

Increasing
Atomic
Radius



CLASSIFICATION OF ELEMENTS — CHAPTER ROADMAP

DEFINITION:

Classification means arranging elements into groups so that similar properties and repeating trends become easy to study.

WHY NEEDED:

- There are many elements.
- Avoids studying each separately.
- Helps organise facts in a systematic way.
- Reveals periodic patterns in properties.
- Predicts properties of new or less familiar elements.

ATOMIC
NUMBER +
ELECTRONIC
CONFIGURATION

POSITION IN
PERIODIC
TABLE

PERIODIC
TRENDS

CHEMICAL
PROPERTIES &
REACTIVITY

CHAPTER ROADMAP

① historical
development

② Modern
Periodic Law

③ periods, groups
and s/p/d/f
blocks

④ atomic and
ionic radii

⑤ ionization enthalpy,
electron gain enthalpy
and electronegativity

⑥ valence, oxidation
states and
chemical reactivity



KEY IDEA: Properties repeat because
valence-shell electronic configurations repeat.

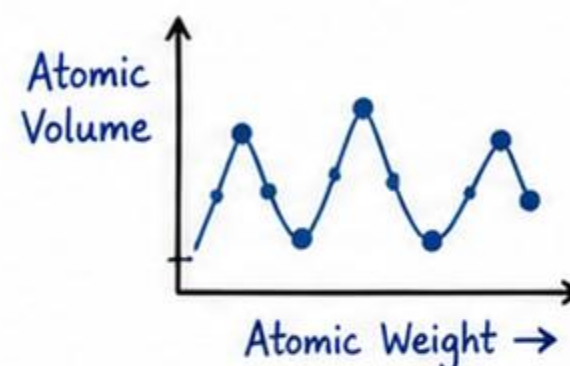
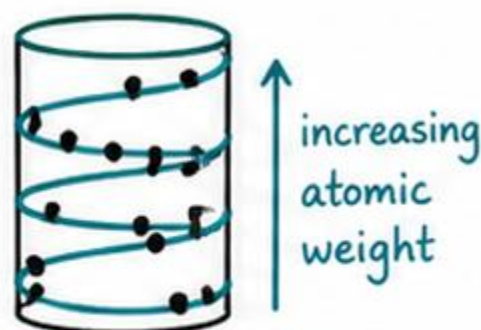


MEMORY LINE: Periodic classification turns a long list of elements into a meaningful pattern.

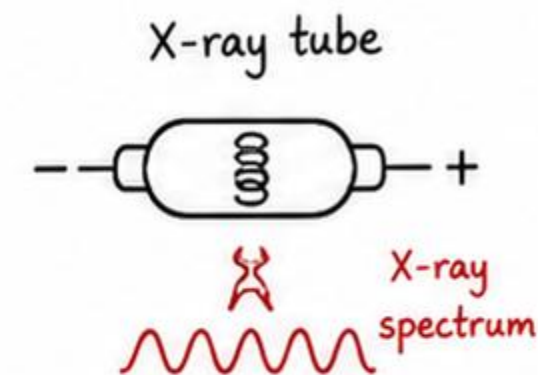
GENESIS OF PERIODIC CLASSIFICATION

* Periodic classification of elements grew out of repeated similarities in the physical and chemical properties of elements.

Li 7	Na 23	K 39
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I	II	III	IV	V	VI	VII	VIII
H	-	-	-	-	-	-	-
Li	Be	B	C	N	O	F	-
Na	Mg	Al	Si	P	S	Cl	-
K	Ca	-	Ti	V	Cr	Mn	Fe
...	...	...	...	...	...	...	...



1829
DOBEREINER
Triads:
The atomic weight of the middle element is approximately the average of the other two.



1862
DE CHANCOURTOIS
Elements were arranged in order of increasing atomic weight on the surface of a cylinder; periodic recurrence of properties appeared.



1865
NEWLANDS
Law of Octaves:
When elements were arranged by increasing atomic weight, every eighth element had similar properties. Worked mainly up to calcium.



1868
LOTHAR MEYER
Plotted atomic volume (physical property) against atomic weight; showed repeating patterns. Also prepared an early table very close to the modern form.



1869
MENDELEEV
Published the periodic law and a table; left gaps for elements not yet discovered and predicted their properties accurately.



