The Periodic Table

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Periodic Table of the Elements

- History of the Periodic Table
- Parts of the Periodic table
- Forms of the Periodic table
- Periodic Trends
- Groups within the Periodic Table

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History of the Periodic Table

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Antoine Lavoisier

1743 - 1794

- In 1789, he compiled a list of the known elements at the time.
- The known elements were broken down into four groups .

Antoine Lavoisier's 1789 classification of substances into four 'element' groups			
acid-making elements	gas-like elements	metallic elements	earthy elements
sulphur	light	cobalt, mercury, tin	lime (calcium oxide)
phosphorus	caloric (heat)	copper, nickel, iron,	magnesia (magnesium oxide)
charcoal (carbon)	oxygen	gold, lead, silver, zinc	barytes (barium sulphate)
	azote (nitrogen)	manganese, tungsten	argilla (aluminium oxide)
	hydrogen	platina (platinum)	silex (silicon dioxide)

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But times were about to change…

- In the 1800's, there were many changes in the world
  - Electricity
  - Spectrometer
  - Industrial Revolution
- As a result, there was an increase in the number of known elements
  - By 1870, there were 70 known elements

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An agreement is reached…

Then in the 1860's, chemists agreed upon a method for accurately determining the atomic mass of elements.

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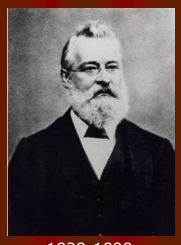
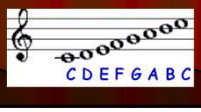
John Newlands



1838-1898



- Noticed when elements were arranged by atomic mass, they repeated properties every 8th element.
- He used the word periodic to describe this pattern
- He gave it the name the Law of Octaves

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John Newlands Periodic Table

No.	No.	No.	No.	No.	No.	No.	No.
H 1	F 8	Cl 15	Co & Ni 22	Br 29	Pd 36	I 42	Pt & Ir 50
Li 2	Na 9	K 16	Cu 23	Rb 30	Ag 37	Cs 44	Os 51
G 3	Mg 10	Ca 17	Zn 24	Sr 31	Cd 38	Ba & V 45	Hg 52
Bo 4	Al 11	Cr 19	Y 25	Ce & La 33	U 40	Ta 46	Tl 53
C 5	Si 12	Ti 18	In 26	Zr 32	Sn 39	W 47	Pb 54
N 6	P 13	Mn 20	As 27	Di & Mo 34	Sb 41	Nb 48	Bi 55
O 7	S 14	Fe 21	Se 28	Ro & Ru 35	To 43	Au 49	Th 56

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Unfortunately…

- Did not work for all the elements
- Criticized because of its association with music
- Did give others the idea of repeating properties - periodic

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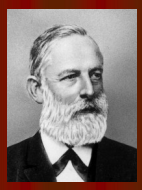
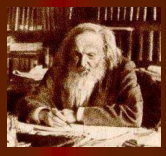
Lothar Meyer and Dmitri Mendeleev



1830-1895



1834 - 1907

- Each made a connection between atomic mass and properties of elements

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The winner is…

Mendeleev

- Mendeleev is given credit because his was published first
- In addition, Mendeleev predicted unknown elements
- However, not completely correct – new elements weren't in correct order

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Mendeleev's Periodic Table (1869)

	I	II	III	IV	V	VI	VII	VIII
	H 1.01							
	Li 6.94	Be 9.01	B 10.8	C 12.0	N 14.0	O 16.0	F 19.0	
	Na 23.0	Mg 24.3	Al 27.0	Si 28.1	P 31.0	S 32.1	Cl 35.5	
	K 39.1	Ca 40.1		Ti 47.9	V 50.9	Cr 52.0	Mn 54.9	Fe 55.9 Co 58.9 Ni 58.7
	Cu 63.5	Zn 65.4			As 74.9	Se 79.0	Br 79.9	
	Rb 85.5	Sr 87.6	Y 88.9	Zr 91.2	Nb 92.9	Mo 95.9		Ru 101 Rh 103 Pd 106
	Ag 108	Cd 112	In 115	Sn 119	Sb 122	Te 128	I 127	
	Ce 133	Ba 137	La 139		Ta 181	W 184		Os 194 Ir 192 Pt 195
	Au 197	Hg 201	Ti 204	Pb 207	Bi 209			
				Th 232		U 238		

