

Question number		Answer	Notes	Marks
1	(a) (i)	C (decreases by 2)		1
	(ii)	D (decreases by 4)		1
	(b)	D (has less penetrating power)		1
	(c)	<p>Any four of:</p> <p>MP1 Use of ratemeter / scaler / counter;</p> <p>MP2 Idea of measuring <u>background</u> radiation e.g. background count / correction /subtraction;</p> <p>MP3 A safety precaution (based on distance or absorption) e.g. use of tongs / shielding;</p> <p>MP4 A controlled variable (time / distance / positioning) e.g. "source near/by/to detector", "for a minute";</p> <p>MP5 A practical consideration e.g. repeat / average / reset (scaler);</p> <p>MP6 Mention of becquerel / Bq</p>	<p>Allow description e.g. "count the clicks"</p> <p>Allow Geiger counter</p> <p>Ignore GM detector or tube</p> <p>Ignore descriptions of GM tube</p> <p>Allow "stand back", "wear gloves / protective clothing" "do not point source at people"</p> <p>Ignore "counts per minute"</p> <p>Ignore: mention of anomalies</p> <p>Accept phonetic spellings</p>	4

Total for question 1 = 7 marks

Question number	Answer	Notes	Marks
2 (a)	A activity		1
(b)	A alpha particle		1
(c)	B beta particle		1
(d)	A alpha particle		1
		Total	4

Question number	Answer	Accept	Reject	Marks
3	<p>An explanation including any five of these ideas (in any order):</p> <p>MP1 alpha particles have less penetrating power /less range ;</p> <p>MP2 alphas have more charge;</p> <p>MP3 alphas cause more ionization;</p> <p>MP4 alphas are bigger / have more mass;</p> <p>MP5 (slowing) force on alpha particles is larger;</p> <p>MP6 (kinetic) energy of alpha lost quickly causing ionization;</p> <p>MP7 (larger) alpha particles are more likely to collide with atoms;</p>	<p>Accept reverse arguments, e.g. beta particles have more penetrating power etc</p> <p>Ignore comparisons of energy/ velocity/ momentum</p>		5

Total 5 marks

Question number	Answer	Notes	Marks
4 (a)	idea that background activity should be subtracted (from each reading);		1
(b)	time taken; and either for amount of (radioactive) nuclei / atoms / isotope to halve; OR for (radio)activity to halve	allow "how long it takes" allow <ul style="list-style-type: none"> decay by half decay to half ignore particles / molecules, "breakdown", "reactivity" reject if implies a single nucleus/atom	2
(c) (i)	evidence of use of graph; 56 ± 3 (s);	e.g. lines to two correct points on graph or appropriate subtraction shown in working	2
(ii)	any 1 from: MP1. idea of {more accurate / smoother} curve; MP2. idea that activity changes quickly; MP3. idea that decay takes very little time;	allow more points to plot on graph decays quickly (sample has) short half life	1

Total 6 marks

Question number	Answer	Notes	Marks
5 (a)	(i) 90		1
	(ii) time; either for amount of (radioactive) isotope to halve; or for (radio)activity to halve;	Allow for amount - (number of un-decayed) nuclei/atoms/molecules (un-decayed) mass of isotope	2
	(iii) Any two of – MP1 Idea that (beta) radiation causes a stated hazard; MP2 Idea that strontium-90 has a long half-life; MP3 Idea that <u>all</u> beta emission will be absorbed by the body;	e.g. causes cancer, kills cells, mutates DNA, ionises tissue Accept lasts a long time Accept answers in terms of range	2
(b)	(i) 90 and 0; -1; $\begin{array}{ccccccc} \boxed{90} & & \boxed{90} & & \boxed{0} & & \\ \text{Sr} & \rightarrow & \text{Y} & + & & & \beta^- \\ \boxed{38} & & \boxed{39} & & \boxed{-1} & & \end{array}$	Must have both Minus is essential	2
	(ii) Any two ideas from – MP1 They are isotopes of different elements; MP2 Strontium-90 (nucleus/atom) has the same number of protons as other strontium (nuclei/atoms); MP3 Yttrium-90 (nucleus/atom) has the same number of protons as other yttrium (nuclei/atoms);	Allow use of proton number data (38) Allow use of proton number data (39)	2

Total 9 marks

Question number	Answer	Notes	Marks
6 (a) (i)	B (53)		1
	(ii) D (131)		1
6 (b)	Any two of - MP1 Beta is (moderately) ionising; MP2 Beta has a short range; MP3 idea that I-131 has a short half-life; MP4 idea that iodine is absorbed (easily) by the thyroid; MP5 (hence) reduces damage to healthy cells; MP6 (hence) does not penetrate out of the body; MP7 (therefore) kills (only) tumour cells;	Ignore I-131 is radioactive, it emits beta	2

Total 4 marks

Question number		Answer	Accept	Reject	Marks												
7	(a)	<table border="1"> <thead> <tr> <th>Type of radiation</th> <th>Charge</th> <th>S</th> </tr> </thead> <tbody> <tr> <td>Alpha particle</td> <td>(+)2</td> <td>Unstable nucleus</td> </tr> <tr> <td>Beta particle</td> <td>-</td> <td>Unstable nucleus</td> </tr> <tr> <td>Gamma ray</td> <td>0</td> <td>Unstable nucleus</td> </tr> </tbody> </table> <p>(As shown) 2 ; Unstable nucleus;</p>	Type of radiation	Charge	S	Alpha particle	(+)2	Unstable nucleus	Beta particle	-	Unstable nucleus	Gamma ray	0	Unstable nucleus	++ Unstable nuclei	-	2
Type of radiation	Charge	S															
Alpha particle	(+)2	Unstable nucleus															
Beta particle	-	Unstable nucleus															
Gamma ray	0	Unstable nucleus															

Question number	Answer	Accept	Reject	Marks
7 (b)	<p>Any three of:</p> <p>MP1 - Idea that alpha particles would not penetrate (enough); e.g. alpha particles absorbed / stopped by {aluminium / foil / a few cm air / paper / card}</p> <p>MP2 - Idea that gamma rays would be too penetrative; e.g. gamma rays {are not absorbed / are unaffected}</p> <p>MP3 - Idea that some beta particles will pass through the foil; e.g. not all of the beta particles are absorbed</p> <p>MP4 - Idea of a correlation between thickness and absorption; e.g. thinner aluminium absorbs fewer beta particles</p>	<p>Ignore references to danger or harm</p> <p>All ideas may be expressed in terms of penetration or absorption.</p> <p>No need to see the word "aluminium," provided the meaning is clear.</p> <p>Accept paper or card will stop alpha for MP1</p> <p>Accept comparisons of aluminium thickness for MP4</p>		3
(c) (i)	${}_{39}^{90}\text{Y}$ <p>both 90 and 39 for mark</p>			1
(ii)	B (the number of protons increases);			1
			Total	7