Exam #2
Monday, 10 October 2022

Instructions:

1. **Read** every problem CAREFULLY!
2. Make sure your answer addresses **each part** of the problem.
3. Make sure your answer is clearly marked by a circle or **box around the answer**.
4. Be sure to include the **proper units** and *3 significant figures* with your answer.
5. You may use a calculator for basic calculations.

Potentially Useful Information (continues on next page)

Constants

$k_B = 8.617 \times 10^{-5}$ eV/K

$= 1.381 \times 10^{-23}$ J/K

$h = 6.626 \times 10^{-34}$ J·s

$m_e = 9.11 \times 10^{-31}$ kg

$N_A = 6.022 \times 10^{23}$ atoms/mole

$R = 8.3145$ J/(K·mol)

$c = 3.00 \times 10^{8}$ m/s

$e = 1.60 \times 10^{-19}$ C

$(4\pi\varepsilon_0)^{-1} = 8.987 \times 10^{9}$ N·m^2·C^{-2}

1.00 eV = 1.60×10^{-19} J

Basics

$$n_i = \frac{w_i / M_i}{\frac{w_1}{M_1} + \frac{w_2}{M_2} + \ldots + \frac{w_N}{M_N}}$$

$$w_B = \frac{n_B M_B}{n_A M_A + n_B M_B + n_C M_C + \ldots}$$

$$\rho = \frac{\sum(\text{Number of atoms of given type in unit cell} \times \text{Atomic mass of this type})}{\text{Volume of unit cell}}$$

$$PV = \left(\frac{N}{N_A}\right)RT = Nk_BT$$

$$L = L_0[1 + \lambda(T - T_0)]$$

$$n_v = N\exp\left(-\frac{E_v}{kT}\right)$$

$$D = D_o\exp\left(-\frac{E_A}{kT}\right)$$

$$L_{rms} = \sqrt{2Dt}$$

$$\rho = \rho_0[1 + \alpha_0\Delta T]$$

$$\rho_{alloy}\alpha_{alloy} = \rho_{pure}\alpha_{pure}$$

$$\rho_{alloy} = \rho_{pure} + CX(1-X)$$

$P = IV = I^2R = V^2/R$

$$V(r) = \frac{-1}{4\pi\varepsilon_0}\frac{e^2}{r}$$

Quantum Mechanics

$KE_{max} = hf - \varphi$

$E_{ph} = hf = hc/\lambda$

$\Gamma_{ph} = \text{Intensity}/(hf) = I\lambda/(hc)$

$p = h/\lambda$

$\Delta x \Delta p \geq h/4\pi$

$$-\frac{\hbar^2}{2m}\nabla^2\psi + V\psi = E\psi$$

$$E_n = \frac{h^2n^2}{8m_ea^2}$$

$$E_{n_x,n_y,n_z} = \frac{\hbar^2\pi^2}{2m}\left(\frac{n_x^2}{l_x^2} + \frac{n_y^2}{l_y^2} + \frac{n_z^2}{l_z^2}\right)$$

$$f(E) = \frac{1}{1 + e^{\frac{E-E_F}{k_BT}}}$$

Metals and Semiconductors

$\sigma = en\mu$

$\lambda = v\tau$

$$\tau = \frac{\mu m}{e}$$