| | Marks |
|---|---|
| • The isotope $^{37}$Ar has a half-life of 35 days. If each decay event releases an energy of 1.0 MeV, calculate how many days it would take for a 0.10 g sample of $^{37}$Ar to release 22.57 × 10$^3$ kJ (enough energy to boil 10.0 L of water)? | 3 |

**1.0 MeV = 1.0 × 10$^6$ eV corresponds to (1.602×10$^{-19}$ × 1.0×10$^6$) J = 1.602 × 10$^{-13}$ J.**

**Each decay event releases 1.602 × 10$^{-13}$ J and so to release 22.57 × 10$^3$ kJ requires:**

$$\textbf{number of decay events required} = \frac{22.57 \times 10^3 \times 10^3 \text{ J}}{1.602 \times 10^{-13} \text{ J}} = 1.409 \times 10^{20}$$

**0.10 g of $^{37}$Ag corresponds to $\frac{0.1 \text{ g}}{37 \text{ g mol}^{-1}}$ = 0.0027 mol. This in turn corresponds to (0.00270 mol × 6.022 × 10$^{23}$ mol$^{-1}$) = 1.63 × 10$^{21}$ nuclei. $N_0$ = 1.63 × 10$^{21}$**

**As the initial number of nuclei present is 1.63 × 10$^{21}$ and the number of decay events required is 1.409 × 10$^{20}$, the final number of nuclei will be:**

**(1.63 × 10$^{21}$ – 1.409 × 10$^{20}$) = 1.49 × 10$^{21}$ = $N_t$**

**As the half life is 35 days, the decay constant is $\frac{\ln 2}{35 \text{ days}}$ = 0.0198 days$^{-1}$. Hence,**

$$\ln\left(\frac{N_0}{N_t}\right) = \lambda t$$

$$\ln\left(\frac{1.63 \times 10^{21}}{1.49 \times 10^{21}}\right) = (0.0198 \text{ days}^{-1})\, t$$

$$t = 4.5 \text{ days}$$

Answer: **4.5 days**

| | |
|---|---|
| • The isotope $^{222}$Rn decays to $^{214}$Bi in three steps. Identify all possible decay paths for this process, including all the intermediate isotopes along each path and the identity of the decay process involved in each individual step. | 3 |