The d- and f-Block Elements

Class 12 Chemistry · 24 NEET MCQs with answers & explanations

The d- and f-Block Elements covers transition metals (3d series), their electronic configurations, oxidation states, magnetic properties, interstitial compounds, alloy formation and important compounds ($KMnO_4$, $K_2Cr_2O_7$). Lanthanoids and actinoids are also covered. NEET tests specific properties, exceptions in electronic configuration, and reactions of $KMnO_4$ and $K_2Cr_2O_7$.

Key d-Block Facts

Property / Compound	Key Fact
Electronic config exceptions	Cr = $[Ar]3d^5 4s^1$ (not $3d^4 4s^2$); Cu = $[Ar]3d^{10} 4s^1$ (not $3d^9 4s^2$) — stability of half/fully filled d
Variable oxidation states	Due to small energy difference between 3d and 4s; Mn shows +2 to +7
Magnetic properties	Paramagnetic if unpaired electrons; $\mu = \sqrt{n(n+2)}$ BM
$KMnO_4$	Strong oxidising agent; purple colour; self-indicator in titrations
$K_2Cr_2O_7$	Orange ($Cr_2O_7^{2-}$) in acid, yellow (CrO_4^{2-}) in base; oxidising agent
Lanthanoid contraction	Gradual decrease in size across 4f series; poor shielding by 4f electrons

Questions

Q1. An atom with electronic configuration [Ar]3d3 4s2 belongs to which group of the periodic table?

(A) Group 3
(B) Group 5
(C) Group 15
(D) Group 2

Q2. Among Cr, Fe, Mn and V, which element exhibits the maximum number of oxidation states?

(A) Fe
(B) V
(C) Mn
(D) Cr

Q3. Which of the following is an interstitial compound?

(A) TiC
(B) NaCl
(C) K2O
(D) CaCl2

Q4. Which property is mainly responsible for the high enthalpies of atomisation in transition metals?

(A) Only 4s electrons bond
(B) Strong metallic bonding
(C) Complete absence of d-electrons
(D) Very weak metal-metal interaction

Q5. Which of the following electronic configurations represents the ground-state atom of chromium?

(A) [Ar] 3d4 4s2 configuration
(B) [Ar] 3d5 4s1 configuration
(C) [Ar] 3d6 4s0 configuration
(D) [Ar] 3d3 4s3 configuration

Q6. Which of the following ions is colourless due to a d0 electronic configuration?

(A) Ti3+ (partially filled 3d)
(B) Cu2+ (partially filled 3d)
(C) Sc3+ (empty 3d subshell)
(D) Fe2+ (partially filled 3d)

Q7. Which is the general electronic configuration of lanthanoids?

(A) [Xe] 4f1-14 5d0-1 6s2
(B) [Rn] 5f1-14 6d0-1 7s2
(C) [Ar] 3d1-10 4s2
(D) [Kr] 4d1-10 5s2

Q8. Which is the most common oxidation state shown by lanthanoids?

(A) 2
(B) 3
(C) 4
(D) 5

Q9. Which block elements are characterized by the filling of d orbitals in their electronic configuration?

(A) s-block elements
(B) p-block elements
(C) d-block elements
(D) f-block elements

Q10. Which is the correct general electronic configuration of d-block elements?

(A) $(n-1)d^{1-10}\ ns^{0-2}$
(B) $(n-2)f^{1-14}\ ns^2$
(C) $ns^2\ np^{1-6}$
(D) $(n-1)d^{1-10}\ ns^2$

Q11. Which of the following transition metals commonly occurs in native (free) state?

(A) Copper occurs in native state
(B) Iron is found as oxide ore
(C) Zinc is found as sulphide ore
(D) Manganese found as oxide ore

Q12. Which method is used for concentration of sulphide ores?

(A) Leaching with acid solution
(B) Froth flotation method used
(C) Calcination in limited air
(D) Roasting in excess air

Q13. Which element shows the maximum number of oxidation states in the 3d series?

(A) Sc
(B) Ti
(C) Mn
(D) Zn

Q14. Which of the following ions is colourless in aqueous solution?

(A) Ti^{3+}
(B) Fe^{3+}
(C) Ni^{2+}
(D) Sc^{3+}

Q15. Which of the following is the strongest oxidizing agent in acidic medium among these options?

(A) KMnO4
(B) K2Cr2O7
(C) FeSO4
(D) CuSO4

Q16. Which compound forms green manganate ion (MnO4 2-) in alkaline medium?