1913
MOSELEY
Using X-ray spectra, showed that atomic number (Z), not atomic mass, is the correct basis of periodic classification.

- * Each step revealed a deeper pattern among elements.
- * Ideas and methods became more accurate and systematic.
- * Tables evolved from simple groupings to a predictive system.
- * This journey led to the modern periodic table based on atomic number, with greater organisation and predictive power.

EARLY BASIS	VS	MODERN BASIS
Arrangement based on ATOMIC WEIGHT		Arrangement based on ATOMIC NUMBER
(Less accurate ordering)		(Correct and Universal)

➔ **KEY MESSAGE:** From triads to atomic number — each step improved the organisation and **PREDICTIVE POWER** of the periodic table.

DOBEREINER'S TRIADS AND NEWLANDS' OCTAVES

DOBEREINER'S TRIADS (1829)

- Three chemically similar elements arranged by increasing atomic weight.
- Atomic weight of the middle element $\approx$ arithmetic mean of the other two.

WORKED EXAMPLE:

$$\begin{array}{ccc} \text{Li} & \longrightarrow & \text{Na} & \longrightarrow & \text{K} \\ 7 & & 23 & & 39 \\ \frac{(7 + 39)}{2} & = & \frac{46}{2} & = & 23 = \text{atomic weight of Na} \end{array}$$

OTHER TRIADS:

$$\begin{array}{ccc} \text{Ca} & \longrightarrow & \text{Sr} & \longrightarrow & \text{Ba} & \left\{ \frac{(40 + 137)}{2} = 88.5 \approx 88 \right. \\ 40 & & 88 & & 137 \\ \text{Cl} & \longrightarrow & \text{Br} & \longrightarrow & \text{I} & \left\{ \frac{(35.5 + 127)}{2} = 81.25 \approx 80 \right. \\ 35.5 & & 80 & & 127 \end{array}$$

LIMITATION: Worked only for a few elements.

NEWLANDS' LAW OF OCTAVES (1865)

- Elements arranged by increasing atomic weight.
- Every eighth element showed properties similar to the first, like the eighth musical note.

1st	2nd	3rd	4th	5th	6th	7th
Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl
K	Ca					

Octave relationships (similar properties):



LIMITATIONS:

- Reliable mainly up to calcium.
- No gaps for undiscovered elements.
- Later elements did not fit the pattern.

TRIADS = groups of 3 | **OCTAVES** = repeating every 8th element | **BOTH** = used atomic weight

MENDELEEV'S PERIODIC LAW AND TABLE

★ Year: 1869

★ Basis: Elements were arranged in the order of increasing atomic weight along with the similarities in their physical and chemical properties.

★ Mendeleev's Periodic Law:

The properties of the elements are a periodic function of their atomic weights.

★ Important Judgement:

- Mendeleev did not follow atomic-weight order blindly.
Example: Iodine (I) was placed with F, Cl and Br in the halogen group even though the Te/I mass order was unusual, because chemical properties were more important.
- He left intentional gaps for elements not yet discovered. —

★ Strengths of Mendeleev's Table:

① Provided a systematic classification of elements.

② Placed similar elements together in the same group.

③ Could accommodate future discoveries.

★ Construction of Mendeleev's Table:

- Elements were arranged in horizontal rows called periods and vertical columns called groups.
- Elements with similar properties were placed in the same group.
- Emphasis was laid on valency, empirical formulas and properties of compounds in deciding the position of elements.

Simplified old-style group/series sketch

Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII	Group VIII
R_2O	RO	R_2O_3	RO_2 RH_4	R_2O_5 RH_3	RO_3 RH_2	R_2O_7 RH	—
H	Be	B	C	N	O	F	Fe, Co, Ni
Li	Mg	Al	Si	P	S	Cl	Ru, Rh, Pd
Na	Ca	—	Ti	As	Se	Br	—
K	Sr	—	Zr	—	Te	I	—
(Cu)	Ba	—	—	—	—	—	—

Why iodine was placed with halogens?

- Iodine showed very similar chemical properties and formed compounds such as AgI and HI, similar in type to halogen compounds. Hence, chemical behaviour was given priority over atomic weight.

KEY IDEA: Mendeleev treated the table as a predictive scientific model, not merely a list.



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