



Introduction

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

At the end of the video are practice assignments for you to attempt.

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Chapter 5: Periodic Classification of Elements

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 $2n^2$, 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.
 - Group 1 elements are known as alkali metals.
 - Group 2 elements are known as alkaline earth metals.
 - Group 15 elements are known as pnictogens.
 - Group 16 elements are known as chalcogens.
 - Group 17 elements are known as halogens.
 - 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 ns^{1-2} 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 ns^2np^{1-6} .
- **d-block elements:** This includes group 3 to 12 elements. They have a general electronic configuration as $(n-1)d^{1-10}ns^{1-2}$.
- **f-block elements:** This block has sets of elements, lanthanides and the actinides. They have the electronic configuration of $(n-2)f^{1-14}(n-1)d^{0-1}ns^2$. 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.

Chapter 5: Periodic Classification of Elements

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

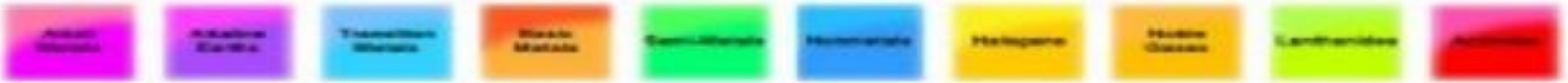
Metallic & Non-metallic Properties

- 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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Periodic Table of the Elements

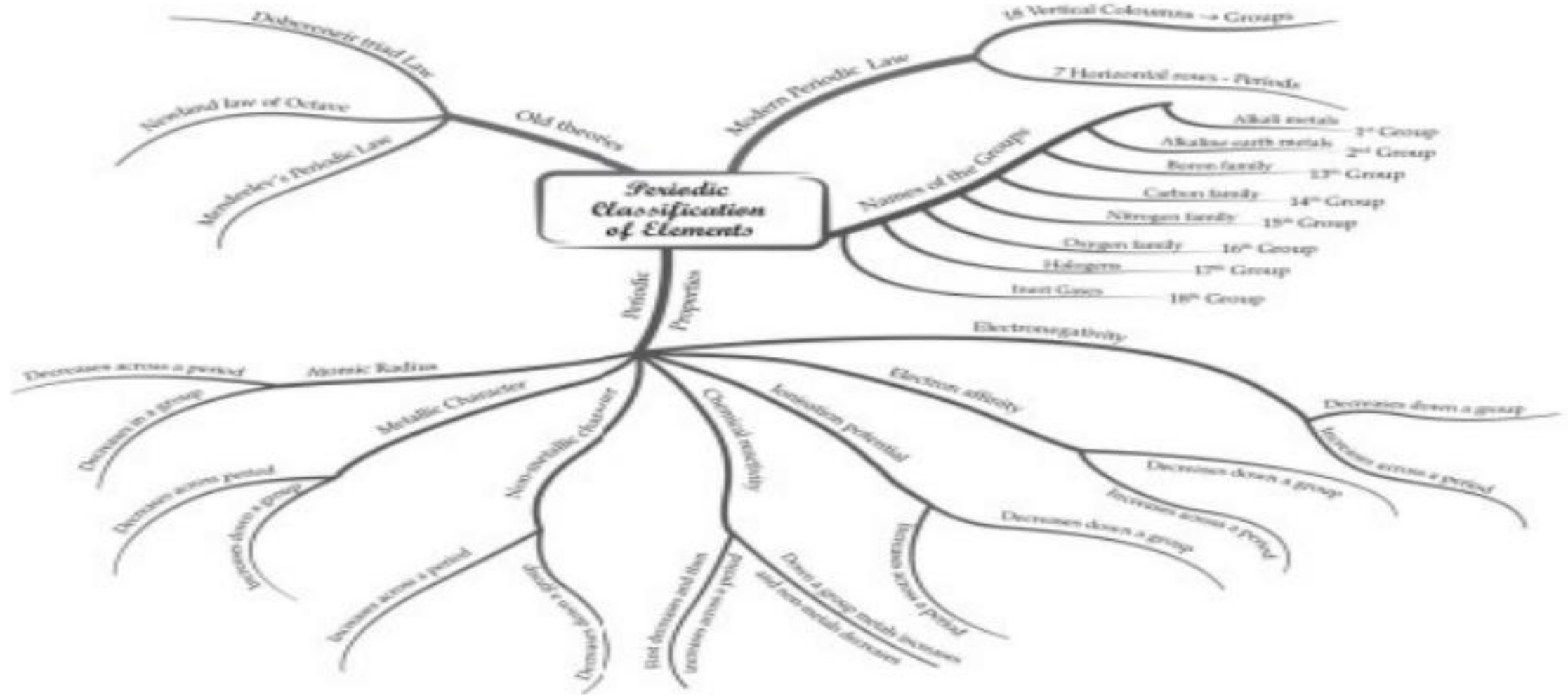
1 1IA 11A	2 IIA 2A											13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A	
1 H Hydrogen 1.008													3 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
3 Li Lithium 6.941	4 Be Beryllium 9.012												13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.06	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.64	33 As Arsenic 74.922	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80	
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium 98.906	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.905	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.757	52 Te Tellurium 127.6	53 I Iodine 126.905	54 Xe Xenon 131.29	
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.384	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium 209	85 At Astatine 210	86 Rn Radon 222	
87 Fr Francium 223	88 Ra Radium 226	89-103 Actinide Series	104 Rf Rutherfordium 261	105 Db Dubnium 262	106 Sg Seaborgium 263	107 Bh Bohrium 264	108 Hs Hassium 265	109 Mt Meitnerium 266	110 Ds Darmstadtium 267	111 Rg Roentgenium 268	112 Cn Copernicium 269	113 Uut Ununtrium 269	114 Fl Flerovium 269	115 Uup Ununpentium 269	116 Lv Livermorium 269	117 Uus Ununseptium 269	118 Uuo Ununoctium 269	
			57 La Lanthanum 138.905	58 Ce Cerium 140.12	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.930	70 Yb Ytterbium 173.054	71 Lu Lutetium 174.967	
			89 Ac Actinium 227	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium 252.083	100 Fm Fermium 257.103	101 Md Mendelevium 258.108	102 No Nobelium 259.108	103 Lr Lawrencium 260.105	



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MIND MAP : LEARNING MADE SIMPLE

Chapter-5



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