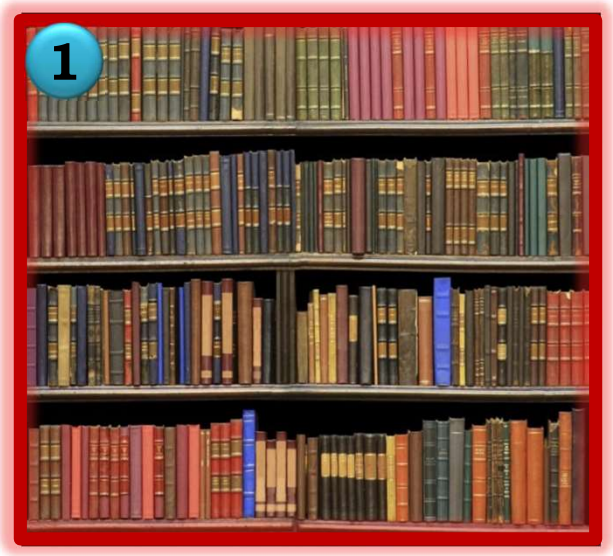
Periodic Classification Of Elements

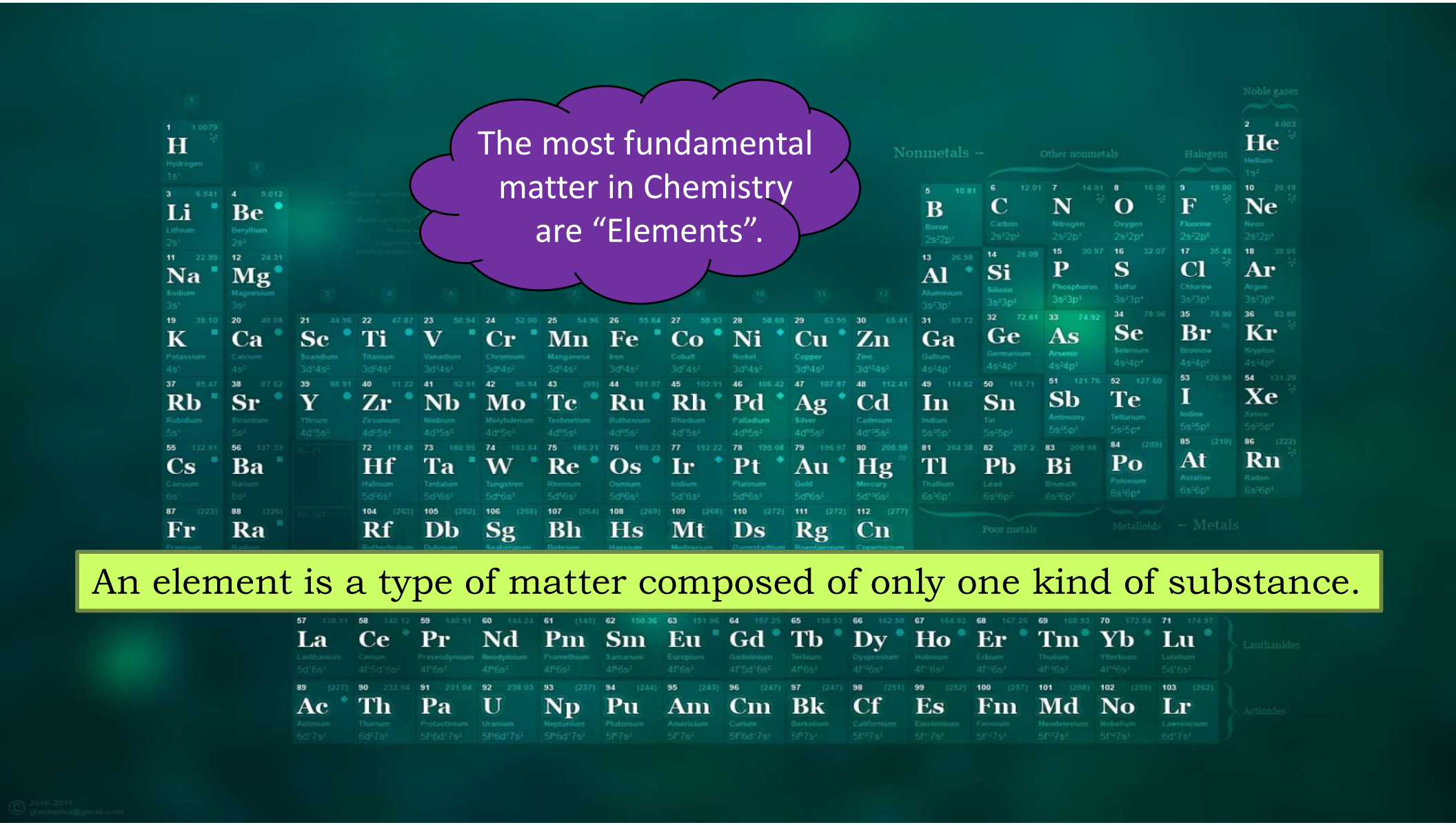
- Introduction
- Need for classification

Systematic arrangement of clothes have been done, so shopping becomes easy


1


2
Billy
COBEN
KAUFFMAN
JOHN CONNOLLY
ALTHAFFLE
Sara Paretsky Tunnel Vision


From where would you get the required book easily???


The most fundamental matter in Chemistry are “Elements”.
An element is a type of matter composed of only one kind of substance.

Initially scientists di… …ts like gold, silver, carbon(coal),

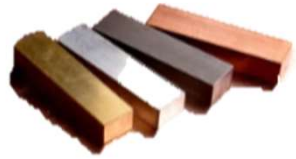
They class… …s.

Some elements showed properties of both metals and non-metals which were known as Metalloids

Metals

…metals

COPPER, SILVER, IRON



CARBON(COAL)

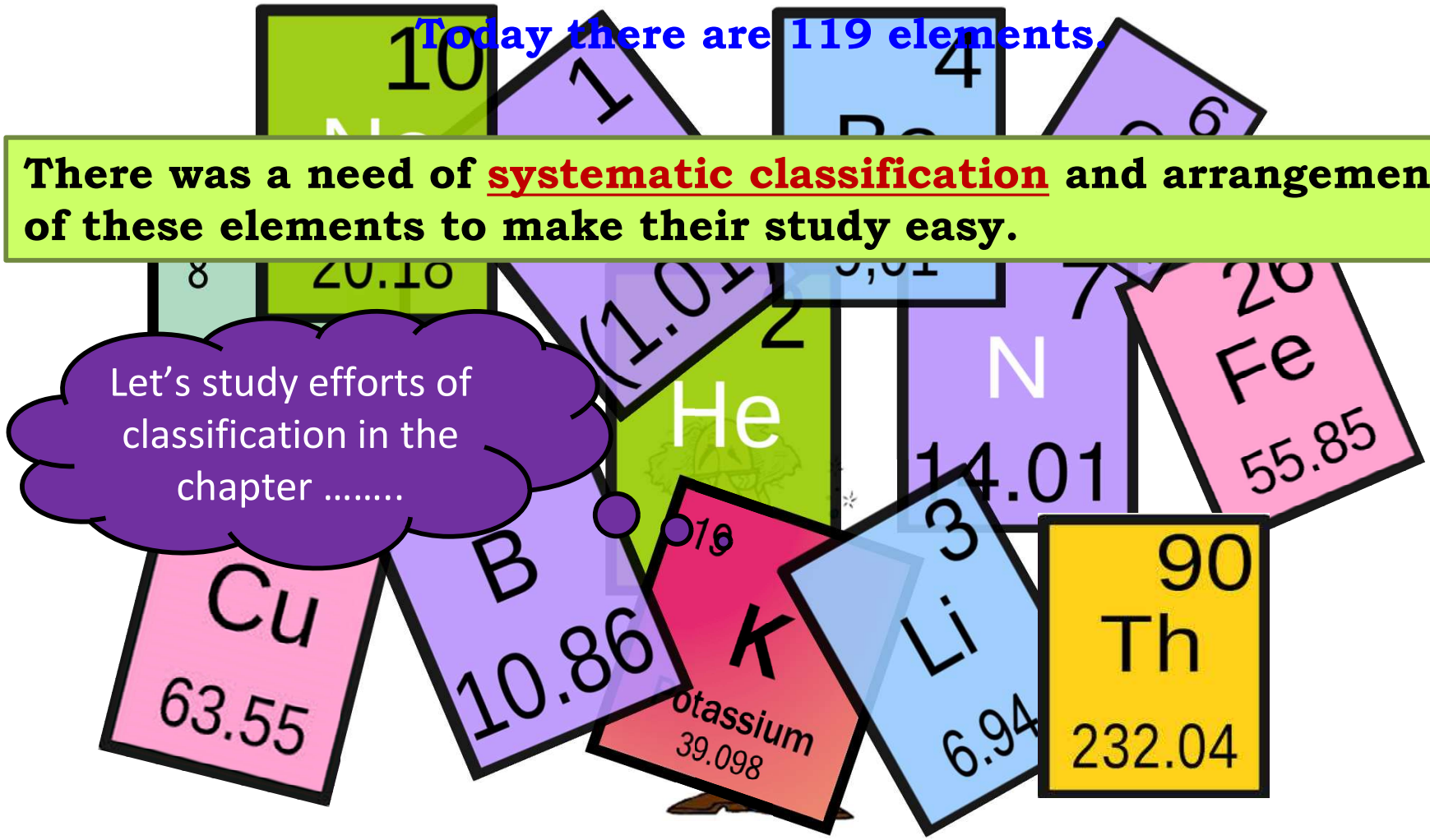
SILICON

GOLD

SULPHUR

Today there are 119 elements.

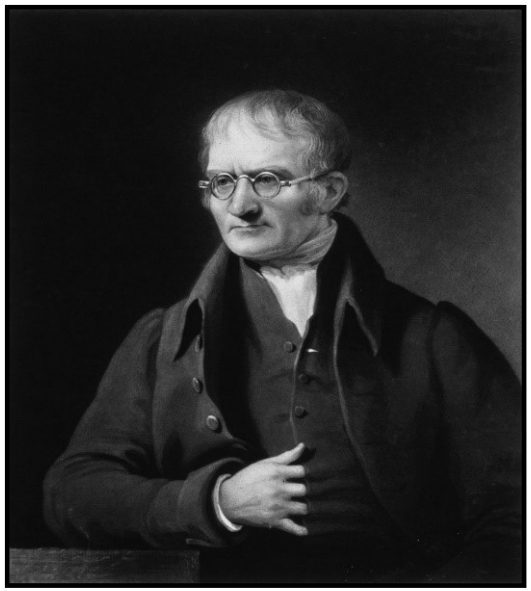
There was a need of systematic classification and arrangement of these elements to make their study easy.



