UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER 1
SESSION 2009/2010

SUBJECT NAME	: MATERIAL SCIENCE
SUBJECT CODE	: DDA 2053
COURSE	: 2 DDX/ DDM
EXAMINATION DATE	: NOVEMBER 2009
DURATION	: 3 HOURS
INSTRUCTION	: ANSWER **FIVE (5)** FROM SIX(6) QUESTIONS.

THIS PAPER CONTAINS EIGHT (8) PAGES

Q1 (a) Define crystal structure, amorphous material and unit cell.

(3 marks)

(b) List THREE (3) component of materials classification and give ONE (1) example for each class.

(3 marks)

(c) Sodium at 20°C is BCC and has a lattice constant of 0.42906 nm. Calculate a value for the atomic radius of a sodium atom in nanometers.

(3 marks)

(d) Sketch the crystallographic planes and direction in simple cubes.

(i) $(3\bar{2}1)$, $(\bar{2}32)$, $(\bar{3}3\bar{1})$, $(30\bar{2})$
(ii) $[321]$, $[0\bar{2}1]$, $[2\,1\,\bar{2}]$

(7 marks)

(e) Determine the Miller indices of the planes in Figure Q1(e).

(4 marks)

Q2 (a) What is mechanical properties? Give THREE (3) examples of mechanical testing.

(5 marks)

(b) List THREE (3) technological devices that use magnetic properties in their application.

(3 marks)

(c) Optical properties is a material response when exposed to electromagnetic radiation and in particular to visible light. Give ONE (1) comparison between the following optical properties;

(i) Transparent materials
(ii) Translucent materials
(iii) Opaque materials

(6 marks)

(d) A 0.505 m. diameter aluminum alloy test bar is subjected to a load of 25,000 N. If the diameter of the bar is 0.490 m. at this load, determine

(i) The engineering stress and strain
(ii) The true stress and strain.

(6 marks)

Q3 (a) Define and give THREE (3) examples of advance ceramic materials.

(5 marks)

(b) What is corrosion? Give FOUR (4) factors that affect the corrosion of metals.

(6 marks)

(c) Distinguish between thermoplastic, thermoset and elastomer.

(6 marks)

(d) List THREE (3) types of polymer processing

(3 marks)

Q4 (a) What is heat treatment? Give TWO (2) important of doing this process for metal and its alloy.

(4 marks)

(b) Describe briefly the following heat treatment process

(i) Annealing
(ii) Normalizing
(iii) Quenching
(iv) Tempering

(8 marks)

(c) Refer to Figure Q4 (c), consider the binary eutectic copper-silver phase diagram and make phase analyses of an 88 wt % Ag–12 wt% Cu alloy at the temperature 800°C. In the phase analyses, include:

(i) The phases present
(ii) The chemical compositions of the phases
(iii) The amount of each phase
(iv) Sketch the microstructure in 2 cm diameter circular fields.

(8 marks)

Q5 (a) Describe the properties of low, medium, and high carbon steel

(6 marks)

(b) Ferrous alloy is those of which iron is the prime constituent. Give THREE (3) factors why ferrous alloys are widely used.

(6 marks)

(c) Compare between stainless steel and bronze in terms of composition, property and application.

(8 marks)

Q6 (a) Describe and illustrate the following types of point imperfection that can be present in metal lattices;

(i) vacancy, and
(ii) interstitial

(6 marks)

(b) Explain briefly THREE (3) factors that influence diffusivity

(6 marks)

(c) A gear of 1018 steel (0.18 wt% C) is to be gas-carburized at 927°C. Calculate the time necessary to increase the carbon content to 0.35 wt% at 0.40 mm below the surface of the gear. Assume the carbon content at the surface to be 1.15 wt% and that the nominal carbon content of the steel gear before carburizing is 0.18 wt%. D (C in γ-iron) at 927°C = 1.28×10^{-11} m^2/s. (Use Table Q6 (c) if necessary)

(8 marks)

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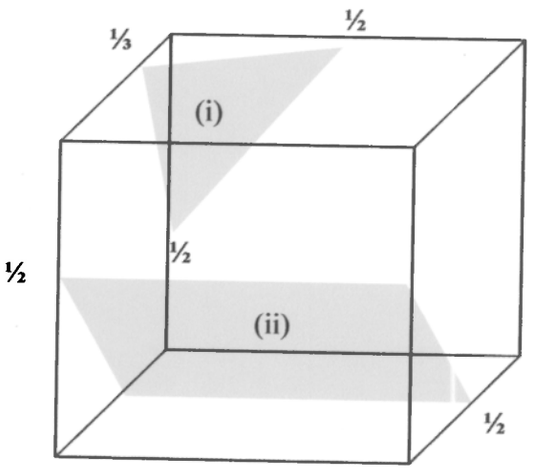

