[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 $\times 10^{8}$ m/s

R = 8.314 J/K mol h = 6.626 $\times 10^{-34}$ Js

Mass of electron = 9.109 $\times 10^{-31}$Kg 1 amu = 931 MeV = 1.66 $\times 10^{-27}$ 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 CO_2 and SO_2 on the basis of dipole moment. **5**

E. Derive and 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 $^{12}C^{16}O$. (I = 1.457$\times 10^{-46}$ kgm^2). **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^{-1}kg) **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 ^{14}C activity of a sample of wood from the sample is 5.6 *dpm/gm*. If in living plants the equilibrium value of ^{14}C activity is 24.4 *dpm/gm*, calculate the age of sample of wood. (Half-life of ^{14}C 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 15.0×10^{-20} 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.

C. Select and write the appropriate answer. **(Any five)** **5**

a. _____ can be used as phosphor in a scintillator counter.
a) NaCl c) Anthracene
b) KCl d) Ethanol

b. The average life of a radioactive element is _____ times the half-time.
a) 0.693 c) 0.44
b) 0.963 d) 1.44

c. The process of converting the stable nucleus of one element into unstable nucleus of another element by bombarding it with fast moving particle is called _____
a) Artificial radioactivity c) Natural disintegration
b) Natural transmutation d) Artificial redox reaction

d. _____ can be used as moderator in nuclear power reactor.
a) D_2O b) Boron c) Ferrous d) Cadmium

e. Q value of nuclear reaction is related to mass defect by relation, Q =
a) 931 / m Mev c) Δm x 931 Mev
b) Δm / 931 Mev d) Δm x 0.931 Mev

f. In Geiger-Muller counter can not detect _____ radiation efficiently.
a) α b) γ c) β d) $^4He_2$

g. Which of the following is fertile material?
a) ^{233}U b) ^{235}U c) ^{239}Pu d) ^{232}Th

h. Predict the projectile in the following reaction.
$^{10}B_5 + \_\_\_\_\_ \rightarrow {}^7Si_3 + {}^4He_2$
a) $^2H_1$ b) $^1n_0$ c) $^1D_2$ d) $^1H_1$

D. **Match the column:** **(Any five)** **5**

a.	Lyophobic sol	i.	Alumina
b.	Gum Arabic	ii.	Cold cream
c.	W/O emulsion	iii.	Gel
d.	SO_2	iv.	Silica gel
e.	Zeta potential	v.	Adsorbate
f.	Adsorbent	vi.	$\zeta=\frac{4\pi l\sigma}{D}$
g.	Diffused double layer	vii.	Dorn effect
		viii.	Proposed by Guoy model
		ix.	Electrophoresis
		x.	Micelles
