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]**

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]**

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)	$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{89}_{36}\mathrm{Kr} + {}^{144}_{56}\mathrm{Ba} + 3{}^{1}_{0}\mathrm{n}$ (+ γ treat as neutral) (1 for symbol equation correct, 1 for 3 neutrons on RHS)	2
		(ii)	Since $(\frac{1}{2}mv^2)\mathrm{Ba} = (\frac{1}{2}mv^2)\mathrm{n}$ (1) (or by implication) Then $144v^2(\mathrm{Ba}) = 1v^2(\mathrm{n})$ $v_{\mathrm{Ba}} = \frac{1}{12}v_{\mathrm{n}}$ (1) Accept $m_{\mathrm{Ba}} = 144\ m_{\mathrm{n}}$ 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)	$mg\Delta h = 320 \text{x} 1.35 \text{x} 120000$ [= 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]**