




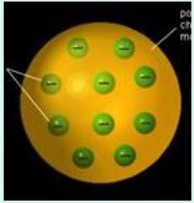
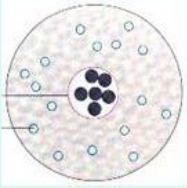
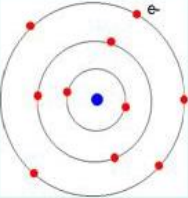
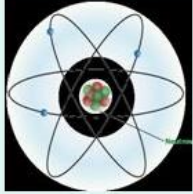

# PHYSICAL SCIENCE

Chapter 4

# INTRODUCTION TO ATOMS

Atomic Theory grew as a series of models that developed from experimental evidence.

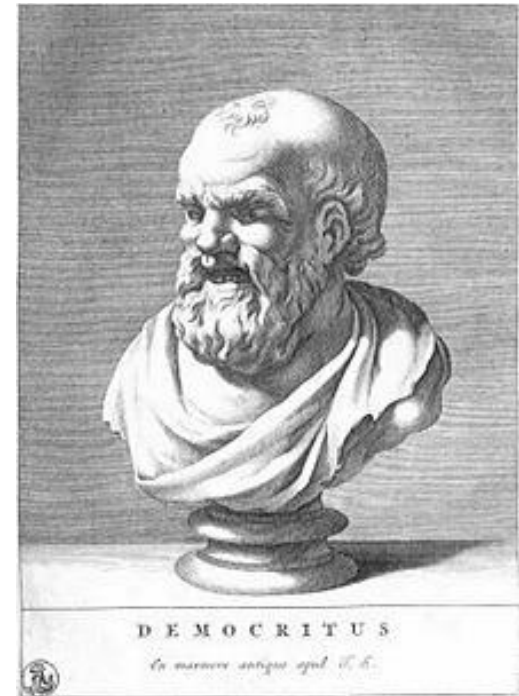
As more evidence was collected, the theory and models were revised.

					
<b>1803</b>	<b>1897</b>	<b>1909</b>	<b>1913</b>	<b>1935</b>	<b>Today</b>
solid particle	electron	proton	e- orbit nucleus	neutron	Quantum Atom theory
Dalton	Thomson	Rutherford	Bohr	Chadwick	Schrodinger and others

# HISTORY OF ATOMIC THEORY

The Greek philosopher, Democritus (~400 B.C.), is the father of modern atomic thought.

He claimed that matter was made of small, hard particles that he called “atomos”.

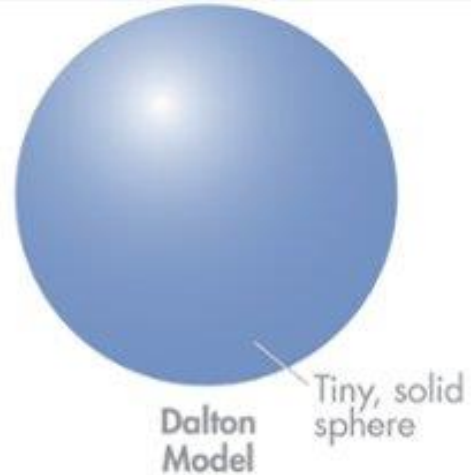


# DALTON'S MODEL

Year: 1803

Model:

- Atoms cannot be divided.
- Atoms of a specific element have the same mass and are identical.
- Atoms of one element can't change into another.

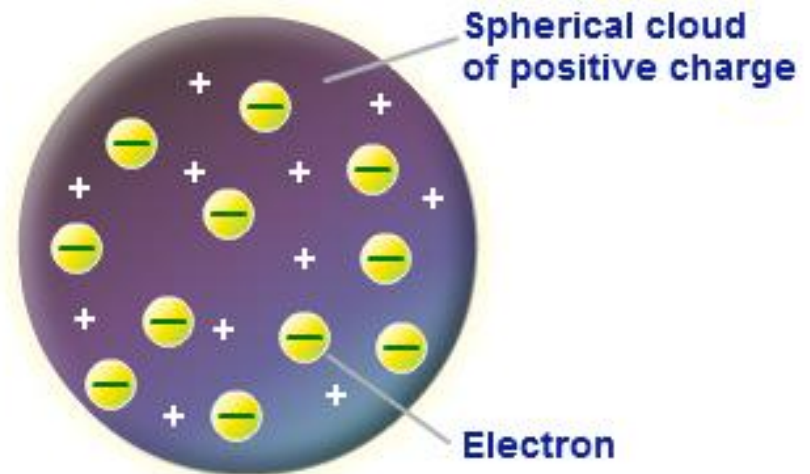


# THOMSON'S MODEL

Year: 1897

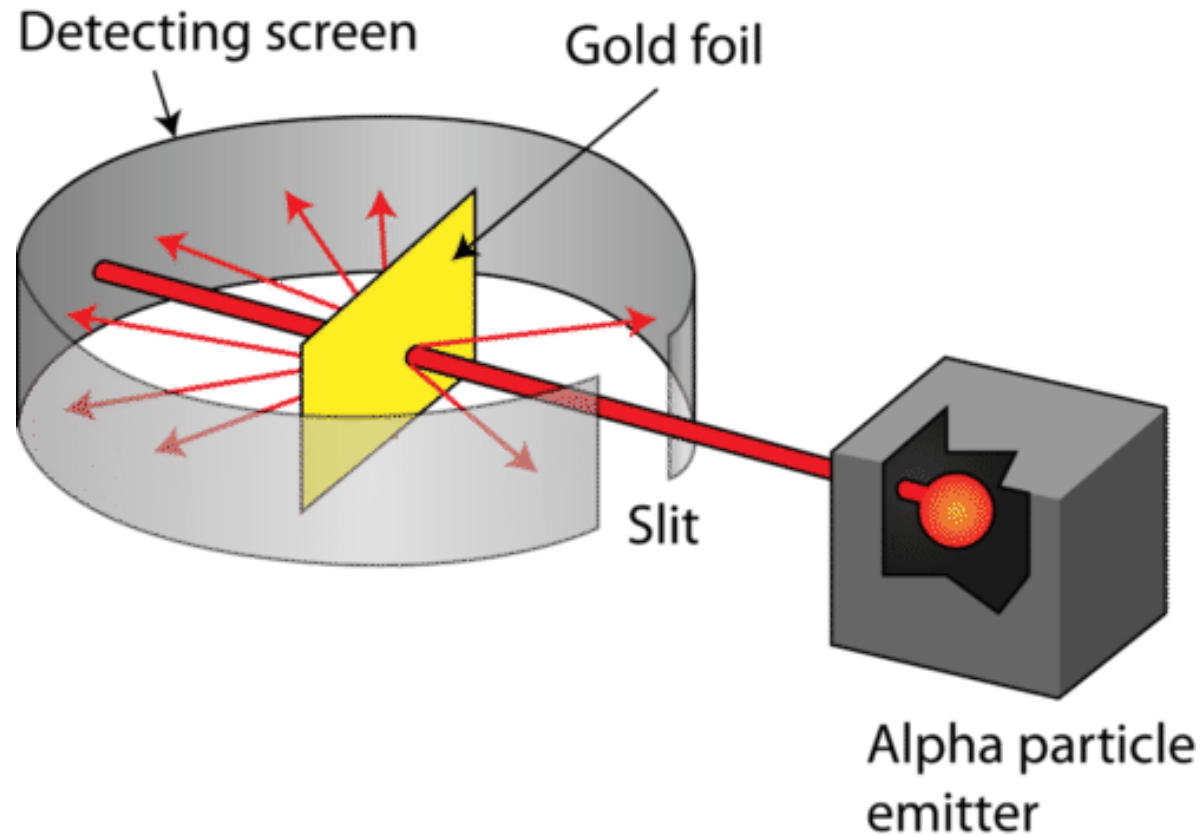
Model:

- Discovery of negatively charged particles, called electron.
- “Plum-pudding model”



Thomson's Plum pudding model

# RUTHERFORD'S GOLD FOIL EXPERIMENT

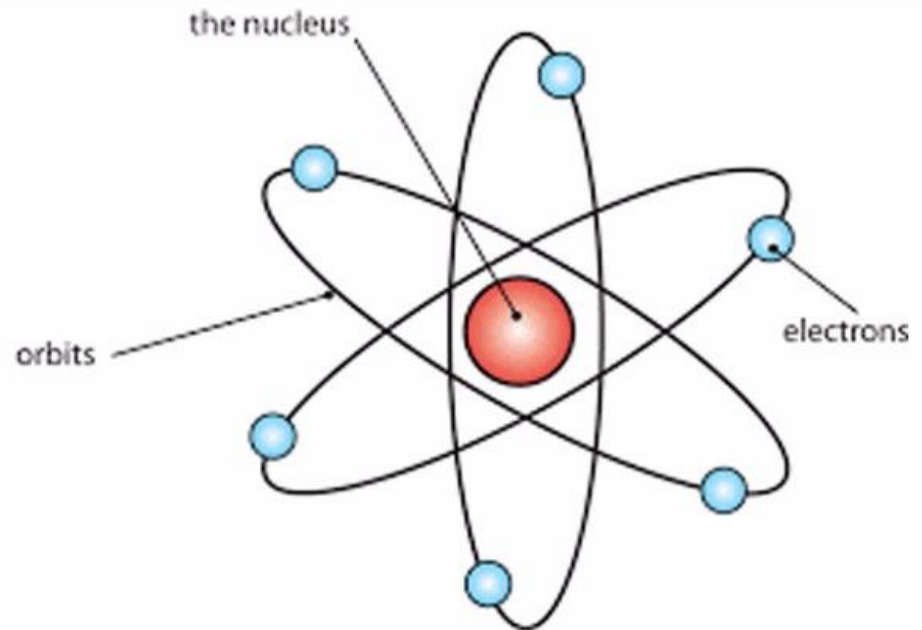


# RUTHERFORD'S MODEL

Year: 1911

Model:

- The nucleus is discovered.
- In the nucleus are positive charges called (protons).

