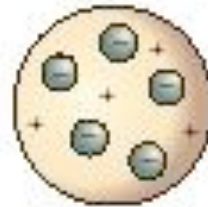


# Atomic Theory

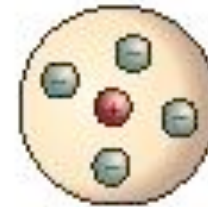
Dalton's atom



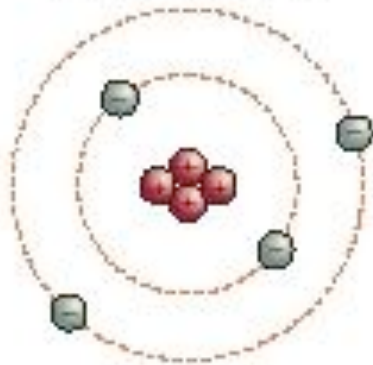
Thomson's plum-pudding atom



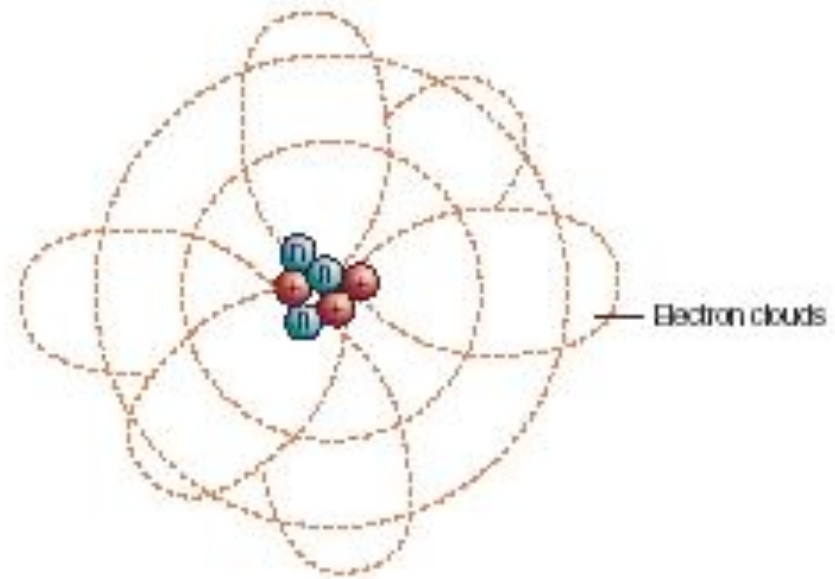
Rutherford's atom



Bohr's planetary atom

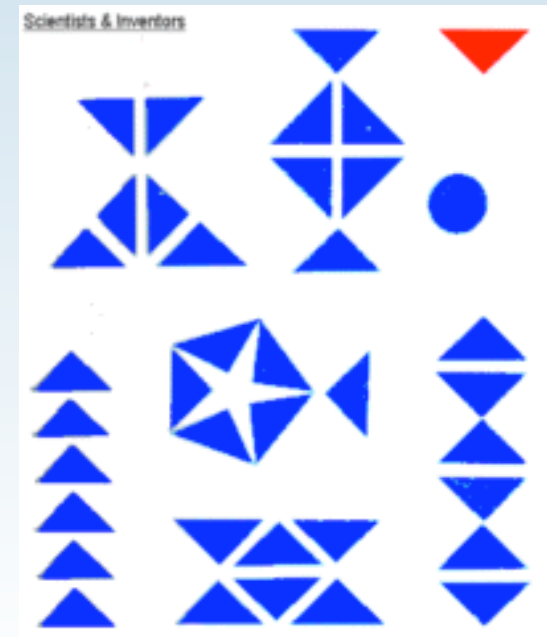


Current orbital atom



# The Beginning of Atomic Theory

- 440 BC – Greek philosopher, Democritus thought all materials could be cut in half over and over until they reached the size of one atom
- **Atom** = Greek for “not able to be divided”
- **Democritus’ Theory:** all atoms are small, hard particles made of one material formed into different shapes and sizes



