M.Sc Sem I June 18

Chemistry - I (Rev)

Q.P. Code : 29464

[Time: 2 $\frac{1}{2}$ Hours] **[Marks: 60]**

Please check whether you have got the right question paper.

N.B:
1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Use of non-programmable scientific calculator is allowed.

Useful constants

$c = 2.998 \times 10^{8}$ m.s^{-1}
$R = 8.314$ J.K^{-1} mol^{-1}
$= 2.0$ cal.mol^{-1}.K^{-1}
$h = 6.626 \times 10^{-34}$Js
$m_e = 9.110 \times 10^{-31}$ kg
$N_A = 6.022 \times 10^{23}$ mol^{-1}

$e = 1.602 \times 10^{-19}$ C
$k = 1.3811 \times 10^{-23}$ JK^{-1}

$1J = 6.24 \times 10^{18}$ev
$1eV = 8.06 \times 10^{3}$ cm^{-1}
$1amu = 1.66 \times 10^{-27}$ kg

Q.1 A) Attempt **any two** of the following :

i) What are the characteristics of entropy? Which molecule of the pair given below has greater molar entropy under same conditions & Why? **4**

CH_3CH_2OH and CH_3CH_2COOH

ii) Starting with van der waal's equation show that $\mu_{J.T} = \frac{1}{C_P}\left(\frac{2a}{RT} - b\right)$ **4**

where the terms have usual meaning.

iii) Using Maxwell's relation prove that **4**

$$\left(\frac{\delta Cp}{\delta P}\right) = \left(\frac{\delta^2 S}{\delta T.\delta P}\right) = -T\left(\frac{\delta^2 V}{\delta T^2}\right)_P$$

iv) Define and discuss Joule – Thomson coefficient. What happens when various gases are subjected to Joule-Thomson experiment ? **4**

B) Attempt **any one** of the following :

i) Calculate the change in entropy in transforming 24g of ice into water at 0°C. Molar heat of fusion $= 6.000$ kJmol^{-1} and enthalpy change for transition of one mole of liquid water to steam at 373K is 40.8 kJmol^{-1}. **4**

ii) Calculate the inversion temperature for CO gas using van der waal's constants. **4**

$a = 150.5 \times 10^{-3}$ Nm^{4}mol^{-2} and $b = 3.985 \times 10^{-5}$ m^{3}mol^{-1}

Q.2 A) Attempt **any two** of the following :

i) Define operator. Prove the commutative property of an operator with a suitable example. **4**

ii) What is meant by normalization of wave function? Normalise the following wave function. **4**

$\psi = A\sin\frac{\cap\pi x}{L}$ in the limit zero to L

iii) Derive the time independent Schrodinger wave equation from Schrodinger's time dependent wave equation. **4**

iv) What is linear harmonic oscillator? Derive Hermite equation for one dimensional simple harmonic oscillator **4**

B) Attempt **any one** of the following :

i) A particle of mass 9×10^{-3} kg is confined in one dimensional box of width 1×10^{-10}m. Calculate the ground state and first exited state energy level in eV. Comment whether the energy levels are quantized. **4**

ii) Which of the following functions are eigen functions for the operator $\frac{d^2}{dx^2}$ a) e^{-4x} b) 3Sin4x **4**

Q.3 A) Attempt **any two** of the following :

i) Show that the rate of polymerization reaction is proportional to square root of its initial concentration of the monomer. **4**

ii) Write the reaction mechanism for the decomposition of acetaldehyde and using steady state principle show that **4**

$\frac{d}{dt}[CH_4]=k[CH_3CHO]^{3/2}$

iii) Discuss Hinshelwood theory of unimolecular reaction. **4**

iv) H_2 reacts with Br_2 to give HBr according to the reactions $H_2+Br_2 \xrightarrow{205-302^0c} 2HBr$. Using the chain reaction mechanism, obtain rate equation for the above thermal reaction. **4**

B) Attempt **any one** of the following :

i) In the following reaction scheme, write the rate equation for the removal of species A,B,C and D in differential form **4**

(i) $A+B \xrightarrow{K1} C+D$

(ii) $C+D \xrightarrow{K2} A+B$

(iii) $C+D \xrightarrow{K3} E+D$

(iv) $2D \xrightarrow{K4} F$

ii) Isopropyl benzene is alkylated by n-butylamine in presence of hydrogen fluoride in a two step consecutive reactions as Isopropyl benzene (A) $\xrightarrow{k_1}$ Isopropyl-sec butylbenxene(B) $\xrightarrow{k_2}$ Isopropyl-di-sec butyl benzene min^{-1}(C). If the initial concentration of isopropyl benzene is 100M and the values of $k_1=4.0 \times 10^{-2}$ min^{-1} and $k_2=4.0 \times 10^{-3}$ min^{-1}. Find the concentration of each species at the end of 20 minutes. **4**

Q.4 A) Attempt **any two** of the following:

i) State Debye-Huckel-Onsagers equation. Explain the two types of deviations from the equation. **4**

ii) Explain the Debye-Falkenhagen effect for the conductance of strong electrolytes and show that the wavelength for the effect to occur must be about 20 m or less. **4**

iii) Explain the construction and working of the phosphoric acid fuel cell. **4**

iv) Explain the process of adsorption of proteins onto metal surfaces from solution. **4**

B) Attempt **any one** of the following :

i) Calculate the mean ionic activity coefficient of $ZnCl_2$ in a solution containing 0.05m $ZnCl_2$ and 0.05m NaCl at 298K. **4**
(A = 0.509 at 298 K)

ii) Calculate the resting membrane potential for the following : 4

Ion Species	Intra Cellular Conc in mM	Extra Cellular Conc in mM
K^+	410	10
Na+	49	460

Given that 2.303 RT/F=60 at 298K

Q.5 Attempt **any five** of the following : 15

a) Derive the Maxwell relation

$$\left(\frac{\partial T}{\partial V}\right)_s = -\left(\frac{\partial P}{\partial s}\right)_v$$

b) Write a note on third law of thermodynamics

c) Find the degenerate and non-degenerate energy levels for a cubical box from the following

$E = \frac{6h^2}{8ma^2}$, $E = \frac{9h^2}{8ma^2}$, $E = \frac{12h^2}{8ma^2}$

d) State the main postulates of quantum mechanics.

e) Explain the term consecutive reaction with suitable example.

f) Explain three explosion limits of H_2 and O_2 reaction.

g) Write a short note on the electrochemical enzyme – catalyzed oxidation of Styrene.

h) Explain any three applications of fuel cells.

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