Marks

- Balance the following nuclear reactions by identifying the missing nuclide. **3**

$$^{36}_{17}\text{Cl} + {}^{0}_{-1}\text{e} \rightarrow \boxed{^{36}_{16}\text{S}}$$

$$^{238}_{92}\text{U} \rightarrow {}^{4}_{2}\alpha + \boxed{^{234}_{90}\text{Th}}$$

$$^{238}_{92}\text{U} + {}^{12}_{6}\text{C} \rightarrow 4\,{}^{1}_{0}\text{n} + \boxed{^{246}_{98}\text{Cf}}$$

- The half life of ^{90}Sr is 29 years. Calculate the remaining activity (in Bq) of a sample containing ^{90}Sr after 100 years given that the initial activity was 1000 Bq. **2**

From $t_{1/2} = \dfrac{\ln 2}{\lambda}$, $\lambda = \dfrac{\ln 2}{29} = 0.0239\,\text{yr}^{-1}$.

The activity after 100 years is related to the initial activity by:

$$\ln\left(\frac{A_0}{A_t}\right) = \lambda t = (0.0239) \times 100 = 2.39 \text{ so } \frac{A_0}{A_t} = e^{2.39}$$

As A_0 = 1000 Bq, $A_t = \dfrac{1000}{e^{2.39}} = 92\,\text{Bq}$

Answer: **92 Bq**

- The three unstable isotopes $^{33}_{17}\text{Cl}$, $^{77}_{36}\text{Kr}$ and $^{27}_{12}\text{Mg}$ are unsuitable for use in medical imaging. For each isotope, provide a reason why it is unsuitable. The following data may be of use: **3**

$^{33}_{17}\text{Cl} \rightarrow {}^{0}_{+1}\text{e} + {}^{33}_{16}\text{S}$ half-life = 2.5 s

$^{77}_{36}\text{Kr} \rightarrow {}^{0}_{+1}\text{e} + {}^{77}_{35}\text{Br}$ half-life = 75 minutes

$^{27}_{12}\text{Mg} \rightarrow {}^{0}_{-1}\text{e} + {}^{27}_{13}\text{Al}$ half-life = 9.5 minutes

$^{33}_{17}$Cl - the half life of 2.5 s is too short to allow for synthesis of host molecules, administration of the nuclide to the patient and measurement of the radiation emitted.

$^{77}_{36}$Kr - krypton is a noble gas and cannot be incorporated into a suitable host molecule for administration to the patient.

$^{27}_{12}$Mg - this nuclide is a β-emitter so little useful radiation would escape the body and local radiation damage would occur.