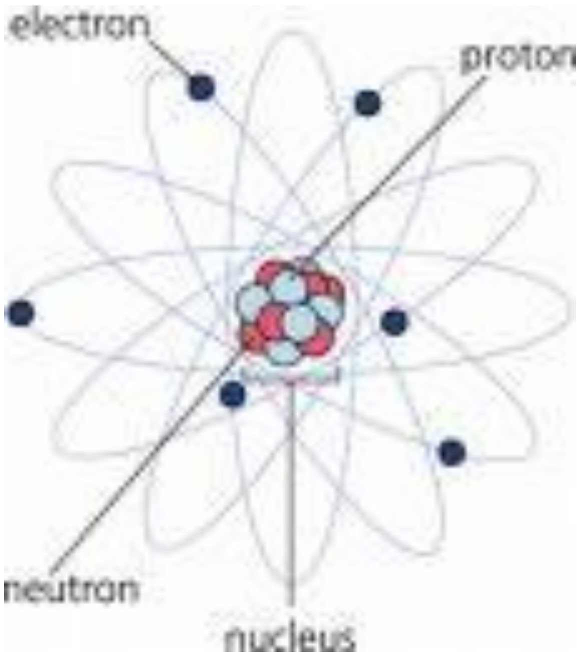
UNIT 3 –THE ATOM AND ATOMIC STRUCTURE

Bravo – 15,000 kilotons

OBJECTIVES

- To determine the structure of any element on the periodic table
- Understand Dalton's Atomic Theory & Modern Atomic Theory
- Define and Identify isotopes
- Understand basic aspects of nuclear chemistry
- Understand and use the Mole Concept

WHAT IS AN ATOM?



Smallest unit of an element that retains all the properties of the element

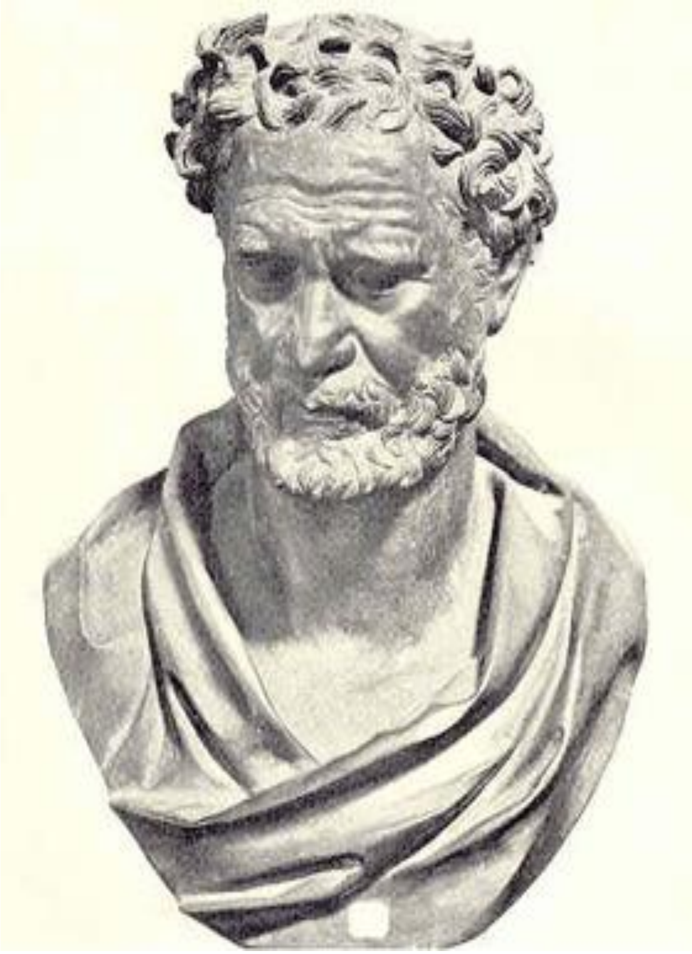
Can combine with other atoms to form compound

THE ROOTS OF ATOMIC THEORY

Democritus (460-370 BC) was a Greek philosopher who was the first to propose that matter was made up of atoms.

He thought that matter was *not divisible*.

Atomos means not divisible in Greek.



DEMOCRITUS'S ATOMIC THEORY

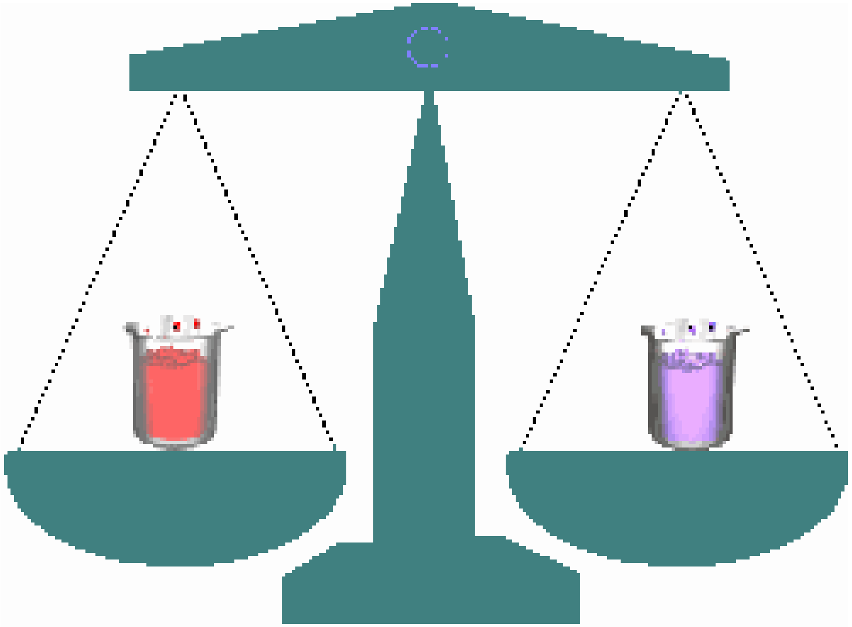
① Matter is composed of atoms, which move through empty space.