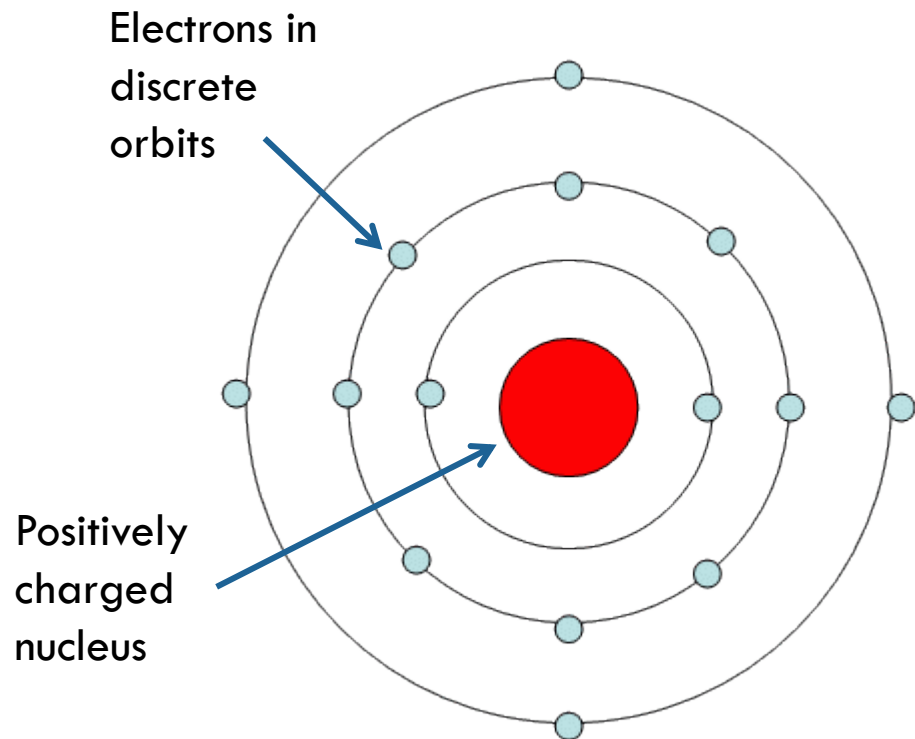


# BOHR'S MODEL

Year: 1913

Model:

- Electrons can only occupy specific energy levels.
- “Solar System” Model



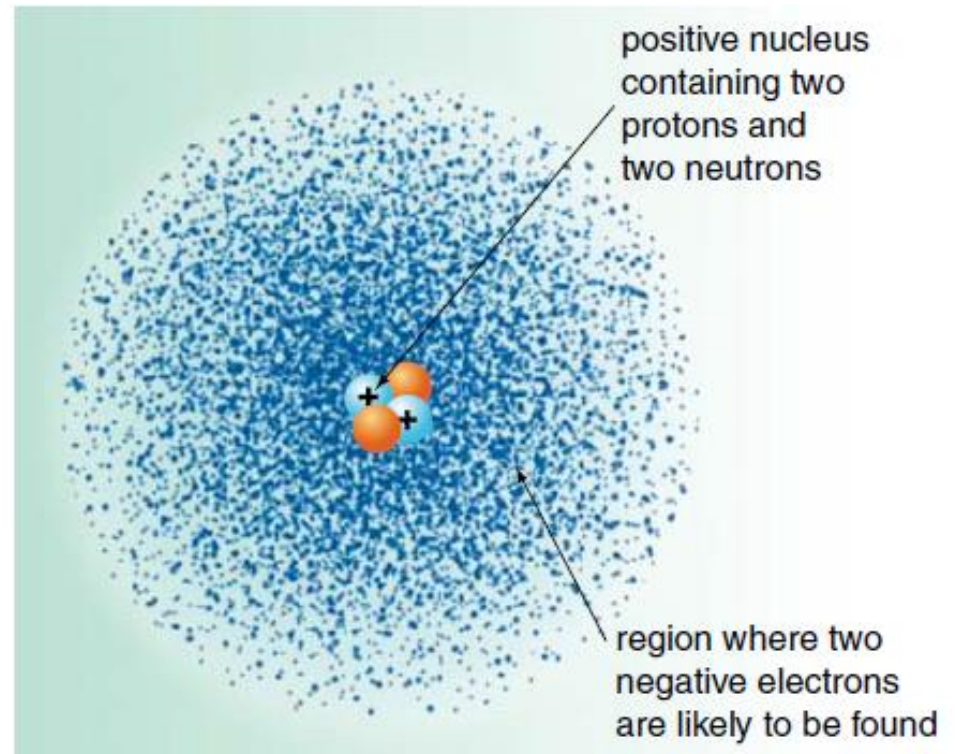


# THE MODERN ATOMIC MODEL

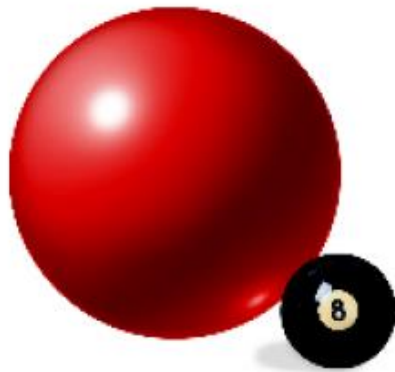
Year: 1920s – 1930s

Model:

- Discovery of neutron in nucleus.
- “Cloud” model



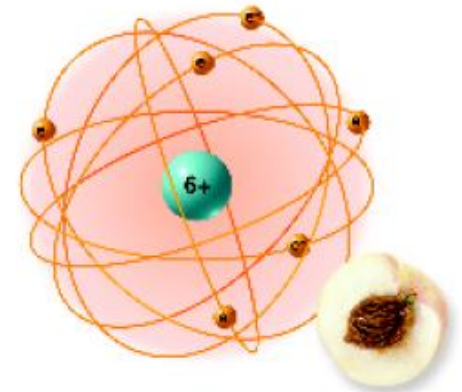
# DEVELOPMENT OF THE ATOMIC MODEL



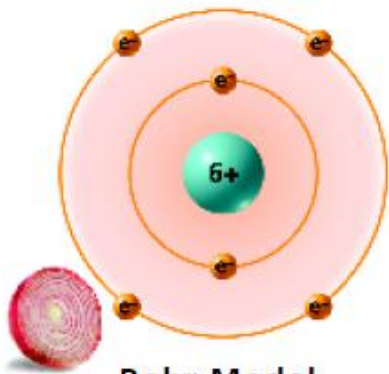
Dalton Model



Thomson Model



Rutherford Model

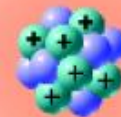


Bohr Model



$6e^-$

Cloud Model



$6e^-$

Modern Atomic Model

# CHARGES OF ATOMIC PARTICLES

*Properties of protons, neutrons and electrons*

	<i>Position in the atom</i>	<i>Relative mass</i>	<i>Relative electric charge</i>
<b>PROTON</b>	nucleus	1	<b>+ 1</b>
<b>NEUTRON</b>	nucleus	1	<b>0</b>
<b>ELECTRON</b>	outside nucleus	0.005	<b>- 1</b>

Mass is in amu (Atomic Mass Units). **1 amu =  $1.66 \times 10^{-24}$  gram**

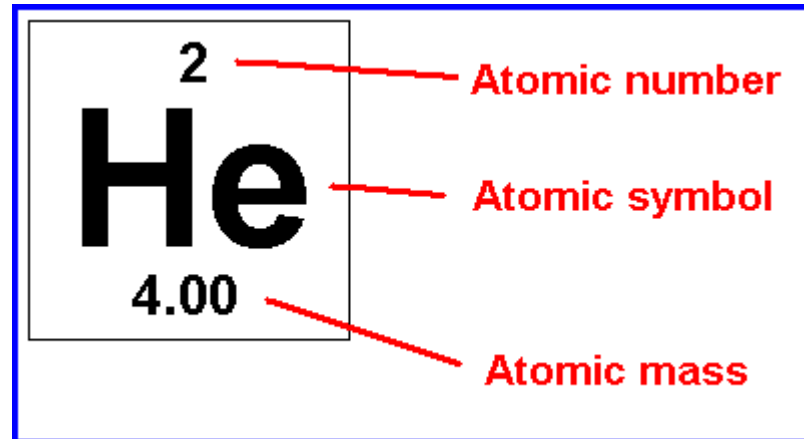
# SCALE AND SIZE OF ATOMS



# ATOMIC NUMBER

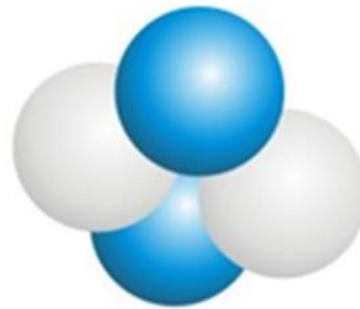
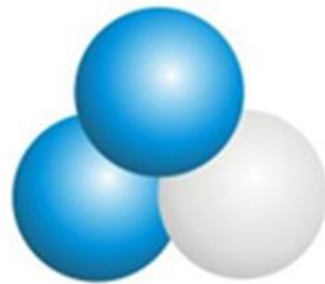
Atomic number is the **number of protons** in the nucleus of an atom. This number determines what element an atom is.

Atomic symbol is the one or two letter abbreviation for the name of the element.



# ISOTOPES

Isotopes are atoms with the same number of protons but differing numbers of neutrons.



# MASS NUMBER

Mass number is the total number of neutrons and protons in the nucleus.



6e<sup>-</sup>

Carbon-12

6 Protons

6 Neutrons

6 Electrons



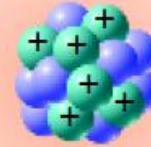
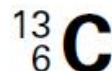
6e<sup>-</sup>

