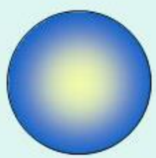
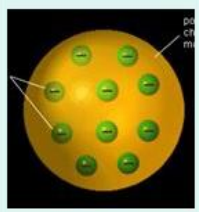
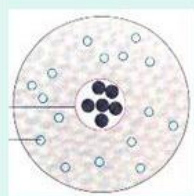
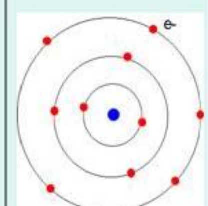
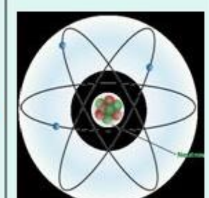
PHYSICAL SCIENCE

Chapter 4

INTRODUCTION TO ATOMS

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

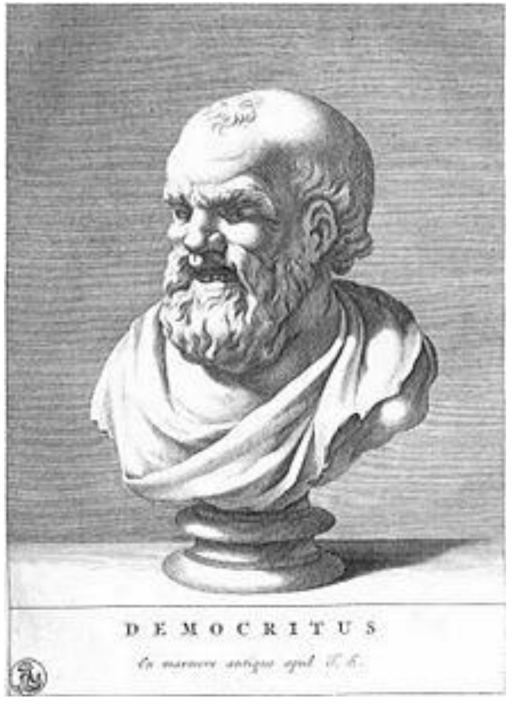
As more evidence was collected, the theory and models were revised.

					
1803	1897	1909	1913	1935	Today
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”.

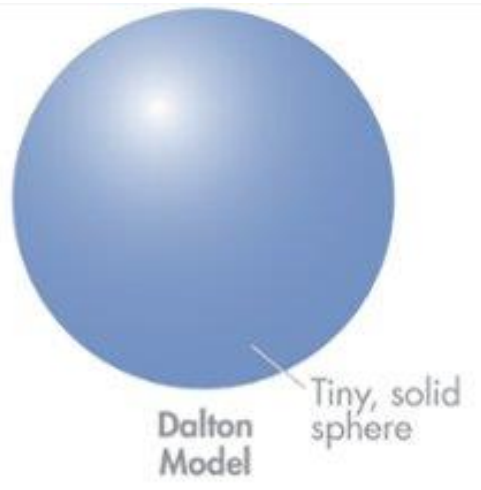


DALTON'S MODEL

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.

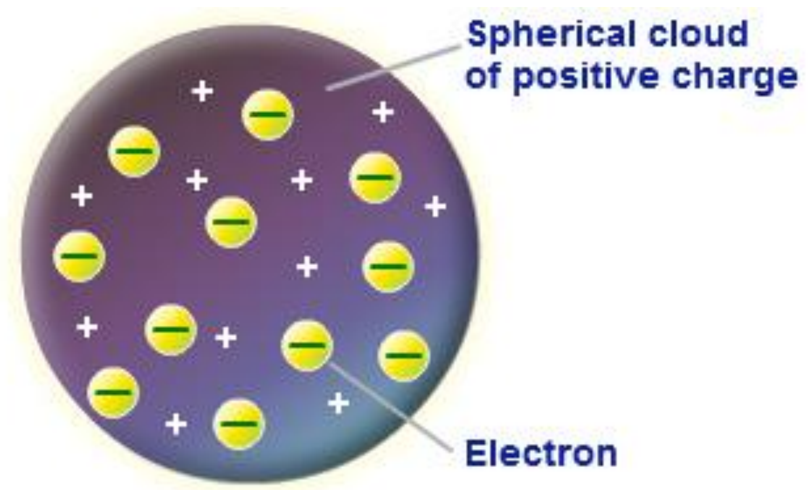


THOMSON'S MODEL

Year: 1897

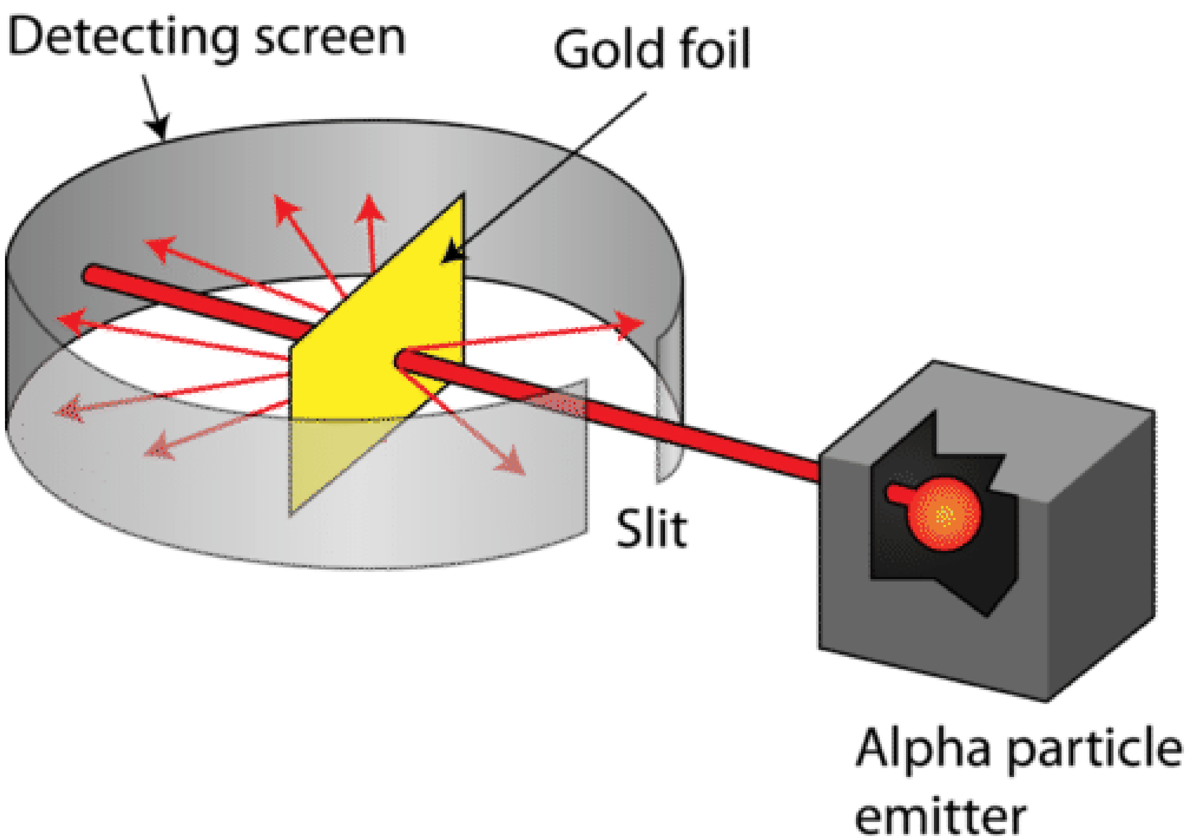
Model:

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



Thomson's Plum pudding model

RUTHERFORD'S GOLD FOIL EXPERIMENT

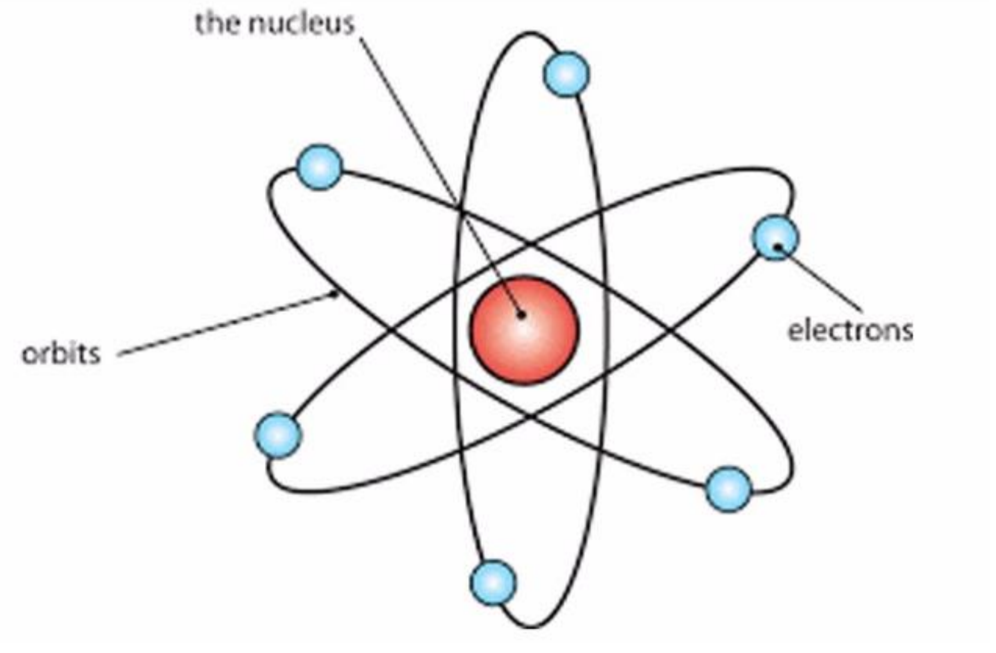


RUTHERFORD'S MODEL

Year: 1911

Model:

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

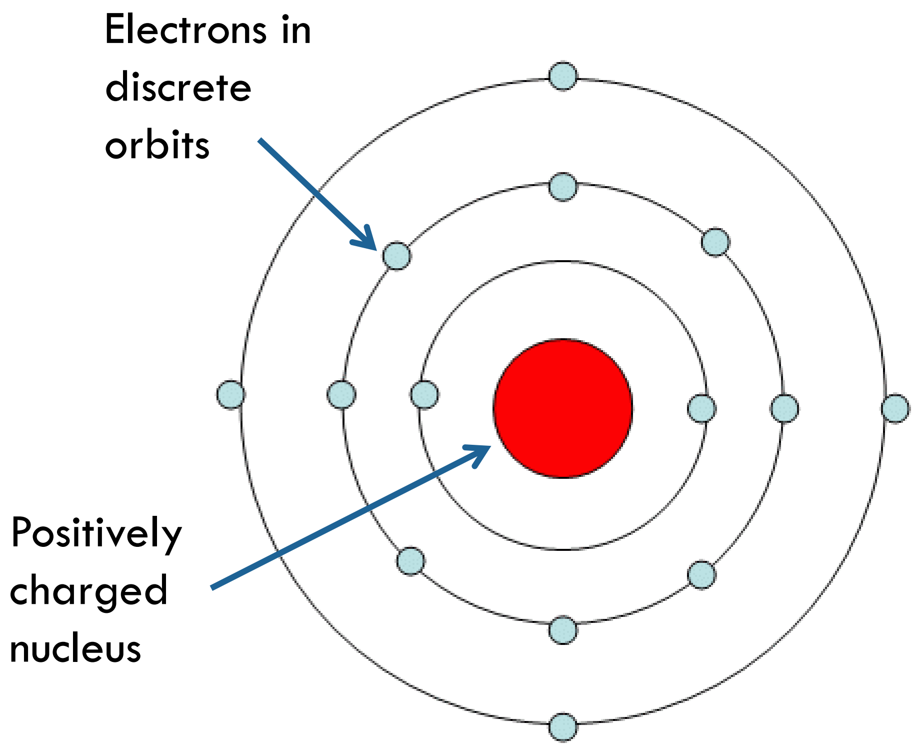


BOHR'S MODEL

Year: 1913

Model:

