

# RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College under University of Calcutta)

M.A./M.SC. THIRD SEMESTER EXAMINATION, DECEMBER 2012

SECOND YEAR

APPLIED CHEMISTRY

Date : 15/12/2012

Time : 11.00 am – 1.00 pm

Paper : XIII

Full Marks : 50

**[Use separate Answer book for each group]**

## Group – A

**Answer any five questions :**

[5×5]

1. a) Give a graphical representation of stress-strain behavior of ductile and brittle material.  
b) In linear elastic region of stress-strain graph compute the value of modulus of resilience.  
c) A cylindrical specimen of steel having an original diameter of 12.8 mm (0.505 in.) is tensile tested to fracture and found to have engineering fracture strength  $\sigma_f$  of 460 MPa (67,000 psi). If its cross-sectional diameter at fracture is 10.7 mm (0.422 in.), determine:  
(i) The ductility in terms of percent reduction in area.  
(ii) The true stress at fracture. [1+1+3]
2. a) Illustrate the Wiedemann –Franz law.  
b) What is thermal stress?  
c) For copper, the heat capacity at constant volume at 20 K is 0.38 J/mol-K, and the Debye temperature is 340 K. Estimate the specific heat (a) at 40 K and (b) at 400 K.  
Given, atomic wt of Cu =63.55 gm. [1+1+3]
3. a) What is “Corrosion penetration rate” (CPR)?  
b) Express cell potential in terms of concentration and temperature?  
c) One half of an electrochemical cell consists of a pure nickel electrode in solution of  $\text{Ni}^{+2}$  ions; the other is a cadmium electrode immersed in a  $\text{Cd}^{+2}$  solution. If the cell is a standard one, write the spontaneous overall reaction and calculate the voltage that is generated. Given, Standard Electrode Potential  $V^0$  (V) of Ni and Cd are -0.250 and -0.403 respectively. [1+1+3]
4. a) Why does the dielectric constant of most materials go down with increasing electrical frequency?  
b) Consider a parallel-plate capacitor having an area of  $6.45 \times 10^{-4} \text{ m}^2$  and a plate separation of  $2 \times 10^{-3} \text{ m}$  across which a potential of 10 V is applied. If a material having a dielectric constant of 6.0 is positioned within the region between the plates, calculate the capacitance and the magnitude of the charge stored on each plate. Given  $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$  [1+4]
5. a) What is the distinction between electronic and ionic conduction?  
b) Will Zn act as a donor or acceptor when added to the compound semiconductor GaAs? Why?  
c) For intrinsic gallium arsenide, the room-temperature electrical conductivity is  $10^{-6} (\Omega\text{-m})^{-1}$ , the electron and hole mobilities are, respectively, 0.85 and  $0.04 \text{ m}^2/\text{V-s}$ . Compute the intrinsic carrier concentration  $n_i$  at room temperature. [1+1+3]

6. a) Cite the major differences between ferromagnetic and ferrimagnetic materials.  
 b) Calculate (i) the saturation magnetization and (ii) the saturation flux density for nickel, which has a density of  $8.90 \text{ g/cm}^3$ .  
 [given : atomic weight of nickel =  $58.71 \text{ g/mol}$ , atomic magnetic moment for Ni =  $0.6 \mu_B$ ,  $\mu_B = 9.27 \times 10^{-24} \text{ A-m}^2$ ].

[1+4]

7. a) Briefly discuss the similarities and differences between photons and phonons.  
 b) The fraction of non-reflected light that is transmitted through a 200 mm thickness of glass is 0.98. Calculate the absorption coefficient of this material.

[2+3]

### Group-B

8. Write short note on the following topics (answer any four questions)

$[2\frac{1}{2} \times 4]$

- a. X ray diffraction (XRD)
- b. Field emission scanning electron microscope (FESEM)
- c. X ray photoelectron spectroscopy (XPS)
- d. Atomic Force Microscopy (AFM)
- e. Scanning Tunnelling Microscopy (STM)

9. Answer any three questions

[5×3]

- a. What is nanomaterial? Classify the different synthesis techniques of nanomaterials and give some examples. Briefly describe the Sol –Gel synthesis technique of  $\text{SiO}_2$  nanoparticles. [ $\frac{1}{2} + 1\frac{1}{2} + 3$ ]
- b. Write down the Euler's theorem of polygon. From this theorem calculate the numbers of pentagon and hexagon associated with a Fullerene ( $\text{C}_{60}$ ) molecule. [1+4]
- c. What is Carbon nanotube? Briefly classify the different types of CNTs. Derive the expression of diameter and Chiral angle of a (n, m) carbon nanotube. [ $\frac{1}{2} + 1\frac{1}{2} + 3$ ]
- d. Define melting point and cohesive energy. Derive the expression of melting point of a spherical nanoparticle. [1+4]
- e. What is density of states? Write down the general relation of density of states with respect to different dimensions and give their graphical representation. [1+4]

