Marks

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

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

$$^{3}_{2}\text{He} + ^{3}_{2}\text{He} \rightarrow 2\ ^{1}_{1}\text{p} + \boxed{\mathbf{^{4}_{2}He}}$$

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

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

Isotope	Mass of isotope (a.m.u.)	Relative abundance
^{204}Pb	203.97304	1.40%
^{206}Pb	205.97446	24.10%
^{207}Pb	206.97589	22.10%
^{208}Pb	207.97664	52.40%

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

$$\textbf{atomic mass} = \left(203.97304 \times \frac{1.40}{100}\right) + \left(205.97446 \times \frac{24.10}{100}\right) + \left(206.97589 \times \frac{22.10}{100}\right) + \left(207.97664 \times \frac{52.40}{100}\right) = 207.2$$

(The relative abundances are given to 4 significant figures and limit the accuracy of the answer.)

Answer: **207.2**

- Calculate the molar activity of ^{11}C (in curie), given its half-life of 20.3 minutes. **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 = 20.3 minutes or 20.3 × 60 s = 1218 s. Hence the molar activity is:

$$A_{mol} = \left(\frac{\ln 2}{1218}\right) \times (6.022 \times 10^{23}) = 3.427 \times 10^{20}\ \text{Bq} = \frac{3.427 \times 10^{20}}{3.70 \times 10^{10}}\ \text{Ci} = 9.26 \times 10^{9}\ \text{Ci}$$

Answer: **9.26×10^{9} Ci**