CLASS 11 CHEMISTRY — FORMULA SHEET

Chapter 3 : Classification of Elements and Periodicity in Properties (NCERT)

3.1 Development of the Periodic Table

Scientist / Law	Key Idea
Dobereiner's Triads	Groups of 3 elements; atomic mass of middle element ≈ average of other two (e.g. Li-7, Na-23, K-39).
Newlands' Law of Octaves	Every 8th element has properties similar to the 1st (worked only up to Ca).
Mendeleev's Periodic Law	Properties are a periodic function of **atomic masses**. Left gaps and predicted Ga (eka-aluminium) and Ge (eka-silicon).
Modern Periodic Law (Moseley)	Properties are a periodic function of **atomic number (Z)**. Basis: $\sqrt{v} = a(Z - b)$.

3.2 Structure of the Modern Periodic Table

Feature	Details
Periods (7)	Elements per period: 1st → 2, 2nd → 8, 3rd → 8, 4th → 18, 5th → 18, 6th → 32, 7th → 32
Groups (18)	Vertical columns; same valence-shell configuration → similar properties
s-block (Gr 1, 2)	ns^{1-2} ; alkali & alkaline earth metals; highly reactive
p-block (Gr 13-18)	ns^2np^{1-6} ; s + p = Representative elements; Gr 18 = noble gases (ns^2np^6)
d-block (Gr 3-12)	$(n-1)d^{1-10}ns^{0-2}$; transition metals; coloured ions, variable oxidation states
f-block	$(n-2)f^{1-14}(n-1)d^{0-1}ns^2$; Lanthanoids (4f) + Actinoids (5f) = inner transition
Metalloids	B, Si, Ge, As, Sb, Te — border the zig-zag line between metals and non-metals
Group number trick	For ns^anp^b elements: Group = 10 + a + b ; for ns^a: Group = a

3.3 IUPAC Nomenclature of Elements with Z > 100

Digit	Root	Digit	Root
0	nil (n)	5	pent (p)
1	un (u)	6	hex (h)
2	bi (b)	7	sept (s)
3	tri (t)	8	oct (o)
4	quad (q)	9	enn (e)

Example	Name & Symbol
Z = 101	Unnilunium (Unu) → official: Mendelevium (Md)
Z = 104	Unnilquadium (Unq) → official: Rutherfordium (Rf)
Z = 120	Unbinilium (Ubn) — add roots in order of digits + 'ium'

3.4 Effective Nuclear Charge & Shielding

Concept	Formula / Statement
Effective nuclear charge	$Z_{eff} = Z - \sigma$ (σ = shielding/screening constant)
Shielding power of subshells	s > p > d > f (s-electrons shield best)
Across a period	Z_{eff} INCREASES (electrons added to same shell shield poorly)
Down a group	Z_{eff} nearly constant; new shells dominate → size increases

3.5 Atomic & Ionic Radius

Concept	Rule / Trend
Types of radii	Covalent radius < Metallic radius < van der Waals radius
Across a period	Radius DECREASES (Z_{eff} ↑) — Li > Be > B > C > N > O > F
Down a group	Radius INCREASES (new shell added) — Li < Na < K < Rb < Cs
Cation vs parent atom	Cation is SMALLER (fewer e^-, higher Z_{eff}): Na^+ < Na
Anion vs parent atom	Anion is LARGER (more e^-–e^- repulsion): Cl^- > Cl
Isoelectronic series	Same number of electrons → MORE protons = SMALLER size: $Al^{3+} < Mg^{2+} < Na^+ < F^- < O^{2-} < N^{3-}$

