

OLD

2016

M.Sc. Part-I Examination

CHEMISTRY

PAPER—I

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Illustrate the answers wherever necessary.

(Physical Chemistry)

For Old Syllabus

Full Marks : 75

Time : 3 Hours

Answer questions for Group-A and Group-B.

Answer *five* questions taking at least *two* from each group.

Group-A

1. (a) Constructing a wave packet from two sine waves prove that for a particle (which is represented by the wave packet) $\Delta x \Delta p_x \geq h$. Where Δx & Δp_x are position and momentum uncertainty respectively. 5

(Turn Over)

(b) The work function of metallic cesium is 2.14 eV. Calculate the kinetic energy of the electron ejected by light of wave length 300 nm. 3

(c) What do you mean by linear and hermitian operator? Prove that two non-degenerate eigenfunctions of a hermitian operator must be orthogonal to each other. 2+2+3

2. (a) Write down the Schrödinger equation for simple harmonic oscillator and express its Hamiltonian in terms of ladder operators. 6

(b) With the help of ladder operator find out the normalised ground state wave function of simple harmonic oscillator. 4

(c) Show that according to Heisenberg uncertainty principle the ground state energy of simple harmonic oscillator can not be zero and also prove that its minimum possible value is $\frac{1}{2}h\nu$. 5

3. Explain what is meant by fugacity. How is this quantity determined experimentally? 5+10

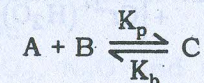
4. Obtain the expression for the thermodynamic probability of distribution of particles describable by symmetric wave function. Derive the appropriate distribution law. 7+8

Group-B

5. (a) Derive an expression for 1st order reaction of integrated rate equation by flow method. 4

(b) What is 'contact time'? 2

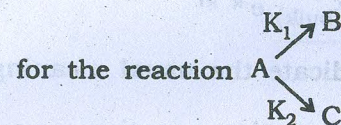
(c) Calculate the relaxation time of the reaction —



3

(d) For parallel reaction prove that

$$\frac{C_B}{C_C} = \frac{K_1}{K_2}$$



3

(e) For a certain reaction time (t) varies arithmetically while con^c varies geometrically —

time	0	t	2t	3t
con^c	a	aa	a^2a	a^3a

Show that the reaction is of 1st order.

6. (a) State limitations of Collision theory. 2

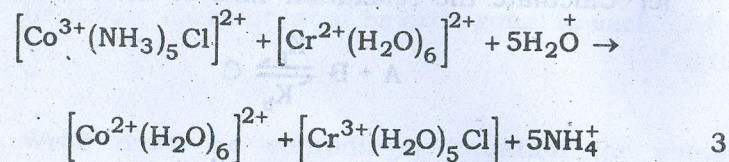
(b) Using transition state theory prove that

$$K_2 = \left[\frac{RT}{N_0 h} \cdot e^{\frac{\Delta S^\ddagger}{R}} \cdot e^{(1 - \Delta n^\ddagger)} \right] \times e^{-E_a/RT}$$

- (c) What is catalysis? For homogeneous catalysis explain the terms —
'Arrhenius Complex' and 'Van't Hoff Complex'.

1+2×2

- (d) Give the mechanism of the following reaction —



7. (a) Show that —

$$P_{(\text{moist})} = P_{(\text{bulk})} \cdot e^{\frac{2v}{R} \cdot \frac{V_e}{RT}}$$

where the terms indicate the usual meaning.

- (b) Established B.ET Adsorption equation.
- (c) A certain solid sample adsorbs 0.52 mg of hydrogen when the pressure of the gas is 34 KPa at the temperature 35°C and 0.21 mg when the pressure is 5 KPa at the same temperature. The Langmuir isotherm describe the above process. Calculate the fraction of surface covered.

8. (a) What do you mean by — (i) first overtone (ii) second overtone and (iii) hot bands? 3

- (b) For the vibration of a diatomic molecule, assuming anharmonic oscillator model calculate bond dissociation energy. 4

- (c) Calculate the no. of vibrational modes of the following molecule and predict which is IR active and which one is Raman active

SO_2 , N_2O and C_2H_2 5

- (d) Calculate the force constant for a bond in HCl from the fact that, the fundamental vibrational frequency is $8.667 \times 10^{13} \text{ sec}^{-1}$ atomic mass of H = 1 gm., Cl = 35.5 gm. 3

