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SET B

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JANUARY 2010 SESSION

SUBJECT CODE	:	FTB 11102
SUBJECT TITLE	:	INTRODUCTION TO MATERIALS SCIENCE
LEVEL	:	BACHELOR
TIME / DURATION	:	9.00 am – 11.00 am (2 HOURS)
DATE	:	26 APRIL 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 SIX (6) questions. Answer FIVE (5) questions only.
6. Answer all questions in English.

THERE ARE 5 PAGES OF QUESTIONS, INCLUDING THIS PAGE AND 3 PAGES OF APPENDICES.

INSTRUCTION: Answer FIVE (5) questions only.

Question 1

(a) List **THREE (3)** types of stainless steel

(3 marks)

(b) Brass and bronze are the examples of copper alloys that widely used in industries. Describe shortly these two types of alloys.

(4 marks)

(c) Explain briefly the **TWO** basic materials regarding its characteristic and applications.

(7 marks)

(d) Using the abbreviated quantum number notation (s, p, d, f), write the electronic configurations of the following ions:

(i) S^{2-} (Atomic number for sulfur = 16)

(ii) Ba^{2+} (Atomic number for barium = 56)

(iii) Ge (Atomic number = 32)

(6 marks)

Question 2

(a) Calculate the volume of a face centered cubic (FCC) unit cell in terms of the atomic radius, R.

(4 marks)

(b) In fiber reinforced composites materials, there are several groups of fiber phases that usually used in industries. Describe briefly each of the fiber phases.

(6 marks)

(c) Indium has a tetragonal unit cell which the 'a' and 'c' lattice parameters are 0.459 and 0.495 nm, respectively.

(ii) If the atomic packing factor and atomic radius are 0.693 and 0.1625 nm, respectively, determine the number of atoms in each unit cell.

(iii) The atomic weight of Indium 114.82 g/mol; compute its theoretical density.

(10 marks)

Question 3

(a) Sketch a respective diagram showing Self-interstitials and Substitution impurity defect.

(4 marks)

(b) Calculate the energy for vacancy formation in silver, given that the equilibrium number of vacancies at 800°C is 3.6×10^{23} m^{-3}. The atomic weight is 107.9 $gmol^{-1}$ and its density is 9.5 gcm^{-3}. Given k is 8.62×10^{-5} $eVatom^{-1}K^{-1}$.

(10 marks)

(c) A maximum concentration of solute atoms that may dissolve in solvent to form a solid solution is called a solubility limit. Explain the three different solubility limits which are limited, unlimited and no solubility.

(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 as A,B and C.

(3 marks)

ii) Name point D

(1 marks)

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

(8 marks)

iv) Upon crossing the eutectic isotherm, the liquid transforms to α and β phases. Give the transformation equation to represent the reaction involved.

(2 marks)

v) Sketch the microstructure in α +L phase.

(2 marks)