# Dalton's Atomic Theory

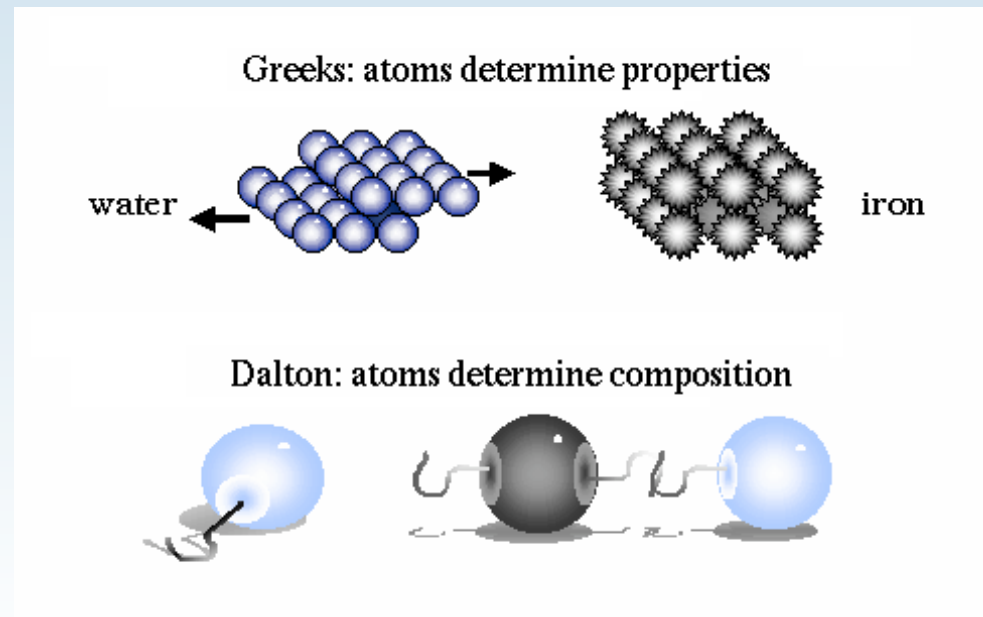
- **John Dalton** – British chemist and school teacher (late 1700's – early 1800's)
- Wanted to know why elements always combine in certain ways
  - (H and O always combine in same proportions to make water)
- His experiments show it happens because elements are made of single atoms



- 1803 – Dalton’s Theory:
  - All substances are made of atoms. Atoms are small particles that can’t be created/destroyed.
  - Atoms of the same element are exactly alike, and atoms of different elements are different
  - Atoms join with other atoms to make new substances



Dalton’s Theory:  
Billiard Ball Atomic Model



# Not Quite Right

- Dalton's theory had some good parts, but as more discoveries were made, some parts didn't fit
- So the search continues....

# J.J. Thomson's Additions



- J.J. Thomson – British scientist in the 1800's
- Showed that Dalton's theory had a flaw – atoms have parts!
- Experimented with a cathode ray and showed that rays bend under the influence of a magnetic field, showing a negative charge
- Negative particles were later named electrons

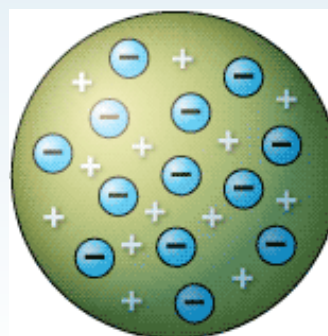
# Thomson's New Model

- He thought the atom had an overall positive charge with some electrons, negative charge, floating around.
- This is called the Plum Pudding model of the atom. *(it looked like a common dessert...you might call it chocolate chip ice cream model)*