Periodic Classification Of Elements

- Dobereiner's law of triads
- Limitations of Dobereiner's law of triad

John Dalton



English Chemist

He proposed the atomic theory ted
from the year 1808
fundamental characteristic of every atom

Johann Wolfgang Dobereiner

German Chemist

In earlier attempts, the elements were classified on the basis of their properties. All the elements having similar properties were put in one group called a family.

Tried to classify the elements for the first time, based on the atomic theory given by Dalton.

Dobereiner's Law Of Triads

- He arranged chemically similar elements
- In the increasing order of their atomic
- In a group of three
- Known as Dobereiner's Triads

In a Tri… The mean was approximately equal to the atomic mass of middle element

E.g.

Elements	Lithium	Sodium	Potassium
Symbols	Li	Na	K
Atomic masses	6.9	23.0	39.0

For example:

i) All these elements are metals

ii) All of them react with water to form alkalis and hydrogen gas

iii) All of them have a valency of 1

Elements	Calcium	Strontium	Barium
Symbols	Ca	Sr	Ba

For example:

i) All these elements are metals

ii) The oxides of all them are alkaline in natu

iii) All these elements have a valency of 2

N P As

Are chemically similar elements

of the triad.

mean of atomic masses of first and the last element of the triad.

Elements	Nitro		enic
Symbols	N	P	As
Atomic masses	14.0	31.0	74.9

$$\frac{14.0 + 74.9}{2} = \frac{88.9}{2} = 44.45$$

Limitations of Dobereiners Law Of Triads

Dobereiner could **identify only few triads** from the elements known at that time, other triads **did not obey Dobereiner's rule.** Hence, the system of triads was not useful.

Periodic Classification Of Elements

- Newlands' law of octaves
- Features of newlands' law of octaves

John Newlands

English Scientist

After the failure of Dobereiner's triad, the next attempt to classify elements was done in the year 1864.

By this time, 56 elements were discovered. Newlands arranged all these elements in an increasing order of their atomic masses.

Elements	Symbols	Elements	Symbols
Hydrogen	H	Aluminium	Al
Lithium	Li	Silicon	Si
Beryllium	Be	Phosphorous	P
Boron	B	Sulphur	S
Carbon	C	Chlorine	Cl
Nitrogen	N	Potassium	K
Oxygen	O	Calcium	Ca
Fluorine	F		
Sodium	Na		
Magnesium	Mg		

Newlands' Law Of Octaves

H Li Be B C N O F Na Mg Al Si P S Cl K Ca

When the elements [illegible] atomic masses, [illegible] the first.

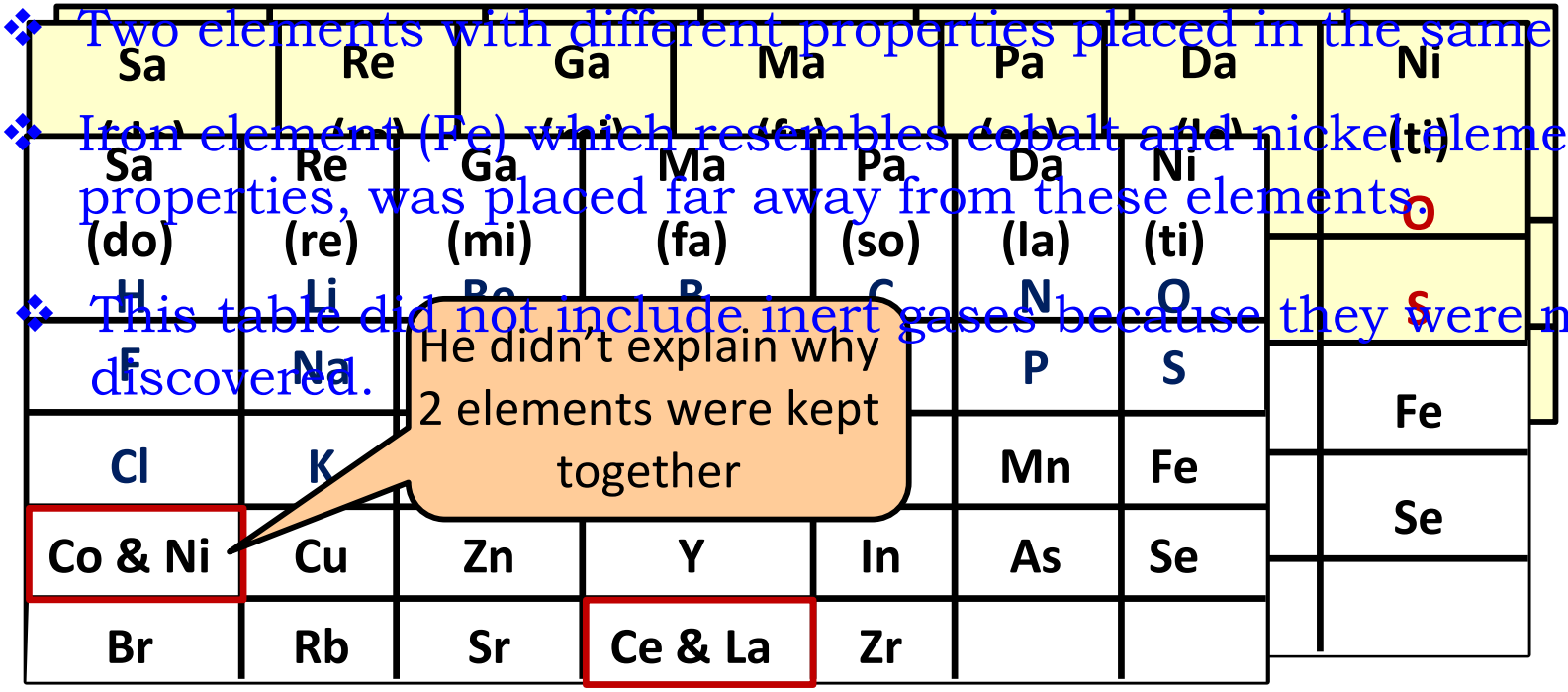
notes

He f[illegible] erties Fluo[illegible] nilar to Hydr[illegible] e placed it belo[illegible]

Sa (do)	Re (re)	(mi)	Ma (fa)	P (so)	(la)	Ni (ti)

Features Of Newlands' Table

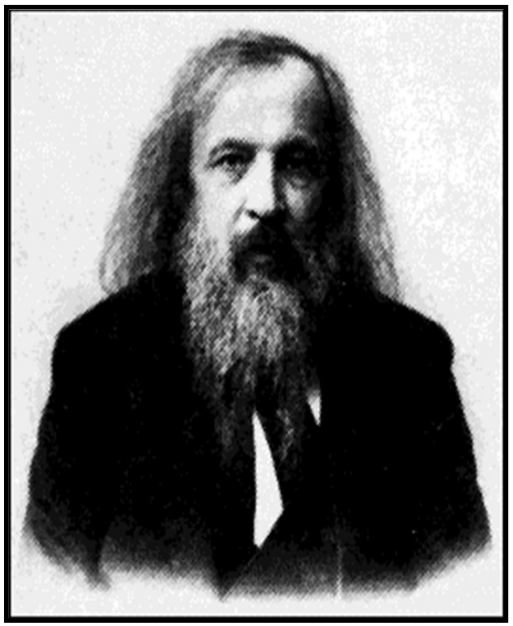
- Newlands knew 56 elements.
- After Calcium every eighth element did not possess properties similar to that of first.
- Two elements with different properties placed in the same box.
- Iron element (Fe) which resembles cobalt and nickel elements in properties, was placed far away from these elements.
- This table did not include inert gases because they were not yet discovered.



Periodic Classification Of Elements

- Mendeleev's periodic classification
- Features of periodic classification

Dimitri Ivanovitch Mendeleev



Russian Chemist

After the failure of Newlands' law of octaves, the next attempt to classify elements was done in the year 1869

Called as father of classification. He also arranged elements according to their atomic masses

- Most important contributor in classification of elements.
- Mendeleev knew 63 elements.
- He classified elements on the basis of **Atomic masses**
- Ar… chemical properties.
- M… of the oxides and hydrides formed by th… perty of elements for their classification in the f… a periodic table.

Since formula of these oxides is same, Mendeleev placed all of them in the same group

Formula for beryllium oxide is **BeO**
Formula for magnesium oxide is **MgO**
Formula for calcium oxide is **CaO**

…was …o …w …we… Silicon which was similar to it. Hence he left vacant space

H			
Li	Be	B	
Na	Mg	Al	
K	Ca		
Fe	Co	Ni	Cu

- On the basis of this Mendeleev formulated a **PERIODIC LAW.**
- The physical and chemical properties of elements are a **Periodic** function of their **"Atomic masses"**
- The tabula… …sed on the periodic law is called th…
- Horizontal … are called **PERIO…**
- …the periodic table …

There are 8 groups numbered from I to VIII, groups I to VII are further divided into A & B sub groups

There are 7 periods numbered from 1 to 7.

Main Features Of Mendeleev's Periodic Table

- The horizontal rows in the periodic table are called periods. There are seven periods. These are numbered from 1 to 7
- Properties of elements in a particular period show **REGULAR GRADATION** from left to right.
- Vertical columns in the periodic table are
  Groups
  and B

