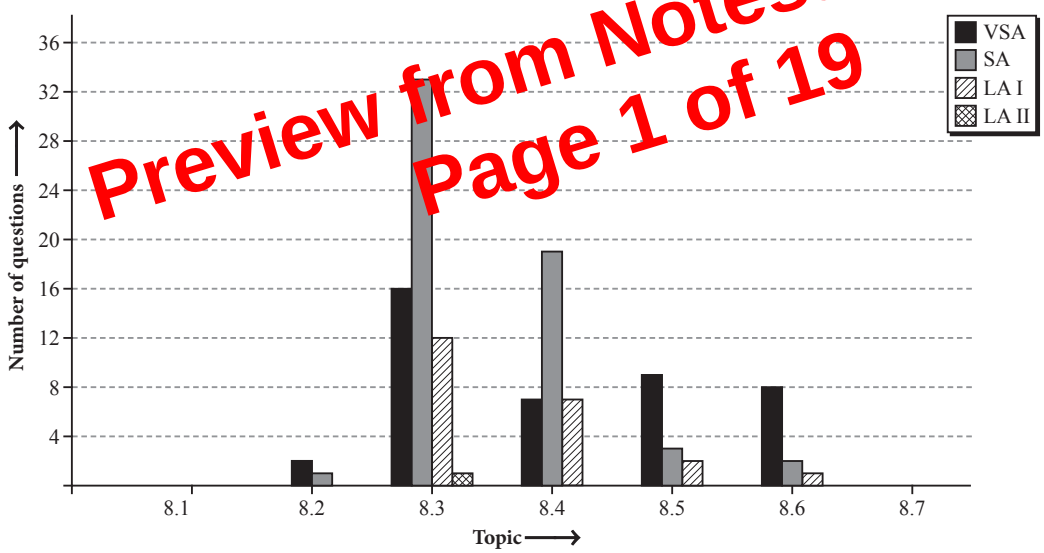
CHAPTER
8

The *d*- and *f*-Block Elements

Topicwise Analysis of Last 10 Years' CBSE Board Questions (2020-2011)



- Maximum total weightage is of *General Properties of the Transition Elements* (*d-Block*).
- Maximum VSA type questions were asked from *General Properties of the Transition Elements* (*d-Block*).
- Maximum SA and LA I type questions were asked from *General Properties of the Transition Elements* (*d-Block*).

QUICK RECAP

TRANSITION ELEMENTS (*d*-BLOCK ELEMENTS)

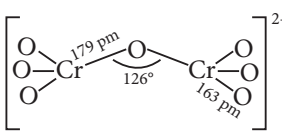
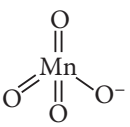
- Elements in which the last electron enters any one of the five *d*-orbitals of their respective penultimate shell are known as *transition elements* or *d-block elements*.
- Their general electronic configuration is $(n-1)d^{1-10}ns^{0-2}$.

Transition series : *d*-block consists of four transition series,
1st Transition series or 3*d* series $_{21}Sc - _{30}Zn$
2nd Transition series or 4*d* series $_{39}Y - _{48}Cd$
3rd Transition series or 5*d* series $_{57}La, _{72}Hf - _{80}Hg$
4th Transition series or 6*d* series $_{89}Ac, _{104}Rf - _{112}Cn$

General characteristics :

Melting and boiling points	High due to strong metallic bonding
Enthalpies of atomisation	High due to strong interatomic interactions
Ionisation enthalpies	Generally increases from left to right in a series
Oxidation states	Variable due to participation of *ns* and $(n-1)d$ electrons
Atomic radii	Decrease from left to right but become constant when pairing of electrons takes place
Complex formation	Form complexes due to high nuclear charge and small size and availability of empty *d*-orbitals to accept lone pair of electrons donated by ligands.
Coloured compounds	Form coloured compounds due to *d-d* transitions
Magnetic properties	Transition metal ions and their compounds are paramagnetic due to presence of unpaired electrons in the $(n-1)d$-orbitals and it is calculated by using the formula, $\mu = \sqrt{n(n+2)}$ where, *n* is the no. of unpaired electrons.
Catalytic behaviour	Due to variable oxidation states and ability to form complexes
Interstitial compounds	Due to empty spaces in their lattices, small atoms can be easily accommodated
Alloy formation	Due to similar atomic sizes

Some important compounds :

