WEIRD CHEMIST

d-Block Elements

Electrode Potentials of Transition Elements

DPP – 04

Topic: Electrode Potentials | **Questions:** 22 Questions | **Exam:** NEET / JEE

▶ TYPE 1 : The Irregular $E^{\ominus}(M^{2+}/M)$ Trend Across the 3d Series

Q1. For the first-row transition metals, the $E^{\ominus}(M^{2+}/M)$ values are:

	V	Cr	Mn	Fe	Co	Ni	Cu
$E^{\ominus}(M^{2+}/M)$	-1.18	-0.91	-1.18	-0.44	-0.28	-0.25	$+0.34$

The irregular trend (rather than a steady increase) seen in the above values is best explained by–

(1) Steady increase in atomic radius across the series
(2) Irregular variation in ionisation enthalpies ($\Delta_i H_1 + \Delta_i H_2$) and sublimation enthalpies, which are relatively much lower for Mn and V
(3) Progressive filling of the $4p$ orbitals across the series
(4) Constant hydration enthalpy of all the M^{2+} ions across the series

Q2. The $E^{\ominus}$ value for the Mn^{3+}/Mn^{2+} couple is much more positive than that for Cr^{3+}/Cr^{2+} or Fe^{3+}/Fe^{2+}. This is mainly because–

(1) Mn^{3+} has a smaller ionic radius than Cr^{3+}
(2) The third ionisation energy of Mn is much larger, since the required change is a stable d^5 to d^4 configuration
(3) Mn^{2+} is more heavily hydrated than Cr^{2+}
(4) Fe^{3+} is more stable than Mn^{3+} due to its d^5 configuration

Q3. Cr^{2+} and Mn^{3+} both have a d^4 configuration, yet Cr^{2+} is reducing while Mn^{3+} is oxidising. This is because–

(1) Cr^{2+} ($d^4 \rightarrow d^3$) moves toward a half-filled t_{2g} level, while Mn^{3+} ($d^4 \rightarrow d^5$) moves toward the extra stability of a half-filled d-subshell
(2) Cr^{2+} is more heavily hydrated than Mn^{3+}
(3) Mn^{3+} has a larger ionic radius than Cr^{2+}
(4) Cr^{2+} has a higher nuclear charge than Mn^{3+}

Q4. The standard reduction potential $E^{\circ}(M^{2+}/M)$ value for copper is positive ($+0.34$ V), unlike most other first-row transition metals. What is the possible reason for this?

(1) Low ionisation enthalpy of copper alone
(2) High enthalpy of atomisation of Cu combined with low hydration enthalpy of Cu^{2+}, which together outweigh the ionisation energy term
(3) High hydration enthalpy of Cu^{2+} alone
(4) Copper has a completely filled $3d$ subshell in its $+2$ state

▶ TYPE 2 : Comparing Reducing Power & E° Values Among 3d Metals

Q5. Four successive members of the first series of the transition metals are listed below. For which one of them the standard potential ($E^{\circ}_{M^{2+}/M}$) value has a positive sign? [AIPMT (Mains)-2012]

(1) Co ($Z = 27$)
(2) Ni ($Z = 28$)
(3) Cu ($Z = 29$)
(4) Fe ($Z = 26$)

Q6. In first series of transition metal, which of the following metal can't be oxidised by 1M H^+(aq) solution? [NCERT Pg. 224]

(1) Zn (2) Mn (3) Cr (4) Cu

Q7. Which is the stronger reducing agent, Cr^{2+} or Fe^{2+}, and why?