Carbon-13

6 Protons

7 Neutrons

6 Electrons



6e<sup>-</sup>

Carbon-14

6 Protons

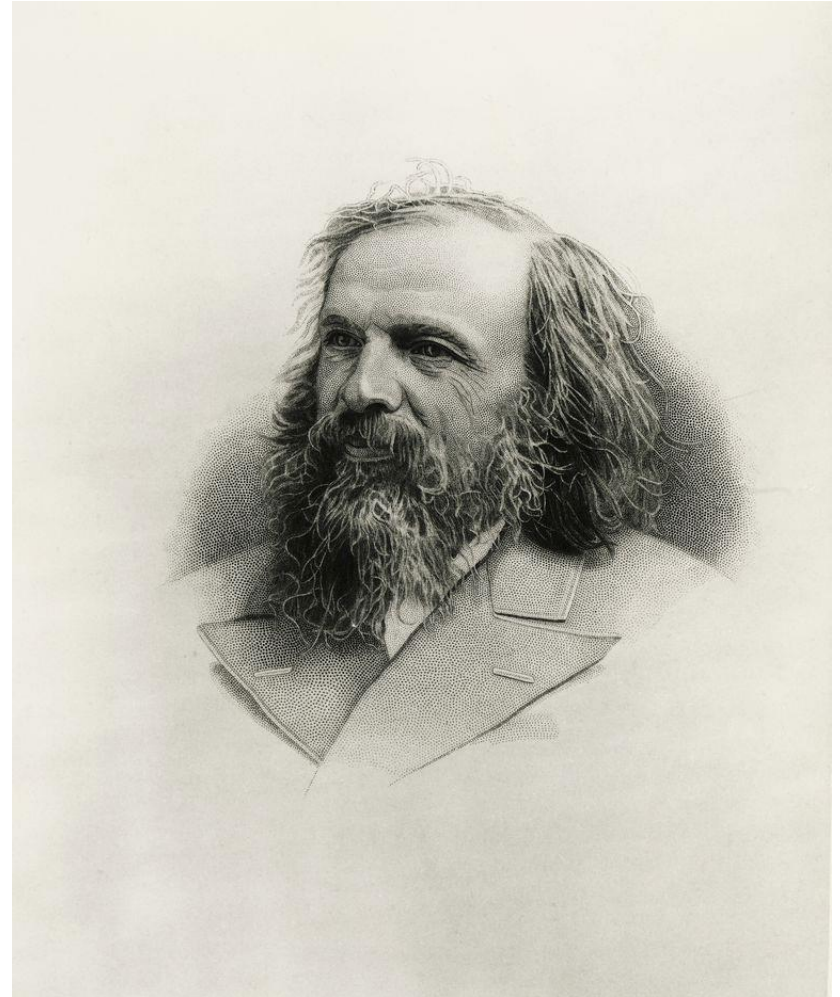
8 Neutrons

6 Electrons



# PATTERNS IN THE ELEMENTS

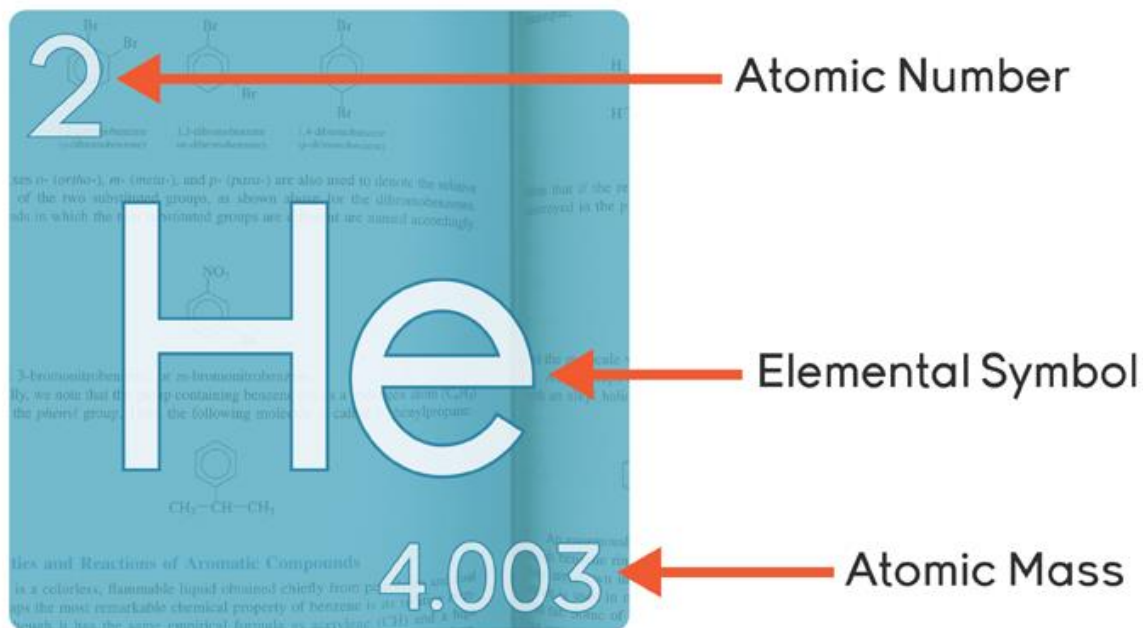
**Dmitri Mendeleev** was a Russian scientist who discovered a set of patterns that applied to all the elements.





# ATOMIC MASS

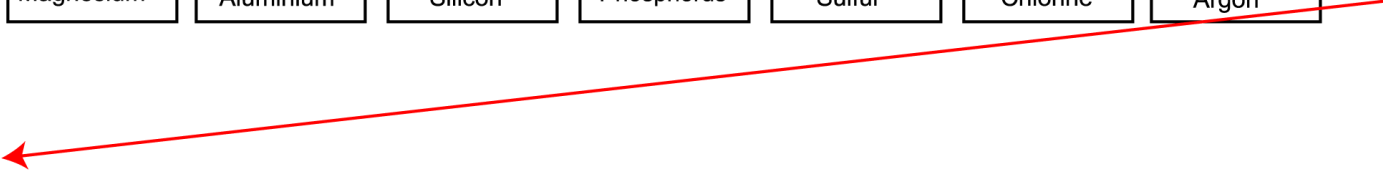
**Atomic mass** is the average mass of all the isotopes of an element.



# MENDELEEV'S PERIODIC TABLE

Arranged by atomic mass, the elements formed a pattern of repeating properties. Mendeleev grouped elements with similar properties together.

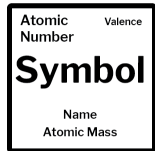
3 <b>Li</b> 1.941 Lithium	4 <b>Be</b> 9.0122 Beryllium	5 <b>B</b> 10.811 Boron	6 <b>C</b> 12.011 Carbon	7 <b>N</b> 14.007 Nitrogen	8 <b>O</b> 15.999 Oxygen	9 <b>F</b> 18.998 Fluorine	10 <b>Ne</b> 20.180 Neon
11 <b>Na</b> 22.990 Sodium	12 <b>Mg</b> 24.305 Magnesium	13 <b>Al</b> 26.982 Aluminium	14 <b>Si</b> 28.086 Silicon	15 <b>P</b> 30.974 Phosphorus	16 <b>S</b> 32.065 Sulfur	17 <b>Cl</b> 35.453 Chlorine	18 <b>Ar</b> 39.948 Argon
19 <b>K</b> 39.098 Potassium							



# THE MODERN PERIODIC TABLE

Periodic Table of the Elements

1 IA 1A																	18 VIIIA 8A
1 <sup>-1,+1</sup> <b>H</b> Hydrogen 1.008	2 IIA 2A											13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	2 <sup>0</sup> <b>He</b> Helium 4.003
3 <sup>+1</sup> <b>Li</b> Lithium 6.941	4 <sup>+2</sup> <b>Be</b> Beryllium 9.012											5 <sup>+3</sup> <b>B</b> Boron 10.811	6 <sup>+4,+3,+2,+1 -4,-3 -2,-1</sup> <b>C</b> Carbon 12.011	7 <sup>+5,+3,-3</sup> <b>N</b> Nitrogen 14.007	8 <sup>-2</sup> <b>O</b> Oxygen 15.999	9 <sup>-1</sup> <b>F</b> Fluorine 18.998	10 <sup>0</sup> <b>Ne</b> Neon 20.180
11 <sup>+1</sup> <b>Na</b> Sodium 22.990	12 <sup>+2</sup> <b>Mg</b> Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 <sup>+6,+3,+2</sup>	9 VIII 8	10 <sup>+3,+2</sup>	11 IB 1B	12 IIB 2B	13 <sup>+3</sup> <b>Al</b> Aluminum 26.982	14 <sup>+4,-4</sup> <b>Si</b> Silicon 28.086	15 <sup>+5,+3,-3</sup> <b>P</b> Phosphorus 30.974	16 <sup>+6,+4,+2,-2</sup> <b>S</b> Sulfur 32.066	17 <sup>+7,+5,+3,+1 -1</sup> <b>Cl</b> Chlorine 35.453	18 <sup>0</sup> <b>Ar</b> Argon 39.948
19 <sup>+1</sup> <b>K</b> Potassium 39.098	20 <sup>+2</sup> <b>Ca</b> Calcium 40.078	21 <sup>+3</sup> <b>Sc</b> Scandium 44.956	22 <sup>+4</sup> <b>Ti</b> Titanium 47.88	23 <sup>+5</sup> <b>V</b> Vanadium 50.942	24 <sup>+6,+3</sup> <b>Cr</b> Chromium 51.996	25 <sup>+7,+4,+2</sup> <b>Mn</b> Manganese 54.938	26 <sup>+6,+3,+2</sup> <b>Fe</b> Iron 55.845	27 <sup>+3,+2</sup> <b>Co</b> Cobalt 58.933	28 <sup>+2</sup> <b>Ni</b> Nickel 58.693	29 <sup>+2</sup> <b>Cu</b> Copper 63.546	30 <sup>+2</sup> <b>Zn</b> Zinc 65.38	31 <sup>+3</sup> <b>Ga</b> Gallium 69.723	32 <sup>+4,+2,-4</sup> <b>Ge</b> Germanium 72.631	33 <sup>+5,+3,-3</sup> <b>As</b> Arsenic 74.922	34 <sup>+6,+4,+2,-2</sup> <b>Se</b> Selenium 78.971	35 <sup>+5,+3,+1,-1</sup> <b>Br</b> Bromine 79.904	36 <sup>+2,0</sup> <b>Kr</b> Krypton 84.798
37 <sup>+1</sup> <b>Rb</b> Rubidium 85.468	38 <sup>+2</sup> <b>Sr</b> Strontium 87.62	39 <sup>+3</sup> <b>Y</b> Yttrium 88.906	40 <sup>+4</sup> <b>Zr</b> Zirconium 91.224	41 <sup>+5</sup> <b>Nb</b> Niobium 92.906	42 <sup>+6,+4</sup> <b>Mo</b> Molybdenum 95.95	43 <sup>+7,+4</sup> <b>Tc</b> Technetium 98.907	44 <sup>+4,+3</sup> <b>Ru</b> Ruthenium 101.07	45 <sup>+3</sup> <b>Rh</b> Rhodium 102.906	46 <sup>+4,+2</sup> <b>Pd</b> Palladium 106.42	47 <sup>+1</sup> <b>Ag</b> Silver 107.868	48 <sup>+2</sup> <b>Cd</b> Cadmium 112.414	49 <sup>+3</sup> <b>In</b> Indium 114.818	50 <sup>+4,+2,-4</sup> <b>Sn</b> Tin 118.711	51 <sup>+5,+3,-3</sup> <b>Sb</b> Antimony 121.760	52 <sup>+6,+4,+2,-2</sup> <b>Te</b> Tellurium 127.6	53 <sup>+7,+5,+3,+1,-1</sup> <b>I</b> Iodine 126.904	54 <sup>+6,+4,+2,0</sup> <b>Xe</b> Xenon 131.294
55 <sup>+1</sup> <b>Cs</b> Cesium 132.905	56 <sup>+2</sup> <b>Ba</b> Barium 137.328	57-71	72 <sup>+4</sup> <b>Hf</b> Hafnium 178.49	73 <sup>+5</sup> <b>Ta</b> Tantalum 180.948	74 <sup>+6,+4</sup> <b>W</b> Tungsten 183.85	75 <sup>+4</sup> <b>Re</b> Rhenium 186.207	76 <sup>+4</sup> <b>Os</b> Osmium 190.23	77 <sup>+4,+3</sup> <b>Ir</b> Iridium 192.22	78 <sup>+4,+2</sup> <b>Pt</b> Platinum 195.08	79 <sup>+3</sup> <b>Au</b> Gold 196.967	80 <sup>+2,+1</sup> <b>Hg</b> Mercury 200.59	81 <sup>+3,+1</sup> <b>Tl</b> Thallium 204.383	82 <sup>+4,+2</sup> <b>Pb</b> Lead 207.2	83 <sup>+3</sup> <b>Bi</b> Bismuth 208.980	84 <sup>+4,+2,-2</sup> <b>Po</b> Polonium [208.982]	85 <sup>+1,-1</sup> <b>At</b> Astatine 209.987	86 <sup>+2,0</sup> <b>Rn</b> Radon 222.018
87 <sup>+1</sup> <b>Fr</b> Francium 223.020	88 <sup>+2</sup> <b>Ra</b> Radium 226.025	89-103	104 <sup>+4</sup> <b>Rf</b> Rutherfordium [261]	105 <sup>+5</sup> <b>Db</b> Dubnium [262]	106 <sup>+6</sup> <b>Sg</b> Seaborgium [266]	107 <sup>+7</sup> <b>Bh</b> Bohrium [264]	108 <sup>+8</sup> <b>Hs</b> Hassium [269]	109 <sup>unknown</sup> <b>Mt</b> Meitnerium [278]	110 <sup>unknown</sup> <b>Ds</b> Darmstadtium [281]	111 <sup>unknown</sup> <b>Rg</b> Roentgenium [280]	112 <sup>+2</sup> <b>Cn</b> Copernicium [285]	113 <sup>unknown</sup> <b>Nh</b> Nihonium [286]	114 <sup>unknown</sup> <b>Fl</b> Flerovium [289]	115 <sup>unknown</sup> <b>Mc</b> Moscovium [289]	116 <sup>unknown</sup> <b>Lv</b> Livermorium [293]	117 <sup>unknown</sup> <b>Ts</b> Tennessine [294]	118 <sup>unknown</sup> <b>Og</b> Oganesson [294]



