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]**

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]**

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]**

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]**