

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)	silica (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

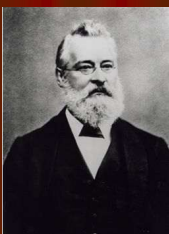
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An agreement is reached...

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...

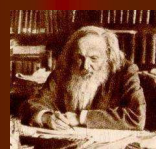
- Did not work for all the elements
- Criticized because of its association with music
- Did give others the idea of repeating properties - periodic

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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				
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	Tl 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		II		III		IV		V		VI		VII		VIII
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	
	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		Ca 20		Sc 21		Ti 22		V 23		Cr 24		Mn 25		Fe 26, Co 27, Ni 28
Kr 36	Rb 37		Sr 38		Y 39		Zr 40		Nb 41		Mo 42		-		Ru 44, Rh 45, Pd 46
	Ag 47		Cd 48		In 49		Sn 50		Sb 51		Te 52		I 53		
Xe 54	Cs 55		Ba 56		57-71		Hf 72		Ta 73		W 74		Re 75		Os 76, Ir 77, Pt 78
	Au 79		Hg 80		Tl 81		Pb 82		Bi 83		Po 84		-		
Rn 86	-		Ra 88		Ac 89		Th 90		Pa 91		U 92		-		

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PERIODIC TABLE OF ELEMENTS

1 H Hydrogen																	2 He Helium														
3 Li Lithium	4 Be Beryllium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon														
11 Na Sodium	12 Mg Magnesium											13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon														
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton														
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon														
55 Cs Cesium	56 Ba Barium	57 La Lanthanum	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89 Ac Actinium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium															

5859606162636465666768697071

CePrNdPmSmEuGd Tb Dy Ho Er Tm Yb Lu

727374757677787980818283

HfTaU Np Pu Am Cm Bk Cf Es Fm Md No Lr

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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.)

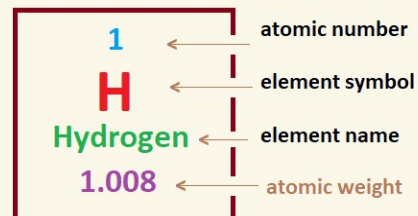
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Most Important Information

- **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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A full periodic table of elements. An arrow points from the text 'Family or Group' to the first column of elements (Group 1), which includes Hydrogen (H), Lithium (Li), Sodium (Na), Potassium (K), Rubidium (Rb), Cesium (Cs), and Francium (Fr).

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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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Period or Series

The diagram shows a periodic table with the first column (Group 1) highlighted in yellow. An arrow points from the text 'Period or Series' to this column, indicating that elements in this group share the same outer shell configuration.

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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.

26

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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Periodic Table of the Elements

The diagram shows a periodic table with group numbers indicated at the top. Groups 1A through 8A are labeled, and groups 1B through 8B are labeled. The elements are color-coded by groups.

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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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Periodic Table of the Elements

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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: $13 - 10 = \text{a valence of } 3$.

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Periodic Table of the Elements

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Parts of the Periodic Table

- The periodic table is made up of three groups.
- Metals
- Metalloids
- 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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Metals, Nonmetals, and Metalloids

Lanthanide: Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu

Actinide: Th, Pa, U, Np, Pu, Am, Cm, Bk, Cf, Es, Fm, Md, No, Lr

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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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Metals, Nonmetals, and Metalloids

H																		He
Li	Be											B	C	N	O	F	Ne	
Na	Mg											Al	Si	P	S	Cl	Ar	metals
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	metalloids
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At		
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Uub	-	Uuq	-	-	-	-	
Lanthanide		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu			
Actinide		Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr			

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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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Metals, Nonmetals, and Metalloids

H																		He
Li	Be												B	C	N	O	F	Ne
Na	Mg												Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	metalloids
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At		
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Uub	-	Uuq	-	-	-	-	nonmetals
Lanthanide		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu			
Actinide		Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr			

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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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Metals, Nonmetals, and Metalloids

H																		He
Li	Be												B	C	N	O	F	Ne
Na	Mg												Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	metalloids
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At		
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Uub	-	Uuq	-	-	-	-	nonmetals
Lanthanide		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu			
Actinide		Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr			

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Predicting Electron Configuration

The periodic table can provide the electron configuration of the elements

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Electron Configurations in the Periodic Table

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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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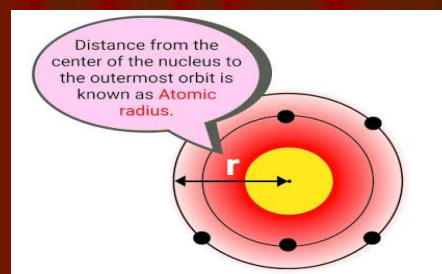
Periodic Trends

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

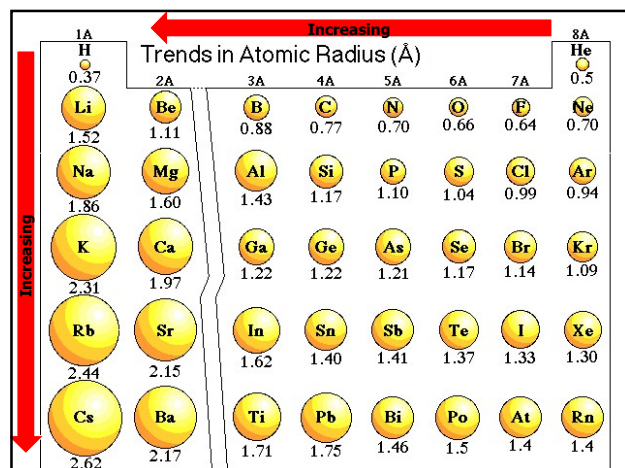
- The atomic radius of the atom (size) increases when moving down a family or group.
- This is due to the addition of another principal energy level.

