

(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	= $6.626 \times 10^{-34}$ Js
N	= $6.022 \times 10^{23}$	c	= $3 \times 10^8$ m s <sup>-1</sup>
F	= 96500 C	pi.( $\pi$ )	= 3.142
R	= $8.314$ J K <sup>-1</sup> mol <sup>-1</sup>	Mass of electron	= $9.109 \times 10^{-31}$ kg.
$\frac{2.303 RT}{F}$	= 0.0592 at 298 K	1 a m u	= $1.66 \times 10^{-27}$ 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 CO<sub>2</sub> and SO<sub>2</sub> 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 CO<sub>2</sub> molecule. 05
- (E) The rotational constant for HCl molecule is  $1059$  m<sup>-1</sup>. Find the bond distance in the molecule. Also Calculate the oscillation frequency of this molecule if the force constant is  $516$  N m<sup>-1</sup>. 05
- (F) A diatomic molecule was exposed to radiations of wave number  $2.222 \times 10^6$  m<sup>-1</sup>. The first Anti Stoke's line was obtained at  $2.2580 \times 10^6$  m<sup>-1</sup>. 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. ( $k_b = 0.512$  K kg mol<sup>-1</sup>). 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  $0.05^{\text{th}}$  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 $\text{CH}_4$ molecule. | v. IR radiations          |
| f. Moment of inertia.                                     | vi. scattering of light   |
| g. Changes in rotational and vibrational energy.          | vii. $\text{kg m}^2$      |
| h. Frequency  | viii. non linear molecule |
|   | ix. $\text{H}_2$ 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  $\text{Na}_2\text{SO}_4$  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
- ( $K > 1$ ,  $^{239}\text{Pu}$ , endoergic, fission,  $^{235}\text{U}$ , 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.
  - $^{238}\text{U}$  can be converted into \_\_\_\_\_
- (D) *Define : ( any five).* 05
- Adsorption isotherm
  - Critical Micelle concentration
  - Sol
  - Gel
  - Dispersed phase
  - Colloidal electrolyte
  - isoelectric point.

\*\*\*\*\*