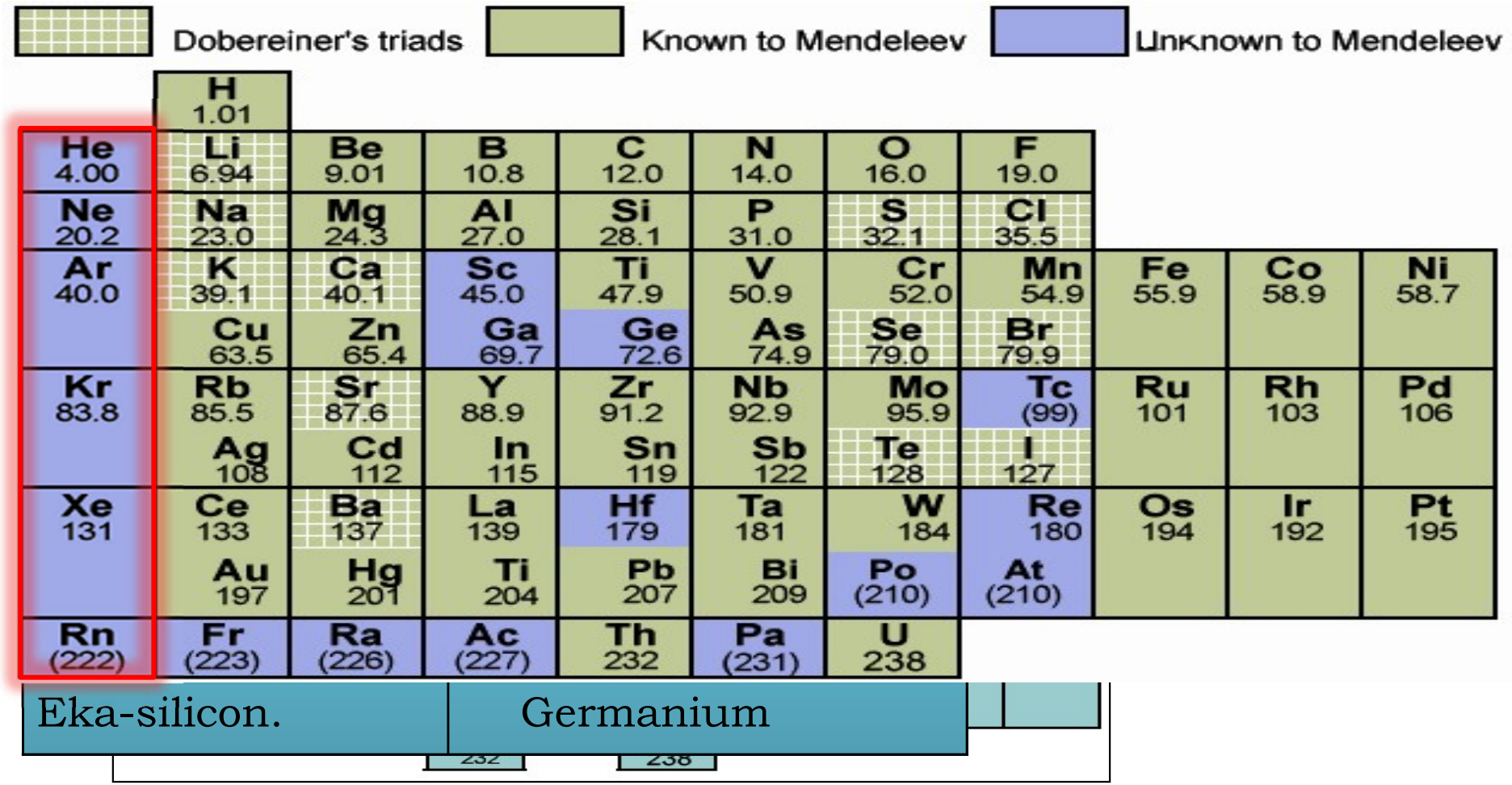
As we go from left to right, you can see a slow variation in the properties of elements from metals to nonmetals

Metals **Metalloid** **Non metals**

Periodic Classification Of Elements

- Merits of Mendeleev's periodic table
- Demerits Mendeleev's periodic table

Merits Of Mendeleev's Periodic Table



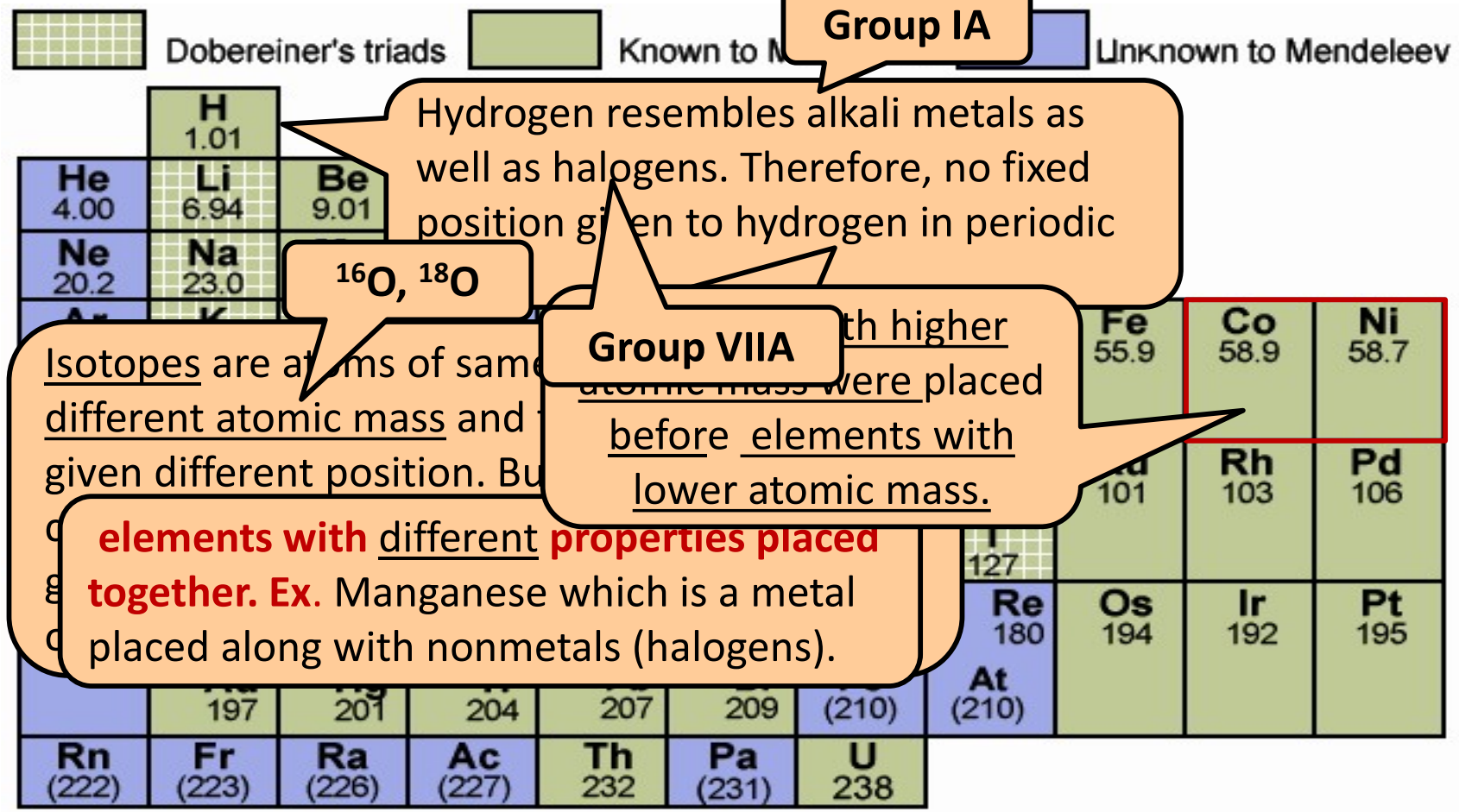
Comparison Of Properties Of Eka-Aluminium And Gallium

	Eka-aluminium	Gallium
Atomic weight	About 68	69.72
Density of solid	6.0g/cm^3	5.9g/cm^3
Melting point	Low	29.78^{0}C
Valency	3	3
Method of discovery	n	Spectroscopically
Oxides	Ea_2O_3	Ga_2O_3

This table confirms that predicted elements & discovered elements are similar .

Low – approximate room temperature

Demerits Of Mendeleev's Periodic Table



Periodic Classification Of Elements

- Modern periodic table
- Layout of modern periodic table

Henry Moseley

ENGLISH PHYSICIST

He studied the demerits of previous attempts of classification and discovered that Atomic number(Z) is the most fundamental property of an element and not its atomic mass.

No. of protons or electrons

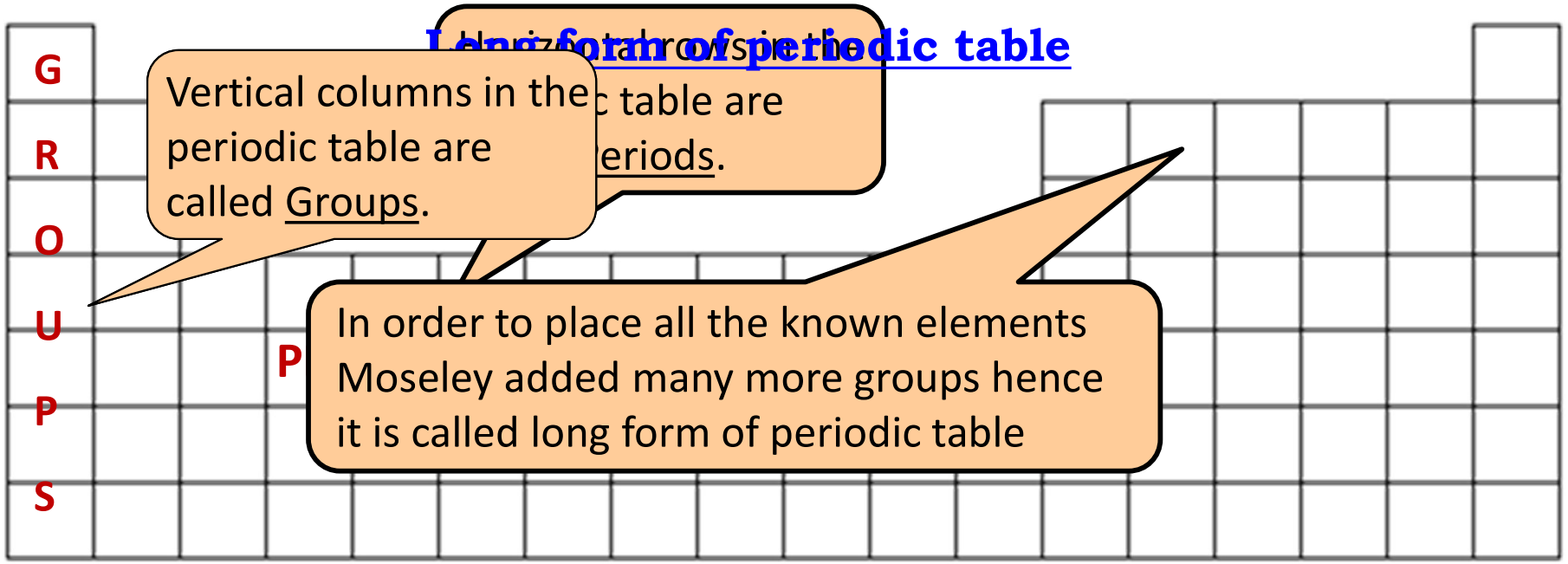
Moseley found that electrons take part in a chemical reaction and not protons.

