Josh Whitehead

Hw 4

1) Assume no energy loss:

$\theta = 0.9$ $\quad R = \theta \phi \times N_T$

$\phi = \frac{10}{1\times10^{6}} \cdot \frac{1\ \alpha}{(1.602\times10^{-19})\cdot 2} = 3.1211\times10^{13}\ \frac{\alpha}{sec}$

$x = \frac{Areal}{\rho} = \frac{0.05}{8.902} = 0.005616715\ cm$

$N_T = \frac{\rho_{Ni}}{M_{Ni}} N_A = 6.022\times10^{23}\ \frac{8.902}{59.9308} = 8.94496\times10^{22}$

$\therefore R = 1.41127\,22125\times10^{10}$

$A = \frac{R\cdot(1-\exp(-\lambda t))}{3.7\times10^{10}}$ $\quad \lambda = \frac{\ln 2}{9.67\ min}$

$t = 15\ min$

$\therefore \boxed{A = 0.251271805\ Ci}$

$\boxed{= 5.57823\times10^{11}\ dpm}$

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2) $Q = \sum \Delta M_{react} - \sum \Delta M_{prod}$

$= (2424.916 + -72535.3 - 0.008665 \cdot 931500 - -69167.2)\ \text{keV}$

$\boxed{= -9014.63\ \text{keV}}$

b) $V_c^{lab} = \frac{A_{Dy}}{A_{Gd}} \cdot \frac{1.44\ Z_\alpha Z_{Gd}}{1.2(A_\alpha^{1/3} + A_{Gd}^{1/3})}$

$= \frac{159}{156} \cdot \frac{1.44 \cdot 2 \cdot 64}{1.2(4^{1/3} + 156^{1/3})}$ $\boxed{= 22.45912\ \text{MeV}}$

c) $E_{th} = \frac{A_{Dy}}{A_{Gd}}(-Q)$

$= \frac{159}{156} \cdot 9014.63\ \text{keV}$ $\boxed{= 9.18799\ \text{MeV}}$

d) This rxn will begin once it overcomes the coulomb barrier @ $\boxed{22.45912\ \text{MeV}}$

3)
a)

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3) a)

$$E^* = \frac{A_c}{A_0} E_\alpha + Q$$

$$Q = \sum \Delta_{react} - \sum \Delta_{prod}$$

$$\therefore Q = (0 + 2424.916 - 8071.448 - 8007.78) \text{ keV}$$

$$= \underline{-13.6541821 \text{ MeV}}$$

$$E^* = \frac{12}{15} \cdot 14.6 - 13.6541821$$

$$\boxed{= -1.9741821 \text{ MeV}}$$

b)

$$R = \sigma \phi x N_T$$

$$\phi = \frac{25}{1\times10^{-9}} \cdot \frac{1\alpha}{1.602\times10^{-19} \cdot 2} = \underline{7.8027465668\times10^{10}\ \alpha/\text{sec}}$$

$$\sigma = 0.025\text{ b} = \underline{2.5\times10^{-26}\text{ cm}^2}$$

$$x = \frac{\text{Areal}}{\rho} = \frac{0.0001}{2.26} = \underline{4.42478\times10^{-5}\text{ cm}}$$

$$N_T = \frac{\rho_c}{M_c} \cdot N_A = \underline{1.13414\times10^{23}\ \frac{\text{atom}}{\text{cm}^3}}$$

$$R = 9789.195797$$

$$\lambda = 6.1756\times10^{-3}\ \frac{1}{\text{sec}}$$

$$t = 240\text{ sec}$$

$$A = \frac{R \cdot (1 - \exp(-\lambda t))}{3.7\times10^{10}}$$

$$\boxed{= 2.0448\times10^{-7}\text{ Ci}}$$

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4) $E^* = \frac{A_T}{A_{CN}} E_{Pr} + Q$

$^{103}Rh + ^{13}C \longrightarrow ^{116}Sb$

$Q = -88031.7 + 3125.00933 + 86822$

$= 1.915309$ MeV

$\therefore E^* = \frac{103}{116} \cdot 50 + 1.915309 \boxed{= 46.31186 \text{ MeV}}$

5) N

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5) $N_x = N_0 e^{-\mu x} \rightarrow x = \frac{\ln\left(\frac{N_x}{N_0}\right)}{-\mu_x} = \frac{\ln(0.05)}{-\mu_x}$

$\mu = 1.7\, \beta_{max}^{-1.14} = 0.66436 \frac{m^2}{kg}$

$\mu_x = \mu \cdot \rho$

$\therefore \mu_{Al} = 0.66436 \cdot 2700 = \underline{1793.771 \frac{1}{m}}$

$\mu_{Cu} = \underline{5952.662 \frac{1}{m}}$

$\mu_{Au} = \underline{12822.14 \frac{1}{m}}$

~~$\therefore x_{Al} = 2.8595 \times 10^{-5}$ m~~

~~$x_{Cu} = 8.61687 \times 10^{-6}$ m~~

~~$x_{Au} = 4.000 \times 10^{-6}$ m~~

$x_{Al} = 1.67$ mm

$x_{Cu} = 0.503$ mm

$x_{Au} = 0.234$ mm

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6) $\boxed{1 \text{ MeV}}$

$$R_e^{sp} = 4.12 \cdot 1^{1.265 - 0.0954 \ln 1} = 4.12 \ \frac{kg}{m^2}$$

$$R_e = \frac{R_e^{sp}}{\rho}$$

$$\therefore R_{e_{Al}} = \frac{4.12}{2700} = 0.1526 \text{ cm}$$

$$R_{e_{Cu}} = \frac{4.12}{8960} = 0.046 \text{ cm}$$

$$R_{e_{Au}} = \frac{4.12}{19300} = 0.0213 \text{ cm}$$

$\boxed{10 \text{ MeV}}$

$$R_e^{sp} = 5.3 \cdot 10 - 1.06 = 51.94 \ \frac{kg}{m^2}$$

$$\therefore R_{e_{Al}} = 1.9237 \text{ cm}$$

$$R_{e_{Cu}} = 0.5797 \text{ cm}$$

$$R_{e_{Au}} = 0.2691 \text{ cm}$$

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7) $\theta_{max} = \cos^{-1}\left(\frac{1}{n}\right)$

$$\therefore \theta_{max} = \cos^{-1}\left(\frac{1}{1.6}\right) \boxed{= 51.3^{\circ}}$$

8) For electrons, $S_{nuclear}$ cannot be ignored.