

[Time : 3Hours]

[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 Constant:

$$N = 6.022 \times 10^{23}$$

$$R = 8.314 \text{ J/K mol}$$

$$\text{Mass of electron} = 9.109 \times 10^{-31} \text{ Kg}$$

$$c = 3.0 \times 10^8 \text{ m/s}$$

$$h = 6.626 \times 10^{-34} \text{ Js}$$

$$1 \text{ amu} = 931 \text{ MeV} = 1.66 \times 10^{-27} \text{ Kg}$$

1. Attempt any four of the following:
- A. A material is irradiated with a wavelength of 435.8 nm and the first Raman line appears at 440.1 nm. Calculate the Raman shift and identify the type of line. 5
 - B. Derive the expression for the moment of inertia (I) of a rigid rotor. 5
 - C. Explain different types of stretching and bending modes of vibration in molecule. 5
 - D. Define dipole moment. Explain the structure of CO_2 and SO_2 on the basis of dipole moment. 5
 - E. Derive an expression for frequency of P and R branch lines in IR spectra of diatomic molecule. 5
 - F. Calculate the wave number of the first four lines in the rotational spectrum of diatomic molecule $^{12}\text{C}^{16}\text{O}$. ($I = 1.457 \times 10^{-46} \text{ kgm}^2$). 5
2. Attempt any four of the following:
- A. Describe the dynamic method for determination of relative lowering of vapour pressure when a nonvolatile solute is added to solvent. 5
 - B. Define ebullioscopic constant. Aqueous solution of urea boils at 374.15 K. What is its molality? ($k_b = 0.512 \text{ Km}^3 \text{ mol}^{-1} \text{ kg}$) 5
 - C. Derive VantHoff's equation for osmotic pressure. 5
 - D. Derive Lindemann's Unimolecular theory of reaction rates. 5
 - E. Describe the stop flow method to study the kinetics of fast reaction. 5
 - F. 2.50 g of naphthalene (m.wt :128) is dissolved in 25.0 g of benzene. The freezing point of pure benzene is 278.5K, and the freezing point of the solution is 275.8K. What is the molal freezing point depression constant, K_f of benzene? 5
3. Attempt any four of the following:
- A. With a neat labeled diagram, explain the principle and working of Geiger-Muller counter. 5
 - B. The ^{14}C activity of a sample of wood from the sample is 5.6 dpm/gm. If in living plants the equilibrium value of ^{14}C activity is 24.4 dpm/gm, calculate the age of sample of wood. (Half-life of ^{14}C is 5720 years) 5
 - C. Derive an equation for the Q value of a nuclear reaction. 5
 - D. Write a note on artificial transmutation. Give any two artificial nuclear reactions. 5

- E. With the help of diagram, describe different components of a nuclear power reactor 5
- F. Write thermonuclear fusion reactions involved in the carbon Nitrogen cycle which occur in stellar bodies. 5
4. Attempt **any four** of the following:
- A. State BET equation; identify terms involved in it. Test the validity of the equation. 5
- B. Explain the different types of adsorption isotherm with one example of each. 5
- C. What is electro-osmosis? How is it studied experimentally? 5
- D. What is meant by electric double layer? Explain it with a diagram. 5
- E. Absorption of hydrogen gas forms a complete monolayer on the surface of charcoal, the volume of hydrogen reduced to S. T. P was found to be 1.79 per g of charcoal. Calculate the surface area of adsorbent, if the area occupied by one hydrogen molecule is $15.0 \times 10^{-20} \text{ m}^2$. 5
- F. Write a note on surfactants. 5
5. Answer the following:
- A. Choose the correct option and fill in the blank (Any five) 5
 [Wagging, Simple harmonic, Isotopes, Negative, Microwave, μr^2 , Zero, Centre of symmetry]
- a. Dipole moment of CO_2 molecule is -----
- b. Equation of moment of inertia $I =$ -----
- c. Rotational spectra are obtained in ----- region.
- d. Vibrational motion of a single particle is ----- motion.
- e. In Anti stokes line Raman shift is -----
- f. Mutual exclusion rule is applicable for those molecules that possess----
- g. ----- is out of plane vibration.
- h. ----- is the same atomic number but different mass number.
- B. Select whether the following statements are **true** or **false** (Any five) 5
- a. A property which depends upon the number of particles of solute and independent of its nature is called additive property.
- b. If a solution boils at a temperature T_1 and solvent at temperature T_2 , then the elevation in boiling point is $T_2 - T_1$.
- c. The depression in freezing point in a one molal solution is called as cryoscopic constant
- d. Ostwald and Walker method is used to determine the osmotic pressure of the solution.
- e. The probability factor in the rate equation considers the orientation of the molecules.
- f. The collision frequency is inversely proportional to the concentration of the reacting molecule.
- g. Flash photolysis technique is used to determine the rate of a slow reaction.

- C. Select and write the appropriate answer. (Any five) 5
- _____ can be used as phosphor in a scintillator counter.
 - NaCl
 - KCl
 - Anthracene
 - Ethanol
 - The average life of a radioactive element is _____ times the half-time.
 - 0.693
 - 0.963
 - 0.44
 - 1.44
 - The process of converting the stable nucleus of one element into unstable nucleus of another element by bombarding it with fast moving particle is called _____.
 - Artificial radioactivity
 - Natural transmutation
 - Natural disintegration
 - Artificial redox reaction
 - _____ can be used as moderator in nuclear power reactor.
 - D₂O
 - Boron
 - Ferrous
 - Cadmium
 - Q value of nuclear reaction is related to mass defect by relation, $Q =$
 - $931 / m$ Mev
 - $\Delta m / 931$ Mev
 - $\Delta m \times 931$ Mev
 - $\Delta m \times 0.931$ Mev
 - In Geiger-Muller counter can not detect _____ radiation efficiently.
 - α
 - γ
 - β
 - ${}^4\text{He}_2$
 - Which of the following is fertile material?
 - ${}^{233}\text{U}$
 - ${}^{235}\text{U}$
 - ${}^{239}\text{Pu}$
 - ${}^{232}\text{Th}$
 - Predict the projectile in the following reaction.

$${}^{10}\text{B}_5 + \text{_____} \rightarrow {}^7\text{Si}_3 + {}^4\text{He}_2$$
 - ${}^2\text{H}_1$
 - ${}^1\text{n}_0$
 - ${}^1\text{D}_2$
 - ${}^1\text{H}_1$

- D. Match the column: (Any five) 5
- | | |
|--------------------------|---------------------------------------|
| a. Lyophobic sol | i. Alumina |
| b. Gum Arabic | ii. Cold cream |
| c. W/O emulsion | iii. Gel |
| d. SO ₂ | iv. Silica gel |
| e. Zeta potential | v. Adsorbate |
| f. Adsorbent | vi. $\zeta = \frac{4\pi l \sigma}{D}$ |
| g. Diffused double layer | vii. Dorn effect |
| | viii. Proposed by Guoy model |
| | ix. Electrophoresis |
| | x. Micelles |