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Introduction

This is a learning as well as an exam preparation video.

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Chapter 5: Periodic Classification of Element

Chapter 5: Periodic Classification of Elements

Early Attempts of Classification of Elements

- Matter around us is present in the form of elements, compounds and mixtures.
- Elements are substances containing atoms of only one type. E.g., Na, Mg, Au, etc.
- There are 118 elements known to us. All these have different properties.
- To make the study of these elements easy, these elements have been divided into few groups in such a way that elements in the same group have similar properties.

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Dobereiner's Triads

For example:

Consider the triad of lithium, sodium and potassium. The atomic mass of sodium is the mean of the atomic masses of lithium and potassium.

Element	Atomic Mass	Average
Lithium	6.9	Atomic mass of Na $= \frac{6.9 + 39}{2} = 23$
Sodium	23	
Potassium	39	

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Newlands' Law of Octaves

Law of Octaves: When elements are arranged in the increasing order of their atomic masses, the properties of every eighth element is similar to the first.

sa (do)	re (re)	ga (mi)	ma (fa)	pa (so)	da (la)	ni (ti)
H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	F
Cl	K	Ca	Cr	Ti	Mn	Fe
Co and Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce and La	Zr	____	____

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Newlands' Law of Octaves

Limitations

- Newland could arrange elements only up to calcium, out of the total 56 elements known.
- After calcium, every eighth element did not possess properties similar to that of the first.
- Only 56 elements were known at the time of Newland, but later several new elements were discovered.
- In order to fit the existing element arrangement, Newland placed two elements in the same position which differed in their properties.

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Newlands' Law of Octaves

Limitations

- For example: Iron, an element which resembles cobalt and nickel in its properties is placed far away from these elements.
- The periodic table did not include inert gases because they were not discovered then.

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Mendeleev’s Periodic Table

Mendeleev’s Periodic Law: The physical and chemical properties of elements are a periodic function of their atomic masses.

Achievements of Mendeleev's Periodic Table:

- **Systematic Study of Elements – The table provided the arrangements of elements showing similar properties into groups. This was very useful in studying and remembering the properties of a large number of elements in a systematic way.**

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Mendeleev's Periodic Table

- **Prediction of New Elements – Mendeleev had predicted new elements and had left three blanks for these undiscovered elements. He was able to predict their properties more or less accurately. He named them eka-boron, eka-aluminium and eka-silicon.**
- **Correction of Atomic Masses - Based on the elements' positions in the periodic table, Mendeleev was able to correct their atomic masses. The atomic mass of beryllium was corrected from 13.5 to 9.0.**

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Mendeleev's Periodic Table

Features of Mendeleev's Periodic Table

- There are seven horizontal rows in the periodic table, numbered from 1 to 7. These seven rows are called periods.
- There are eight vertical columns numbered from I to VIII. These eight columns are called groups. Groups I to VII are further divided into sub groups A and B.
- The properties of elements in a particular period show regular gradation from left to right.

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Mendeleev's Periodic Table

Merits of Mendeleev's Periodic Table

- Mendeleev kept some blank spaces in the periodic table for the elements which were yet to be discovered.

Predicted element	Actual element discovered later
Eka-boron	Scandium
Eka-aluminium	Gallium
Eka-silicon	Germanium

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Mendeleev's Periodic Table

- He also predicted properties of some elements even before their discovery which were later found to be correct.

Property	Eka-aluminium	Gallium
Atomic mass	68	69.7
Formula of oxide	E_2O_3	Ga_2O_3
Formula of chloride	ECl_3	$GaCl_3$

- Mendeleev's periodic table could accommodate noble gases when they were discovered.

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Mendeleev's Periodic Table

Demerits of Mendeleev's Periodic Table

- Hydrogen resembles alkali metals as well as halogens. So, a correct position could not be assigned to hydrogen in the periodic table.
- The position of isotopes could not be explained. Isotopes are atoms of the same element having similar chemical properties but different atomic masses. If the elements are arranged according to atomic masses, the isotopes should be placed in different groups of the periodic table.

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Mendeleev's Periodic Table

- At certain places, an element of higher atomic mass was placed before an element of lower atomic mass.
- For example: Cobalt (Co = 58.93) was placed before nickel (Ni = 58.71).
- Some elements placed in the same sub group had different properties.

