

BTech Important Questions

Basic Inorganic Chemistry

1. Define atomic radius, van der Waals radius, and ionic radius. Atomic size decreases from Li to F, but it increases from F to Ne. Arrange the following O, O⁻, O²⁻ in their increasing order of radius. Explain the reason. Define ionization potential, electronegativity, electro positivity, and electron affinity. Give its variation along the period and down the group of the periodic table with examples. Explain why the first ionization energy of Al is lower than Mg. Arrange in increasing order of atomic radius (N, O, S, P).
2. Give a brief account of hard soft acid base (HSAB) principles. Discuss the difference between hard and soft acids as well as hard and soft bases. Write a note on the application of HSAB. What are the limitations of HSAB principles?
3. What is the effective nuclear charge (Z_{eff})? Define the Slater's rule. Calculate the shielding constant and effective nuclear charge (Z_{eff}) experienced by (a) 3d electron in Cu ($Z=29$) and Zn ($Z=30$), (b) 2p electron of Mg^{2+} ion ($Z=12$), (c) 3p electron of Cl ($Z=17$), (d) 3d electron of Cr ($Z=24$), (e) 3d electron in Br ($Z=35$). Justify using the Slater's rule: (a) Cl^- ion is bigger than Cl ($Z=17$), (b) Li^+ is smaller than Li ($Z=3$), (c) filling of 4s orbital before the filling of 3d orbital in case of K ($Z=19$).

Isomerism of transition metal complexes

4. Discuss the geometrical (ionization, coordination, hydration, linkage isomerism) and optical isomerism experienced by the transition metal compounds (Octahedral and tetrahedral) with examples. Describe stereoisomerism in coordination compounds with suitable examples.

Crystal field theory of "d" orbital splitting

5. Describe the salient features of crystal field theory. Write down its application and limitations. Discuss the crystal field splitting (Δ) of d-orbital in octahedral, and tetrahedral complexes and, the calculation of crystal field stabilization energy (CFSE) and magnetic moment for Cr^{2+} , Mn^{2+} , Fe^{2+} , Co^{2+} , Ni^{2+} coordination complex.
6. Discuss the factors that affect the crystal field splitting (Δ) of d-orbital.
7. Explain the influence of cyanide and amine ligands on crystal field splitting energy (Δ_o) and CFSE of octahedral complexes of those ions.
8. An octahedral complex absorbs light with a wavenumber of 18700 cm^{-1} . Determine the crystal field splitting energy (Δ_o).
9. What is a spectrochemical series? Discuss the importance of the series. State and explain the arrangement of ligands in spectrochemical series.
10. Give examples of high-spin complexes with weak-field ligands and low-spin complexes with strong-field ligands. Illustrate why tetrahedral complexes are always high spin.
11. Explain the influence of ligands in the formation of high and low spin complexes. Arrange the following complexes, $[\text{Co}(\text{NH}_3)_6]^{3+}$, $[\text{Co}(\text{CN})_6]^{3-}$, $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$, in their increasing order of wavelength of light absorbed. Calculate the crystal field stabilization energy (CFSE) and magnetic moment of (a) $[\text{MnCl}_4]^{2-}$ (b) $[\text{Ni}(\text{CN})_6]^{4-}$ (c) $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ (d) $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$

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12. The mean pairing energy (P) of $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$ is 23500 cm^{-1} and The Δ_o value is 13900 cm^{-1} . Calculate the CFSE for this complex ion corresponding to the high-spin and low-spin state.
13. The maximum absorption of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ occurs at 499 nm . Calculate the Δ_o value and predict the colour of the complex. [$h = 6.626 \times 10^{-34} \text{ Js}$, $c = 2.99 \times 10^8 \text{ m/s}$].
14. Strong ligand complexes are usually yellow, orange, or red in color while weak ligand complexes are blue, green, or indigo. Explain.
15. Convert 20000 cm^{-1} wavenumber to wavelength (cm or nm). Calculate the wavelength of light absorbed by $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ complex with a frequency of 25000 cm^{-1} .
16. Explain briefly about high-spin and low-spin complexes with examples. Calculate the magnetic moment of $[\text{Fe}(\text{NH}_3)_6]^{3+}$ and $[\text{FeF}_6]^{3-}$ complexes and $[\text{Co}(\text{NH}_3)_6]^{3+}$ and $[\text{CoF}_6]^{3-}$ complexes.
17. The energy gap between t_{2g} and e_g of an octahedral complex is 239.23 KJ/mol ($1 \text{ KJ/mol} = 83.6 \text{ cm}^{-1}$). Find the wavelength of absorption by the complex for d-d transition and predict the color of the sample. Determine CFSE and magnetic moment of a d^6 octahedral complexes having $P = 15000 \text{ cm}^{-1}$ and Δ_o value is 25000 cm^{-1} .
18. Calculate the CFSE values in terms of Δ and P for high-spin and low-spin octahedral complexes of Fe(II). Predict whether the complexes are paramagnetic or diamagnetic. Calculate the octahedral crystal field splitting energy in KJ for $[\text{Fe}(\text{CN})_6]^{4-}$, if the wavelength of the most intensely absorbed light is 305 nm . [$h = 6.626 \times 10^{-34} \text{ Js}$, $c = 2.99 \times 10^8 \text{ m/s}$]. For Mn^{2+} ion, $P = 28000 \text{ cm}^{-1}$ and Δ_o value for $[\text{Mn}(\text{CN})_6]^{3-}$ ion is 38500 cm^{-1} . Predict whether the complex is high-spin or low-spin. Write the configuration and calculate CFSE in cm^{-1} . Which of the following complexes have a larger crystal field splitting (Δ) of d-orbitals and why?
 - (a) $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$
 - (b) $[\text{Co}(\text{NH}_3)_6]^{3+}$ and $[\text{Rh}(\text{NH}_3)_6]^{3+}$
 - (c) $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$
 - (d) $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$
 - (e) $[\text{V}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$
 - (f) $[\text{Co}(\text{CN})_6]^{3-}$ and $[\text{Co}(\text{NH}_3)_6]^{3+}$