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

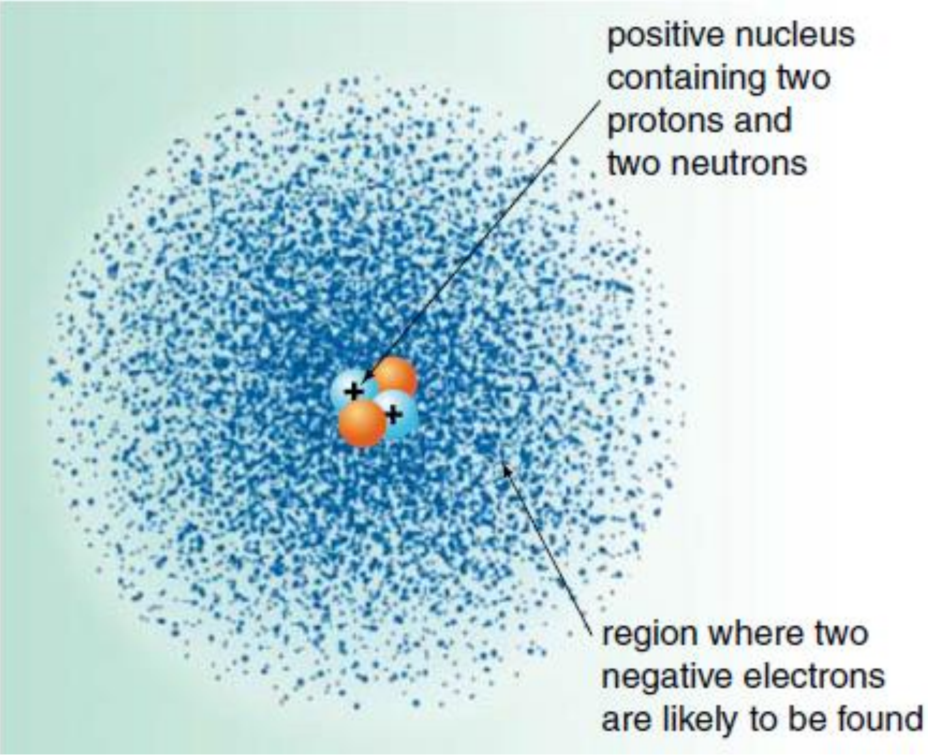


THE MODERN ATOMIC MODEL

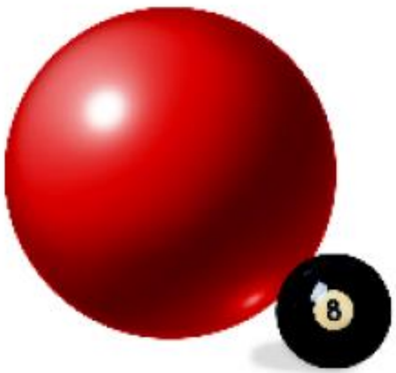
Year: 1920s – 1930s

Model:

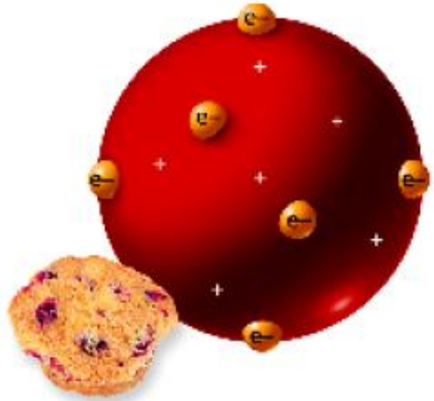
- Discovery of neutron in nucleus.
- "Cloud" model



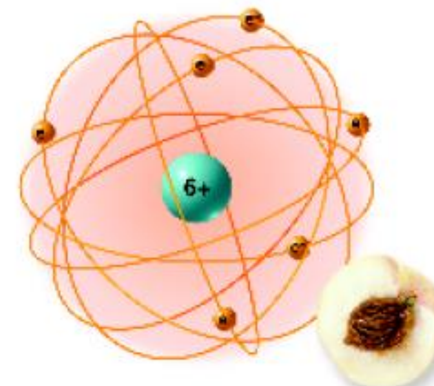
DEVELOPMENT OF THE ATOMIC MODEL



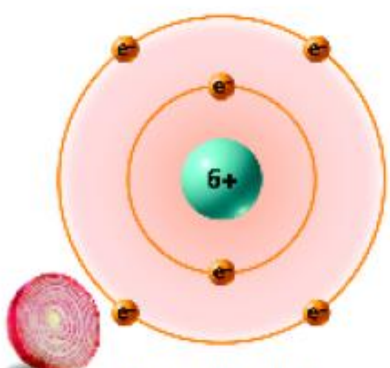
Dalton Model



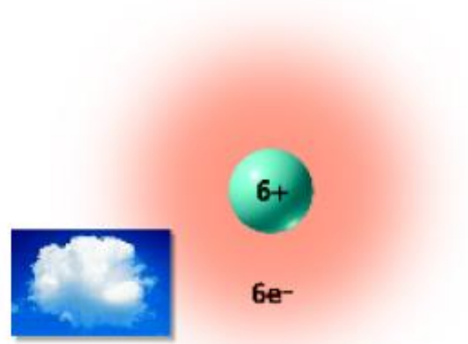
Thomson Model



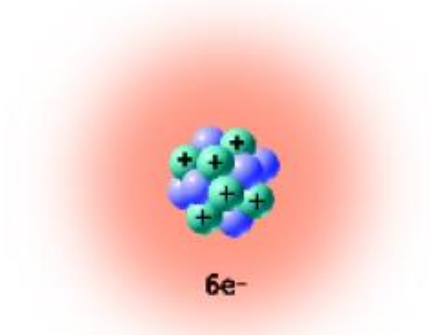
Rutherford Model



Bohr Model



Cloud Model



Modern Atomic Model

CHARGES OF ATOMIC PARTICLES

Properties of protons, neutrons and electrons

	Position in the atom	Relative mass	Relative electric charge
PROTON	nucleus	1	+ 1
NEUTRON	nucleus	1	0
ELECTRON	outside nucleus	0.005	- 1

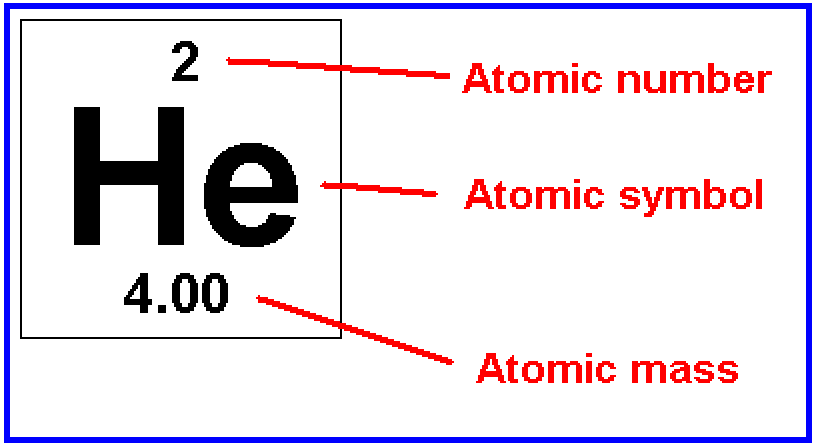
Mass is in amu (Atomic Mass Units). 1 amu = 1.66 x 10^{-24} gram

SCALE AND SIZE OF ATOMS

ATOMIC NUMBER

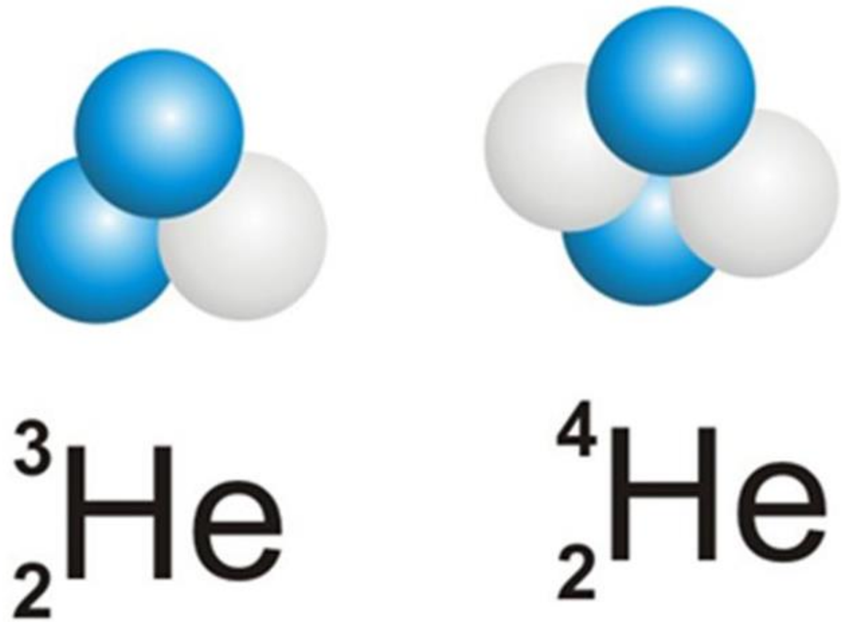
Atomic number is the **number of protons** in the nucleus of an atom. This number determines what element an atom is.

