



SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JULY 2010 SESSION

SUBJECT CODE : FTD 11102
SUBJECT TITLE : MATERIAL SCIENCE 1
LEVEL : DIPLOMA
DURATION : 12.30pm – 2.30pm
(2 HOURS)
DATE / TIME : 09 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 TWO (2) sections. Section A and B. Answer ALL questions in Section A and THREE (3) questions only in Section B.
6. Answer all questions in English.
7. Graph paper is provided

THERE ARE 7 PRINTED PAGES OF QUESTIONS, 1 PAGE OF FORMULAE AND 3 PAGE OF APPENDIX EXCLUDING THIS PAGE.

SECTION A (Total: 25 marks)**INSTRUCTION: Answer ALL questions.****Please use the answer booklet provided.**

- Which of the following is **NOT** categorized in the metal properties?
 - Good heat conductor
 - High corrosion resistance
 - Opague
 - Good electrical conductor
- From the compounds listed below, select compound which is **NOT** a ceramic?
 - HCl
 - SiO₂
 - SiC
 - Al₂O₃
- Calcium has an atomic weight of 40 and 20 protons. How many neutrons does the calcium have?
 - 60
 - 30
 - 20
 - 10
- What type of bonding involves the electron transfer from one atom to another?
 - Metallic bonding
 - Van der Walls bonding
 - Covalent bonding
 - Ionic bonding
- Which of the following materials does **NOT** have covalent bonds?
 - Diamond
 - Sodium chloride
 - Ethylene molecule
 - Gallium arsenide
- Atomic number for scandium is 21. Which of the following is the correct electronic configuration for scandium?
 - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$
 - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$
 - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4$
 - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$
- How many atoms are needed for the formation of a Body Centered Cubic (BCC)?
 - 2
 - 6
 - 4
 - 8

16. Once a system is at a state of equilibrium, a shift from equilibrium may result by alteration of the following?
- A. Pressure
B. Temperature
C. Composition
D. All of the above
17. A solvus line separates which of the following phase fields?
- A. Liquid and liquid + α
B. α and liquid + α
C. α and $\alpha + \beta$
D. Liquid + α and $\alpha + \beta$
18. A eutectoid reaction involves which of the following phases?
- A. One liquid and one solid
B. Two solids and one solid
C. One liquid and two solid
D. Two liquids and one solid
19. What will happen to material upon reaching the liquidus line during cooling?
- A. The first liquids begin to form
B. The first solids begin to form
C. Material becomes all in solid form
D. Material becomes all in liquid form
20. The following materials are categorized as Ferrous metal **EXCEPT**
- A. Nodular Cast Iron
B. Stainless Steel
C. Tungsten
D. High Carbon Steel
21. Which of the following is **TRUE** about Periodic Table?
- A. The different columns of elements are called Periods
B. It does not provide some basic information about element
C. It is useful for the scientist to determine the properties of elements
D. Mechanical properties of each element can be also be obtained from it
22. Which of the following crystal structures does not has angles $\alpha = \beta = \gamma = 90^\circ$?
- A. Cubic
B. Orthorhombic
C. Monoclinic
D. Tetragonal
23. Which of the following materials is an electric conductor?
- A. Fiber Glass
B. Ceramic Matrix Composites
C. Polymer
D. Semiconductor

24. Which of the following bonding types has the highest electrical conductivity?

- A. metallic bonding
- B. covalent bonding
- C. Van der Waals bonding
- D. ionic bonding

25. A eutectoid reaction involves which of the following phases?

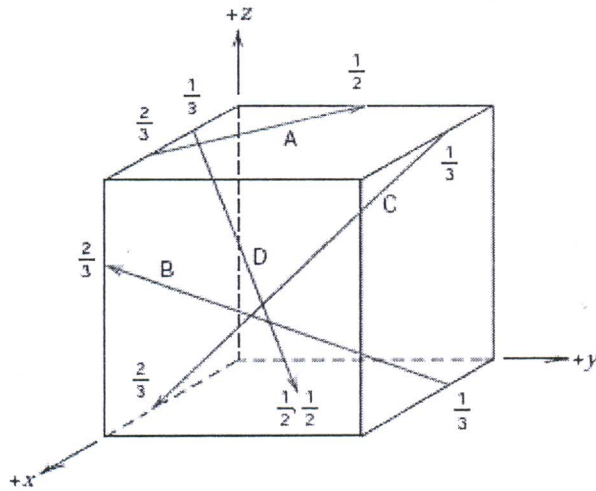
- A. One liquid and one solid
- B. One liquid and two solid
- C. Two liquids and one solid
- D. Three solid

SECTION B (Total: 75 marks)**INSTRUCTIONS: Answer THREE (3) questions only****Please use the answer booklet provided.****Question 1**