For example: Manganese is placed with the halogens which are totally different in their properties.

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Modern Periodic Table

- In the year 1913, an English physicist named Henry Mosely found that the atomic number of an element, which was denoted by the symbol ‘Z’ was a more basic property to group them instead of their atomic masses. Thus Mendeleev's periodic table was modified for the same. The elements were now grouped based on the increasing atomic number.

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Modern Periodic Table

- This came to be known as the Modern Periodic Law and it states, ‘properties of the elements are a periodic function of their atomic number’. Hence the new classification of the elements based on this came into existence and was termed as ‘Modern Periodic Table.
- With this system of grouping, it was easy to predict the properties of the elements when they were arranged in the order of increasing atomic numbers. It is to be noted that the periodicity of the elements is based on the electronic configuration or the number of protons in the nucleus.

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Position of Elements in the Periodic Table

Periods

- The horizontal rows in the Modern Periodic Table are called periods.
- There are 7 periods in this table. The periods have the same elements that have the same valence shell or the energy shell. Example - Na, Mg, Al, Si, P, S, Cl are placed in the same shell as they have the electronic shells as K, L and M.

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Position of Elements in the Periodic Table

Periods

- In a period, the number of electrons present in the energy shells increases by 1 on moving from left to right within a period. Example - Na - 1, Mg - 2, Al - 3, and so on.
- The number of elements present in a period can be determined by the formula 2n2, where n is the number of the shell from the nucleus.
- The first period consists of two elements only namely, hydrogen and helium as they have only 1 valence shell. Example - hydrogen (Z = 1 or shell as K = 1), helium (Z = 2 or shell as K = 2)

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Position of Elements in the Periodic Table

Periods

- The second period has 8 elements with 2 shells and it starts with lithium (Z = 3 or shells as K = 2, L = 1) and ends with neon (Z = 10 or shells as K = 2, L = 8).
- The third period has 8 elements with 3 shells and it starts with sodium (Z = 11 or shells as K = 2, L = 8, M = 1) and ends with argon (Z = 18 or shells as K = 2, L = 8, M = 8).
- Similarly, the fourth period has 18 elements with 4 shells and starts with potassium (Z = 19) and ends with krypton (Z = 36).

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Position of Elements in the Periodic Table

Periods

- The fifth period having 18 elements with 5 shells starts with rubidium (Z = 37) and ends with xenon (Z = 54).
- The sixth period with 32 elements has 6 shells and it starts with caesium (Z = 55) ending with radon (Z = 86).
- The seventh and last period is incomplete with 19 elements starts francium (Z = 87) and going on till oganesson (Z = 118).

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Position of Elements in the Periodic Table

Groups

- The vertical columns are called groups and consist of eighteen groups numbered from 1 to 18.

o Group 1 elements are known as alkali metals.

o Group 2 elements are known as alkaline earth metals.

o Group 15 elements are known as pnicogens.

o Group 16 elements are known as chalcogens.

o Group 17 elements are known as halogens.

o Group 18 elements are known as noble gases.

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Position of Elements in the Periodic Table

Groups

- Elements having the same number of valence electrons are present in the same group.
- Elements present in the same group show the same chemical properties.

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Position of Elements in the Periodic Table

Blocks

The periodic table is also divided into 4 blocks that are based on the subshell of the valence electrons. They are:

- s-Block elements: All the elements of group 1 and 2 are included in this block and their general electronic configuration is ns1−2 Example - Hydrogen (H), Sodium (Na), etc from group 1 and Magnesium (Mg), Calcium (Ca), etc from group 2.

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Position of Elements in the Periodic Table

Blocks

- p-Block elements: This includes the elements from group 13 to 18. They have an electronic configuration as ns2np1−6.
- d-block elements: This includes group 3 to 12 elements. They have a general electronic configuration as (n−1)d1−10ns1−2.
- f-block elements: This block has sets of elements, lanthanides and the actinides. They have the electronic configuration of (n−2)f1−14(n−1)d0−1ns2. The lanthanides starts from Lanthanum (La) - Lutetium (Lu) and the actinides starts from Actinium (Ac) - Lawrencium (Lr).