② Atoms are solid, homogeneous, indestructible, and indivisible.

③ Different kinds of atoms have different sizes and shapes.

④ Size, shape, and movement of atoms determine the properties of matter.

LAW OF CONSERVATION OF MATTER



Mass is not created (gained) nor destroyed (lost) during ordinary physical and chemical reactions.

Proven by Antoine Lavoisier 200 years ago

LAW OF DEFINITE PROPORTIONS

Chemical compound contains the same elements in exactly the same proportions by mass regardless of sample size or source of substance

1700's Joseph Proust

We all know the chemical formula for water is H_2O . It is essential for the body. The water from a Poland Spring bottle and from a your tap at home is always 2 hydrogen atoms to 1 oxygen atom

LAW OF MULTIPLE PROPORTIONS

Two elements may combine in different ratios to form different compounds.

Change the ratio …Change the compound

John Dalton

Water is composed of hydrogen and oxygen in a 2 to 1 ratio needed for body

Hydrogen Peroxide is H_2O_2 in a ratio of 2 to 2. Used as an antiseptic poisonous to body

DALTON'S ATOMIC THEORY (1803)

① Matter is composed of extremely small particles called atoms.

② Atoms are indivisible and indestructible.

③ Atoms of a given element are identical in size, mass, and chemical properties.

④ Atoms of a specific element are different from those of another element.

⑤ Atoms combine in simple whole number ratios to form compounds.

⑥ In a chemical reaction, atoms are separated, combined, or rearranged.

MODERN ATOMIC THEORY

- All matter is composed of atoms

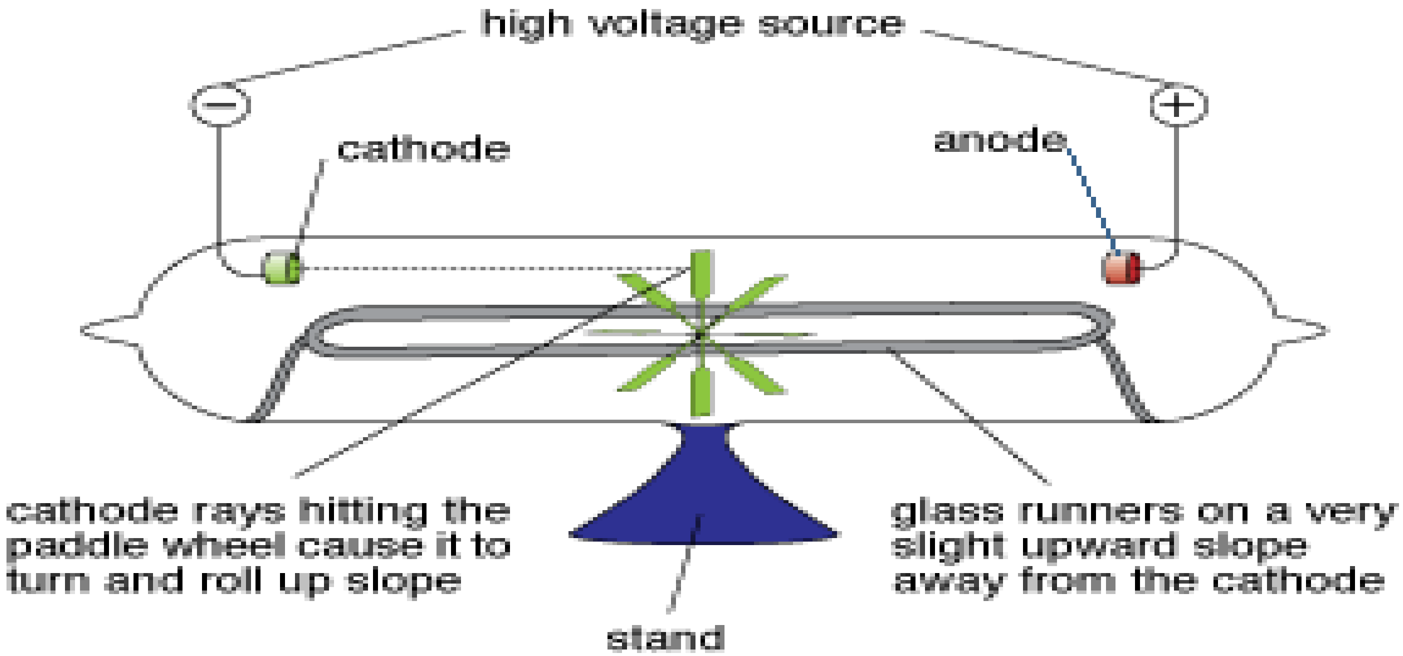
- Atoms cannot be subdivided, created, or destroyed in ordinary chemical reactions. However, these changes CAN occur in nuclear reactions!

- Atoms of an element have a characteristic average mass which is unique to that element.

