2018

CHEMISTRY

[Honours]

PAPER – II

Full Marks : 90

Time : 4 hours

The figures in the right hand margin indicate marks

GROUP – A

(*Physical*)

Subgroup -- A (a)

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

1. (*a*) One mole of an ideal gas at 1 atm and 300 K undergoes free expansion adiabatically to

double its initial volume. Calculate the final temperature, Δs of the system and Δs of the surroundings: 1 + 2 + 1

(*b*) If out of "*n*" molecules of a gas at a given temperature dn_u molecules have their *x*-component of velocity in the range *u* to $u + du$ then $\frac{1}{n}\frac{dn_u}{du}$ should be a function of u^2 – justify or contradict. 3

(*c*) Explain how from (*i*) Amagat's isothermal below Boyle temperature and (*ii*) existence of inversion temperature it can be argued that gas molecules move under two opposite constraints. 4

(*d*) Deduce the mathematical expression for measuring surface tension of a liquid by capillary rise method explaining the terms involved. 4

2. (*a*) A compound '*X*' decomposes by two parallel paths (1st order) to give products *Y* and *Z*.

The specific rate constant and the energy of activation for the two paths are K_1, E_1 and K_2, E_2 respectively. Show that the overall rate constant (K) and activation energy (E) are given by : $K = K_1 + K_2$ and $E = (K_1E_1 + K_2E_2)/(K_1 + K_2)$. 4

(*b*) What is Carnot Cycle ? Represent Carnot Cycle in a H-T diagram with proper labels and explanation. 1 + 2

(*c*) The Kinetics of the reaction :

$$[Co(NH_3)_5Br]^{++} + OH^- \rightarrow [Co(NH_3)_5OH]^{++} + Br^-$$

was studied in aqueous solution of (*i*) 0·1 (N) KCl and (*ii*) 0·2 (N) KCl. State with reason, whether the rate constant of the reaction in the case of (*i*) would be greater than, less than or equal to that in the case (*ii*). 4

(*d*) Show that Gibbs adsorption isotherm leads to a two dimensional gas equation for small concentration of surface active substance. 4

Subgroup – A (b)

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

3. (*a*) As no heat enters a system under adiabatic condition its energy is conserved during expansion. Justify or contradict. 2

(*b*) You are studying the first order kinetics of Hydrolysis of ester by measuring the amount of acid formed by titration with a base. Convert the rate expression in terms of volume of base. 4

(*c*) What do you understand by the term compressibility factor Z of a gas. Show that the initial slope Z vs. P curve (at $P = 0$) is (*i*) Positive if $b > \frac{a}{RT}$ and (*ii*) Zero if $b = \frac{a}{RT}$, (*iii*) Negative if $b < \frac{a}{RT}$. 4

4. (*a*) Discuss how an unimolecular reaction involving gaseous reactant behaves at high and low pressure according to Lindermann. 4

(*b*) A certain gas has the equation of state for one gm. mole :

$$P = \frac{RT}{V - bT} - \frac{a}{V^3}$$

where '*a*' and '*b*' are constant characteristic of the gas. Show that,

$$a = \frac{4T_C V_C^2}{3} \text{ and } b = \frac{V_C}{2T_C};$$

where V_C and T_C are critical constants. 4

(*c*) What is Zeta potential ? What is its importance ? 2

5. (*a*) What is Contact angle ? Describe with suitable diagram for a liquid-solid interface, the conditions for the contact angle being an acute and an obtuse angle. 4

(*b*) Write down the mathematical expression of Poiseuille equation, explaining the sysmbols used. Show how the simple working formula

of Ostwald viscometer is derived from this equation. Give a neat sketch of Ostwald viscometer. 1 + 2 + 2

(*c*) Show that the final volume in isothermal expansion is greater than that in the adiabatic expansion for the same final pressure. 1

6. (*a*) 10^3 litre of an ideal monoatomic gas $\left(C_v = \frac{3R}{2}\right)$ at 0°C and 10 atm pressure is expanded adiabatically to a final pressure of 1 atm. Calculate the ΔU if the process is carried out in a single irreversible step. Explain in a P-V diagram how the final state would differ if the process were reversible. 4

(*b*) If a gas obeys the equation :

$$\frac{P\bar{V}}{RT} = 1 + \alpha P + \beta P^2$$

show that the following restrictions are imposed on α and β :