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Henry Moseley

1887-1915

- Solved this problem by arranging the elements by increasing atomic number.
- The periodic repetition of chemical and physical properties of elements when arranged by atomic number is now known as Periodic Law

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Moseley's Periodic Table

Group 0	I a	I b	II a	II b	III a	III b	IV a	IV b	V a	V b	VI a	VI b	VII a	VII b	VIII
	H 1														
He 2	Li 3		Be 4		B 5		C 6		N 7		O 8		F 9		
Ne 10	Na 11		Mg 12		Al 13		Si 14		P 15		S 16		Cl 17		
Ar 18	K 19	Cu 29	Ca 20	Zn 30	Sc 21	Ga 31	Ti 22	Ge 32	V 23	As 33	Cr 24	Se 34	Mn 25	Br 35	Fe 26, Co 27, Ni 28
Kr 36	Rb 37	Ag 47	Sr 38	Cd 48	Y 39	In 49	Zr 40	Sn 50	Nb 41	Sb 51	Mo 42	Te 52	–	I 53	Ru 44, Rh 45, Pd 46
Xe 54	Cs 55	Au 79	Ba 56	Hg 80	57-71*	Tl 81	Hf 72	Pb 82	Ta 73	Bi 83	W 74	Po 84	Re 75	–	Os 76, Ir 77, Pt 78
Rn 86	–		Ra 88		Ac 89		Th 90		Pa 91		U 92				

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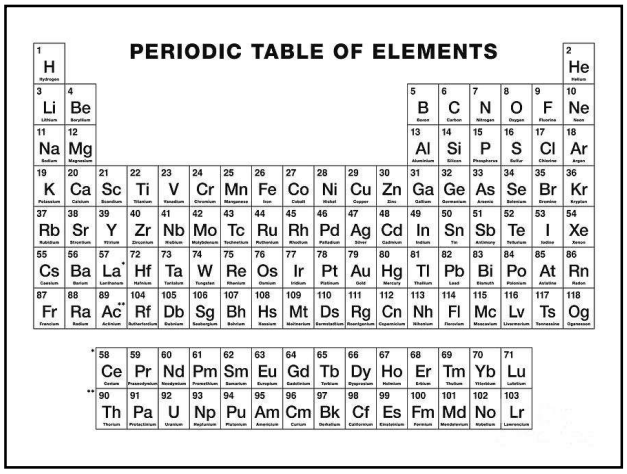

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How the Periodic Table Works

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Element Cell

- The periodic table consists of various element cells.
- Element cells are the blocks that give information about individual elements on the periodic table.
- Depending on the type of table, these cells can vary regarding what information is provided.

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Common Element Cell Information

- Element name and symbol
- Atomic number
- Atomic weight
- Color-coded according group
- Electron Configuration
- Elemental properties (state of matter, boiling point, etc.

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Most Important Information

- **Atomic Number = Number of Protons or Number of Electrons**
- **Atomic Weight = Number of Protons and the number of Neutrons**

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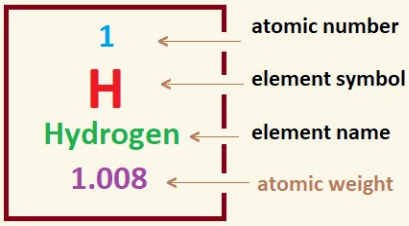
Periodic Table of the Elements



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Parts of the Periodic Table

Family or Group

A column of elements on the periodic chart, usually have similar physical and chemical properties.

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Parts of the Periodic Table

Family or Group

The similar properties are due to their similar electron configuration.

