Question number	Answer	Notes	Marks
9 (a) (i)	number of protons = 1; number of neutrons = 2;		2
(ii)	any three of the following **comparisons**: MP1. beta particle is negatively charged <u>and</u> alpha is positively charged; MP2. beta particle has lower/less mass ORA; MP3. beta particle has 1 charge but alpha has 2 charges; MP4. beta particle is an electron but alpha is 2p + 2n /eq; MP5. beta is less ionising; MP6. beta has higher speed; MP7. beta particles have larger range; MP8. beta has higher penetrating ability;	ignore descriptions of applications of types of radiation allow 'beta is lighter' ORA allow beta can pass through paper but alpha will be stopped	3
(iii)	any sensible suggestion; e.g. • alpha is 4 nucleons, tritium has (only) 3 / eq • tritium has only 1p, 2p are in alpha • tritium has not got enough mass / mass number too low • tritium has not got enough nucleons • tritium has not got enough p / atomic number too low • tritium has not got enough p+n	ignore tritium is too small	1
(b)	any two from: MP1. energy explanation; e.g. beta particles have given up all their KE on impact MP2. absorption explanation; e.g. beta particles have hit (and been absorbed by) phosphor MP3. penetration explanation; e.g. beta cannot penetrate (thick) glass / tube MP4. range explanation; e.g. signs are further away than the range of beta	ignore: • beta particles have low ionisation /OWTTE • no gas can escape	2

Question number	Answer	Notes	Marks
9 (c) (i)	time taken; and either of • for (radio)activity to **halve**; • for **half** of (radioactive) nuclei / atoms / isotope to decay;	allow how long it takes reject 'half the time' allow count rate for activity reject: • particles • molecules • substance • 'break down' • 'reactivity' • a nucleus / an atom • halve in mass • to completely/fully decay	2
(ii)	working seen/appropriate line(s) on graph seen; 13.5 years;	 tolerance ± 0.5 years	2
(d)	MP1. correct judgment re claim; MP2. (because) EITHER correct statement re time (at which the activity is 400); OR activity (at 20 years); e.g. the manufacturer is correct because the time would be 21.5 years (to reach an activity of 400) OR the manufacturer is correct because the activity is 420 (counts per minute) (at 20 years)	 allow range of 21-22 years allow range of 410 to 440 total marks = 14	2