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



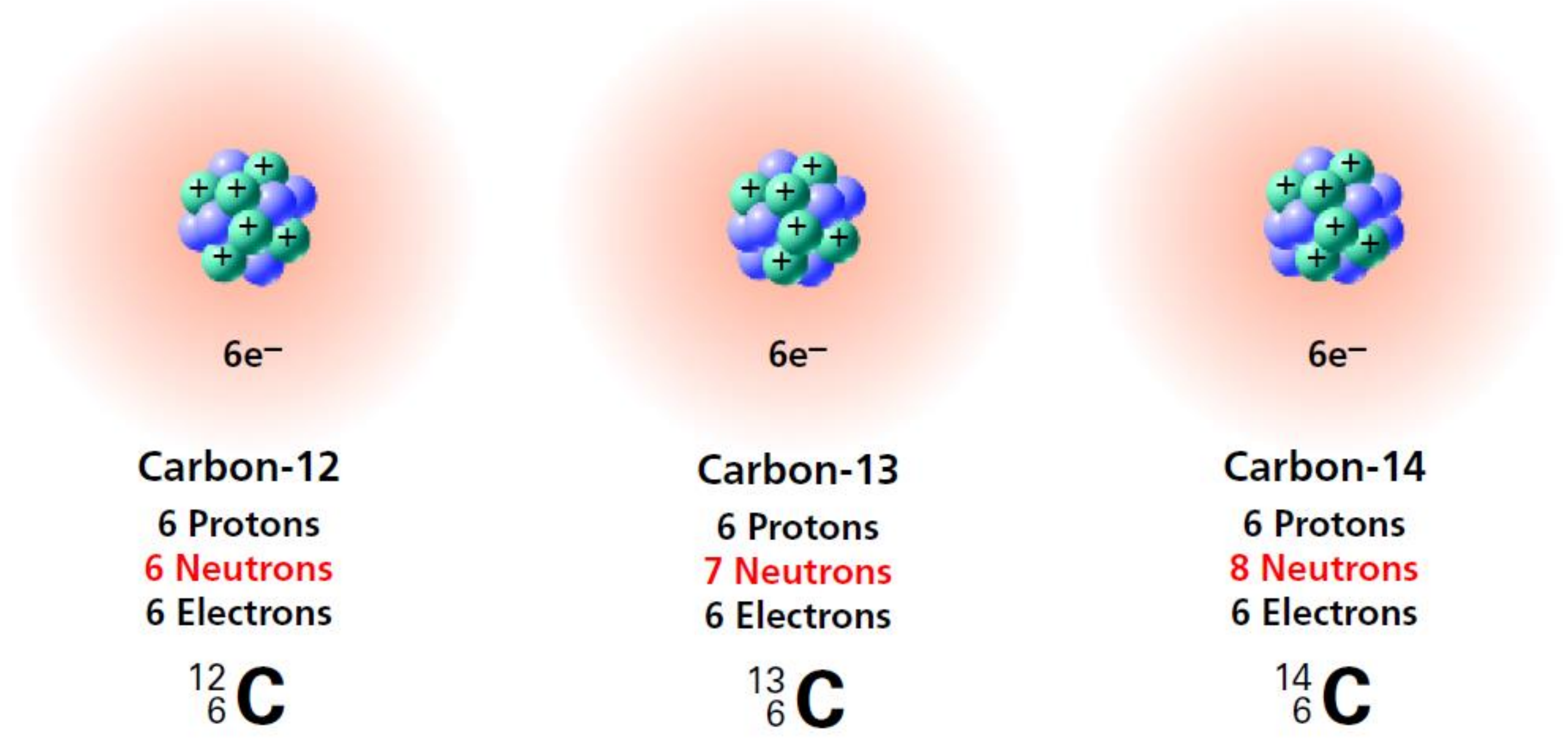
ISOTOPES

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



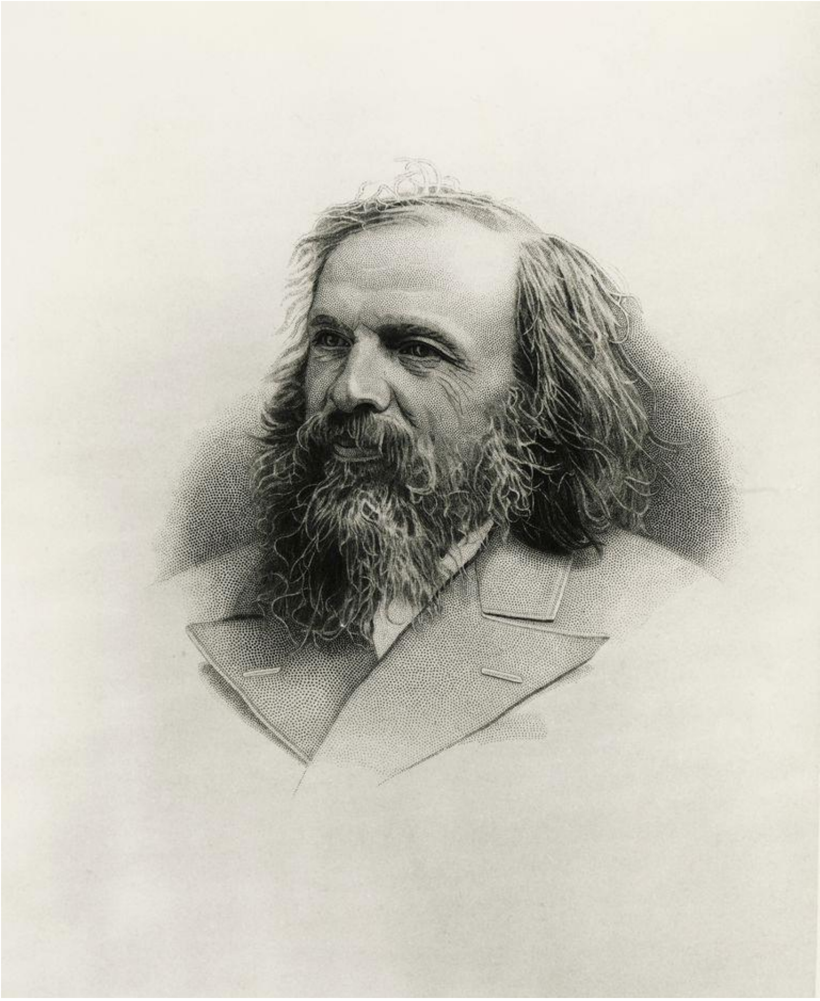
MASS NUMBER

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



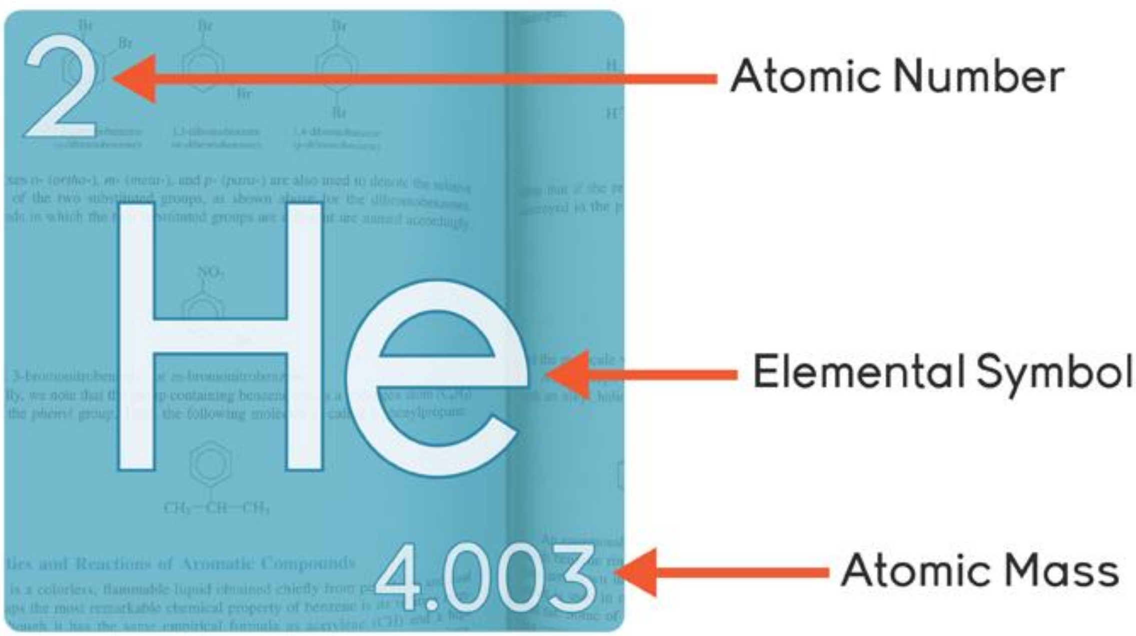
PATTERNS IN THE ELEMENTS

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



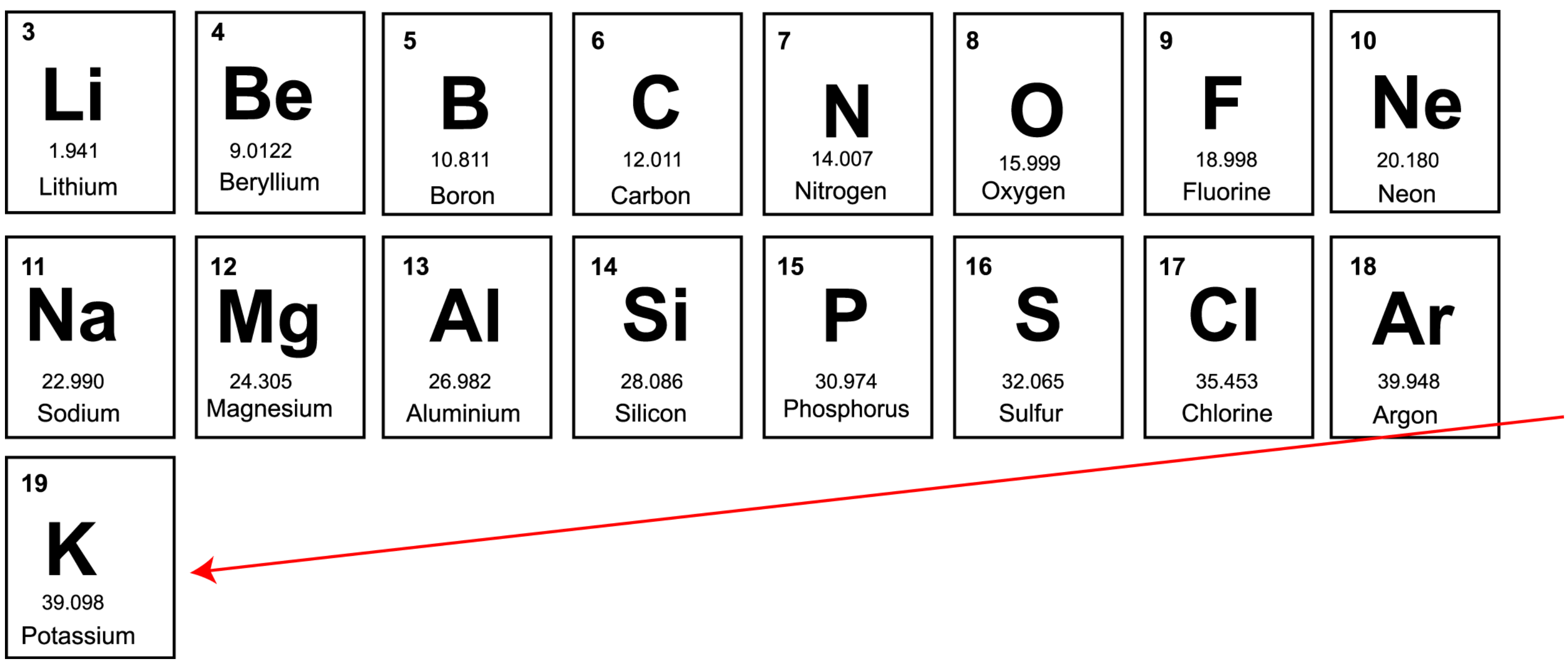
ATOMIC MASS

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

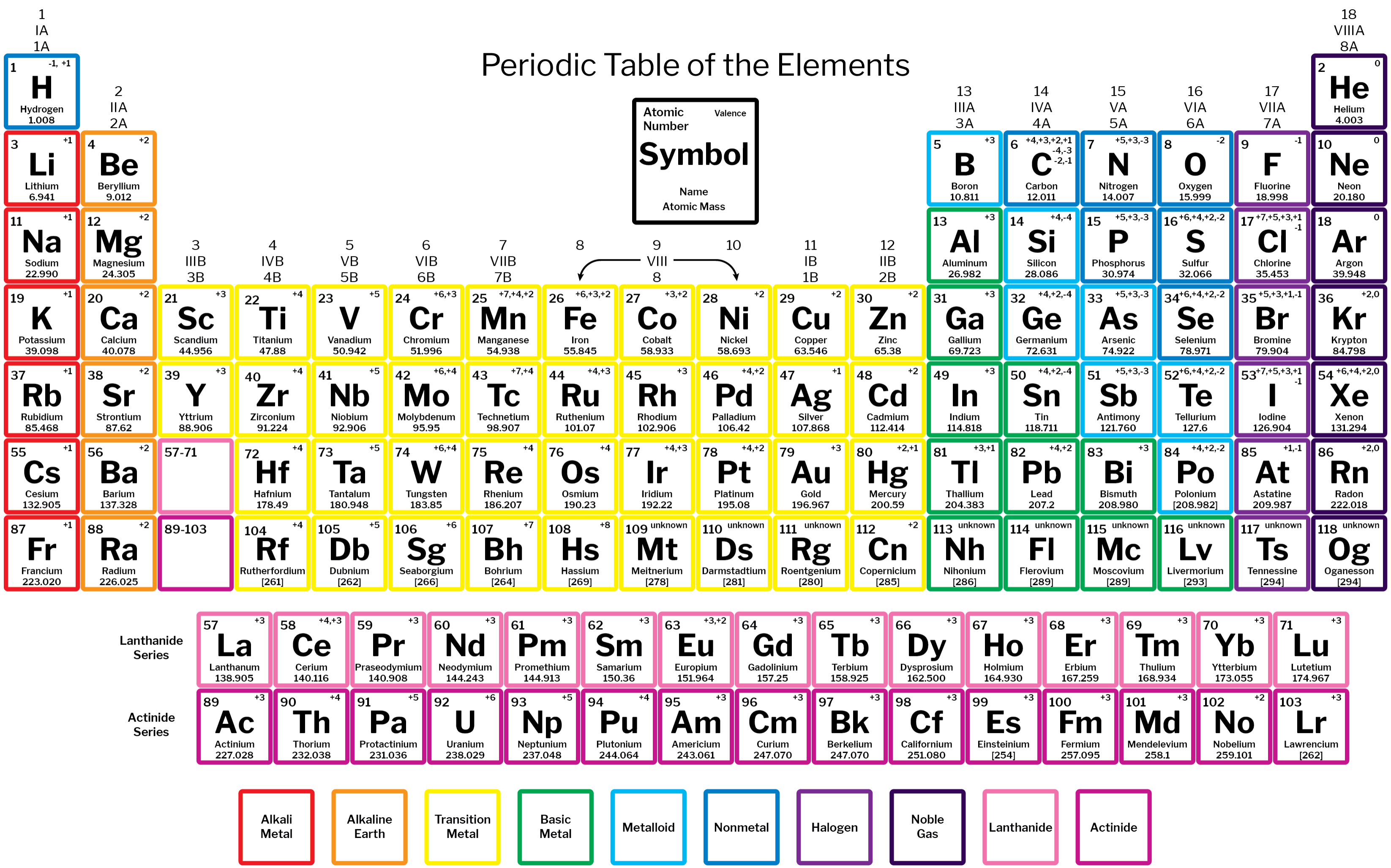