(A) K2Cr2O7
(B) KMnO4
(C) K2CrO4
(D) FeCl3

Q17. Which is the most common oxidation state exhibited by actinoids?

(A) 2
(B) 3
(C) 4
(D) 6

Q18. Which actinoid most commonly exhibits the highest stable oxidation state of +6?

(A) Thorium
(B) Uranium
(C) Neptunium
(D) Plutonium

Q19. Which transition metal acts as a catalyst in the Haber process for industrial synthesis of ammonia?

(A) Ni
(B) Fe
(C) Cu
(D) V

Q20. Which of the following correctly states the composition of stainless steel?

(A) Iron with chromium and nickel
(B) Iron with copper and zinc
(C) Iron with manganese and cobalt
(D) Iron with vanadium and titanium

Q21. Which of the following ions is colourless due to absence of d electrons?

(A) Ti3+
(B) Fe2+
(C) Sc3+
(D) Ni2+

Q22. Which of the following transition metal ions has the maximum number of unpaired electrons?

(A) Fe2+
(B) Mn2+
(C) Co2+
(D) Ni2+

Q23. Which of the following correctly explains why d-block elements are called transition elements?

(A) They transition between metals and nonmetals
(B) They are placed between s-block and p-block in the periodic table
(C) Their atomic radii decrease sharply across periods
(D) They have variable oxidation states only

Q24. Which of the following is NOT considered a transition element as per IUPAC definition?

(A) Fe
(B) Cr
(C) Mn
(D) Zn

Answer key

1-B	**2-C**	**3-A**	**4-B**	**5-B**	**6-C**	**7-A**	**8-B**
9-C	**10-A**	**11-A**	**12-B**	**13-C**	**14-D**	**15-A**	**16-B**
17-B	**18-B**	**19-B**	**20-A**	**21-C**	**22-B**	**23-B**	**24-D**

Answers with explanations

Q1 — Answer: (B) Group 5
The configuration [Ar]3d3 4s2 corresponds to vanadium (Z=23). The group number equals the total valence electrons in 3d and 4s: 3+2=5. Therefore vanadium belongs to Group 5. Group 3 has a different d-electron count; Group 2 has no d-electrons; Group 15 is a main-group element.

Q2 — Answer: (C) Mn
Manganese (Mn) exhibits the widest range of oxidation states (+2 to +7) among these elements because all 3d and 4s electrons can participate in bonding. Cr reaches up to +6, V up to +5, and Fe commonly +3. Mn alone attains +7 in KMnO4.

Q3 — Answer: (A) TiC
TiC is formed when small carbon atoms occupy interstitial sites in the titanium lattice. Transition metals readily form interstitial compounds with small atoms such as H, B, C and N. NaCl, K2O and CaCl2 are ionic compounds.

Q4 — Answer: (B) Strong metallic bonding
Strong metallic bonding in transition metals results from participation of both ns and (n-1)d electrons. This gives them high enthalpies of atomisation compared to s-block metals.

Q5 — Answer: (B) [Ar] 3d5 4s1 configuration
Chromium adopts the exceptional [Ar]3d5 4s1 configuration because the half-filled 3d5 arrangement provides additional stability. The expected [Ar]3d4 4s2 configuration is less stable by comparison. The other options are not valid ground-state configurations for chromium.

Q6 — Answer: (C) Sc3+ (empty 3d subshell)
Sc3+ has the [Ar]3d0 configuration, making ordinary d-d transitions impossible and rendering it colourless. Ti3+ is 3d1, Fe2+ is 3d6 and Cu2+ is 3d9; all have partially filled d-subshells and can show colour.

Q7 — Answer: (A) [Xe] 4f1-14 5d0-1 6s2
Lanthanoids (Ce to Lu) follow [Xe] $4f^{1-14}$ $5d^{0-1}$ $6s^2$ configuration. Option B is the actinoid configuration. Options C and D are 3d and 4d transition series configurations respectively.

Q8 — Answer: (B) 3
Lanthanoids predominantly show +3 oxidation state formed by losing two 6s and one 5d (or 4f) electron. This is the most stable state across the entire series. +4 and +2 are shown only by a few exceptions.

Q9 — Answer: (C) d-block elements
d-block elements are defined by progressive filling of (n-1)d orbitals. This distinguishes them from s-block (ns filling), p-block (np filling), and f-block (nf filling) elements. Their position in the periodic table between s- and p-blocks reflects this orbital filling sequence.