Lanthanide Series	57 <sup>+3</sup> <b>La</b> Lanthanum 138.905	58 <sup>+4,+3</sup> <b>Ce</b> Cerium 140.116	59 <sup>+3</sup> <b>Pr</b> Praseodymium 140.908	60 <sup>+3</sup> <b>Nd</b> Neodymium 144.243	61 <sup>+3</sup> <b>Pm</b> Promethium 144.913	62 <sup>+3</sup> <b>Sm</b> Samarium 150.36	63 <sup>+3,+2</sup> <b>Eu</b> Europium 151.964	64 <sup>+3</sup> <b>Gd</b> Gadolinium 157.25	65 <sup>+3</sup> <b>Tb</b> Terbium 158.925	66 <sup>+3</sup> <b>Dy</b> Dysprosium 162.500	67 <sup>+3</sup> <b>Ho</b> Holmium 164.930	68 <sup>+3</sup> <b>Er</b> Erbium 167.259	69 <sup>+3</sup> <b>Tm</b> Thulium 168.934	70 <sup>+3</sup> <b>Yb</b> Ytterbium 173.055	71 <sup>+3</sup> <b>Lu</b> Lutetium 174.967
Actinide Series	89 <sup>+3</sup> <b>Ac</b> Actinium 227.028	90 <sup>+4</sup> <b>Th</b> Thorium 232.038	91 <sup>+5</sup> <b>Pa</b> Protactinium 231.036	92 <sup>+6</sup> <b>U</b> Uranium 238.029	93 <sup>+5</sup> <b>Np</b> Neptunium 237.048	94 <sup>+4</sup> <b>Pu</b> Plutonium 244.064	95 <sup>+3</sup> <b>Am</b> Americium 243.061	96 <sup>+3</sup> <b>Cm</b> Curium 247.070	97 <sup>+3</sup> <b>Bk</b> Berkelium 247.070	98 <sup>+3</sup> <b>Cf</b> Californium 251.080	99 <sup>+3</sup> <b>Es</b> Einsteinium [254]	100 <sup>+3</sup> <b>Fm</b> Fermium 257.095	101 <sup>+3</sup> <b>Md</b> Mendelevium 258.1	102 <sup>+2</sup> <b>No</b> Nobelium 259.101	103 <sup>+3</sup> <b>Lr</b> Lawrencium [262]

- Alkali Metal
- Alkaline Earth
- Transition Metal
- Basic Metal
- Metalloid
- Nonmetal
- Halogen
- Noble Gas
- Lanthanide
- Actinide

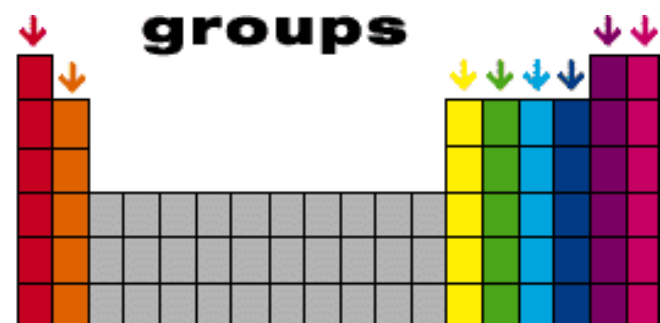
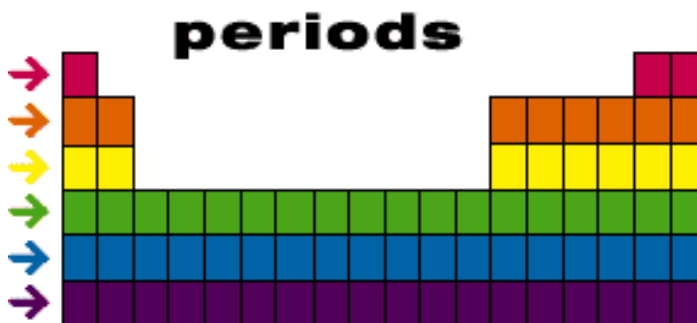
# PERIODS AND GROUPS

Periods are the horizontal rows.

- Generally go from very reactive on the left side to non reactive on the right.

Groups are the vertical columns, sometimes called families.

- All have similar characteristics



# LANTHANIDES AND ACTINIDES

Periodic table shown with Lanthanides and Actinides inserted:

1	1 H																	2 He														
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne														
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar														
4	19 K	20 Ca											21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr				
5	37 Rb	38 Sr											39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe				
6	55 Cs	56 Ba	57 La	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	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus	118 Uuo

Alkali metals	Alkaline earth metals	Lanthanides	Actinides	Transition metals
Poor metals	Metalloids	Nonmetals	Halogens	Noble gases

State at standard temperature and pressure

Atomic number in red: gas

Atomic number in blue: liquid

Atomic number in black: solid

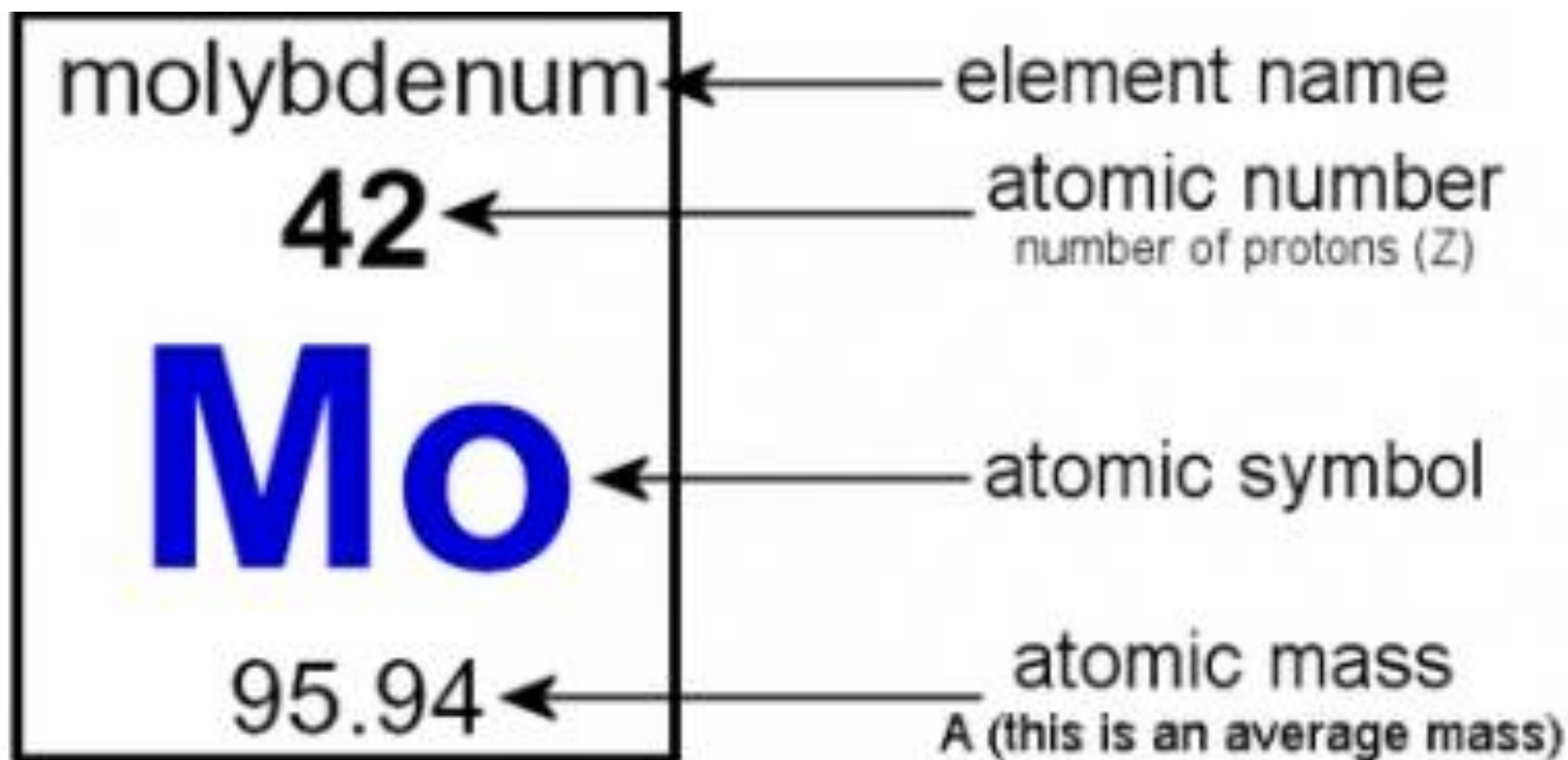
solid border: at least one isotope is older than the Earth (Primordial elements)

dashed border: at least one isotope naturally arise from decay of other chemical elements and no isotopes are older than the earth

dotted border: only artificially made isotopes (synthetic elements)

