

Time: Four Hours

Full Marks: 60

Questions are of value as indicated in the margin.

Group - A

Answer *any two* questions.

1. a) What will be the stablest structure of PCl_3F_2 according to Bent's rule. Give explanation. 3
b) Comment on the stability order of O_2 , O_2^+ and O_2^{++} according to MO theory. 3
c) What will be the hybridized state of central atoms of the following molecules?
(i) BF_3 , (ii) H_2O , (iii) C_2H_4 and (iv) SF_4 4
2. a) What is intramolecular hydrogen bonding? Give example. 2
b) Sort out the following molecules according to polar and non-polar character:
(i) NH_3 , (ii) C_2H_2 , (iii) CO_2 and (iv) CH_3Cl . 2
c) What do you mean by dipole moment of any molecule? Comment on the dipole moment of NF_3 . 2+2
d) Show the stablest structure of ClF_3 according to VSEPR theory and explain. 2
3. a) Comment on the stability and boiling point of H_2O and H_2S . 3
b) What do you mean by lattice energy of any molecule? Show the different steps of Born-Haber cycle to relate lattice energy and other energy parameters of NaCl . 2+3
c) Compare the bond energy of Cl_2 and Br_2 . 2

Group - B

Answer *any two* questions.

1. a) What do you mean by the term 'radical'? Write down a reaction that involves the formation of radical intermediate. Show the reaction mechanism of the reaction. 2+2+4
b) Write down the structure of 2-methyl-1-butanol. 2
2. Write down the name of the different types of nucleophilic substitution reaction. Discuss in detail the mechanism of any one kind of such reaction. Comment on the stereochemistry involved in that reaction. 2+4+4
3. What do you mean by elimination reaction? State the differences between elimination and addition reaction. Offer an example of a nucleophilic addition reaction and show the mechanism of it. 2+2+(2+4)

Group - C

Answer *any two* questions.

1. a) State the Arrhenius theory of dissociation. 2
b) Show that for any aqueous solution.
$$\text{pH} + \text{pOH} = \text{pK}_w$$
 4
c) Show that $[\text{H}_3\text{O}^+] \approx \sqrt{K_n C}$ in a solution containing a salt formed from a weak base and a strong acid. 4
2. a) What is the pH of 0.02 M NaOH . 3

- b) In a saturated solution of calcium phosphate, the concentration of PO_4^{3-} ion is $3.3 \times 10^{-7} \text{ M}$.
Calculate the K_{sp}° of $\text{Ca}_3(\text{PO}_4)_2$. 4
- c) Explain why a solution of CuSO_4 is acidic? 3
3. a) What do you understand by the terms buffer capacity? 2
b) What is an acid-base indicator? 2
c) Why is the synthesis of NH_3 preferably carried out at low temperature and high pressure? 3
d) For a chemical reaction at equilibrium involving only gases, derive the following expressions:
$$K_{\text{p}}^\circ = K_{\text{c}}^\circ \left(C^\circ \text{RT} / P^\circ \right)^{\Delta v_{\text{g}}}$$
and K_{p}° , K_{c}° have their usual meanings. 3
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