Exlia

[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

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. State and explain the Rule of Mutual exclusion with the help of CO_2 molecule. **5**

D. Distinguish between Stoke's and Antistoke's line **5**

E. The frequency separation between the rotational lines of CO is 19.8cm^{-1}. Calculate the rotational constant and bond length at equilibrium. (C=12, O=16) **5**

F. Define Raman shift. 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. Define colligative properties and molal elevation constant .Give the equation relating molal elevation constant and latent heat of vaporization per gram of the solvent **5**

B. Show thermodynamically the elevation of boiling point of a dilute solution varies directly to the mole fraction of a solute **5**

C. Determine experimentally the Osmotic Pressure of a solution by Berkley and Hartley's Method **5**

D. 3.5g of a substance X (M.wt =180) is dissolved in 100g of water .Calculate the boiling point of the solution (k_b =0.512 Kmol^{-1}kg) **5**

E. Give an expression for collision number. What are the merits of collision theory of reaction rate **5**

F. Discuss the classification of reactions based in rate constant and half life time of the reaction. **5**

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

A. With a neat labelled diagram, explain the principle and working of scintillator counter. **5**

B. Write note on i) Artificial transmutation ii) Artificial radioactivity **5**

C. The activity of radioactive carbon (^{14}C) of a sample of wood obtained from a excavation is 2.7 *dpm/gm*. If in living plant the equilibrium value for radioactive carbon (^{14}C) is 10.8 *dpm/gm*, calculate the age of the sample of wood. (Given: Half life time for ^{14}C is 5730 years. **5**

D. What is Q value of nuclear reaction? What is mass defect? Derive relation between mass defect and Q value for nuclear reaction. **5**

E. Explain role of essential components of nuclear reactors. **5**

F. Write thermonuclear fusion reactions involved in the carbon cycle which occur on stellar bodies. **5**

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

A. Distinguish between physical adsorption and chemical adsorption. 5

B. State the postulates of Langmuir adsorption isotherm 5

C. How the surface area of adsorbent is determined using BET equation? 5

D. Discuss with illustration the origin of electric charge on a colloid. 5

E. Volume of nitrogen gas V_m measured at STP required to form a complete monolayer on a sample of silica gel is 129 cm^3/ gram of gel. Calculate the surface area per gram of the gel, if each nitrogen molecule occupies area $16.2 \times 10^{-20} m^2$ 5

F. Write a note on surfactants 5

5. **Answer the following:**

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

a. Carbon dioxide has permanent dipole moment

b. Molecules exhibit electronic transitions in the UV-visible region.

c. The zero point energy in anharmonic oscillator is zero

d. For Anti-Stokes line, Raman shift is negative.

e. A non-linear molecule with N atoms has 3N-6 modes of vibration.

f. Rayleigh scattering takes place when wavelength of incident radiation equals to wavelength of scattered radiation.

g. Scissoring is an out of plane vibration.

h. In CO_2 molecule symmetric stretching is Raman inactive

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

a. Colligative property depends on ____
(amount of volatile solute added, type of the solute, amount of non-volatile solute added)

b. Osmotic pressure is inversely proportional to _____ of the solution
(volume , temperature ,concentration)

c. When a non-volatile solute added to a solvent there is_____.
(increase in freezing point , decrease in boiling point, lowering of vapour pressure)

d. Beckmann Method is used to experimentally determine _____
(elevation in boiling point ,lowering of vapour pressure , depression in freezing point)

e. For ideal solutions Vant Hoff's factor is _____.
(one, greater than one ,lesser than one)

f. Lindemann's theory is applicable to _____ reactions
(bimolecular, unimolecular , trimolecular)

g. Energy of activation _____
(of fast reaction is greater than for a slow reaction , of fast reaction is lower than for a slow reaction ,is same for all type of reactions)

h. When a chemical reaction obeys collision theory, the probability factor is_____
(P=1 , P < 1 ,P > 1)

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

a. In Geiger-Muller counter is based on the principle of _____.
a) Cloud chamber b) Scintillation c) Ionization chamber d) Vaporization

b. _____ can be used as shielding material in nuclear power reactor.
a) Graphite b) Carbon c) Lead d) Cadmium

c. In the nuclear transmutation reaction, the parent element which is bombarded with fast moving particle is called _____.
a) Target b) Recoil Nucleus c) Projectile d) Ejected particle

d. If multiplication factor (K) for nuclear reaction is greater than one, reaction said is to be _____
a) Super critical b) Inert b) Sub critical d) self-sustained

e. Geiger-Muller counter cannot detect _____ radiation efficiently.
a) α b) γ c) β d) positron

f. For a nuclear reaction, if Q value is positive reaction is said to be
a) exoergic b) Endoergic c) Exothermic d) Endothermic

g. Thermonuclear reactions are _____ type of nuclear reaction.
a) Fission b) Fusion c) artificial d) low energy

h. Predict the projectile in the following reaction.

$$^{10}B_5 + \_\_\_\_ \rightarrow {}^{7}Si_3 + {}^{4}He_2$$

a) $^{2}H_1$ b) $^{1}n_0$ c) $^{1}D_2$ d) $^{1}H_1$

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

a.	Adsorbate	i.	Silica gel
b.	Adsorbent	ii.	SO_2 gas
c.	Sol	iii.	Nickel
d.	Stabilizer	iv	Retard the rate of reaction
e.	Gum arabic	v.	Gel
f.	Inhibitor	vi.	Stabilise the emulsion
g.	Electric double layer	vii.	Chemisorption
		viii.	Helmholtz model
		ix.	Micelle

