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.

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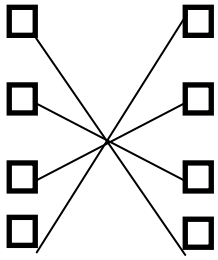
GCSE Science - Physics 1 Mark Scheme

January 2015

FOUNDATION TIER

Question			Marking details	Marks
1			 All four correct – 3 marks 2 or 3 correct - 2 marks 1 correct – 1 mark **AWARD a MAXIMUM OF 3 marks** **Question total**	3 **[3]**
2.	(a)		Ticks in boxes 1, 5 and 6 (3) 1 mark penalty for any extra tick.	3
	(b)		Has to travel back / distance travelled by the signal is double the height of the satellite above the earth. **Don't accept** travel further / take longer / double the time **Question total**	1 **[4]**
3.	(a)		lead, aluminium, beta, gamma. **Accept** symbols β and γ All four correct – 3 marks 2 or 3 correct - 2 marks 1 correct – 1 mark **AWARD a MAXIMUM OF 3 marks**	3
	(b)	(i)	[Radioactive decay is] a random (haphazard or unpredictable) [process] **Don't accept** taken at different times / not the same	1
		(ii)	mean = $\frac{30(1)}{60}$ (1)= [0.5 counts/s] **Award 1 mark** for 30 wherever it appears (if nothing else shown) **Award 1 mark** for division by 60 **Award 2 marks** for an answer only of 0.5 [counts/s]	2

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Question			Marking details	Marks
		(iii)	rocks / cosmic / radon / food / Sun / buildings **Accept** soil / ground / correctly named rocks e.g. granite Don't accept Earth / air / named foods **Question total**	1 **[7]**
4.	(a)		700 [security light] (1), 700 [microwave] (1)	2
	(b)	(i)	Watt[s] **Accept** wat	1
		(ii)	$\%\ \text{efficiency} = \frac{80}{200}(1 - \text{subs})[\text{x } 100] = 40(1)$ **Award 1 mark** for an answer of 0.4	2
	(c)	(i)	Units = 1 × 4 (1) = 4 (1) **Award 1 mark** for an answer only of 4 000 (i.e. no workings shown). Don't award any marks for an answer only of 40 or 400.	2
		(ii)	cost = 4 (**ecf**) × 15 = 60 Mark is for the answer **Accept** £0.60 **Don't accept** £0.60 p **Question total**	1 **[8]**
5.	(a)	(i)	1 000	1
		(ii)	1 000(**ecf**) × 0.7 (1 – subs) = 700 [km^2] (1-answer)	2
		(iii)	$\frac{60}{20}(1)\text{x } 1000(\mathbf{ecf}) = 3\ 000[1 - \text{answer}]$ Answer of 3 **award 1 mark**	2
	(b)		Wind doesn't always blow / nuclear runs all of the time / takes less ground space / fewer habitats destroyed / total commissioning cost is less / longer lifetime. **Accept** more reliable / bigger power [output] / bigger energy [output] / more electricity. **Question total**	1 **[6]**
6.	(a)		[A system of] **cables/wires** (1) **Accept** power lines from **power stations** (1) to **consumers/users** (1) (**accept** 2 named consumers e.g. schools, hospitals, factories, houses)	3
	(b)	(i)	They step up (increase) the voltage **Don't accept** increase the voltage and power / decrease the current	1

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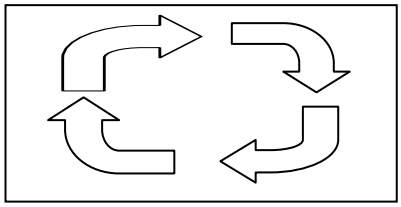
Question			Marking details	Marks
		(ii)	To reduce energy losses / heat losses / to improve efficiency / prevent overheating **Don't accept** any reference to stopping energy / heat losses	1
	(c)	(i)	50 000 at A, 132 000 at B, 230 at C 2 marks for all 3, 1 mark for 1 or 2 correct. **AWARD a MAXIMUM OF 2 marks**	2
		(ii)	Step-up transformer	1
			Question total	**[8]**
7.	(a)		Can cause cancer / deform babies (1) because they ionise **or** damage **or** mutate **or** kill cells / ionising (1) **The 2nd mark must be linked to the 1st mark.**	2
	(b)		Abdomen [X –ray] (1) because it causes the largest received dose / highest dose or units / most days of radiation [given to the patient] (1) **The 2nd mark must be linked to the 1st mark.** **Don't accept** just a reference to 225	2
	(c)	(i)	$\frac{140}{2}$ (1 - subs) = 70 (1)	2
		(ii)	210 days (1)(**ecf**) 3 × answer to (i)) × 43 200 = 9 072 000 [counts] (1) **Award 1 mark** for [70 (**ecf**) × 43 200] = 3 024 000 **Award 1 mark** for [3 × 43 200] = 129 600	2
			Question total	**[8]**
8.	(a)	(i)	Circulation of air from the radiator inside the room (1) arrows in clockwise direction (1) 	2
		(ii)	Air heated all along floor /air heated over bigger area (1) so rises at all points (everywhere) / more convection currents (1) **The 2nd mark must be linked to the 1st mark.** **Don't accept** heat rises or air in the room heats up faster	2

