

[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 -  
 $^{235}\text{U} + {}^1_0\text{n} \rightarrow {}^{141}\text{Ba} + {}^{92}\text{Kr} + 3 {}^1_0\text{n}$  5  
 Given isotopic masses in a.m.u. -  
 U = 235.1175      Kr = 91.9264  
 Ba = 140.9527      n = 1.0089
- F. The activity of a radioelement falls to half its initial value in 5 days. Calculate: (i) decay constant and (ii) the time for the activity to fall to  $1/10^{\text{th}}$  its original value. 5

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. Calculate its surface area. (1 molecule of  $\text{N}_2$  occupies  $1.7 \times 10^{-19} \text{ m}^2$  surface.) 5

5. Answer the following:

- A. State whether the following statements are true or false (Any five) 5
- Unit of dipole moment is kg.
  - Water has a linear structure.
  - Rotational spectra is observed in HBr molecule.
  - For linear molecules degrees of freedom is  $(3n-5)$ .
  - In stretching vibrations, the bond length changes.
  - Scissoring vibrations are in-plane vibrations.
  - Twisting vibrations are out-of-plane vibrations.
  - 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 freezing 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)

- 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) Bismuth
- 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         |