NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

APPLIED PHYSICS DEPARTMENT

SPH 4104 MATERIALS SCIENCE

SUPPLEMENTARY EXAMINATIONS

BSc HONOURS PART IV : MAY 2001 DURATION : 3 HOURS

ANSWER ALL PARTS OF QUESTION 1 IN SECTION A AND ANY THREE QUESTIONS FROM SECTION B. SECTION A CARRIES 40 MARKS AND SECTION B CARRIES 60 MARKS.

SECTION A

1. (a) Make sketches of the (020) and (010) planes of a simple cube and determine their planar densities. [5]

(b) Show that the packing factor for an FCC unit cell is 0.74. [5]

(c) (i) Define 'resolved sheer stress'. [3]

(ii) A force of 3800N is applied in the [111] direction of tin. What is the resolved force in the [110] direction. [4]

(d) The melting point of A is 400°C and that of B is 600°C. The eutectic temperature and composition of an AB alloy is at 250° C and 40% A respectively. The maximum solubility of A in B is 15% and that of B in A is 10% while the minimum solubilities are 5% and 2% respectively. Draw on a graph paper a fully labelled equilibrium diagram. Mark all phase spaces. [10]

(e) Write brief notes on

(i) nitriding
(ii) carburizing
(iii) fatigue life
(iv) specific strength. [8]

(f) (i) What is the relation between the Young's modulus, E ; Bulk modulus B; and the shear modulus G ? [3]

(ii) Define the Poisson's ratio. [2]

SECTION B

2. (a) Define the following terms

(i) Self-diffusion
(ii) Grain boundary diffusion
(iii) Volume diffusion [6]

State Fick's second law of diffusion and give two examples of its application. [8]

4) A 1 mm sheet of FCC iron is used to contain nitrogen in a heat exchanger at 1200^0C. The concentration of nitrogen at one surface is 0,04 atomic percent and the concentration at the second surface is 0,05 atomic percent. Determine the flux of nitrogen through the foil in atoms $m^{-2}.5^{-1}$. $D_o = 3.4 \times 10^{-7}$; Activation energy Q = 606696J
R = 8,314 $Jm^{-1} K^{-1}$ [6]

3. (a) List 5 parameters that can be obtained from a tensile test. [5]

(b) Show that true strain is given by $\epsilon_t = \ln\left(\frac{A_o}{A}\right)$ [5]

(c) A steel cable 31 mm in diameter and 15,25m long is to lift a 0.2 MN load. What is the length of the metal during lifting. (The modulus of elasticity of steel is 210 GP. [5]

(d) Explain why the theoretical and experimental values of the yield stress have such a large discrepancy? [5]

4. (a) (i) Draw a fully labelled creep curve. Explain what happens at each stage. [10]

(ii) Of what importance is it ?

(b) (i) With the aid of absorbed energy (in impact) versus temperature curve, explain what the glass transition temperature is. [5]

(iii) Explain the effect of notches in BCC and FCC iron. [5]

5. (a) State the conditions for complete solubility ? [4]
Explain the following with regard to the strengthening of alloys.

(i) Solid solution strengthening [4]

(ii) grain boundary strengthening [4]

(b) A test bar 12.83 mm in diameter with a 50 mm gage length is loaded elastically with 156 kN is stretched 0,356 mm. Its diameter is 12.80 mm under load.

(i) What is the bulk modulus and [4]

(ii) The shear modulus of the bar ? [4]

6. (a) (i) Distinguish hardness from toughness of a material. [5]

(ii) In the Rockwell hardness test, a minor load is always applied before the major load. Why? [3]

(iii) Why are hardness tests frequently done as compared to other tests? [3]

at are the advantages and disadvantages of the following non-destructive tests?

(i) ultrasonic testing
(ii) radiographic testing and
(iii) magnetic particle testing. [9]

END OF PAPER