## 52 Radioactive Decay ♡

Some nuclei are stable, and will remain as they are for ever. Others are unstable. After an unpredictable period of time, unstable nuclei will change. This change is called decay. When a nucleus decays, it gives out highly energetic, ionizing radiation. The main forms of ionizing radiation are alpha particles, beta particles and gamma rays.

| Type of decay | Particle given out | Penetrating ability | Ionising ability | Change to the original nucleus |
|---|---|---|---|---|
| Alpha | ${}^{4}_{2}\alpha$ - Helium nucleus (2 protons + 2 neutrons) | Low - stopped by 5 cm of air, by skin or paper | High | Mass number reduces by 4 Atomic number reduces by 2 |
| Beta minus | ${}^{0}_{-1}\beta$ - High speed electron produced when a neutron turns into a proton | Medium - can pass 1 mm of aluminium, but stopped by 2 cm | Medium | Mass number doesn't change Atomic number increases by 1 |
| Beta plus | ${}^{0}_{+1}\beta$ - High speed positron (anti-electron) produced when a proton turns into a neutron | Very low - annihilates on contact with normal matter | N/A | Mass number doesn't change Atomic number reduces by 1 |
| Gamma | ${}^{0}_{0}\gamma$ - High frequency electromagnetic wave | High - can pass through many cm of lead | Low | Mass number doesn't change Atomic number doesn't change Excess nuclear potential energy is released |

Example 1 - Write the equation for the alpha decay of $^{241}_{95}$Am into Np.

The symbol for the alpha particle is $^{4}_{2}\alpha$.
We write the equation $^{241}_{95}\text{Am} \longrightarrow \text{Np} + {}^{4}_{2}\alpha$ to show the decay.
Next, we need to put mass and atomic numbers on the Np. We do this using the rules in the table: $^{241}_{95}\text{Am} \longrightarrow {}^{237}_{93}\text{Np} + {}^{4}_{2}\alpha$.
Notice that once the equation is complete the numbers on the top balance ($214 = 237 + 4$), as do the numbers on the bottom ($95 = 93 + 2$).

Example 2 - Write the equation for the beta minus decay of $^{3}_{1}$H into He.

Firstly, we write $^{3}_{1}\text{H} \longrightarrow \text{He} + {}^{0}_{-1}\beta$, then put numbers on He to balance it: $^{3}_{1}\text{H} \longrightarrow {}^{3}_{2}\text{He} + {}^{0}_{-1}\beta$.
Again notice that the top row balances ($3 = 3 + 0$) and so does the bottom ($1 = 2 - 1$).

Write equations for the following decays.

52.1 The alpha decay of $^{238}_{92}$U into Th.

52.2 The beta minus decay of $^{14}_{6}$C into N.

52.3 The gamma decay of $^{60}_{27}$Co. *[Hint: with no change to the atomic number, the decay produces Co]*

52.4 The beta minus decay of $^{90}_{38}$Sr into Y.

52.5 ♡ The beta plus decay of $^{11}_{6}$C into B.

52.6 The beta minus decay of $^{8}_{3}$Li into Be.

52.7 The beta minus decay of $^{40}_{19}$K into Ca.

52.8 The alpha decay of $^{239}_{94}$Pu into U.

52.9 The alpha decay of $^{210}_{86}$Rn into Po.

52.10 ♡ The beta plus decay of $^{14}_{8}$O into N.