Quest° 1 $\lambda = 1.54\,\text{Å}$

a)	37	44	65	77	82
θ:	18.5	22	32.5	38.5	41
$\sin^2\theta$:	0.1	0.14	0.29	0.39	0.43
ratio:	1	1.4	2.9	3.9	4.3

fcc ~~bcc~~

$$\sin^2(\theta) = \frac{\lambda^2}{4a^2}(h^2+k^2+l^2)$$

$$a^2 = \frac{\lambda^2}{4\sin^2\theta}(\dots) = \frac{\lambda^2}{4\sin^2(32.5)}\,3 = 1$$ 4.10

$$a = \frac{\sqrt{385}}{10}\,\text{Å} \simeq 1\,\text{Å}$$

2mm = 20Å → 20 unit cells

×2 atoms = 40

Quest° 2

$$n = z\frac{\nu}{V} = \frac{4}{a^3} = 0.058 = 5.8\ \text{Å/cm}^3$$ ×10²² /cm³

$z = 1$

$\nu = 4$

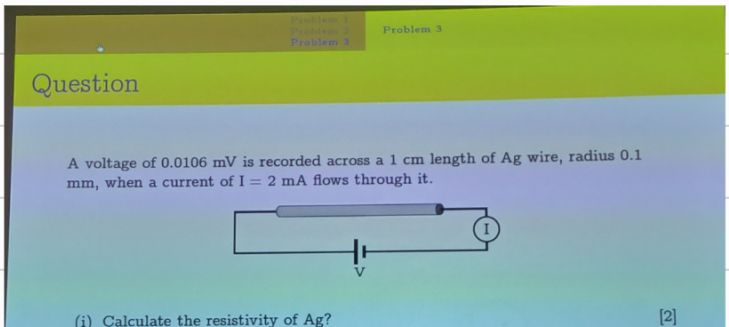
$V = \frac{a^3}{4} = a^3$

Monoatomic : $z = 1$

? primitive cubic cell

Quest° 3

$$\begin{cases} V = 0.0106\ \text{mV} \\ d = 1\ \text{cm} \\ r = 0.1\ \text{mm} \\ I = 2\ \text{mA} \end{cases}$$



i) $R = \rho\frac{l}{A}$

(ii) What is the scattering time τ for Ag? [2]

(iii) What is the drift velocity of the electrons? [1]

(iv) [h?] The voltage is switched off. What happens (quantitatively) to the average electron motion. [2]

$[e = 1.6 \times 10^{-19}$ C; $m = 9.1 \times 10^{-31}$ kg; $n = 5.85 \times 10^{22}/\text{cm}^3$.]

$\rho = \frac{\rho_3}{A}$

$V = Ih$

$R = \frac{V}{I}$

$\rho = \frac{RA}{L} = 1.67 \mu\Omega\text{cm}$

$\vec{\rho} = \frac{AL}{n} = \frac{AV}{IL}$

ii) $\rho = \frac{1}{\sigma} = \frac{m}{ne^2\tau}$

$\tau = \frac{m}{ne^2\rho}$

$\tau = 3.6 \times 10^{-14}$ s

iii)

Problem 3

Answer

(iii) What is the drift velocity?

Use Drude equation of motion in steady state ($d/dt = 0$):

$$\frac{d\vec{p}}{dt} = \vec{F} - \frac{\vec{p}}{\tau} \quad \Rightarrow \quad 0 = -e\vec{\mathcal{E}} - \frac{\vec{p}}{\tau} \quad \Rightarrow \quad m\vec{v}_d = -e\tau\vec{\mathcal{E}}$$

Voltage drop V in distance L corresponds to an electric field $\mathcal{E} = V/L = 1.06$ mV/m. So

$$|v_d| = \left|-\frac{e\tau\mathcal{E}}{m}\right| = \frac{1.6 \times 10^{-19} \times 3.6 \times 10^{-14} \times 1.06 \times 10^{-3}}{9.1 \times 10^{-31}} = 6.7 \times 10^{-6} \text{ m/s}$$

Or use $\vec{j} = -ne\vec{v}_d = I/A$, so $|v_d| = \frac{I}{neA}$. Putting in numbers,

$$|v_d| = \frac{2 \times 10^{-3}}{5.85 \times 10^{28} \times 1.6 \times 10^{-19} \times \pi \times (1 \times 10^{-4})^2} = 6.8 \times 10^{-6}\text{m/s}$$

iv)