Dalton

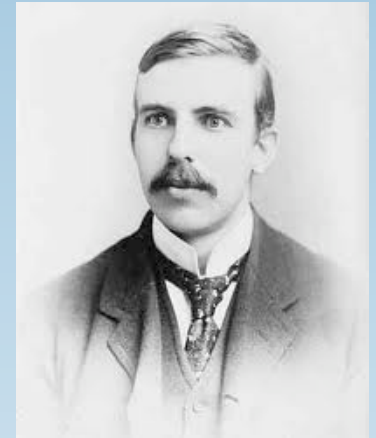


J.J. Thomson

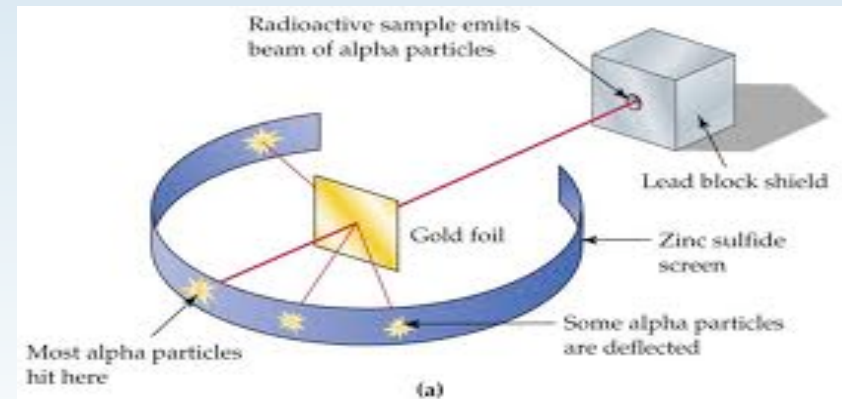




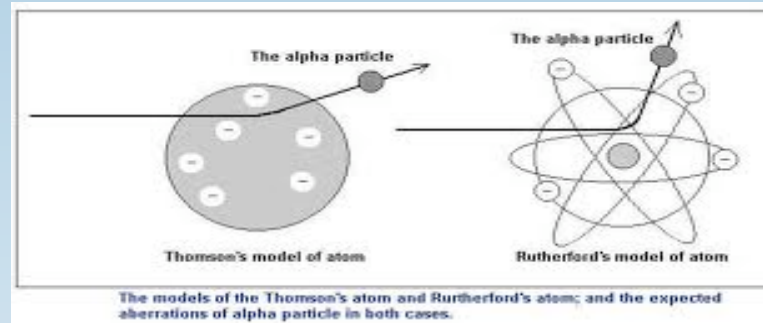
# Earnest Rutherford



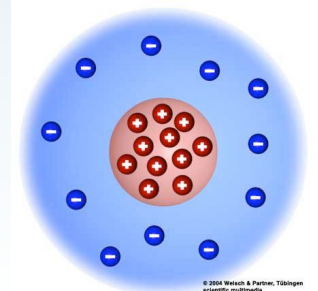
- Former student of J.J. Thomson
- 1909 - Tested Thomson's theory by studying the parts of an atom in the "Gold Foil Experiment"
- Gold Foil Experiment:
  - Positive particles are shot at an element (gold)
  - If Thompson's model was right, all particles would be evenly deflected since there were +/- charges spread throughout to push/pull the positive particles



# Rutherford's Conclusions & New Model - 1911



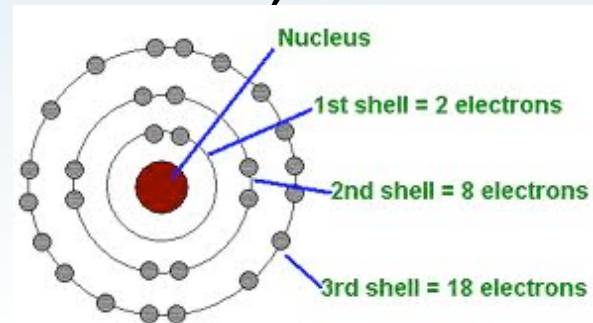
1. Since most of the particles passed through the foil undeflected, therefore most of the atom is empty.
2. Small angles of deflection show that positively charged particles were attracted by electrons.  
(*negative attracts positive*)
3. Large angles of deflection show that there is a massive positively charged body present in the atom called a nucleus  
(*positive strongly repulses positive*)



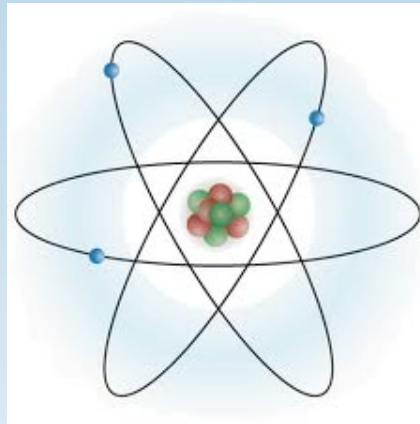
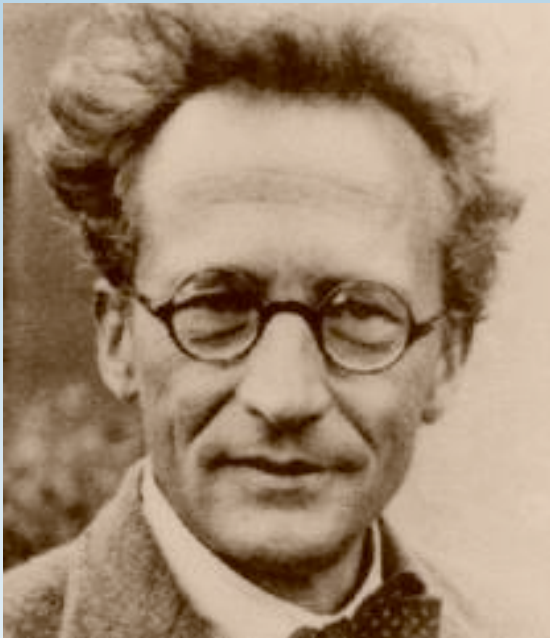