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Trends in the Modern Periodic Table

Valency

- The valency of an element is determined by the number of valence electrons present in its outermost shell.
- In a group, all the elements have the same number of valence electrons.
- On moving from left to right in each short period, the valency increases from 1 to 4 and then decreases to zero.

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Trends in the Modern Periodic Table

Atomic Size

- Atomic size refers to the radius of the atom.
- It is the distance between the centre of the nucleus and the outermost shell of an isolated atom.
- In a period, the atomic radius decreases from left to right. This is because electrons are added to the same shell and so they experience a greater pull from the nucleus.
- Moving in a group from top to bottom, the atomic radius increases as new shells are added, resulting in the outermost electrons being farther away from the nucleus.

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Trends in the Modern Periodic Table

Metallic & Non-metallic Properties

- Metals show a tendency to lose electrons and are said to be electropositive.
- Non-metals show a tendency to accept or share electrons and are said to be electronegative.
- Moving from left to right in a period, the metallic character decreases and the nonmetallic character increases. The atomic size decreases and so electrons are not released easily.

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Trends in the Modern Periodic Table

Metallic & Non-metallic Properties

- In a group, the metallic character increases from top to bottom and the non-metallic character decreases. This is because, as the atomic size increases the valence electrons can be easily removed.
- Elements on the left of the periodic table are all metals and on the right of the periodic table are all non-metals.
- A zigzag line in the periodic table separates the metals from non-metals. The borderline elements show intermediate properties and are called metalloids.

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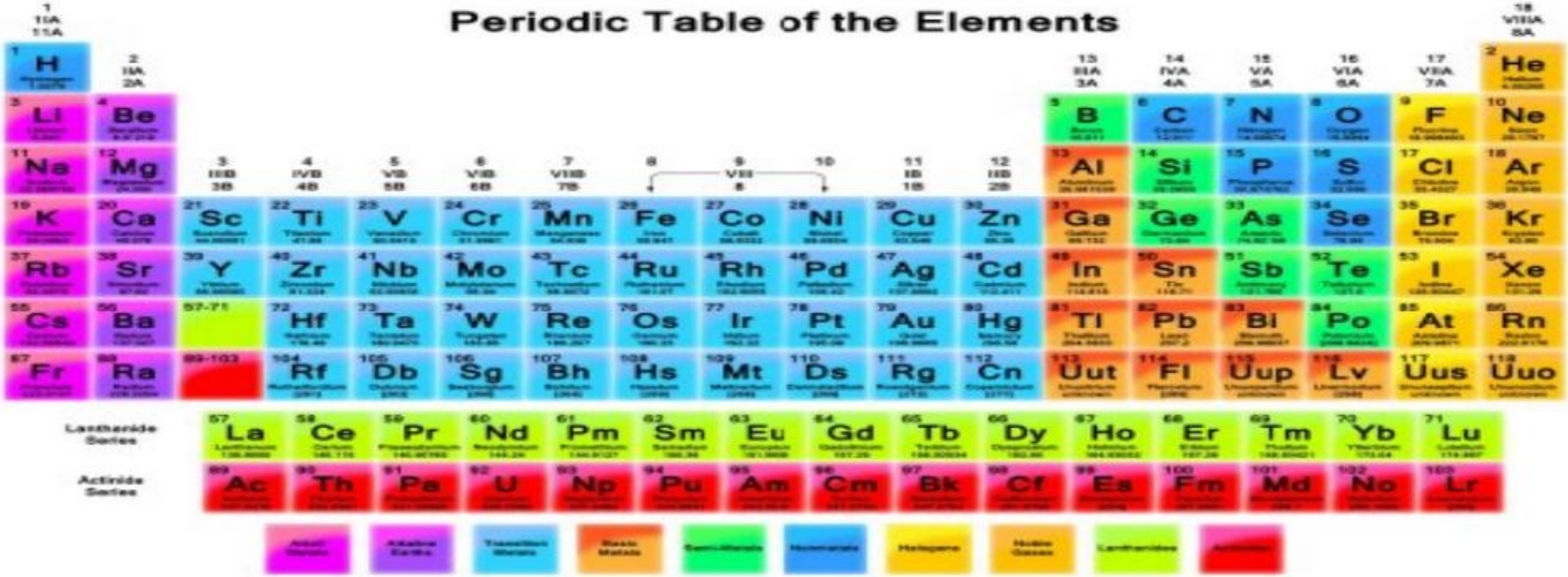