- **Discovery of atomic number changed the whole perspective about elements and their properties.**
- **Accordingly, Mendeleev's periodic law was modified into 'Modern Periodic Law'.**

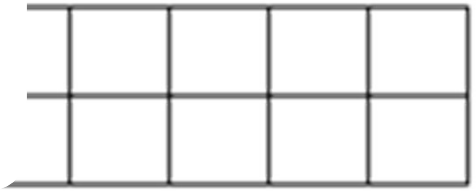
MODERN PERIODIC LAW

- **The chemical and physical properties of elements are a Periodic function of their "Atomic Numbers".**
- **The periodic table based on modern periodic law is called the Modern Periodic Table.**

Layout Of Modern Periodic Table



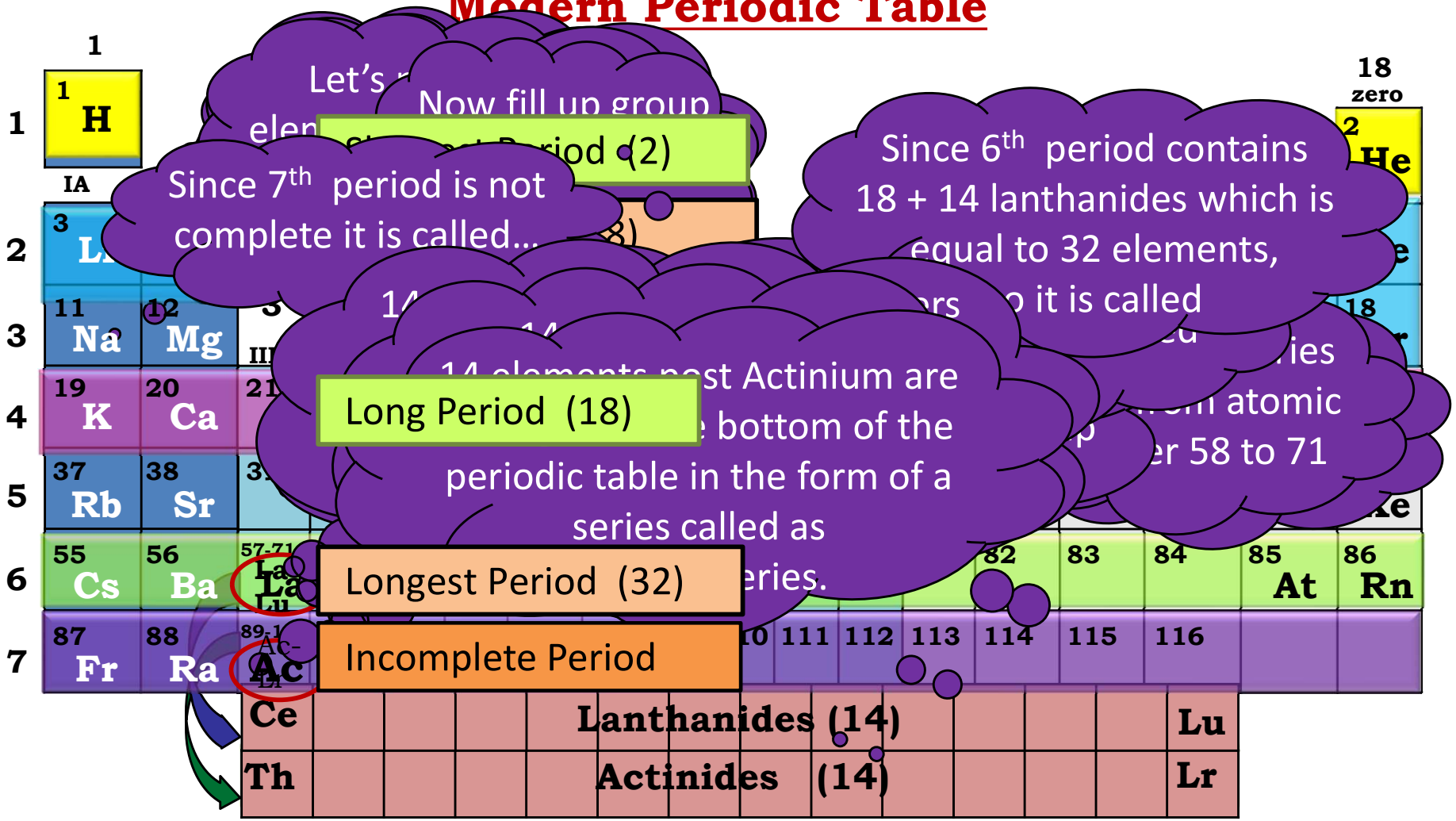
In modern periodic table there are 18 groups, 7 periods and 2 additional series at the bottom of the periodic table



Periodic Classification Of Elements

- **Modern periodic table**

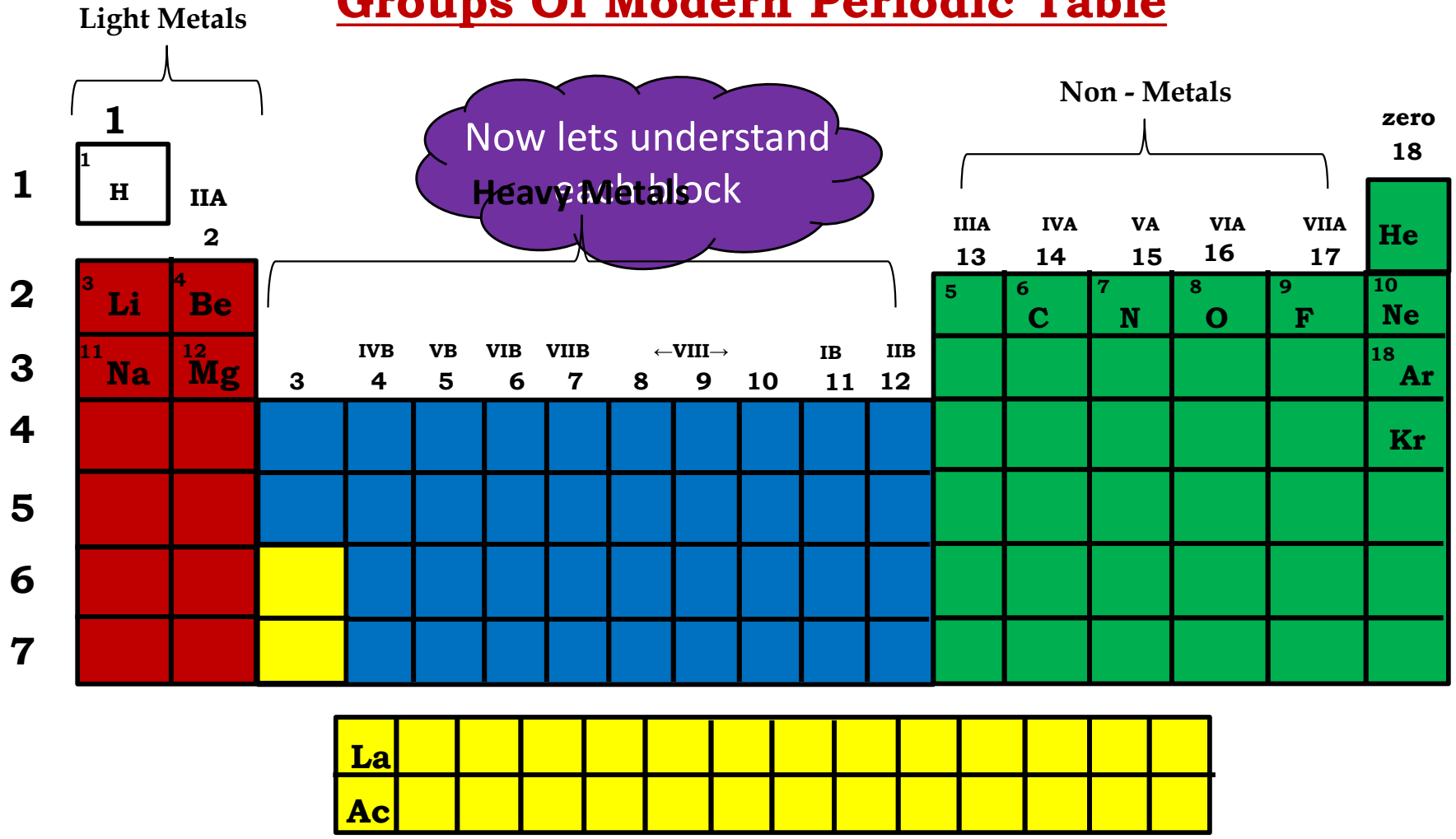
Modern Periodic Table

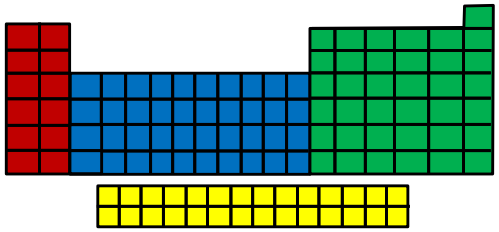


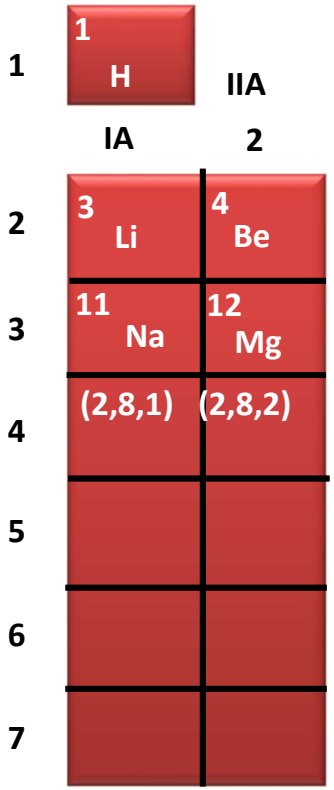
Periodic Classification Of Elements

- Classification of elements in groups
- Characteristics of group I and II

Groups Of Modern Periodic Table

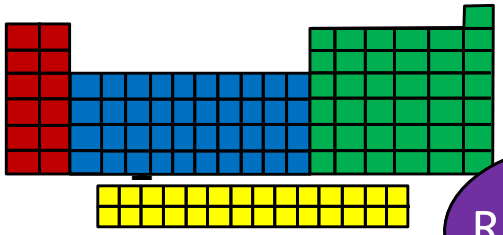






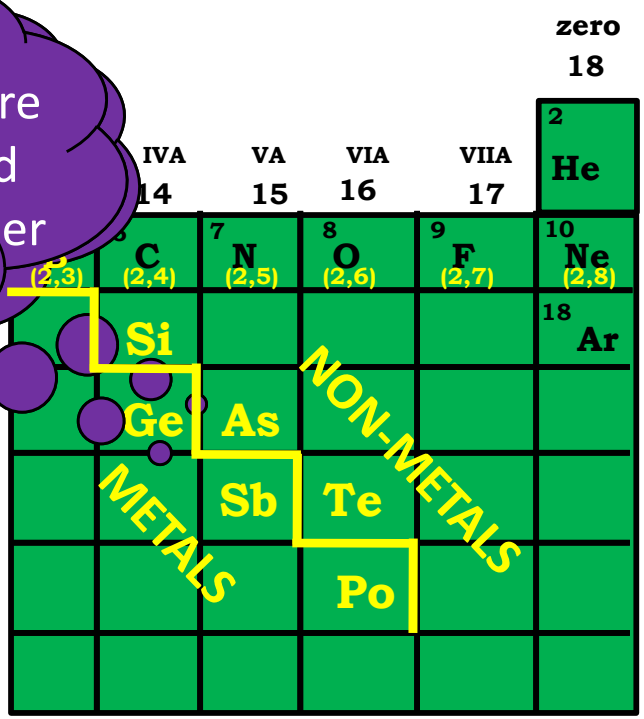
Group 1 & 2

- Lets take electronic configuration of Na & Mg
- All the elements in group 1 and 2 will have either 1 or 2 electrons in the outermost orbit
- All of them in order to become stable donate electrons. Therefore all are metals except hydrogen
- Since, only outermost shell is incomplete they are called as 'Normal elements'.



