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)** <u>atom</u> 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]