

(3 Hours)

[Total Marks: 100]

- N.B. :** (1) All questions are compulsory.
 (2) Figures to the right indicate full marks.
 (3) Use of logarithmic table / non-programmable calculator is allowed.

Physical constants :

A	= 0.509 at 298 K for water.	h	= 6.626×10^{-34} Js
N	= 6.022×10^{23}	c	= 3×10^8 m s ⁻¹
F	= 96500 C	pi.(π)	= 3.142
R	= $8.314 \text{ J K}^{-1} \text{ mol}^{-1}$	Mass of electron	= 9.109×10^{-31} kg.
$\frac{2.303 RT}{F}$	= 0.0592 at 298 K	1 a m u	= 1.66×10^{-27} kg
1 a m u	= 931 MeV		
H	= 1		
Cl	= 35.5		

Q.1 Attempt any four of the following

- (A) What is the origin of dipole moment? Explain the structure of CO₂ and SO₂ on basis of dipole moment. **05**
- (B) Obtain the expression for the wave number of fundamental band and first overtone in an anharmonic oscillator. **05**
- (C) Give a comparative study of IR spectra with Raman spectra. (any five points). **05**
- (D) Explain the Rule of Mutual Exclusion with the help of CO₂ molecule. **05**
- (E) The rotational constant for HCl molecule is 1059 m^{-1} . Find the bond distance in the molecule. Also Calculate the oscillation frequency of this molecule if the force constant is 516 N m^{-1} . **05**
- (F) A diatomic molecule was exposed to radiations of wave number $2.222 \times 10^6 \text{ m}^{-1}$. The first Anti Stoke's line was obtained at $2.2580 \times 10^6 \text{ m}^{-1}$. Calculate the Raman shift, wave number for first Stoke's line and difference between first Stoke's and Anti Stoke's line. **05**

Q.2 Attempt any four of the following

- (A) Describe the Dynamic method for measuring the lowering of vapour pressure. **05**
- (B) What is meant by reverse osmosis? Give any three applications of it. **05**
- (C) Derive thermodynamically the expression for relation between boiling point elevation of a solution and mole fraction of solute. **05**
- (D) An aqueous solution of compound A (mol wt = 60) boils at 373.12 K, determine the concentration of the solution. By how much would the normal boiling point of water be raised on dissolving 3.0 g of the same compound A in 84.0 g water. ($k_b = 0.512 \text{ K kg mol}^{-1}$). **05**
- (E) Explain the Lindemann's unimolecular theory of reaction rate. **05**
- (F) Describe the Flash Photolysis method to study fast reactions. **05**

- Q.3** Attempt any four of the following 15
- (A) Explain the construction and working of Geiger Muller counter with the help of appropriate diagram. 05
- (B) Give an example of artificial radioactivity. Distinguish between artificial and natural radioactivity (any three points). 05
- (C) Describe the basic components of a nuclear reactor. 05
- (D) Give two applications of radioisotopes being used as tracers to study reaction mechanism. 05
- (E) The Q-value of the nuclear reaction: $^{24}\text{Mg} + {}^2\text{H} \longrightarrow \text{Na} + {}^4\text{He}$. is 2.1413 MeV. Calculate the isotopic mass of Na, the mass of:
 $^{24}\text{Mg} = 23.9427 \text{ a m u}$, ${}^2\text{H} = 2.0147 \text{ a m u}$, ${}^4\text{He} = 4.00381 \text{ a m u}$. 05
- (F) Define decay constant. A radio element has half-life of 140 days. How much time in seconds will be required so that activity falls to 0.05^{th} of its original value. 05
- Q.4** Attempt any four of the following
- (A) State BET equation, identify the terms involved in it, test the validity of the equation. 05
- (B) Give the assumptions on which Langmuir adsorption isotherm is based. 05
- (C) Describe any two methods by which colloids acquire electric charge. 05
- (D) Derive an expression to show that at equilibrium, the distribution of diffusible salt is influenced by the presence of non-diffusible salt across semipermeable membrane. 05
- (E) Describe an experiment to study electrophoresis. 05
- (F) Explain the use of surfactants in pesticide and food industry. 05
- Q.5** Answer the following questions
- (A) Match the following the following. (any five) 05
- | | |
|---|---------------------------|
| a. Rotational energy level. | i. Hertz |
| b. Raman spectra. | ii. HCl molecule |
| c. Microwave active. | iii. linear molecule |
| d. $3n-5$ | iv. unequally spaced |
| e. Number of vibrational mode for CH_4 molecule. | v. IR radiations |
| f. Moment of inertia. | vi. scattering of light |
| g. Changes in rotational and vibrational energy. | vii. kg m^2 |
| h. Frequency | viii. non linear molecule |
| | ix. H_2 molecule |
| | x. 9 |
| | xi. 10 |

- (B) State **True** or **False** for the following. (any five) 05
- Berkley Hartley method is used to determine depression in freezing point .
 - The salt of Na_2SO_4 in aqueous solution dissociates to give two ions
 - Liquids with weak intermolecular forces are less volatile.
 - Osmotic pressure is related to the activity of the solvent.
 - Beckmann thermometer is a differential thermometer.
 - For slow reaction $P < 1$.
 - Collision theory considers reacting molecules as rigid spheres.
 - According to Collision theory, the colliding molecules possess translational and rotational motion.
- (C) Fill in the blanks from the given words. (any five) 05
- ($K > 1$, ^{239}Pu , endoergic , fission , ^{235}U , exoergic, fusion, (n,p), anthracene, (p, n), $K = 0$.)
- _____ is used as phosphor in Scintillation counter.
 - Threshold energy is calculated for _____ nuclear reactions.
 - _____ is fissile material.
 - Fission reaction is sustained if _____.
 - _____ reactions are known as thermonuclear reactions.
 - $^{27}\text{Al} + ^1_0\text{n} \longrightarrow ^{27}\text{Mg} + ^1_1\text{H}$ is _____ type of transmutation.
 - ^{238}U can be converted into _____
- (D) Define : (any five). 05
- Adsorption isotherm
 - Critical Micelle concentration
 - Sol
 - Gel
 - Dispersed phase
 - Colloidal electrolyte
 - isoelectric point.
