graph	2
		(iii)		65 $\pm$ 1 [cm/s] allow **ecf** from graph	1
	(c)			Any row of data used. E.g. Distance = 30 x 3.0 = 90 [cm] (1) Tray length = $\dfrac{90}{4}$ (1) for dividing by 4, allow **ecf** for 90 = 22.5 [cm] (1) $\pm$ 0.1cm (allow **ecf** if depth 3.0 cm data used) For 90 [cm] on answer line award 1 mark.	3
				Question total	**[10]**
4.		(i)		total power input = 44 000 MW (1) useful power output = 0.9 x 44 000 **(ecf)** MW (1) = 39 600 [MW] (1) Award 2 marks for 37 582 [MW]	3
		(ii)		<u>step-up transformer</u> / <u>high voltage</u> (1) so <u>decrease / lower / less</u> current **or** <u>less</u> power / heat / energy loss [in cables] (1) (treat small current as neutral) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
		(iii)		Correct power of 996 MW used (1) Division of power by voltage with matching units (1) A division by 8 appearing anywhere (1) Award 2 marks for $\dfrac{996}{0.27} = 3\,689$ [A] Award 1 mark for $\dfrac{996}{270} = 3.689$ [A]	3
				Question total	**[8]**

Question				Marking details	Marks
5.				X is iodine – 131 (1) Reasoning: count rate only reduced by lead / so must be gamma emitter (1) Y is silver – 110 (1) Reasoning: count rate reduced by aluminium and lead / so must be beta and gamma emitter (1) Z is radium – 226 (1) Reasoning: count rate reduced by paper and lead / so must be alpha and gamma emitter (1) **AWARD A MAXIMUM OF 5 MARKS ONLY**	5
				Question total	**[5]**
6.	(a)	(i)		X-rays & ultraviolet 1 mark each – correctly positioned	2
		(ii)		<table><tr><td>Region of em spectrum</td><td>Wavelength range (m)</td></tr><tr><td>Gamma rays</td><td>$<1 \times 10^{-11}$</td></tr><tr><td>X rays</td><td>1×10^{-11} to 1×10^{-9}</td></tr><tr><td>Ultraviolet</td><td>1×10^{-9} to 4×10^{-7}</td></tr><tr><td>Visible light</td><td>4×10^{-7} to 7×10^{-7}</td></tr></table> shortest wavelength inserted alongside gamma rays (1) correct sequence for the remaining 3 (1)	2
	(b)			Use of 1×10^{-9} (1) subs & manip (1) ans 3×10^{17} [Hz] (1) If answer of 7.5×10^{14} [Hz] award 2 marks	3
				Question total	**[7]**

Question				Marking details	Marks
7.				**Indicative content:** They are spectra of light crossed by dark lines. They can tell us the composition of the star/galaxy gas cloud because different elements will absorb light at different wavelengths to produce each dark line. They can also tell us how far away the galaxy is from us, and the further away from us the faster the galaxy moves because the further the dark lines are red shifted. **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]**
				HIGHER TIER PAPER TOTAL	**[60]**

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 = <u>15</u> [N]	1
		(ii)	$\dfrac{15(ecf)}{0.5}$ (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]**

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 short<u>est</u> / area under graph small<u>est</u> / big<u>gest</u> deceleration / steep<u>est</u> line (accept steeper than others) / big<u>gest</u> gradient / stops in <u>only</u> 5 s (1) Neutral – longest or shortest gradient Don't accept – stops at 5 s or steeper rate	2
			Question total	**[9]**

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] <u>number</u> (accept amount) <u>of protons</u> / <u>53 protons</u> / [same] <u>proton number</u> / 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 <u>decays</u> 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 <u>and</u> 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]**

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.	6
	Question total	**[6]**
	FOUNDATION TIER PAPER TOTAL	**[60]**

Question				Marking details	Marks
1.		(i)		$a = \frac{(0-15)}{5}$ OR $a = \frac{(15-0)}{5}$ [1 – subs] = -3[1 – ans] [m/s²] 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] <u>number</u> (accept amount) <u>of protons</u> / <u>53 protons</u> / [same] <u>proton number</u> / 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 <u>decays</u> 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 <u>and</u> 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]**

	Question		Marking details	Marks
3.			**Indicative content:** Name of air bag, seat belt, head rest or crumple zone.	6
			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]**

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)	$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{89}_{36}Kr + ^{144}_{56}Ba + 3^{1}_{0}n$ (+ γ treat as neutral) (1 for symbol equation correct, 1 for 3 neutrons on RHS)	2
		(ii)	Since $(\frac{1}{2}mv^2)Ba = (\frac{1}{2}mv^2)n$ (1) (or by implication) Then $144v^2(Ba) = 1v^2(n)$ $v_{Ba} = \frac{1}{12}v_n$ (1) Accept $m_{Ba} = 144\ m_n$ 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]**

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)	$mg\Delta h = 320 \times 1.35 \times 120000 \, [= 51\,840\,000 \text{ J}]$ Correct value for m (320 kg)(1), correct value for g x1.35(1), correct value for Δh x120000) (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 <u>lost</u>, but accept <u>lost</u> and changes) to <u>work being</u> done against <u>friction</u> [in the atmosphere] / increasing the heat energy or temperature <u>of the</u> 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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