CLASS 12 CHEMISTRY — FORMULA SHEET

Chapter 4 : The d- and f-Block Elements (NCERT)

4.1 Position & General Introduction

Concept	Detail
d-block elements	Groups 3–12 ; last electron enters d-orbital
Transition element (definition)	Has partially filled d-orbital in atom OR in a stable ion
Four series	3d (Sc–Zn), 4d (Y–Cd), 5d (La, Hf–Hg), 6d (incomplete)
General configuration	$(n-1)d^{(1-10)}\ ns^{(1-2)}$
Zn, Cd, Hg	Not typical transition metals (d^{10}, fully filled)
f-block elements	Lanthanoids (4f) and Actinoids (5f) ; inner transition

4.2 General Properties of Transition Metals

Property	Trend / Detail
Metallic character	All are metals ; hard, high m.p. & b.p. (strong metallic bonding)
Atomic radius	Decreases then nearly constant across a series
Ionisation enthalpy	Increases across the series (irregularly)
Variable oxidation states	Due to similar energy of (n−1)d and ns electrons
Common oxidation states	Mn shows max range (+2 to +7)
Catalytic property	Variable states + surface adsorption (e.g. Fe, V_2O_5, Ni)
Complex formation	Small size, high charge, vacant d-orbitals
Alloy formation	Similar radii → readily form alloys

4.3 Colour, Magnetism & Special Behaviour

Property	Explanation / Formula
Coloured ions	d–d transition of electrons (absorb visible light)
Colourless ions	d^0 (e.g. Sc^{3+}) or d^{10} (e.g. Zn^{2+}) → no d–d transition
Magnetic moment (spin only)	$\mu = \sqrt{n(n+2)}$ BM (n = unpaired electrons)
Paramagnetic	Has unpaired electrons (attracted to magnetic field)
Diamagnetic	All electrons paired
Catalytic examples	Fe (Haber), V_2O_5 (contact process), Ni (hydrogenation)
Interstitial compounds	Small atoms (H, C, N) occupy lattice gaps → hard, high m.p.

4.4 Important Compounds

Compound	Detail
Potassium dichromate	$K_2Cr_2O_7$; orange ; strong oxidising agent

Compound	Detail
Dichromate–chromate equilibrium	$Cr_2O_7^{2-} + 2OH^- \rightleftharpoons 2CrO_4^{2-} + H_2O$ (orange ⇌ yellow)
Cr in dichromate	Oxidation state +6
Potassium permanganate	$KMnO_4$; purple ; strong oxidising agent
Mn in permanganate	Oxidation state +7
$KMnO_4$ in acidic medium	$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$
Preparation of $KMnO_4$	From pyrolusite (MnO_2) → fuse → oxidise

4.5 Lanthanoids & Actinoids

Concept	Detail
Lanthanoids	Ce (58) to Lu (71) ; filling of 4f orbitals
Lanthanoid contraction	Steady decrease in size due to poor 4f shielding
Consequences of contraction	Similar size of 4d & 5d elements ; hard to separate lanthanoids
Common oxidation state (Ln)	+3 (most stable)
Actinoids	Th (90) to Lr (103) ; filling of 5f orbitals
Actinoid features	Radioactive ; show more oxidation states than lanthanoids
Actinoid contraction	Greater than lanthanoid (5f shields even more poorly)

★ QUICK MEMORY AIDS & TRICKS

Transition definition	Partially filled d-orbital in ATOM or a stable ION (so Zn/Cd/Hg aren't typical).
Variable oxidation	(n−1)d and ns have close energy → many states. Mn: +2 to +7 (widest).
Magnetic moment	$\mu = \sqrt{n(n+2)}$ BM. n = number of unpaired electrons.
Colour	d–d transitions cause colour. d^0 and d^{10} ions are colourless.
Dichromate/chromate	Orange $Cr_2O_7^{2-}$ (acidic) ⇌ yellow CrO_4^{2-} (basic). Cr is +6.
Permanganate	$KMnO_4$ purple, Mn is +7 ; acidic medium → Mn^{2+} (5 electrons).
Lanthanoid contraction	Poor 4f shielding shrinks size — makes 4d/5d elements similar.
Lanthanoids vs actinoids	Ln: mostly +3, non-radioactive. An: many states, radioactive.