Exam 2, Problem 1

Begin by finding the rate constant:

$[A] = [A_0] e^{-kt}$

$1/2[A_0] = [A_0] e^{-k(45)}$

$1/2 = e^{-kt} \quad \Rightarrow k = 1.78 \cdot 10^{-7} \, s^{-1}$

Then, plug k into the equation

$k = A \cdot \exp\left(-\frac{E_a}{RT}\right) \Rightarrow 1.78 \cdot 10^{-7} = (8 \cdot 10^{-12}) \exp\left(\frac{140\,000}{8.314 \cdot T}\right)$

$\Rightarrow T = 372.1 \, K$

Exam 2, Problem 2

Refer to typed solution.

Exam 2, Problem 3

Write the equation

$$\frac{7 \cdot 10^{17} \text{ carriers}}{1 \text{ cm}^3} = \frac{1 \text{ carriler}}{1 \text{ atom As}} \cdot \frac{1 \text{ mol S}}{12.06 \text{ cm}^3 \text{ Si}} \cdot \frac{6.02 \cdot 10^{23} \text{ atoms As}}{1 \text{ mol As}} \cdot \frac{x \text{ mol As}}{1 \text{ mol Si}}$$

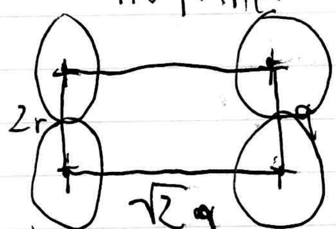
$\Rightarrow$

$$x \text{ moles As} = 1.4 \cdot 10^{-5} \text{ moles As}$$
$$= 1.05 \cdot 10^{-3} \text{ grams As}$$

Exam 2, Problem 4

Sketch the system given that the element has simple cubic crystal structure:

110 plane:



We are given that the molar volume is 22.2 cm^3/mol; thus

$$\frac{22.2\ cm}{mol} \cdot \frac{1\ mol}{6.02 \cdot 10^{23}\ atoms} \cdot \frac{1\ atom}{1\ cell} = 3.691 \cdot 10^{-23}\ cm/cell;$$

since

$$V = a^3;\ \cancel{3}.691 = a^3 \Rightarrow a = 3.33 \cdot 10^{-8} = 2r.$$

Thus, the atomic density is

$6.381 \cdot 10^{24}$ atoms/cm^2;

We also see that

$$d_{NN_2} = \sqrt{2}a = 4.708 \cdot 10^{-8}\ cm$$

Exam 2, Problem 5

Recall that energy to produce a peak is correlated with Z; we must consider $Z=47$ (Silver) then. Then recall the equation

$$v = \left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right) R (Z-\sigma)^2 = \frac{1}{\lambda k_\alpha}$$

Assume a change from $n=1 \rightarrow n=2$, $Z=47$, and $\sigma=1$; The R = rydberg constant.

$$v = \frac{3}{4} R (47-1)^2 = 1.740939 \cdot 10^{10}$$

Then by

$E = hcv$, $E = 2.61 \cdot 10^4$ eV

Exam 2, Problem 6

Once again recall

$$v = \frac{1}{\lambda} = \left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right) R (Z-\sigma)^2$$

Let $n_i = 1$, $n_f = 2$, $R = 1.097 \cdot 10^7$, $Z = 27$

$$V = \frac{1}{\lambda} = 5.66 \cdot 10^9 \Rightarrow \lambda = 1.8 \cdot 10^{-10} \text{ m}$$

See that

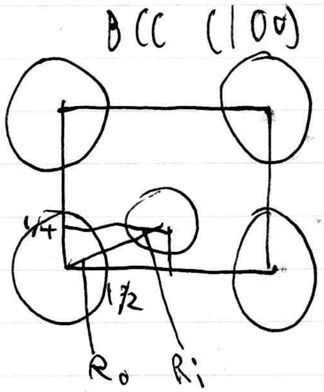
$$\lambda_{swl} = \frac{hc}{E} = \frac{3 \cdot 10^8 \cdot 6.63 \cdot 10^{-34}}{1.602 \cdot 10^{-19} \cdot 53000} = 2.34 \cdot 10^{-11} \text{ m}$$

Exam 2, Problem 7

(a): option 2
(b): option 2
(c): option 2

Exam 2, Problem 8

Sketch the system!



See by Pythagoras that

$$(R_o + R_i)^2 = a^2/4 + a^2/16 \Rightarrow R_o + R_i = \frac{\sqrt{5}}{4} a.$$

We know that

$$R_o = \frac{\sqrt{3}}{4} a; \text{ thus } R_i = \frac{\sqrt{5}}{4} a - \frac{\sqrt{3}}{4} a$$

We know that

$$V_{cell} = 2.36 \times 10^{-23} \text{ cm}^3/\text{cell} \Rightarrow a = 2.868 \text{Å} ; \text{ thus}$$

$$R_i = 3.615 \times 10^{-11} \text{ m}$$

Exam 2, Problem 9

See that the {110} family has 6 associated non-parallel planes that go through the center:

(110)
(101)
(011)
$(1\bar{1}0)$
$(10\bar{1})$
$(01\bar{1})$

Thus, there are 6 slip systems.

Exam 2, Problem 10

(a): ~~We have that, for glasse~~

For glass A:

$$\frac{0.15 + 0.1 + 0.75 \cdot 2}{0.75} \simeq 2.33$$

For glass B:

$$\frac{0.05 + 0.025 + 0.0125 \cdot 3 + 0.8 \cdot 2}{0.125 \cdot 2 + 0.87} = 1.952$$

(b): For glass A: $0.\overline{6}$

For glass B: 0.142

(c): Glass B

Exam 2, Problem 11

(a): option 1

(b): option 1

(c): option 1