

ANSWERS

- 1 (a) β -emission is the emission of fast-moving electrons from an unstable nucleus.
 (b) Proton number = 28, nucleon number = 60.
 (c) From 100% $\rightarrow$ 50% $\rightarrow$ 25% $\rightarrow$ 12.5%, so it needs 3 $\frac{1}{2}$ -lives which is $3 \times 5.3 = 15.9$ yrs.

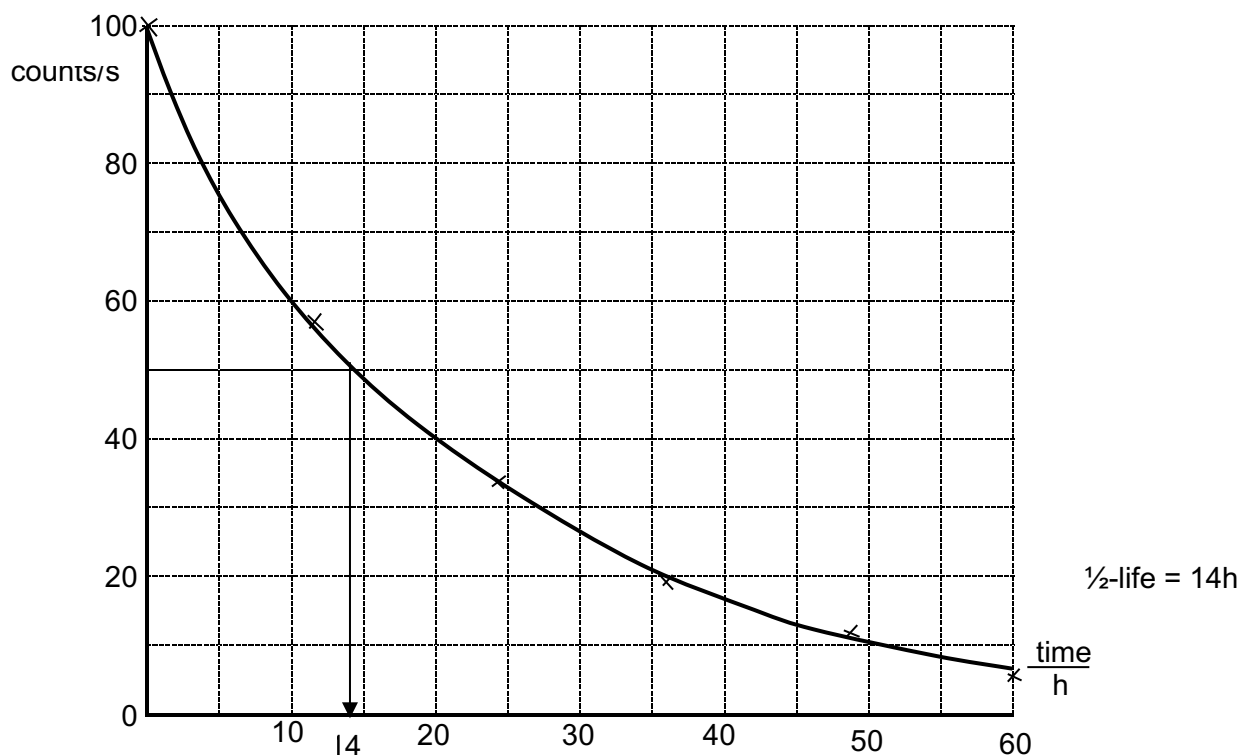
- 2 The isotope does not emit α -particles although there is a drop in count-rate from 860 to 850, this most probably due to the random property of emission or minimal absorption in the card.
 The isotope emits β -particles which are absorbed by the aluminium causing a drop in count-rate from 850 to 25 which is the background count rate.
 There is no γ -rays since the count-rate is not affected by the lead / the count rate is already at the background count rate.

3

Element	nucleon number	Proton number	neutron number	Radioactive decay
Radium	228	88	140	${}_{88}^{228}\text{Ra} \longrightarrow {}_2^4\text{He} + {}_{86}^{224}\text{Rn} + \gamma\text{-rays}$
Radon	224	86	138	${}_{86}^{224}\text{Rn} \longrightarrow {}_2^4\text{He} + {}_{84}^{220}\text{Po}$
Polonium	220	84	136	${}_{84}^{220}\text{Po} \longrightarrow {}_2^4\text{He} + {}_{82}^{216}\text{Pb}$
Lead	216	82	134	${}_{82}^{216}\text{Pb} \longrightarrow {}_{-1}^0\text{e} + {}_{83}^{216}\text{Bi} + \gamma\text{-rays}$
Bismuth	216	83	133	

- 4 (a) 53 is the proton number and 135 is the nucleon number /mass number (total number of protons and neutrons).
 (b) (i) As nuclear decay is a random process
 (ii) $(1880+1960+1940+1820+1080)/5 = 1916 = 1920$ (3 s.f.)
 (iii) 21 h = 3 half-lives
 final average count rate = $1916 \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = 240$ counts/min (3 s.f.)

5



- 6
- (a)
 - (i) Approximately 1.3 minutes.
 - (ii) 16.5 millions
 - (b) 1 minute.
 - (c) After 8 minutes, sample A almost stop decaying as the graph shows the number of radioactive atoms in the sample goes to '0' at $t=8$ minutes. There are about 7 millions of radioactive atoms in sample B.