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Extra

[Time : 2 ½ Hours] [Total marks :75]

N.B. : (1) All questions are compulsory.
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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

1. Attempt **Any Three** of the following: 15
   - **A.** Explain the effect of isotopic substitution on the rotational energy level of a diatomic molecule 5
   - **B.** Show that in an anharmonic oscillator the fundamental, first overtone band are in the ratio of 1:2 5
   - **C.** Explain the different stretching and bending modes of vibrations in a molecule. 5
   - **D.** Write a short note on quantum theory of Raman spectra. 5
   - **E.** A diatomic molecule is irradiated with the radiation of wavelength 437nm. A Raman line appears at 459.5nm. Calculate the Raman Shift. Also comment whether the line is Stokes or Anti Stokes line. 5

2. Attempt **Any Three** of the following: 15
   - **A.** Show thermodynamically the elevation in boiling point of the solution is a colligative property. 5
   - **B.** Describe the experimental determination of relative lowering of vapour pressure by static method. 5
   - **C.** Calculate the osmotic pressure of the solution containing 3.5g of urea (molecular weight 60 g/mole) dissolved in 100 cm^3 of water at 293K. 5
   - **D.** Derive Lindemann's theory of reaction rate of a unimolecular reaction. 5
   - **E.** Describe how flash photolysis method used to study the kinetics of fast reactions. 5

3. Attempt **Any Three** of the following: 15
   - **A.** With a neat labelled diagram, explain the principle and working of Geiger-Muller counter 5
   - **B.** Differentiate between natural and artificial radioactivity. 5
   - **C.** Explain, how process of carbon dating is used in determination of age of material? 5
   - **D.** Calculate the nuclear energy value for the following nuclear reaction. 5

$$^{24}_{12}Mg + {}^{2}_{1}H \rightarrow {}^{22}_{11}Na + {}^{4}_{2}He$$

($^{24}_{12}$N = 23.9972 amu; $^{4}_{2}$He = 4.00381 amu; $^{22}_{11}$Na = 22.0013 amu; $^{2}_{1}$H = 2.0147 amu)

   - **E.** What are essential components of nuclear reactors? Discuss their roles in nuclear reactors. 5

4. Attempt **Any Three** of the following: 15

A. State the assumptions or postulates on which Langmuir adsorption isotherm is based. 5

B. Adsorption of a certain gas forms a complete monolayer on charcoal. The volume of gas adsorbed reduced to NTP conditions was found to be 125 cm^3 per gram of adsorbent. Calculate the surface area of the adsorbent. The area occupied by each gas molecule is 14.6×10^{-20} m^2. 5

C. Describe any two methods by which colloids acquire electric charge. 5

D. Explain Electrophoresis with a neat labelled diagram, state equation relating electrophoretic mobility and zeta potential. 5

E. What are surfactants? Discuss the application of surfactants in (i) food industry (ii) detergents. 5

5. **Answer the following:**

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

a. The dipole moment of trans chloroethane is zero

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

c. The salt of K_2SO_4 in aqueous solution dissociates to give two ions

d. Collision theory considers reacting molecules as rigid spheres.

e. SI unit of radioactivity is 1 curie.

f. Controlled thermonuclear reactions are possible with the heavier isotopes of hydrogen.

g. Physical adsorption is a multimolecular phenomenon.

h. Lyophilic colloids are water hating

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

a. _____ line is not a part of Raman lines.
a) Rayleigh b) Stoke's c) Antistoke's d) absorption

b. Rule of mutual exclusion is applicable to those molecules which possess_____ of symmetry
a) Centre b) axis c) plane d) length

c. Relative lowering of vapour pressure for a solution is equal to mole fraction of the _____.
a) ions b) volatile solvent
c) non volatile solute d) non volatile solvent

d. Ebullioscopic constant is the elevation in boiling point produced when one mole of solute is dissolved in _____ of solvent
a) 100g b) 10g c) 1000g d)1g

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

f. Which of the given is not an application of radiotracer technique_____
a) Photosynthesis b) Power Generation
c) Carbon dating d) Determination of reaction mechanism

g. The heat of adsorption in chemical adsorption is in between____ $KJ\ mol^{-1}$.
a) 40-400 b) 4-40 c) 4 - 400 d) 400 - 4000

h. _____ is a system in which liquid is a dispersed phase and solid is the dispersion medium
a) Gel b) Emulsion c) Solid foam d) solution

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

a.	Non-linear molecule	i.	Adsorbate
b.	CO_2 molecule	ii.	Van't Hoff factor is greater than 1
c.	Solute dissociates in solution	iii.	heterogeneous in nature
d.	Collision frequency	Iv	Number of collisions per unit time
e.	Breeder reactor	v.	Van't Hoff factor is less than 1
f.	Multiplication factor	vi.	3n-6
g.	SO_2	vii.	Fertile material
h.	Colloids	viii.	Zero dipole moment
		ix.	Production factor
		x.	Adsorbent