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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.

50



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Periodic Trends

Reactivity

The ease with which an atom acquires or donates electrons

52

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.

53

Ionization Energy

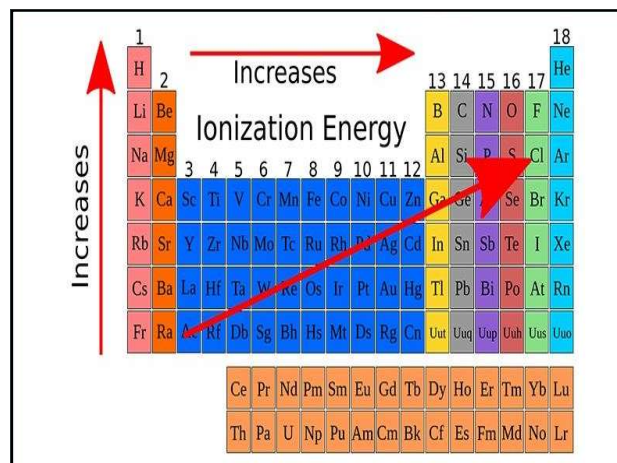
- In a period or series, the Ionization energy increases from left to right across the periods.
- This is because of the increased mass and attraction within the atom

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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.

55



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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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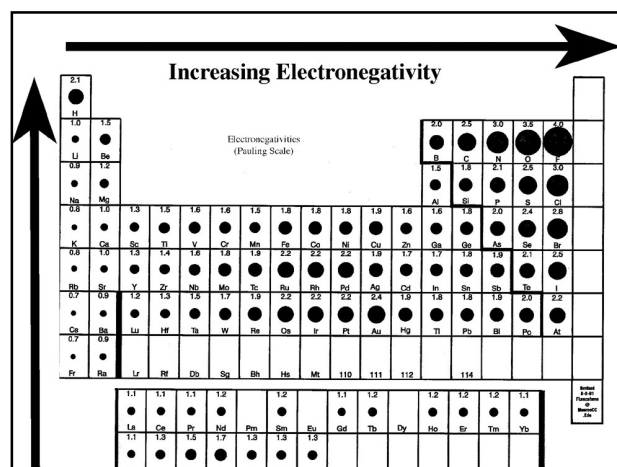
Electronegativity

Pauline Scale .7 to 4.0

Families - Decreases from top to bottom

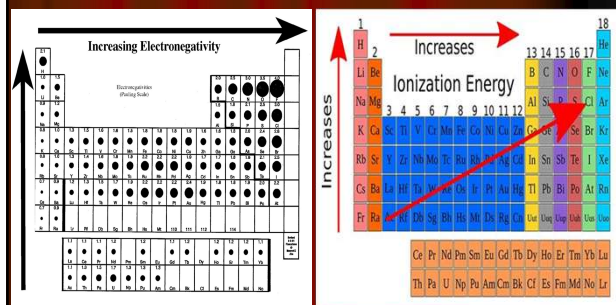
Period - increases from Left to Right

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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**

63

PERIODIC TABLE OF THE ELEMENTS

Alkali Metals

The periodic table shows elements from Hydrogen (H) to Oganesson (Og). Group 1 elements (Li, Na, K, Rb, Cs, Fr) are highlighted in red. A purple arrow points to this group.

64

Group 2 Alkali Earth Metals

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

65

Group 2 Alkali Earth Metals

Chemical Properties

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

66

PERIODIC TABLE OF THE ELEMENTS

Alkali Earth Metals

The periodic table shows elements from Hydrogen (1) to Oganesson (118). Groups 2 and 12 are highlighted in yellow. A purple arrow points from the title 'Alkali Earth Metals' to the highlighted elements.

67

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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PERIODIC TABLE OF THE ELEMENTS

**B Group
Transitional Metals**

The periodic table shows elements from Hydrogen (1) to Oganesson (118). Groups 3 through 10 are highlighted in orange. A purple arrow points from the title 'B Group Transitional Metals' to the highlighted elements.

69

Inner Transition Metals

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

70

Inner Transition Metals

Chemical properties

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

71

PERIODIC TABLE OF THE ELEMENTS

Inner Transitional Metals

The periodic table shows elements from Hydrogen (1) to Oganesson (118). The Lanthanide and Actinide series are highlighted in yellow. A purple arrow points from the title 'Inner Transitional Metals' to the highlighted elements.

72

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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PERIODIC TABLE OF THE ELEMENTS

Halogens

The periodic table shows elements from Hydrogen (1) to Oganesson (118). The Halogens group (Group 17) is highlighted with a purple arrow pointing to it. The elements in this group are Fluorine (F), Chlorine (Cl), Bromine (Br), and Iodine (I). The table also includes the Lanthanide Series and Actinide Series at the bottom.

75

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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PERIODIC TABLE OF THE ELEMENTS

Noble Gases

The periodic table shows elements from Hydrogen (1) to Oganesson (118). The Noble Gases group (Group 18) is highlighted with a purple arrow pointing to it. The elements in this group are Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr), Xenon (Xe), and Oganesson (Og). The table also includes the Lanthanide Series and Actinide Series at the bottom.

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The Periodic Table

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