- Atoms of any one element differ in properties from atoms of another element

DISCOVERY OF THE ELECTRON

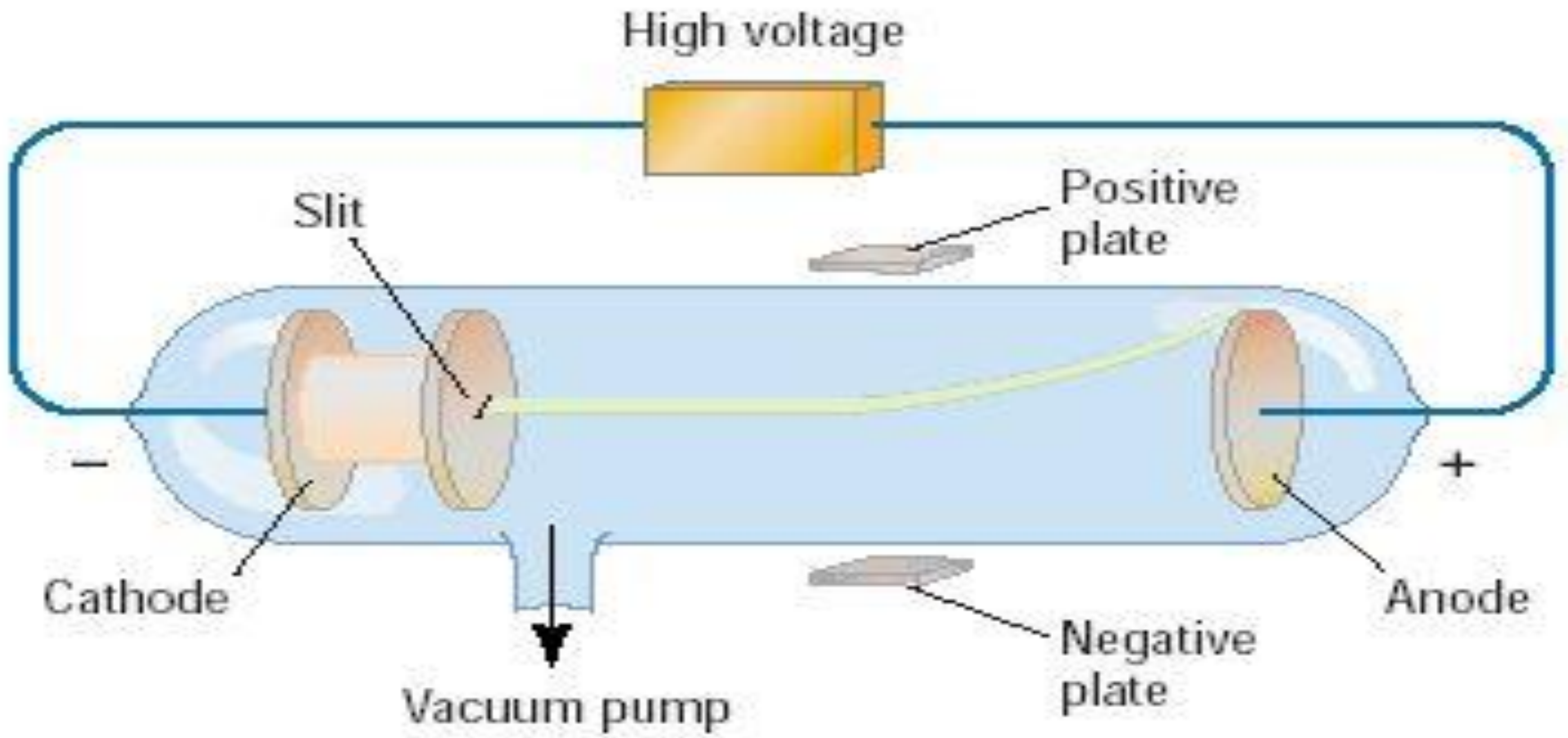
In 1897, J.J. Thomson used a cathode ray tube to deduce the presence of a negatively charged particle.



Cathode ray tubes pass electricity through a gas that is contained at a very low pressure.

Experiments

THE PARTICLES WERE DETERMINED
TO HAVE A NEGATIVE CHARGE DUE TO THEIR ATTRACTION TO A POSITIVELY CHARGED PLATE



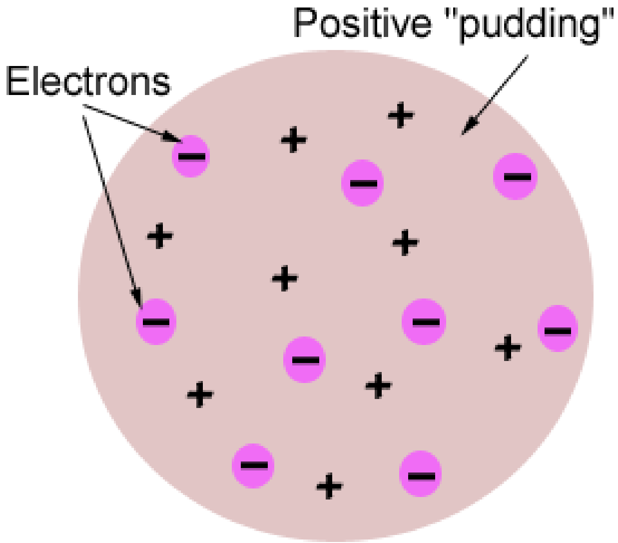
CONCLUSIONS FROM THE STUDY OF THE ELECTRON

- Cathode rays have identical properties regardless of the element used to produce them. All elements must contain identically charged electrons.

- Atoms are neutral, so there must be positive particles in the atom to balance the negative charge of the electrons

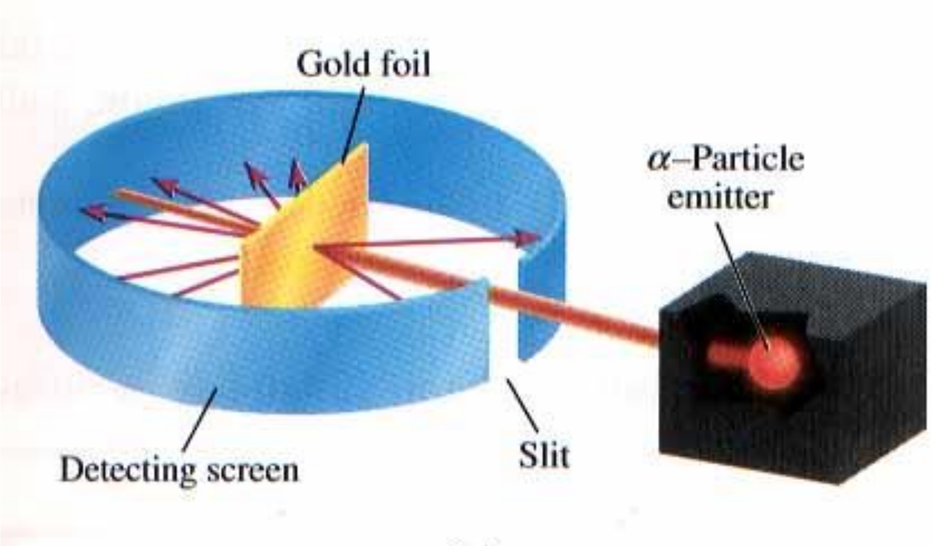
- Electrons have so little mass that atoms must contain other particles that account for most of the mass