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Question			Marking details	Marks
	(b)	(i)	Plots (allow ± ½ small square division) (2) -1 for each error to a maximum of 2. No penalty for missing origin plot. Straight line (1) (ruler must be used) line must be extended back towards origin	3
		(ii)	**Award 2 marks** for: They're proportional **OR** As the area doubles the power doubles **OR** As the area increases the power increases at a constant rate **OR** Power = area $\times$ 150 **Award 1 mark** for: As the area increases so does the power **OR** Power α wire gird	2
		(iii)	1 800 [W]	1
	(c)		**Indicative content:** Conduction and radiation will take place in all directions from the hot wire grid. The wire grid is at a higher temperature than the bottom surface of the concrete floor. This temperature difference causes energy to flow down through the floor. The foam insulation reduces heat transfer through the concrete by conduction. The silver foil reduces heat loss because it reflects radiant heat back up into the room. **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**	**[16]**
			FOUNDATION TIER PAPER TOTAL	**[60]**

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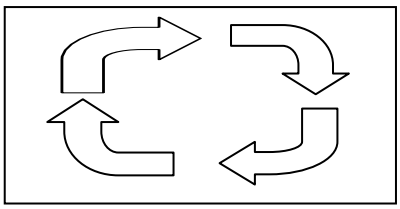
HIGHER TIER

Question			Marking details	Marks
1.	(a)		Can cause cancer / deform babies (1) because they ionise **or** damage **or** mutate **or** kill cells / ionising (1) **The 2nd mark must be linked to the 1st mark.**	2
	(b)		Abdomen [X –ray] (1) because it causes the largest received dose / highest dose or units / most days of radiation [given to the patient] (1) **The 2nd mark must be linked to the 1st mark.** **Don't accept** just a reference to 225	2
	(c)	(i)	$\frac{140}{2}$ (1 - subs) = 70 (1)	2
		(ii)	210 days (1)(**ecf**) 3 × answer to (i)) × 43 200 = 9 072 000 [counts] (1) **Award 1 mark** for [70 (**ecf**) × 43 200] = 3 024 000 **Award 1 mark** for [3 × 43 200] = 129 600	2
			Question total	**[8]**
2.	(a)	(i)	Circulation of air from the radiator inside the room (1) arrows in clockwise direction (1) 	2
		(ii)	Air heated all along floor /air heated over bigger area (1) so rises at all points (everywhere) / more convection currents (1) **The 2nd mark must be linked to the 1st mark.** **Don't accept** heat rises or air in the room heats up faster	2
	(b)	(i)	Plots (allow ± ½ small square division) (2) -1 for each error to a maximum of 2. No penalty for missing origin plot. Straight line (1) (ruler must be used) line must be extended back towards origin	3

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Question			Marking details	Marks
		(ii)	**Award 2 marks** for: They're proportional **OR** As the area doubles the power doubles **OR** As the area increases the power increases at a constant rate **OR** Power = area $\times$ 150 **Award 1 mark** for: As the area increases so does the power **OR** Power α wire gird	2
		(iii)	1 800 [W]	1
	(c)		**Indicative content:** Conduction and radiation will take place in all directions from the hot wire grid. The wire grid is at a higher temperature than the bottom surface of the concrete floor. This temperature difference causes energy to flow down through the floor. The foam insulation reduces heat transfer through the concrete by conduction. The silver foil reduces heat loss because it reflects radiant heat back up into the room. **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	**[16]**