no border: undiscovered

# READING AN ELEMENT'S SQUARE

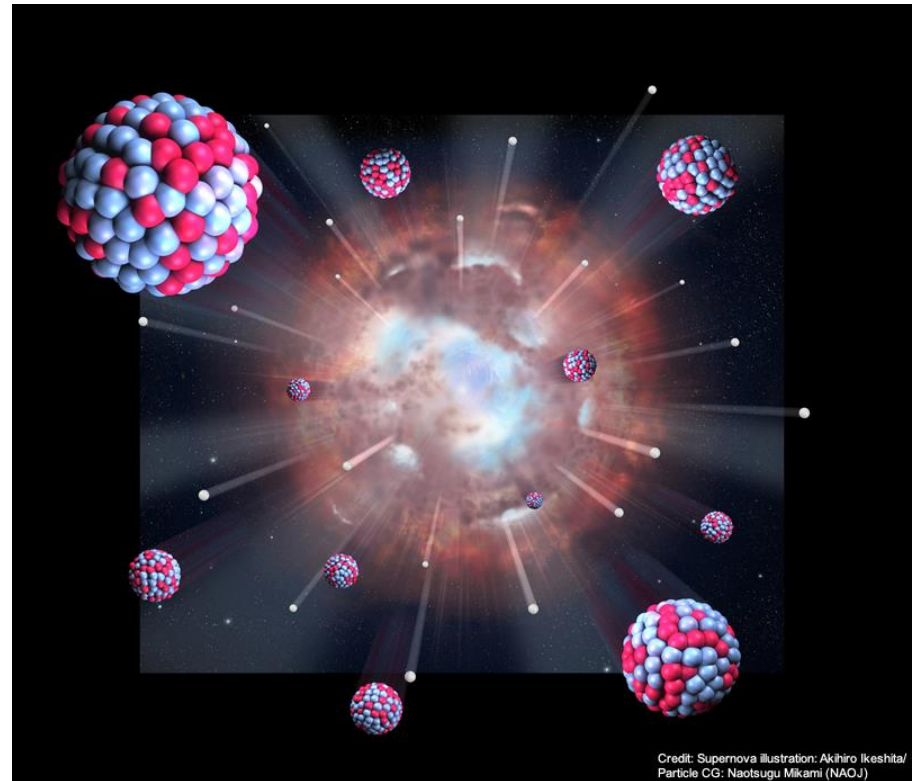


# WHERE DID ALL THE ELEMENTS COME FROM?

The universe is mostly H and He with all other elements together making up only 1-2% of the total!

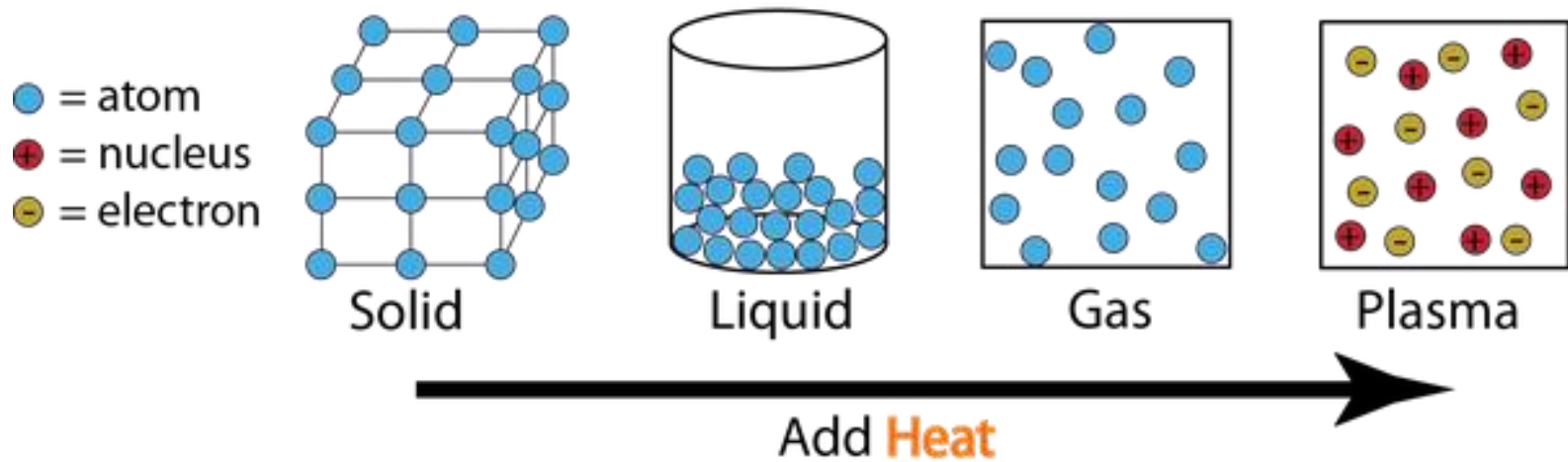
H and He were created at the very beginning of the universe.

All other elements were created in stars – either by fusion or in supernovae.



# PLASMA

Plasma is a gas-like mixture of free electrons and nuclei of atoms that have been stripped of electrons.

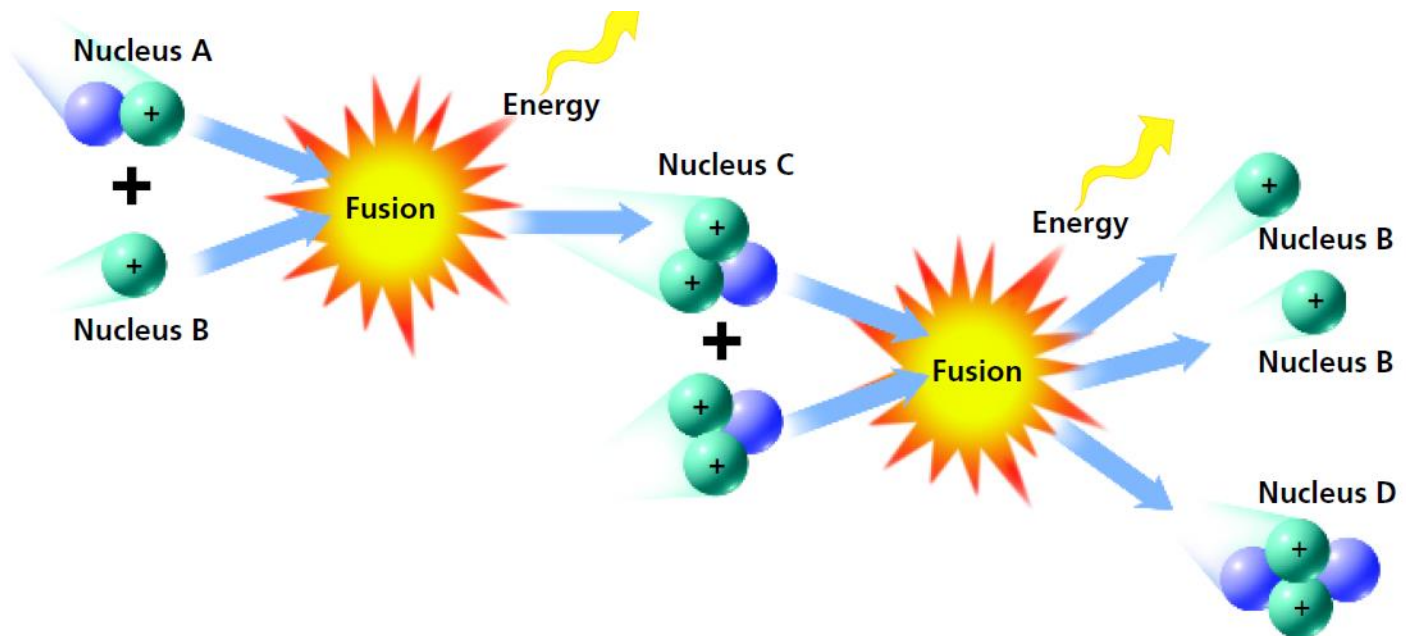




# NEW ELEMENTS FROM FUSION

When colliding nuclei have enough energy, they can join together.

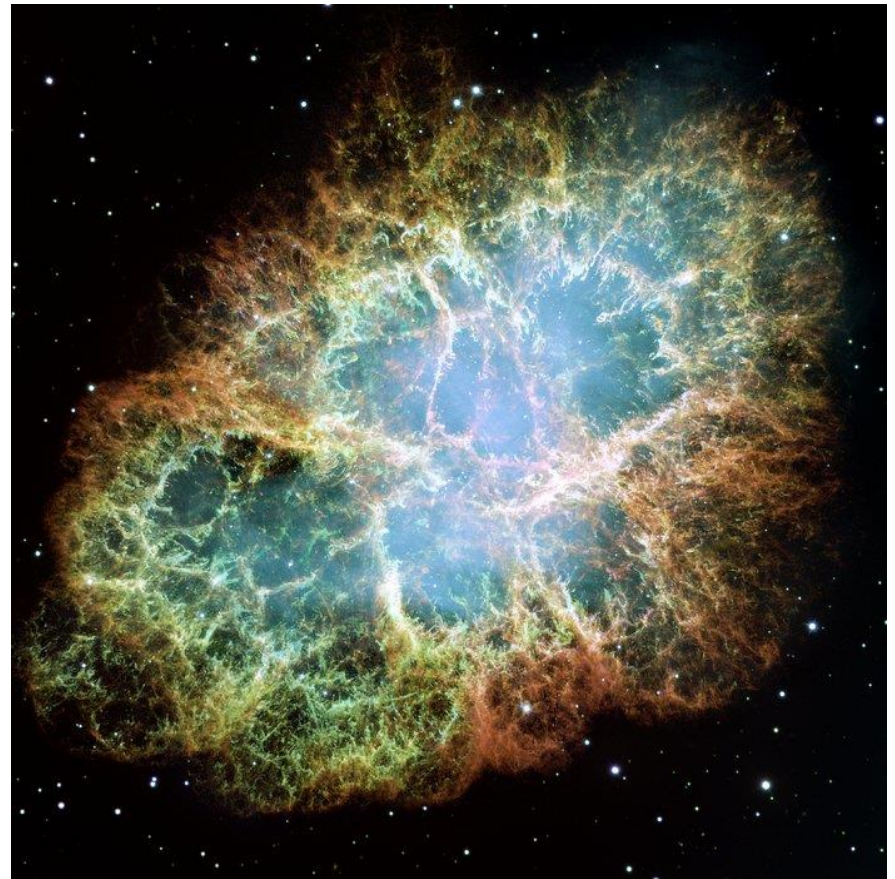
Nuclear fusion is the process in which two atomic nuclei combine, forming a larger nucleus and releasing huge amounts of energy.



# SUPERNOVAE

A supernova occurs in the final hours of the most massive stars, when gravitational forces win out over fusion.

Extreme pressure and temperature provide enough energy for fusion of heavy elements – up to uranium.