3.6 Ionization Enthalpy (ΔiH)

Concept	Rule / Trend
Definition	Energy required to remove the outermost electron from an isolated gaseous atom: $X(g) \rightarrow X^+(g) + e^-$
Successive IE	$\Delta_iH_1 < \Delta_iH_2 < \Delta_iH_3$ … (each removal from a more positive ion)
Across a period	Generally INCREASES (Z_{eff} ↑, size ↓)
Down a group	DECREASES (size ↑, shielding ↑)
Exception: Be > B	Be ($2s^2$ fully filled) needs more energy than B (removes easy $2p^1$)
Exception: N > O	N ($2p^3$ half-filled, extra stable) > O ($2p^4$, pairing repulsion)
Factors	↑ with Z_{eff} & half/fully-filled stability ; ↓ with size & shielding

3.7 Electron Gain Enthalpy (ΔegH)

Concept	Rule / Trend
Definition	Enthalpy change when an isolated gaseous atom gains an electron: $X(g) + e^- \rightarrow X^-(g)$
Sign	Usually NEGATIVE (energy released); 2nd $\Delta_{eg}H$ is always POSITIVE ($O^- + e^- \rightarrow O^{2-}$ needs energy)
Across a period	More negative (halogens most negative in their period)
Down a group	Less negative (size ↑)
Exception: Cl > F	Cl has the MOST negative $\Delta_{eg}H$ (F is too small — strong e^-–e^- repulsion in compact 2p)
Noble gases	Positive $\Delta_{eg}H$ (stable ns^2np^6 configuration resists extra electron)

3.8 Electronegativity (EN)

Concept	Rule / Trend
Definition	Tendency of an atom in a COMPOUND to attract shared electrons (not measurable for isolated atom; no units)
Scales	Pauling scale (most common): F = 4.0 (highest), O = 3.5, N = Cl = 3.0; Cs ≈ 0.7 (lowest)
Across a period	INCREASES (Li 1.0 → F 4.0)
Down a group	DECREASES (F > Cl > Br > I)
Relation	EN ∝ Z_{eff} ∝ 1/size ; high EN → non-metallic character

3.9 Master Trend Table

Property	Across Period (→)	Down Group (↓)
Atomic radius	Decreases	Increases
Ionization enthalpy	Increases	Decreases
Electron gain enthalpy (magnitude)	Increases	Decreases
Electronegativity	Increases	Decreases
Metallic character	Decreases	Increases
Non-metallic character	Increases	Decreases
Z_{eff}	Increases	Almost constant
Basic nature of oxides	Decreases (basic → amphoteric → acidic)	Increases

3.10 Valence, Oxides & Anomalous Behaviour

Concept	Rule / Example
Valence (groups 1-14)	= number of valence electrons; (groups 15-18) = 8 − valence electrons
Oxides across period 3	Na_2O (basic) → MgO (basic) → Al_2O_3 (amphoteric) → SiO_2 (weakly acidic) → P_2O_5, SO_3, Cl_2O_7 (acidic)
Anomalous 2nd period	Li, Be, B, C differ from their groups: small size, high EN, no d-orbitals, max covalence = 4
Diagonal relationship	Li ↔ Mg, Be ↔ Al, B ↔ Si (similar size & EN diagonally)
Reactivity pattern	Highest at the two extremes (Gr 1 metals & Gr 17 halogens); lowest in the middle

★ QUICK MEMORY AIDS & TRICKS

Z > 100 roots	'nil un bi tri quad pent hex sept oct enn' → 0-9; just read digits of Z and add 'ium'.
IE exceptions	'Be beats B, N beats O' — full $2s^2$ and half-filled $2p^3$ are extra stable.
$\Delta_{eg}H$ champion	Cl (not F!) has most negative electron gain enthalpy: Cl > F > Br > I.
Isoelectronic size	More protons pull harder → smaller ion. 'Cations shrink, anions swell.'
EN order to memorise	F (4.0) > O (3.5) > Cl = N (3.0) > Br (2.8) > S = C (2.5) > H (2.1)
Group number trick	p-block: Group = 10 + (s electrons) + (p electrons). e.g. $3s^2 3p^5$ → 10+2+5 = Group 17 (Cl).

Metalloid mnemonic	'B Si Ge As Sb Te' → 'Basi GeAs SabTe' — the staircase elements.