# Bohr's Electron Levels

- Niels Bohr – Danish scientist; worked with Rutherford
  - Studied the way atoms react to light
  - Thought electrons move around the nucleus in specific paths (energy levels)
  - Helped predict atomic behavior, but was still flawed



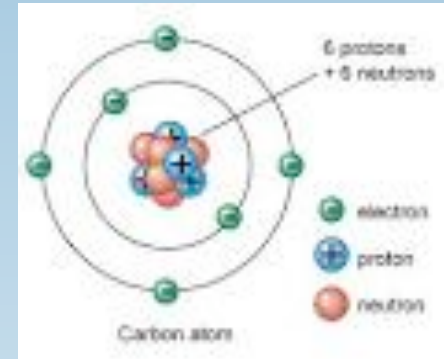
# New Evidence for Electrons



Erwin Schrodinger (Austrian physicist) & Werner Heisenberg (German physicist) - explained how electrons really behave

- Electrons don't have a definite path, but regions where they are likely to be (electron clouds)

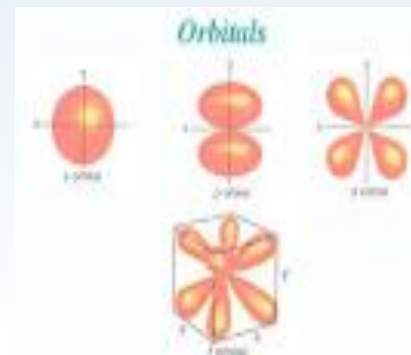
# Structure of an Atom



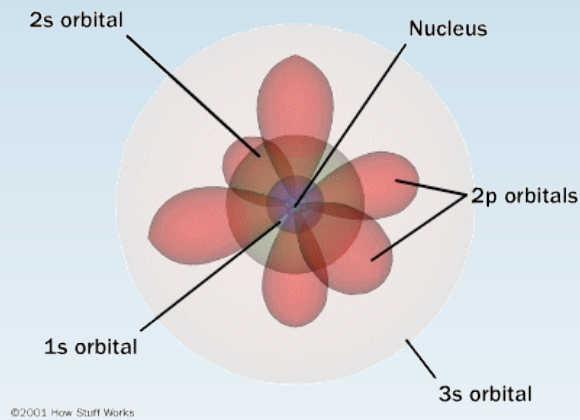
Atoms have 3 parts:

1. Protons – positively charged particle in nucleus
2. Neutrons – neutral particle in nucleus
3. Electrons – negatively charged particles orbiting outside the nucleus

\*\* Electrons are found in many orbits around the nucleus, called orbitals



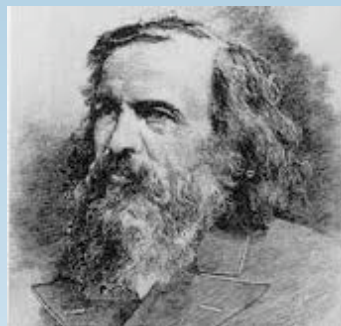
# Current Atomic Theory



1. Elements are made of small atoms.
2. All atoms of a given element have the same chemical properties and contain the same number of protons.
3. Compounds are made by combining two or more different atoms.
4. Atoms are the units of chemical change.



# Building the Periodic Table

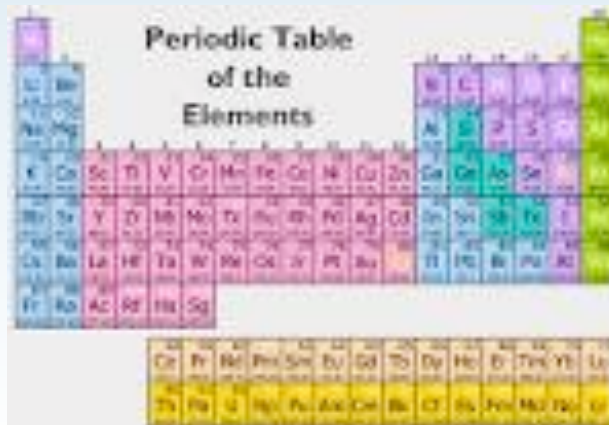


- 1869 – Dmitri Mendeleev arranged the 63 known elements into the periodic table
- Elements are in ascending order (small to big) by atomic weight and grouped by similar properties
- He predicted the existence of elements that had yet to be discovered and corrected accepted atomic weights that were wrong



