Marks

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

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

$$^{2}_{1}\text{H} + ^{1}_{1}\text{H} \rightarrow ^{3}_{2}\text{He} + \boxed{\boldsymbol{\gamma}}$$

$$^{15}_{7}\text{N} + ^{1}_{1}\text{p} \rightarrow ^{15}_{8}\text{O} + \boxed{\mathbf{^{1}_{0}n}}$$

- Calculate the atomic mass of silicon from the isotope information provided. **2**

Isotope	Mass of isotope (a.m.u.)	Relative abundance
^{28}Si	27.97693	92.21%
^{29}Si	28.97649	4.70%
^{30}Si	29.97376	3.09%

The relative atomic mass of silicon is the weighted average of the masses of its isotopes:

$$\left(27.97693\times\frac{92.21}{100}\right)+\left(28.97649\times\frac{4.70}{100}\right)+\left(29.97376\times\frac{3.09}{100}\right)=28.09\,\text{g}\,\text{mol}^{-1}$$

Answer: **28.09 g mol^{-1}**

- Calculate the molar activity of ^{3}H (in Curie), given its half-life of 12.26 years. **3**

The molar activity is given by $A_{mol} = \lambda N_a$ where λ is the decay constant which is related to the half life $t_{1/2}$ by $\lambda = \frac{\ln 2}{t_{1/2}}$.

The half life = 12.26 years or 12.26 × 365 × 24 × 3600 s = 3.866 × 10^{8} s. Hence the molar activity is:

$$A_{mol} = \frac{\ln(2)}{3.87\times10^{8}\ \text{s}} \times (6.022 \times 10^{23} \text{ disintegrations mol}^{-1})$$

$$= 1.080 \times 10^{15} \text{ disintegtration s}^{-1}\ \text{mol}^{-1}$$

As 1 Ci = 3.70 × 10^{10} disintegrations s^{-1}, the molar activity in Curie is:
1.080 × 10^{18} / 3.70 × 10^{10} = 2.92 × 10^{4} Ci mol^{-1}.

Answer: **2.92 × 10^{4} Ci mol^{-1}**