

ENGR-1600-01 Quiz 6 - 100 pts Prof. Lewis Name: \_\_\_\_\_

Some useful equations are given below:

$$n\lambda = 2d \sin(\theta) \quad d_{hkl} = \frac{a}{\sqrt{(h^2 + k^2 + l^2)}} \quad N_A = 6.023 \cdot 10^{23} \quad \rho = \frac{nA}{V_C N_A}$$

$$\sigma = \frac{F}{A_0} \quad \sigma = E\epsilon \quad \tau_{crss} = \sigma_y \cos \theta \cos \phi \quad \nu = -\frac{\epsilon_x}{\epsilon_z} = -\frac{\epsilon_y}{\epsilon_z}$$

$$SC : a = 2R \quad FCC : a = \frac{4R}{\sqrt{2}} \quad BCC : a = \frac{4R}{\sqrt{3}} \quad \mathbf{a} \cdot \mathbf{b} = |a||b| \cos \theta$$

$$\%CW = \frac{A_0 - A_f}{A_0} \cdot 100 \quad K_{IC} = Y \sigma_c \sqrt{\pi a} \quad \epsilon = \frac{l_i - l_0}{l_0} = \frac{\Delta l}{l_0}$$

$$N = N_0 \exp(-Q_v/(kT)) \quad P+F=C+2$$

1. (20) Silver has a vacancy formation energy of 1.1 eV. Calculate the equilibrium vacancy concentration at 293K and 1233K. (Boltzmann's constant is equal to  $8.62 \cdot 10^{-5}$  eV/(atom-K)).

$$\frac{N}{N_0} = \exp\left(\frac{-1.1}{293 \cdot k}\right) = 1.2 \times 10^{-19} \quad (1)$$

$$\frac{N}{N_0} = \exp\left(\frac{-1.1}{1233 \cdot k}\right) = 3.2 \times 10^{-5} \quad (2)$$

2. (20) Explain 3 of the following 4 factors that effect the degree of solubility in metallic solutions:

A) Atomic size - if the atom sizes are within 15% high solubility is expected.

B) Crystal structure - if the pure materials have the same crystal structure high solubility is expected. For example, Cu-Ni.

C) Electronegativity - if the electronegativity is similar, the elements or molecules are less likely to form compounds. If there are no compounds, or intermediate phases, then more solubility is likely.

D) Valence - a lower valence element is more likely to dissolve in a higher valence element and therefore have a higher solubility.

3. (20) Identify the correct phrase to complete the following statement and explain why the phrase you select is correct.

In NaCl, removing one Cl ion from the lattice produces...

A. a Cl interstitial \_\_\_\_\_

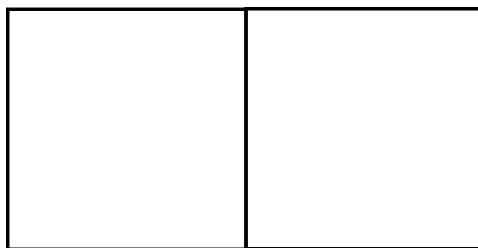
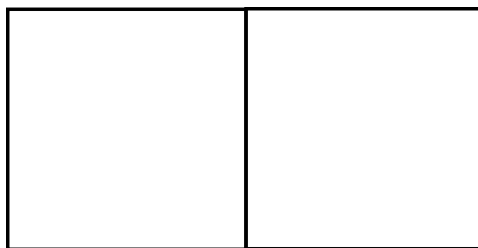
B. a Na vacancy - one Na vacancy will be created in order to maintain charge balance.

C. a Na interstitial \_\_\_\_\_

D. nothing \_\_\_\_\_

4. (20) One mol of pure, solid Cu is joined to one mol of pure, solid Ni. Cu and Ni are mutually and completely soluble. The diffusion-couple is then heated up and allowed to interdiffuse. Draw the concentration profiles you would expect at the start of the experiment, after some time "t" and as t approaches infinity.

*(See your ready notes page 173!)*



5. (20) The phase diagram for H<sub>2</sub>O is shown. Indicate the number of phases and the degrees of freedom at each of the points. Show your work in each case for full credit. For a class participation point, correctly name the author of a science fiction novel about an unconditionally stable form of H<sub>2</sub>O.

A: 2, B: 1, C: 0, D: 0. Use  $P+F=C+2$  in each case for full credit.