(*i*) $\alpha < 0$ and $\beta > 0$

(*ii*) $4\beta > \alpha^2$. 4

(*c*) Show that for a first-order reaction, $A \rightarrow$ Products, the time required for the successive reduction in the concentration of A by a constant factor is independent of the initial-concentration of A. 2

Subgroup – A (c)

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

(*a*) Use appropriate Maxwell's relation to derive the following :

$$Tds = C_v dT + T\left(\frac{\partial P}{\partial T}\right)_v dv$$

(*b*) Explain why the internal energy of an ideal gas is only dependent on temperature whereas the internal energy of a real gas is a function of both temperature and volume.

(*c*) Define coefficient of performance of a refrigerator. Why is defrosting done in a refrigerator ?

(*d*) Calculate the mean free path of nitrogen molecule at 300 K and one atmosphere pressure. The molecular diameter of nitrogen is $3{\cdot}5 \times 10^{-8}$ cm.

(*e*) The rate of a reaction (r) of a substrate (s), catalyzed by an enzyme (E) is given by the equation : $r = K_1[E]\,[S]/K_2 + [S]$. Draw the '$r$' vs. $[S]$ graph. Suggest one linear plot for determination of K_1 and K_2.

(*f*) A positive catalyst usually makes the reaction proceed via a path having lower activation energy. Explain. Is the reverse statement true for a negative catalyst ?

(*g*) Show that Joule-Thomson effect for a real gas originates due to deviation from Joule's law and Boyle's law.

(*h*) The signs of temperature coefficient of viscosity are different for liquids and gases – explain.

GROUP – B

(*Industrial*)

Subgroup – B (a)

Answer any **one** question : 15×1

8. (*a*) Discuss the principle of thin layer chromatography. What is R_f factor. $3 + 1$

(*b*) Discuss about the process of catalytic cracking. Why craking is done ? $4 + 2$

(*c*) Define vitrification and devitrification of glass. 2

(*d*) What are pesticides ? Name one organochloride pesticide and one organo phosphate pesticide. 3

9. (*a*) Define hydrogenation of oil. Why it is done ? Discuss physicochemical principles of hydrogenation of oil. $(1\frac{1}{2} + 1\frac{1}{2} + 4)$

(*b*) Why gypsum is added to portland cement ? Explain. 2

(*c*) Define iodine number. Discuss Wij's method for quantitative evaluation of unsaturation in fat or oil. 1 + 3

(*d*) What is carburated water gas ? 2

Subgroup – B (b)

Answer any **two** questions : 10 × 2

10. (*a*) Briefly discuss the process for deionisation of water. 4

(*b*) What do you mean by mixed fertiliser ? Discuss the process of manufacturing of urea from ammonia with flow chart. 1 + 3

(*c*) What is reclaimed rubber ? 2

11. (*a*) Discuss the process of manufacture of portland cement with flow diagram. 2

(*b*) Detergents are better than soap for working with hard water. – Comment. 4

(*c*) Methyl orange is used as an indicator but not as a dye. – Comment. 2

(*d*) Why HCV is higher than LCV ? 2

12. (*a*) What is Ziegler-Natta catalyst ? Write its use. 2

(*b*) Write down the structure of repeat unit and name of monomer for the following polymers : 2

(*i*) SBR

(*ii*) PET.

(*c*) What is sequestering agent ? 2

(*d*) Define the following : 2

(*i*) Flash point

(*ii*) Aniline point.

(*e*) What is toner ? 2

13. (*a*) Discuss the method of manufacture of Nylon-66 with flow diagram. 4

(*b*) What is the meaning of 66 of Nylon-66 ? 1

(*c*) Give physical and chemical definition of glass. 2

(*d*) Why AS_2O_3 is added to the raw materials for preparation of glass ? 1

(*e*) What is semi water gas ? 2

Subgroup — B (c)

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

(*a*) What is AK-33 X ? Write its use.

(*b*) What is white cement ?

(*c*) How refinery gas is freed from H_2S ?

(*d*) What are the qualities of a good fertilizer ?

(*e*) What is repeat unit ? What is the minimum value of repeat unit for a polymer ?

(*f*) Why does photochromatic glass not function in lamp light ?

(*g*) Write the full name and use of DOP.

(*h*) What do you mean by standard deviation ?

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