FREE NOTES · NCERT + JEE/NEET LEVEL

Classification of Elements & Periodicity

History of classification, Mendeleev's table, modern periodic law, naming of new elements, s, p, d, f blocks, and trends in atomic radius, ionisation enthalpy, electron gain enthalpy, electronegativity and valence.

01 Early attempts
02 Mendeleev's periodic table
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05 s, p, d, f blocks
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01 Early attempts

- **Döbereiner's triads:** groups of 3 similar elements; middle element's atomic mass ≈ average of the other two (Li, Na, K; Cl, Br, I).
- **Newlands' law of octaves:** every 8th element (by atomic mass) is similar, like musical notes. Worked only up to Ca.
- **Lothar Meyer:** plotted atomic volume vs atomic mass; showed periodicity.

02 Mendeleev's periodic table

Periodic law: properties of elements are a periodic function of their **atomic masses**.

- Left **gaps** for undiscovered elements and predicted their properties: eka-aluminium (gallium), eka-silicon (germanium).
- Corrected some atomic masses; put Te (127.6) before I (126.9) based on properties.
- Drawbacks: position of hydrogen, isotopes, anomalous pairs (Ar/K, Co/Ni).

03 Modern periodic table

Moseley showed $\sqrt{\nu}$ of X-rays $\propto$ atomic number. **Modern periodic law:** properties are a periodic function of **atomic number**.

- 18 groups (vertical), 7 periods (horizontal). Period number = principal quantum number of the outermost shell.
- Elements per period: 2, 8, 8, 18, 18, 32, 32.
- Lanthanoids and actinoids are placed separately at the bottom.

04 Naming elements with Z > 100 (IUPAC)

0	1	2	3	4	5	6	7	8	9
nil	un	bi	tri	quad	pent	hex	sept	oct	enn

Join the roots and add "-ium". 120 = un-bi-nil-ium = **Unbinilium (Ubn)**; 114 = Ununquadium (Uuq, now Flerovium).

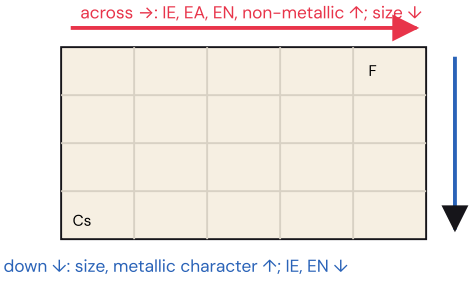
05 s, p, d, f blocks

Block	Groups	Outer configuration	Nature
s	1, 2	ns^{1-2}	Reactive metals, low IE, form ionic compounds (except Li, Be)
p	13–18	$ns^2\ np^{1-6}$	Metals, non-metals, metalloids; group 18 noble gases
d	3–12	$(n-1)d^{1-10}\ ns^{0-2}$	Transition metals: coloured ions, variable valency, catalysts
f	Lanthanoids, actinoids	$(n-2)f^{1-14}\ (n-1)d^{0-1}\ ns^2$	Inner transition; actinoids radioactive

Group of a p-block element = 10 + valence electrons (ns + np). Metalloids: B, Si, Ge, As, Sb, Te.

06 Atomic & ionic radius

- **Across a period: decreases** (nuclear charge rises, same shell).
- **Down a group: increases** (new shell added).
- Covalent radius < metallic radius < van der Waals radius.
- **Cation smaller** than parent atom; **anion larger**.
- **Isoelectronic species:** more protons ⇒ smaller. $O^{2-} > F^- > Na^+ > Mg^{2+} > Al^{3+}$.



General trends in the periodic table

07 Ionisation enthalpy (IE)

Energy to remove the outermost electron from an isolated gaseous atom: $X(g) \rightarrow X^+(g) + e^-$. Always positive. $IE_1 < IE_2 < IE_3$.

- Increases across a period; decreases down a group.
- Depends on: nuclear charge, size, **shielding**, penetration (s > p > d > f) and stability of the configuration.

TWO KEY EXCEPTIONS IN PERIOD 2 AND 3

Be > B (2s is more penetrating than 2p, and $2s^2$ is filled) and **N > O** (N has stable half-filled $2p^3$; O's $2p^4$ has a paired electron that repels). Similarly Mg > Al, P > S.