Compounds	Preparation	Properties	Uses
Potassium dichromate ($K_2Cr_2O_7$)  	From sodium dichromate (obtained from chromite ore) $4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \longrightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$ $2Na_2CrO_4 + 2H^+ \longrightarrow Na_2Cr_2O_7 + 2Na^+ + H_2O$ $Na_2Cr_2O_7 + 2KCl \longrightarrow K_2Cr_2O_7 + 2NaCl$	Orange red crystalline solid, oxidising agent having melting point 398°C. **Oxidising agent in acidic medium :** $Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$ **Oxidises :** I^- to I_2, H_2S to S, Sn^{2+} to Sn^{4+} and Fe^{2+} to Fe^{3+}	In dyeing, photography and leather industry.
Potassium permanganate ($KMnO_4$)  	From potassium manganate (obtained from pyrolusite) $2MnO_2 + 4KOH + O_2 \longrightarrow 2K_2MnO_4 + 2H_2O$ $2K_2MnO_4 + Cl_2 \longrightarrow 2KMnO_4 + 2KCl$	Deep purple crystalline solid, oxidising agent, having melting point 240°C. **Oxidising agent in acidic medium :** $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$ **Oxidises :** I^- to I_2, Fe^{2+} to Fe^{3+}, $C_2O_4^{2-}$ to CO_2, S^{2-} to S, SO_3^{2-} to SO_4^{2-}, NO_2^- to NO_3^- **Oxidising agent in faintly alkaline or neutral medium :** $MnO_4^- + 2H_2O + 3e^- \longrightarrow MnO_2 + 4OH^-$ **Oxidises :** I^- to IO_3^-, $S_2O_3^{2-}$ to SO_4^{2-}, Mn^{2+} to MnO_2	As a disinfectant, germicide, and Baeyer's reagent (alkaline $KMnO_4$).

Previous Years' CBSE Board Questions

8.2 Electronic Configurations of the *d*-Block Elements

VSA (1 mark)

1. Account for the following :
Zn, Cd, Hg are considered as *d*-block elements but not as transition elements.
(1/5, 2020)

2. Account for the following :
Zn is not considered as a transition element.
(1/5, AI 2014)

SA (2 marks)

3. What are the transition elements? Write two characteristics of the transition elements.
(Delhi 2015)

8.3 General Properties of the Transition Elements (*d*-Block)

VSA (1 mark)

Read the given passage and answer the questions number (4 to 8) that follow :

The *d*-block of the periodic table contains the elements of groups 3-12 and are known as transition elements. In general, the electronic configuration of these elements is $(n - 1)d^{1-10} ns^{1-2}$. The *d*-orbitals of the penultimate energy level in their atoms receive electrons giving rise to three rows of the transition metals *i.e.,* 3*d*, 4*d* and 5*d* series. However, Zn, Cd and Hg are not regarded as transition elements. Transition elements exhibit certain characteristic properties like variable oxidation states, complex formation, formation of coloured ions and alloys, catalytic activity, etc. Transition metals are hard (except Zn, Cd and Hg) and have a high melting point.
(2020)

4. Why are Zn, Cd and Hg non-transition elements?

5. Which transition metal of 3*d* series does not show variable oxidation states?

6. Why do transition metals and their compounds show catalytic activity?

7. Why are melting points of transition metals high?

8. Why is Cu^{2+} ion coloured while Zn^{2+} ion is colourless in aqueous solution?

9. Out of zinc and tin, whose coating is better to protect iron objects? *(One word, 2020)*

10. Out of the following transition elements, the maximum number of oxidation states are shown by
(a) Sc ($Z = 21$) (b) Cr ($Z = 24$)
(c) Mn ($Z = 25$) (d) Fe ($Z = 26$)
(2020)

11. **Assertion (A) :** Transition metals have high melting point.
Reason (R) : Transition metals have completely filled *d*-orbitals.
(a) Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is correct, but Reason (R) is incorrect statement.
(d) Assertion (A) is incorrect, but Reason (R) is correct statement. *(2020)*

12. Account for the following :
Copper(I) compounds are white whereas copper(II) compounds are coloured.
(1/5, 2020)

13. Write the formula of an oxoanion of chromium (Cr) in which it shows the oxidation state equal to its group number. *(Delhi 2017)*

14. Write the formula of an oxoanion of manganese (Mn) in which it shows the oxidation state equal to its group number.
(Delhi 2017)

15. How would you account for the following :
Transition metals form coloured compounds?
(1/3, Delhi 2015)