MENDELEEV'S PERIODIC TABLE

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



THE MODERN PERIODIC TABLE



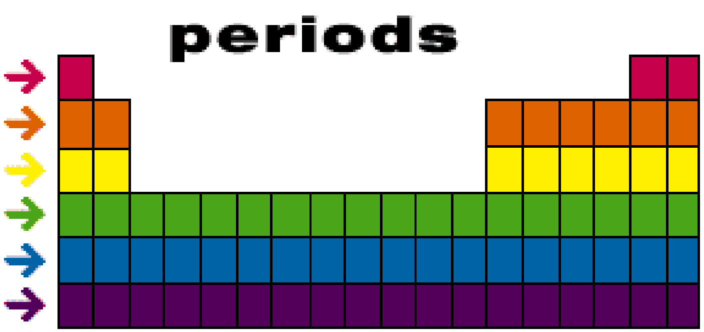
PERIODS AND GROUPS

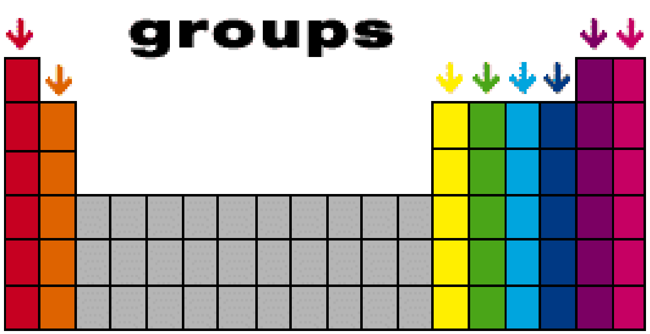
Periods are the horizontal rows.

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

Groups are the vertical columns, sometimes called families.

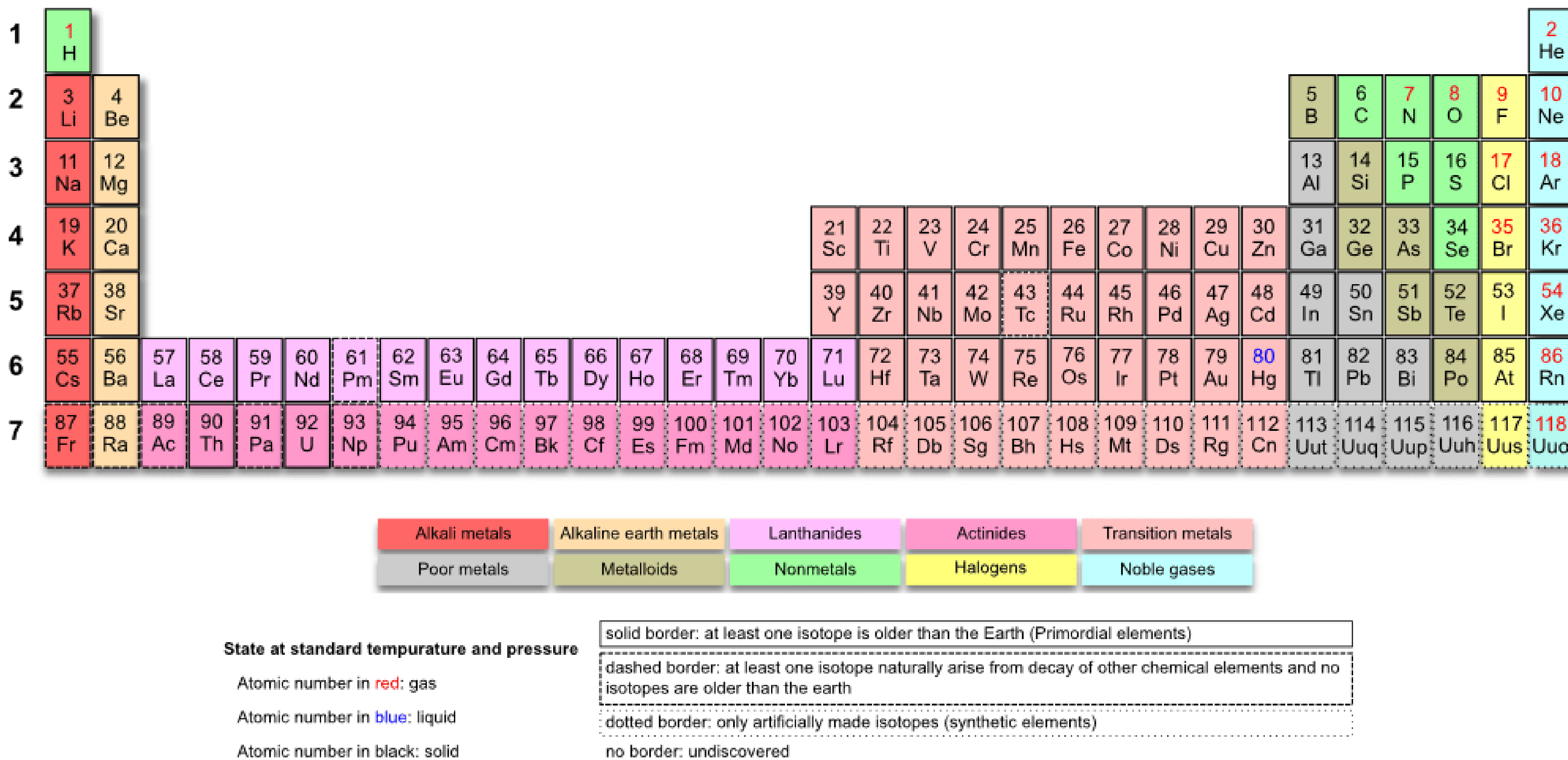
- All have similar characteristics



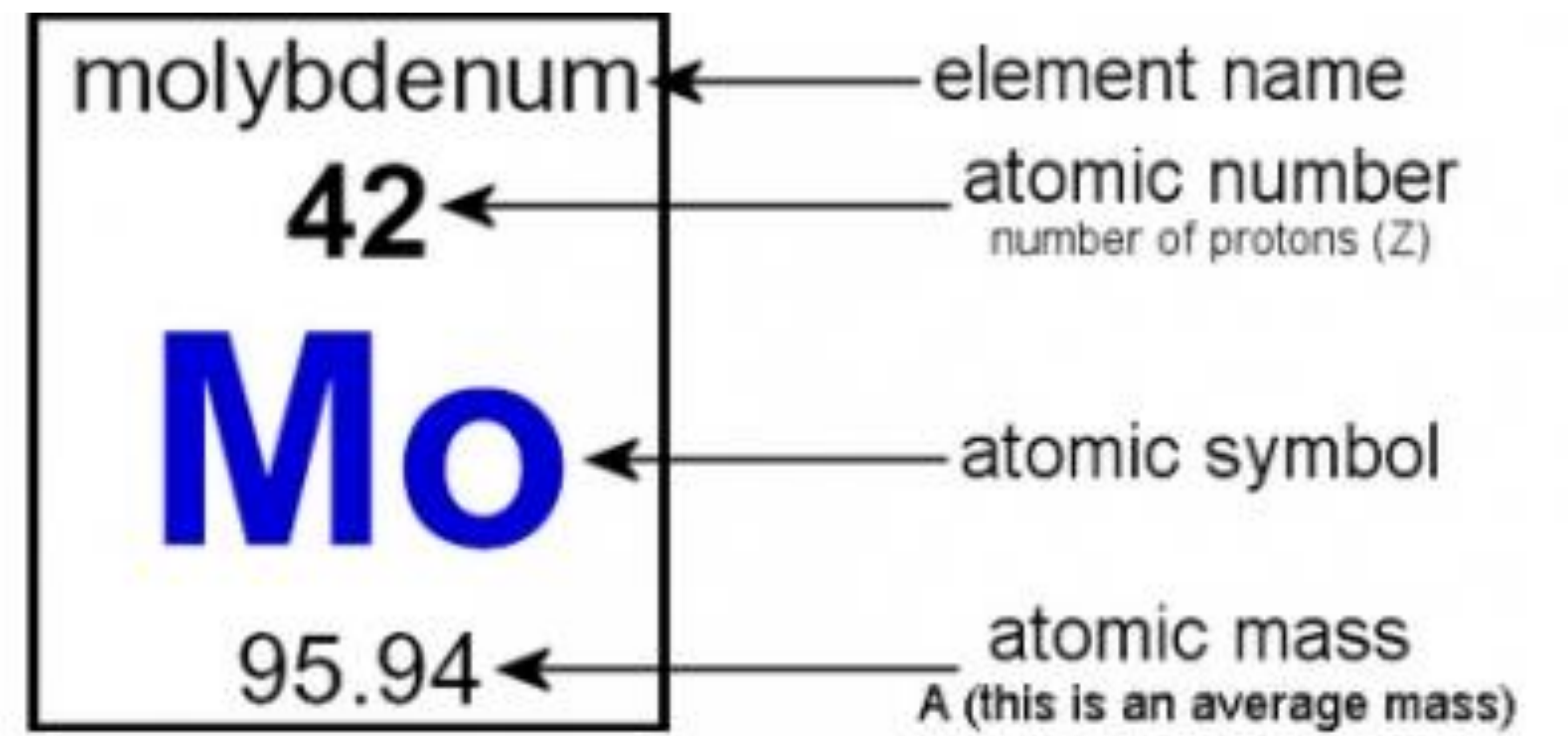


LANTHANIDES AND ACTINIDES

Periodic table shown with Lanthanides and Actinides inserted:



