M.Sc. 2nd Semester Examination, 2011

CHEMISTRY

(*Physical*)

PAPER—CEM-201

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

Illustrate the answers wherever necessary

GROUP—A

Answer any *one* of the following

1. In a potential step problem with $E < V$. Show with derivation that both probability and probability current are conserved. 5 + 5

2. Derive an expression for $\Delta p.\Delta q$ by operator technique for linear harmonic oscillator. 10

Or

Set up Schrödinger equation for a simple harmonic oscillator and solve it by the ladder operator method for the energy eigenvalue. 10

GROUP–B

Answer any *one* of the following

3. (*a*) What do you mean by enzyme inhibition ? Show how the rate constant of an enzyme catalysis reaction changes in presence of an inhibitor. 5

(*b*) Antibiotic-resistant bacteria have an enzyme, penicillinase, that catalyzes the decomposition of the antibiotic. The molecular mass of penicillinase is 30,000 $g.mol^{-1}$. The turnover number of the enzyme at 28 °C is 2000 s^{-1}. If 6·4 μg of penicillinase catalyzes the destruction of 3·11 mg of amoxicillin, an antibiotic with a

molecular mass of 364 $g.mol^{-1}$, in 20 seconds at 28 °C, how many active sites does the enzyme have ? 4

(*c*) Give one example of heterogeneous catalysis reaction. 1

4. (*a*) What is the essential condition to occur a redox reaction by inner sphere mechanism ? 3

(*b*) What is Autocatalyse ? Find out the rate constant of the autocatalytic reaction 2 + 5

$$A \rightarrow P$$

GROUP–C

Answer any *one* of the following

5. (*a*) What do you mean by asymmetry and electrophoretic effects ? Compute electrophoretic component of velocity of a moving ion. 2 + 2 + 2

(*b*) Write short note on dispersion of conductance. 4

6. (*a*) When does the concentration overpotential arise ? Derive an equation relating concentration overpotential and limiting current density. 2 + 5

(*b*) How do you obtain equilibrium exchange current density using high field approximation of Butler Volmer equation ? 3

Or

(*a*) What is Polarographic wave ? What do you mean by half-wave potential ? 2 + 2

(*b*) How can the co-ordination number of a complex ion and the stability constant of a complex be determined by use of half wave potential ? 6

GROUP–D

Answer any *one* of the following

7. (*a*) Use free electron model to obtain the frequency of transition (HOMO → LUMO) for a π-conjugated system having '*N*' number of π-electrons. 3

(*b*) Depict the bonding (σ, π) and antibonding (σ, π^*) orbitals when (*i*) two *p*-orbital, (*ii*) two *d*-orbital are combined to form bond. 3

(*c*) State Franck-Condon principle. Explain the relative intensity of vibronic transitions when (*i*) $r''_e < r'_e$, (*ii*) $r''_e = r'_e$. r''_e and r'_e are the minimum of potential curve of ground and excited state respectively. 4

8. (*a*) Show that the potential energy (V) of interaction between an *n*-pole and an *m*-pole can be written as,

$$V \propto \frac{1}{r^{n+m-1}}$$

where 'r' is the distance (centre to centre) between the two poles. 7

(*b*) Write a short note on London dispersion interaction. 3
