M.Sc. 2nd Semester Examination, 2010

CHEMISTRY

PAPER — CH-1201

Full Marks : 40

Time : 2 hours

The figures in the right-hand margin indicate marks

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

GROUP—A

Answer any *two* of the following :

1. (*a*) Derive $\Delta x . \Delta p_x$ for a particle in one dimensional box and comment.

(*b*) Find out $\{ \bar{H}, r_{\pm}^{n} \}$ where the terms have their usual meaning. 5 + 5

2. (*a*) Show that $\hat{L} \times \hat{L} \neq 0$.

(*b*) Derive $\hat{L}^2$ in spherical polar co-ordinate system. 5 + 5

3. (*a*) Show that $\hat{L}_+$ and $\hat{L}_-$ act as ladder operators to $\hat{L}_z$ eigenvalues but have no effect on $\hat{L}^2$ eigenvalues.

(*b*) Prove that

$$\{\hat{L}^2, Y\} = 2i\hbar (Z\hat{L}_x - \hat{L}_z X). \qquad 5 + 5$$

4. (*a*) Derive the radial equation for *H*-atom.

(*b*) Show that

$$\langle \psi_{nlm} | \psi_{n'l'm'} \rangle = \delta_{nn'} \delta_{ll'} \delta_{mm'}. \qquad 5 + 5$$

GROUP—B

Answer any *one* of the following :

5. (*a*) Explain the mechanism of activated bridge complex formation with a suitable example.

(*b*) Give one example of each complementary and non-complementary electron transfer reactions.

(*c*) For the autocatalytic reaction $A \rightarrow P$ prove that

$$\frac{x}{[P_0]} = \frac{e^{at} - 1}{be^{at} + 1}$$

where $a = ([A_0] + [P_0])K$

$$b = \frac{[P_0]}{[A_0]}$$

and all the terms have their usual meanings.

6 + 1 + 3

6. (*a*) Show that the rate of a enzyme catalysed reaction is

$$v = \frac{K_2 [E_0][S]}{K_m + [S]}$$

where the terms have their usual meanings.

(*b*) Antibiotic-resistant bacteria have an enzyme, penicillinase, that catalyzes the decomposition of antibiotic. The molecular mass of penicillinase is 30,000 g mol^{-1}. The turnover number of the enzyme at 28°C is 2000 sec^{-1}. If 6·4 μg of penicillinase catalyzes the destruction of 3·11 mg of amoxicillin, an antibiotic with molecular mass of 364 g mol^{-1}, in 20 secs at 28°C, how many active sites does the enzyme have? 4 + 6

GROUP—C

Answer any *one* of the following :

7. Potential energy of interaction between two parallelly placed dipole having dipole moment μ_1 and μ_2 is given by,

$$V = \frac{\mu_1 \mu_2}{4\pi\epsilon_0 r^3}(1 - 3\cos^2\theta)$$

where r is the centre to centre distance between two dipole: θ is the angle between r and any

one of the dipole. Use the above expression to show, that in the bulk.

$$V_{\text{dipole-dipole}} \propto \frac{1}{r^6 T}$$

and $V_{\text{dipole-induced dipole}} \propto \frac{1}{r^6}$

Comment on the above expressions. 5 + 5

8. (*a*) Show that the local electric field (Σ_{10c}) in an isotropic nonpolar dielectric material is given by,

$$\Sigma_{10c} = \frac{\sigma - P}{\epsilon_0} + \frac{P}{3\epsilon_0}$$

where σ is the cavity surface charge density and P is the polarization of dielectric material.

(*b*) What do you mean by London dispersion interaction? F_2 and Cl_2 are gases at room temperature, Br_2 is liquid and I_2 is solid. Explain. 6 + (2 + 2)

Or

What do you mean by polarographic half wave potential ? How can you determine the coordination number and stability constant of a complex using polarographic measurement ? 3 + 7
