

$$1) \quad E_\alpha = 5.30 \text{ MeV}$$

$$Z_{Au} = 79$$

$$Z_H = 2$$

$$E_\alpha = V_{DOCA} = \frac{Z_1 Z_2 e^2}{r_{min}}$$

$$r_{min} = \frac{Z_1 Z_2 e^2}{E_\alpha}$$

$$= \frac{2(79) \cdot 197 \text{ MeV-fm}}{137} = 5.30 \text{ MeV}$$

$$r_{min} = 42.9 \text{ fm}$$

$$b) \quad E_\alpha = 5.3 \text{ MeV} \quad I = 10^4 \text{ particles/s}$$

$$\rho_{Au} = 19.3 \text{ g/cm}^3 \quad t = 10^{-5} \text{ cm} \quad A = 1.0 \text{ cm}^2 \quad r_d = 10 \text{ cm}$$

$$\theta_1 = 10^\circ \quad \theta_2 = 45^\circ \quad A_{Au} = 197$$

$$\frac{dN}{dt} = \frac{d\sigma}{d\Omega} \frac{d\Omega}{d\Omega} I n_{tgt}$$

$$n_{tgt} = \rho_{Au} t \cdot \frac{N_A}{M}$$

$$= \left(19.3 \frac{\text{g}}{\text{cm}^3} \right) (10^{-5} \text{ cm}) \frac{6.02 \times 10^{23} \text{ particles/mole}}{197 \text{ g/mole}}$$

$$= 5.90 \times 10^{17} \text{ particles/cm}^2$$

$$d\Omega = \frac{A}{r^2} = \frac{1.0 \text{ cm}^2}{(10 \text{ cm})^2} = 0.01 \text{ sr}$$

$$\frac{d\sigma}{d\Omega} = \left(\frac{Z_1 Z_2 e^2}{4E_{cm}} \right)^2 \frac{1}{\sin^4(\theta/2)}$$

$$E_{cm} = \frac{M_{Au}}{M_\alpha + M_{Au}} E_\alpha \approx E_\alpha$$

$$\frac{d\sigma_1}{d\Omega} = \left(\frac{2.79 \cdot \frac{197 \text{ MeV} \cdot \text{fm}}{137}}{4.53 \text{ MeV}} \right)^2 \frac{1}{\sin^4\left(\frac{10^\circ}{2}\right)}$$

$$= (114.9 \text{ fm}^2) (17331)$$

$$\frac{d\sigma_1}{d\Omega} = 1.99 \times 10^6 \text{ fm}^2$$

$$\frac{dN_1}{dt} = (1.99 \times 10^6 \text{ fm}^2) \left(\frac{10^{-15} \text{ m}}{\text{fm}} \right)^2 \times (0.01 \text{ sr}) \times$$

$$\left(\frac{10^4 \text{ particles}}{\text{s}} \right) \times \left(5.9 \times 10^{17} \frac{\text{particles}}{\text{cm}^2} \right) \times$$

$$\left(\frac{100 \text{ cm}}{\text{m}} \right)^2$$

$$= 1.15 \frac{\text{particles}}{\text{s}} \left(\frac{3600 \text{ s}}{\text{hr}} \right)$$

$$= 4230 \text{ particles/hr}$$

$$\frac{dN_2}{dt} = \frac{d\sigma_2}{d\Omega} d\Omega \cdot I \cdot a_{\text{tgt}}$$

$$\frac{d\sigma_2}{d\Omega} = (114.9 \text{ fm}^2) \left(\frac{1}{\sin^4\left(\frac{45^\circ}{2}\right)} \right)$$

$$= (114.9 \text{ fm}^2) (46.6)$$

$$= 5355 \text{ fm}^2$$

$$\frac{dN_2}{dt} = (1.99 \times 10^6 \text{ fm}^2) \left(\frac{10^{-15} \text{ m}}{\text{fm}} \right)^2 (0.01 \text{ sr}) \left(\frac{10^4 \text{ particles}}{\text{s}} \right) \times$$

$$\left(5.9 \times 10^{17} \frac{\text{particles}}{\text{cm}^2} \right) \left(\frac{100 \text{ cm}}{\text{m}} \right)^2 \left(\frac{3600 \text{ s}}{\text{hr}} \right)$$

$$= 11.4 \text{ particles/hr.}$$

$$\frac{dN}{dt} = \frac{d\sigma}{d\Omega} d\Omega I n_{tgt}$$

$$\left(\frac{2, 2, c^2}{4 E_{cm}} \right)^2 \frac{1}{\sin^4 \theta/2} = \frac{dN/dt}{d\Omega \, I \, n_{tgt}}$$

$$E_{\text{an}} \sim E_x \quad n_{\text{tgt}} = \rho t \frac{N_A}{M}, \quad d\Omega = \frac{A}{r^2} d\Omega$$

$$Z_2 = \sqrt{\frac{dN/dt}{\frac{A}{v_d^2} \cdot I_p + \frac{N_A}{M}}} \left(\sin^2 \frac{\theta}{2} \right) \frac{4 E_{cm}}{Z_1 e^2}$$

$$= \left[\frac{820 \frac{\cancel{cts}}{hr}}{\cancel{hr} \cdot 3600s} \times \left(\frac{1.0 \cancel{cm}^2}{(10 \cancel{cm})^2} \right) \left(10^4 \frac{\cancel{p}}{s} \right) \left(8.9 \frac{\cancel{g}}{\cancel{cm}^3} \right) \left(10^{-5} \cancel{cm} \right) \left(\frac{6.02 \times 10^{23}}{63.6g} \right) \right] \times \left(10^{-2} \frac{\cancel{cm}}{m} \right)^2 \times \left(\frac{1}{2} \right)$$

$$= 28.5 \text{ (Cu)}$$