



UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JULY 2010 SESSION

SUBJECT CODE : FTB 11203
SUBJECT TITLE : MATERIALS SCIENCE
LEVEL : BACHELOR
TIME / DURATION : 8.00pm – 10.00pm
(2 HOURS)
DATE : 11 NOVEMBER 2010

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. This question paper consists of FIVE (5) questions. Answer FOUR (4) questions only.
6. Answer all questions in English.

THERE ARE 4 PAGES OF QUESTIONS AND 2 PAGES OF APPENDIX, EXCLUDING THIS PAGE.

INSTRUCTION: Answer FOUR (4) questions only.

Question 1

- (a) You would like to design an aircraft that can be flown by human power nonstop for a distance of 30km. What types of material properties would you recommend? What materials would be appropriate?
(10 marks)
- (b) Suppose an element has a valence of 2 and an atomic number of 27. Based only on the quantum numbers, how many electrons must be present in the 3d energy level?
(4 marks)
- (c) Car breaks are typically made using cast iron and weigh about 20 pounds. What other materials can be used to make breaks that would last long and weigh less?
(10 marks)

Question 2

- (a) Calculate the volume of a face centered cubic (FCC) unit cell in terms of the atomic radius, R.
(5 marks)
- (b) Assuming that silica (SiO_2) has 100% covalent bonding, describe how oxygen and silicon atoms in silica (SiO_2) are joined?
(5 marks)
- (c) Scientist are considering using nano-particles of such magnetic materials as iron-platinum (Fe-Pt) as a medium for ultrahigh density data storage. Arrays of such particles potentially can lead to storage of trillions of bits of data per square inch- a capacity that will be 10 to 100 times higher than any other devices such as computer hard disks. Consider on (Fe) particles that are 3 nm in diameter, what will be the number of atoms in one such particle? Assume magnetic particles are spherical in shape, density of iron is 7.8 g/cm^3 , and atomic mass number of iron is 56 g/mol.

Calculate mass of each Fe nano-particle in unit of gram?

(10 marks)

- (d) Draw within a cubic unit cell the $(\bar{2}12)$ planes.

(5 marks)

Question 3

- (a) Sketch a respective diagram showing self-interstitial impurity and Frenkel defect.

(4 marks)

- (b) Calculate the concentration of vacancies in copper at room temperature (25°C). What temperature will be needed to heat treat copper such that the concentration of vacancies produced will be 1000 times more than the equilibrium concentration of vacancies at room temperature? Assume that 20,000 cal are required to produce a mole of vacancies in copper and lattice parameter is 0.36151 nm.

(10 marks)

- (c) Dislocations are most significant in metals and alloys since they provide a mechanism for plastic deformation. Discuss why would metals behave as brittle materials without dislocations?

(5 marks)

- (d) Materials with more than one crystal structure are called allotropic or polymorphic. Explain the difference of each term in crystal structure.

(6 marks)

Question 4

- (a) A Copper – Silver (Cu - Ag) phase diagram is shown in the Figure 1. Consider a 48% Ag and 52% Cu alloy.

i) Name the line that labeled A,B and C.

(3 marks)

ii) Identify point D

(2 marks)

iii) Determine the percentage of the phases at 778°C in $\alpha + \beta$ phase

(10 marks)

- (b) A crankshaft in a diesel engine fails. Examination of the crankshaft reveals no plastic deformation. The fracture surface is smooth. In addition, several other cracks appear at other locations in the crankshaft. What type of failure mechanism would you expect?

(10 marks)