- a.) Briefly cite the main differences between ionic, covalent and metallic bonding. (6 marks)
- b.) Predict the chemical formula Na_xO_y of the compound that results from the reaction between the elements Na and O. (4 marks)
- c.) Use energy level diagram to show how electrons of Bromine (Br) atom are distributed in a ground-state and state the electron-configuration notation. (5 marks)
- d.) In the Crystal Systems arrangements, Molybdenum (Mo) has a Body Center Cubic (BCC) crystal structure with an atomic radius of 0.136 nm. Calculate the lattice Parameter a , for BCC Molybdenum (Mo). (3 marks)
- e.) Compute the theoretical density ρ of Molybdenum (Mo). (7 marks)

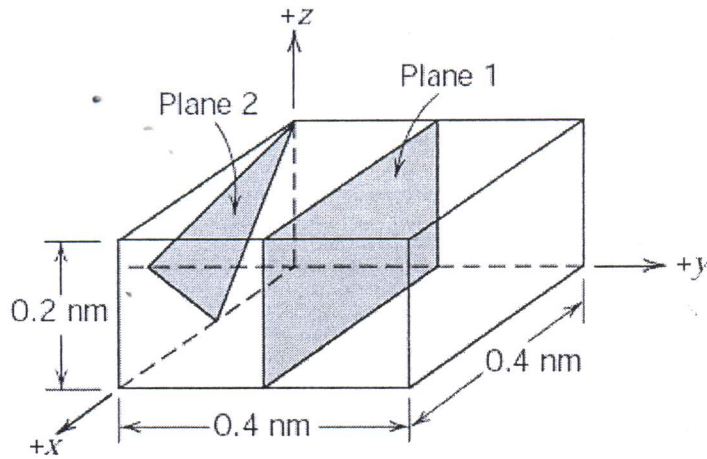
Question 2

- a.) Iodine has an orthorhombic unit cell for which the a , b , c lattice parameters are 0.479, 0.725 and 0.978 nm respectively, If the atomic packing factor (APF) and atomic radius (R) are 0.547 and 0.177 nm respectively, determine the number of atoms in each unit cell. (7 marks)
- b.) Determine the miller indices for the direction shown in the following unit cell;



(12 marks)

c.) Determine the miller indices for the planes shown in the following unit cell;



(6 marks)

Question 3

a.) Sketch or describe **TWO (2)** types of linear defects.

(4 marks)

b.) Calculate the equilibrium number of vacancies N_v , per cubic meter in Gold (Au) at 900°C. The energy for vacancy formation is 0.98 eV/atom and its density ρ , is 19.32 g/cm³. Given k is 8.62×10^{-5} eV/atom.

(10 marks)

- c.) Cite two reasons why interstitial diffusion is normally more rapid than vacancy diffusion. (4 marks)
- d.) The steady-state diffusion flux through a metal plate is 7.8×10^{-8} kg/m²-s at temperature of 1200°C when the concentration gradient is -500 kg/m⁴. Calculate the diffusivity and assuming activation energy for diffusion of 145,000 J/mol. (5 marks)

Question 4

- a.) Draw a Complete Solid Solution Phase Diagram and show the important points in the diagram. (6 marks)
- b.) Verify **TWO (2)** important areas in the Complete Solid Solution Phase Diagram that you have drawn in Question 4(a), (6marks)
- c.) By referring Copper-silver alloy phase diagram in Appendix 1 below, for 35% wt Cu-65% wt Ag at temperature 600°C,
- Determine the phases present. (2 marks)
 - Determine the compositions of the phases in Question 4b (i) and show it in the phase diagram given in appendix 1. (5 marks)
 - Calculate the relative amount of each phases present in mass fraction. (6 marks)

END OF QUESTIONS

APPENDIX 3

$$APF = \frac{V_s}{V_c}$$

$$V_s = (\text{no of atom per unit cell}) \times (\text{Sphere volume})$$

$$V_c = a^3$$

$$\text{Sphere volume} = \frac{4}{3} \pi R^3$$

$$\text{Avogadro's number } N_A = 6.023 \times 10^{23}$$

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

$$a = \frac{4r}{\sqrt{2}}$$

$$a = \frac{4r}{\sqrt{3}}$$

$$a = 2r$$

$$l = \sqrt{2}a = 4R$$

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

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

$$J = -D \frac{\Delta C}{\Delta X}$$

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

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

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$$\rho_\alpha = \frac{100}{\frac{C_{Sn(\alpha)}}{\rho_{Sn}} + \frac{C_{Pb(\alpha)}}{\rho_{Pb}}}$$

$$\rho_\beta = \frac{100}{\frac{C_{Sn(\beta)}}{\rho_{Sn}} + \frac{C_{Pb(\beta)}}{\rho_{Pb}}}$$

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

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

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

ANSWER SCREPT

APPENDIX 1 Copper -silver alloy phase diagram