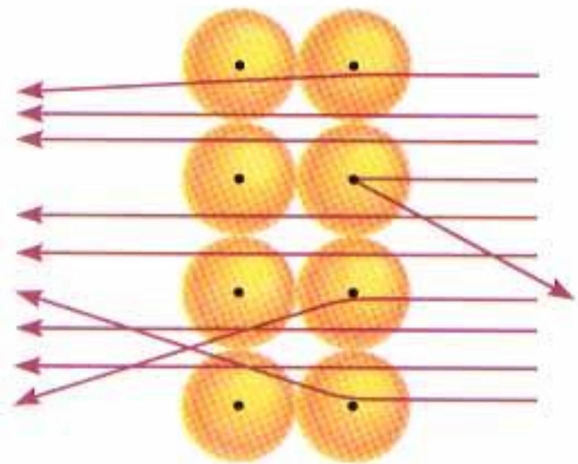
THOMSON'S ATOMIC MODEL



Thomson believed that the electrons were like plums embedded in a positively charged "pudding," thus it was called the "plum pudding" model.

RUTHERFORD'S GOLD FOIL EXPERIMENT

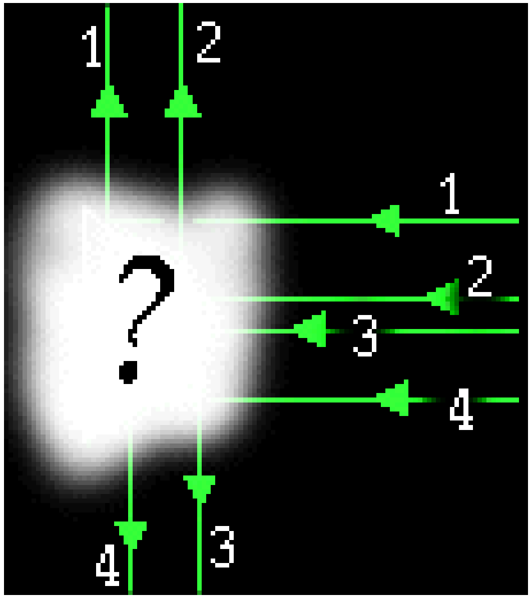


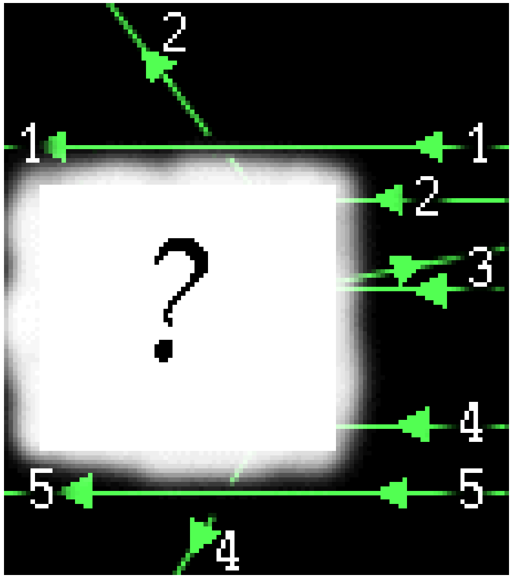


- Alpha particles are helium nuclei which are large, positively charged particles
- Particles were fired at a thin sheet of gold foil
- Particle hits on the detecting screen (film) are recorded

TRY IT YOURSELF!

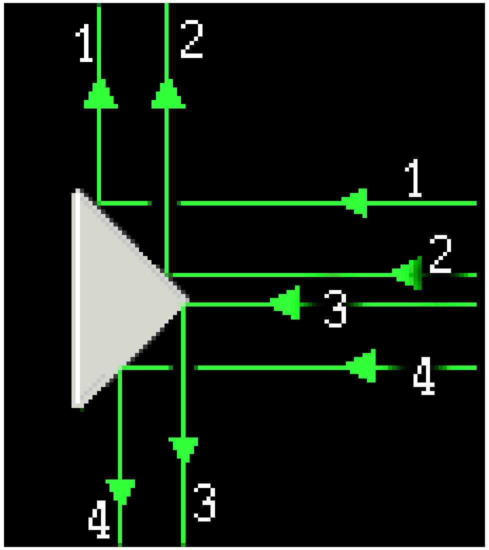
In the following pictures, there is a target hidden by a cloud. To figure out the shape of the target, we shot some beams into the cloud and recorded where the beams came out. Can you figure out the shape of the target?



