|  | Marks |
|---|---|
|  | 3 |

- Balance the following nuclear reactions by identifying the missing nuclide.

$$^{55}_{26}Fe \; + \; ^{0}_{-1}e \; \rightarrow \; \boxed{^{55}_{25}Mn}$$

$$^{232}_{90}Th \; \rightarrow \; ^{4}_{2}\alpha \; + \; \boxed{^{228}_{88}Ra}$$

$$^{218}_{84}Po \; \rightarrow \; ^{0}_{-1}e \; + \; \boxed{^{218}_{85}At}$$
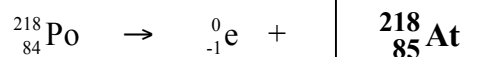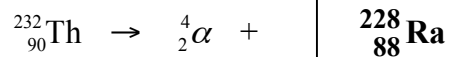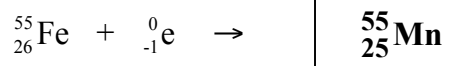
- Over 50 years, the activity of a sample of strontium-90 decreases from 1000 Bq to 303 Bq. Calculate the half-life of strontium-90 (in years) to the nearest year.

**2**

> **The number of radioactive nuclei N decreases with time according to the equation,**
>
> $$\ln\left(\frac{N_0}{N_t}\right) = \lambda t$$
>
> **where $\lambda$ is the decay constant. As activity is proportional to the number of nuclei, the decay constant can be calculated from ratios of the activities:**
>
> $$\ln\left(\frac{1000}{303}\right) = \lambda \times 50 = 1.194$$
>
> **Hence, $\lambda = 0.0239$ year$^{-1}$. The half life is related to the decay constant by:**
>
> $$t_{1/2} = \frac{\ln 2}{\lambda} = \frac{\ln 2}{0.0239} = 29 \, \text{years}$$
>
> Answer: **29 years**

- Identify three desirable properties of an unstable isotope to be used in medical imaging.

**3**

> - **non-toxic**
> - **either a $\gamma$ or $\beta^+$ emitter (not an $\alpha$ or $\beta^-$ emitter)**
> - **half-life within range of 1 minute to 10 hours**
> - **chemically capable of being incorporated into appropriate molecule**
> - **easily produced or produced onsite**