READING AN ELEMENT'S SQUARE

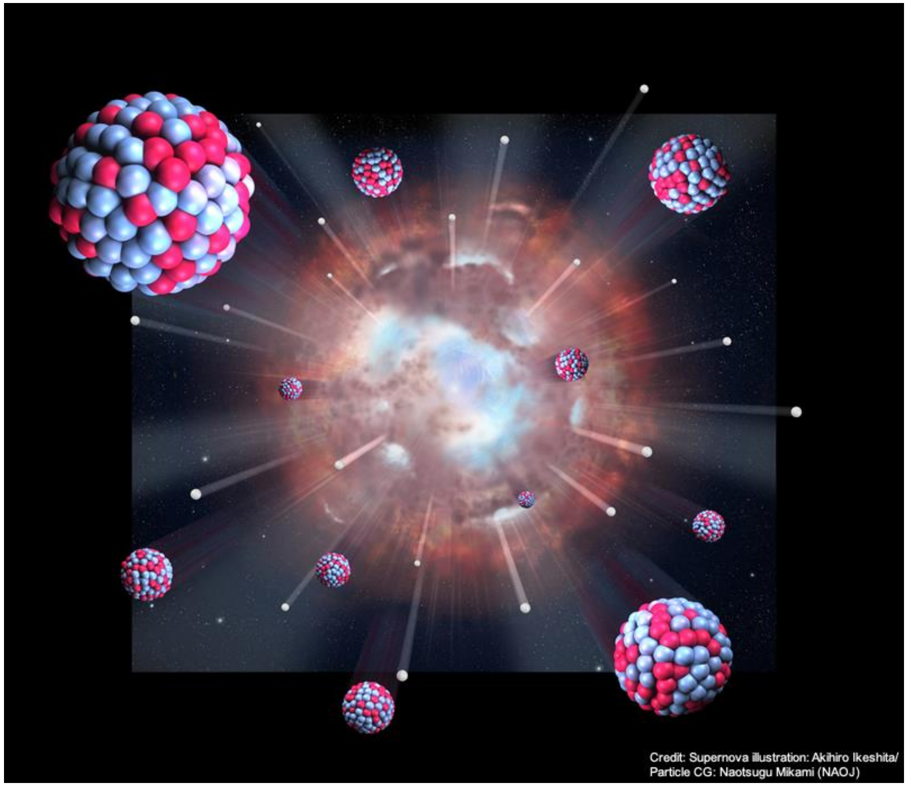


WHERE DID ALL THE ELEMENTS COME FROM?

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

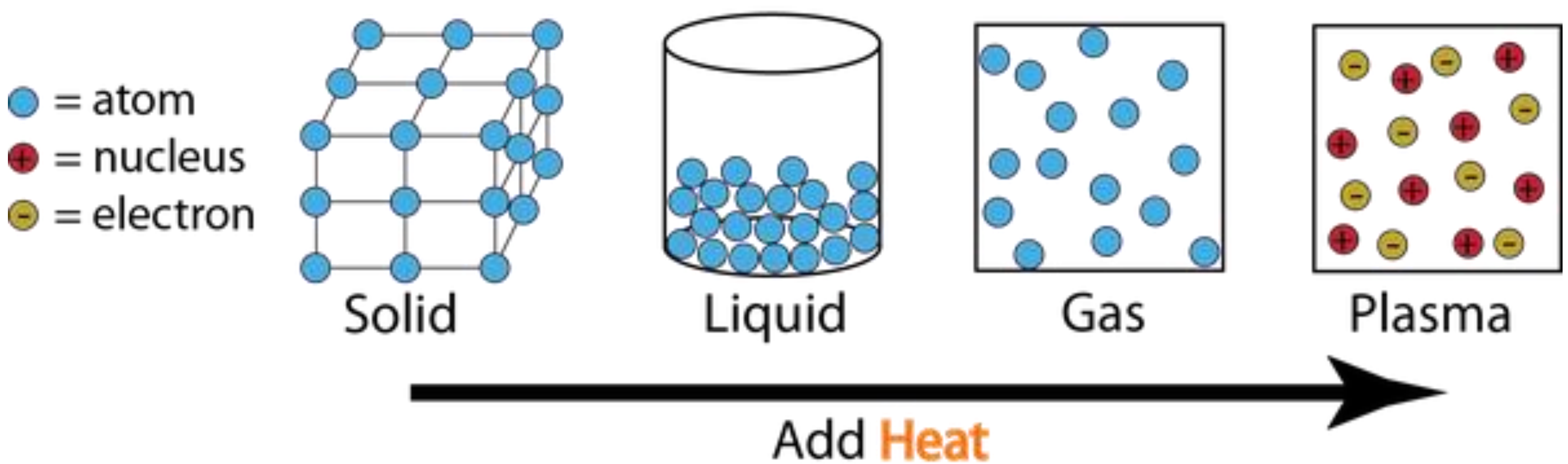
H and He were created at the very beginning of the universe.

All other elements were created in stars – either by <u>fusion</u> or in <u>supernovae</u>.



PLASMA

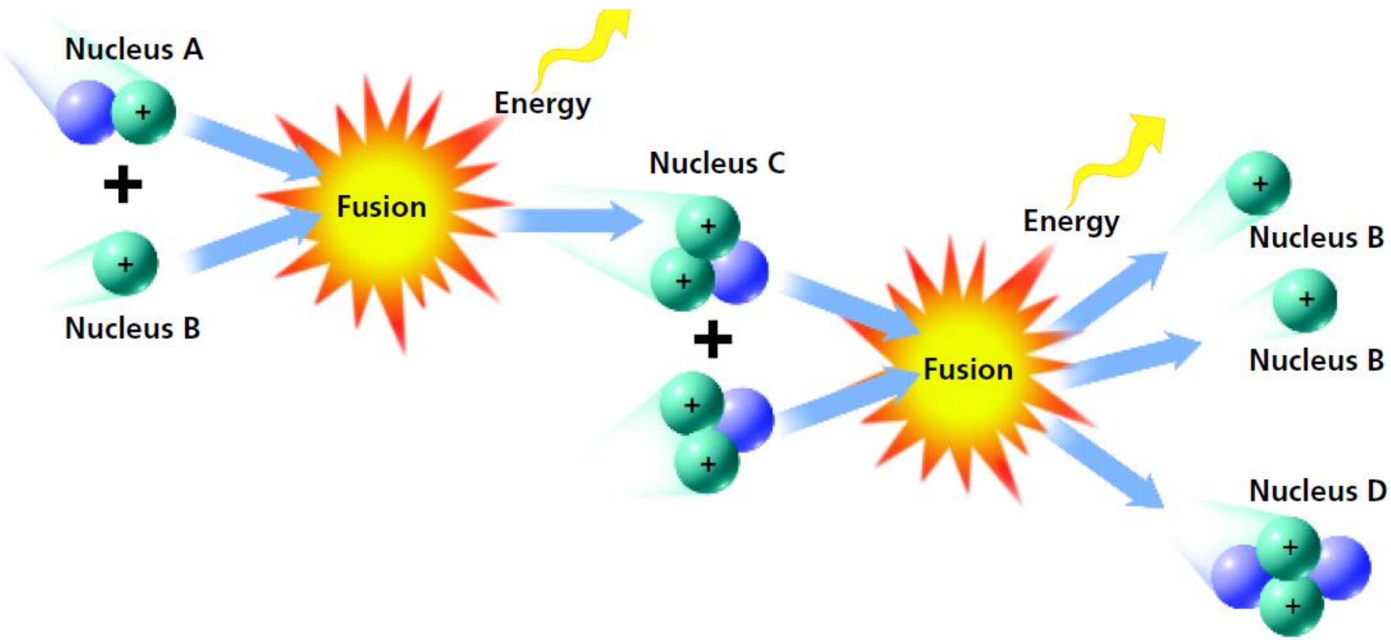
Plasma is a gas-like mixture of free electrons and nuclei of atoms that have been stripped of electrons.



NEW ELEMENTS FROM FUSION

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

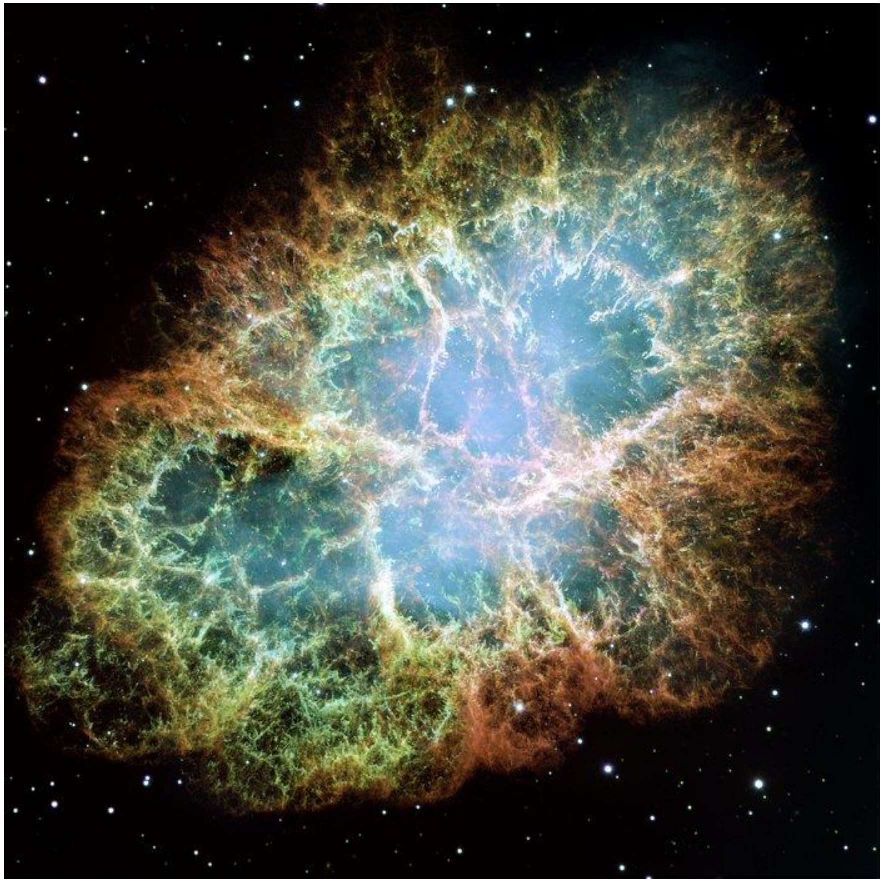
Nuclear fusion is the process in which two atomic nuclei combine, forming a larger nucleus and releasing huge amounts of energy.



