

# RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. THIRD SEMESTER EXAMINATION, DECEMBER 2016

SECOND YEAR [BATCH 2015-18]

INDUSTRIAL CHEMISTRY [Honours]

Date : 13/12/2016

Time : 11 am – 3 pm

Paper : III

Full Marks : 75

[Use a separate Answer Book for each Group]

## Group - A

(Answer any four questions)

[4×5]

1. a) Classify the various types of materials with example.  
b) Distinguish between amorphous and crystalline solid with examples.  
c) Draw  $(0\bar{1}2)$  plane and  $[120]$  direction in a cubic crystal. [2+2+1]
2. a) Briefly discuss on different nanostructure materials.  
b) Describe the Sol-gel technique for preparation of  $\text{SiO}_2$  nanoparticles. [2+3]
3. a) Write Pauling 2<sup>nd</sup> rule for coordination polyhedral.  
b) Calculate the  $\frac{r}{R}$  ratio in a tetra hedral void where  $r$  = cationic radius,  $R$  = anionic radius.  
c) Cobalt has HCP crystal structure, an atomic radius of 0.1253 nm and  $\frac{c}{a}$  ratio of 1.623. Compute the volume of the unit cell for Cobalt. [1+2+2]
4. a) Write the difference between single crystalline and poly crystalline material.  
b) Determine the expected diffraction angle for the first order reflection from the (310) set of planes for BCC chromium having atomic radius 0.1249 nm, when monochromatic radiation of wave length 0.0711 nm is used. [2+3]
5. a) What is polymorphic transformation? Give example.  
b) Calculate the concentration of vacancies in copper at 25<sup>0</sup>C. What temperature will be needed to heat treat copper such as that the concentration of vacancies produced will be 1000 times more than the equilibrium concentration of vacancies at room temperature? Assume that 20,000 cal are required to produce a mole of vacancies in copper. [Given Cu has FCC crystal structure & lattice parameter is 0.36151 nm and  $R = 1.987 \text{ cal}/(\text{mol-K})$  or  $8.31 \text{ Joules}/(\text{mol-K})$ ] [1+4]
6. a) Write down Hall Petch equation and mention its importance on nano crystalline materials.  
b) What is the yield strength of a material with a grain size of 10  $\mu\text{m}$ ? The yield strength of a single crystal of this material is 80 GPa and its Hall Petch constant is  $0.6 \text{ NM.m}^{-3/2}$ . [2+3]

## Group - B

(Answer any four questions)

[4×5]

7. a) Briefly discuss the Zachariasen's structural model of glass formation.  
b) Draw the viscosity versus temperature plot of the commercial soda-lime –silica glass and define annealing point, strain point and working point. [2+3]
8. a) Define the terms 'glass' and 'glass ceramics'.

- b) A day Tank Furnace is charged with an intimately ground mixture of 1200 kg Quartz Powder, 880 Kg Lime Stone Powder, 240 Kg Potash Feldspar ( $K_2O \cdot Al_2O_3 \cdot 6SiO_2$ ) and 420 Kg soda Ash. Calculate the quantity of glass produced and its composition in % of oxides basis. [1+4]
9. a) Draw and explain the T-T-T diagram of glassy melt. Define the critical cooling rate (CCR) from this diagram.  
b) Why borosilicate glasses have better thermal shock resistance and better chemical durability than soda-lime silica glass? [(2+1)+2]
10. a) Enumerate the essential characteristics required for a refractory material.  
b) Explain the different steps involved in the manufacture of silica bricks. Mention its properties and uses. [2+(2+1)]
11. a) Explain the differences between acidic and basic refractories with suitable examples.  
b) Write a short note on (*any one*):  
(i) Thermal Spalling  
(ii) Pyrometric cone equivalent [2+3]
12. a) What are disadvantages of conventional castable refractories?  
b) What is the new heating schedule of castable refractories followed by industries?  
c) What do you mean by ULCC? [2+2+1]

### **Group - C**

(Answer any four questions)

- [4×5]
13. a) Aluminium cannot be extracted by reduction of its ores.— Explain.  
b) What are the methods used for purification of metals? [3+2]
14. a) Which phase diagram usually results when solid solubility is limited and the melting points of the components are not vastly different?  
b) Find out the degree of freedom of a single component system?  
c) Show the effect of temperature on the molar Gibbs energy of a eutectic phase system? [1½+1½+2]
15. a) What is meant by annealing of steel?  
b) What is meant by tempering of steel? Outline the processes involved in tempering of steel.  
c) Give the name and composition of an alloy possessing zero coefficient of expansion. [2+2+1]
16. a) What is DRI?  
b) What is the main difference between coal based and gas based sponge iron process?  
c) Describe any one coal based sponge iron process. [1+1+3]
17. a) How dephosphorisation is taken place in steel melting?  
b) What are the basic differences between dephosphorisation and desulphurisation process of steel melting?  
c) Describe the principles of LD process. [1+2+2]
18. a) Describe continuous casting of steel by drawing a vertical type continuous casting machine.  
b) Describe some of the ingot defects. [3+2]

### **Group - D**

(Answer any three questions)

[3×5]

19. a) Describe with sketch Lurgi-Spül process of Low Temperature Carbonisation on coal.  
b) Differentiate between “Soft” and “Hard” coke from view point of manufacture and use. [3+2]
20. a) What are the different types of coal? Write the main factors which are taken into consideration for selection of coal for different purposes.  
b) Calculate the weight and volume of air required for the combustion of 3 kg of carbon. [3+2]
21. a) A bio diesel derived from Jatropha seed is of molecular formula  $C_{17}H_{35}COOCH_3$ . Whereas, that of Diesel, a Petroleum distillate is  $C_{16}H_{34}$ .  
Calculate calorific value of each.  
(Heat value of C = 8137 cal/g and H = 34500 cal/g)  
A bituminous coal was analysed as under:  
% Moisture = 3.2, % Volatile matter = 30.0, % Ash = 20, Calculate Fixed carbon content. [4+1]
22. a) What is the main purpose of Proximate analysis of coal?  
b) What is the importance of ultimate analysis of coal? How do you determine sulphur content in the coal sample?  
c) Why coke is preferred to coal in metallurgical processes? What is meant by gross calorific value and net calorific value of a fuel? [1+2+2]
23. The proximate analysis of a Jharkhand coal is:  
Moisture – 1.6%  
Ash – 15.7%  
Volatile Matter – 27.8%  
Calculate % Fixed carbon (i) daf basis (ii) dmmf basis  
(Mineral matter = 1.1 Ash)
- Fill up the blank:  
Coal and Fuel Fired Furnaces can generate temperature upto \_\_\_\_\_  
Electric Furnaces can operate in temperature as high as \_\_\_\_\_ [3+2]

\_\_\_\_\_ × \_\_\_\_\_