

MIND MAP

Periodic Table

Dobereiner Triad Rule

- He made groups of three elements having similar chemical properties called TRIAD.

- In Dobereiner triad, atomic weight of middle element is nearly equal to the average atomic weight of first and third element.

Newland's Octave Rule

Elements in the increasing order of their atomic masses

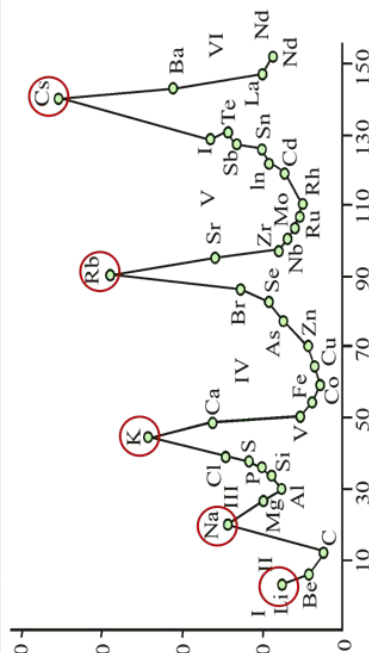
Properties of every 8th element was similar to the 1st element (like in the case of musical vowels notation).

Drawbacks or Limitations :

- This rule is valid only upto Ca, because after Ca there is difference of 18 elements instead of 8 element.
- After the discovery of Inert gases and including them into the periodic table it becomes the 8th element from Alkali metal so this law had to be dropped out.

Periodic Table of the Elements

1 H Hydrogen 1.008	2 He Helium 4.003	3 Li Lithium 6.941	4 Be Beryllium 9.012	5 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	11 Na Sodium 22.990	12 Mg Magnesium 24.305	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.06	17 Cl Chlorine 35.45	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 72.631	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 83.798	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 112.414	49 In Indium 114.818	50 Sn Tin 118.710	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 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 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.055	71 Lu Lutetium 174.967	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 192.222	78 Pt Platinum 195.084	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 Lanthanide Series	104 Rf Rutherfordium 261	105 Db Dubnium 262	106 Sg Seaborgium 266	107 Bh Bohrium 264	108 Hs Hassium 277	109 Mt Meitnerium 268	110 Ds Darmstadtium 271	111 Rg Roentgenium 272	112 Cn Copernicium 285	113 Nh Nihonium 284	114 Fl Flerovium 289	115 Uup Ununpentium 288	116 Lv Livermorium 293	117 Uus Ununseptium 294	118 Uuo Ununoctium 294	119 Ts Tennessine 294	120 Og Oganesson 294	121-150 Actinide Series	151 Lu Lutetium 174.967	152 Yb Ytterbium 173.055	153 Tm Thulium 168.934	154 Er Erbium 167.259	155 Ho Holmium 164.930	156 Dy Dysprosium 162.50	157 Tb Terbium 160.930	158 Gd Gadolinium 157.25	159 Eu Europium 151.964	160 Sm Samarium 150.36	161 Pm Promethium 144.913	162 Nd Neodymium 144.24	163 Pr Praseodymium 140.908	164 Ce Cerium 140.12	165 La Lanthanum 138.905	166 Ac Actinium 227	167 Th Thorium 232.038	168 Pa Protactinium 231.036	169 U Uranium 238.029	170 Np Neptunium 237.048	171 Pu Plutonium 244.064	172 Am Americium 243.061	173 Cm Curium 247.07	174 Bk Berkelium 247.07	175 Cf Californium 251.083	176 Es Einsteinium 252.083	177 Fm Fermium 257.10	178 Md Mendelevium 258.10	179 No Nobelium 259.10	180 Lr Lawrencium 262
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Lother meyer's curve

Development of Periodic Table

Lavoisier Classification :

- Lavoisier classified the elements simply in metals and non metals.

Periodic function

When the elements are arranged in the increasing order of their atomic weight, elements having similar properties gets repeated after a regular interval.

Mendeleev's Periodic Table

The physical and chemical properties of elements are the periodic function of their atomic weight.

Characteristics of Mendeleev's periodic table :

- (a) It was based on atomic weight.
- (b) 63 elements were known, noble gases were not discovered.

Moseley's Discovery

$$\sqrt{\nu} \propto Z$$

wave length of x-ray decreases (or frequency increases) in the regular way on moving from lighter to heavier element.

Property of x-ray depends on charge in nucleus (positive charge, proton). Moseley found that the physical and chemical properties of the elements are periodic function of their atomic number.

