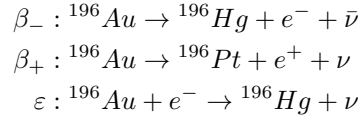


## Q1)



$$Q_{\beta_-} = [m({}^A X) - m({}^A X')] c^2 = [195.966544 - 195.965807] * 931.502 \text{ MeV} \\ = 686.517 \text{ keV}$$

$$Q_{\beta_+} = [m({}^A X) - m({}^A X') - 2m_e] c^2 = [195.966544 - 195.964926 - 2 * 5.485803 \times 10^{-4}] * 931.502 \text{ MeV} \\ = 485.163 \text{ keV}$$

$$Q_{\varepsilon} = [m({}^A X) - m({}^A X')] c^2 - B_n = [195.966544 - 195.964926] * 931.502 \text{ MeV} - 7.914861 \text{ MeV} \\ = -6.40769 \text{ keV}$$

## Q2)

- a)  $\Delta I = 2$ ;  $\Delta\pi = \text{yes}$  : First Forbidden  
b)  $\Delta I = 2$ ;  $\Delta\pi = \text{no}$  : Second Forbidden  
c)  $\Delta I = 3$ ;  $\Delta\pi = \text{no}$  : Second Forbidden  
d)  $\Delta I = 0$ ;  $\Delta\pi = \text{no}$  : Allowed Decay  
e)  $\Delta I = 0$ ;  $\Delta\pi = \text{yes}$  : First Forbidden

## Q3)

First, we need to get the energy of the excited state of  ${}^{20}\text{Ne}$  by employing conservation of Energy.  $E_1$  represents the energy the excited state has over the ground state of  ${}^{20}\text{Ne}$ :

$$\begin{aligned}{}^{20}\text{Na} &\rightarrow {}^{20}\text{Ne}^* + e^+ + \nu \\ E_1 &= [m({}^{20}\text{Na}) - m({}^{20}\text{Ne})] * c^2 - T_e \\ E_1 &= [20.007344 - 19.992436] * 931.502 \text{ MeV} - 5.55 \text{ MeV} = 8.34 \text{ MeV} \\ {}^{20}\text{Ne}^* &\rightarrow {}^{16}\text{O} + \alpha \\ E_2 &= [m({}^{20}\text{Ne}) - m({}^{16}\text{O}) - m({}^4\text{He})] * c^2 \\ E_2 &= [19.992436 - 15.994915 - 4.002603] * 931.502 \text{ MeV} = -4.73389 \\ Q &= E_1 + E_2 = 8.34 - 4.73389 = 3.61 \text{ MeV} \\ T_{\alpha} &= \frac{Q}{1 + \frac{m_{\alpha}}{m_{X'}}} = \frac{3.61}{1 + \frac{4.00150618}{15.994915}} \text{ MeV} = 2.89 \text{ MeV}\end{aligned}$$

## Q4)

a)

$$\rho * R = 0.421 * E - 0.106 \implies R = \frac{0.421 * E^{-0.106}}{\rho} = \frac{0.412 * (3.58)^{-0.106}}{2.7} = 0.133 \text{ cm}$$

b) For Al  $\mu/\rho = 5.006 \times 10^{-2} \implies \mu = 0.135 \text{ cm}^{-1}$ .  $t_{1/2} = 12.36 \text{ hrs} = 44496 \text{ s}$

$$A_0 = 10 \text{ mCi}; \quad \text{by } \gamma : 2.5 \text{ mCi}$$

$$A = A_0 e^{-\mu x} = 2.5 e^{-0.135 * 0.133} = 2.46 \text{ mCi} = 91020000 \text{ Decays/s}$$

$$N = \lambda A = \frac{\ln 2}{t_{1/2}} * A = \frac{\ln 2}{44496} * 91020000 = 1418 \text{ photons}$$

c)

$$1 - \frac{N}{N_0} = 1 - \frac{\frac{\ln 2}{t_{1/2}} * A}{\frac{\ln 2}{t_{1/2}} * A_0} = 1 - \frac{A}{A_0} = 1 - \frac{2.46}{2.5} = 0.016 = 1.6\% \text{ Absorbed}$$

d) Compton Effect