

Periodic Table and Periodicity of Properties

Comprehensive lecture notes covering historical periodic attempts, Modern Periodic Law, table organization, and periodic trends.

Historical Background & Dobereiner's Triads

Early systematic attempts to classify elements based on atomic masses.

J.W. DOBEREINER (1829)

Law of Triads

Grouped elements into sets of three (triads) where the atomic mass of the middle element was approximately the arithmetic mean of the other two.

Example: $\text{Li}(7), \text{Na}(23), \text{K}(39) \rightarrow (7 + 39)/2 = 23$.

LIMITATIONS

Why Triads Failed

Only a small number of elements could be arranged into triads (e.g., halogens, alkali metals). It could not accommodate newly discovered elements, proving to be an insufficient general law.

Newlands' Octaves & Mendeleev's Table

The progression toward periodic repetition and atomic mass ordering.

JOHN NEWLANDS (1864)

Law of Octaves

Arranged elements by increasing atomic mass. Noted that every 8th element had properties repeating similar to musical notes.
Rejected due to forcing dissimilar elements together.

DMITRI MENDELEEV (1869)

Periodic Law (Mass-based)

"Properties of elements are a periodic function of their atomic masses." Left blank spaces for undiscovered elements (e.g., Eka-silicon/Germanium) with remarkable accuracy.

Modern Periodic Law & Moseley's Discovery

Shifting from atomic mass to atomic number as the fundamental organizing principle.

HENRY MOSELEY (1913)

Atomic Number (Z)

Discovered that atomic number (positive nuclear charge) is a more fundamental property than atomic mass. X-ray spectra proved regular frequency progression with atomic number.

MODERN PERIODIC LAW

Periodic Function of Z

"Properties of elements are a periodic function of their atomic numbers." This resolved anomalies in Mendeleev's table (such as Co/Ni ordering).

Structure of the Modern Periodic Table

Arrangement of 7 horizontal periods and 18 vertical groups.

Periods (Rows)

7 horizontal rows. Period number equals the principal quantum number (n) or valence shell. Short periods (1–3) and long periods (4–7).

Groups (Columns)

18 vertical columns numbered 1 to 18. Elements in the same group possess identical valence shell electronic configurations and similar chemical properties.

Blocks (s, p, d, f)

Divided into 4 blocks based on the subshell receiving the last electron: s-block (Groups 1–2), p-block (Groups 13–18), d-block (Transition metals), f-block (Lanthanides/Actinides).

Periodic Trend: Atomic Radius

Variation of atomic size across periods and down groups.

Definition & Measurement

Atomic radius is half the distance between the nuclei of two identical atoms bonded together (covalent radius). Measured in picometers (pm) or Angstroms (Å).

Trends across Table

- **Along a Period (Left to Right):** Decreases. Nuclear charge increases, pulling electrons closer.
- **Down a Group (Top to Bottom):** Increases. New principal shells are added, increasing shielding and distance.

Periodic Trend: Ionization Energy

Energy required to remove an electron from an isolated gaseous atom.

Concept & Equation

First Ionization Energy (IE_1) is the energy needed to remove the most loosely bound valence electron.



Trends across Table

- **Along a Period (Left to Right):** Increases. Atomic size shrinks; nuclear attraction is stronger.
- **Down a Group (Top to Bottom):** Decreases. Outer electrons are farther and shielded by inner shells.

Electron Affinity & Electronegativity

Ability to attract or accept electrons in chemical bonding.

Electron Affinity (EA)

Energy released when an electron is added to a gaseous atom to form an anion.

Trend: Increases across period, decreases down group.

Electronegativity (EN)

Relative tendency of an atom to attract shared electron pairs in a covalent bond (Pauling scale).

Trend: Increases left-to-right (Fluorine highest), decreases top-to-bottom.

Summary of Periodic Trends

Quick-reference guide for exam preparation.

Property	Trend Along Period (Left → Right)	Trend Down Group (Top → Bottom)
Atomic Radius	Decreases	Increases
Ionization Energy	Increases	Decreases
Electron Affinity	Increases (more negative)	Decreases
Electronegativity	Increases	Decreases

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Chapter 3 Complete

You have mastered the periodic table organization, periodic law, and periodic trends for your board exams.

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