



SET A

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**UNIVERSITI KUALA LUMPUR**  
**Malaysia France Institute**

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**FINAL EXAMINATION**  
**JULY 2010 SESSION**

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**SUBJECT CODE** : FTD 11302  
**SUBJECT TITLE** : MATERIALS SCIENCE  
**LEVEL** : DIPLOMA  
**DURATION** : 9.00am – 11.00am  
( 2 HOURS )  
**DATE / TIME** : 12 NOVEMBER 2010

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**INSTRUCTIONS TO CANDIDATES**

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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 **FOUR (4)** questions only in Section B.
6. Answer all questions in English.

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**THERE ARE 5 PRINTED PAGES OF QUESTIONS AND 3 PAGE OF APPENDIX, EXCLUDING THIS PAGE.**

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**SECTION A (Total: 20 marks)****INSTRUCTION: Answer ALL questions.****Please use the answer booklet provided.**

1. The directions of  $[100]$ ,  $[100]$ ,  $[010]$ ,  $[010]$ ,  $\bar{[001]}$ ,  $[001]$  can be classified as \_\_\_\_\_ family. (2 Marks)
2. A bonding that is the result from interaction of atomic or molecular dipoles is referred to \_\_\_\_\_. (2 Marks)
3. All solids are elastic for small enough deformations or strains, but if the stress exceeds a certain amount known as the \_\_\_\_\_, a permanent deformation is produced. (2 Marks)
4. The simplest or smallest unit representative structure is known as \_\_\_\_\_ (2 Marks)
5. The Face Centered Cubic (FCC) unit cell consists of a net total of \_\_\_\_\_ atoms (2 marks)
6. Force divided by area is called \_\_\_\_\_ (2 marks)
7. In tensile tests, if the deformation is elastic, the stress-strain relationship is called \_\_\_\_\_ (2 marks)
8. \_\_\_\_\_ is defined as a ratio of increase in length to original length. (2 marks)
9. A vacancy is produced when an atom is \_\_\_\_\_ from normal site. (2 marks)
10. The boundary (line) separate between solid phase + liquid phase and solid phase in phase diagram is called \_\_\_\_\_ (2 marks)

**SECTION B (Total: 80 marks)****INSTRUCTIONS: Answer four (4) questions only****Please use the answer booklet provided.****Question 1**

- a.) Name five groups of material. (5 marks)
- b.) Predict the chemical formula  $Al_xO_y$  of the compound that results from the reaction between the elements Al and O. (4 marks)
- c.) Use energy level diagram to show how electrons of Potassium Atom (K) atom are distributed in a ground-state and state the electron-configuration notation. (5 marks)
- d.) Briefly cite the main differences between ionic, covalent and metallic bonding. (6 marks)

**Question 2**

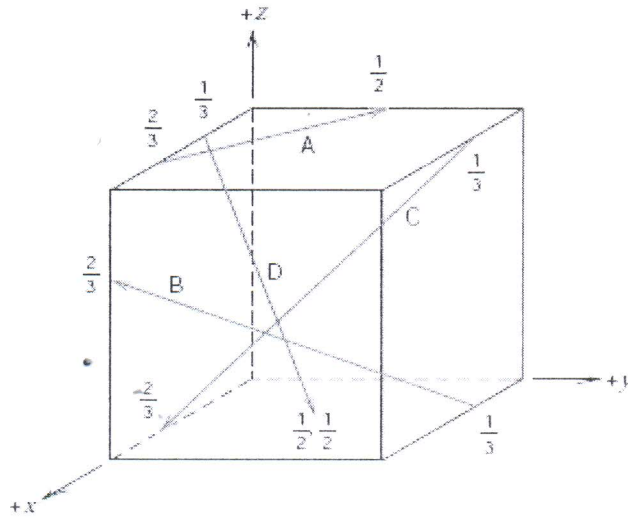
- a.) In the Crystal Systems arrangements, Iridium (Ir) atom, has an FCC crystal structure, a density of  $22.4 \text{ g/cm}^3$ , and an atomic weight of  $192.2 \text{ g/mol}$
- i. **Show** that the unit cell edge length 'a' for face-centered cubic crystal structure (FCC) and the atomic radius R is related through  $a = \frac{4R}{\sqrt{2}}$  with help of sketches. (5marks)
- ii. Calculate their atomic radius(R). (10 marks)

- b.) Besides basic cubic, there are other six types of crystal systems in Bravais lattices. List down other five (5) types of crystal systems in Bravais lattices.

(5 marks)

**Question 3**

- a.) Determine the miller indices for the direction shown in the following unit cell;



(12 marks)

- b.) **Show** that the atomic packing factor APF for FCC is 0.74.

(8 marks)

**Question 4**

- a.) Consider a cylindrical titanium wire of 3.0 mm in diameter and  $2.5 \times 10^4$  mm long. By assuming that the deformation is totally elastic, calculate its stress when a load of 500 N is applied.

(4 marks)

- b) The following data (Table 1) were collected from tensile test of a cylindrical specimen of cast iron that having a diameter of 12.8 mm and original gauge length is 50.800 mm.