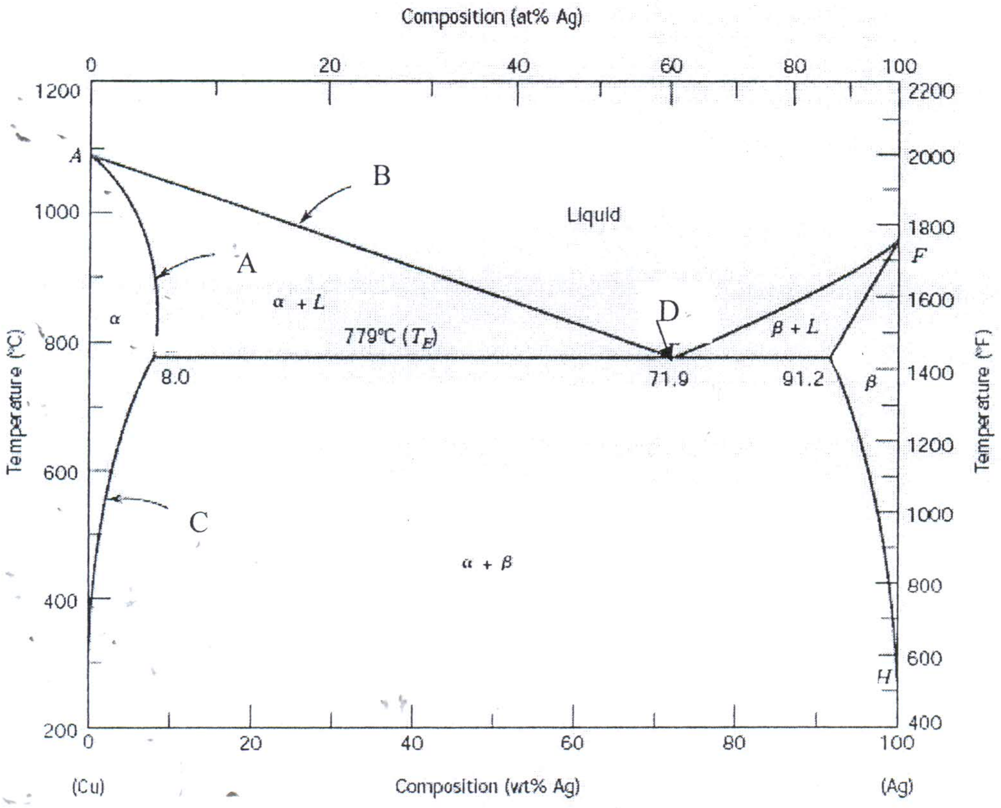

Figure 1: Cu-Ag Phase Diagram

(b) For a bronze alloy, the stress at which plastic deformation begins is 275 MPa, and the modulus of elasticity is 115 GPa.

What is the maximum load that may be applied to a specimen with a cross-sectional area of 325 mm^2 without plastic deformation?

(4 marks)

Question 5

(a) Discuss the advantages of metal matrix composites compared to the bulk metals and its alloys.

(5 marks)

(b) A metal wire is 2.5 mm diameter and 2 m long. A force of 12 N is applied and it stretches to 0.3 mm. Assume the material is elastic. Determine the following.

a. the stress in the wire σ

b. the strain in the wire ε.

(5 marks)

(c) Using the diagram in Figure 1, for an iron-carbon alloy of eutectoid composition, specify the nature of the final microstructure (in terms of microconstituents present and approximate percentages) of a small specimen that has been subjected to the following time-temperature treatments. In each case, assume that the temperature of the specimen begins at 760°C. Sketch the thermal history for all three cases in Figure 1 of Appendix 1.

(i) Rapidly cooled to 350°C, hold for 10^4 s, and quench to room temperature.
(ii) Rapidly cooled to 250°C, hold for 100 s, and quench to room temperature.
(iii) Rapidly cool to 650°C, hold for 20 s, rapidly cool to 400°C, hold for 10^3 s, and quench to room temperature.

(10 marks)

Question 6

(a) List **FOUR (4)** applications of ferrous metals that you encounter everyday.

(6 marks)

(b) A Brinell hardness measurement, using a 10 mm diameter indenter and 500 kg load, produced an indentation of 4.5 mm on an aluminum plate. Sketch the side view of the indentation. Determine the Brinell hardness number (BHN) of the aluminum plate.

(6 marks)

(c) Describe the differences between Izod and Charpy Impact tests.

(8 marks)

