

(10.3) In a Rutherford scattering experiment ^2D atoms of 150 keV are used to bombard a thin ^{58}Ni foil having a surface density of $67 \cdot 10^{-6} \text{ g cm}^{-2}$. The detector subtends a solid angle of $1.12 \cdot 10^{-4} \text{ sr}$ and detects 4816 deuterons out of a total of $1.88 \cdot 10^{12}$ incident on target. Calculate (a) the differential cross-section (in barns). (b) What is the distance between target and the solid state detector, which has a surface area of 0.2 cm^2 ?

(a) Use eqn (10.19) and $N_v \cdot x = x \cdot \rho \cdot N_A / M$, where $x \cdot \rho$ is the surface density.

$$M := 58 \cdot 10^{-3} \cdot \frac{\text{kg}}{\text{mole}} \quad N_A := 6.022 \cdot 10^{23} \cdot \text{mole}^{-1} \quad x\rho := 67 \cdot 10^{-6} \cdot 10^4 \cdot 10^{-3} \cdot \text{kg} \cdot \text{m}^{-2}$$

$$xN_v := x\rho \cdot \frac{N_A}{M} \quad xN_v = 6.956 \cdot 10^{21} \cdot \text{m}^{-2}$$

$$n := 4816 \quad n_0 := 1.88 \cdot 10^{12} \quad \Delta\Omega := 1.12 \cdot 10^{-4}$$

$$\sigma \sigma \Delta\Omega := \frac{n}{n_0 \cdot xN_v \cdot \Delta\Omega} \quad \sigma \sigma \Delta\Omega = 3.288 \cdot 10^{-27} \cdot \text{m}^2 \quad \text{or} \quad \frac{3.288 \cdot 10^{-27}}{10^{-28}} = 32.88 \quad \text{barn/sr}$$

(b) Use eqn (10.20) to calculate distance r :

$$A_d := 0.2 \cdot 10^{-4} \cdot \text{m}^2 \quad r := \sqrt{\frac{A_d}{\Delta\Omega}} \quad r = 0.423 \cdot \text{m} \quad \text{or} \quad r = 42.258 \cdot \text{cm}$$