This is also known as 'Modern Periodic Law'.

MIND MAP

Periodic Table

Nomenclature of elements

0	Nil
1	Un
2	Bi
3	Tri
4	Quad
5	Pent
6	Hex
7	Sept
8	Oct
9	Enn

101	ununilium	Unu
102	unnibium	Unb
103	unnitrium	Unt

Inner Transition Elements

- The general electronic configuration of p-block elements is ns^2, np^{1-6} (where $n = 2$ to 6)
- The elements, in which the last electron enters into $(n - 1)d$ -orbital are called d-block elements.
- The general electronic configuration of d-block elements is $(n-1)d^{1-10} ns^{1-2}$.
- Zn, Cd and Hg (IIB or 12th group) are d-block elements but not transition elements because these elements have d^{10} configuration in neutral as well as in stable +2 oxidation state.
- Their outermost electronic configuration is similar to d-block elements i.e. $(n-1)d^{1-10} ns^{1-2}$.
- In these elements last three shells i.e. outermost, penultimate and prepenultimate shells are incomplete.
- (a) In these elements last three shells i.e. outermost, penultimate and prepenultimate shells are incomplete.
- (b) These are related to IIIB i.e. group 3.

Period number (n) = number of outermost shell/highest shell number.

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Periodic Table

Block identification

- If np electron present in the last shell then p - block ($ns^2 np^{1-6}$)
group number = $12 + np$ electrons

In the periodic table

Number of elements in

- 1st period = 2
2nd period = 8
3rd period = 8
4th period = 18
5th period = 18
6th period = 32
7th period = 32

Number of Gaseous elements –

11 (H, N, O, F, Cl + Noble gases)

Number of Liquid elements – 6

(Cs, Fr, Ga, Hg, Br, Uub)

Bromine is the only non-metal which exists in liquid form.

Number of Solid elements – 95
(if discovered elements are 112)

(a) Metals

Majority of the elements in periodic table are metals and appear on the left side of the periodic table.

All d-block elements are metals.

(b) Non-Metals

These are placed at the top right hand side of periodic table. As we move horizontally along a period, the property of elements changes from metallic (on left) to non-metallic (on the right).

Periodicity

The regular gradation in properties from top to bottom in a group and from left to right in a period is called periodicity in properties.

Periodicity

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3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne
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In a period, the ultimate shell remains same, but the number of e⁻ gradually increases.

In a group, the number of e⁻ in the ultimate subshell remains same, but the values of n increases.

(a) The cause of periodicity in properties is due to the same outermost shell electronic configuration coming at regular intervals.

(b) In the periodic table, elements with similar properties occur at intervals of 2, 8, 18, 18 and 32. These numbers are called as magic numbers.

Atomic Radius

The average distance of valence shell e⁻ from nucleus is called atomic radius.

(i) The decrease in force of attraction on valence e⁻ due to inner shell e⁻ is called screening effect or shielding effect.

$$Z_{\text{eff}} = Z - \sigma$$

Periodic variation :

(a) From left to right in a period Z_{eff} increases, generally.

Element $\text{Li} < \text{Be} < \text{B} < \text{C}$

Element $\text{N} < \text{O} < \text{F} < \text{Ne}$

From top to bottom in a group Z_{eff} remain constant for almost all.

Element $\text{Na} \approx \text{K} \approx \text{Rb} \approx \text{Cs} \approx \text{Fr}$

Z_{eff} for ions

$$Z_{\text{eff}} \propto \begin{cases} \text{positive charge} \\ \text{negative charge} \end{cases}$$

(ii) Z_{eff} of isoelectronic species

Ex. $\text{H}^- < \text{Li}^+ < \text{Be}^{+2} < \text{B}^{+3}$
($2e^-$ species)

Ex : $\text{N}^{-3} < \text{O}^{-2} < \text{F}^- < \text{Na}^+ < \text{Mg}^{+2}$
($10e^-$ species)

Endothermic

1. If energy is absorbed during a process, it is called an endothermic process.

2. Energy absorbed is taken as positive by sign convention.

Exothermic

1. If energy is released during a process, it is called an exothermic process.

2. Energy released/evolved is taken as negative by sign convention.

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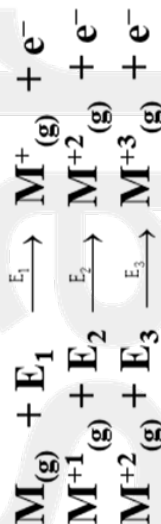
Periodic Table

Ionisation Potential / Ionisation Energy / Ionisation Enthalpy (IP / IE)

Minimum energy required to remove most loosely bonded outer most shell e^- from an isolated gaseous atom is known as ionisation energy.

