

2024

2nd Semester Examination (CCFUP : NEP)

CHEMISTRY

Paper : MJ 2-T (Single Core Major)

(Inorganic Chemistry - I)

Full Marks : 40

Time : Two Hours

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers  
in their own words as far as practicable.*

Group - A

Answer any *five* questions.

2×5=10

1. Show that the de-Broglie wavelength of the electron in the first Bohr orbit of hydrogen atom is  $2\pi a_0$  [where  $a_0 = 1^{\text{st}}$  Bohr radius].
2. The atomic radii of Zr and Hf are almost identical. Explain.
3. What is auride ion? Why is it formed?
4. State Hund's rule of maximum multiplicity. Calculate the exchange energy of  $d^6$  system.

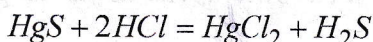
P.T.O.

( 2 )

5. Show that the oxidizing power of  $KMnO_4$  depends on the  $pH$  of the medium.
6. Deduce the atomic ground term symbol of gaseous  $Cr$  atom.
7. Calculate the equilibrium constant for the following redox reaction :  $Fe^{II} + Ce^{IV} = Fe^{III} + Ce^{III}$  (at  $25^\circ C$ )

$$\left[ E^\circ(Ce^{IV} / Ce^{III}) = 1.44 \text{ V and } E^\circ(Fe^{III} / Fe^{II}) = 0.77 \text{ V} \right]$$

8. Indicate with reasons about the direction of following reaction :



### Group - B

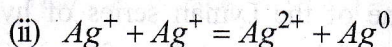
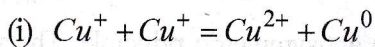
Answer any **four** questions.

5×4=20

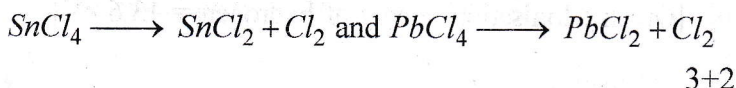
9. (a) If the bond length in  $KCl$  is  $3.14 \text{ \AA}$ , calculate the ionic radii of  $K^+$  and  $Cl^-$  using Slater's rule.  
(b) Electron affinity of  $Mn^{+3}$  is greater than that of  $Fe^{+3}$ . Explain. 3+2
10. (a) What is the levelling and differentiating effect of solvents?  
(b) How is Hardness of a base evaluated? Why methyl-mercury cation is chosen as the standard for the SHAB principle? 2+3

( 3 )

11. (a) Indicate the direction in which the following reactions proceed spontaneously and assign the reactions with appropriate name :



- (b) Compare the feasibility of the following thermal decomposition reactions with proper reasons :



12. (a) How does standard reduction potential of a redox couple differ from formal potential?

- (b) Explain the observation :  $Cu^{+2}$  ion easily liberates  $I_2$  from iodide but in presence of ethylenediamine it does not.

[Given :  $E^0(Cu^{2+}/Cu^+) = 0.15V$ ,  $E^0(Cu^{2+}/CuI) = 0.87V$

and  $E^0(I_2/I^-) = 0.54V$ ] 2+3

13. (a) State and explain the effect on acidity in the following cases :

(i) Addition of  $BiN$  to liquid  $NH_3$

(ii) Addition of glycerol in  $H_3BO_3$

P.T.O.



( 4 )

- (b) Using Pauling's first rule identify the structural formulation that nearly consistent with the first  $pK_a$  value 2.0 for  $H_3PO_2$ . 4+1

14. State the Pauli's antisymmetric principle. The wavelength of the first line of the Lyman series of hydrogen is identical to that of the second line of the Balmer series for some hydrogen like ion 'X'. Identify the ion and also find its ionisation energy.

[Given : Ionisation energy of hydrogen = 13.6 eV].

1+4

### Group - C

Answer any **one** question.

10×1=10

15. (a) What is the significance of the term 'Orbital magnetic quantum number'? Draw the vector orientation of the  $m_l$  values corresponding to  $l = 2$  in magnetic field. Terms are all of their usual significance.
- (b) What is radial distribution function? Compare radial distribution plots for  $2s$ ,  $2p$  and  $3s$  orbitals and hence comment on their relative penetration power.
- (c) The F-F bond distance in  $F_2$  is 141.4 pm. Calculate Allred-Rochow electronegativity of fluorine using Slater's rule. 3+4+3
16. (a) What are super acids? How the acidity of such solutions is measured? Explain with example.

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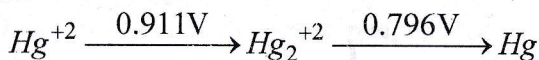
- (b) Addition of  $H_3PO_4$  is essential during the estimation of  $Fe(II)$  by  $K_2Cr_2O_7$  using Barium Diphenylamine Sulphonate (BDS) as indicator. Explain with suitable reasons.

$$\text{Given : } E^0 (Cr_2O_7^{-2} / Cr^{+3}) = 1.33V$$

$$E^0 (Fe^{+3} / Fe^{+2}) = 0.77V$$

$$E^0 [Ind(ox) / Ind(red)] = 0.76V$$

- (c) Draw a Frost diagram for mercury in acid solution from the given Latimer diagram :



Comment on the tendency of any of the species to undergo disproportionation. 3+3+4