

RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

M.A./M.Sc. SECOND SEMESTER EXAMINATION, MAY 2017

FIRST YEAR [BATCH 2016-18]

APPLIED CHEMISTRY [Material Science-I]

Date : 22/5/2017

Time : 11 am – 1 pm

Paper : VIII

Full Marks : 50

Group – A

(Answer any five questions)

[5×5]

1. a) What is the difference between crystal structure and crystal system of solids? Mention different crystal systems. [3]
b) What are the symmetry elements present in a crystal system? [2]
2. a) Draw $(\bar{2} 0 1)$ Plane and $[\bar{1} \bar{2} \bar{1}]$ direction in a Cubic crystal. [2]
b) Define packing fraction. Calculate the packing fraction of a FCC unit cell. [3]
3. State the Bragg's law for X-Ray Diffraction. Why the XRD pattern of an amorphous solid shows broad hump instead of sharp peak? Explain the reason of lower angle peak shifting for doping of a larger atom in the host lattice. [1+2+2]
4. a) How cation : anion radii ratio determine the coordination geometry and configuration of ionic solids? [2]
b) The first peak in the powder in the powder X-ray diffraction pattern of a FCC metal appears at a Bragg angle of 19.2° . The wavelength of $\text{Cu} - K_\alpha$ radiation used is 0.154 nm . Calculate the lattice parameter in nm. The full width at half maximum (FWHM) of the peak is 0.35° . Calculate the crystallite size of the sample in nm. [3]
5. a) State briefly the Pauling 2nd rule for coordination polyhedron. Show that MgO has the sodium chloride crystal structure and calculate the density of MgO. $(r_{\text{Mg}^{2+}} = 0.066 \text{ nm}$ and $r_{\text{O}^{2-}} = 0.132 \text{ nm})$. [1+2]
b) Calculate the radius of FCC Iridium atom having density 22.4 gm/cc and atomic weight 192.2 gm/mol . [2]
6. a) Write the positions of divalent cation and tri-valent cations in the tetrahedral voids and octahedral voids of MgAl_2O_4 spinel. [2]
b) An X-ray diffractometer recorder chart for an element that has either BCC or the FCC crystal structure shows diffraction peaks at the following 2θ angles (in degree) $40, 58, 73, 86.8, 100.4$ and 114.7 . The wavelength of the incoming X-ray used was 0.154 nm . [3]
i) Determine the crystal structure of the element.
ii) Determine the lattice constant of the element.
7. a) What is vacancy diffusion and interstitial diffusion? Explain with example. [2]
b) Briefly explain the concept of steady state diffusion with concentration and position graph. [3]
8. a) Write and explain the factors that influence the diffusion (mainly temperature). What is activation energy? [3]

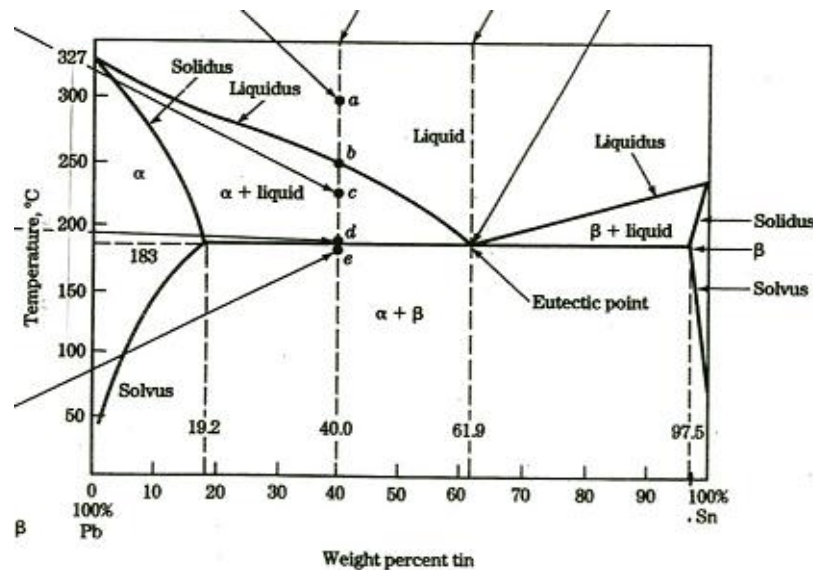
- b) The diffusion coefficient for copper in aluminium at 600 and 800°C are 4.8×10^{-14} and $5.6 \times 10^{-13} \text{ m}^2/\text{s}$ respectively. Determine approximate time at 600°C that will produce same diffusion result as a 12 hour heat treatment at 800°C. [2]

Group – B

(Answer any five questions)

[5×5]

9. Define Triple point in single component system. Calculate the degree of freedom of the triple point in a single component system. Why the ductility of intermetallic compounds are less in comparison with pure metal? [1+2+2]
10. Explain the effect of alloying elements of TTT diagram. Define the terms eutectic, eutectoid, peritectic, peritectoid, monotectic reaction. [2.5+2.5]
11. Write short notes on (any two) : [2×2.5]
- Hard working and Cold Working of metal
 - Tempering of steel
 - Nucleation and grain growth
12. a) A lead-tin (Pb-Sn) alloy contains 64 wt% proeutectic α and 36 wt% eutectic $\alpha + \beta$ at 183°C shown in fig. Calculate the composition of the alloy (wt% of Sn and Pb = ?) [2]



- Briefly describe Hume Rothery rule for the degree of solid solubility. [1.5]
 - Why tempering is important? [1.5]
13. Write a short note on Iron-Carbon phase diagram & show the invariant reactions which occurs in this system. What is martensite transformation? [2+2+1]
14. a) Calculate the percentage crystallinity of a branched polyethylene that has a density of 0.935 gm/cm^3 . The density for the totally amorphous material is 0.885 gm/cm^3 & density of crystalline phase is 0.988 gm/cm^3 . [2]
- b) State one application of following ceramics :
- Mullite
 - Alumina
 - Partially stabilized zirconia
 - Yttrium aluminium garnet.
- [2]

c) Match the correct options :

[1]

Materials	Applications
P. BaTiO ₃	1. Shape Memory alloy
Q. YBa ₂ Cu ₃ O ₇	2. Oxygen sensor
R. Ni _{0.46} Ti _{0.46}	3. Piezoelectric
S. ZrO ₂	4. Super conductor

15. a) Classify the Engineering materials and mention one important properties of each category. [2]

b) Write the differences between addition polymerisation and condensation polymerisation with suitable example. [2]

c) State important properties of high tension electrical insulator. [1]

16. a) The density and associated percent crystallinity for two polypropylene materials are as follows : [1.5+1.5]

Density (gm/cc)	Crystallinity (%)
0.904	62.8
0.895	54.4

i) Compute the density for the totally amorphous & density of crystalline phase for the polypropylene?

ii) Determine the density of a specimen having 74.6% crystallinity?

b) What is polymorphic transformation? Write the polymorphic transformation for silica. [2]

_____ × _____