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End Semester Examination of Semester–III, 2015
Subject : CHEMISTRY (HONS.)
Paper : CEMH-302
Full Marks : 20
Time : 1 Hr.

The figures in the margin indicate the marks corresponding to the question

Candidates are requested to give their answers in their own word as far as practicable.

Illustrate the answers wherever necessary.

Group A

Answer **1 (one) question :** 10x1=10

1. a) Can you measure kinetic energy and momentum of a particle simultaneously? Justify your answer. 2

   b) Using Debye-Huckel limiting law, calculate the mean ionic activity co-efficient of 0·001 (M) aqueous solution of $K_4[Fe(CN)_6]$. 2

   c) The decomposition of gaseous N_2O_5 was found to be of first order during initial stages. Show that the following mechanism can account for this observation by applying steady state treatment to NO_3 and NO.

$$2N_2O_5 \underset{K_{-1}}{\overset{K_1}{\rightleftharpoons}} 2NO_2 + 2NO_3$$

$$NO_3 \xrightarrow{K_2} NO + O_2$$

$$NO + NO_3 \xrightarrow{K_3} 2NO_2$$ 4

d) A particle has the wave function

$$\Psi(r)=\left(\frac{1}{\Pi a_0^{\,3}}\right)^{\frac{1}{2}}.e^{-\frac{r}{a_0}}$$

where a_o is a constant. Calculate <r>. 2

2. a) Prove that $\sum_i n_i d\mu_i = 0$, where n_i and μ_i are number of moles and chemical potential of ith substance respectively. 3

b) Calculate the entropy of mixing when 2 moles of N_2 and 3 moles of H_2 are mixed together at 27^0C. Consider both gases are ideal in nature. 2

c) Discuss the effect of addition of an inert gas to the equilibrium of the following gaseous reaction. 3

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

d) Explain what is meant by pH range of an acid base indicator. 2

Group–B

Answer any **one** question: 6x1=6

3. a) Consider two equilibria:

$A_2 \rightleftharpoons 2A$ ..... (1)

$AB \rightleftharpoons A + B$ ..... (2)

Assume that ΔG^0 and K_p is same for both the reaction. Show that, equilibrium value of advancement of reaction (2) (ξ_2) is greater than the corresponding value of reaction(1) (ξ_1). What is the physical reason for this result? 4

b) A catalyst does not effect the rate of a chemical reaction – Justify. 2

4. a) A particle of mass 10^{-6} kg is rolling on the smooth floor of a 10^{-4} meter wide box with a speed of $3{\cdot}3313 \times 10^{-3}$ m/s. Applying particle in a box problem calculate the quantum number corresponding to the translational energy of the ball. 4

b) A reaction is 25% complete, in 30 min at 227^{0}C and in 10 min at 273^{0}C. Find the energy of activation of this reaction. 2

Group–C

Answer any **two** questions: 2x2=4

5. Find the probability of finding a particle in a 1D box of length 'L' in the region between 'L/4' and '3L/4' for quantum number; n = 1. 2

6. What is temperature co-efficient of a reaction? Arrhenius factor (A) is high temperature limiting value of rate constant of a chemical reaction – Justify. 2

7. Draw and explain the plot of '$ln K_p$' vs '1/T' for the following reaction : 2

   $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

8. Consider a particle in a cubic box. Find the degenaracy of the energy level which has an energy twice of the ground state energy. 2