3 hours **Total Marks: 100**

N.B.

1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Use of log tables /non-programmable calculator is allowed.

Physical constants:

N=6.023 x 10^{23}

F=96500 Coulombs

R=8.314 J/K/mol

h=6.626 x10^{-34} J.s

c= 3x 10^{8} m/s

1 a. m. u =1.66 x10^{-27} kg = 931 MeV

Q1 Attempt ***any four*** of the following:

A. Derive an expression for frequency separation of lines in the rotational spectrum of a diatomic molecule. **5**

B. i. The vibrational frequency of a molecule 3× 10^{5} m^{-1}. Calculate the zero point energy. **3**

ii. Draw a suitable diagram to explain the isotopic effect on energy level of rotational spectrum of C^{12} O and C^{13} O molecules. **2**

C. Derive the general expression for frequency of R-branch lines. Diagrammatically show the transition for R_0, R_1, R_2 and R_3 lines. **5**

D. i. A substance was exposed to radiation of wavelength 4.5 × 10^{-6} m. The first Stokes line appeared at 5.4 × 10^{-6} m. Calculate the Raman Shift. **3**

ii. Calculate degree of vibrational freedom for H_2O and CO_2 molecules. **2**

E. What is meant by Raman Scattering? What are Stokes and Anti Stoke's lines? How do they differ from Rayleigh line? **5**

F. Show that for an anharmonic oscillator the wave number of the fundamental and first overtone bands are in the ratio of 1:2. **5**

Q2 Attempt ***any four*** of the following:

A. Derive thermodynamically the relation $\Delta T_b = K_b \times m$. **5**

B. i. State and explain Raoult's law of lowering of vapour pressure. **3**

ii. Explain 'Reverse osmosis'. **2**

C. State the important assumptions of collision theory of reaction rates. **5**

D. Calculate the boiling point of a solution containing 1.02 g of anthracene (M = 176) in 70 g chloroform. The boiling point of pure chloroform is 334.2 K. and its ebullioscopic constant is 3.85 Kkgmol^{-1}. **5**

E. Explain the 'flash photolysis' method to study fast reactions. **5**

F. Describe Rast method to determine the depression in freezing point. **5**

Q3 Attempt ***any four*** of the following:

A. Explain the construction and working of Scintillation counter. **5**

B. Explain the important components of a nuclear power reactor. **5**

C. The Q – value for the reaction $^{27}Al + {}^{2}H \rightarrow {}^{25}Mg + {}^{4}He$ **5**

is 6.7033MeV. Calculate the isotopic mass of ^{2}H

^{27}Al = 26.9900 amu

^{4}He = 4.0038 amu

^{25}Mg= 24.9937 amu

D. i. Distinguish between Natural radioactivity and Artificial radioactivity. **3**

ii. Define the following terms: i) Curie ii) Mass number iii) Isotope **2**

E. Explain the thermonuclear reactions occurring on earth. **5**

F. The activity of a radioactive element falls to half its original value in 4.0 hours. Calculate the decay constant and average life of the radioelement. Also calculate the time in which activity reduces to one tenth of its original value. **5**

Q4 Attempt ***any four*** of the following:

A. i. State the postulates of Langmuir's adsorption isotherm. **3**
ii. Explain the use of surfactants in the food industry. **2**

B. Explain the origin of electric charge on a colloid (any two methods) **5**

C. i. State the BET equation and test the validity for it. **5**

D. i. Distinguish between physical and chemical adsorption (any two points). **3**
ii. Define:- i) Colloidal electrolytes ii) Micelle iii) Critical Micelle concentration **2**

E. Explain the Donnan Membrane Equilibrium. **5**

F. Explain the Helmholtz and Stern's concept electrical double layer. **5**

Q5 A) Fill in the blanks**:- (Any five)** **5**

(second overtone, greater, microwave, rocking, waging, kgm^2, $\lambda s > \lambda i$, $\frac{h}{8\pi^2 Ic}$, $\lambda s < \lambda i$ 1^{st} overtone)

a. Unit for moment of inertia for a rotating molecule is _____.
b. Out of plane vibration _____.
c. In plane vibration _____.
d. Molecules exhibit rotation spectra in _____ region.
e. In Stoke's scattering, _____.
f. For an anharmonic oscillator, transition from v=0 to v=3 is called as _____.
g. Rotational constant B = _____.
h. Greater the value of force constant 'K', _____ is the bond length.

Q5 B) State true or false:- **(any five)** **5**

a. A Beckman thermometer is a differential thermometer.

b. Van't Hoff factor 'i' is always unity for non electrolytes.
c. Ostwald & Walker method is used to determine lowering of vapor pressure.
d. Osmotic pressure is not a colligative property.
e. The freezing point of solvent will not change on addition of the solute.
f. Lindemann's theory is applicable to unimolecular reactions.
g. Stop flow method is used to study the kinetics of slow reactions.
h. When a chemical reaction obeys collision theory p=1.

Q5 C) Fill in the blanks**:- (any five)** **5**

(K=1, Target, ethanol vapor, ^{235}U, ^{238}U, gamma rays, $_{94}Pu^{239}$)

a. In G-M counter, _____ is used as a quenching agent.
b. The parent element which is bombarded with a fast moving particle is called _____.
c. _____ is a fissile material.
d. _____ is a fertile material.
e. If _____ fission reaction proceeds at a steady rate.
f. In a breeder reaction $_{92}U^{238}$ is converted into _____.
g. _____ are not effected by magnetic and electric field.

Q5 D) Match the following: - **(any five)** **5**

Column A		Column B	
a.	Lyophilic colloid	i.	Unimolecular adsorption
b.	Langmuir's adsorption isotherm	ii.	Multi molecular adsorption
c.	Promoter	iii.	Retards rate of reaction
d.	Silicagel	iv.	Soap
e.	Colloidal electrolyte	v.	Sodium chloride
f.	BET isotherm	vi.	Solvent loving
g.	inhibitor	vii.	Increases rate of reaction
		viii.	Adsorbate

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