2016

CHEMISTRY

[Honours]

PAPER – II

Full Marks : 90

Time : 4 hours

The figures in the right hand margin indicate marks

Use separate answer scripts for Group – A & B

[NEW SYLLABUS]

GROUP – A

(*Physical*)

GROUP – A (a)

Answer any **one** of the following from **Q. Nos. 1 & 2** : 15×1

1. (*a*) Use the Maxwell distribution of molecular

speed to verify that $\langle v^2 \rangle = 3RT/M$. Use it to find the average kinetic energy. 3 + 1

$$\left[\int_0^{\infty} x^{2n} e^{-ax^2} dx = \frac{(2n)! \pi^{1/2}}{2^{2n+1} n!\, a^{n+1/2}} \right]$$

(*b*) One evaluates (*i*) the number of collisions per second made by one molecule; (*ii*) the number of collibions per second per cubic centimeter. The values are Z_1 and Z_2, respectively, at 25 °C, 1·0 atm. Find the above two quantities of (*i*) and (*ii*) in terms of Z_1 and Z_2, respectively when the gas pressure is $1{\cdot}0 \times 10^{-3}$ atm, at 25 °C. 4

(*c*) For the gas-phase reaction $2HI \rightarrow H_2 + I_2$, values of K (rate constant) are $1{\cdot}2 \times 10^{-3}$ and $3{\cdot}0 \times 10^{-5}$ $dm^3\ mol^{-1} s^{-1}$ at 700 K and 629 K, respectively. Estimate E_a and A. Can you predict the order of the reaction ? 4

(*d*) Explain with proper diagram the zeta potential. Mention how does it differ from thermodynamic potential. 3

2. (*a*) Give the SI units of each of the following properties and state whether each is extensive or intensive : 4

(*i*) $\left(\frac{\partial v}{\partial T}\right)_P$

(*ii*) $V^{-1}\left(\frac{\partial v}{\partial T}\right)_P$

(*iii*) $\left(\frac{\partial u}{\partial v}\right)_T$

(*b*) A perfect gas with $\overline{C}_v = 3R$ independent of T expands adiabattically into a vacuum, thereby doubling its volume. Student-A uses $TV^{\gamma-1} = C$ to find $T_2 = T_1/2^{1/3}$ and student-B finds $T_2 = T_1$. Who is correct ? Justify your answer. 4

(*c*) Establish the equation that is the basis for capillary-rise method. Explain how the method allows calculation of surface tension (γ). 4

(*d*) Show that the viscosity coefficient of gas is independent of pressure. You may use the relevant expressions from simple kinetic molecular theory of gases. Also give a physical explanation of your argument. 3

GROUP – A (b)

Answer any **two** of the following questions : 10 × 2

3. (*a*) One mole of an ideal gas expand isothermally and reversibly from 90 to 300 L at 300 K.

(*i*) Calculate ΔU, ΔS, W, and q for this system.

(*ii*) If the expansion is carried out irreversibly by allowing the gas to expand into an evaluated container, what are the values of ΔU, ΔS, W, and q ? 3 + 3

(*b*) (*i*) Mention the probable source for origin of charge on colloidal particles.

(*ii*) Explain with example the Schulze-Hardy rule. 2 + 2

4. (*a*) Depict the variation of S with T graphically, at a constant pressure when a solid (at a temperature T_i) is converted to vapour at a temperature T_f ($T_f > T_b$, T_b being the boiling point of the liquid). Explain the variation with the appropriate equation. 4

(*b*) For an ionic reaction, $A^- + B^+ \rightarrow C$, the rate constant changes with the progress of the reaction. Justify or criticize. 3

(*c*) For a first order gaseous reaction $2A(g) \rightarrow B(g) + C(g) + D(g)$, find the rate expression in terms of the initial presure (p_0) and the presure at time t (p_t). 3

5. (*a*) State the Langmuir adsorption isotherm and indicate the term 'adsorption coefficient (K)'. Explain that : A plot of P/V *vs.* P would give a straight line with slope/intercept = K. 4

(*b*) For the mechanism

$A + B \rightarrow C$
$2C \rightarrow F$
$F + B \rightarrow 2A + G$

(*i*) Give the stoichiometric number of each step and give the overall reaction,

(*ii*) Classify each species as reactant, product, intermediate, or catalyst. 3

(*c*) What is standard heat of reaction (ΔH°) ? Establish a suitable equation that gives the temperature dependence of ΔH°. 3

6. (*a*) Consider a zeroth order reaction A $\rightarrow$ P : $1\frac{1}{2} \times 4$

(*i*) Give the differential and integrated rate law,

(*ii*) Give a suitable plot of a straight line to evaluate the rate constant,

(*iii*) Obtain the expression for $t_{1/2}$,

(*iv*) Can it be a single step reaction ?

