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 Nuggest ? How electrode potential values determine the occurrence of meatal 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}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 – $La(OH)_3$ or $Lu(OH)_3$? Why ?

(x) What are interfering radicals ? When and Why is it necesary 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 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 *Cu*(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 :

$$Fe^{3+} \xrightarrow{+0.77} Fe^{2+} \xrightarrow{-0.44} Fe$$

(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 infomation will it provide in terms of symmetry ? 3

(b) What is the origin of paramagnetism in inorganic compound ? $[Fe(H_2O)_6]^{3+}$ more paramagnetic than $[Fe(CN)_6]^{3-}$. Why ? 2+2=4

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(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 eletronic configuration of d^4 in therms 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 Δ=25000 cm^{-1} and P=15000 cm^{-1}. 3

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

$$O_2 \xrightarrow{+0.70} H_2O_2 \xrightarrow{+1.76} H_2O$$

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