Groups 13 to 18

Right hand side of zig-zag line are all non-metals and on left hand side all metals. And on the border all metalloids are present.

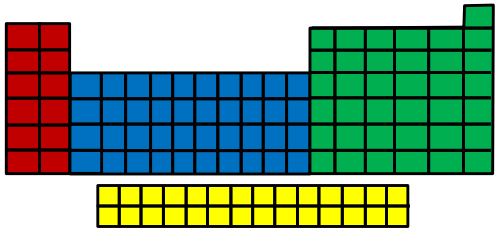


- **All the elem… 3 to 8 electr…**
- **Zig-zag line in this block divides entire periodic table into two parts**
- **This bl… …etals, non-meta…**
- **as well …s**
- **This block contains normal as well as inert elements.**

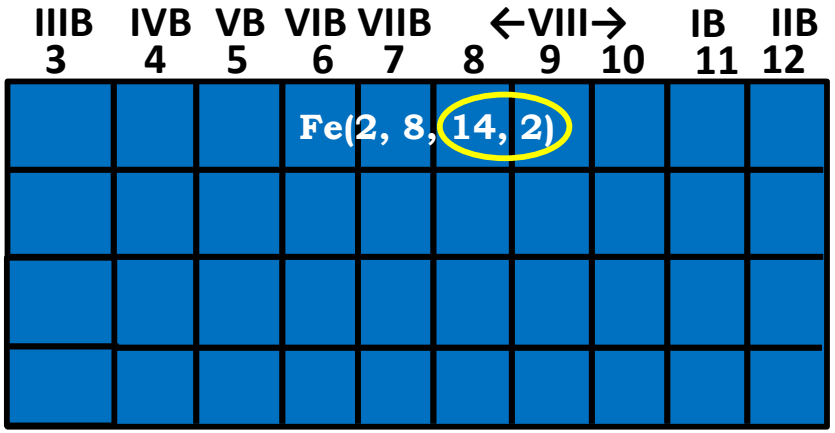
Chemically inactive

Periodic Classification Of Elements

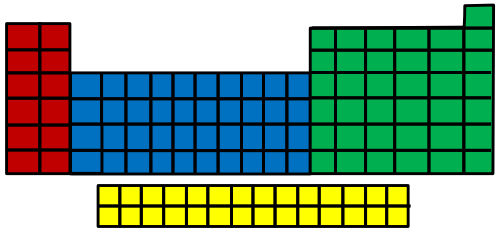
- Transition elements
- Inner transition elements



Groups 3 to 12



- Group 3 to 12 are known as heavy metals.
- These elements have last two shells incomplete
- All these elements are metals since they are on the left hand side of the zig-zag line
- They are known as transition elements

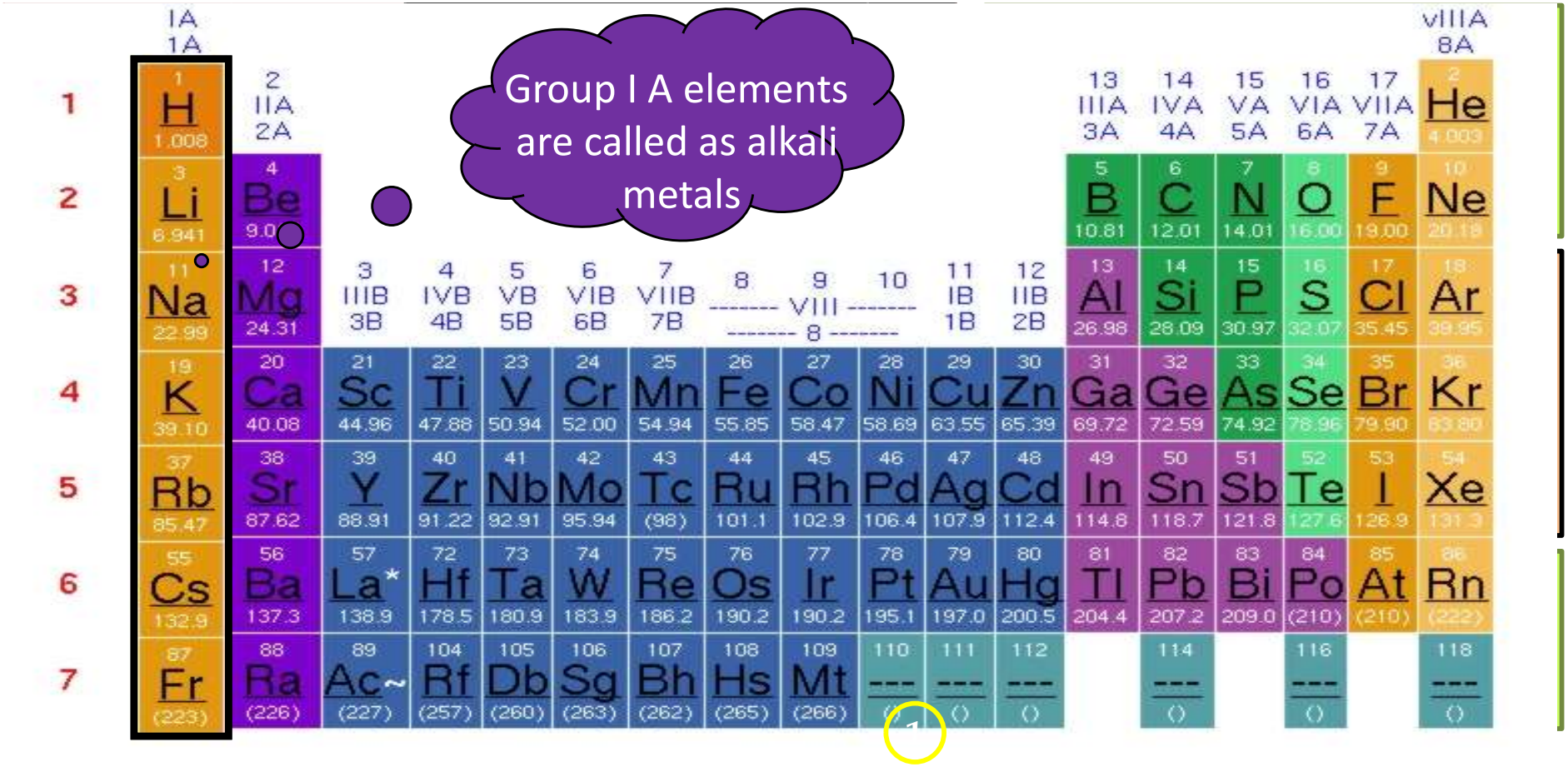


Lanthanide & Actinide Series

- Elements present at the bottom of the periodic table is called as lanthanides and actinides series.
- They have their last 3 shells incompletely filled. They are metals.
- They are also known as inner transition elements.

Ce													Lu
Th													Lr

Similarities Between Hydrogen And Alkali Metals



Similarities Between Hydrogen And Halogens

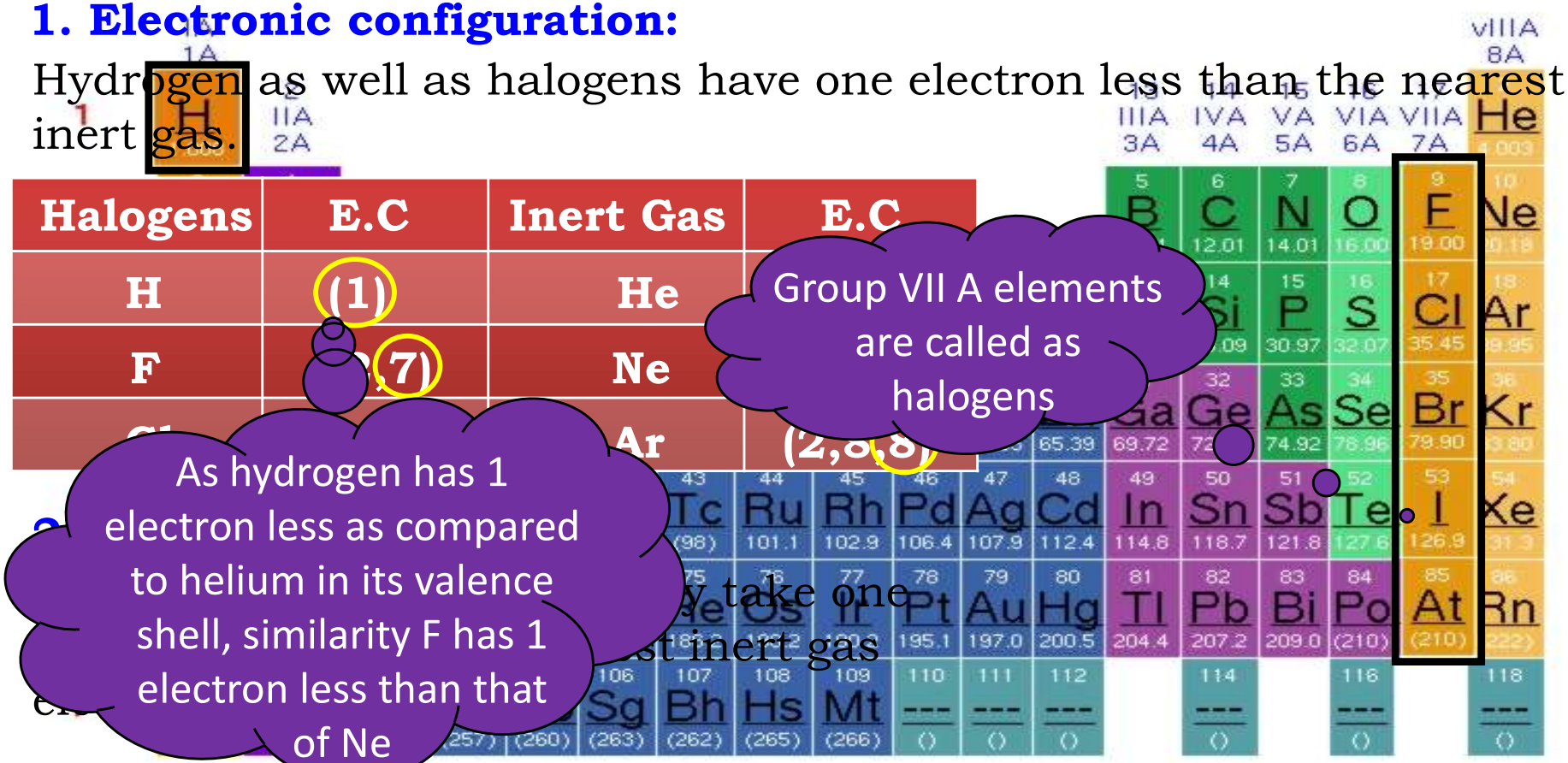
1. Electronic configuration:

Hydrogen as well as halogens have one electron less than the nearest inert gas.

