

[Time: 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:

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

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

$$F=96500 \text{ Coulombs}$$

$$k=1.38 \times 10^{-23} \text{ K}^{-1}$$

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

$$1 \text{ a.m.u.} = 1.66 \times 10^{-27} \text{ kg} = 931 \text{ MeV}$$

$$c=3 \times 10^8 \text{ m/s}$$

$$H=1 \text{ a.m.u.}$$

$$\pi=3.142$$

$$Cl=35.5 \text{ a.m.u.}$$

**1. Attempt any four of the following:**

- A.** Explain the structure of  $\text{CO}_2$  and  $\text{SO}_2$  on the basis of dipole moment. **5**
- B.** Derive an expression for frequency separation of lines in the rotational spectrum of a diatomic molecule. **5**
- C.** Explain P and R branch lines in rotational –vibrational spectra. **5**
- D.** What is Raman effect and Raman shift? Explain Stokes and anti-Stokes lines. **5**
- E.** The frequency separation in rotational spectra of  $\text{HCl}$  is  $1100 \text{ m}^{-1}$ . Calculate the bond length. **5**
- F.** Define zero point energy. The vibrational frequency of a molecule is  $5.1 \times 10^5 \text{ m}^{-1}$ . Calculate the zero point energy of the molecule. **5**

**2. Attempt any four of the following:**

- A.** Derive the expression for the relationship between the freezing point of depression of a solution and the mole fraction of the dissolved solute. **5**
- B.** Describe the Beckmann method and Rast method to determine depression in freezing point. **5**
- C.** Define van't Hoff factor. What is significance? How is it useful in the study of association or dissociation of electrolytes in solution? **5**
- D.** What is fast reaction? Describe the stop flow method to study the kinetics of fast reaction. **5**
- E.** Explain the following terms. **5**
  - i) Activation energy
  - ii) Molecular activation
- F.** Calculate the boiling point of a solution containing 1.04 g of anthracene ( $M=176$ ) in 70 g Chloroform. The boiling point of pure chloroform is  $334.2 \text{ K}$  and its ebullioscopic constant is  $3.85 \text{ K kg mol}^{-1}$ . **5**

3. Attempt **any four** of the following:

- A. What is a scintillation counter? Describe its working with particular reference to the Photomultiplier tube. 5
- B. Explain how radioisotopes are used as tracers in reaction mechanism of Photosynthesis and structure determination. 5
- C. Explain with the help of a labelled diagram, the principle and working of a nuclear reactor. 5
- D. What is a scintillation counter? Describe its working with particular reference to the Photomultiplier tube. 5
- E. Calculate Q – value for the following nuclear reaction – 5  
 $^{235}\text{U} + {}^1_0\text{n} \rightarrow {}^{141}\text{Ba} + {}^{92}\text{Kr} + 3 {}^1_0\text{n}$   
 Given isotopic masses in a.m.u. –  
 $\text{U} = 235.1175$                        $\text{Kr} = 91.9264$   
 $\text{Ba} = 140.9527$                        $\text{n} = 1.0089$
- F. The activity of a radioelement falls to half its initial value in 5 days. 5  
 Calculate (i) decay constant and (ii) the time for the activity to fall to  $1/10^{\text{th}}$  its original value.

4. Attempt **any four** of the following:

- A. Discuss with the example, theory of preferential adsorption accounting for charge on colloids. 5
- B. What is meant by electrokinetic potential? List the four electrokinetic effects associated with colloids? 5
- C. Write a short note on Donnan membrane equilibrium. 5
- D. What are surfactants? Give applications of surfactants. 5
- E. State the postulates of Langmuir adsorption isotherm. 5
- F.  $15 \times 10^{-3} \text{ dm}^3$  of nitrogen is adsorbed by 1 g of powder copper at S. T. P. 5  
 Calculate its surface area. (1 molecule of  $\text{N}_2$  occupies  $1.7 \times 10^{-19} \text{ m}^2$  surface.)

5. Answer the following:

- A. State whether the following statements are **true or false (Any five)** 5
  - a. Unit of dipole moment is kg.
  - b. Water has a linear structure.
  - c. Rotational spectra is observed in HBr molecule.
  - d. For linear molecules degrees of freedom is  $(3n-5)$ .
  - e. In stretching vibrations, the bond length changes.
  - f. Scissoring vibrations are in-plane vibrations.
  - g. Twisting vibrations are out-of-plane vibrations.
  - h. Raman spectra is obtained due to scattering of radiation.
- B. Fill in the blank with appropriate words given in the bracket (**Any five**) 5
  - a. [ ----- ]  
 ----- is not of the colligative property.  
 [ vapour pressure , Elevation of boiling point ,  
 Depression of frizzling point , Osmotic pressure ]

- b. The relative lowering of vapour pressure is equal to the ----- of the solute in a solution  
[ fraction , mole fraction , normality, molarity ]
- c. A semipermeable membrane is permeable to ----- molecule only.  
[ solvent , solute , solution , collides ]
- d. A Beckmann thermometer is a ----- thermometer.  
[ regular , normal , differential , fractional ]
- e. The van't Hoff equation for osmotic pressure is valid for ----- solution.  
[ concentrated , saturated , dilute , distilled water ]
- f. The rate of reaction increased by a factor of ----- for 100 rise in temperature.  
[ two , one , zero , ten ]
- g. Kinetics of photochemical reactions are studied using ----- method.  
[ stop flow , flash , photolysis , flash photolysis ]

C. Select and write the appropriate answer. (Any five)

5

- a. Which type of radiation is the least penetrating?  
a) alpha  
b) beta  
c) gamma  
d) neutron
- b. Nuclear fission always  
a) has Very less energy released.  
b) is an energetically favorable process for heavy atoms.  
c) a neutron is split into a neutron and an electron.  
d) are non spontaneous.
- c. Which particle is absorbed when  $^{58}\text{Fe} \rightarrow ^{59}\text{Fe}$ ?  
 $? + ^{58}\text{Fe} \rightarrow ^{59}\text{Fe}$   
a)  $\alpha$  particle  
b) electron  
c) neutron  
d) proton
- d. Name the coolant used in the nuclear reactor?  
a) Plutonium  
b) Thorium  
c) Graphite  
d) Boron
- e. The atomic number increases by one during what type of radioactive decay?  
a) alpha  
b) beta  
c) gamma  
d) positron

- f.  $\alpha$  particles are identical with
- Helium nucleus
  - Hydrogen nucleus
  - Electron
  - proton
- g. These have an unstable nucleus and undergoes radioactive decay.
- Radioisotopes
  - Isotones
  - Isobars
  - isotopes
- h. Which isotope of Uranium has the capacity to sustain the chain reaction?
- U-230
  - U-235
  - U-245
  - U-225

**D.**

**Match the column:**

**(Any five)**

**5**

- |  |                                    |
|--|------------------------------------|
| a. Freundlich Adsorption Isotherm        | i. Smoke                           |
| b. Langmuir Adsorption Isotherm          | ii. Foam                           |
| c. Adsorbent                             | iii. Gelatin                       |
| d. Aerosol solid                         | iv. $\frac{x}{m} = kP^{1/n}$       |
| e. Lyophobic sol                         | v. Gold sol                        |
| f. Emulsifier                            | vi. $\theta = \frac{K_p}{1 + K_p}$ |
| g. $\text{AgNO}_3$ added to excess of KI | vii. Silica gel                    |
|  | viii. Surfactant                   |
|  | ix. Negatively charged sols        |
|  | x. Positively charged sols         |

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