

[Time :2 ½ Hours]

[Total marks: 75]

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 Three of the following: 15
- A. Derive an expression for the wave number of a line in the pure rotational spectrum of a diatomic molecule. ($\Delta\bar{\nu} = 2B$) 5
- B. Define dipole moment. Explain, how the following pairs of molecules can be distinguished using based on dipole moment: 5
- (i) BF_3 and NH_3
- (ii) SO_2 and CO_2
- C. What are the different modes of vibration, explain them with suitable diagram. 5
- D. Distinguish between Stoke's and Antistoke's line and explain with energy diagram. 5
- E. A laser of 488 nm excites a molecule, and a Raman line appears at 512 nm. 5
- i) Is it Stokes line or Antistokes line ii) Calculate the Raman shift
2. Attempt Any Three of the following 15
- A. Derive the relation between the freezing point depression of a solution containing a non-volatile solute and the mole fraction of the dissolved solute. 5
- B. State relative lowering of vapour pressure. Describe the static method for experimental determination of relative lowering of vapour pressure 5
- C. Calculate the boiling point of a solution containing 1.5 g of anthracene ($M = 176$) in 50 g chloroform. The boiling point of pure chloroform is 334.2 K, and its ebullioscopic constant is 3.85 Kkgmol^{-1} . 5
- D. Describe how stop flow method is used to study the kinetics of fast reactions 5
- E. Derive Lindemann theory of reaction rate of a unimolecular reaction 5
3. Attempt Any Three of the following 15
- A. i) What are phosphor materials used in scintillator counter. Give an example 5
- ii) Give advantages of scintillator counter over G-M counter
- B. Differentiate between chemical equilibrium and radioactive equilibrium 5
- C. Calculate the nuclear energy value (Q value) for the following nuclear reaction. 5
- $${}^{14}_7\text{N} + {}^4_2\text{He} \rightarrow {}^{17}_8\text{O} + {}^1_1\text{H}$$
- (${}^{14}_7\text{N} = 14.0075 \text{ amu}$; ${}^4_2\text{He} = 4.0038 \text{ amu}$; ${}^{17}_8\text{O} = 17.0045 \text{ amu}$; ${}^1_1\text{H} = 1.0079 \text{ amu}$)
- D. With the help of a suitable diagram, explain the working of a nuclear power reactor. 5
- E. Explain the term multiplication factor (K). 5
- Give conditions, where $K = 1$, $K > 1$ and $K < 1$.

C.

Match the column:

(Any five)

5

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|------------------------------|---|
| a. Out of plane vibration | i. Has a centre of symmetry |
| b. CO ₂ | ii. Fission nuclear reaction |
| c. Starch dissolved in water | iii. Endoergic nuclear reaction |
| d. Fast reaction | iv. Charcoal |
| e. Artificial transmutation | v. Twisting |
| f. Stellar bodies | vi. $i=1$ |
| g. Adsorbent | vii. $i < 1$ |
| h. Stern model | viii. Rate constant between 10^2 to $10^5 \text{ dm}^3 \text{ mol}^{-1} \text{ s}^{-1}$ |
| | ix. Fusion nuclear reaction |
| | x. diffused layer of oppositely charged ions |
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