

2023

(CBCS)

(1st Semester)

CHEMISTRY

FIRST PAPER

(Inorganic Chemistry—I)

Full Marks : 75

Time : 3 hours

The figures in the margin indicate full marks for the questions

(SECTION : A—OBJECTIVE)

(Marks : 10)

Tick (✓) the correct answer in the brackets provided :

1×10=10

1. Which of the following sets of quantum number is feasible?

(a) $n = 2, l = 2, m = -2, m_s = -1/2$ ()(b) $n = 2, l = 1, m = -1, m_s = +1/2$ ()(c) $n = 2, l = 0, m = -1, m_s = 0$ ()(d) $n = 2, l = 3, m = +1, m_s = +1/2$ ()

2. The radial wave function of an orbital determines

(a) size of the orbital ()

(b) size and orientation of the orbital ()

(c) orientation of the orbital ()

(d) None of the above ()

3. In the modern periodic table, the physical and chemical properties of the elements are periodic functions of their

- (a) atomic weight ()
- (b) mass number ()
- (c) electronic configurations ()
- (d) atomic number ()

4. What is the oxidation number of chlorine atom in HClO_2 ?

- (a) +1 ()
- (b) +2 ()
- (c) +3 ()
- (d) -1 ()

5. What is the geometrical shape of H_3O^+ ion according to VSEPR theory?

- (a) Trigonal bipyramidal ()
- (b) Tetrahedral ()
- (c) Square planar ()
- (d) Linear ()

6. Which of the following molecules has least tendency to form H-bonding?

- (a) H_2O ()
- (b) HCl ()
- (c) HF ()
- (d) NH_3 ()

7. Which of the following is a bidentate ligand?

(a) CN^- ()

(b) O_2^- ()

(c) $\text{H}_2\text{N}-\text{CH}_2-\text{CH}_2-\text{NH}_2$ ()

(d) NH_3 ()

8. What is the coordination number of cobalt in $[\text{Co}(\text{en})_2(\text{NH}_3)_2]\text{Cl}_3$?

(a) 3 ()

(b) 9 ()

(c) 4 ()

(d) 6 ()

9. During a β -decay, the atomic number increases by

(a) 2 units ()

(b) 1 unit ()

(c) 4 units ()

(d) 0 unit ()

10. Heavy water is used in nuclear reactor as

(a) a coolant ()

(b) a moderator ()

(c) both coolant and moderator ()

(d) a control rod ()

(SECTION : B—SHORT ANSWERS)

(Marks : 15)

Answer the following :

3×5=15

UNIT—I

1. Write down the mathematical form of Schrödinger wave equation and explain the terms involved in it.

OR

2. Explain why filling of 4s orbital takes place before 3d orbital.

UNIT—II

3. Define ionization energy and state its trend in a group of periodic table.

OR

4. Define oxidation number. Find the oxidation number of chromium atom in $K_2Cr_2O_7$ and $[Cr(H_2O)_6]Cl_3$.

UNIT—III

5. Write the hybridization and shapes of the BeF_2 and SF_6 using VSEPR theory.

OR

6. Explain why H_2O is a liquid whereas H_2S is a gas.

UNIT—IV

7. What are primary and secondary valences in a coordination compound? Explain the terms with examples.

OR

8. What do you mean by chelate effect? Give one example of a chelating ligand.

UNIT—V

9. Explain artificial radioactivity by giving suitable example.

OR

10. Write the group displacement law of radioactivity.

(SECTION : C—DESCRIPTIVE)

(Marks : 50)

Answer the following :

10×5=50

UNIT—I

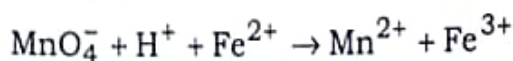
1. (a) Calculate the wavelength of an electron of mass 9.11×10^{-31} kg moving with a speed of 2.5×10^{-7} m/s. (Given : $h = 6.63 \times 10^{-34}$ J-s) 3
- (b) Write a brief note on Hund's rule of maximum multiplicity and apply it to write the electronic configuration of nitrogen and chromium. $1\frac{1}{2} + 1\frac{1}{2} = 3$
- (c) State and explain Pauli's exclusion principle. 2
- (d) Write down the Heisenberg's uncertainty principle and explain the terms involved in it. 2