# METALS

## Physical Properties of Metals:

1. Shiny
2. Malleable
3. Ductile
4. Conductive



# 1. METALS ARE SHINY

Metals appear shiny or reflective.



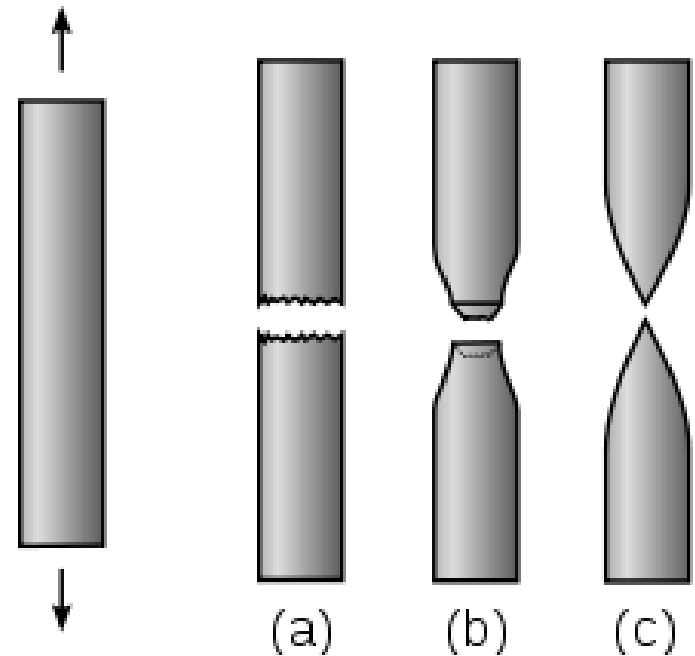
## 2. METALS ARE MALLEABLE

Malleable means that they can be manipulated into various shapes by rolling or hammering.



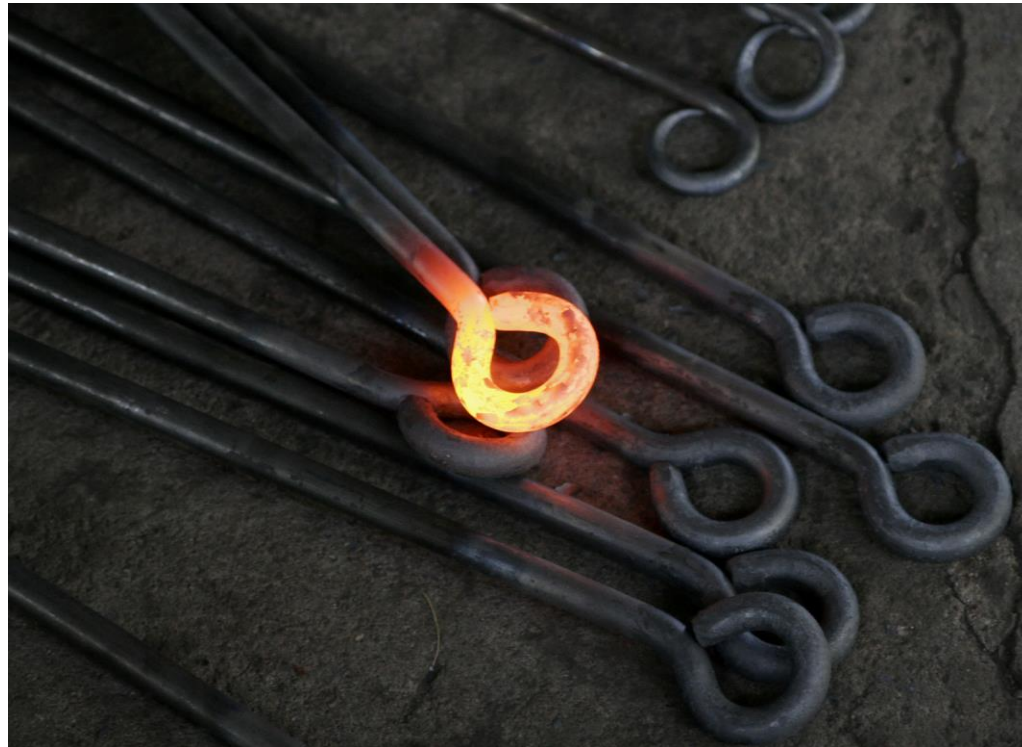
# 3. METALS ARE DUCTILE

Ductile means that metals can be pulled out or drawn into a long wire.



## 4. METALS ARE CONDUCTIVE

Conductivity is the ability to transfer heat or electricity to another object.



# REACTIVITY

Reactivity is the ease and speed with which an element combines with or reacts with other elements and compounds.

Corrosion is the destruction of a metal through oxidation.





# ALKALI METALS

- VERY reactive.
- React by losing 1 electron.
- Never found as uncombined elements in nature.



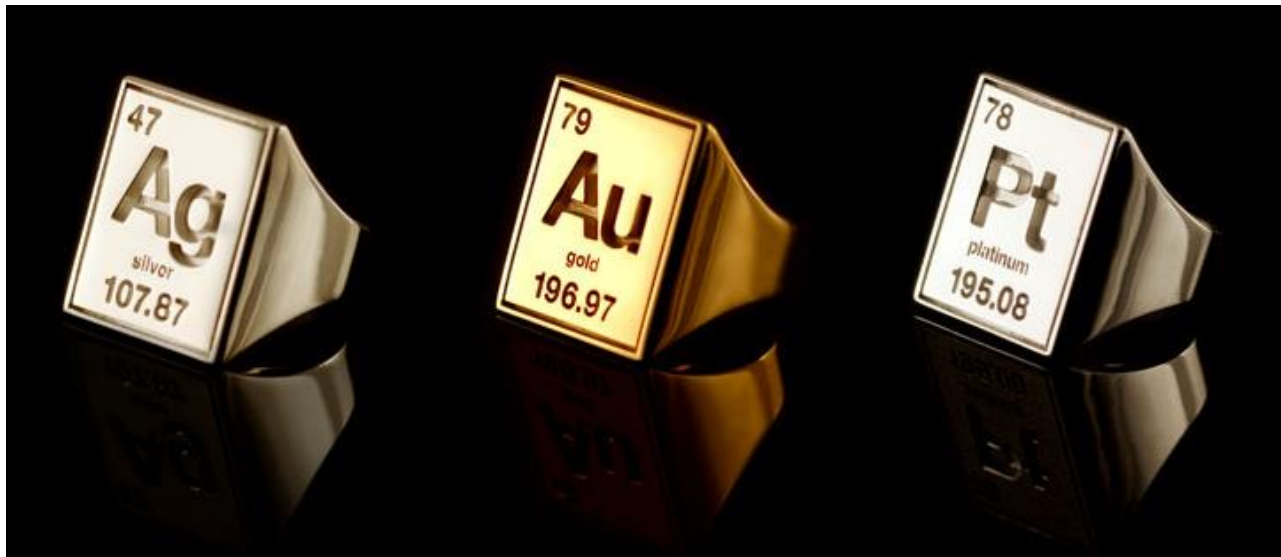
# ALKALINE EARTH METALS

- All fairly hard, gray-white and good conductors
- React by losing 2 electrons.
- Not as reactive as Alkali Metals but still never found as uncombined elements in nature.



# TRANSITION METALS

- Groups 3 - 12
- Most are hard and shiny , all are good conductors of electricity.
- Not as reactive as Groups 1-2



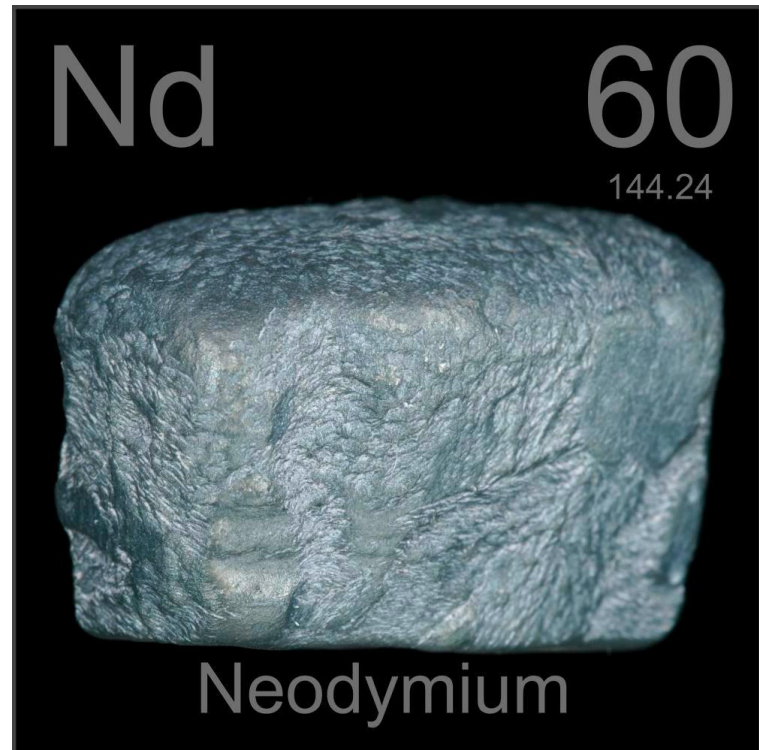
# METALS IN MIXED GROUPS

- Groups 13 – 15 are mixed
- Not nearly as reactive as those on the left.
- Most well-known are aluminum, tin and lead.



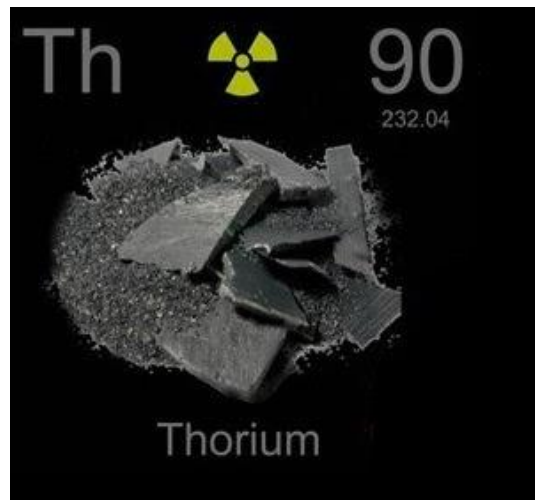
# LANTHANIDES

- Soft, malleable, shiny, high conductivity



# ACTINIDES

- Only 4 occur naturally on earth: Ac, Th, Pa, U
- After Uranium, all were created synthetically in a lab
- Their nuclei are very unstable and they break apart quickly into smaller nuclei.
- Some last for only a fraction of a second after they are made.



# SYNTHETIC ELEMENTS

How do scientists make elements that are heavier than uranium?

By forcing nuclear particles to smash into each other!



