Chem 988 Winter/2009

1) simple way – use the nomograph in text p. 376 → ~ $10^4\ \Omega$-cm

hard way: $d \simeq \left(\frac{2\epsilon V}{q_e \nu_e}\right)^{1/2}$ & $\nu_e = \frac{1}{q_e \mu_e \rho}$ → $d^2 = \frac{2\epsilon V q_e \mu_e \rho}{q_e}$

see Table 11.1

$$\rho = \frac{d^2}{2\epsilon \mu_e V} = \frac{\left(0.517\ \text{mm} \times 10^{-3}\ \text{m/mm}\right)^2}{2 \times 12 \times 8.85\times10^{-12}\ \frac{\text{F}}{\text{m}} \times \frac{\text{C/V}}{\text{F}} \times 90\ \text{V} \times 1350\ \frac{\text{cm}^2}{\text{V s}} \times 10^{-4}\ \frac{\text{m}^2}{\text{cm}^2}}$$

$$= 104.\ \Omega\ \text{m} = 1.0 \times 10^{4}\ \Omega\ \text{cm}$$

... Hum, the same number.

2) ① $t = \frac{1\ \text{chan}}{30\times10^{6}/\text{s}} \times 2240 \times 1680 = 0.125\ \text{s}$

② $N_{photons} = \frac{20\, e^- \times W}{E_{photon}} = 20 \times \frac{3.62\ \text{eV}}{e^-} \Big/ \overbrace{\frac{6.626\times10^{-34}\ \text{J}\cdot\text{s} \times 3\times10^{8}\ \text{m/s}}{430\times10^{-9}\ \text{m} \times 1.602\times10^{-19}\ \frac{\text{J}}{\text{eV}}}}^{2.89\ \text{eV}}$

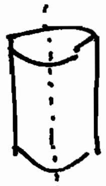
$= 26$ photons

3) $R = \frac{\#\text{photons } {}^{40}\text{K photopeak}}{\#\text{photon average CR}}$

${}^{40}\text{K} - E_\gamma = 1.460\ \text{MeV} \times 38000/\text{MeV}$ (don't need this)

CR ~ $1.5\ \text{keV}/\text{mg/cm}^2$

→ need average path in mg/cm^2 of NaI



assume average path is the long axis ⇒ $\Delta x = 3'' \times 2.54\ \frac{\text{cm}}{\text{in}}$

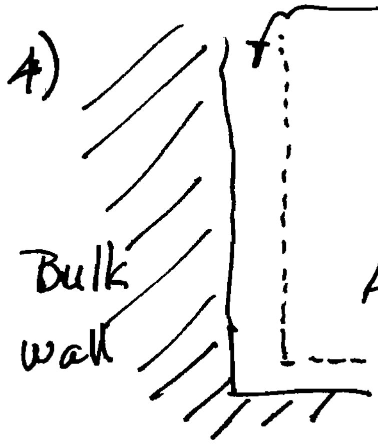
$\rho_{mass}(\text{NaI}) = 3.67\ \frac{\text{g}}{\text{cm}^3}$ ⇝ $\rho_{Areal} = 3.67\ \frac{\text{g}}{\text{cm}^3} \times 3 \times 2.54\ \text{cm}$

$\rho_{Areal} = 27.97\ \text{g/cm}^2$

$$R = \frac{1.460\ \text{MeV} \times \#\text{photon/MeV}}{1.5\ \frac{\text{keV}}{\text{mg/cm}^2} \times \frac{10^{-3}\ \text{MeV/keV}}{10^{-3}\ \text{g/mg}} \times 27.97\ \frac{\text{g}}{\text{cm}^2}}$$

$R = 0.0348 \sim \frac{1}{29}$

4)



active layer $\Delta X = \frac{\text{Range}(^{235}U\text{-alpha})}{2}$

$$A = N\lambda = N(^{235}U)\,\lambda(^{235}U)$$

$$A = \frac{\rho_{Al} \times N_A}{MM(Al)} * 20\times10^{-9}\,\frac{U}{Al} * 7.2\times10^{-3}\,\frac{U^{235}}{U} * \Delta x * \lambda(^{235}U)$$

$$\lambda(^{235}U) \sim \frac{\ln 2}{7\times10^{8}\,yr \times 3.15\times10^{7}\,\frac{s}{yr}} = 3.14\times10^{-17}$$

^{235}U Q_α = 4678 keV $\rightarrow$ $E_\alpha = \frac{231}{235}\,4678\,\text{keV} = 4598\,\text{keV}$

Range (He, E = 4598 keV in Al) $\simeq$ 19.4 μm from Lise++

$$A = \overbrace{\frac{2.7\,g/cm^3 \times 6.022\times10^{23}/mol}{27\,g/mol} \times 20\times10^{-9} \times 7.2\times10^{-3}}^{8.67\times10^{12}\ ^{235}U/cm^3} \times \frac{19.4\times10^{-4}\,cm}{2} \times 3.14\times10^{-17}/s$$

$$A = \frac{5.2\times10^{-7}}{2}\,/s/cm^2$$ $\rightarrow$ not too much of a problem!