

Section 1: Multiple Choice: 1A 2D 3B 4B 5D 6D 7B 8D 9B 10A

Section 2: Radioactivity

Qu	Solution	Notes	Marks
1.	$3.2 \times 10^{-19} \text{ C}$		1
2 i)	(i) An explanation linking any two of the following: (they) lose energy (quickly)/ slow down (because they) are highly ionising have (many) collisions (with other atoms) are massive particles	<i>Ignore less penetrating</i> <i>Do not allow 'ionising'</i> <i>without correct qualification</i> Allow heavy /large(r) Accept big(ger)	2
2 ii)	Beta particles are less ionising	Accept beta particles are travelling a lot faster / have less mass/lighter / smaller Accept less collisions Ignore more penetrating	1
2.iii)	substitution (1) $8.1 \times 10^{-13} = \frac{1}{2} \times 6.6 \times 10^{-27} \times v^2$ transposition (1) $(v^2) = 2 \times 8.1 \times 10^{-13} (= 2.5 \times 10^{14})$ 6.6×10^{-27} evaluation (1) $v = 1.6 \times 10^7 \text{ (m/s)}$ ($1.57 \times 10^7 \text{ (m/s)}$) (no sf penalty)	Substitution and transposition in any order (2.45×10^{14}) Full marks are awarded for the correct numerical answer with no working Any power of ten mistake would lose one mark in the process Use of $E = mc^2$ or mv^2 no marks (not K.E.)	3
2.iv)	speed / velocity of light / $3 \times 10^8 \text{ (m/s)}$	Allow 3×10^8 with no units but reject when with wrong unit	1
3i)	$\text{Ra} - 226 = \text{Rn} - 222 + \text{alpha}$		3
ii)	No chemical bonds broken between He and Rn, instead nuclear Distinct proton number with stable isotopes, therefore element	Either explanation can get 2 marks	2
4i)	Relevant working on graph 8days	for example ; line from 90 mg to curve OR from curve to 8 days 7.5 to 8.5 days	2

		Allow both marks for correct answer with no working shown.	
ii)	20000		1

Section 3: Electricity

Qu	Solution	Notes	Marks
1i)	voltmeter in parallel with lamp		1
ii)	P.D. across variable resistor = $12 - 4 = 8.0 \text{ V}$ Substitution: (using $R=V/I$) $8.0 / 0.37$ Evaluation: $21.6 (\Omega)$ (Approx 22)	Accept answer of 21.6 with no working for two marks Accept answer of 4.07 with no working for both marks	3
iii)	An explanation linking some of the following points: Change in resistance calculation of two (different) resistances resistance of lamp constant up to (about)3V resistance of lamp increases with increasing voltage/current qualitative comparison of lamp resistance values at different voltages/currents relationship between voltage and current linear at low values but becomes non-linear Change in temperature higher currents / voltages produce higher temperatures/heating in lamp/ increase in brightness Change in energy transfer Higher currents / voltages result in greater energy transfer (per second) Events in lattice energy transfer as a result of collisions in filament collisions between electrons (and ions in lattice) lattice vibrations linked to temperature		3
iv)	V fixed when plugged into mains So low resistance leads to bigger Power output Alice is correct		3

Section 4: Kinematics and Dynamics

Qu	Solution	Notes	Marks
1	Appropriate vector diagrams C impossible		4
2i)	Evidence of calculation of gradient of graph during acceleration Evaluation: 6.3 (m/s ²)	Allow full marks for correct answer with no working shown accept values from 6.0 to 6.5 inclusive	2
ii)	Line with smaller initial gradient and then horizontal at 17 m/s	Ignore time at which acceleration stops. Judge horizontal value by eye but do not accept any part of line which goes outside range of 16 to 18	1
iii)	A reason which includes reference to air resistance / drag / friction	Accept Wind resistance overcome resistance	1

Section 5: Energy

Qu	Solution	Notes	Marks
1ai)	Substitution into $PE = m \times g \times h$: $18 \times 9500 \times 10$ Evaluation: 1 710 000 (J) 1 710 kJ	Allow 1 mark for evaluation of 2 375 000 (arising from using 25m for distance) Allow full marks for correct answer with no working shown	2
ii)	1 710 000 J	Allow ecf from (i)	1
iii)	A description to include An energy transfer involving (gravitational) potential energy and kinetic energy Correct direction of that transfer, i.e. potential energy increases / kinetic energy decreases (from C to D)	second mark point is dependent on first Ignore heat / sound energy Accept kinetic energy is transferred into potential energy for both marks	2

iv)	<p>Substitution into $p = m \times v$ $150\,000 = 9\,500 \times v$ Transposition: $v = 150\,000 / 9\,500$ Evaluation: 18 (m/s)</p>	<p>Substitution and transposition can be in either order Answers which round to 18 such as 17.8, 17.79 etc Allow full marks for correct answer with no working shown</p>	2
v)	<p>Expect KE = 171000 so $v = 18$ m/s “Lost energy” = $171000 - 0.5m18^2$ 171000 J (1) $W = F \times d$ (1) $d = \sqrt{18^2 + (\sqrt{25^2 - 18^2})} = 20.4$ m (2) $F = 171000/20.4 = 8400$N (1)</p>		5
b)	<p>An explanation linking any two from EITHER (larger distance) allows more time to stop smaller rate of change of momentum / velocity smaller force (on passengers) OR Use of work done = force x distance smaller force (on passengers) to do work (required to bring car to a stop) slow down gradually owtte</p>	<p>Note: takes “longer” without reference to time gets no credit for first MP(repeat of stem)</p>	2