# Elements as Building Blocks

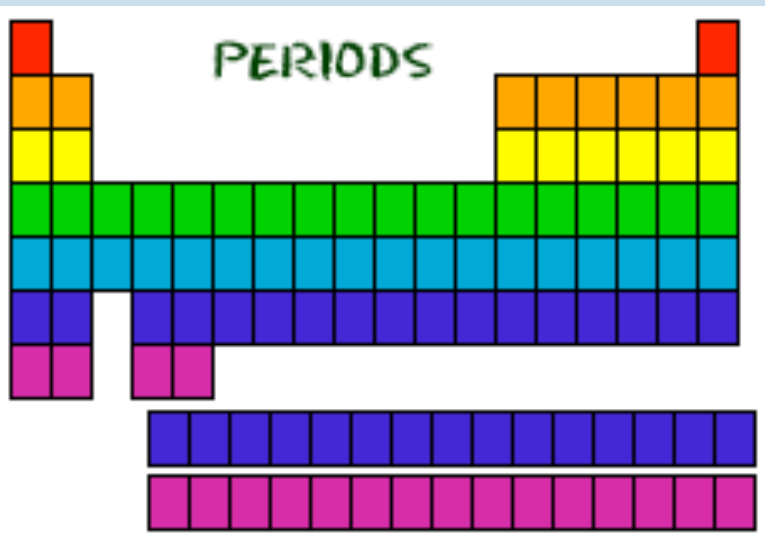
- Periodic Table is organized like a big grid
- Elements are placed in specific places because of how they look and act.
- There are rows (left to right) and columns (up and down)
- Rows and columns mean different things



The image shows a standard periodic table of elements, color-coded by groups. The title is "Periodic Table of the Elements". The elements are arranged in rows and columns, with the lanthanide and actinide series shown as separate rows at the bottom. The colors used are purple, blue, pink, light blue, green, yellow, and orange.

Periodic Table of the Elements																	
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	Ba	La
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tm	Yb	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au
Fr	Ra	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	
Lanthanide and Actinide Series																	

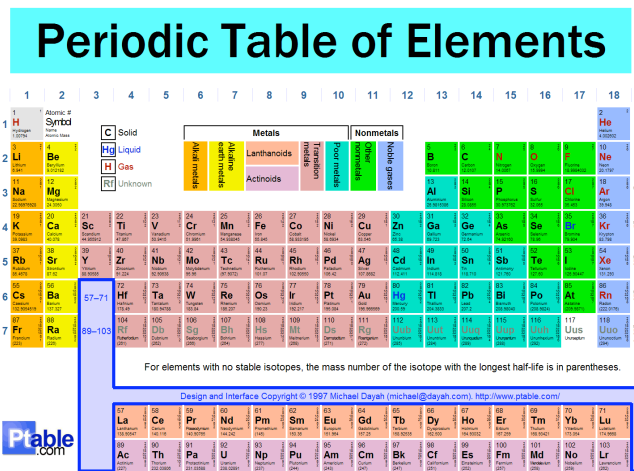
# Periods (Rows)



- All of the rows go left to right (even if there's big gaps in the row)
- Each row is a different period.
- Elements in the same period have the same number of orbitals.

# 1st and 2nd Period

- Period 1: Hydrogen & Helium
  - 1 orbital
- Period 2: Lithium, Beryllium, Boron, Carbon, Nitrogen, Oxygen, Fluorine, Neon
  - 2 orbitals
- elements in a period have the same number of atomic orbitals
- The row number (1-7) tells you how many orbitals they have



