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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 $[\text{E}(\text{en})_2(\text{C}_2\text{O}_4)]\text{NO}_2$ (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 $[\text{Fe}(\text{CN})_6]^{3-}$.
- (vi) Tetrahedral complexes are only high spin complexes. Explain.

(vii) ^{24}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 donot ?

(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 : $5 \times 4 = 20$

(i) Discuss the conditions under which symmetry elements form a group.

(ii) Find and show with diagram all the symmetry elements of either NH_3 or BF_3 molecule and write its point group.

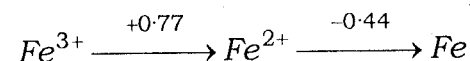
(iii) How the energy level of d -orbital changes during distortion of an octahedral $\text{Cu}(\text{II})$ complex ? Discuss.

(iv) Explain the trend in the acid-base character of oxides across the first-row transition elements. Why does TiO_2 exhibit amphoteric behaviour, while 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 Fe^{3+} to Fe . 2

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

(c) Does it 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 :

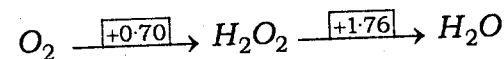
- (i) (a) A given molecule is assigned with the point group D_{3h} . What information will it provide in terms of symmetry ? 3
- (b) What is the origin of paramagnetism in inorganic compound ? $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ more paramagnetic than $[\text{Fe}(\text{CN})_6]^{3-}$. Why ? 2+2=4
- (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.



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