END OF QUESTION

Appendix 1

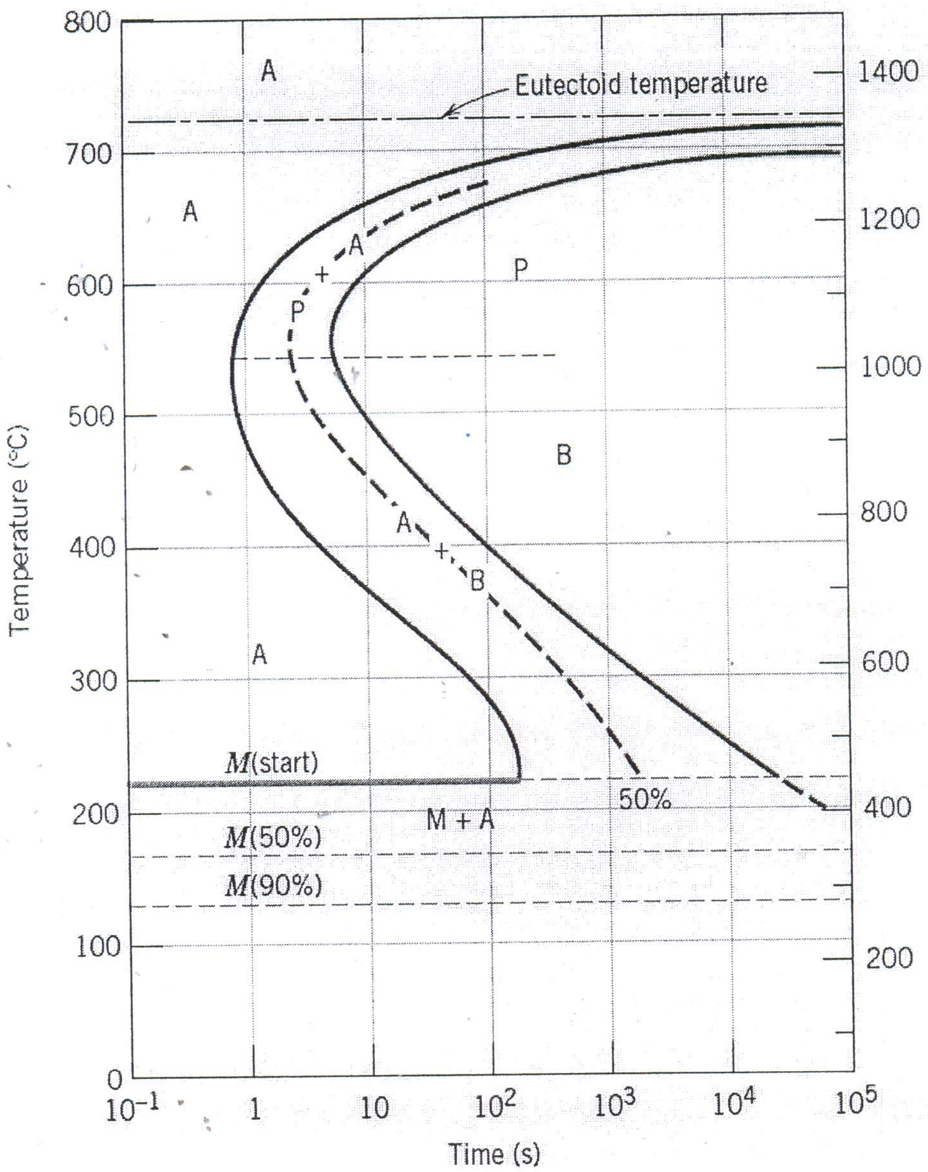

Figure 1: TTT Diagram

Key: 29 – Atomic number; Cu – Symbol; 63.54 – Atomic weight

Metal | Nonmetal | Intermediate

IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII	VIII	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	0
1 H 1.0080																	2 He 4.0026
3 Li 6.939	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.183
11 Na 22.990	12 Mg 24.312											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.064	17 Cl 35.453	18 Ar 39.948
19 K 39.102	20 Ca 40.08	21 Sc 44.956	22 Ti 47.90	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.922	34 Se 78.96	35 Br 79.91	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (99)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.4	47 Ag 107.87	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30
55 Cs 132.91	56 Ba 137.34	Rare earth series	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.98	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	Acti-nide series															

Rare earth series	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.92	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
Actinide series	89 Ac (227)	90 Th 232.04	91 Pa (231)	92 U 238.03	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (249)	99 Es (254)	100 Fm (253)	101 Md (256)	102 No (254)	103 Lw (257)

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

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

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

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

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

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

$$a_{sc} = 2r$$

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

$$m_\alpha\, phase = \frac{m_\beta - m_x}{m_\beta - m_\alpha} x Total\ Mass$$

$$m_\beta\, phase = \frac{m_x - m_\alpha}{m_\beta - m_\alpha} x Total\ Mass$$

$$m_L\, phase\% = \frac{m_s\% - m_x\%}{m_s\% - m_{L\%}} x100$$

$$m_s\, phase\% = \frac{m_x\% - m_L\%}{m_s\% - m_{L\%}} x100$$

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

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

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

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

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

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

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

$$\%elongation = \frac{\Delta l}{l_o} x100\%$$

$$\%\ area\ reduction = \frac{\Delta A}{A_o} x100\%$$

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

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