

Grades: #1 _____ #2 _____ #3 _____ #4 _____ Total _____

ENGR 220
PRACTICE EXAM I: FALL 2009

Name _____

Student Number _____

Section Number _____

Closed book, closed note exam. Formulas given on attached formula sheet. You may use a calculator, periodic table and ruler. You will be given one hour to complete the exam. Please show all work for full credit.

1. 1 .(30 pts, 3 pts each) Please respond True or False to the statements listed below.

RECORD YOUR ANSWERS ON THE SPACES GIVEN AT THE BOTTOM OF PAGES ONE AND TWO. WRITE OUT ENTIRE WORD: TRUE OR FALSE

- a. You are given two material samples. The first has a very fine grain or crystal structure (a lot of small crystals) while the second has a courser grain structure (larger crystals). The processing conditions of the two materials were likely the same.
- b. Propane (C_3H_8) has a higher melt temperature than dodecane ($C_{12}H_{26}$).
- c. The higher the bond energy for an interatomic bond, the lower the melt temperature of the material.
- d. Ionic and covalent bonds are non-directional in nature, while metallic bonds are highly directional.
- e. I would expect a material with a higher atomic packing factor to have a higher density than one with a lower atomic packing factor.
- f. Carbon has a higher diffusion coefficient in FCC Fe than in BCC Fe at the same temperature.

Answers (True of False, write out complete word, please):

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

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- g. I would expect to see many grain boundaries in a polycrystalline material, but none in a single crystal or amorphous material.
- h. Carbon diffuses in Iron at a higher rate than Iron diffuses in Iron at a given temperature.
- i. Impurities always reduce the mechanical properties of a material.
- j. Materials I is my favorite course because I love to explore the process, structure and properties relationships of all materials!

Answers (True or False, write out complete word, please):

- g. _____
- h. _____
- i. _____
- j. _____

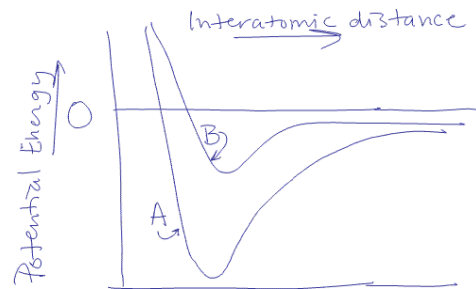
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2. (25 pts)

a. (10 pts) Consider one Fe atom at the front of this auditorium and another at the rear. Describe the interatomic forces that are acting on the two atoms as they are brought *close* together by sketching a curve of F vs. r . Label and define the equilibrium atomic spacing.

b. (10 pts) Derive the expression for bonding energy in terms of the equilibrium atomic spacing. Calculate the bond energy for $A=1.44$ $B=5.9 \times 10^{-6}$ $n=9$

c. (5 pts) Consider the plot below. Which material would you select to serve as a structural support for a bridge? Why?



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3. (25 pts)

- a. (9 pts) Some hypothetical metal has the simple cubic crystal structure. If its atomic weight is 70.4 g/mol and the atomic radius is 0.126 nm, compute its density.

(16 pts) It has been determined that the steady-state diffusion flux of nitrogen through a steel plate is $1.5 \times 10^{-8} \text{ kg/m}^2\text{-s}$ at a temperature of 1300 K (1027 C), and a concentration gradient of -300 kg/m^4 .

(1) What concentration gradient is necessary to give a diffusion flux of $4.0 \times 10^{-8} \text{ kg/m}^2\text{-s}$ at 1400 K (1127 C) if the activation energy for diffusion is 124,000 J/mol?

(2) What is the driving force for steady state diffusion?

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4. (20 pts)

a. (4pts) Rank the magnitude of diffusion coefficients from greatest (1) to least (4) for the following systems. Both Fe and Cr have BCC crystal structures, and the atomic radii for Fe is 0.124 nm, Cr is 0.125 nm, and N is 0.065 nm.

Rank	Diffusion System
_____	N in Fe @ 700 degrees C
_____	Cr in Fe @ 700 degrees C
_____	N in Fe @ 900 degrees C
_____	Cr in Fe @ 900 degrees C

b. (10 pts) The number of vacancies per cubic meter present in iron at 850C (1173 K). The energy for vacancy formation is 1.08 eV/atom. Furthermore, the density and atomic weight for Fe are 7.65g/cm³ and 55.85 g/mol, respectively.