Ionisation Energy $\text{Li} = 520 \text{ KJ/mol}$

Successive Ionisation Energy



$$\text{E}_1 < \text{E}_2 < \text{E}_3 \dots \dots \dots$$

(Always for an element)

Factors Affecting IE

(i) Atomic size : with increasing size ionisation energy decreases.

$$\text{Ionisation Energy} \propto \frac{1}{\text{atomic size}}$$

(ii) Effective nuclear charge (Z_{eff})

Ionisation Energy $\propto Z_{\text{eff}}$

Penetration power of sub shells

$$s > p > d > f$$

Ionisation Energy $\text{Ga} > \text{Al}$ (due to poor shielding of 3d)

Ionisation Energy of $5d > 4d$ (due to lanthanide contraction) **Ex. $\text{Hf} > \text{Zr}$**

$$\begin{aligned} \text{E}_1 &= \text{1st Ionisation energy} \\ \text{E}_2 &= \text{2nd Ionisation energy} \\ \text{E}_3 &= \text{3rd Ionisation energy} \end{aligned}$$

The value of ionization energy of

$\text{Be}(1s^2 2s^2)$ is more than $\text{B}(1s^2 2s^2 2p^1)$ because the penetration power of 2s-electrons of Be is more than the 2p electron of B

(b) In a period, the ionization energy of 15th group elements is more than the elements of 16th because the half filled p^3 configuration of 15th elements is comparatively of higher stability.

(c) IE $\text{Al} < \text{IE Ga}$ due to poor shielding of 3d

Electron Gain Enthalpy (ΔH_{eg})

- (1) The amount of energy change when an electron is added to the valence shell of an isolated gaseous atom is known as EGE.



Is EGE positive or negative?

- (2) Generally first electron addition in an isolated gaseous atom is an exothermic process (except stable electronic configuration)



(a) Atomic Size

$$\text{Atomic Size} \propto \frac{1}{EA}$$

(b) Effective Nuclear Charge

As effective nuclear charge increases, amount of energy released is more. Hence electron gain enthalpy value becomes more negative.

(c) Stability of Half-filled and Completely filled Orbitals

Half-filled orbitals of a sub shell is comparatively more stable, so it is difficult to add electron in such orbitals and lesser energy is released on addition of electron hence the electron gain enthalpy will become less negative.

MIND MAP

Periodic Table

EGE of N, Be, Ne are positive

(a) In Group

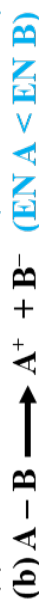
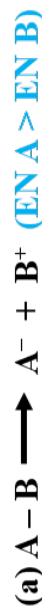
In a group, the electron affinity decreases on moving from top to bottom, that is, less and less amount of energy is released.

Electron affinity of 3rd period element is greater than electron affinity of 2nd period elements of the respective group.



Electronegativity (χ)

The tendency of a covalently bonded atom to attract shared pair of electrons towards itself is called electronegativity.



(a) Atomic size

$$\text{Electronegativity} \propto \frac{1}{\text{Atomic size}}$$

(b) Effective nuclear charge (Z_{eff})

$$\text{Electronegativity} \propto Z_{eff} \propto \begin{array}{l} \text{positive charge} \\ \text{negative charge} \end{array}$$



Variation in Electronegativity

(a) Electronegativity decreases down the group.

(b) In period on moving from left to right electronegativity increases.

Li	Be	B	C	N	O	F
1.0	1.5	2.0	2.5	3.0	3.5	4.0
Na	Mg	Al	Si	P	S	Cl
0.9	1.2	1.5	1.8	2.1	2.5	3.0
K						Br
0.8						2.8
Rb						I
0.8						2.5

Schomaker and Stevenson law

As per Schomaker and Stevenson – The reduction in bond length depends on the difference in electronegativities of atoms in following manner –

$$d_{A-B} = r_A + r_B - 0.09 (\chi_A - \chi_B)$$

Nature of oxides

1. Along a period acidic nature increases.
2. Down the group basic nature increases.

When in periodic table the distance between the element and oxygen increases, basic character increases.

BeO, Al₂O₃, ZnO, SnO, PbO, SnO₂, PbO₂, Sb₂O₃ etc. are amphoteric oxides.

CO, H₂O, NO, N₂O etc. are neutral oxides.