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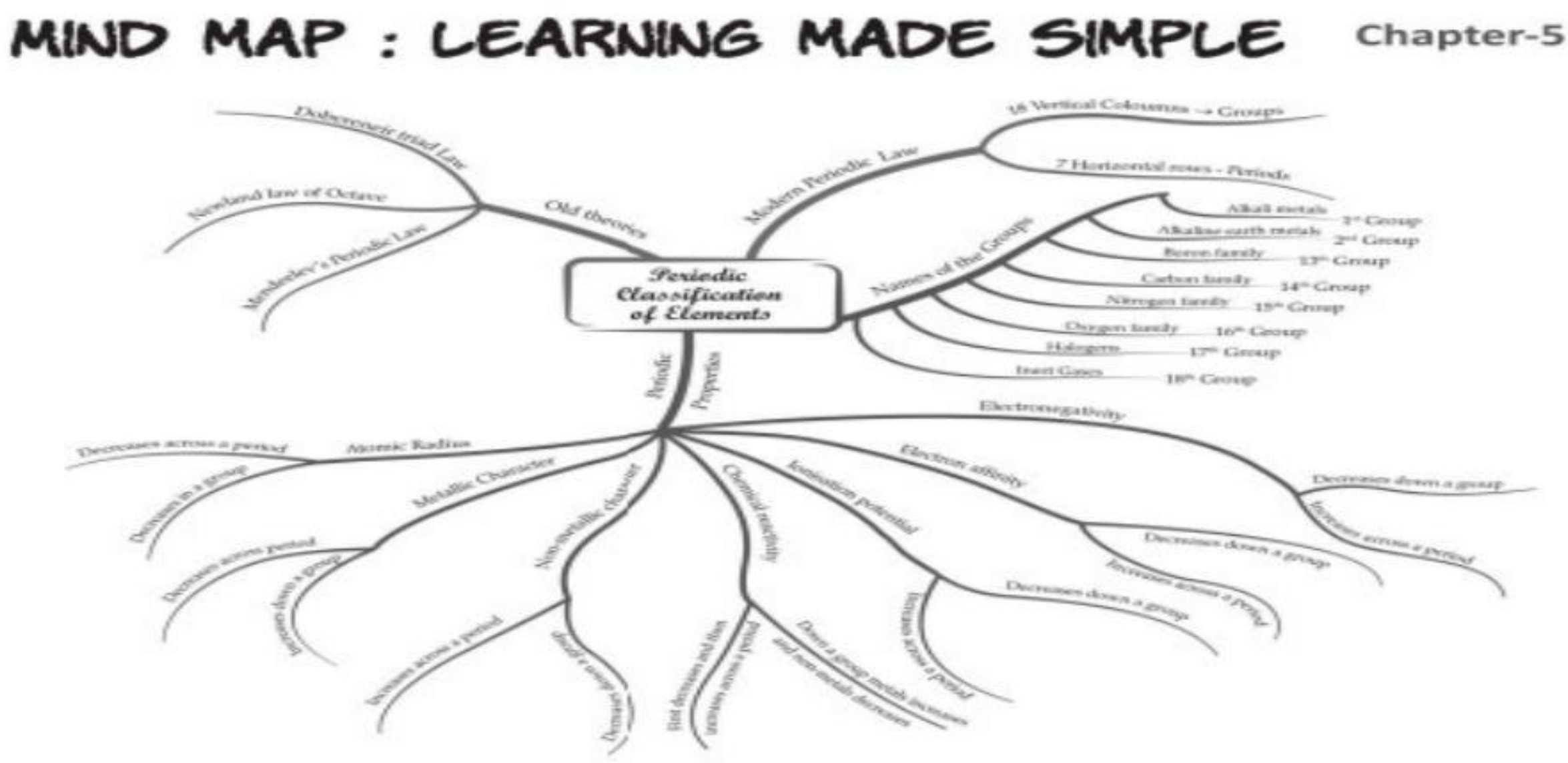

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