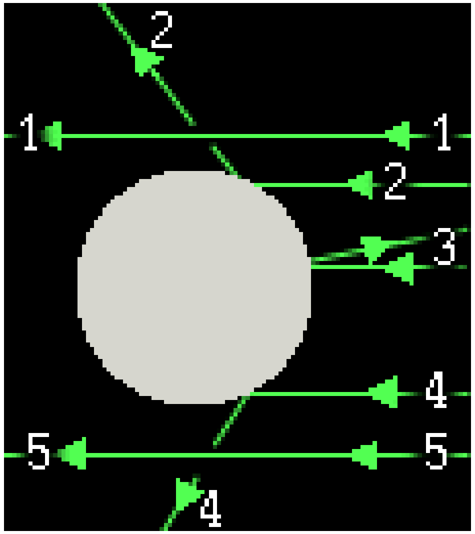


THE ANSWERS

Target #1



Target #2



RUTHERFORD'S FINDINGS

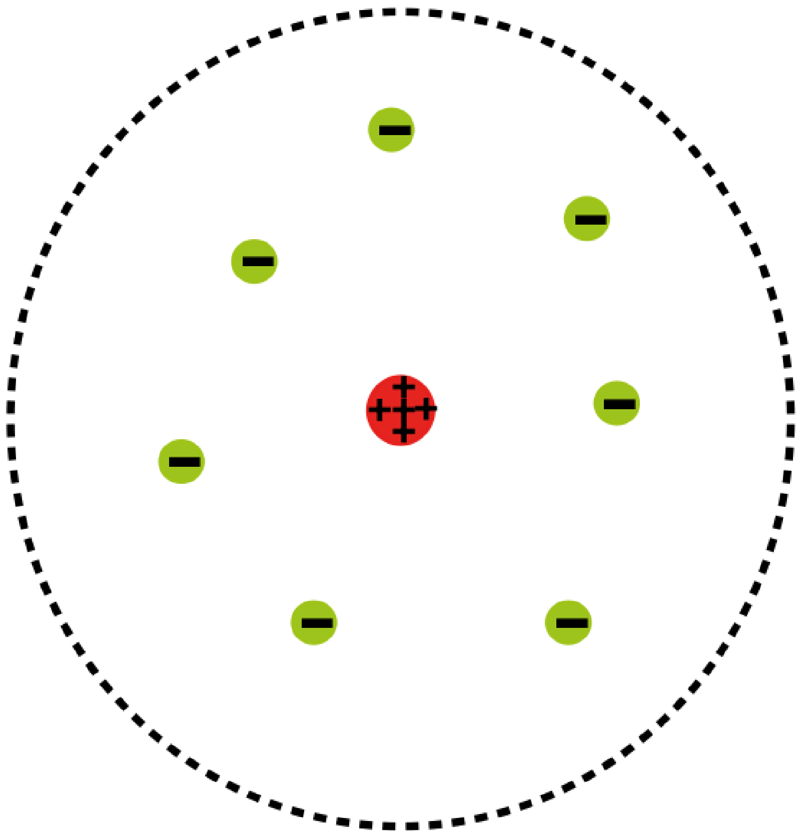
- Most of the particles passed right through
- A few particles were deflected
- VERY FEW were greatly deflected

"Like howitzer shells bouncing off of tissue paper!"

Conclusions:

- Rutherford disproved the Plum Pudding Model.
- The nucleus is small
- The nucleus is dense
- The nucleus is positively charged
- He guessed electrons circled this dense region.

RUTHERFORD'S ATOMIC MODEL

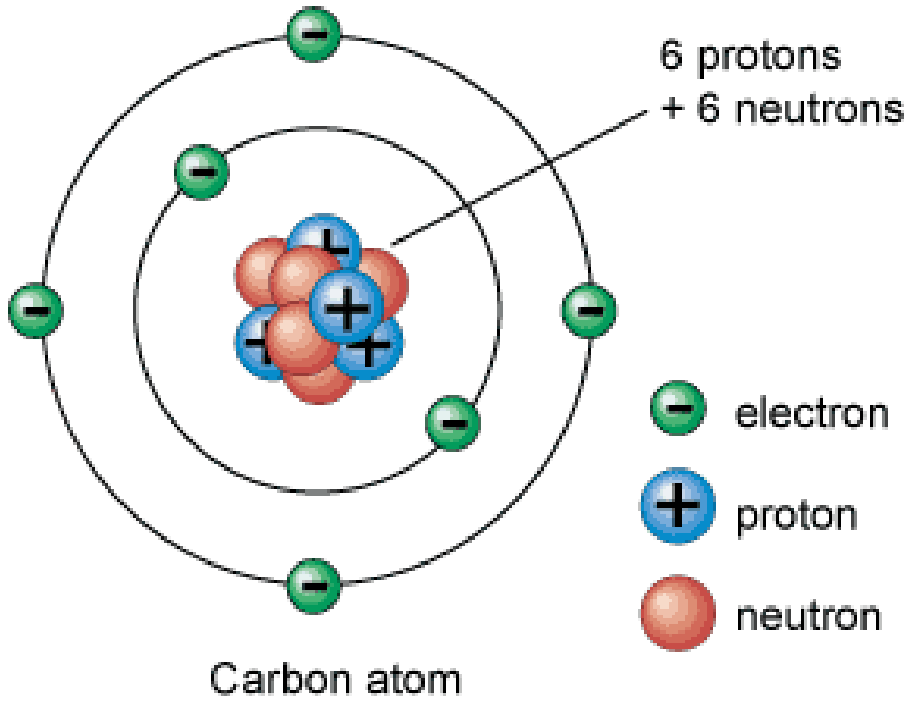


DISCOVERY OF PROTONS AND NEUTRONS

- By 1920 Ernest Rutherford finally determined that the nucleus contained positively charged particles called protons.
- James Chadwick, in 1932, determined that the nucleus contains a neutral particle as well and he called it the neutron. He was Rutherford's lab partner and based his discovery off of the Gold Foil Experiment.