(1) Fe^{2+}, because $E^{\circ}(Fe^{2+}/Fe) = -0.44$ V is more negative than $E^{\circ}(Cr^{2+}/Cr)$
(2) Cr^{2+}, because $E^{\circ}(Cr^{2+}/Cr) = -0.90$ V is more negative than $E^{\circ}(Fe^{2+}/Fe) = -0.44$ V
(3) Both are equally strong reducing agents
(4) Fe^{2+}, because it has a smaller ionic radius than Cr^{2+}

Q8. For the four successive transition elements (Cr, Mn, Fe and Co), the stability of $+2$ oxidation state will be there in which of the following order? (At. No. Cr $= 24$, Mn $= 25$, Fe $= 26$, Co $= 27$) [AIPMT (Prelims)-2011]

(1) Cr > Mn > Co > Fe
(2) Mn > Fe > Cr > Co
(3) Fe > Mn > Co > Cr
(4) Co > Mn > Fe > Cr

Q9. Choose the correct

(1) Cr^{2+} is stronger reducing agent than Fe^{2+} in aqueous medium
(2) Cu^{2+} undergoes disproportionation in aqueous medium
(3) Silver is not a transition element
(4) All are correct

▶ TYPE 3 : Stability of Ions in Aqueous Solution

Q10. Which of the following ions most stable in aqueous solution?

(1) $_{23}V^{3+}$
(2) $_{22}Ti^{3+}$
(3) $_{25}Mn^{3+}$
(4) $_{24}Cr^{3+}$

Q11. Which one of the following ions is the most stable in aqueous solution? (Atomic number Ti = 22, V = 23, Cr = 24, Mn = 25) [AIPMT (Prelims)-2007]

(1) Mn^{2+} (2) Cr^{3+} (3) V^{3+} (4) Ti^{3+}

Q12. The most stable oxidation state of Cr in aq. medium is –

(1) Cr^{2+} (2) Cr^{3+} (3) Cr^{4+} (4) Cr^{6+}

Q13. Cu^{+} ion is not stable in aqueous solution, due to–

(1) d^{10} configuration
(2) Disproportionation
(3) Less charge
(4) Pseudo inert gas configuration

Q14. Which of the following pair of transition metal ions are the best oxidising agents in aqueous solutions?

(1) V^{2+} and Cr^{2+}
(2) Ti^{2+} and Cr^{2+}
(3) Mn^{3+} and Co^{3+}
(4) V^{2+} and Fe^{2+}

Q15. Which of the following pairs of transition metal ions are the stronger oxodising agents in aqueous solutions?

(1) V^{2+} and Cr^{3+}
(2) Ti^{2+} and Cr^{2+}
(3) Mn^{3+} and Co^{3+}
(4) V^{3+} and Fe^{2+}

▶ TYPE 4 : Highest Oxidation States – Configurations, Species & Stabilising Halogens

Q16. Among the following outermost configurations of transition metals, which shows the highest oxidation state:

(1) $3d^3, 4s^2$
(2) $3d^5, 4s^1$
(3) $3d^5, 4s^2$
(4) $3d^6, 4s^2$

Q17. Amongst the following, identify the species with an atom in $+6$ oxidation state:

(1) MnO_4^- (2) $Cr(CN)_6^{3-}$ (3) NiF_6^{2-} (4) CrO_2Cl_2

Q18. Choose from the following elements, which can bring a transition metal into its highest oxidation state:

(1) F (2) Cl (3) Br (4) I

▶ TYPE 5 : General Concepts & Statement Evaluation on Transition Elements

Q19. Which of the following metals exhibit more than one oxidation state?

(1) Na (2) Mg (3) Fe (4) All

Q20. The property, which is not characteristic of transition metals, is:

(1) Variable oxidation states
(2) Tendency to form complexes
(3) Formation of coloured compounds
(4) Natural-radioactivity

Q21. Which of the following fact about d and f-block elements is wrong?

(1) Oxidation states of 'd' and 'f' block elements differ by one unit.
(2) Most common oxidation state for d & f-block elements is '$+2$'.
(3) In d-block, down the group stability of higher oxidation state increases.
(4) Lanthanum and Actinium are 'd' block elements

Q22. In context with the transition elements, which of the following statements is incorrect?

(1) In addition to the normal oxidation states, the zero oxidation state is also shown by these elements in complex
(2) In the highest oxidation states, the transition metals show basic character and form cationic complexes
(3) In the highest oxidation states of the first five transition elements (Sc to Mn), all the $4s$ and $3d$ electrons are used for bonding
(4) Once the d^5 configuration is exceeded, the tendency to involve all the $3d$ electrons in bonding decreases