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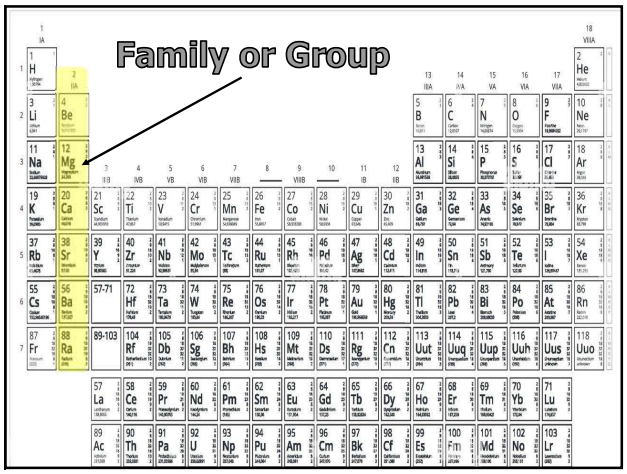

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Parts of the Periodic Table

Period or Series

The name given to rows of elements on the Periodic Chart.

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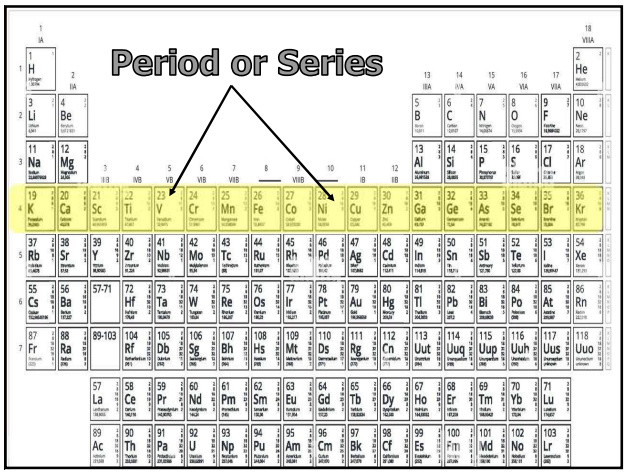

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Parts of the Periodic Table

Period or Series

These elements have the same energy level in their outer most shell (1-7) although the number of electrons in that outer most shell are different.

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Parts of the Periodic Table

- **In older tables a Roman numeral represents the number of Valence electrons**
- **Elements in the column that have a Roman numeral II have two valence electrons.**

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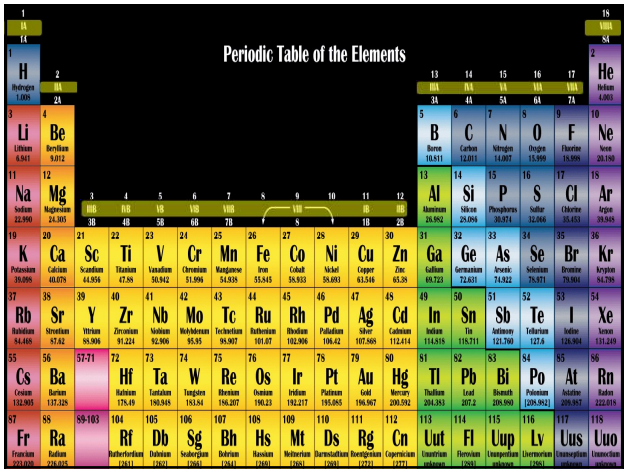

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Parts of the Periodic Table

- **In addition, these numbers have either an A or B after them.**
- **A = Main Group elements**
- **B = Transitional Group elements**

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Parts of the Periodic Table

- **In newer tables the whole number at the top of the column represents the Valence electrons. The A and B designation is still used.**
- **Elements in the column that have the number 7A have seven valence electrons and are main group elements.**

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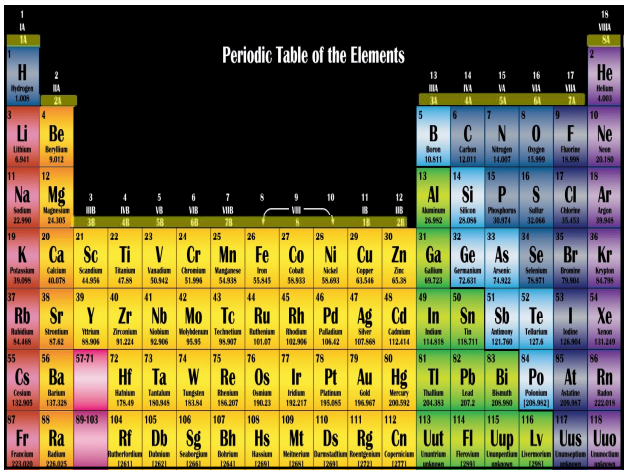

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Parts of the Periodic Table

- Some tables do not use the A&B group designation and simply number the groups 1-18.
- In this case for columns 13-18 you must subtract 10 from the number to determine the number of valence electrons.
- Example: 13 -10 = a valence of 3.