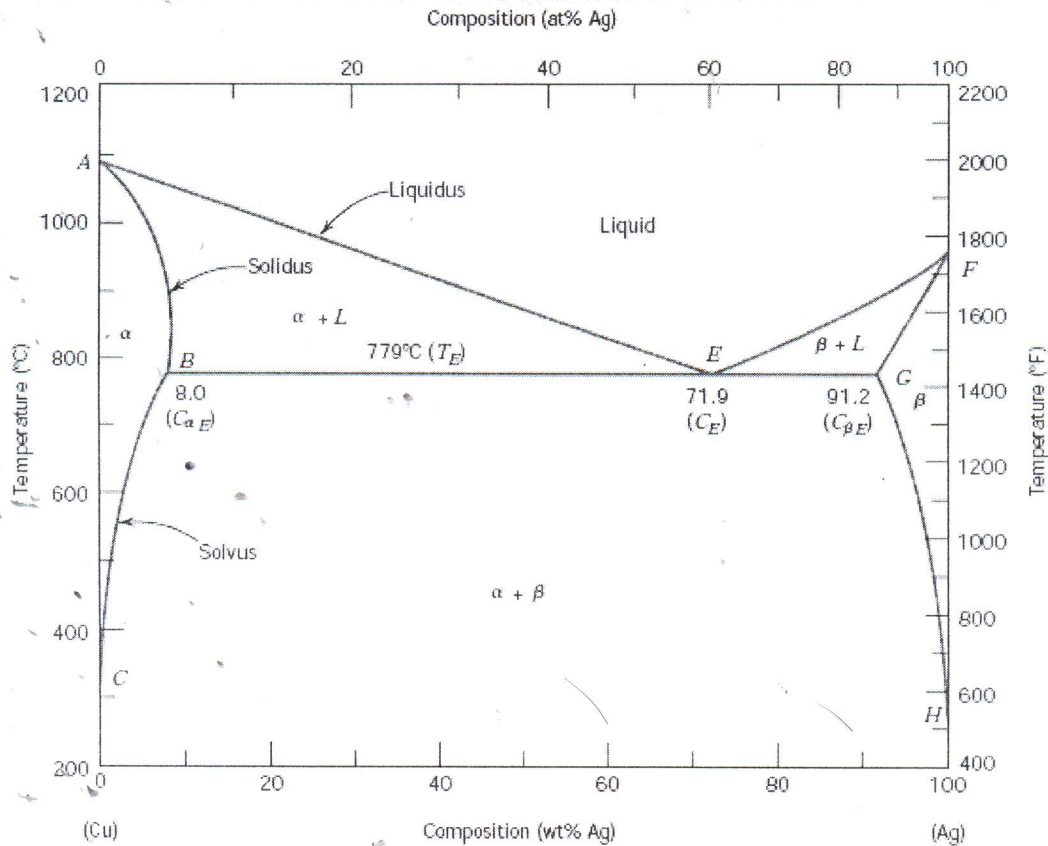


Figure 1

Question 5

- (a) Describe the grinding and polishing process.

(10 marks)

- (b) Sketch a cementite-pearlite structure. Label each region clearly.

(5 marks)

- (c) A titanium pipe used to transport a corrosive material at 400°C is found to fail after several months. How would you determine the cause for the failure?

(10 marks)

END OF QUESTION

$$APF = (n) \left(\frac{4\pi r^3}{3} \right) \left(\frac{1}{a^3} \right)$$

$$\rho = \frac{nA}{V_c N_A}$$

$$N = \frac{N_A \rho}{A}$$

$$N_v = N \exp\left(\frac{-Q}{kT}\right)$$

$$a_{fcc} = \frac{4r}{\sqrt{2}}$$

$$a_{bcc} = \frac{4r}{\sqrt{3}}$$

$$a_{sc} = 2r$$

$$D = D_o \exp\left(\frac{-Q_d}{RT}\right)$$

$$m_{\alpha} \text{ phase} = \frac{m_{\beta} - m_x}{m_{\beta} - m_{\alpha}} \times \text{Total Mass}$$

$$m_{\beta} \text{ phase} = \frac{m_x - m_{\alpha}}{m_{\beta} - m_{\alpha}} \times \text{Total Mass}$$

$$m_L \text{ phase} \% = \frac{m_s \% - m_x \%}{m_s \% - m_{L\%}} \times 100$$

$$m_s \text{ phase} \% = \frac{m_x \% - m_L \%}{m_s \% - m_{L\%}} \times 100$$

$$\rho_{\alpha} = \frac{100}{\frac{C_{A(\alpha)}}{\rho_A} + \frac{C_{B(\alpha)}}{\rho_B}}$$

$$\rho_{\beta} = \frac{100}{\frac{C_{A(\beta)}}{\rho_A} + \frac{C_{B(\beta)}}{\rho_B}}$$

$$V_{\alpha} = \frac{\frac{m_{\alpha}}{\rho_{\alpha}}}{\frac{m_{\alpha}}{\rho_{\alpha}} + \frac{m_{\beta}}{\rho_{\beta}}}$$

$$V_{\beta} = \frac{\frac{m_{\beta}}{\rho_{\beta}}}{\frac{m_{\alpha}}{\rho_{\alpha}} + \frac{m_{\beta}}{\rho_{\beta}}}$$

$$\sigma = \frac{F}{A_o}$$

$$\varepsilon = \frac{\Delta l}{l_o}$$

$$E = \frac{\sigma}{\varepsilon}$$

$$\% \text{ elongation} = \frac{\Delta l}{l_o} \times 100\%$$

$$\% \text{ area reduction} = \frac{\Delta A}{A_o} \times 100\%$$

$$BHN = \frac{F}{\frac{\pi D}{2} (D - \sqrt{D^2 - d^2})}$$

$$VHN = \frac{1.85F}{d^2}$$