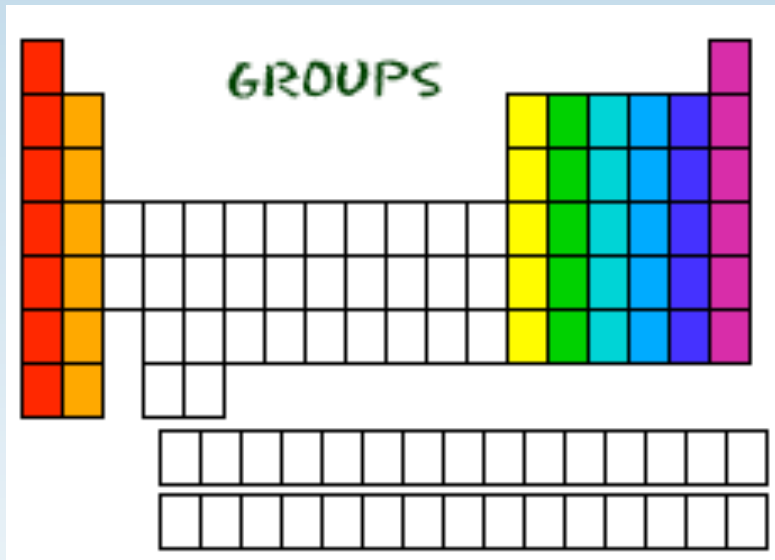
**Periodic Table of Elements**

The image shows a standard periodic table with 18 columns and 7 rows. The columns are numbered 1 through 18. The rows are numbered 1 through 7. The table is color-coded by groups: Group 1 (yellow), Group 2 (orange), Groups 3-10 (various shades of blue and purple), Group 11 (green), Group 12 (light blue), Groups 13-18 (various shades of green and yellow). The elements are arranged in order of increasing atomic number. The table includes the following information for each element: atomic number, symbol, name, and atomic weight. The table is titled "Periodic Table of Elements" and includes a copyright notice: "Design and Interface Copyright © 1997 Michael Dayeh (michael@dayeh.com) http://www.ptable.com/".

For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.

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# Periodic Groups (Columns)



\*\* Transition elements (clear blocks) are an exception

- When a column goes from top to bottom, it's called a **GROUP**
- Groups have a common property: number of outer (valence) electrons
- **Valence Electron:** the number of electrons in the outer most orbital
  - **Group 1** (red stripe) has 1 valence electron
  - **Group 3** (yellow stripe) has 3 valence electrons
  - **Group 8** (purple stripe) has 8 valence electrons

# Special Group Names: Families

- Several groups have special names and are called families

- Group 1: Alkali Metals
- Group 2: Alkaline-Earth Metals
- Group 7: Halogen Gases
- Group 8: Noble Gases
- Groups 1B-8B (middle): Transition Metals

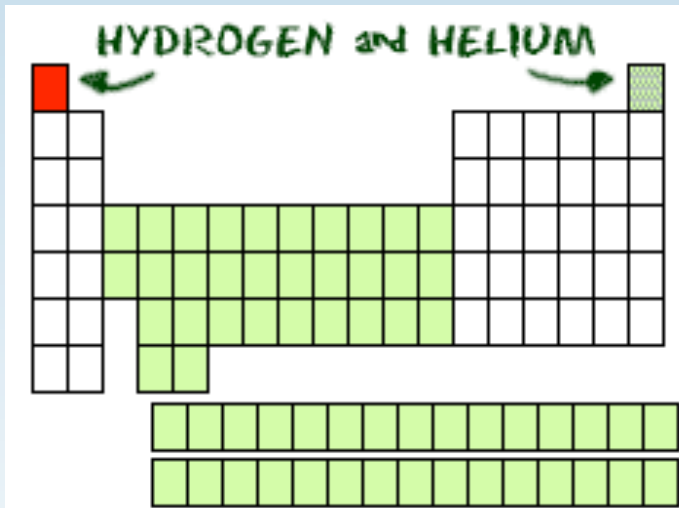
The diagram shows a simplified periodic table with the following families highlighted by color and labeled vertically or horizontally:

- Alkali Metal Family** (Group 1, light blue)
- Alkali EARTH Metal Family** (Group 2, green)
- Transition Metal Family** (Groups 3-10, yellow)
- Boron Family** (Group 11, yellow)
- Carbon Family** (Group 12, blue)
- Nitrogen Family** (Group 13, orange)
- Oxygen Family** (Group 14, pink)
- Halogen Family** (Group 15, red)
- Noble Gas Family** (Group 16, green)
- Lanthanide Series** (bottom row, orange)
- Actinide Series** (bottom row, teal)