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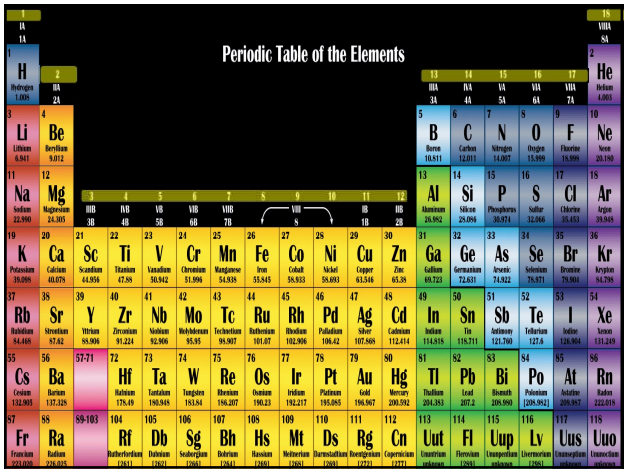

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Parts of the Periodic Table

- The periodic table is made up of three groups.
- Metals
- Metaloids
- Non-metals

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Groups of the Periodic Table

Metals

Hard, shiny, malleable, ductile and are good conductors of heat and electricity. There are some exceptions such as mercury which is a liquid.

(Middle and left of stair stepped line)

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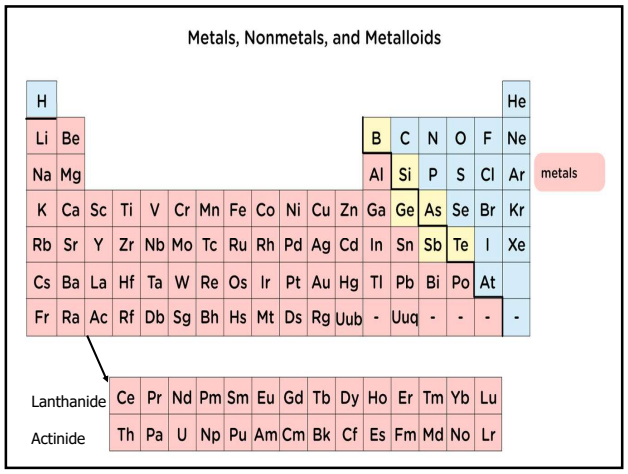

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Groups of the Periodic Table

Metalloids

These elements have the properties of both metals and non-metals.

(Touching the stair stepped line)

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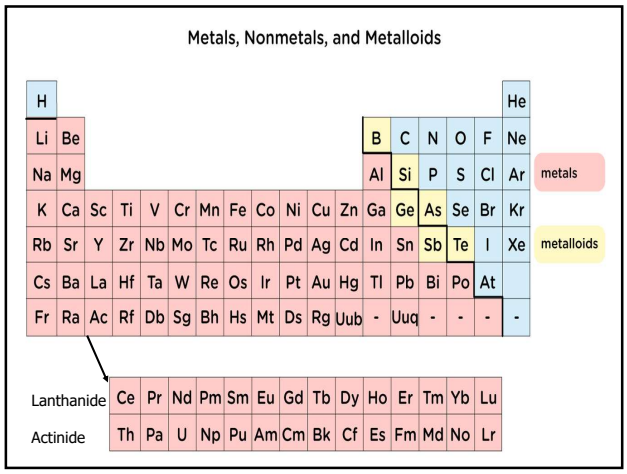

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Groups of the Periodic Table

Non-Metals

Usually gases, or soft solids although there are some exceptions like Bromine which is a liquid

(Right of the stair stepped line and includes Hydrogen)

