Question	Answer	Mark
1(a)	83 protons 131 neutrons	 **B2**
(b)	$^{0}_{1}\beta$ Superscript 0 Subscript –1 $^{214}_{84}Po$	 **B1** **B1** **B1**
(c)	(After 20 min count rate is) 360 / 2 or 180 (count / s) (After 40 min count rate is) 180 / 2 or 90 (counts / s) (After 60 min count rate is) 90 / 2 OR new count-rate = 360/(2 × 2 × 2) or 360 / 8 or 3 half-lives 45 (counts / s)	 **C1** **A1**

Question	Answer	Mark
1(d)	Any two points chosen from the lists below: (economic): high cost of storage / shielding / guarding / need to store for a long time OR reduction in tourism OR loss of farming produce / land OR reduction of land / property values (social): fear of cancer / causes cancer / genetic mutations / radiation sickness in people / animals OR local objections OR cause people to move away (environmental): crop mutations OR leakage into water supplies OR pollution <u>of atmosphere</u> / water supply	**B2**
		Total: 9

2 **(a)** top bent down to R of layer [1]
middle straight on [1]
bottom deflected back to left [1]

(b) **(** deflection greater than 90°/the bottom one [1]

(ii) positive ignore n [1]

(iii) nothing/vacuum/space/electrons [1]

(c) 2 AND 2 [1]

3 **(a** (nuclear) fusion B1

(b) **(i)** charges are moving (and current is the (rate of) flow of charge) B1

(ii) $Q = It$ AND t is time B1

(c) **(i)** **1.** (they are) perpendicular OR at right angles OR at 90° B1

2. (they are) perpendicular OR at right angles OR at 90° B1

(ii) arrow (labelled *F*) perpendicular to direction AND pointing towards the bottom right of the page B1

[Total: 6]

4 **(a)** different number of neutrons (in the nucleus) OR different neutron number B1

(b) **(** **1** letter Q at nucleon number = 208 B1
proton number = 81 B1

2 letter R at nucleon number = 212 B1
proton number = 84 B1

(ii) evidence of dividing original number by 2 C1
75 (counts) / min OR 1.25 (counts) / s OR 4500 (counts) / hr

[Total: 7]

5 **(a)** **(i)** number of / more neutrons B1
4 more neutrons B1

(ii) same number of protons / proton number / atomic number / chemical reactions / number of electrons (in neutral atom) B1

(b) any **two** lines from:
larger charge
slower moving
more massive
greater volume / more chance of collision
more energy B2

(c) **(i)** atom is mostly empty space OR nucleus very small OR mass concentrated at centre / nucleus OR greater distance between nuclei B1

(ii) charge concentrated at centre / nucleus B1

[Total: 7]

6 **(a)** Both have positive/same charge B1

(b) A continues along original line B1
B deflected by any angle up to 135° (by eye) B1
C returns along same line OR deflected more than 135° (by eye) B1

(c) Any two from: B2

Atom is mostly empty space OR Nucleus is (very) much smaller than the atom OR Nucleus is very small

Charge of nucleus is (very) concentrated / (very) dense
OR Nucleus contains all the positive charge of the atom
OR Nucleus has positive charge

Nucleus contains most of the mass of the atom
OR Nucleus is (very) massive OR Nucleus is (very) dense

[Total: 6]

7 **(a)**

	hydrogen-1	**deuterium**	**tritium**
no.of protons	1		1
no. of neutrons	0		2
no. of electrons	1		1

proton line correct B1
neutron line correct, do not accept blank for 0 B1
electron line correct B1 [3]

(b) ignore any reference to background radiation throughout this part

(i) beta / fast moving electrons B1 [1]

(ii) any two from:
beta stopped by 5 mm/thick Al / beta not stopped by 0.5 mm/thin Al B1
alpha stopped by 0.5mm/thin Al
accept stopped by paper B1 [2]
gamma not stopped by 5 mm or more/thick Al
ignore any reference to range in air

(c) **(i)** fusion / thermonuclear (reaction) B1 [1]

(ii) (energy) released B1 [1]

(d) fission B1 [1]

[Total: 9]