[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 Constants:

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

$\frac{2.303\ RT}{nF} = \frac{0.0592}{n}$ at 298K

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

A. Show that the separation between successive lines in the rotational spectrum of a diatomic molecule are always equally spaced. **5**

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

C. Write a short note on the Rule of Mutual exclusion. **5**

D. Distinguish between Stokes and Antistokes line. **5**

E. The equilibrium, internuclear distance in NO molecule is $1.15A^0$.Calculate the energy of the first rotational energy level in the molecule(N=14,O=16) **5**

F. A substance was exposed to radiation of wavelength 400 nm. The first Stokes line appeared at 500 nm. Calculate the Raman shift and energy change for the molecule. **5**

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

A. Derive thermodynamic relationship for osmotic pressure π = CRT **5**

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

C. i) Explain how relative lowering of vapour pressure is related to the mole fraction of solute. **5**

ii) Give any two applications of reverse osmosis

D. 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 K and its ebullioscopic constant is 3.85 K .Kg.mol $^{-1}$ **5**

E. Explain Lindemann's unimolecular theory of reaction rate. **5**

F. Explain flash photolysis method to study ultra-fast reactions. **5**

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

A. Describe the construction and working of G.M. counter. **5**

B. What are Phosphors? What are conditions for ideal phosphors and explain its classification. **5**

C. What are tracers? Explain it's application in establishing mechanism of Ester hydrolysis and Photosynthesis reaction. **5**

D. What is nuclear transmutation? Explain it with two nuclear reactions. **5**

E. For ^{27}Al (n, γ) reaction Q value is 7.222 MeV. If the mass of ^{27}Al and the neutron is 26.990080 a.m.u. and 1.0089830 a.m.u. respectively. Calculate the mass of the product nucleus? **5**

F. What is nuclear fission? Explain the factors controlling fission process. **5**

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

A. Explain the different types of absorption isotherms. **5**

B. What is electro-osmosis ? How is it studied experimentally? **5**

C. Absorption of nitrogen on an iron catalyst was determined at 78 K. The BET plot of the data yielded the value of V_m is 8.40×10^{-3} dm^3 per gram of adsorbent, when reduced to NTP. Assuming that the gas molecules adsorbed in the first layer are closely packed. Calculate the surface area of adsorbent. Molecular area of nitrogen is 0.16×10^{-18} m^2. **5**

D. Explain the terms --- **5**

i) Surfactants

ii) Emulsifier

E. Explain the postulates of Langmuir adsorption isotherms. **5**

F. Write short note on Donnan membrane equilibrium. **5**

5. Answer the following:

A. Select whether the following statements are **true** or **false (Any five)** **5**

a. The selection rule for the rotational spectrum in a diatomic molecule is $\triangle J = +2$

b. Molecules exhibit electronic transitions in IR region

c. Benzene has 30 modes of vibrations.

d. In Stokes scattering the frequency of the scattered radiation is less than that of the incident radiation.

e. For water molecule symmetric stretching vibrational modes are IR Active.

f. The isotopic abundance can be determined by intensity of spectra lines.

g. For Stokes line, Raman shift is positive.

h. The dipole moment of BF_3 molecule is zero.

B. Fill in the blank with appropriate words **(Any five)** **5**

a. Relation between ebullioscopic constant, molecular weight and elevation of boiling point is –

a) $\Delta T_b = K_b \times m$ b) $\Delta T_f = K_f \times m$ c) $\Delta T_b = K_b / m$ d) $\Delta T_b = T - T_0$

b. In --------method to determine lowering of vapour pressure, $CaCl_2$ is used as adsorbent.

a) Rast b) Beckmann c) Dynamic d) Berkeley

c. For a solute undergoing dissociation the Vant Hoff's factor "i "has value----

a) i=1 b) i>1 c) i<1 d) i=0

d. Which if the following is not colligative property?

a) Vapour pressure b) Elevation of boiling point

c) Depression in freezing point d)Lowering of vapour pressure

e. Reaction of heamoglobin with O_2 and CO_2 is example of----------
a)Fast reaction b) slow reaction c) ultra slow reaction d) moderate reaction

f. The number of collisions per second per cubic centimeter in any gas given by kinetic theory of gases as ----------

a) $Z= 2\ n^2\ \sigma^2 \sqrt{\frac{\pi RT}{M}}$ b) $Z= n^2\ \sigma^2 \sqrt{\frac{\pi RT}{M}}$

c) $k= Z\ .-e^{-Ea/RT}$ d)) $k = 2\ Z\ .-e^{-Ea/RT}$

g. In Stop flow method mixing of reactants occurs for time of----seconds
a) 10^{-3} b) 10^{-4} c) 10^{-5} d) 10^{-6}

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

a. Average life of radioactive nuclei is ----------times its half-life period
a) 1/0.693 b) 0.693 c) 1.14 d) 8.314

b. If 10 grams and 100 grams radioactive samples of same radioactive element is taken. Which of the following is correct about its half-life?
a) 10 grams will have more half-life b)100 grams will have more half life
c) Both will have same half-life c) depend upon temperature of the sample

c. 1 Curie is equal to ---------- dps.
a) 3.7 b) 3.7×10^{10} c) 3.14×10^{6} d) 3.7×10^{4}

d. Which of the following isotopes is not a radioisotope?
a) ^{14}C b) ^{18}O c) ^{2}H d) ^{14}N

e. Which one of the following processes results in an increase in the atomic number?
a) gamma emission b) positron emission c) beta emission d) alpha emission

f. Nuclear detectors don't measure ------- of radiation
a) Energy b) Count c) Type d) Source

g. Using Carbon dating, age of which of the following sample cannot be determined
a) Human bodies b) Teakwood c) Iron rod d) Coal sample

h. If Δm is 0.1 amu, Q value is -----
a) 93.1MeV b) 1.966MeV c) 200.6MeV d) 931x 10^4MeV

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

a.	Adsorbent	i.	Gum arabic
b.	Electrophoresis	ii.	Nickel
c.	Gel	iii.	Retards the rate of reaction
d.	Milk	iv	O/W emulsion
e.	Lyophobic sol	v.	Helmholtz model
f.	Electric double layer	vi.	Micelle
g.	Inhibitor	vii.	The migration of ion under the influence of applied electric field
		viii.	Silica gel
		ix.	Sterns model
		x.	Cold cream

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