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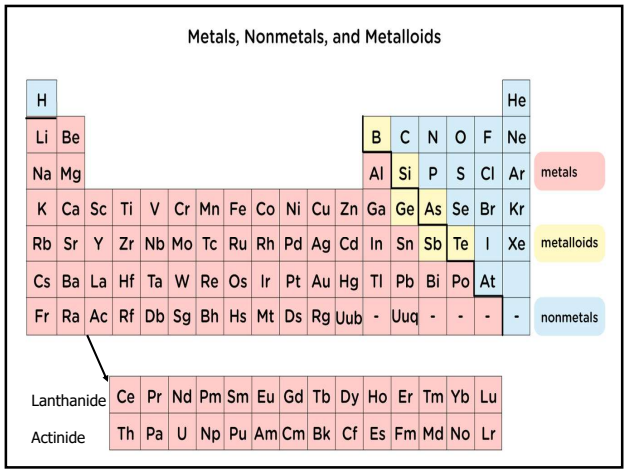

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Special Groups of the Periodic Table

Lanthanide series

Fits in the table after Lanthanide

Actinide Series

Fits in the table after Actinide

(Both are taken out to make the table of a manageable size)

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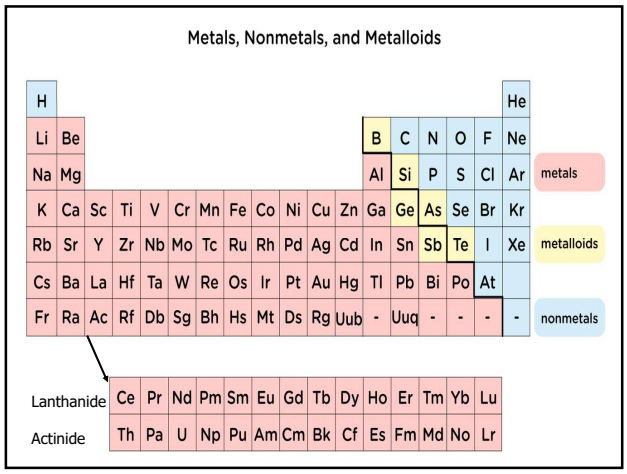

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Predicting Electron Configuration

The periodic table can provide the electron configuration of the elements

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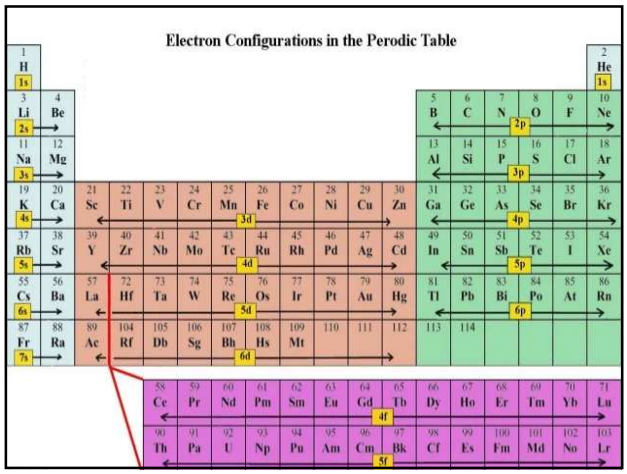

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Trends within the Periodic Table

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Periodic Trends

- **Periodic trends are specific patterns found in the periodic table**
- **These trends include electronegativity, ionization energy, electron affinity, atomic radius, etc.**

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Periodic Trends

Periodic trends are divided into two categories.

- **Trend: A pattern that repeats at regular intervals (i.e. atomic radius).**
- **Quasi-trend: A recurrence pattern with some degree of predictability but still shows some irregularity (i.e. melting point).**

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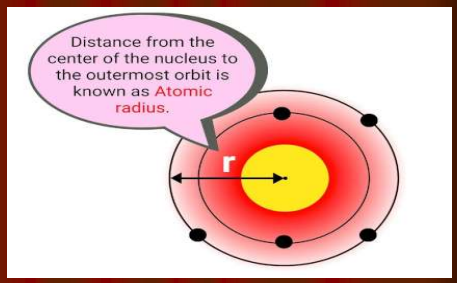
Periodic Trends (atomic radius)



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Periodic Trends

- The atomic radius of the atom (size) increases when moving down a family or group.
- This is due to the addition of another principal energy level.