Halogens	E.C	Inert Gas	E.C
H	(1)	He	
F	(2,7)	Ne	
		Ar	(2,8,8)

Group VII A elements are called as halogens

As hydrogen has 1 electron less as compared to helium in its valence shell, similarity F has 1 electron less than that of Ne



Periodic Classification Of Elements

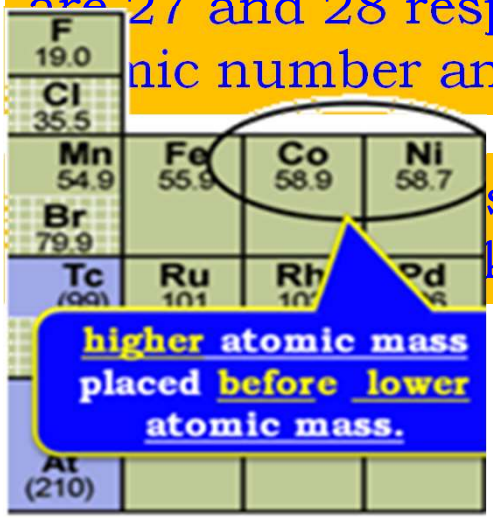
- Merits of Modern periodic table
- Periodic properties

Merits Of Modern Periodic Table

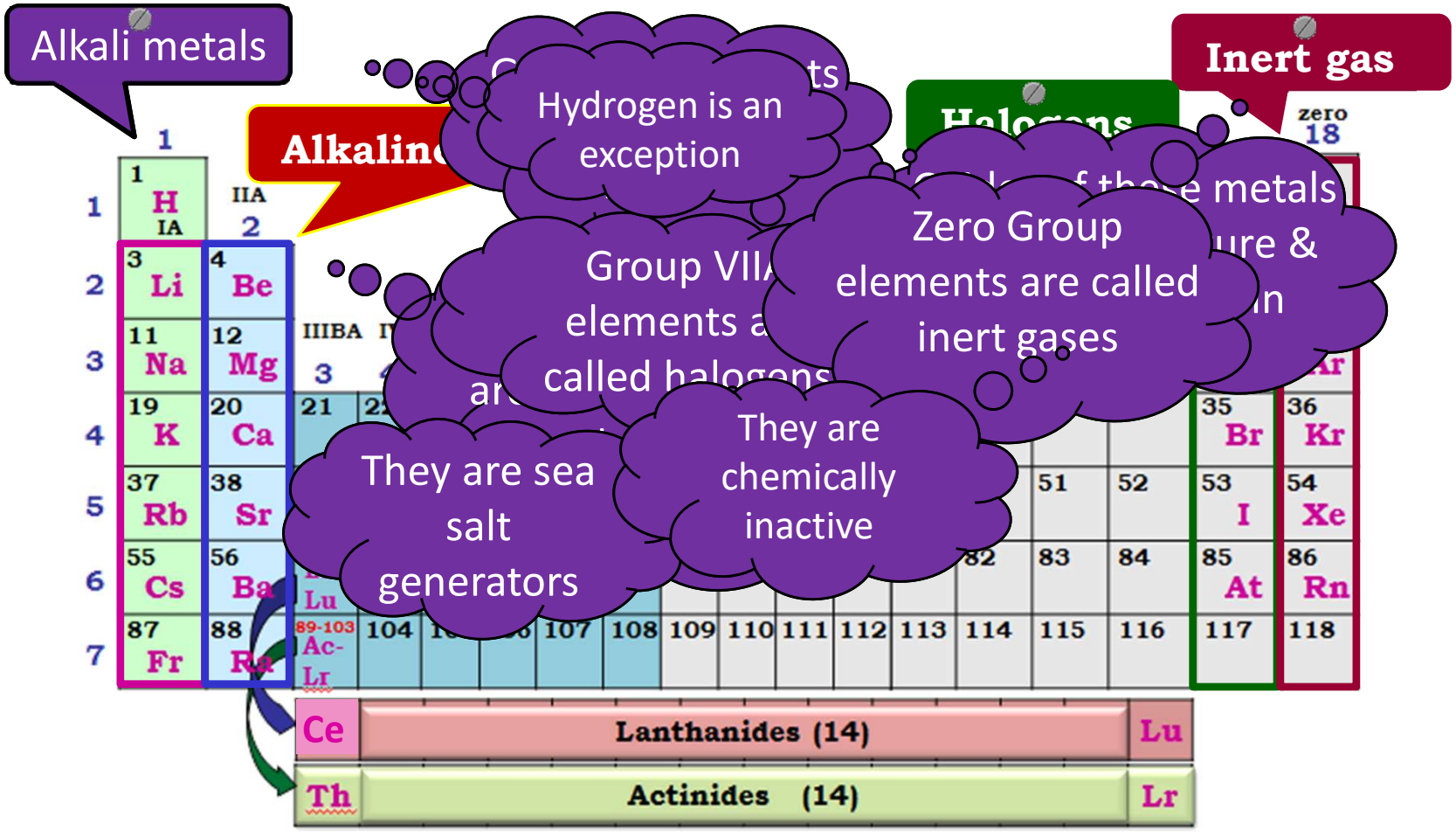
All isotopes of the same elements occupy the same position in the modern periodic table .

Since the elements are arranged according to their atomic number, the anomalies regarding certain pairs of elements in Mendeleev's periodic table disappears. E.g. Atomic number of cobalt and nickel are 27 and 28 respectively. Therefore cobalt will come first due to its nic number and then nickel although its atomic mass is greater.

sified according to their electronic configuration ks.

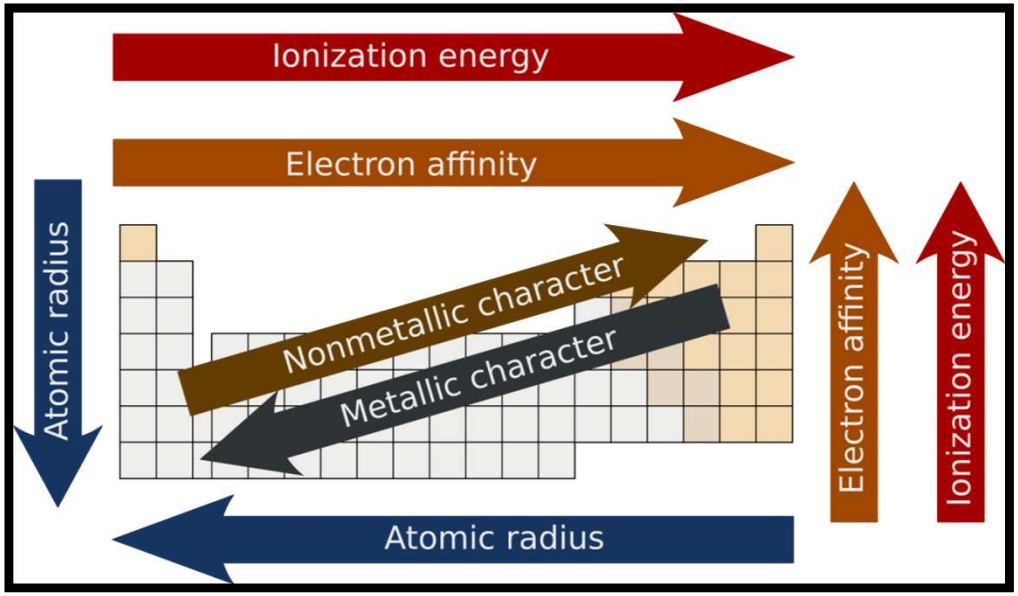


Common Name For Important Groups



Characteristics Of Periods And Groups

The properties which show gradual variation in a group and in a period and they repeat themselves after a certain interval of atomic number are called periodic properties.



1. **Valency**
2. **Atomic size**
3. **Metallic & non-metallic properties**

Periodic Classification Of Elements

- Valence electrons
- Board Questions

Valence Electrons (Or Outermost Electrons)

On moving from left to right in a period , the number of valence electrons in elements increases from 1 to 8

Elements of third period	11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
Electronic configurations	2,8,1	2,8,2	2,8,3	2,8,4	2,8,5	2,8,6	2,8,7	2,8,8
Number of Valence electrons	1	2	3	4	5	6	7	8

The first element in every period has 1 Valence electron and the last element in every period has 8 valence electron (except in the first period where last element helium has only 2 valence electrons)

Valence Electrons (Or Outermost Electrons)

All the elements of a group of the periodic table have the same Number of valence electrons.

Group 1	Electronic configuration	No. of valence electrons
Li	2, 1	1
Na	2, 8, 1	1
K	2, 8, 8, 1	1

Since all the elements in a group have similar electronic configuration having the same number of valence electrons they show similar chemical properties

On moving down in a particular group of the periodic table, the number of valence electrons in the elements remains the same.

How to find the group number of an element in the periodic. table from the number of valence electrons in its atom.

i) The group number of elements h… lectrons is equal to the number of vale…

If number of valence electrons…
If number of valence electrons …

ii) The group number of elements having up … valence electrons is equal to the number of valence electrons plus 10.

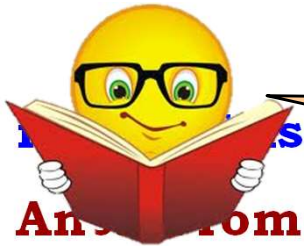
There is, however, one exception to this rule. The noble gas 'helium' has 2 valence electrons in K shell but its group number is 18.

If number of valence electrons is 3, then group number is 3+10=13

If number of valence electrons is 4, then group number is 4+10=14

If number of valence electrons is 7, then group number is 7+10=17

The electronic configuration of an element X is: K L M
2, 8, 6



i) What is the group number of element X in the periodic table?

Ans: From the above given electronic configuration we find that element X has 6 valence electrons in the outermost shell so the group number of element X in periodic table is 6+10=16.

ii) What is the period number of element X in the periodic table?

ii) What is the period number of element X in the periodic table?

iii) What is the number of valence electrons in an atom of X?

Ans: Element X has 3 electron shells (K,L and M) in its atom, so the period number of X is 3. That is , X belongs to 3rd period of the periodic table.

iv) What is the valency of X?

v) Is it a metal or a non metal?

iii) What is the number of valence electrons in an atom of X?

Ans: Elements X has 6 valence electrons.

