

[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:

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

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

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

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

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

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

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 CO₂ and SO₂ 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 ¹²C¹⁶O. (I = 1.457 × 10⁻⁴⁶ kgm²). **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 Kmol⁻¹kg) **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 ¹⁴C activity of a sample of wood from the sample is 5.6 dpm/gm. If in living plants the equilibrium value of ¹⁴C activity is 24.4 dpm/gm, calculate the age of sample of wood. (Half-life of ¹⁴C 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.

