# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESSION 2012/2013

| | | |
|---|---|---|
| COURSE NAME | : | MATERIALS SCIENCES |
| COURSE CODE | : | DAM 20803 |
| PROGRAMME | : | 2 DAM |
| EXAMINATION DATE | : | OCTOBER 2012 |
| DURATION | : | 3 HOURS |
| INSTRUCTIONS | : | ANSWER **FIVE (5)** QUESTIONS FROM **SIX (6)** QUESTIONS |

THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES

**Q1** a) What are the main classes of engineering materials?

(2 marks)

b) Define TWO (2) types of solid materials. Give an example for each type and sketch an appropriate structure.

(7 marks)

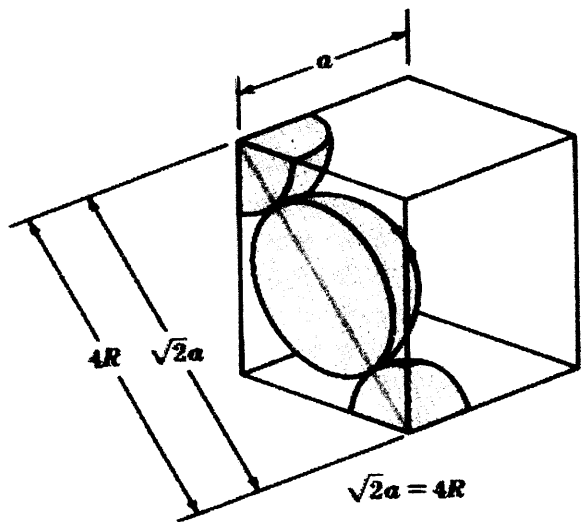
c) How many atoms per unit cell are there in the FCC crystal structure?

(2 marks)

d) Strontium is FCC and has an atomic radius of 0.215 nm. Calculate a value for its lattice constant in nanometers.

(3 marks)

e) Copper has the FCC crystal structure with atomic radius, R = 0.1278nm. Assume the atoms to be hard spheres and packed as close together as possible along the FCC unit cell cross-section. Calculate the theoretical volume density of copper in $mg/m^3$. **(Atomic mass of Cu = 63.54 g/mol)**




(6 marks)

**Q2** a) Sketch with complete label for the following directions and crystal planes in cubic unit cell:

(i) $[1\ \bar{1}\ \bar{2}]$, $[1\ 2\ \bar{2}]$

(ii) $(1\ 0\ \bar{2})$, $(3\ \bar{1}\ 2)$,

( 4 marks)

b) A tensile specimen of cartridge brass sheet has a cross section of 0.350 cm × 0.125cm and a gage length of 2.00 cm. Calculate the engineering strain that occurred during a test if the distance between gage markings is 2.55 cm after the test

(3 marks)

c) Calculate the engineering stress in SI units on bar 37 cm long and having a cross section of 4.25 mm X 12.0 mm that is subjected to load of 2800 kg.

(3 marks)

d) **Define** the hardness. State **TWO (4)** common types of hardness test.

(2 marks)

e) Twenty-cm- long rod with a diameter of 0.250 cm is loaded with a 5000 N weight. If the diameter decreases to 0.210 cm, at this load determine:

i) The engineering stress and strain

ii) The true stress and strain

(8 marks)

**Q3** a) List down the **FOUR** types of crystal imperfections

(4 marks)

b) Describe and illustrate the following imperfections:

i) Frenkel imperfection

ii) Schottky imperfection

(6 marks)

c) A gear made of 1020 steel (0.20 wt % C) is to be gas-carburized at 927°C (1700°F). Calculate the carbon content at 0.90 mm below the surface of the gear after a 4.0-hour carburizing time. Assume the carbon content at the surface of the gear is 1.00 wt %. *D* (C in ë iron) at 927°C = $1.28 \times 10^{-11}$ $m^2/s$. **(Refer Table 1)**

(10 marks)

**Q4** a) Consider an alloy containing 60 wt% Pb (refer **Figure 1**) in equilibriumcondition. Make analysis at (a) 183°C + ΔT and (b) 183°C - ΔT for the system below which include the following:

i) What phases are present?

ii) State the chemical composition for each phase in each situation

iii) Determine the weight fraction of α in each phase

iv) Sketch the microstructure for (b) 183°C - ΔT **only**

(20 marks)

**Q5** a) Explain briefly 'high carbon steel', in terms of the following:

i) carbon content and other related elements

ii) mechanical properties (list three properties)

iii) engineering applications (three examples)

(8 marks)

b) Briefly explain why stainless steels have good corrosion resistance property

( 2 marks)

c) Differentiate between ferrous and non ferrous metals. For each one, name two metals.

(4 marks)

d) Name the two copper alloys. For each one, name their alloying elements and one related products.

( 6 marks)

Q6 a) Explain briefly traditional and advanced ceramics. Include one example for each type

( 6 marks)

b) Show how the basic process of clay products is made.

( 3 marks)

c) Refractories are ceramic materials. List three of their characteristics and list two applications of the refractory materials.

( 5 marks)

d) List three differences between thermoset and thermoplastics materials. (you can use table to show differences)

(6 marks)

**FINAL EXAMINATION**

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## TABLE Q3 (C)

**Table 1: Tabulation of Error Function Values**

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

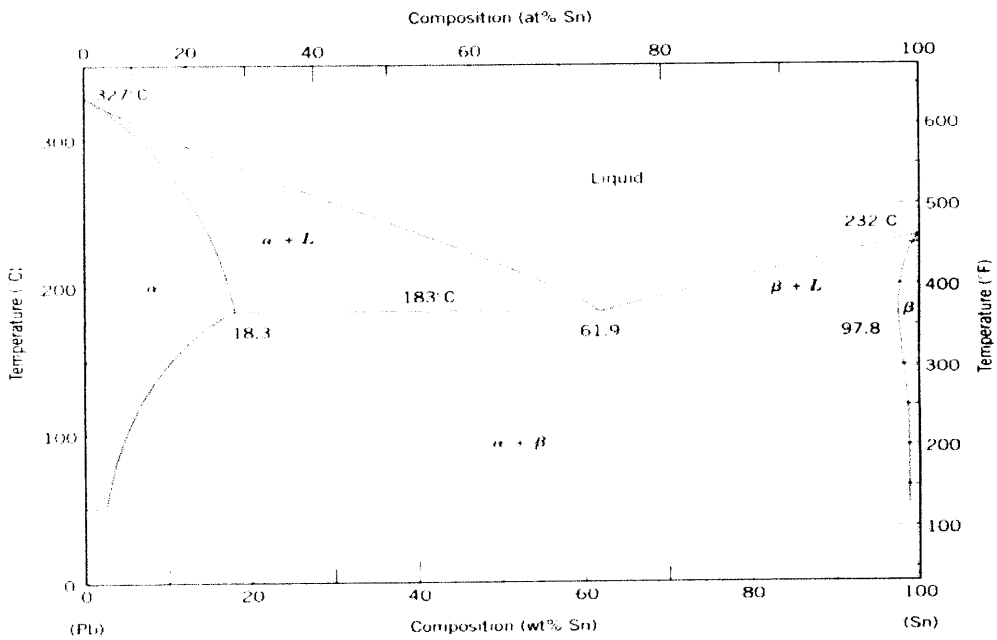


**FIGURE Q4**

**Figure 1: The Pb – Sn equilibrium system**