Chemistry Study Materials for Class 12 (NCERT Based Questions with Answers)

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The d & f - Block Elements

Question 11: Explain giving reasons:

(i) Transition metals and many of their compounds show paramagnetic behaviour.

(ii) The enthalpies of atomisation of the transition metals are high.

(iii) The transition metals generally form coloured compounds.

(iv) Transition metals and their many compounds act as good catalyst.

Solution 11: (i) Transition metals show paramagnetic behaviour. Paramagnetism arises due to the presence of unpaired electrons with each electron having a magnetic moment associated with its spin angular momentum and orbital angular momentum. However, in the first transition series, the orbital angular momentum is quenched. Therefore, the resulting Paramagnetism is only because of the unpaired electron.

(ii)Transition elements have high effective nuclear charge and a large number of valence electrons. Therefore, they form very strong metallic bonds. As a result, the enthalpy of atomization of transition metals is high.

(iii)Most of the complexes of transition metals are coloured. This is because of the absorption of radiation from visible light region to promote an electron from one of the *d*−orbitals to another. in the presence of ligands, the *d*-orbitals split up into two sets of orbitals having different energies. Therefore, the transition of electrons can take place from one set to another. The energy required for these transitions is quite small and falls in the visible region of radiation. The ions of transition metals absorb the radiation of a particular wavelength and the rest is reflected, imparting colour to the solution.

(iv) The catalytic activity of the transition elements can be explained by two basic facts.

(a)Owing to their ability to show variable oxidation states and form complexes, transition metals form unstable intermediate compounds. Thus, they provide a new path with lower activation energy, E_a, for the reaction.

(b) Transition metals also provide a suitable surface for the reactions to occur.

Question 12: What are interstitial compounds? Why are such compounds well known for transition metals?

Solution 12: Transition metals are large in size and contain lots of interstitial sites. Transition elements can trap atoms of other elements (that have small atomic size), such as H, C, N, in the interstitial sites of their crystal lattices. The resulting compounds are called interstitial compounds.

Question 13: How is the variability in oxidation states of transition metals different from that of the non- transition metals? Illustrate with examples.

Solution 13: In transition elements, the oxidation state can vary from +1 to the highest oxidation state by removing all its valence electrons. Also, in transition elements, the oxidation states differ by 1 (Fe^{2+} and Fe^{3+} Cu^{1+} and Cu^{2+}) in non-transition elements, the oxidation states differ by 2, for example, +2 and +4 or +3 and +5, etc.

Question 14: Describe the preparation of potassium dichromate from iron chromite ore. What is the effect of increasing pH on a solution of potassium dichromate?

Solution 14: Potassium dichromate is prepared from chromite ore $FeCr_2O_4$ in the following steps.

Step (1): Preparation of sodium chromate

$$4FeCr_2O_4 + 16NaOH + 7O_2 \longrightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8H_2O$$

Step (2): Conversion of sodium chromate into sodium dichromate

$$2Na_2CrO_4 + conc.H_2SO_4 \longrightarrow Na_2Cr_2O_7 + Na_2SO_4 + H_2O$$

Step(3): Conversion of sodium dichromate to potassium dichromate

$$Na_2Cr_2O_7 + 2KCl \longrightarrow K_2Cr_2O_7 + 2NaCl$$

Potassium chloride being less soluble than sodium chloride is obtained in the form of orange coloured crystals and can be removed by filtration. The dichromate ion CrO_4^{2-} exists in equilibrium with chromate CrO_4^{2-} ion at pH 4. However, by changing the pH, they can be interconverted.

$$CrO_4^{-2} \underset{alkali}{\overset{acid}{\rightleftharpoons}} 2HCrO_4^{-1} \underset{alkali}{\overset{acid}{\rightleftharpoons}} Cr_2O_7^{-2}$$

Chromate	*Hydrogen*	*Dichromate*
(Yellow)	Chromate	(*Orange*)

Question 15: Describe the oxidizing action of potassium dichromate and write the ionic equations for its reaction with: (i) iodide (ii) **iron(II) solution and** (iii) **H2 S**

Solution 15: $K_2Cr_2O_7$ acts as a very strong oxidizing agent in the acidic medium.

$$K_2Cr_2O_7 + 4H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + 4H_2O + 3[O]$$

(i) $K_2Cr_2O_7$ takes up electrons to get reduced and acts as an oxidizing agent. The reaction with

other iodide, iron (II) solution, and $H2S$ are given below. (i) $K_2Cr_2O_7$ oxidizes iodide to iodine.

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$$

$$2I^- \longrightarrow I_2 + 2e^-]\times 3$$

$$Cr_2O_7^{2-} + 6I^- + 14H^+ \longrightarrow 2Cr^{3+} + 3I_2 + 7H_2O$$

(ii) $K_2Cr_2O_7$ oxidizes iron (II) solution to iron (III) Solution i.e., ferrous ions to ferric ions.

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$$

$$Fe^{2+} \qquad Fe^{3+} + e^-]\times 6$$

$$Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \qquad 2Cr^{3+} + 6Fe^{3+} + 7H_2O$$

(iii) $K_2Cr_2O_7$ Oxidizes H2S to sulphur

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$$

$$H_2S \longrightarrow S + 2H^+ + 2e^-]\times 3$$

$$Cr_2O_7^{2-} + 8H^+ + 3H_2S \longrightarrow 2Cr^{3+} + 3S + 7H_2O$$

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