The electronic configuration of an element X is: K L M
2, 8, 6

5 mark question

iv) What is the valency of X?

Ans: Elements X has 6 valence electrons so it needs 2 more electrons to complete its octet 8 electrons in valence shell and become stable. Thus, the valency of element X is 2.

v) Is it a metal or a non metal?

Ans: The elements of group 16 are non-metals. So, X is a non-metal.

An element X is in group 13 of the periodic table. What is the formula of its oxide?

5 mark Questions

Solution:

We know that the element aluminium belongs to group 13 of the periodic table and has a valency of 3. So, the element X of the above given problem could be aluminium, Al and the oxide X_2O_3 could be actually aluminium oxide, Al_2O_3.

In order ... he oxide of element X, we should k ... f group 13 elements is 3. So, the vale ... dy know that the valency of oxygen ... onclusions:

Element	
X	**3**
O	**2**

Since the valency of element X is 3 and that of O is 2, two atoms of X will combine with three atoms of O to form an oxide X_2O_3. Thus, the formula of oxide of element X is X_2O_3.

Periodic Classification Of Elements

- **Valency**

Valency

The valency of an … e number of valence electrons.

Valency increa… decreases fro…

All the elemen… Therefore, …

Group number … indi…

Lets consider e… of first 3 peri…

Na, Mg & Al co… electrons respective… outermost shell, to become s… it is easier for t…m to donate electrons. So their valency is

Give, T… Share el…

C & Si contains 4 electrons in their outermost shell, to become stable it is easier for them to share electrons. So their valency is

…it is easier …lectrons. So …cy is

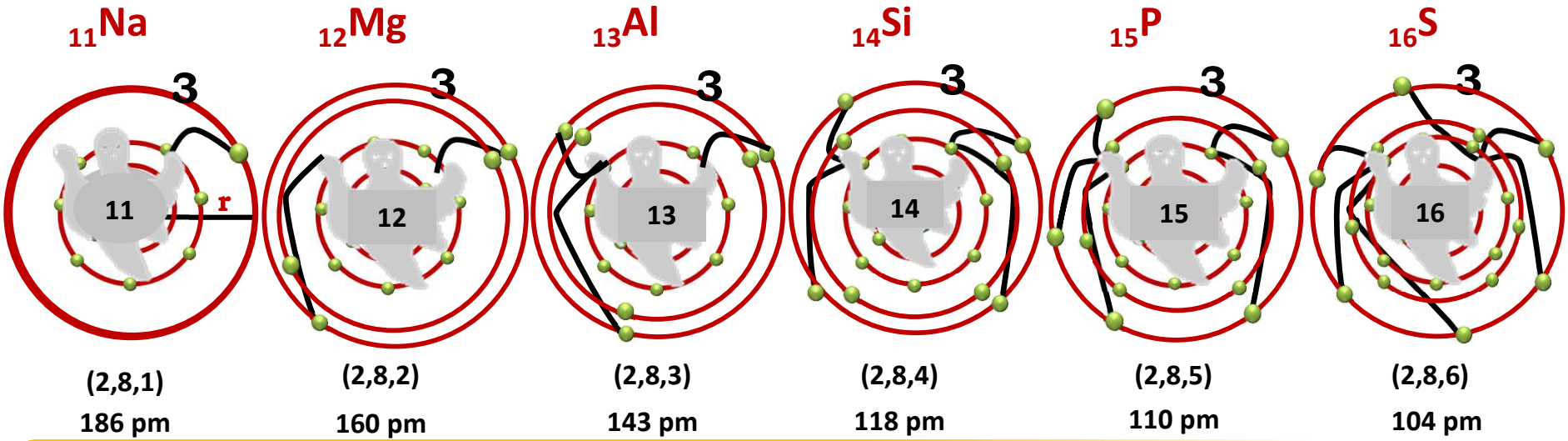
1 (K)	1 H (1)							
		IIA	IIIA					
2 (K,L)			5 B (2,3)	6 C	N (2,5)	8 O	F (2,7)	(2,8)
3 (K,L,M)	11 Na (2,8,1)	12 Mg (2,8,2)	13 Al (2,8,3)	14 Si (2,8,4)	15 P (2,8,5)	S (2,8,6)	17 Cl (2,8,7)	18 Ar (2,8,8)
Valency	1	2	3	4	3	2	1	0

Periodic Classification Of Elements

- **Atomic size in period and group**

Atomic Size Across The Period

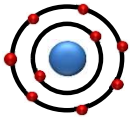
- **The term atomic size refers to the radius of an atom.**
- **Atomic radius is the distance between the centre of atom & outermost shell.**



As we go from left to right in a period, the nuclear charge increases, thus the pull between the electrons and protons increases. Therefore, the atomic size decreases as we go from left to right.

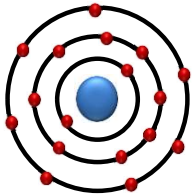
Atomic Radius Down The Group

F
r = 64pm



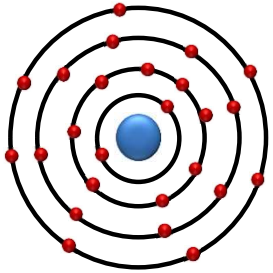
2

Cl
r =99pm



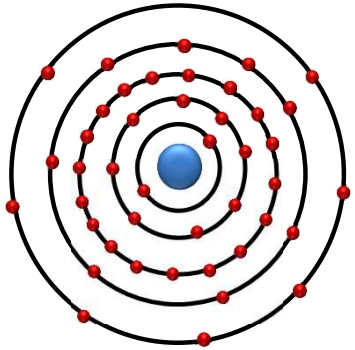
3

Br
r =114pm



4

I
r=133pm



5

Atomic radius increases in a group from top to bottom as new shells are added bringing outermost electrons farther from the nucleus

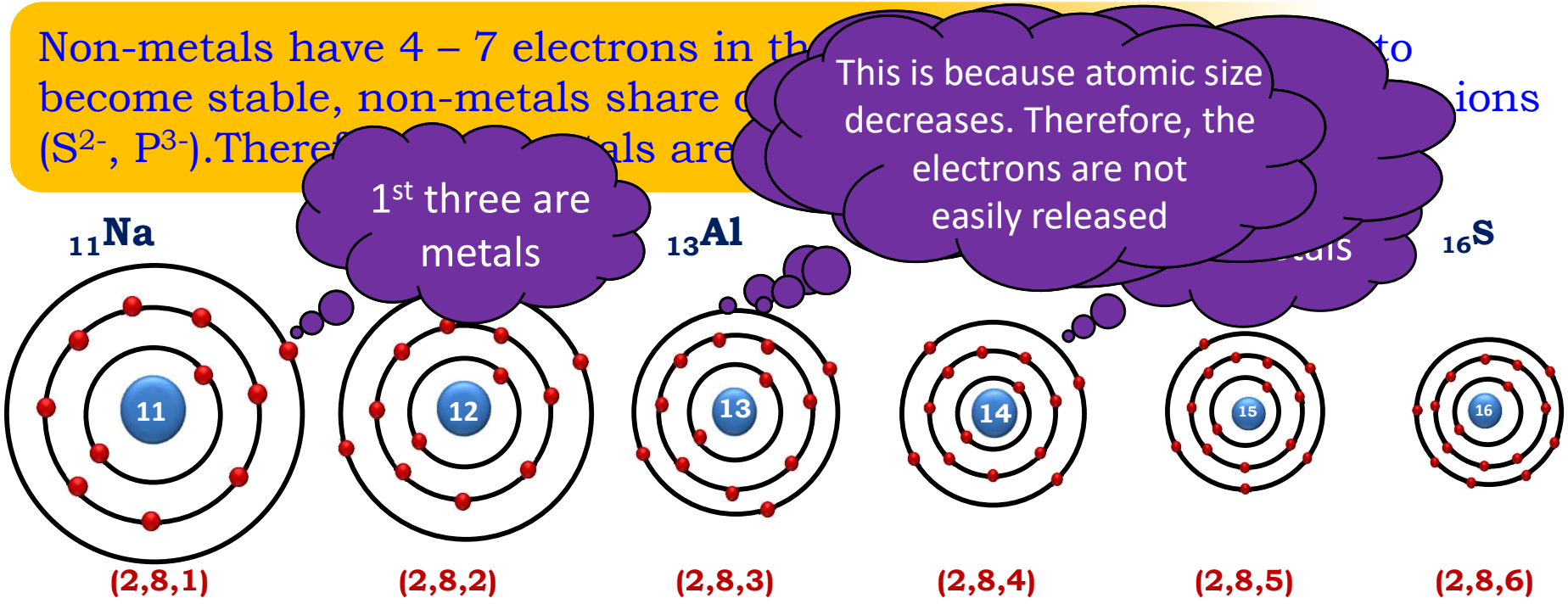
Periodic Classification Of Elements

- **Metallic & Non-metallic character**

Metallic & Non-Metallic Character

Metals have 1,2 or 3 electrons in their outermost orbit. In order to become stable, metals donate electrons & form positive ions (Na^{+}, Mg^{+2}). Therefore metals are said to be **ELECTROPOSITIVE.**

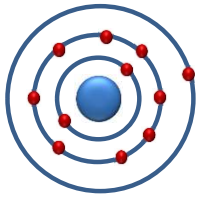
Non-metals have 4 – 7 electrons in th… to become stable, non-metals share … ions (S^{2-}, P^{3-}).There… als are …



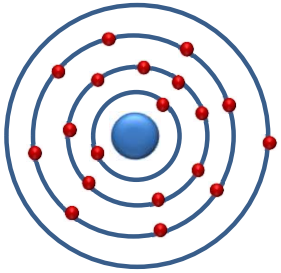
Metallic & Non-Metallic Character Down The Groups