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Periodic Trends

- The atomic radius of the atom (size) decreases in size as you move from left to right.
- This is due to the greater mass and attraction making the electron clouds more compact.

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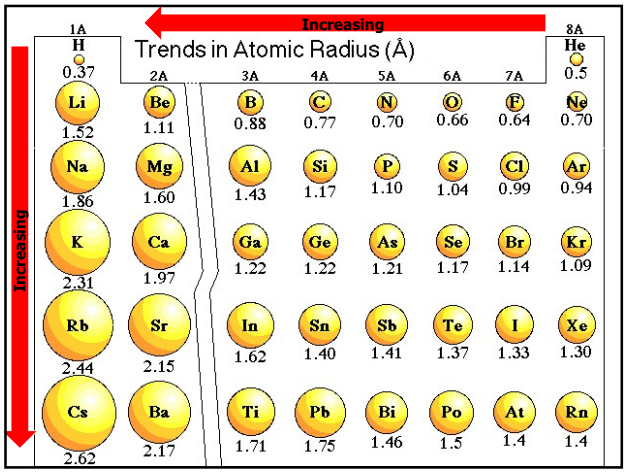

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Periodic Trends

Reactivity

The ease with which an atom acquires or donates electrons

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Ionization Energy

- The minimal energy required to give up a neutral atoms outermost electron(s)
- The higher the ionization energy the more difficult it is to remove or give up an electron.

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Ionization Energy

- In a period or series, the Ionization energy increases from left to right across the periods.
- This is because of the increased mass and attraction within the atom

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Ionization Energy

- In a family or group, the Ionization energy decrease from the top of the table to the bottom making it easier to give up electrons.
- The energy levels are farther away from the nucleus.

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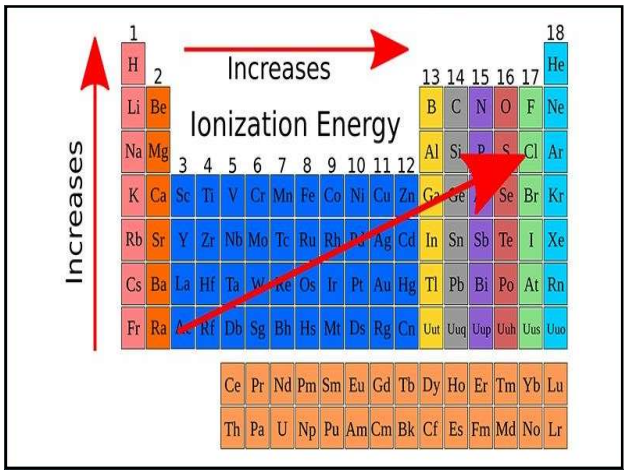

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Electronegativity

- An atom's electronegativity reflects its ability to attract electrons in a chemical bond.
- Increases across a period and decreases down a group

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Electronegativity

The Pauline scale of electronegativity is a widely used method to measure the tendency of an atom to attract shared electrons in a chemical bond. The scale ranges from 0.70 to 4.00.

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Electronegativity

Pauline Scale .7 to 4.0

Families - Decreases from top to bottom

Period - increases from Left to Right

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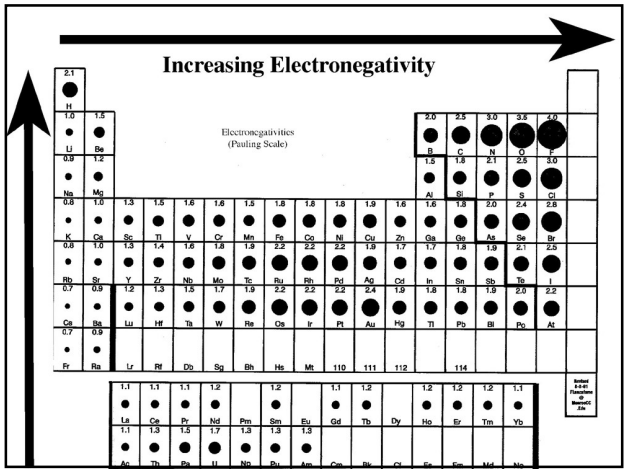