Q10 — Answer: (A) (n-1)d^{1-10} ns^{0-2}
d-block elements have (n-1)d^{1-10} ns^{0-2} configuration; the ns^0 case is critical — Pd ($4d^{10}$ $5s^0$) is a real example. Option D is tempting but restricts ns to only ns^2, which is incorrect.

Q11 — Answer: (A) Copper occurs in native state
Cu, Ag, and Au occur in native/free state due to low reactivity and position low in the electrochemical series. Fe, Zn, and Mn are highly reactive and always found as compound ores. Option B is tempting as iron is abundant but it occurs as haematite/magnetite.

Q12 — Answer: (B) Froth flotation method used
Froth flotation exploits the difference in wettability between sulphide ore particles (wetted by oil) and gangue (wetted by water). Leaching is used for oxide/carbonate ores. Calcination and roasting are pyrometallurgical steps, not concentration steps.

Q13 — Answer: (C) Mn
Mn shows oxidation states from +2 to +7 due to the maximum number of unpaired d-electrons (d^5 in Mn^{2+}), allowing maximum involvement of electrons in bonding. Sc is limited to +3 (no d-electrons after ionisation) and Zn is limited to +2 (d^{10}).

Q14 — Answer: (D) Sc^{3+}
Sc^{3+} has configuration [Ar] $3d^0$ — no d-electrons means no d-d transition is possible, so no visible light is absorbed and the ion appears colourless. Ti^{3+} (d^1), Fe^{3+} (d^5), and Ni^{2+} (d^8) all have d-electrons and show colour.

Q15 — Answer: (A) KMnO4
KMnO4 with Mn in +7 state is a stronger oxidizer than K2Cr2O7 (Cr +6) in acidic medium; it gains 5e- per Mn atom vs 3e- per Cr atom, making it more powerful. FeSO4 and CuSO4 are not significant oxidizers under standard conditions.

Q16 — Answer: (B) KMnO4
In alkaline medium, KMnO4 (MnO4-, purple) is reduced to MnO4 2- (manganate ion), which is green. K2Cr2O7 and K2CrO4 are chromium compounds; FeCl3 forms Fe(OH)3 in alkaline medium.

Q17 — Answer: (B) 3
+3 is the most common oxidation state of actinoids, similar to lanthanoids. However, unlike lanthanoids, actinoids also commonly show +4, +5, +6 due to comparable 5f, 6d, 7s energies.

Q18 — Answer: (B) Uranium
Uranium most commonly and stably shows +6 (e.g., UO_2^{2+}, UF_6). While Np and Pu can reach +7, +6 is not their most stable state. Thorium is most stable at +4 and rarely exceeds it.

Q19 — Answer: (B) Fe
Iron (Fe) is the catalyst in the Haber process ($N_2 + 3H_2 \rightarrow 2NH_3$). Ni catalyses hydrogenation reactions. V_2O_5 is the catalyst in the Contact process for H_2SO_4. Cu has no role here.

Q20 — Answer: (A) Iron with chromium and nickel
Stainless steel contains iron alloyed with chromium (~18%) and nickel (~8%). Chromium provides corrosion resistance by forming a passive Cr_2O_3 layer; nickel improves toughness. Option B and C are incorrect alloy combinations not classified as stainless steel.

Q21 — Answer: (C) Sc3+
Sc^{3+} has configuration [Ar] $3d^0$ — no d electrons, hence no d-d transitions possible, making it colourless. Ti^{3+} ($3d^1$), Fe^{2+} ($3d^6$), and Ni^{2+} ($3d^8$) all have partially filled d orbitals and form coloured ions.

Q22 — Answer: (B) Mn2+
Mn^{2+} has configuration [Ar] $3d^5$ — five unpaired electrons (one in each d orbital). Fe^{2+} is $3d^6$ (4 unpaired), Co^{2+} is $3d^7$ (3 unpaired), Ni^{2+} is $3d^8$ (2 unpaired). Half-filled d^5 gives maximum unpaired electrons.

Q23 — Answer: (B) They are placed between s-block and p-block in the periodic table
IUPAC defines transition elements as those with partially filled d orbitals in ground state or common oxidation states — but the name "transition" refers to their periodic table position bridging s- and p-blocks. Option A is a common misconception; option C and D describe properties, not the reason for the name.

Q24 — Answer: (D) Zn
IUPAC defines transition elements as those having partially filled d orbitals in the ground state or in any stable oxidation state. Zn has $3d^{10}$ $4s^2$ ground state and its only stable ion Zn^{2+} is also $3d^{10}$ — fully filled throughout. Fe, Cr, and Mn all form ions with partially filled d orbitals.

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