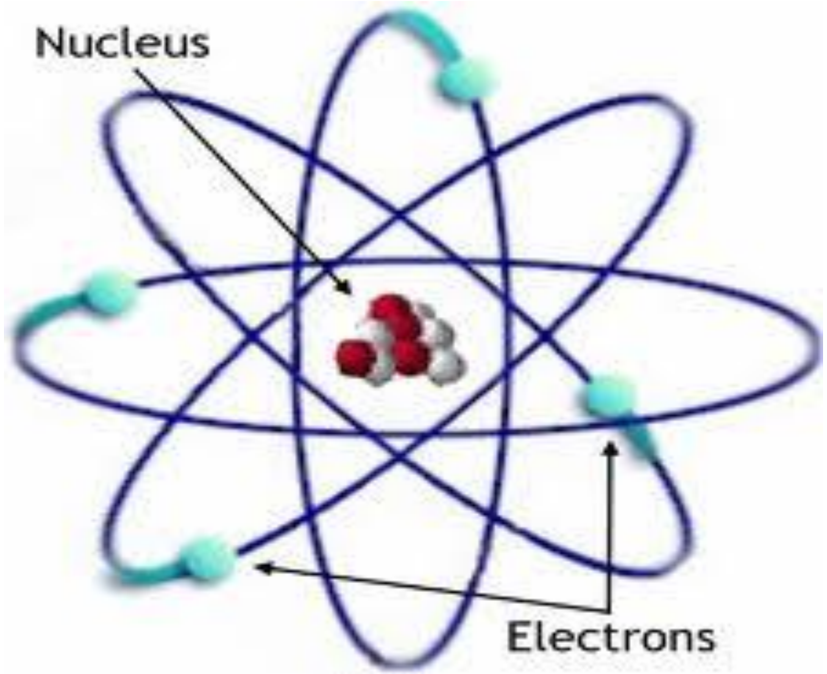
BOHR MODEL OF THE ATOM

In 1913, Neils Bohr published a theory that proposed that electrons traveled about the nucleus of the atom on elliptical paths called orbits. This was similar to the solar system, with the electrons held in place by electrostatic attraction instead of gravity.



Atoms have two main parts.

- **Nucleus** – dense region in the center of an atom that contains protons and neutrons. The nucleus is the *heaviest* part of the atom. Accounts for most of the Mass of an Atom
- **Electron Cloud** – surrounds the nucleus of the atom and it contains electrons. The electron cloud is largest part of the atom, mostly empty space. Accounts for most of the Volume of an Atom.

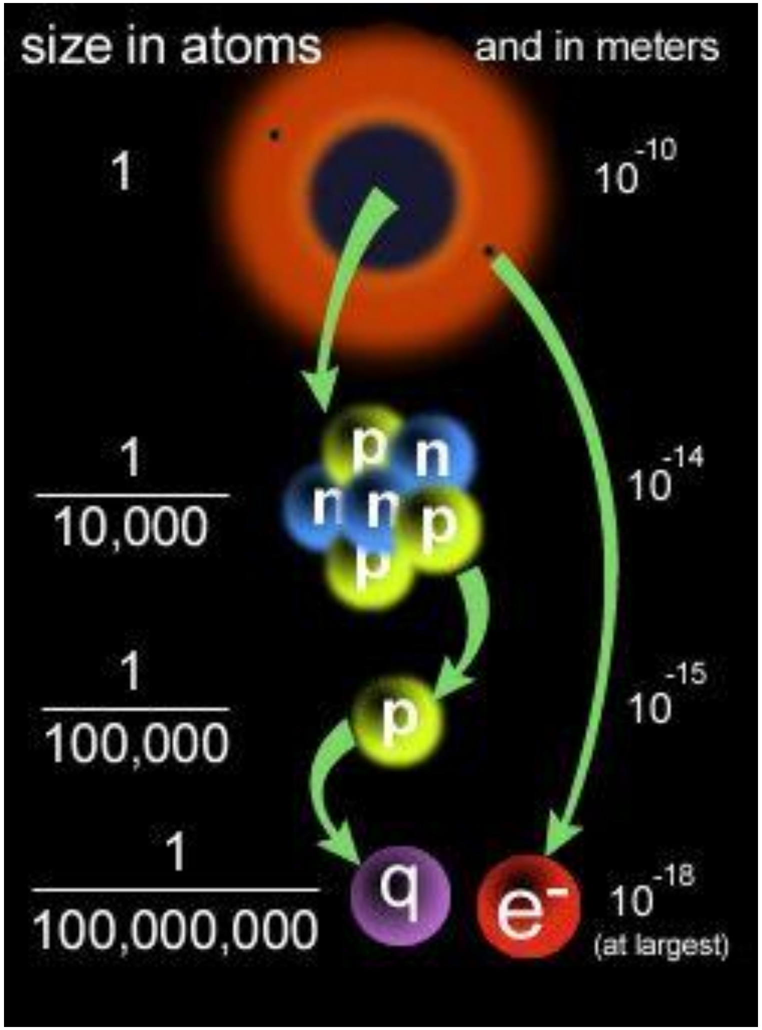


ATOMIC PARTICLES

Particle	Charge	Mass #	Location
Electron	-1	0	Electron cloud
Proton	+1	1	Nucleus
Neutron	0	1	Nucleus

THE ATOMIC SCALE

- Most of the mass of the atom is in the nucleus (protons and neutrons)
- Electrons are found outside of the nucleus (the electron cloud)
- Most of the volume of the atom is empty space



"q" is a particle called a "quark"