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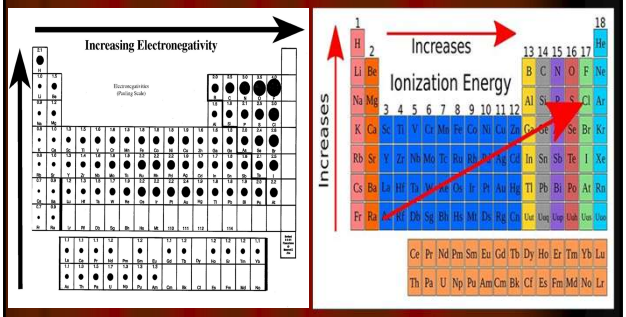
Ionization vs Electronegativity



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Groups within the Periodic Table

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Group 1
Alkali Metals

Chemical properties

- Very Reactive (easily lose their outermost electron)
- Most reactive metallic family
- React violently with water
- Form an alkaline compound in water

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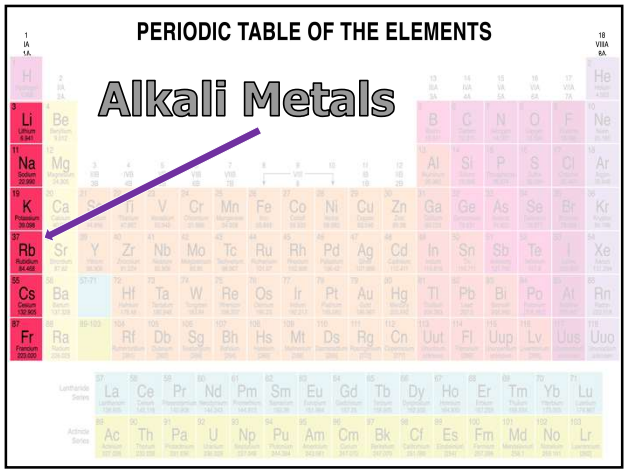

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Group 2
Alkali Earth Metals

Get their name because they are commonly found dissolved in water. (Hard Water)

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Group 2
Alkali Earth Metals

Chemical Properties

- Reactive, especially in water
- Reactivity increases as the elements get larger

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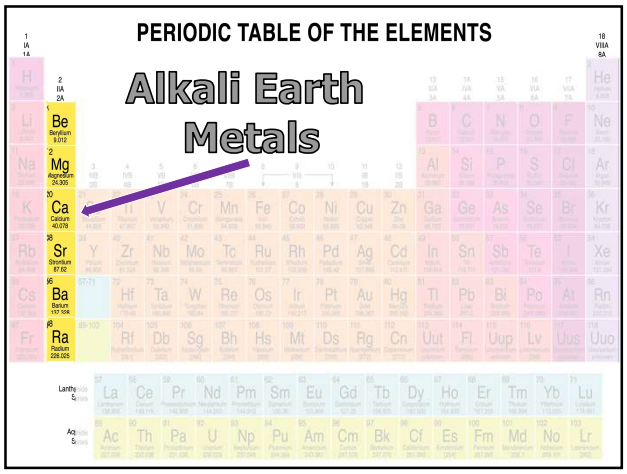

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The B Groups (3-12) Transition metals

Chemical Properties

- Vary according to their position
- Some are very reactive (iron, copper)
- Some are non-reactive (gold, silver)
- Some produce magnetic fields (Iron and nickel)
- Many can bond in various ways

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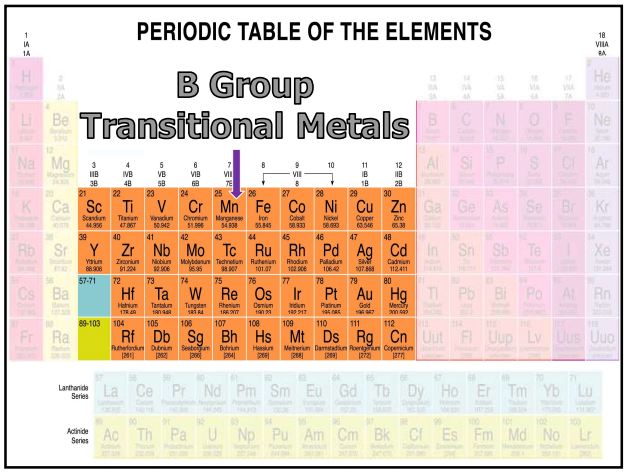

