Marks 4

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

$$^{1}_{1}\mathrm{H} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{2}_{1}\mathrm{H} + \boxed{{}^{0}_{1}\beta}$$

$$^{2}_{1}\mathrm{H} + \boxed{{}^{1}_{1}\mathrm{p}} \rightarrow {}^{3}_{2}\mathrm{He}$$

$$^{3}_{2}\mathrm{He} + {}^{3}_{2}\mathrm{He} \rightarrow \boxed{{}^{4}_{2}\mathrm{He}} + {}^{1}_{1}\mathrm{H} + {}^{1}_{1}\mathrm{H}$$

Where might these reactions occur naturally?

In stars

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- The half life of ^{131}I is 8.06 days. Calculate the activity, in Bq, of 12.0 g of pure ^{131}I. Calculate the activity of ^{131}I in Ci mol^{-1}.

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 = 8.06 days or 8.06 × 24 × 3600 s = 696384 s. Hence the molar activity is:

$$A_{mol} = \left(\frac{\ln 2}{696384}\right) \times (6.02 \times 10^{23}) = 5.99 \times 10^{17} \text{ disintegrations s}^{-1} \text{ mol}^{-1}$$

12.0 g of ^{131}I corresponds to 12.0 / 131 = 0.092 mol. The activity of this amount of ^{131}I is therefore 0.092 × (5.99 × 10^{17}) = 5.49 × 10^{16} Bq

As 1 Ci = 3.70 × 10^{10} disintegrations s^{-1}, the molar activity in Curie is:

$$\text{molar activity} = \frac{5.99 \times 10^{17}}{3.70 \times 10^{10}} = 1.62 \times 10^{7} \text{ Ci mol}^{-1}.$$

Answer: **5.49 × 10^{16}** Bq	Answer: **1.62 × 10^{7}** Ci mol^{-1}