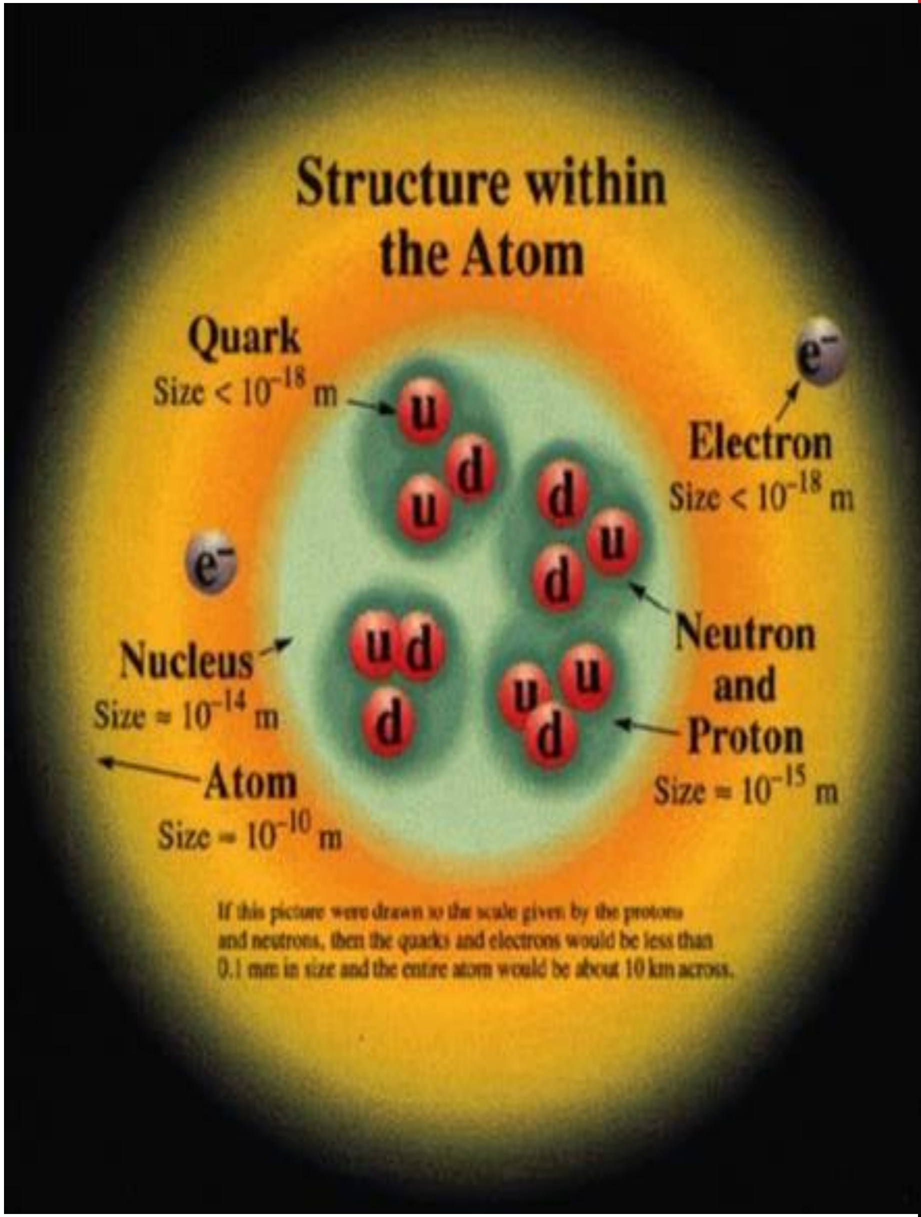
ABOUT QUARKS…

Protons and neutrons are <u>NOT</u> fundamental particles.

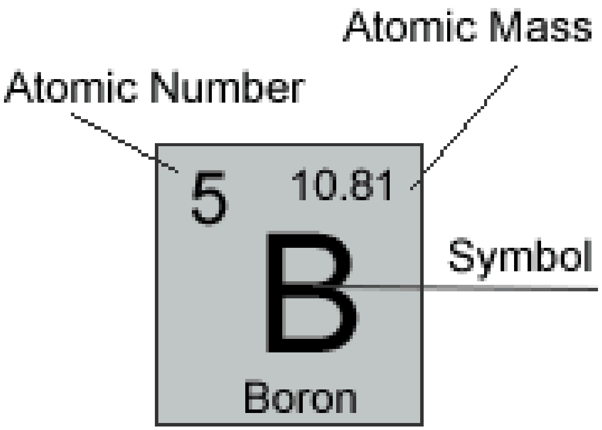
Protons are made of two "up" quarks and one "down" quark.

Neutrons are made of one "up" quark and two "down" quarks.

Quarks are held together by "gluons"



DETERMINING ATOMIC STRUCTURE



Atomic Number is equal to the number of protons in the nucleus.

Abbreviated as Z

- It is like a social security number because it identifies the element.
- No two elements have the same atomic number.

Element	# of protons	Atomic # (Z)
Carbon	6	6
Phosphorus	15	15
Gold	79	79

MASS NUMBER

Mass number is the number of protons and neutrons in the nucleus of an isotope.

$$\text{Mass \#} = p^+ + n^0$$

Nuclide	p^+	n^0	e^-	Mass #
Oxygen - 18	8	10	8	18
Arsenic - 75	33	42	33	75
Phosphorus - 31	15	16	15	31

Mass # is abbreviated as *A*

EXAMPLE 1

Determine the sub-atomic structure of the following elements:

Element	Atomic Number	Mass Number	$\#p^+$	$\#n^0$	$\#e^-$
Oxygen	8	16	8	8	8
Sodium	11	23	11	12	11
Chlorine	17	35	17	18	17

SHORTHAND NOTATION

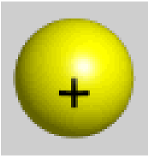
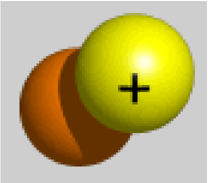
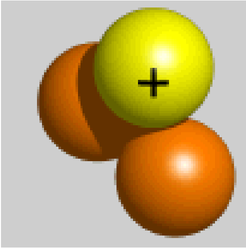
Method of showing the mass number(A), atomic number (Z) and atomic symbol

$$^{A}_{Z}\mathrm{X}$$

$$^{19}_{9}F$$

ISOTOPES

Isotopes are atoms of the same element having different masses due to varying numbers of neutrons.

Isotope	Protons	Electrons	Neutrons	Nucleus
Hydrogen-1 (protium)	1	1	0	
Hydrogen-2 (deuterium)	1	1	1	
Hydrogen-3 (tritium)	1	1	2	

ATOMIC MASSES

Atomic mass is the average of all the naturally occuring isotopes of that element.