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Inner Transition Metals

- Lanthanide Series (rare earth metals)
- Actinide Series (most are man made and do not exist in nature)

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Inner Transition Metals

Chemical properties

- Lanthanide - reactive, weakly attracted by magnetic fields.
- Actinide - Very radioactive and toxic at very low doses.

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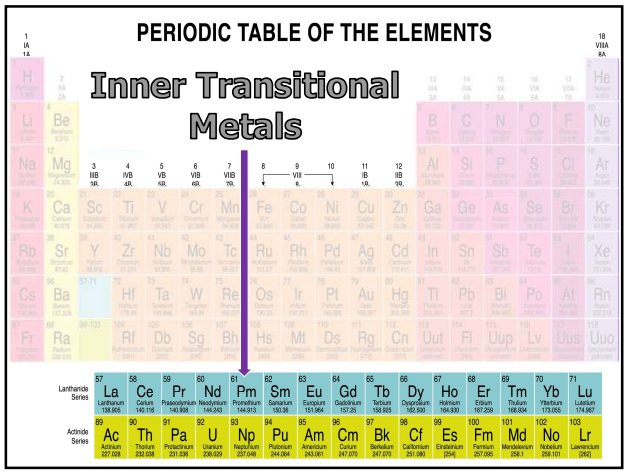

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Group 17 Halogens

- Form salts when they react with metals
- Difficult to obtain in their elemental form

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Group 17 Halogens

Chemical Properties

- Highly reactive
- Ignite substances on contact
- Especially reactive with Hydrogen based compounds

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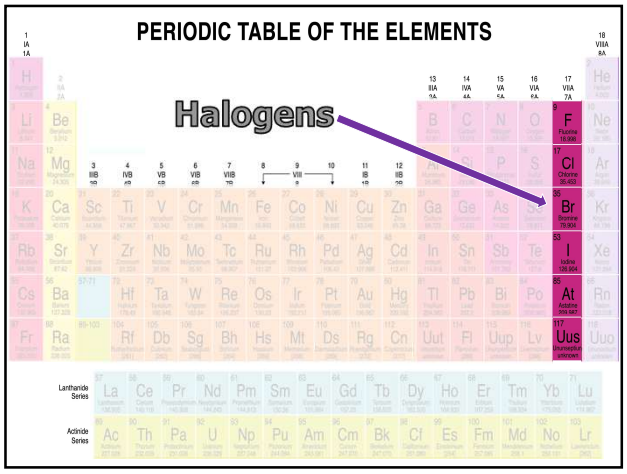

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Group 18 Noble Gases

Chemical Properties

- Do not react with other elements
- Stay separate and are found normally as individual elements in nature.
- Vary from Non-toxic to carcinogenic

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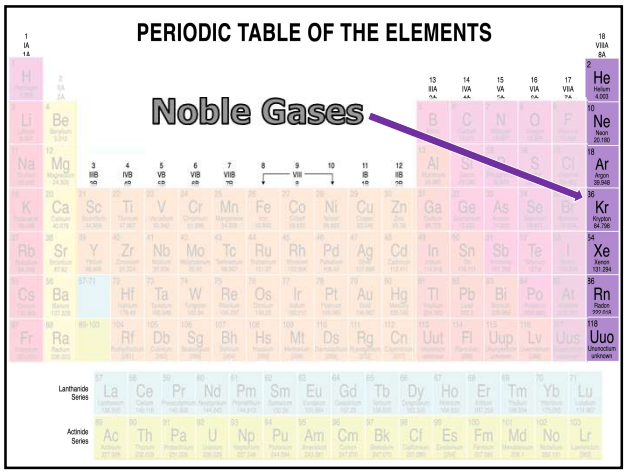

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The Periodic Table

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