# NON-METALS

hydrogen 1 H 1.01	Carbon 6 C 12.01	nitrogen 7 N 14.01	oxygen 8 O 16.00	Fluorine 9 F 19.00	neon 20 Ne 20.18
		phosphorus 15 P 30.97	sulphur 16 S 32.06	Chlorine 17 Cl 35.45	argon 18 Ar 39.95
			selenium 34 Se 78.96	bromine 35 Br 79.90	krypton 36 Kr 83.80
				Iodine 53 I 126.90	xenon 54 Xe 131.29
					radon 86 Rn (222)

A non-metal is an element that lacks most of the properties of a metal.

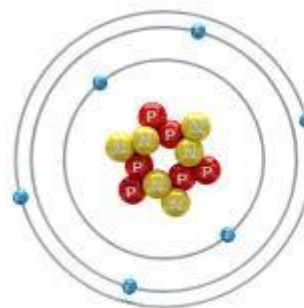
- ❖ There are 16, ten of them are gases at room temp.
- ❖ The solid non-metals tend to be dull and brittle
- ❖ Poor conductors of heat and electricity
- ❖ Tend to be reactive



# THE CARBON FAMILY

## Group 14

- ❖ Have 4 electrons to gain, lose or share when reacting with other elements.
- ❖ Fuels – most have carbon (coal, gas, etc.)

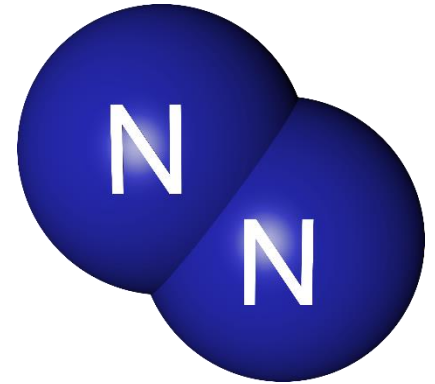


# THE CARBON FAMILY

- ❖ Carbon is especially important in Organic Chemistry
- ❖ Every living thing contains molecules made of long chains of carbon atoms.



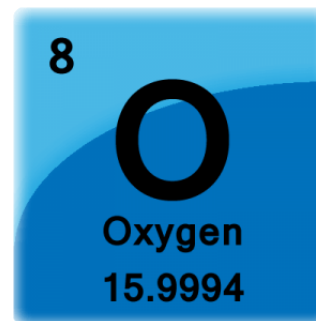
# THE NITROGEN FAMILY



## Group 15

- ❖ Nitrogen and Phosphorous make up this group
- ❖ Nitrogen makes up about 80% of our atmosphere
- ❖ Gain or share 3 electrons when reacting
- ❖ They form diatomic molecules – 2 atoms of the same element bonded. In this form, they are not very reactive.
- ❖ Phosphorous is more reactive than Nitrogen. In nature, it is always found in compounds.
- ❖ Match heads contain phosphorous.

# THE OXYGEN FAMILY



## Group 16

- ❖ Contains 3 non-metals: Oxygen, Sulfur, Selenium
- ❖ Gain or share 2 electrons when reacting
- ❖ Oxygen forms diatomic molecules like Nitrogen – sometimes triatomic (3 atoms).  $O_3$  is known as Ozone.
- ❖ Oxygen is highly reactive and is the most abundant element in Earth's crust.

# THE HALOGEN FAMILY

Group 17:

- ❖ Fluorine, Chlorine, Bromine, Iodine, Astatine
- ❖ “Halogen” means salt-forming.
- ❖ Gain or share 1 electron in reacting.
- ❖ All are VERY reactive and so uncombined are very dangerous to humans.

19 F 9
35 Cl 17
80 Br 35
127 I 53
210 At 85

# THE NOBLE GASES

Group 18:

- ❖ Unreactive. They don't usually form compounds because their atoms don't usually gain or lose or share electron.

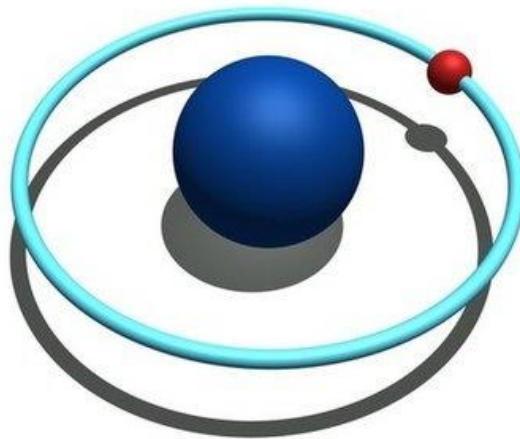
helium <b>He</b> 2	neon <b>Ne</b> 10	argon <b>Ar</b> 18	<b>Noble gases</b> have a full outer electrons shell, which makes these elements non-reactive. <small>Buzzle.com</small>
krypton <b>Kr</b> 36	xenon <b>Xe</b> 54	radon <b>Rn</b> 86	

# HYDROGEN

Hydrogen is so different than other elements that it is off by itself.

Hydrogen makes up more than 90% of the atoms in the universe.

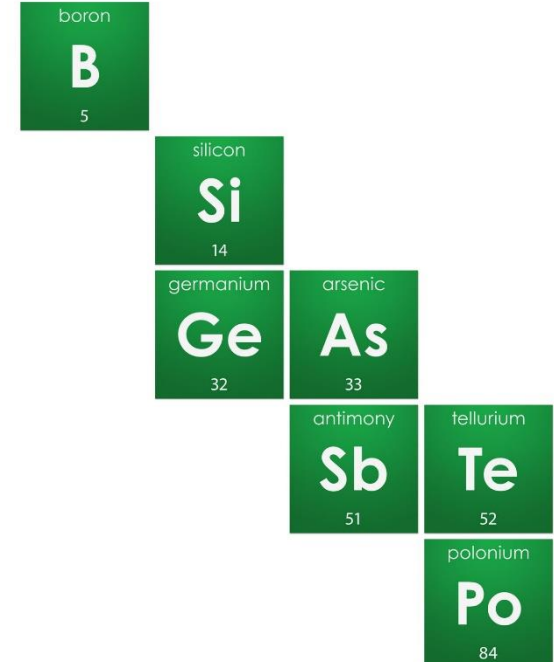
Rarely found as a pure element.



# METALLOIDS

Metalloids have characteristics of both metals and non-metals.

- ❖ They are all solids at room temp
- ❖ Brittle, hard
- ❖ Somewhat reactive
- ❖ Most useful property is their varying ability to conduct electricity.
- ❖ Somewhat reactive
- ❖ Most common metalloid is Silicon

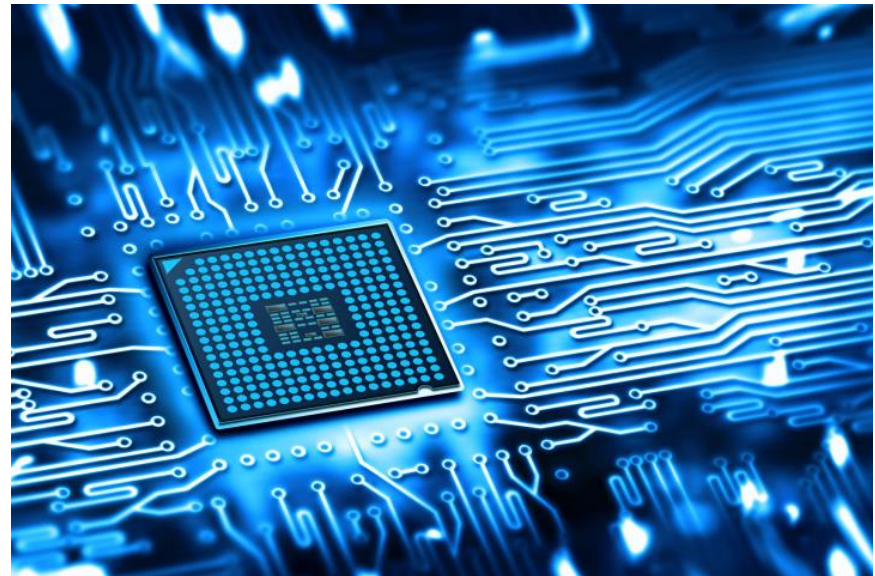




# SEMICONDUCTORS

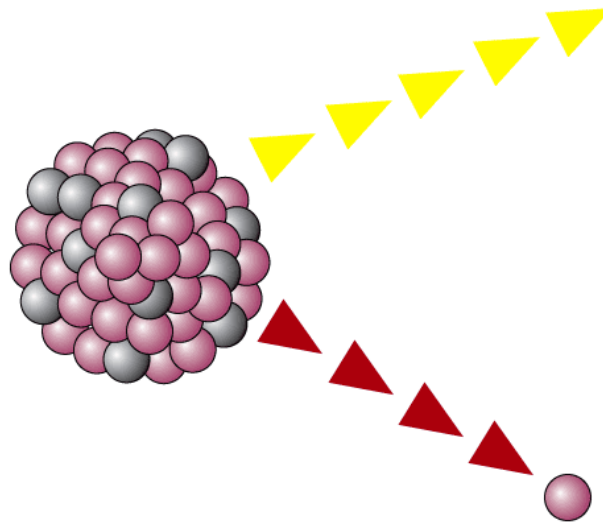
Semiconductors conduct electricity under some conditions but not other conditions. They are used for computer chips, transistors, lasers.

Silicon is the most well-known semiconductor.



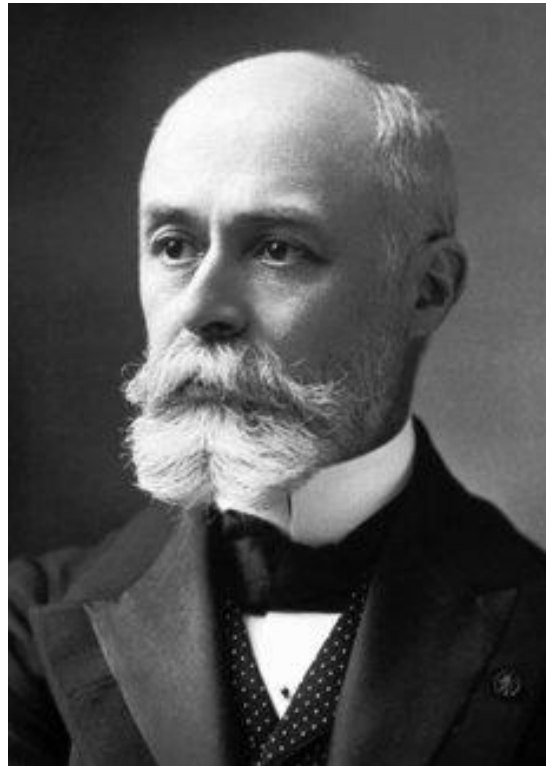
# RADIOACTIVITY

Radioactive decay is the process in which atomic nuclei of unstable isotopes release fast-moving particles and energy.



# RADIOACTIVITY

Henri Becquerel in 1896 discovered radioactive decay.