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

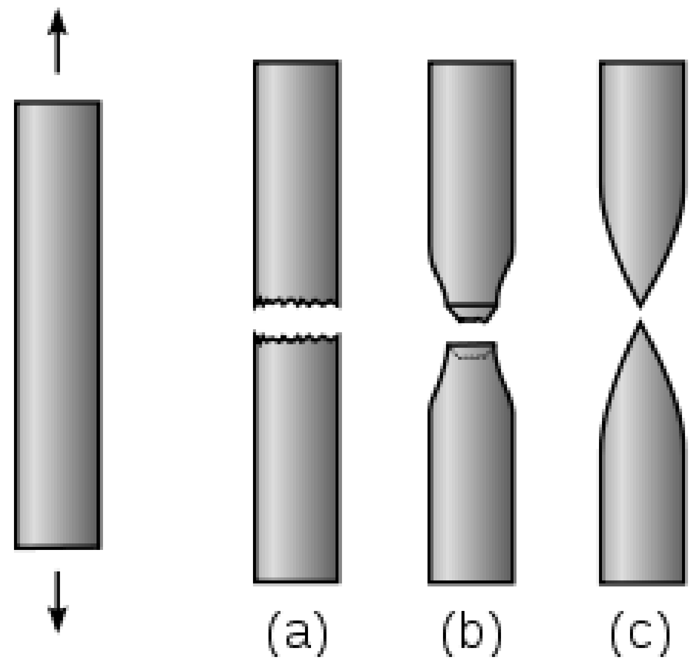
Metals appear shiny or reflective.

2. METALS ARE MALLEABLE

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

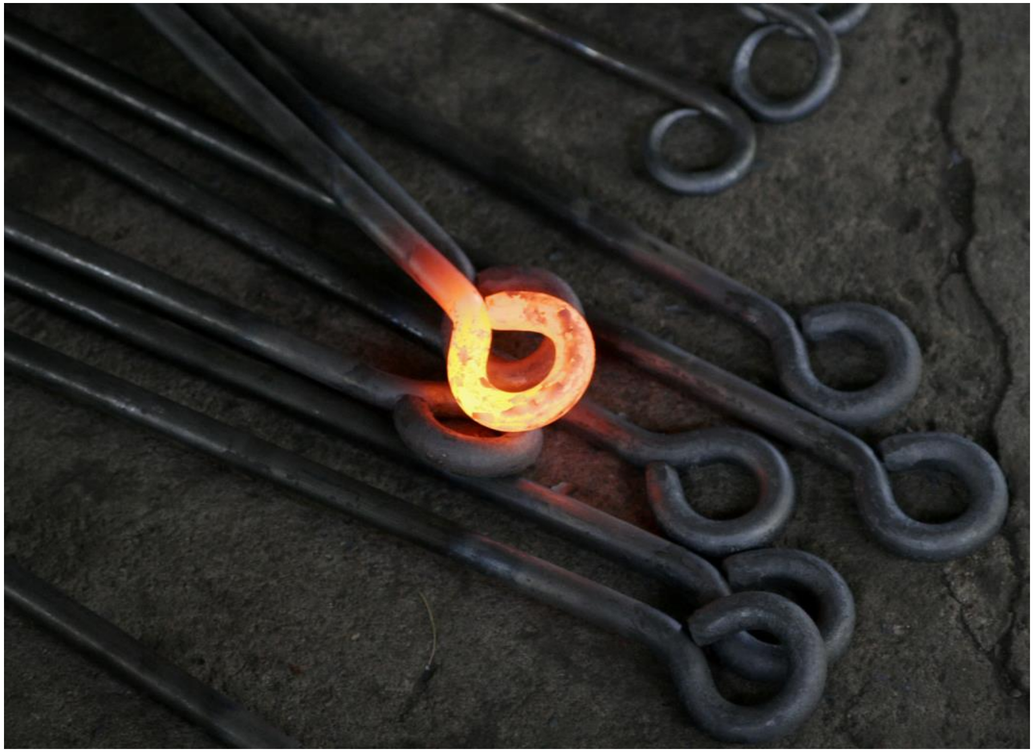
3. METALS ARE DUCTILE

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

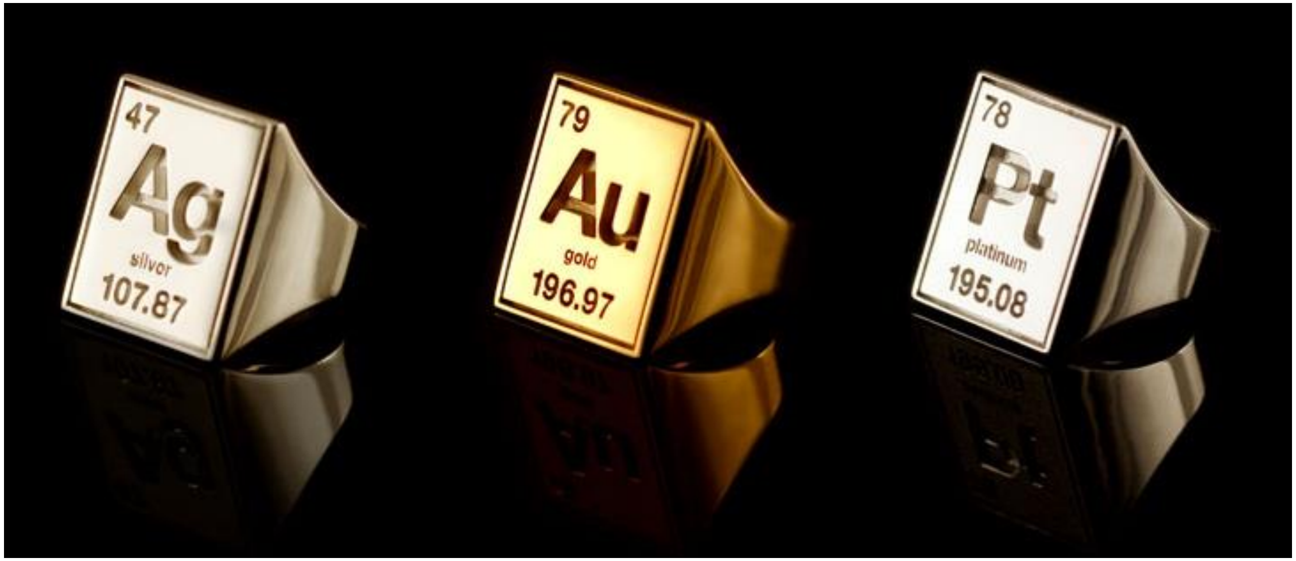
- VERY reactive.
- React by losing 1 electron.
- Never found as uncombined elements in nature.

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

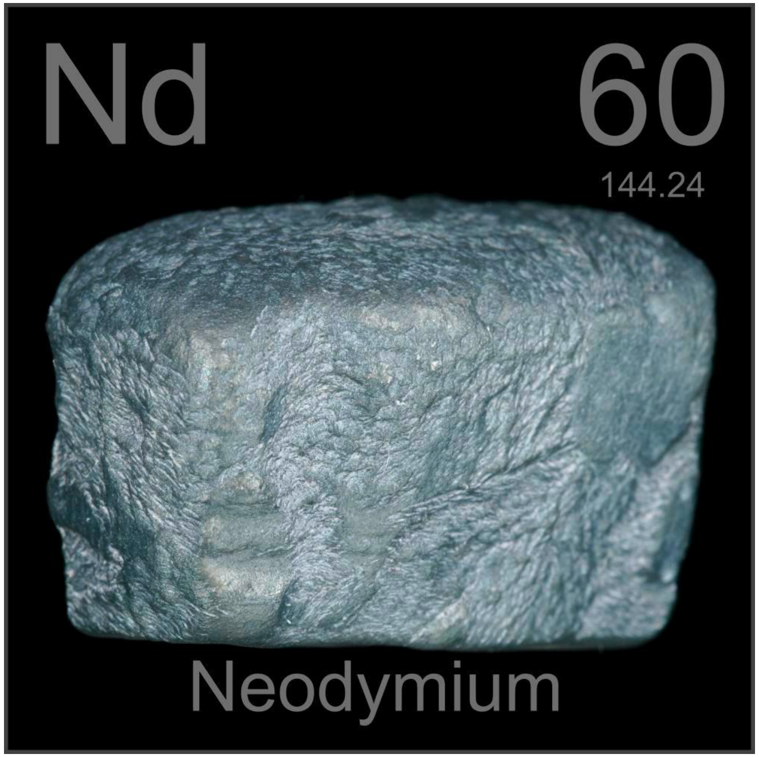


METALS IN MIXED GROUPS

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

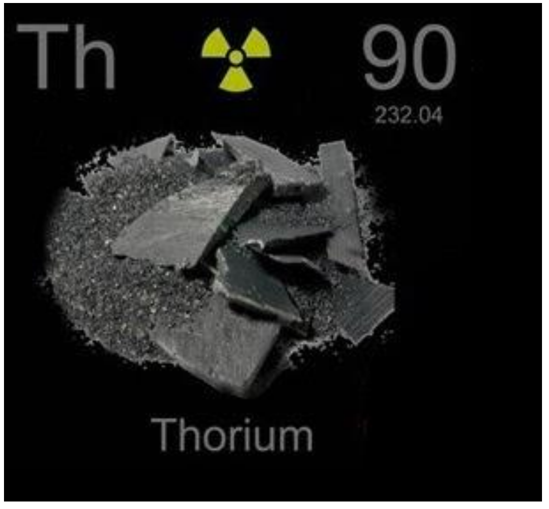
LANTHANIDES

- 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.

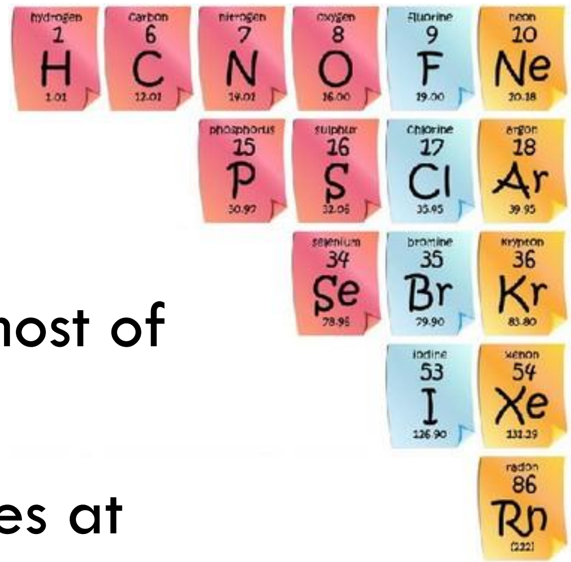


SYNTHETIC ELEMENTS

How do scientists make elements that area heavier than uranium?

By forcing nuclear particles to smash into each other!