- Families are grouped by their chemical properties

- Reactivity
- Valence Electrons
- Radioactivity

# Rule Breakers: Hydrogen & Helium



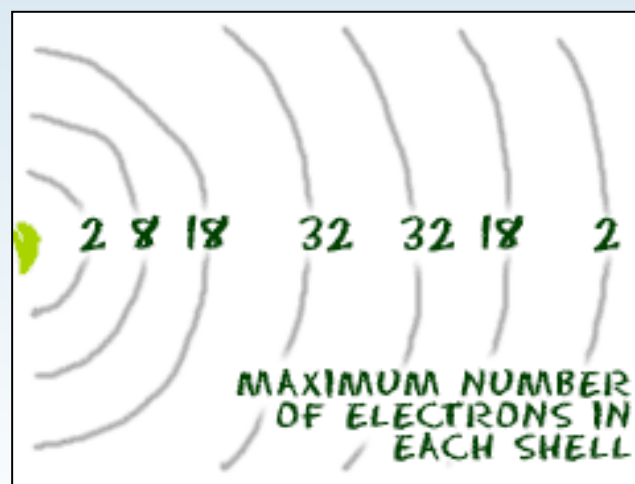
- Hydrogen and Helium are special elements
- Hydrogen can have the talents and electrons of two groups: 1 and 7
  - It's seen as having one extra electron (like group 1) or missing one (like group 7)
- Helium is different from all other elements. It only has two valence electrons, but is grouped with noble gases

# Rule Breakers: Transition Metals

- Transition Metals
  - They live in the center of the periodic table
  - They have special electron rules, which allows them to bind with more elements

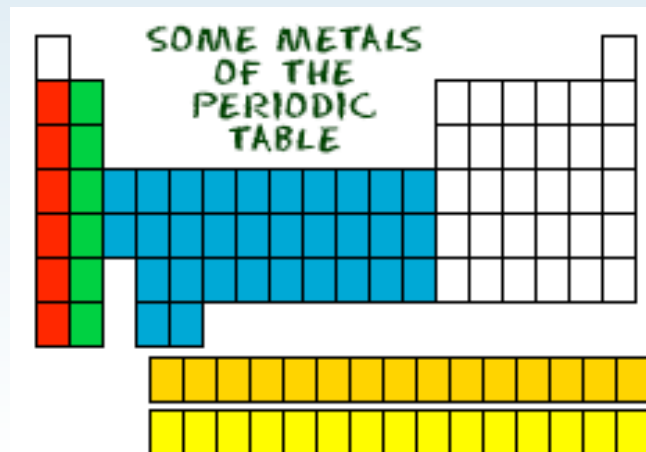
TRANSITION METALS

The diagram shows a simplified periodic table with a grid of 18 columns and 7 rows. The central block of 10 columns (columns 3 through 12) is highlighted in yellow. This block includes the d-block elements and the f-block elements (lanthanides and actinides) which are shown as two separate rows of 14 elements each below the main body of the table. The text 'TRANSITION METALS' is written in green above the yellow block.



# Metals

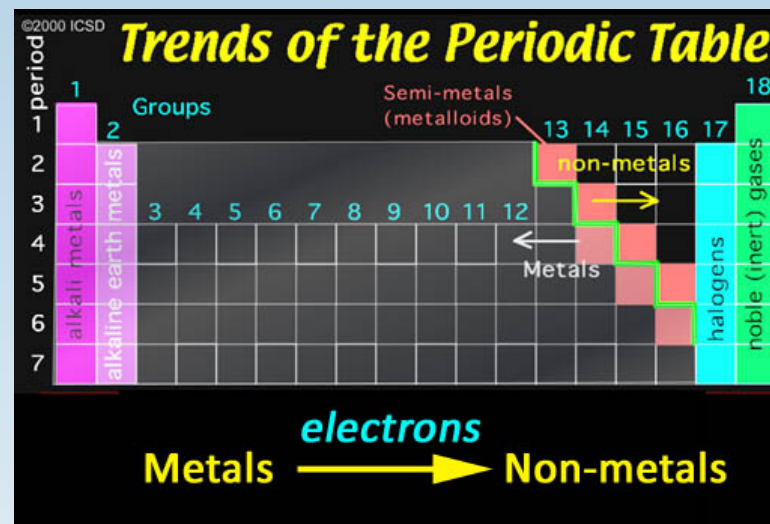
- Almost 75% of elements are metals
- Not all of them are shiny like gold and silver!
- What are characteristics of metals?
  - Good conductors of electricity (Ag, Cu)
  - Reactive (form compounds easily) (Na, K)
  - Solid at room temperature
  - Form alloys (combine 2+ metals) (steel, bronze)





# Nonmetals

- Found just above the “staircase” in Groups 4 through 8.
- Not good conductors of electricity or heat.
- Found only as a gas or solid at room temperature.
- Examples:
  - Hydrogen, Nitrogen, Oxygen, Sulfur, etc.



# Metalloids

- Found along the “staircase” on the Periodic Table.
- Share properties of both metals and nonmetals.