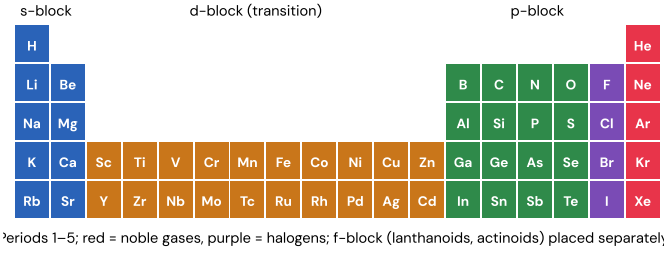
08 Electron gain enthalpy, electronegativity, valence

- **Electron gain enthalpy ($\Delta_{eg}H$):** energy change when an atom gains an electron. Mostly negative; becomes more negative across a period, less negative down a group.
  Cl has the most negative (not F: F is very small, so added electron is repelled). Noble gases, Be, Mg, N have positive or near-zero values. Second electron gain is always positive.
- **Electronegativity:** ability of a bonded atom to attract shared electrons (no unit; Pauling scale). Increases across, decreases down. F (4.0) is the most electronegative.
- **Metallic character** decreases across a period, increases down a group. Oxides: left = basic (Na_2O), middle = amphoteric (Al_2O_3), right = acidic (Cl_2O_7).
- **Valence** of s/p-block = valence electrons or 8 - valence electrons.
- **Anomalous 2nd period** elements (Li, Be, B ...) show diagonal relationship with the next group in period 3 (Li–Mg, Be–Al, B–Si).

09 JEE Extra + Tricks

JEE LEVEL

- Diagonal relationship: Li–Mg, Be–Al, B–Si (similar charge/size ratio).
- Ionisation enthalpy exceptions: IE(N) > IE(O) (half-filled p^3), IE(Be) > IE(B) (full $2s^2$).
- Electron gain enthalpy: Cl has the most negative (not F, due to small size of F, high electron repulsion). Noble gases and N, Be: positive.
- Isoelectronic species: size decreases as nuclear charge increases: $N^{3-} > O^{2-} > F^- > Na^+ > Mg^{2+} > Al^{3+}$.
- Inert pair effect and lanthanoid contraction (Zr ≈ Hf size) are favourite JEE reasons.
- JEE also asks p-block (Groups 13–18) properties: anomalous behaviour of first element, inert pair effect (Tl^+, Pb^{2+}, Bi^{3+} stable), oxides acidity across a period.



Periodic table (first five periods) with blocks

10 Solved questions

Q1. Arrange in order of size: Mg^{2+}, O^{2-}, Na^+, F^-, N^{3-}.

All have 10 electrons: $N^{3-} > O^{2-} > F^- > Na^+ > Mg^{2+}$.

Q2. Why is IE of N higher than O?

N is $2p^3$ (half-filled, extra stable); O is $2p^4$ where a paired electron is easier to remove.

Q3. IUPAC name and symbol of element 107.

un-nil-sept-ium ⇒ **Unnilseptium, Uns** (official name Bohrium).

Q4. Which block, period and group: [Ar] $3d^{10}$ $4s^2$ $4p^5$?

p-block, period 4, group 17 (bromine).

11 Mistakes & practice

- Saying F has the most negative electron gain enthalpy (it's Cl).
- Saying IE always increases across a period (Be/B and N/O are exceptions).
- Mixing electronegativity (bonded atom) with electron gain enthalpy (isolated atom).

1. Who said properties depend on atomic number?
2. Most electronegative element?
3. Which is larger: Na or Na^+?
4. Nature of Al_2O_3?
5. Eka-silicon is now called?

ANSWERS

1) Moseley · 2) Fluorine · 3) Na · 4) Amphoteric · 5) Germanium

12 Quick revision: 5 minutes before the exam

HISTORY

- Döbereiner triads, Newlands octaves.
- Mendeleev: atomic mass, gaps.
- Moseley: atomic number.

ACROSS A PERIOD

- Size ↓, IE ↑, EN ↑.
- Be > B, N > O (IE).
- Oxides: basic → acidic.

DOWN A GROUP

- Size ↑, IE ↓, EN ↓.
- Metallic character ↑.
- Cl most negative $\Delta_{eg}H$.

IONS

- Cation < atom < anion.
- Isoelectronic: more Z, smaller.
- Names: nil un bi tri quad pent hex sept oct enn.

Have a doubt? Ask the AI Doubt Solver at padhaiadda.netlify.app, or take the mock test on this chapter.