Lithium

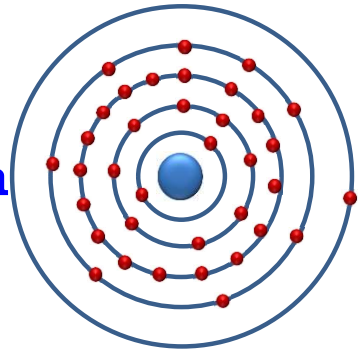
Sodium



Potassium



Rubidium



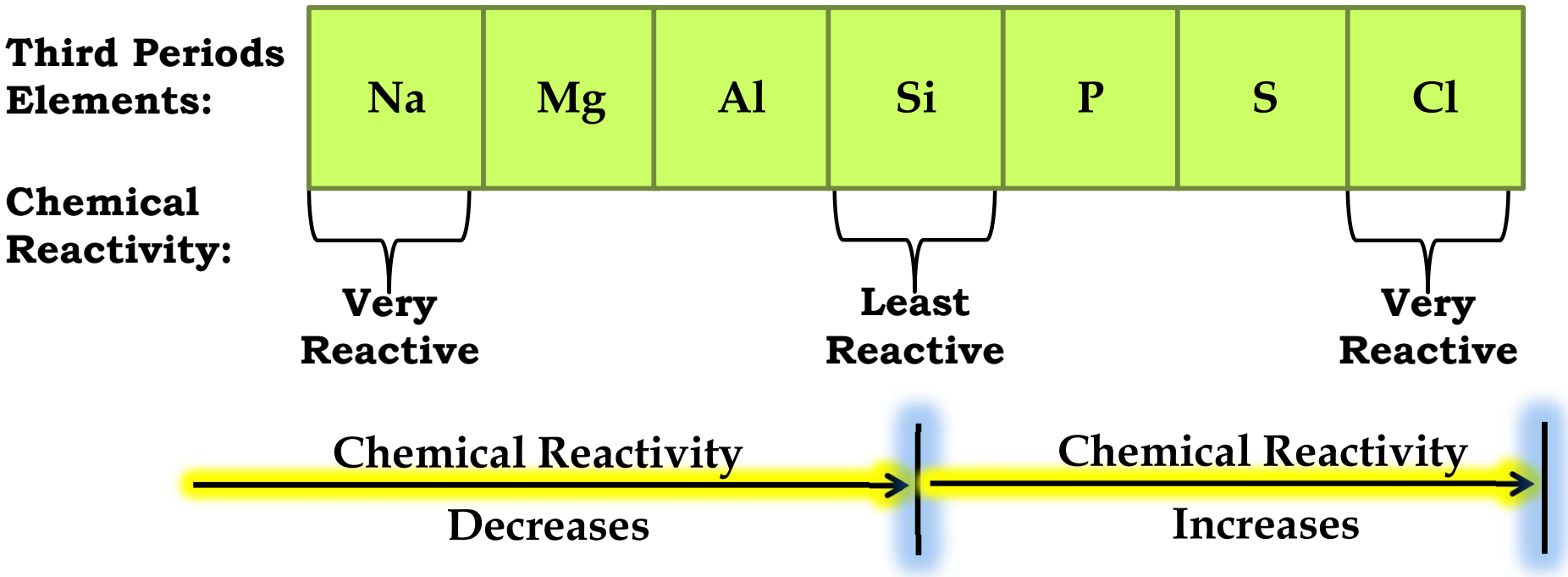
In a group, metallic character increases and non-metallic character decreases from top to bottom. This is because atomic size increases and valence electrons can be easily removed.

Periodic Classification Of Elements

- Chemical Reactivity
- Nature of oxides

Chemical Reactivity

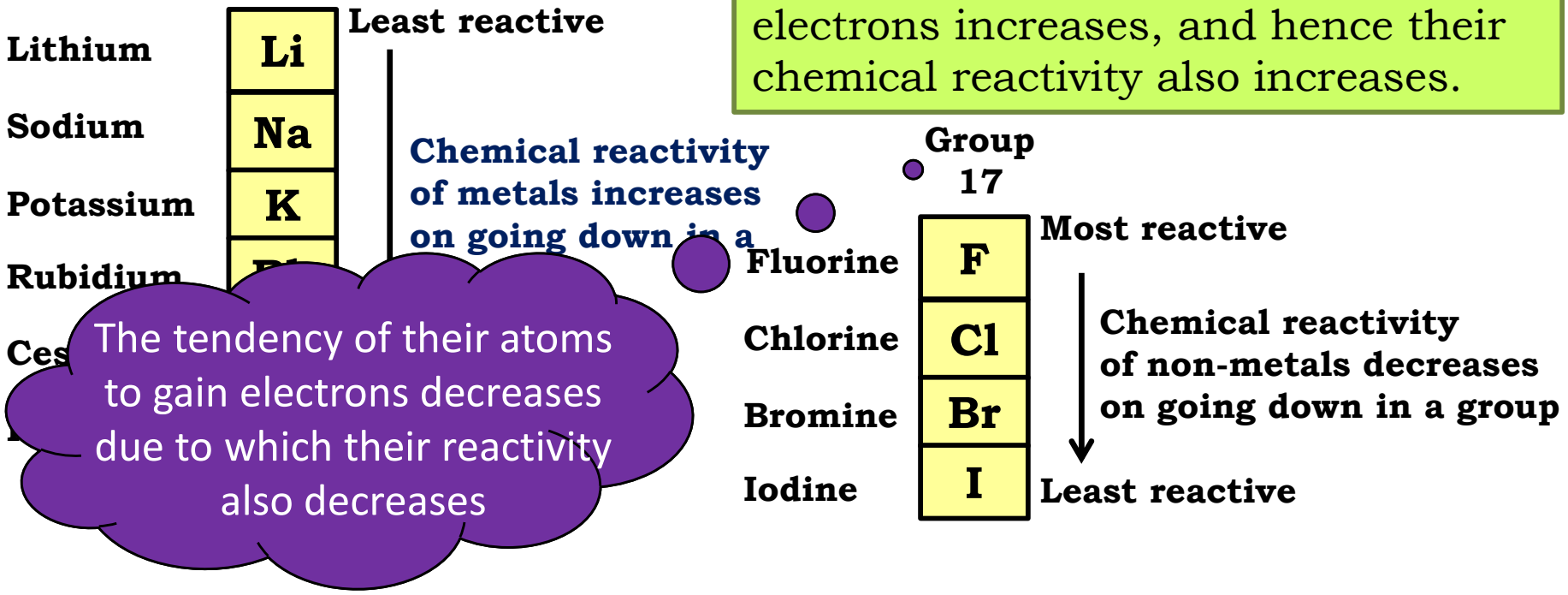
On moving from left to right in a period, the chemical reactivity of elements first decreases and then increases.



Chemical Reactivity

The chemical reactivity of metals increases on going down in a Group of the periodic table.

As we go down in a group of metals, the tendency of their atoms to lose electrons increases, and hence their chemical reactivity also increases.



Nature Of Oxides

On going down in a group of the peri[illegible]e is no change in the nature of oxides of ele[illegible]

All the elements of group 17 are non-metals and non-metals tend to form acidic oxide.

Lithium	Li
Sodium	Na
Potassium	K
Rubidium	Rb
Cesium	Cs
Francium	Fr

All the elements of group1 form basic oxides.

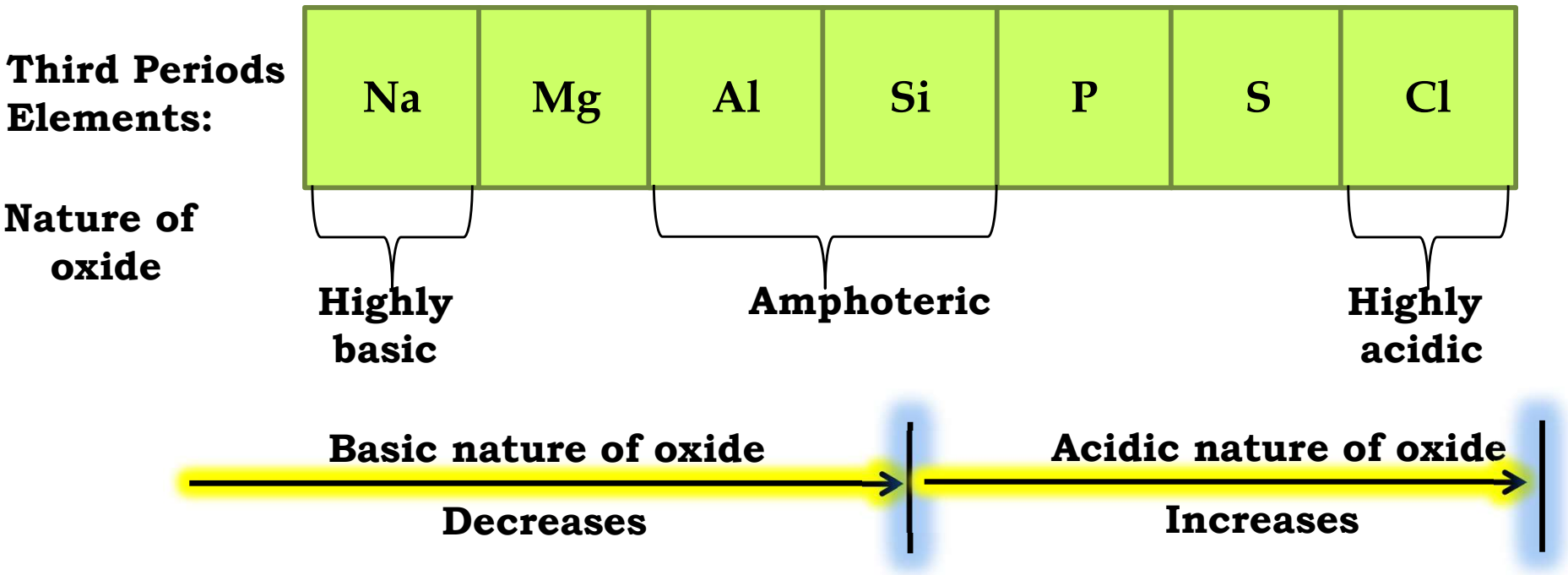
Group 17

Fluorine	F
Chlorine	Cl
Bromine	Br
Iodine	I

All the elements of group 17 form acidic oxides.

Nature Of Oxides

On moving from left to right in a period, the basic nature of oxide decreases and the acidic nature of oxide increases.



Periodic Classification Of Elements

- **Electron Affinity**
- **Ionisation Potential**

Electron Affinity Decreases As Period From Left To Right

Elements	E.A. [eV]	Trends in electron affinity down a group		ELECTRON AFFINITY
F (2,7)	-3.60	• ATOMIC RADII Increases	• ELECTRON AFFINITY Decreases	DECREASES DOWN A GROUP
Cl (2,8,7)	-3.80	[No. of shells increases]		
Br (2,8,18,7)	-3.50	• NUCLEAR CHARGE Increases	• ELECTRON AFFINITY Should increase	
I (2,8,18,18,7)	-3.20	— Increases in atomic radii dominates over Increases in nuclear charge ∴ Overall electron affinity - Decreases		

Factors Which Affect The Ionisation Potential

From Left To Right

Atomic Size- Increases

a loosely bound electron from the

Elements	I.P. [eV]	Trends in ionisation potential down a group		IONISATION POTENTIAL
Li (2,1)	5.4	• ATOMIC RADII Increases	IONISATION POTENTIAL Decreases	DECREASES DOWN A GROUP
Na (2,8,1)	5.1	[No. of shells increases]		
K (2,8,8,1)	4.3	• NUCLEAR CHARGE Increases	IONISATION POTENTIAL Should increase	
Rb (2,8,18,8,1)	4.2	— Increases in atomic radii dominates over increases in nuclear charge		
Cs (2,8,18,18,8,1)	3.9	∴ Overall ionisation potential - Decreases		

Thank You