UG/III/CHEM/H/VII/18(New)

2018

CHEMISTRY

[Honours]

PAPER – VII

Full Marks : 45

Time : 2 hours

The figures in the right hand margin indicate marks

[NEW SYLLABUS]

GROUP – A

Answer any **one** questions from the following : 15×1

1. (*a*) Define optical density. On which factors it depends ? $1 + 2$

(*b*) In the process of extraction of a solute from a solution the extracting liquid should not be used in one lot but in a number of smaller lots. Justify the statement. 3

(*c*) Consider a particle is moving to and fro in a box of length a. If the particle is in its ground state, what is the probability of finding the particle in the range $\frac{a}{3}$ to $\frac{2a}{3}$? 3

(*d*) Find the simplest formula of a solid containing A and B atoms in a cubic arrangement in which A occupy corner and B the centre of the faces of unit cell. If side length is 5Å estimate the density of the solid assuming atomic weights of A and B as 60 and 90 respectively. 3

(*e*) Suppose a molecule has two nondegenerate energy levels $\epsilon_1 = 0$ and $\epsilon_2 = kT$. Calculate (*i*) the partition function and (*ii*) ratio of the number of molecules in the two levels. [k = Boltzmann constant and T is the temperature in K]. $1\frac{1}{2} + 1\frac{1}{2}$

2. (*a*) Find out $< x >$ and $< x^2 >$ of a simple harmonic oscillator in its ground state,

$$\psi_0 = \left(\frac{\alpha}{\pi}\right)^{\frac{1}{4}} e^{-\alpha x^2/2}$$ and hence the uncertainty in finding the position, Δx.

Given, $\int_0^\infty x^2 e^{-\alpha x^2} dx = \frac{1}{4}\sqrt{\frac{\pi}{\alpha^3}}$. 1 + 2 + 2

(*b*) Inspite of chain reaction quantum yield of the reaction $H_2 + Br_2 = 2HBr$ is very low at room temperature. Explain. 3

(*c*) Define critical solution temperature. Give example of a system where both UCST and LCST is present. 2

(*d*) Define hot band in IR spectra. The fundamental and first overtone transition of NO molecule are centered at 1876 cm^{-1} and 3724 cm^{-1} respectively. Evaluate the *equilibrium* vibrational frequency. 2 + 3

GROUP – B

Answer any **two** questions from the following : 10×2

3. (*a*) Define chemical actinometer. An actinometer contains 20 c.c. 0·05 (M) oxalic acid through which light of 350 nm was passed for 2 hrs. The light was absorbed by the uranyl oxalate. After exposure the solution required 34 c.c. $KMnO_4$ to titrate the undecomposed oxalic acid. The same volume i.e 20 c.c. required 40 c.c. $KMnO_4$ before exposure. Calculate the energy absorbed in Joule/sec. if $\phi = 0{\cdot}57$. 1 + 4

(*b*) Stokes lines are more intense than antistokes lines. Explain. 2

(*c*) You are supplied three identical metal rods —one of pure metal, another mixture of two metals with eutectic composition and the third being a mixture with non eutectic composition. How do you identify ? 3

4. (*a*) Calculate the length of one dimensional box in which one electron absorbs energy

corresponding to the wavelength $\lambda = 500$ nm when it undergoes transition from the lowest to the next higher level. 4

(*b*) Explain the terms macrostate, microstate and thermodynamic probability. 3

(*c*) During heating at atmospheric pressure ice melts but dry ice sublimates. Explain. 3

5. (*a*) Show that E_n of hydrogen atom is n^2 fold degenerate. 3

(*b*) Define eutectic mixture with proper diagram. 3

(*c*) C-H stretching vibration in organic compound occurs at 2900 cm^{-1}. At what wave number would C-D stretching vibration occur assuming the force constant to be the same. 3

(*d*) What is the Miller indices of the plane that intersect crystal axes at *a*, 2*b*, 3*c* ? 1

6. (*a*) State Nernst distribution law. Give an example where this law is not valid. 3

(*b*) Is it possible to distinguish a polar molecule from a non-polar one from the temperature variation of molar polarization? How dipole moment of a polar molecule is experimentally measured? 2 + 2

(*c*) The first order reflection from a crystal plane in a cubic lattice occurs at $13°41'$. Find the Miller indices of the plane. Given edge length
$a = 5{\cdot}63$ Å, $\lambda = 1{\cdot}54$ Å ($\sin^2 13°41' = 0{\cdot}056$). 3

GROUP -- C

Answer any **five** questions : 2 × 5

7. (*a*) Define quenching of fluorescence.

(*b*) A sample was excited by the 4358 Å line of mercury. A Raman line was observed at 4447 Å. Calculate Raman shift in cm^{-1}.

(*c*) Spacing between rotational spectral lines in DCl is less than that of HCl. Explain.

(*d*) Find out the mutual angles formed by the following pairs of intersecting planes in a cubic system. (*i*) 110 , 101 (*ii*) 100, 110.

(*e*) Calculate the degeneracy of the level having energy of $\frac{7h^2}{4ma^2}$ for a particle of mass m confined in a cubic box of dimension a.

(*f*) Using Boltzmann Plank equation calculate the residual entropy of 1 mole CO at OK.

(*g*) Define Bravais lattice.

(*h*) State number of phase, number of component and hence calculate number of degrees of freedom for the following reaction :

$$3Fe\,(s) + 4\,H_2O\,(g) \rightleftharpoons Fe_3\,O_4\,(s) + 4\,H_2\,(g)$$