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Question			Marking details	Marks
3.		(i)	Electricity is transmitted at high (increases the) voltages (1) to reduce the current (1). This reduces energy losses due to heat (1). **Either the 2nd mark must be linked to the 1st mark or the 3rd mark must be linked to the 2nd mark.** If reference to power increasing is made the maximum mark that can be awarded is 2. **Don't accept** any reference to stopping energy losses	3
		(ii)	$3950 \text{x} \left(\frac{92}{100} \right)$ (1 - substitution) = 3 634 [MW] (1)	2
		(iii)	**EITHER**: 230 × 80 = 18 400 [W] (1) Then pair of values with consistent units e.g $\frac{3634}{0.0184}$ or $\frac{3634000}{18.4}$ or $\frac{3634000000}{18400}$ (1) = 197 500 (1) (allow **ecf** from (ii) and on 18 400) **OR**: current = $\frac{3634000000(1)}{230(1)}$, $\frac{15800000}{80}$ = 197 500 (1) N.B. mark after 230 moves to after the 2nd division **Award 2 marks** for an answer of 214 674	3
			Question total	**[8]**
4.		(i)	2.22 × 10^6 years **Don't accept** light years	1
		(ii)	Atoms of gas (1) absorb light (1) at certain wavelengths / frequencies / colours **accept** re-emitted in all directions (1) **Either the 2nd mark must be linked to the 1st mark or the 3rd mark must be linked to the 2nd mark.**	3
		(iii)	Red shift measurements show that galaxies are continuing to move apart / away (1) CMBR originated from waves / gamma rays (produced at the birth of the Universe) which have stretched (1) **Don't accept** reference to any other em wave **which** means the Universe (space) is expanding / does not look the same over time (1) **Don't accept** started from the same point **Either the 3rd mark must be linked to the 1st mark or the 2nd mark.**	3
			Question total	**[7]**

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Question			Marking details	Marks
5.		(i)	Conversion of 1.5 GHz to 1.5×10^9 or 3×10^8 to 0.3 Gm/s (1) Substitution & manipulation (1) Answer = 0.2 [m] (1) **Award 2 marks** for answer of 2×10^8 [m] Any other answer of 2×10^n can be awarded a maximum of 2 marks if clear workings shown.	3
		(ii)	Conversion of 35 km to 35 000 m (1) Substitution & manipulation (1) Answer = 1.17×10^{-4} [s] (1) **Accept** 1.2×10^{-4} [s] **Don't accept** 1.16×10^{-4} [s] **Award 2 marks** for answer of 1.17×10^{-7} [s] **Award 1 mark** for answer of 1.16×10^{-7} [s] Any other answer of 1.17×10^{-n} can be awarded a maximum of 2 marks if clear workings shown.	3
			Question total	**[6]**
6.	(a)		It provides power (electricity) to consumers / users (1) (**accept** 2 named consumers e.g. schools, hospitals, factories, houses) and maintains a reliable supply / is capable of responding to fluctuating demand / caters for a power station breakdown (1) **Don't accept** reference to efficiency	2
	(b)	(i)	Energy = $P \times t = \frac{5400(1)}{60(1)} \times 0.95$ (1) = 85.5 [MWh] **Award 2 marks** for an answer of 5 130 [MWh] **Award 2 marks** for an answer of 90	3
		(ii)	**EITHER:** 85.5 MWh **(ecf)** = 85 500 kWh (1) Cost = 85 500 × [£]0.05 (1) = [£]4 275(1) $\frac{650000}{4275}$ = 152 [weeks] (1) **OR:** 85.5 MWh **(ecf)** = 85 500 kWh (1) Cost = 85 500 × 5 [p] = 427 500 [p] (1) 65 000 000 (1) ÷ 427 500 = 152 [weeks] (1) **OR:** (650 000 ÷ 0.05) (1) = 13 000 000 [kWh] (1) 13 000 000 ÷ 85 500(1-conversion) = 152 [weeks] (1) **Accept** an answer of 153 [weeks] if correct workings shown	4

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Question			Marking details	Marks
	(c)		**Indicative content:** The number of wind turbines required to meet the demand is $\frac{40000}{0.95}$ = 42 106. This compares with 16 nuclear power stations. The area of land or sea required for this number of turbines would be extremely large. Is there sufficient area available? Wind turbines can only operate between certain wind speeds. They will not produce a consistent power supply. However, wind turbines do not use any fuel so will not produce any waste. Running wind turbines will not produce greenhouse gases so will not contribute to global warming or acid rain. Some people consider wind turbines to be a source of visual and noise pollution. **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 **[15]**
			HIGHER TIER PAPER TOTAL	**[60]**

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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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