(*b*) Define and mention the thermodynamic expression : Joul coefficient (μ_J), Joule Thomson coefficient ($\mu_{J\text{-}T}$). Find their values for a gas obeying $P(\bar{v} - b) = RT$. 2 + 2

GROUP – A (c)

7. Answer any *five* questions : 2×5

(*a*) Give reasons :

(*i*) van der Waals constant (a & b) can be expressed using any two quantities of $P_C, \overline{V}_C$ and T_C.

(*ii*) We prefer the pair (P_C, T_C) rather than $(T_C, \overline{V}_C)$ for finding a & b.

(*b*) Justify that 1 CGS unit = 0·1 SI unit for viscosity coefficient.

(*c*) Does the term "reversible" have the same meaning in kinetics as in thermodynamics ?

(*d*) $du < 0$ is a thermodynamic criterion for spontancity at constant volume and constant entropy condition. On the other hand entropy increases in a spotaneous change. How would you sort out the apparent contradiction of the statements ?

(*e*) Write down the pair of thermodynamic equations of state. Why are they so called ?

(*f*) What are (*i*) CMC (*ii*) Gold number ?

(*g*) For the reaction $2A + B \rightarrow P$, which statement is true ? Give reason.

(*i*) $\frac{dn_A}{dt} = 2\frac{dn_B}{dt}$

(*ii*) $2\frac{dn_A}{dt} = \frac{dn_B}{dt}$

(Symbols have their usual significances)

(*h*) State and explain the terms therein :

Gibbs adsorption isotherm.
Explain surface excess.

GROUP – B

(*Industrial*)

GROUP – B (a)

Answer any **one** question : 15 × 1

8. (*a*) What is GLC ? Discuss one application of GLC for separation and identification of the components in a mixture. 1 + 4

(*b*) What are the products of high temperature carbonisation ? How are they separated ? Give their uses. 2 + 3 + 2

(*c*) Differentiate between ultimate analysis and proximate analysis of coal. 3

9. (*a*) Discuss the method of recovery of glycobine from spent lye. 4

(*b*) Describe briefly a process for deionisation of water. Mention the causes of hardness of water. 4 + 2

(*c*) Write down the composition of common soda glass. 2

(*d*) State the purpose of annealing of glass. What is borosilicate glass ? 2 + 1

GROUP – B (b)

Answer any **two** questions : 10×2

10. (*a*) Describe briefly the process of hydrogenation of vegetable oils. Why is an oil hydrogenated ? Give uses of hydrogenated ? Give uses of hydrogenated oils. $4 + 2 + 1$

(*b*) What are typical advantages of a ceramic product ? Give one use of solid fuel. $2 + 1$

11. (*a*) Given definition of a pigment and name some common pigments used in making paints. $2 + 2$

(*b*) Why methyl orange is used as an indicator but not as dye ? 2

(*c*) Discuss the manufactured of DDT with a flow diagram. 4

12. (*a*) What do you understand by high polymer ? What structural differences distinguish the thermosetting polymer from thermoplastic polymer. $1 + 3$

(*b*) Discuss briefly how nylon 66 is prepared in laboratory ? 3

(*c*) Write down the chemical structure of repeat unit for the following polymers : 3

(*i*) Neoprene

(*ii*) PVC

(*iii*) Buna-S

13. (*a*) What do you mean by NPK fertilizer ? Discuss the manufacturing of urea from ammonia with flow chart. 1 + 3

(*b*) What is triple superphosphate ? Give one example of straight fertilizer and complex fertilizer respectively. 2 + 2

(*c*) Why hardness of water is exprressed in terms of $CaCO_3$ equivalent ? 2

GROUP – B (c)

14. Answer any *five* questions : 2 × 5

(*a*) What do mean by accuracy and precision ?

(*b*) What is high alumina cement ?

(*c*) Define cullet.

(*d*) What are the advantages and disadvantages of using DDT as pesticide ?

(*e*) Define saponification value of oils.

(*f*) Write down the composition and heating value of coal gas and producer gas.

(*g*) Name important constituents of petroleum.

(*h*) Distinguish between oil and fat.

(*i*) What are drying oils ? Give one example.