# TYPES OF RADIOACTIVE DECAY

Natural radioactive decay can produce three types of particles and energy:

1. Alpha Particles
2. Beta Particles
3. Gamma Rays

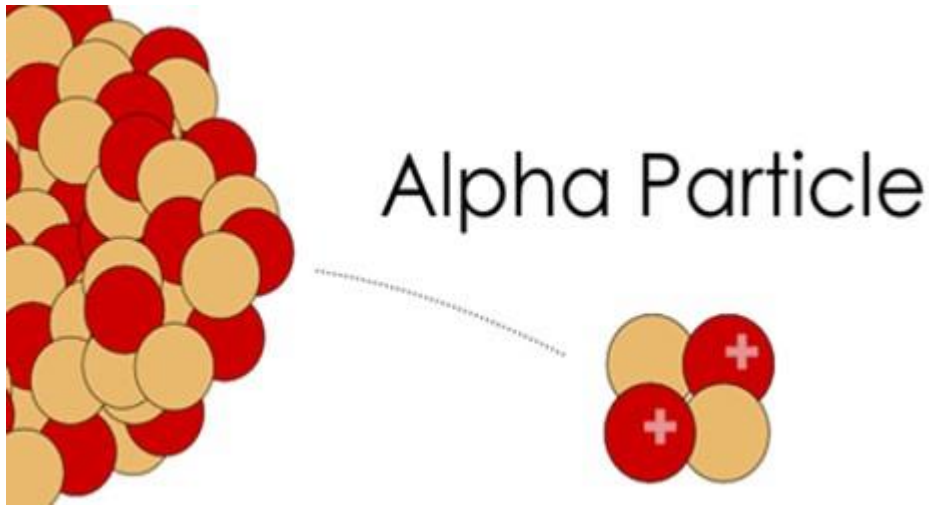
# ALPHA PARTICLES

An alpha particle consists of two protons and two neutrons and is positively charged. It is the same as a helium nucleus.

Result:

Atomic Number -2

Mass Number -4



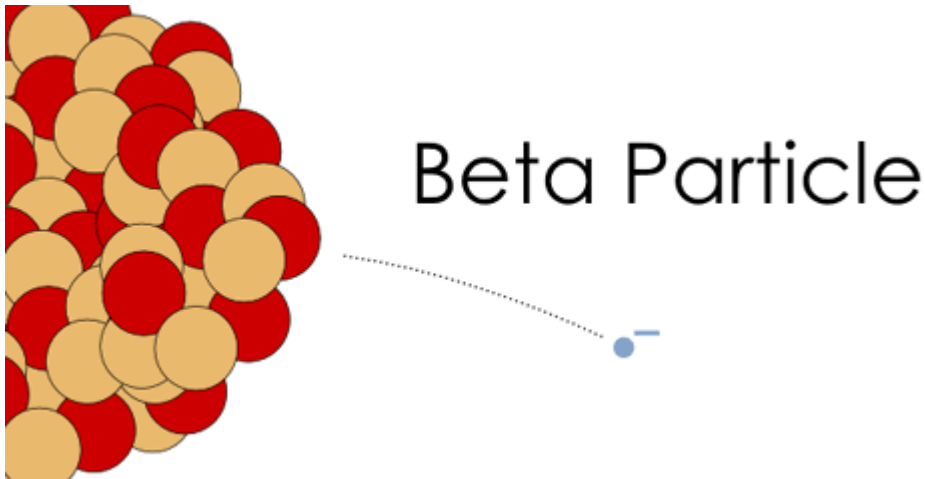
# BETA PARTICLE

A beta particle is a fast moving electron given off by a nucleus during radioactive decay.

Result:

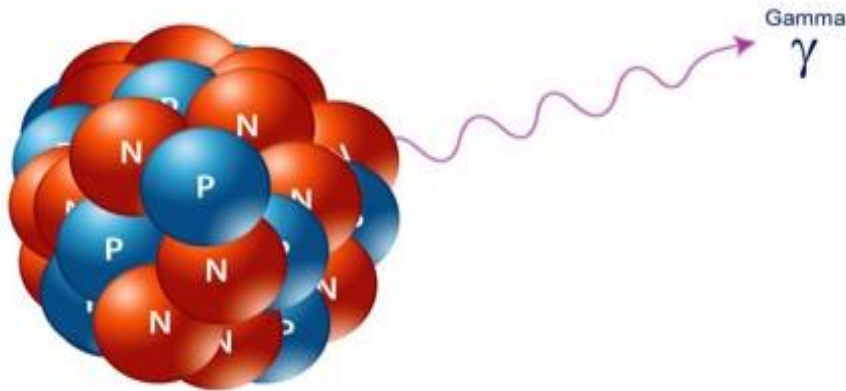
Atomic Number +1

Mass Number  $\pm 0$



# GAMMA RADIATION

Gamma radiation consists of high-energy waves, similar to x-rays. Gamma radiation has no charge and does not cause a change in either the atomic mass or the atomic number.

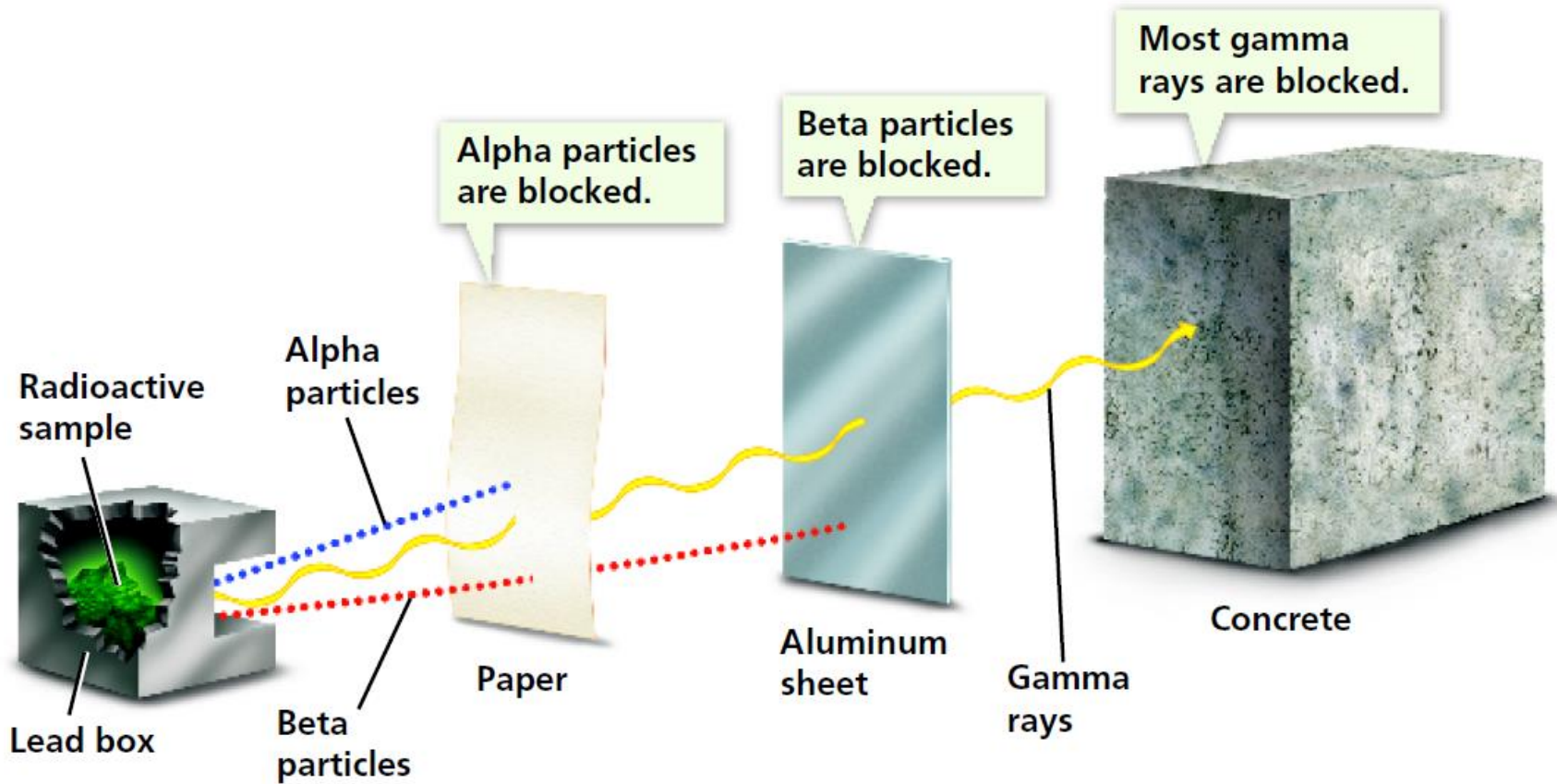


Result:

Atomic Number  $+0$

Mass Number  $\pm 0$

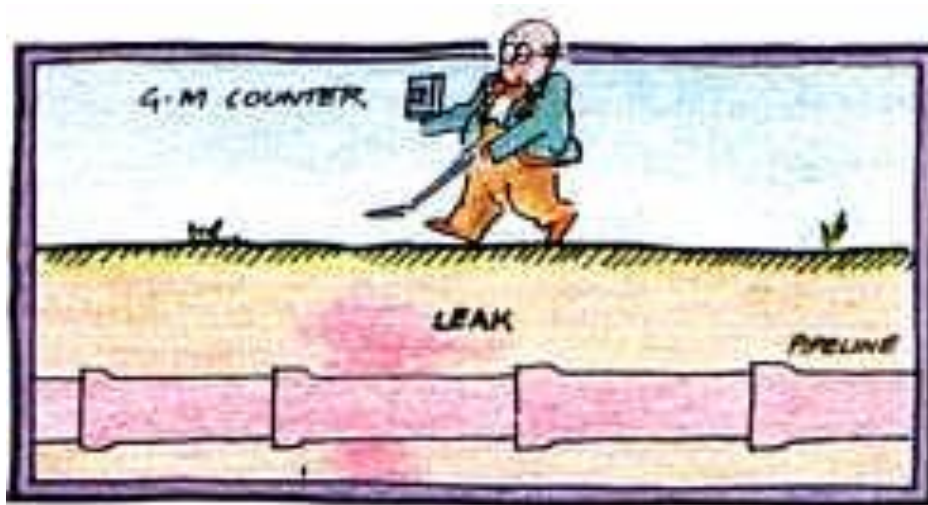
# PENETRATION POWER OF RADIATION





# USING RADIOACTIVE ISOTOPES

- ❖ Nuclear power plants – harness radioactivity to generate electricity.
- ❖ Tracers are radioactive isotopes that can be followed through the steps of a chemical reaction or an industrial process.



# USING RADIOACTIVE ISOTOPES

- ❖ Radiation Therapy – used to target and destroy cancerous cells.

