

CSM : 17

CHEMISTRY PAPER - I

Time Allowed : 3 hours

Full Marks : 100

Marks for each question is indicated against it.

Attempt any 5 (five) questions taking not more than 3 (three) questions from each Part.

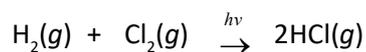
PART - A

1. (a) Discuss the elements of symmetry present in a cubic crystal. (5)
- (b) Calculate the maximum radius ratio r_A/r_B for an atom A to fit in the simple cubic lattice of atom B. (4)
- (c) Represent diagrammatically the unit cell for body centred cubic lattice. Show that the volume of space occupied for a *bcc* arrangement is about 68%. (1+4=5)
- (d) Draw and explain the phase diagram for water system and also point out the difference from the carbon dioxide system. (6)
2. (a) State the principle of equipartition of energy and discuss its application in estimating the heat capacity of an ideal gas at room temperature. (5)
- (b) For hydrogen gas, calculate the root mean square velocity, average velocity and most probable velocity at 0°C.
[Given that molar mass of $H_2 = 2.016 \text{ g mol}^{-1}$, $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$] (5)
- (c) Derive expression for the entropy change of an ideal gas accompanying variation of temperature and pressure. (5)
- (d) What is inversion temperature? Show that for a van der Waals gas, the inversion temperature is given by $T_i = 2a/Rb$. (5)
3. (a) Discuss the Michelis-Menten equation for an enzyme-substrate reaction. (4)
- (b) Write the expression for Langmuir adsorption isotherm and Freundlich adsorption isotherm and show that at normal pressure, Langmuir's unimolecular adsorption isotherm becomes identical with Freundlich adsorption isotherm. (2+4=6)

- (c) What is meant by electrochemical series? Using the data given below, find out whether Zn and Ag would react with dilute sulphuric acid or not. (1+4=5)

Given: Electrodes	$E_{\text{electrode}}^{\circ}$ (Volts)
$\text{Zn}^{2+}, \text{Zn}$	-0.76
Ag^{+}, Ag	+0.80
$2\text{H}^{+}, \text{H}_2(\text{g}); \text{Pt}$	0.00

- (d) Discuss the advantages of dropping mercury electrode (DME) as the working electrode in polarography. (5)
4. (a) Obtain the integrated rate expression for the second order reaction when both the reactants are the same. (4)
- (b) What is temperature coefficient and discuss the effect of temperature on reaction rates. (4)
- (c) What are radiative and non-radiative transitions? Discuss the Jablonski diagram for depicting various photophysical processes. (2+4=6)
- (d) Discuss the kinetics of the following photochemical reaction: (6)



PART B

5. (a) Explain Heisenberg's uncertainty principle and show that this principle is valid only for microscopic particles and not for macroscopic objects. (5)
- (b) Describe the radial probability distribution curves for electrons in 3s, 3p and 3d orbitals. (5)
- (c) How is the neutron-to-proton ratio related to nuclear stability? (5)
- (d) Point out the important applications of radioactive isotopes in the field of medicine and analytical chemistry. (5)
6. (a) Explain the geometry of NH_3 and BF_3 on the basis of hybridization and VSEPR theory. (5)
- (b) Write the molecular orbital energy level diagram of oxygen molecule and explain the magnetic property of O_2 . Also explain why it is different from the MO energy level diagram of N_2 molecule. (1½ + 1½ + 2 = 5)
- (c) What is hydrogen bond? Discuss the effect of hydrogen bonding on the melting point and boiling point of compounds. (1+4=5)
- (d) What do you mean by Cooperativity effect and Bohr's effect in hemoglobin? (5)

7. (a) What is meant by catenation? Discuss the catenation property of group 15 elements. **(1+4=5)**
- (b) What is inert pair effect? Discuss how it affects the relative stability of various oxidation states among group 13 elements. **(1+4=5)**
- (c) Write a brief note on the variable oxidation states shown by elements of first transition series. **(5)**
- (d) Give a brief account of the tendency of transition metals to form complex compounds and the stability of their complexes. **(5)**
8. (a) Describe ion-exchange method for the separation of lanthanides. **(5)**
- (b) Explain the structure and bonding in diborane. **(5)**
- (c) Discuss viscosity method for the determination of molar mass of macromolecules. **(6)**
- (d) Write one method of preparation of polyphosphonitrilic chloride and also discuss structure of the cyclic trimer. **(1+3=4)**

* * * * *