

RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. THIRD SEMESTER EXAMINATION, DECEMBER 2018

SECOND YEAR [BATCH 2017-20]

INDUSTRIAL CHEMISTRY [Honours]

Date : 15/12/2018

Time : 11 am – 3 pm

Paper : III

Full Marks : 75

[Use a separate Answer Book for each Group]

Group – A

Answer **any five** questions:

[5×5]

1. a) Write down the energy expression for simple harmonic oscillator. [1]
b) Calculate the difference in energy of two successive levels. [2]
c) Calculate the frequency of light which induces a vibrational transition in terms of the frequency of vibration for a simple harmonic oscillator. [2]
2. a) What is the essential condition for a (i) light-induced vibrational transition (ii) light induced rotational transmission (iii) Raman scattering? [3]
b) Explain how the effect of anharmonicity is reflected in a vibrational spectrum of a diatomic molecule. [2]
3. a) A vibration transition is always accompanied with rotational transitions. With the help of a schematic diagram show how instead of a single line in a vibrational spectrum we get a series of lines due to coupled vibrational and rotational modes. [3]
b) The spacing between the lines in the microwave spectrum of H^{35}Cl is $6.350 \times 10^{11} \text{ Hz}$. Calculate the bond length of H^{35}Cl . [2]
4. a) What is a photostationary state? How does this differ from the Equilibrium state. [1+2]
b) What is the difference between overtones and hot bands in the IR-spectra? Give one example of photosensitized reactions. [1+1]
5. a) The Vibrational energy levels of F_2 molecule is given by the expression: [3]

$$E_v(\text{cm}^{-1}) = 215\left(v + \frac{1}{2}\right) \left\{ 1 - 0.003 \left(v + \frac{1}{2} \right) \right\}$$

Find (i) the anharmonicity constant (ii) Equilibrium oscillation frequency and (iii) zero-point energy of the molecule.

- b) Explain why fluorescence has lower frequency compared to the absorbed light. [2]
6. a) Explain what do you mean by:
(i) Chemiluminescence (ii) Frank Condon principle [2.5×2]
7. a) Invoking the idea of virtual states explain the origin of Stokes and anti-Stokes lines. [3]
b) Which of the two lines is more intense and why? [2]

8. a) The force constant of $^{79}\text{Br}^{79}\text{Br}$ is 240 N.m^{-1} . Calculate the fundamental vibrational frequency and the zero-point energy of $^{79}\text{Br}_2$. [4]
- b) What is the zero point energy of a rigid rotor? [1]

Group – B
(Answer any five questions)

[5×5]

9. a) What is microstructure and nanocrystalline structure? [1+1+3]
b) Illustrate the different types of structure.
c) Write the structure-property-application co-relationship of materials.
10. a) Define melting point and cohesive energy.
b) Derive the expression of melting point of a spherical nanoparticle. [1+4]
11. a) What is the difference between 'lattice' and 'basis'? [2]
b) What is 'Miller indices'? How is it calculated? Illustrate with an example. [3]
12. a) List the point co-ordinates for all atoms that are associated with BCC unit cell. [2]
b) Draw an orthorhombic unit cell and within that cell indicate the $[2\bar{1}1]$ direction and $(2\bar{1}1)$ plane. [3]
13. a) Calculate the 'atomic packing factor' for simple cubic lattice and FCC lattice. [1.5+1.5]
b) If the atomic radius of lead is 0.175 nm, calculate the volume of its unit cell in cubic meters. Given that Lead has FCC crystal structure. [2]
14. a) Niobium has an atomic radius of 0.1430 nm and a density of 8.57 g/cm^3 . Determine whether it has a FCC or BCC crystal structure. Given $A_{\text{Nb}}=92.91 \text{ g/mol}$. [3]
b) The density and associated percent crystallinity for two polypropylene materials are as follows:

$\rho(\text{g / cm}^3)$	Crystallinity (%)
0.904	62.8
0.895	54.4

Compare the density of totally crystalline and totally amorphous polypropylene. [2]

15. a) A BCC crystal is used to measure the wavelength of some X-rays. The Bragg angle for reflection from (110) planes is 21.5° . What is the wavelength? The lattice parameter for the crystal is $2.85 \text{ \AA}$. [2]
b) From the tracing of a diffractometer, the following 2θ values in degrees were measured : 28.4, 47.3, 56.1, 69.1, 76.5, 88.1, 95.0 and 106.8. Copper k_α radiation ($1.54 \text{ \AA}$) was used. Index the lines, find the crystal structure and the lattice parameter. How many more peaks do you expect in the total XRD profile? [3]
16. a) Why 'defect' is so abundant in natural crystal? Write two major kind of defects observed generally in solids. [2]
b) Calculate the number of Schottky defects per cubic meter in KCl at 500°C . The energy required to form Schottky defect is 2.6 eV, while the density of KCl (at 500°C) is 1.955 g/cm^3 . Given $A_{\text{K}}=39.10 \text{ g/mol}$ and $A_{\text{Cl}} = 35.45 \text{ g/mol}$, and Boltzmann constant $K = 8.62 \times 10^{-5} \text{ eV K}^{-1}$. [2]
c) How dislocation is formed in a solid material? [1]

Group – C
(Answer any five questions)

[5×5]

17. a) What are the hypo eutectic alloys & hyper eutectic alloys. [2]
 b) Show the peritectic reaction in a silver-platinum phase diagram where melting point of silver & platinum are 961°C & 1769°C respectively. [3]
18. a) What are the important ores of Aluminium? [1]
 b) How the metal is extracted from its ore? [3]
 c) 'Aluminium Cannot be extracted by reduction of its ores by Carbon'— Explain. [1]
19. a) Write down the significance of Ellingham Diagram. [2.5]
 b) Draw the predominance Diagram for Ni-S-O system at 1000 K. [2.5]
20. a) What are alloys? [1]
 b) Describe briefly the methods employed for the manufacture of alloys. [2]
 c) Mention the Compositions of the following alloys: a) gun metal b) Duralumin. Mention their uses. [2]
21. a) Discuss the various steps involved in powder metallurgy process. [3]
 b) What are the advantages and limitations of powder metallurgy— Explain. [2]
22. a) Give the name and composition of an alloy possessing zero coefficient of expansion. [1]
 b) How can Copper be removed from nickel? [1]
 c) What is the main difference between grey cast Iron and white cast Iron. [1]
 d) What is the purest form of commercial Iron? What is the percentage of carbon in it? [1]
 e) What is the effect of increasing Carbon content in steel? [1+1+1+1+1]
23. a) Explain different types of Ingot Defect & their remedies. [3]
 b) Write down the principle of Continuous Casting. [2]
24. a) What is Thermax Flame Temperature. [2]
 b) Write down the Principles of LD process. [3]

_____ × _____