[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 = 6.023 x 10^{23}	1 a.m.u. = 1.66 x 10^{-27} kg
F = 96,500 C	**= 931 MeV**
R = 8.314 J / K/mol	2.303RT / F = 0.05916 at 298K
h = 6.626 x 10^{-34} J.s	H = 1 a. m. u.
c = 3 x 10^{8}	I = 127 a. m. u.

1. 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. Explain the structure of CH_4 on the basis of dipole moment. **5**

C. Show that the frequency of fundamental, first and second overtone bands in anharmonic oscillator are in the ratio 1: 2: 3. **5**

D. What is Raman effect and Raman shift? Explain Stokes and anti-Stokes lines. **5**

E. The frequency separation in rotational spectra of HI is 1100 m^{-1}. Calculate the bond length. **5**

F. A substance was exposed to radiation of wavelength 3.5 x 10^{-6} m. The first Stokes line appeared at 4.5 x 10^{-6} m. Calculate the Raman shift. **5**

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

A. What is meant by relative lowering of vapour pressure? Explain the Dynamic method of measurement of lowering of vapour pressure. **1+4**

B. Derive from the Thermodynamic principles the relation for elevation in boiling point $\Delta T_b = \frac{RT_0^2}{\Delta H_v} x^2$. **5**

C. Explain reverse Osmosis and give any two of its applications. **3+2**

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

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

F. When 3g of phenol, was dissolved in 50g of benzene the solution was found to freeze at 3.55^0C. The freezing point of benzene is 5.5^0 C and its cryoscopic constant is 5.12 K kg mol^{-1}. Calculate the molecular weight of phenol in benzene. **5**

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

A. Explain the behaviour of ion pairs in electric field. **5**

B. Explain how reaction mechanism of Friedel-crafts reaction and ester hydrolysis be explained with the help of radioisotopes used as tracers. **5**

C. With the help of suitable example distinguish between fissile and fertile material. **5**

D. Explain the Carbon – Nitrogen cycle. **5**

E. Calculate Q – value for the following nuclear reaction – **5**
$^{24}Mg + {}^{2}H \rightarrow {}^{22}Na + {}^{4}He$
Given isotopic masses in a.m.u. –
Mg = 23.9927 H = 2.0147
Na = 22.0013 He = 4.004

F. Wooden artifact and a freshly cut tree give 8.3 and 24.9 counts $min^{-1}g^{-1}$ carbon. The half-life period of carbon is 57760 years. Calculate the age of the wooden artifact. **5**

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

A. Distinguish between physical adsorption and chemical adsorption. **5**

B. What is adsorption phenomenon? Adsorption of hydrogen on a certain catalyst material was determined at 78 K. The BET plot data yielded the value of υ_m as 1.56×10^{-3} dm^3g^{-1} of the adsorbent, when reduced to NTP. Assuming that the gas molecule adsorbed in first layer are closely packed, calculate the surface area of the adsorbent. Molecular area of hydrogen is 15.84×10^{-20} $m^{2.}$ **5**

C. What are emulsions? How are they classified? Give example for each type. **5**

D. Write a short note on electrophoresis of sols. **5**

E. Give applications of surfactants. **5**

F. Discuss origin of charge on colloidal particle due to effect of dispersion medium and self-dissociation of colloidal solutions. **5**

5. Answer the following:

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

a. Unit of dipole moment is cm.
b. Water has a linear structure.
c. Rotational spectra are observed only for molecules having permanent dipole moment
d. For non-linear molecules degrees of freedom is (3n-6).
e. In stretching vibrations, the bond length changes.
f. Rocking vibrations are in-plane vibrations.
g. Twisting vibrations are out-of-plane vibrations.
h. For a molecule to be Raman active, there must be change in polarizability of the molecule.

B. Choose the correct answer. **(Any five)** **5**

a. For an Ideal solution, Van't Hoff factor '*i*' is_____
i) Zero
ii) Equal to one
iii) Less than one
iv) Greater than one

b. _____ method is used for determination of molecular weight of solute.
i) Static
ii) Rast
iii) Dynamic
iv) Berkeley and Hartley's

c. Molal elevation constant is the elevation in boiling point when _____ of solute is dissolved in 1 Kg of solvent.
- i) 1 g
- ii) 1 Kg
- iii) 1 mole
- iv) 1 milli mole

d. When NaCl solution is separated from water by a semipermeable membrane,
- i) Water flows into NaCl Solution
- ii) Both flow into each other
- iii) There is no flow of water or NaCl
- iv) NaCl flows into water

e. The minimum energy molecule must possess so that they can react upon collision is called as _____.
- i) Boltzmann energy
- ii) Collision energy
- iii) Activation energy
- iv) Molecular energy

f. Stop flow method is used to study kinetics of _____ reactions.
- i) Slow
- ii) Very slow
- iii) Fast
- iv) Moderate

g. Maxwell-Boltzmann law gives explanation about _____.
- i) basis for bimolecular reactions
- ii) The collision theory
- iii) Activated complex theory.
- iv) Distribution of velocities of gases

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

a. In a nuclear reaction
- i. Change in nucleus of the atom takes place.
- ii. New elements can be produced.
- iii. Rate of reaction is dependent on temperature.
- iv. They are not often accompanied by the release of enormous amounts of energy.

b. A Geiger-Muller tube is a _____.
- i. gas ionization detector
- ii. cloud chamber
- iii. fluorescence detector
- iv. photographic detector

c. Which of the following describes what occurs in the fission process?
- i. A heavy nucleus is fragmented into lighter ones.
- ii. A neutron is split into a neutron and proton.
- iii. Two light nuclei are combined into a heavier one.
- iv. A proton is split into three parts.

d. Complete and balance the following equation. The missing term is.
^{239}Pu + alpha particle → ____ + neutron
i. 2 ^{106}Rh
ii. ^{235}U
iii. ^{233}Pa
iv. ^{242}Cm

e. The neutrons used for fission process are called as
i. Fast neutrons
ii. Slow neutrons
iii. fermions
iv. bosons

f. After three half-lives, what fraction of the original radioactive isotope remains?
i. 1/16
ii. 1/4
iii. 1/8
iv. 1/2

g. A nuclear reactor that produces more fuel than it consumes for power production are called.
i. Power reactor
ii. Batch reactor
iii. Breeder reactor
iv. Thermal reactor

h. Name the moderator used in the nuclear reactor?
i. Plutonium
ii. Thorium
iii. Graphite
iv. Berilium

D. Match the column: (Any five) 5

a.	$[AgCl]Cl^- \mid K^+$	**i.**	Catalysts
b.	Vanishing cream	**ii.**	Electrokinetic phenomenon
c.	Adsorbent	**iii.**	Colloidal electrolyte
d.	Sedimentation potential	**iv.**	Negative charged
e.	Unequal distribution of NaCl across semipermeable membrane in presence of protein	**v.**	Positive charged
f.	Potassium oleate	**vi.**	Electroosmosis
g.	Thixotropy	**vii.**	Donnan equilibrium
		viii.	Water in oil
		ix.	Oil in water
		x.	Gelatine