MSH 453

Time : 3 Hours   Max. Marks : 70

Instructions : 1) **Scientific** *calculator may be allowed.*
              2) *Answer **all** questions.*

1. a) Describe the different types of defects in crystalline materials.

   b) Obtain an expression for concentration of vacancies in a metal at thermal equilibrium. **(12+8)**

                    OR

2. a) Describe the atomic models for interstitial diffusion and vacancy diffusion in solid matrix.

   b) At 900°C, what is the time required to carburize steel with an initial composition of 0.2% carbon at a depth of 0.2 mm ? Assume a constant surface concentration of 1.4% carbon due to the carburizing atmosphere. Given $D_o = 0.7 \times 10^{-4}$ m^2/sec. Q = 157 kJ/mole. **(14+6)**

3. a) Distinguish between elastic, anelastic and viscoelastic behaviour.

   b) Describe the atomic model of elasticity and discuss how the Young's modulus of a material is connected to the nature of chemical bonding in it. **(8+12)**

                    OR

4. a) Discuss the cohesive and brittle fracture strengths of materials.

   b) Define Griffith's law and correlate the critical length of the crack in a material to the applied tensile stress. **(10+10)**

5. a) Derive an expression for critical resolved shear stress and show that it is about one sixth of the shear modulus according to the perfect crystal model. Compare this with theoretical resolved stress in a real crystal.

b) Define creep and describe the mechanism of creep in materials. What is the effect of temperature on creep ?   **(10+10)**

OR

6. a) Describe the role of dislocation in the plastic deformation of crystalline materials. Explain work hardening.

b) Describe the role of grain boundaries in strengthening crystalline materials against yield at low temperature of deformation.

c) For a poly crystalline material the yield strength increases from 120 MPa to 220 MPa when the grain size is decreased from 0.04 mm to 0.01 mm. What would be the yield strength of this material if its ASTM grain size number is 8 ?

(10+5+5)

7. Answer the following. **Each** question carries **two** marks.   **(2×5=10)**

a) State Fick's laws of diffusion and identify the terms.

b) Activation energy for a vacancy production in a metal lattice is 1.5 eV. Estimate the number of such defects at room temperature.

c) How can materials be protected against fracture ?

d) Identify the slip system in BCC crystal.

e) What is the effect of grain size on dislocation motion ?

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