1A 1	2A 2											3A 13	4A 14	5A 15	6A 16	7A 17	8A 18
1 H Hydrogen 1.00794												5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.00642	8 O Oxygen 15.9994	9 F Fluorine 18.9984032	10 Ne Neon 20.1797
2 Li Lithium 6.941	4 Be Beryllium 9.012182											13 Al Aluminum 26.98154	14 Si Silicon 28.0855	15 P Phosphorus 30.973762	16 S Sulfur 32.065	17 Cl Chlorine 35.453	18 Ar Argon 39.948
3 Na Sodium 22.98976928	12 Mg Magnesium 24.304	3B	4B	5B	6B	7B	8B 8 9 10	1B	2B								
4 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955912	22 Ti Titanium 47.88	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938044	26 Fe Iron 55.845	27 Co Cobalt 58.933195	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.630	33 As Arsenic 74.9216	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
5 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90584	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium [98]	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.36	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	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
6 Cs Cesium 132.90545	56 Ba Barium 137.327	57 La Lanthanum 138.9055	58 Ce Cerium 140.12	59 Pr Praseodymium 140.90766	60 Nd Neodymium 144.242	61 Pm Promethium [145]	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50015	67 Ho Holmium 164.93033	68 Er Erbium 167.259	69 Tm Thulium 168.93032	70 Yb Ytterbium 173.054	71 Lu Lutetium 174.967	
7 Fr Francium [223]	88 Ra Radium 226.0254	89 Ac Actinium 227.0277	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	111	112						
			58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	

# Family: Alkali Metals

The image shows a simplified periodic table with the first column highlighted in green. The label 'ALKALI METALS' is written in green above the highlighted column. The table consists of a grid of boxes representing elements, with the first column being the highlighted alkali metals.

- Notice that Hydrogen is NOT part of this family. It's in group 1, but it's NOT an alkali metal
- Family Members:
  - Lithium (Li), Sodium (Na), Potassium (K), Rubidium (Rb), Cesium (Cs) and Francium (Fr).
- These are VERY reactive because they have one electron in their outer shell.
  - That's one away from having a full shell. When you are that close to having a full shell, you want to bond with other elements and lose that electron.
  - Increased desire to bond = greater reactivity

# Family: Alkaline Earth Metals

- They live in **group 2**

- Family Members:

Beryllium (**Be**), Magnesium (**Mg**), Calcium (**Ca**), Strontium (**Sr**), Barium (**Ba**), and Radium (**Ra**).

ALKALINE EARTH METALS

A simplified periodic table diagram. The second column from the left is highlighted in green. Above the first two columns, the text 'ALKALINE EARTH METALS' is written in green. The rest of the periodic table is shown in white with black outlines.

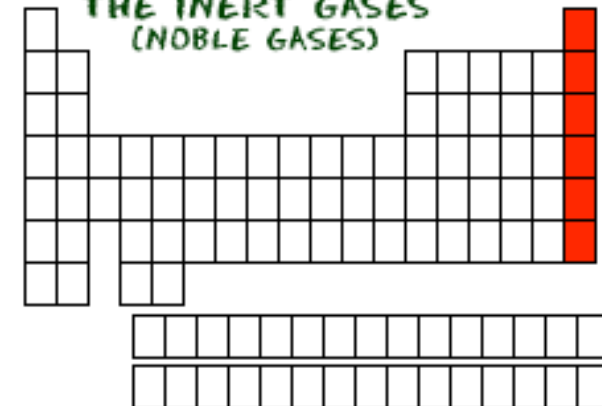
- **Second most reactive** group on the table (alkali metals are first)
- They have two electrons in their outer shell that they want to give up to have a full shell



# Family: Noble (Inert) Gases

- Located on the far right column
- Family Members:
  - Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr), Xenon (Xe), and Radon (Rn)
- They are the most stable of all (don't react with much) because they have full shells
  - They don't want to give up or take any more electrons than they already have
- Glow when given electricity

THE INERT GASES  
(NOBLE GASES)



The diagram shows a simplified periodic table with the noble gas column highlighted in red. The title "THE INERT GASES (NOBLE GASES)" is written above the red column. The table has the following structure:

- Row 1: 2 boxes (He)
- Row 2: 2 boxes (Ne)
- Row 3: 8 boxes (Ar)
- Row 4: 18 boxes (Kr)
- Row 5: 18 boxes (Xe)
- Row 6: 18 boxes (Rn)
- Row 7: 18 boxes
- Row 8: 18 boxes

The red column contains the noble gases: He, Ne, Ar, Kr, Xe, and Rn.