

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 $\pm \frac{1}{2}$ 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 $\frac{1}{4}$ of original value	2
	(d)	(i) Identifying 3 half-lives (1) $\frac{210}{3} = 70$ [s] (1-ans) Don't accept $80 \rightarrow 40 \rightarrow 20 \rightarrow 10$ 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]

Question		Marking details	Marks
2.	(a)	$\frac{(800-200)(1)}{80(1)} = 7.5 \text{ (1-ans) [m/s}^2\text{]}$ <p>Award 1 mark for 600 anywhere</p>	3
	(b) (i)	<p>Indicative content:</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>0 marks The candidate does not make any attempt or give a relevant answer worthy of credit.</p>	6
	(ii)	<p>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.</p>	3
Question total			[12]

Question			Marking details	Marks	
3.	(a)	(i)	$P = I^2R$ $18 = I^2 \times 8$ (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) $\times 8$ (1-sub), = 12 [V] (1) ecf must be 8 \times 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: <u>Supply</u> 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 <u>across each bulb</u> 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)	$P = I^2R = 0.75^2 \times 8$ (1 - sub) = 4.5 [W] (1) Or accept $P = VI = 6$ (ecf from (a)(iii)) $\times 0.75$ (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 <u>supply</u> voltage across them	1	
				Question total	[11]

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) $\Delta v = a \times t = 10 \times 0.8$ (1-sub+manip) = 8 [m/s](1-ans)	2
		(iii) EITHER: $a = \frac{8(\text{ecf})}{0.2} = 40$ [m/s ²](1) $F = ma = 0.5 \times 40$ (ecf) (1) = 20 [N] (1) OR: $F = \frac{\Delta p}{t} = \frac{[0-]0.5 \times 8(\text{ecf})(1)}{0.2(1)} = 20$ [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)	$(\frac{1}{2} \times 1500 \times 12^2) + (1500 \times 10 \times 40)$ = 108 000 (1) + 600 000 (1) = 708 000 [J] (1- ans) ecf from PE or KE	3
	(ii)	EITHER : $h = \frac{708\,000 (\text{ecf})}{1\,500 \times 10}$ (1 – sub+manip) = 47.2 [m] (1-ans) OR : $mgh = \frac{1}{2} \times 1500 \times 12^2$ 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]	

Question	Marking details	Marks
6.	${}_{92}^{235}\text{U} + {}_0^1\text{n} \rightarrow {}_{36}^{90}\text{Kr} + {}_{56}^{144}\text{Ba} + 2{}_0^1\text{n}$ <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>0 marks The candidate does not make any attempt or give a relevant answer worthy of credit.</p> <p style="text-align: right;">Question total</p>	6
	HIGHER TIER PAPER TOTAL	[60]