OR

2. (a) What is effective nuclear charge (Z_{eff})? Calculate the effective nuclear charge for 3s-electron of cobalt. (Atomic Number = 27). $1+3=4$
- (b) Draw the radial probability distribution curve for 1s and 2p orbitals. 3
- (c) Find the values for the principal quantum number (n), azimuthal quantum number (l) and magnetic quantum number (m) of seventh electron in oxygen atom. 3

UNIT—II

3. (a) Why is electron affinity of chlorine higher than that of fluorine? Explain. 3
 (b) Why is second ionization potential usually higher than the first IP of elements? 3
 (c) Balance the following redox reaction by ion-electron method showing all the steps involved : 4



OR

4. (a) Define the equivalent weight of reducing agent. Calculate the equivalent weight of $\text{Na}_2\text{S}_2\text{O}_3$ in the following equation (mass = 248) : 1+3=4

$$\text{I}_2 + \text{Na}_2\text{S}_2\text{O}_3 \rightarrow \text{Na}_2\text{S}_4\text{O}_6 + \text{I}^-$$

 (b) Explain how ionic and atomic radii vary in a group and in a period. 3
 (c) What do you understand by the term 'electronegativity'? How does it change along a period in the periodic table? 3

UNIT—III

5. (a) Define coordinate bond. Explain its formation with the help of one example. 3
 (b) What are the hybridizations shown by the following molecules? Discuss the bond angles using VSEPR theory : 3

$$\text{CH}_4, \text{NH}_3, \text{H}_2\text{O}$$

 (c) Define hydrogen bonding. Write the two types of H-bonding with suitable examples. 2+2=4

OR

6. (a) Write the factors that cause the polarity in a covalent bond. 3
 (b) Predict the shapes of BF_3 and PCl_5 using VSEPR theory. 4
 (c) Define dipole moment. Explain why BH_3 does not have dipole moment whereas NH_3 has a dipole moment. 1+2=3

UNIT—IV

7. (a) Write the important postulates of Werner's theory. Write the different compositions of $\text{Co}(\text{NH}_3)_6 \cdot \text{Cl}_3$ according to Werner's theory. 4
- (b) Write the IUPAC name for the following compounds : $1 \times 3 = 3$
- (i) $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$
 - (ii) $\text{K}_3[\text{Fe}(\text{CN})_6]$
 - (iii) $[\text{PtCl}_2(\text{NH}_3)_4][\text{PtCl}_4]$
- (c) Define geometrical isomerism. Draw the *cis*- and *trans*-isomers of $[\text{PtCl}(\text{py})_2\text{NH}_3]$, where $\text{py} = \text{C}_5\text{H}_5\text{N}$. 3

OR

8. (a) Differentiate between double salt and coordination compound with suitable examples. 3
- (b) What is effective atomic number (EAN)? Calculate the EAN of the central atom in $\text{K}_3[\text{Fe}(\text{CN})_6]$. $1 + 2 = 3$
- (c) Define the following terms : $1 \times 4 = 4$
- (i) Ambident ligand
 - (ii) Coordination sphere
 - (iii) Coordination number
 - (iv) Bidentate ligand

UNIT—V

9. (a) Explain neutron-proton ratio of a nucleus and its implication on nuclear stability. 3
- (b) Write a brief note on nuclear fusion reaction. 3
- (c) Define half-life and average life of radioactive elements. How is the average life related to the half-life? $2 + 2 = 4$

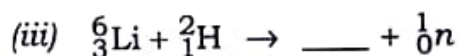
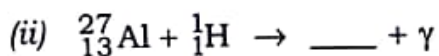
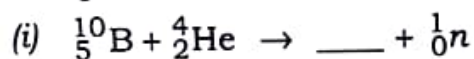
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10. (a) Write a short note on nuclear fission reaction.

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(b) Complete the following nuclear reactions :

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(c) Define mass defect and nuclear binding energy. How is the binding energy per nucleon related to the nuclear stability?

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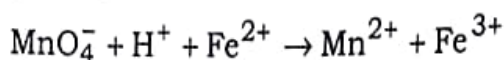
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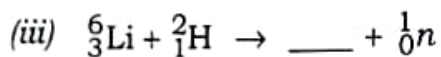
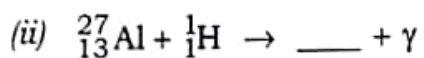
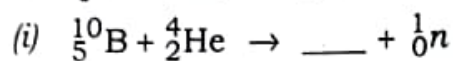
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