Figure O1 (e)

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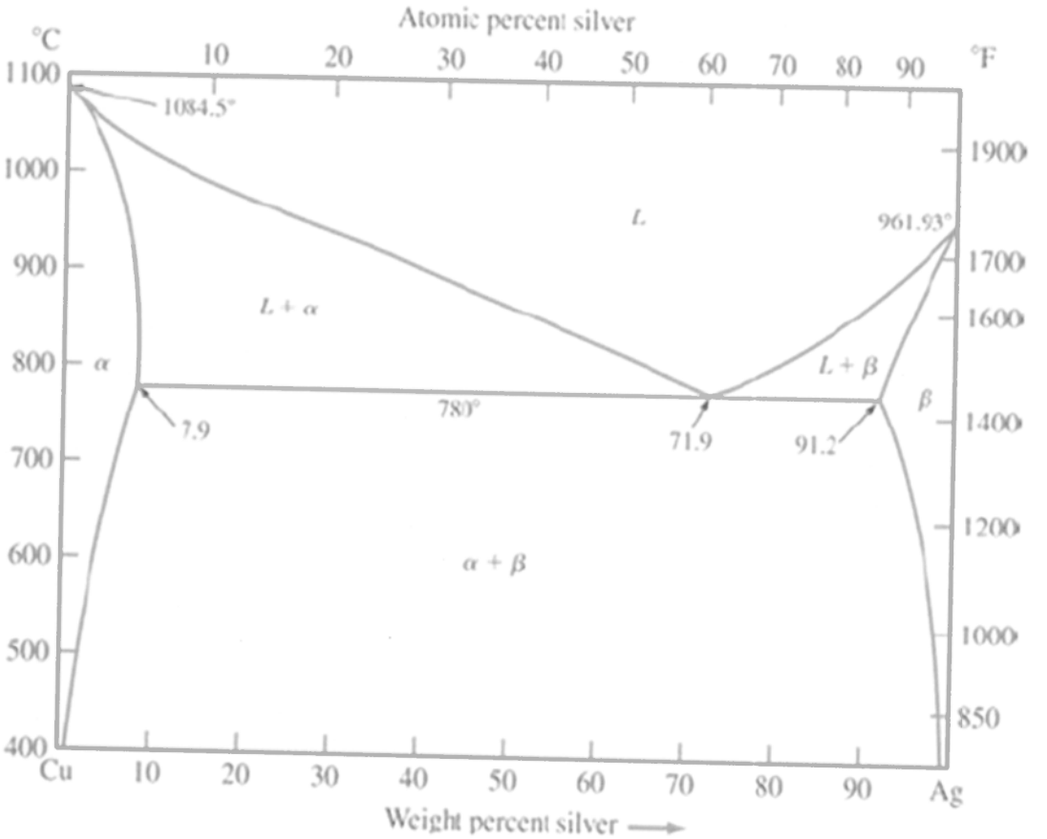

Figure Q4 (c)

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Table Q6(c)

Table of the error function

z	erf z	z	erf z	z	erf z	z	erf z
0	0	0.40	0.4284	0.85	0.7707	1.6	0.9763
0.025	0.0282	0.45	0.4755	0.90	0.7970	1.7	0.9838
0.05	0.0564	0.50	0.5205	0.95	0.8209	1.8	0.9891
0.10	0.1125	0.55	0.5633	1.0	0.8427	1.9	0.9928
0.15	0.1680	0.60	0.6039	1.1	0.8802	2.0	0.9953
0.20	0.2227	0.65	0.6420	1.2	0.9103	2.2	0.9981
0.25	0.2763	0.70	0.6778	1.3	0.9340	2.4	0.9993
0.30	0.3286	0.75	0.7112	1.4	0.9523	2.6	0.9998
0.35	0.3794	0.80	0.7421	1.5	0.9661	2.8	0.9999

EQUATION

$$\text{Concentration gradient} = \frac{dC}{dx} = \frac{C_A - C_B}{x_A - x_B}$$

$$\frac{C_x - C_o}{C_s - C_o} = 1 - \text{erf}\left(\frac{x}{2\sqrt{Dt}}\right)$$

$$\frac{x}{2\sqrt{Dt}} = z = \text{constant}$$

$$J = -D\frac{dC}{dx}$$