

Total number of printed pages-7

1 (Sem-4) CHE 1

2025

**CHEMISTRY**

Paper : CHE0400104

**(Inorganic Chemistry-I)**

Full Marks : 45

Time : Two hours

***The figures in the margin indicate full marks for the questions.***

1. Answer the following questions as directed :

1×5=5

(i) The point group symmetry for benzene is :

(a)  $C_{6h}$

(b)  $D_{6h}$

(c)  $C_{6v}$

(d)  $D_{2d}$

*(Choose the correct option)*



(ii) In the complex  $[E(en)_2(C_2O_4)]NO_2$  (where (en) ethylenediamine); the coordination number and the oxidation state of the element 'E' are respectively.

- (a) 6 and 2
- (b) 2 and 2
- (c) 4 and 3
- (d) 6 and 3

(Choose the correct option)

(iii)  $La^{3+}$ ,  $Lu^{3+}$ ,  $Yb^{2+}$ ,  $Ce^{4+}$  is diamagnetic, while  $Sm^{3+}$  exhibits low paramagnetic behaviour. Why?

(iv) Which of the following oxides of a first-row transition metal is most acidic in nature?

- (a)  $TiO_2$
- (b)  $Mn_2O_7$
- (c)  $Fe_2O_3$
- (d)  $CuO$

(Choose the correct option)

(v) The mass defect of a nucleus is 0.035 amu. If 1 amu corresponds to 931.5 MeV of energy, what is the binding energy of the nucleus?

- (a) 32.6 MeV
- (b) 326.0 MeV

(c) 26.6 MeV

(d) 931.5 MeV

(Choose the correct option)

2. Answer **any five** from the following questions : 2×5=10

(i) What do you mean by identity (E) and n-fold proper axis of symmetry ( $C_n$ ) element?

(ii) What is Nugget? How electrode potential values determine the occurrence of metal in ore.

(iii) Why do second and third transition series elements (e.g., Mo, W) exhibit higher oxidation states more readily than their first-row counterparts (e.g., Cr)?

(iv) Aqueous solution of  $Cu^{2+}$  ions is blue in colour whereas that of  $Zn^{2+}$  is colorless. Explain.

(v) Determine the configuration in term of  $t_{2g}^x e_g^y$  and the number of unpaired electrons of the  $[Fe(CN)_6]^{3-}$ .

(vi) Tetrahedral complexes are only high spin complexes. Explain.

- (vii)  $^{24}\text{Na}$  decays to one-fourth of its initial amount in 29.8 hours. Find out its decay constant.
- (viii) Explain why actinides form oxocation while lanthanides do not ?
- (ix) Which is more basic -  $\text{La}(\text{OH})_3$  or  $\text{Lu}(\text{OH})_3$  ? Why ?
- (x) What are interfering radicals ? When and Why is it necessary to remove ?

3. Answer **any four** from the following questions : 5×4=20

- (i) Discuss the conditions under which symmetry elements form a group.
- (ii) Find and show with diagram all the symmetry elements of either  $\text{NH}_3$  or  $\text{BF}_3$  molecule and write its point group.
- (iii) How the energy level of *d*-orbital changes during distortion of an octahedral  $\text{Cu}(\text{II})$  complex ? Discuss.
- (iv) Explain the trend in the acid-base character of oxides across the first-row transition elements. Why does  $\text{TiO}_2$  exhibit amphoteric behaviour, while  $\text{CuO}$  is basic ?

(v) Show and explain the *d*-orbital splitting from octahedral to square planar complexes via square pyramidal structure.

(vi) What is lanthanide contraction and what is its cause ? How the lanthanide contraction affects the basicity of ions ?

$$2+1+2=5$$

(vii) The Latimer diagram of Fe in acidic solution is given below :



(a) Calculate the  $E^0$  for the reduction of  $\text{Fe}^{3+}$  to Fe. 2

(b) What is the most stable oxidation state of Iron ? 1

(c) Does  $\text{Fe}^{2+}$  undergoes disproportionation ? Justify your answer. 2

(viii) Describe Fermi's theory of beta decay. Explain how the theory accounts for the emission of electrons and neutrinos in beta-minus decay.

4. Answer **any one** from the following questions :

(i) (a) A given molecule is assigned with the point group  $D_{3h}$ . What information will it provide in terms of symmetry ? 3

(b) What is the origin of paramagnetism in inorganic compound ?  $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$  more paramagnetic than  $[\text{Fe}(\text{CN})_6]^{3-}$ . Why ? 2+2=4

(c) What is an Ellingham diagram? What thermodynamic information does it provide about the formation of metal oxides ? 1+2=3

(ii) (a) Give an account for oxidation states, stability and magnetic properties of actinide elements and compare with those of the transition metals. 2×3=6

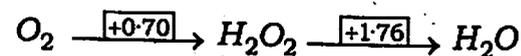
(b) What factors determine the stability of a nucleus, and how does the neutron-to-proton ratio influence whether a nucleus is likely to undergo radioactive decay ? 2+2=4

(iii) (a) What is meant by crystal field splitting energy ? On the basis of crystal field theory, write the electronic configuration of  $d^4$  in terms of  $t_{2g}$  and  $e_g$  in an octahedral field when (i)  $\Delta_0 > P$  and (ii)  $\Delta_0 < P$ . 1+2=3

(b) What is Jahn-Teller distortion ? Describe the conditions which lead to Z-out distortion in octahedral complexes ? 1+3=4

(c) Calculate the CFSE of a  $d^6$  complex having  $\Delta = 25000 \text{ cm}^{-1}$  and  $P = 15000 \text{ cm}^{-1}$ . 3

(iv) (a) Construct a Frost diagram from the following Latimer diagram.



5

(b) Discuss the applications of radioisotopes in age determinations. 5