NON-METALS



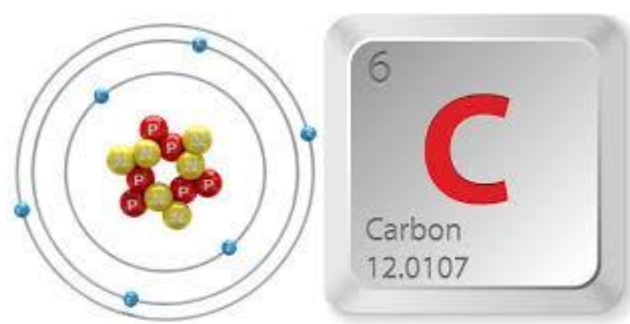
A non-metal is an element that lacks most of the properties of a metal.

- 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

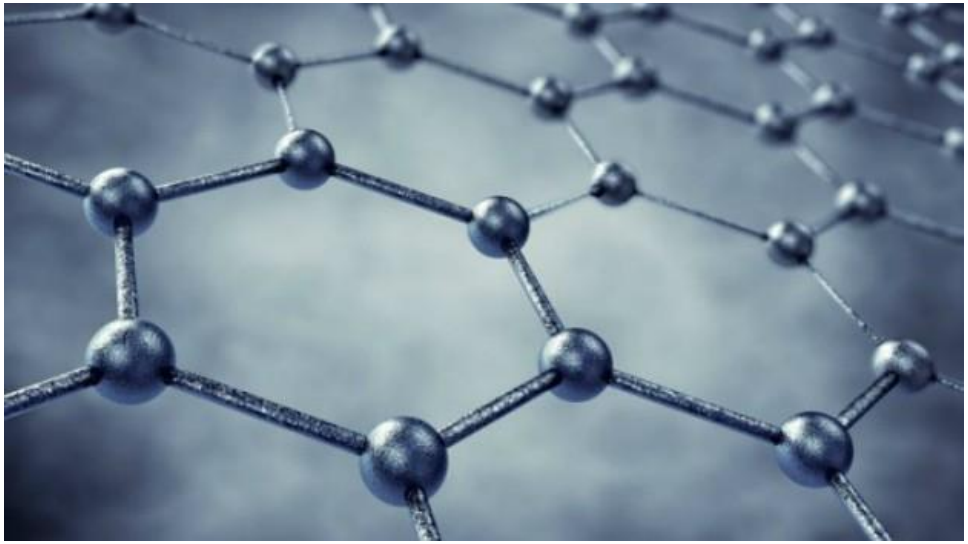
Group 14

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

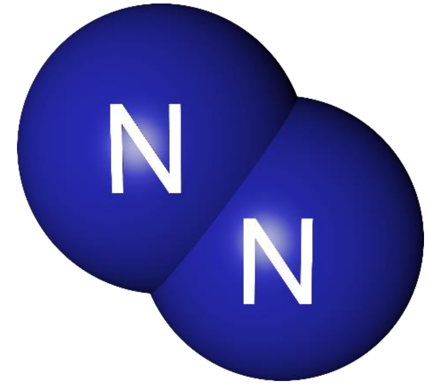


THE CARBON FAMILY

- 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

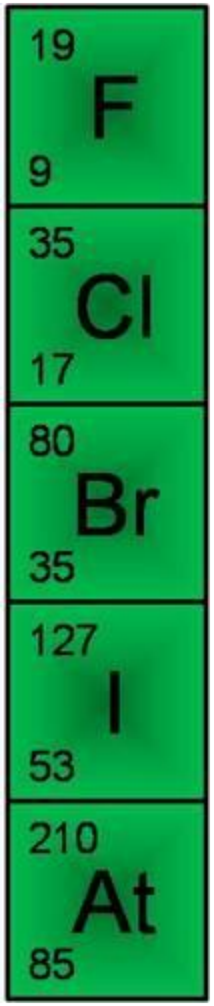
Group 16

- 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:

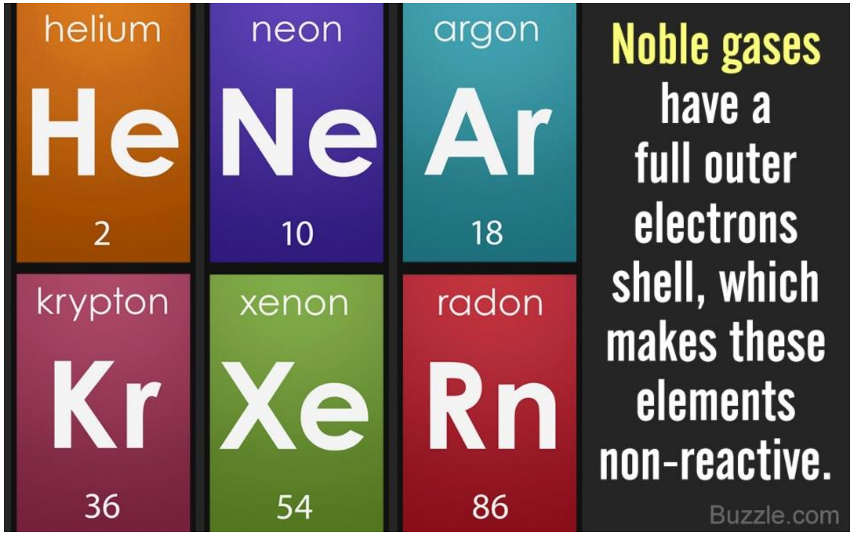
- Florine, Chlorine, Bromine, Iodine, Astatine
- "Halogen" means salt-forming.
- Gain or share 1 electron in reacting.
- All are VERY reactive and so uncombined are very dangerous to humans.



THE NOBLE GASES

Group 18:

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

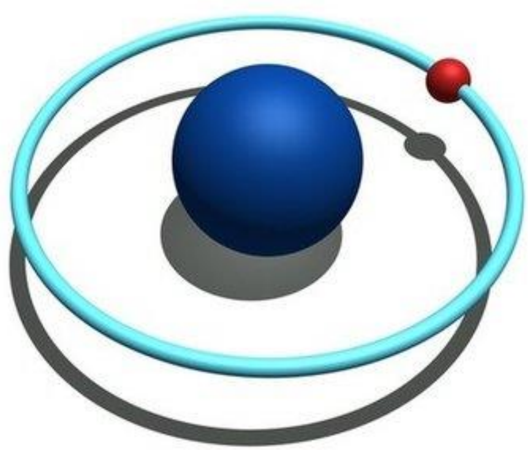


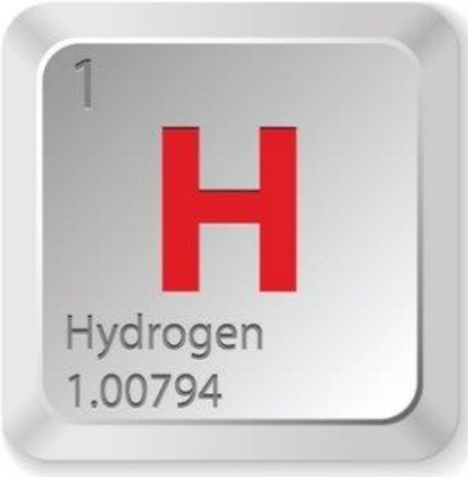
HYDROGEN

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.

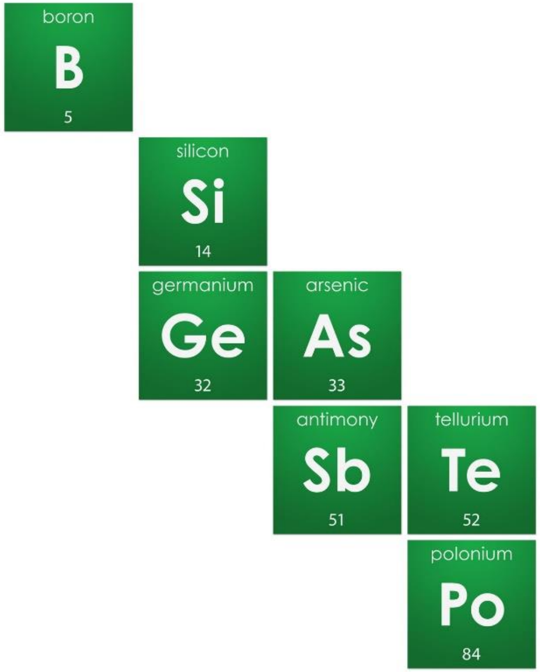




METALLOIDS

Metalloids have characteristics of both metals and non-metals.

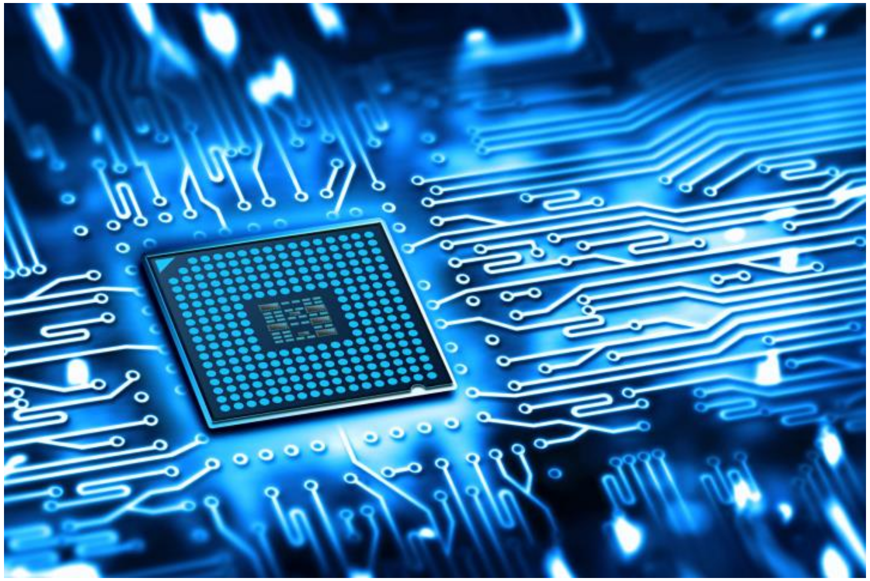
- They are all solids at room temp
- Brittle, hard
- Somewhat reactive
- Most useful property is their varying ability to conduct electricity.
- Somewhat reactive
- Most common metalloid is Silicon



SEMICONDUCTORS

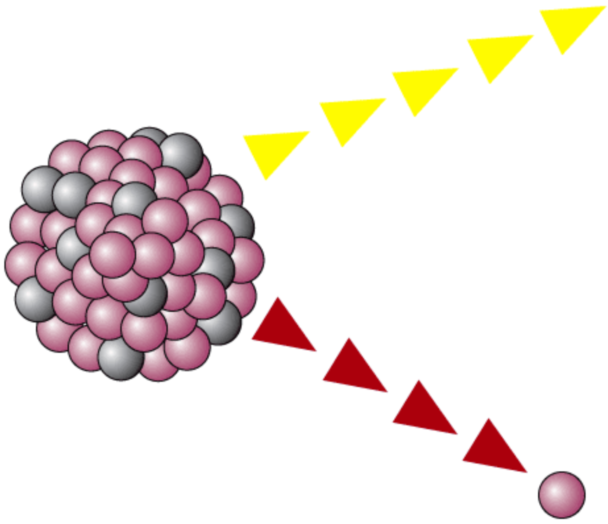
Semiconductors conduct electricity under some conditions but not other conditions. They are used for computer chips, transistors, lasers.

Silicon is the most well-known semiconductor.