Table 1: Data for tensile test of cast iron

| Strain (mm/mm) | Stress (MPa) |
|----------------|--------------|
| 0.0000         | 0            |
| 0.0010         | 57           |
| 0.0020         | 117.3        |
| 0.0030         | 179.5        |
| 0.0040         | 236.2        |
| 0.0050         | 267.3        |
| 0.0100         | 298.4        |
| 0.0200         | 320.9        |
| 0.0400         | 348.1        |
| 0.0600         | 359          |
| 0.0800         | 367.5        |
| 0.1000         | 369          |
| 0.1200         | 358.2        |
| 0.1350         | 348.1        |
| 0.1500         | 331          |
| 0.1650         | 282.8        |
|                | Fracture     |

i) Plot Stress Strain curve.

(10 marks)

ii) Determine the yield strength by 0.2% offset.

(2 marks)

iii) Calculate its ductility.

(4 marks)

**Question 5**

a.) Refer to equilibrium phase diagram in appendix 1, for 40wt% Ag -60wt% Cu at temperature 780°C.

i. Determine the maximum solubility of Copper (Cu) in Silver (Ag) and Silver (Ag) in Copper (Cu).

(5 Marks)

ii. Determine the eutectic composition and write the eutectic reaction, and show it in the phase diagram given in appendix 1

(5 Marks)

iii. Calculate the amount of each phases present

(6 Marks)

iv. Calculate the amount of  $\alpha$  and  $\beta$  at 778°C for 40% Ag-60% Cu.

(6 Marks)

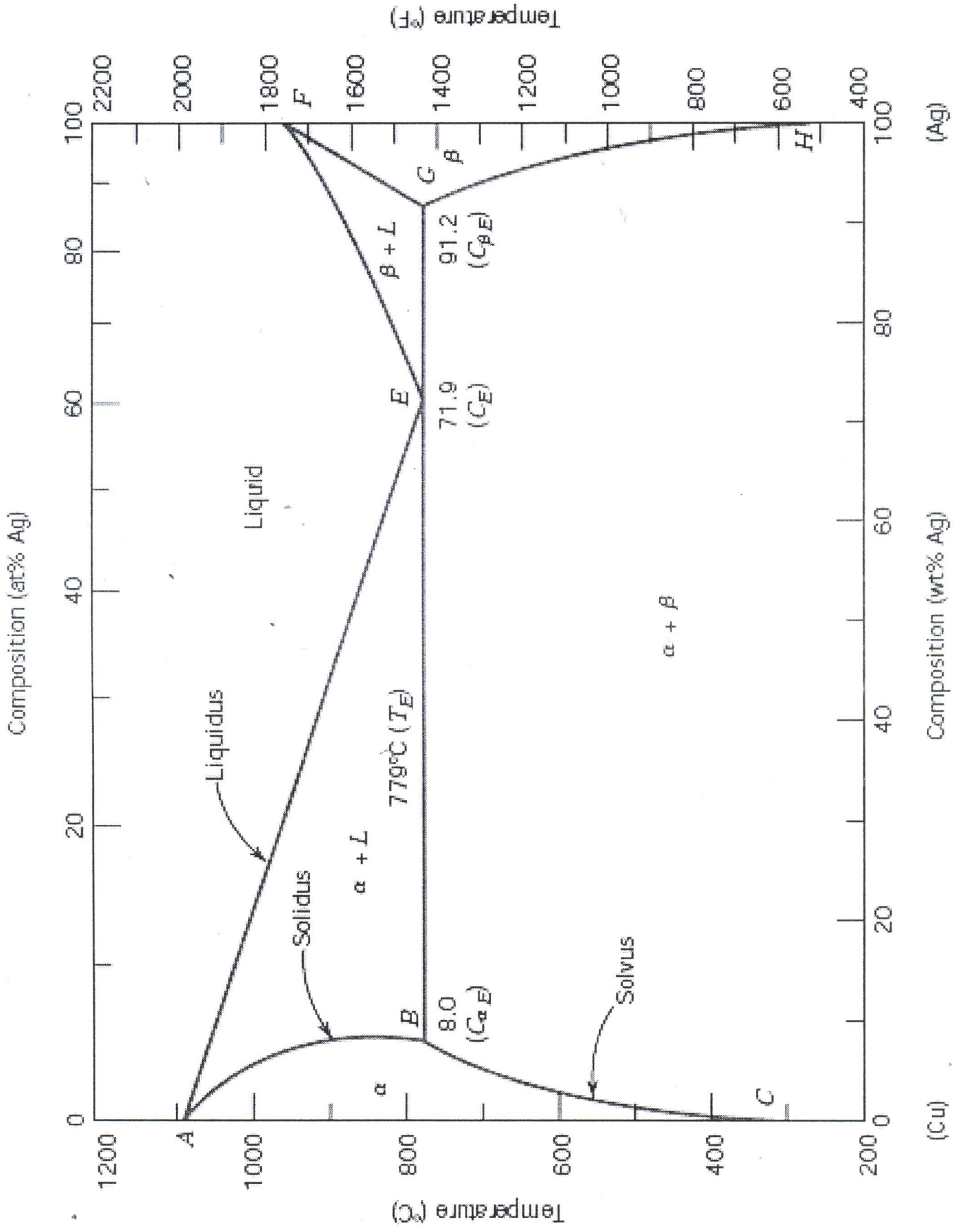
v. Sketch the microstructure of question (d).

(3 Marks)

**END OF QUESTION**

ANSWER SCREPT

APPENDIX 1 Cu-Ag phase diagram







## APPENDIX 3

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

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

$$V_c = a^3$$

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

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

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

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

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

$$a = 2r$$

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

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

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

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

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

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

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

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

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

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