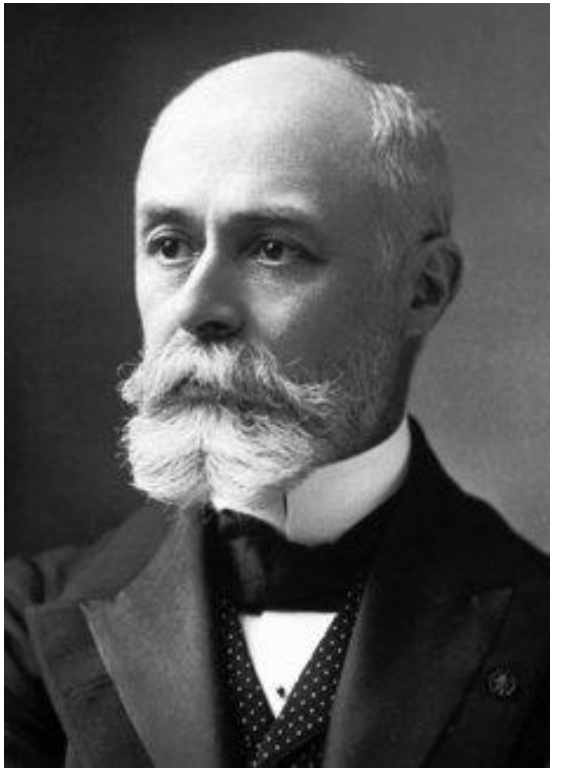
RADIOACTIVITY

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.



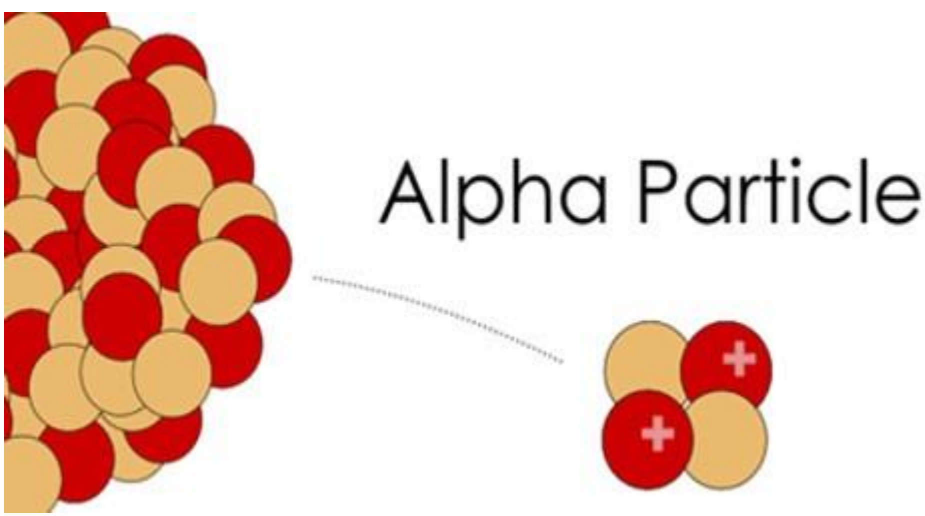
TYPES OF RADIOACTIVE DECAY

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 charge. It is the same as a helium nucleus.



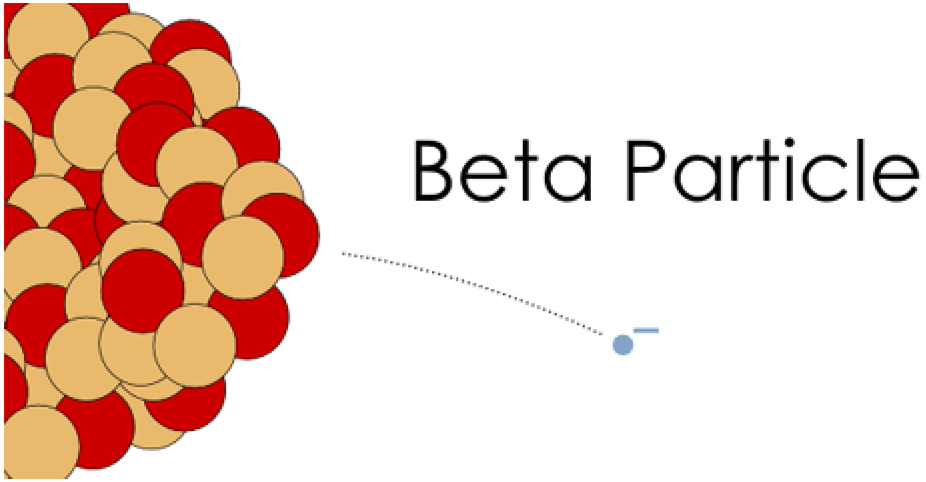
Result:

Atomic Number -2

Mass Number -4

BETA PARTICLE

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



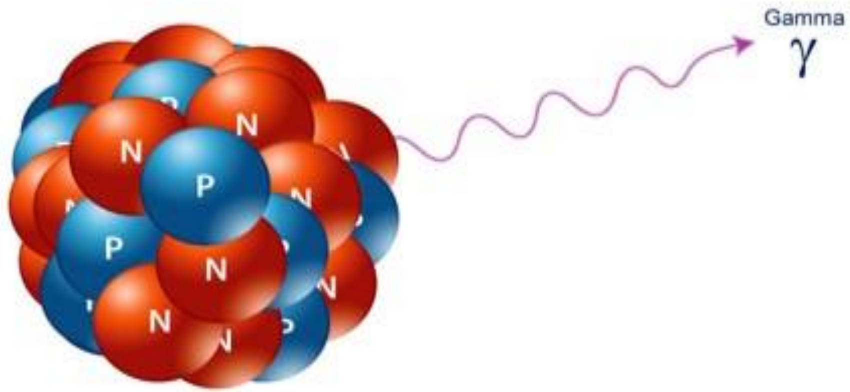
<u>Result</u>:

Atomic Number +1

Mass Number ±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.

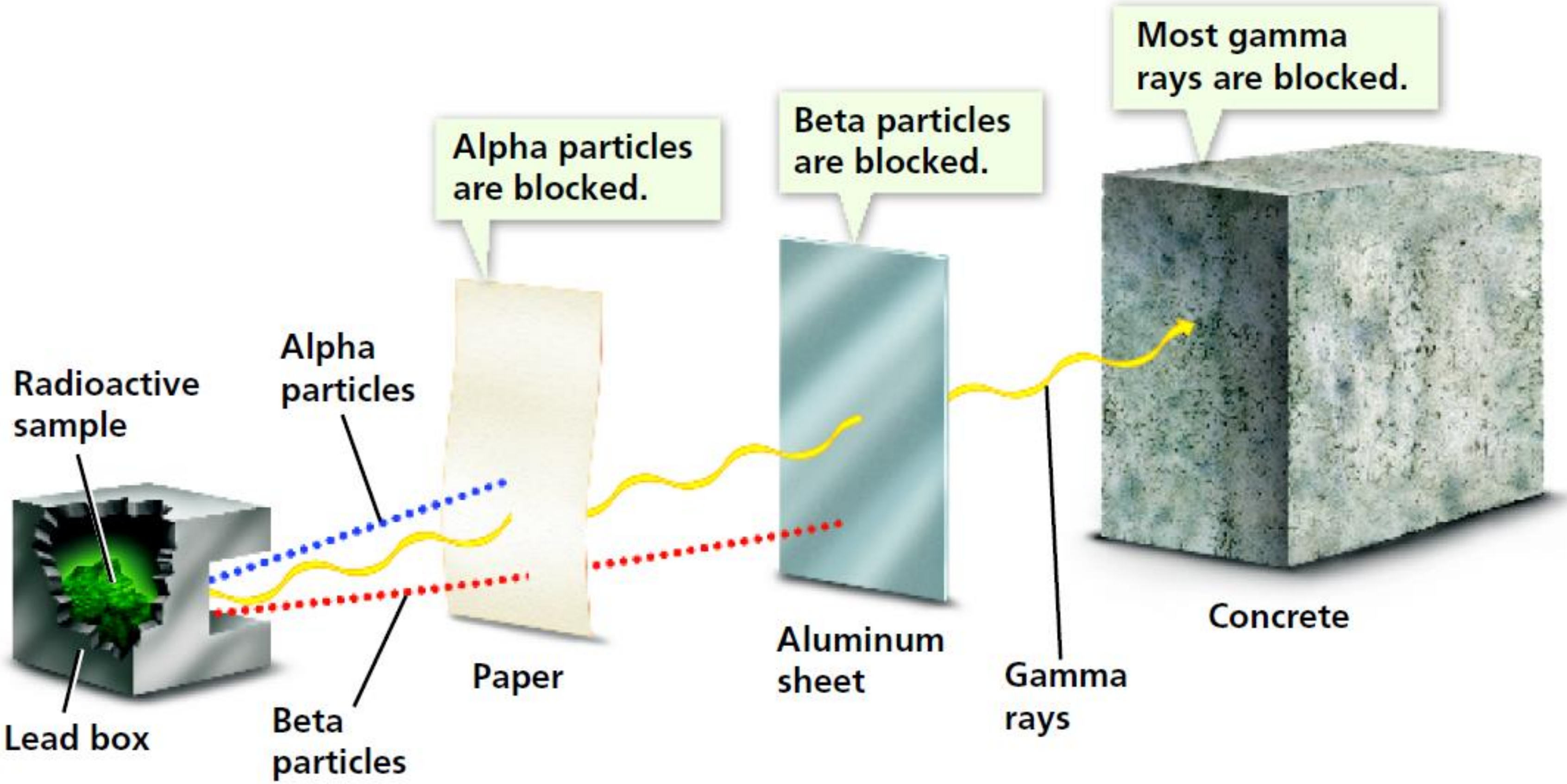


Result:

Atomic Number +0

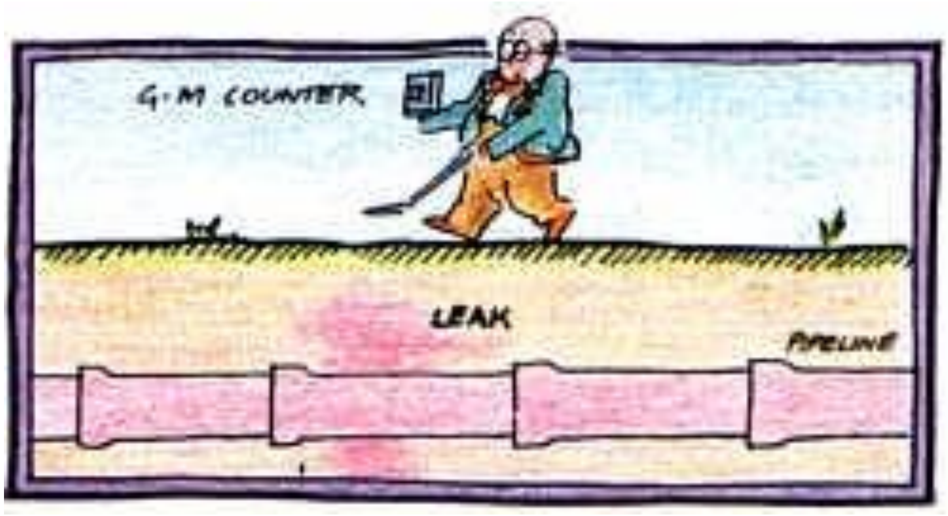
Mass Number ±0

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.