Carbon = 12.011

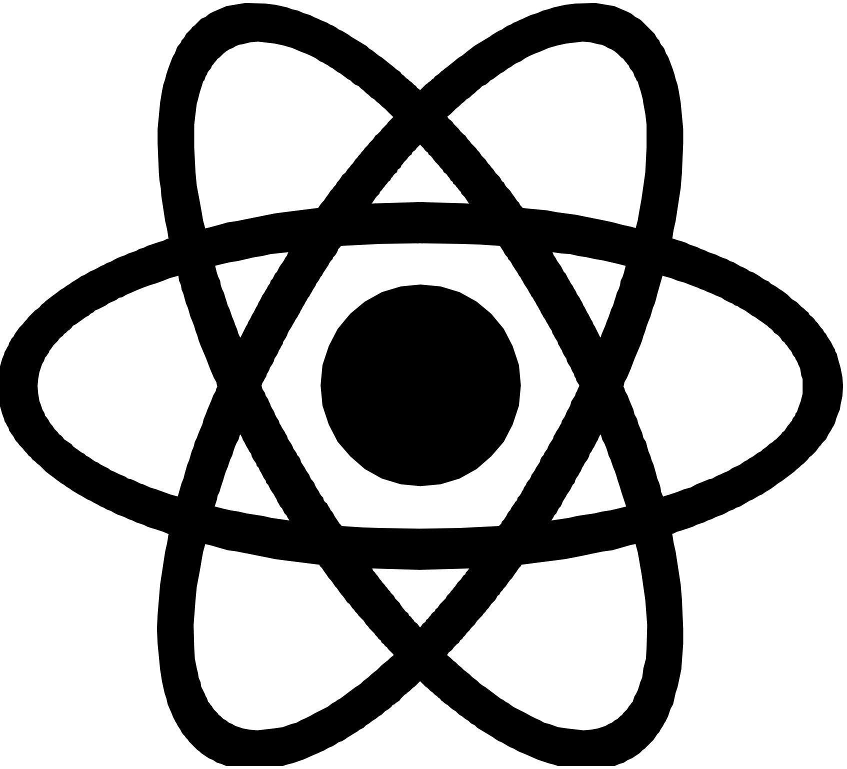
Isotope	Symbol	Composition of the nucleus	% in nature
Carbon-12	^{12}C	6 protons 6 neutrons	98.89%
Carbon-13	^{13}C	6 protons 7 neutrons	1.11%
Carbon-14	^{14}C	6 protons 8 neutrons	<0.01%

ION: AN ATOM THAT HAS A DIFFERENT NUMBER OF ELECTRONS AND RESULTS IN A CHARGE. (RESULT OF TRYING TO BECOME MORE SABLE AND HAVE 8 VALENCE ELECTRONS)

Determine the sub-atomic structure of the following Ions:

Element	Atomic Number	Mass Number	$\#p^+$	$\#n^0$	$\#e^-$
O^{-2}	8	16			
Na^{+1}	11	23			
Cl^{-1}	17	35			

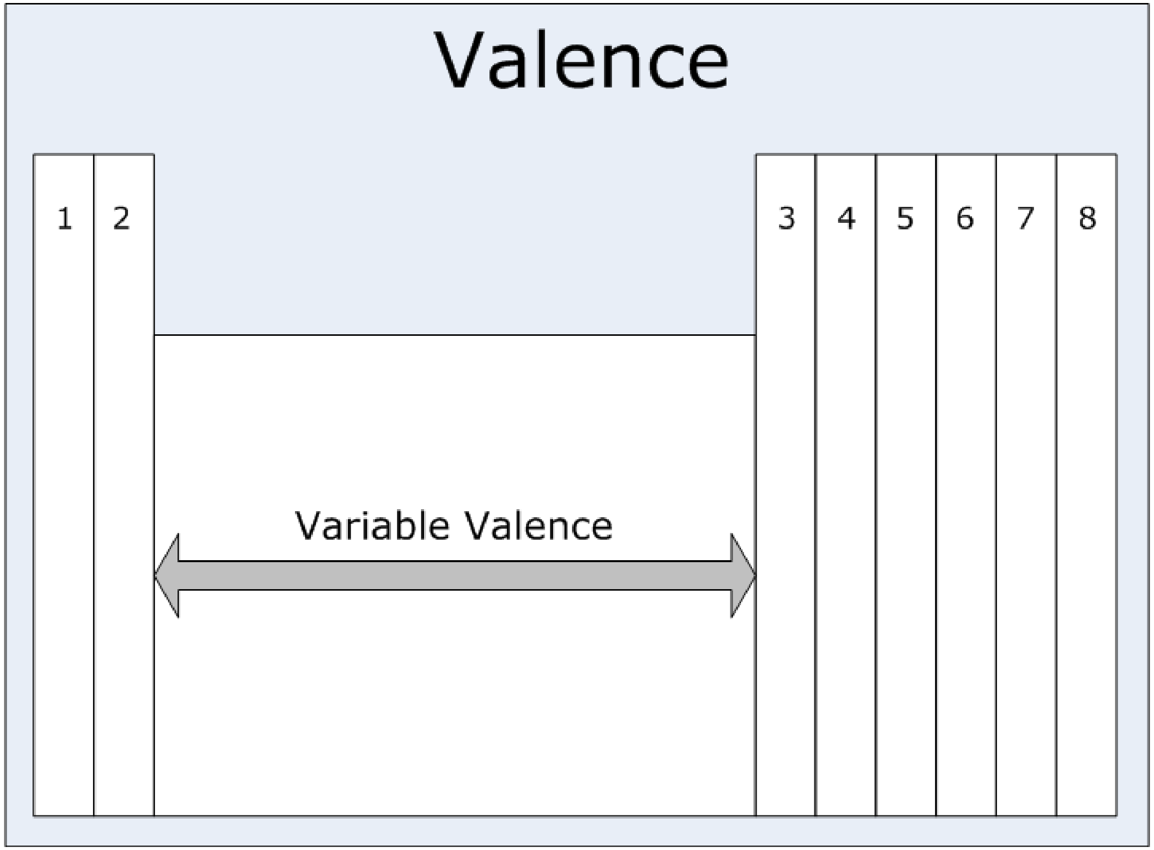
VALENCE ELECTRONS



Valence electrons: an electron that is able to be lost gained or shared during bonding, due to it's location in the outer shell of the electron cloud.

Number of Valence electrons = group number

VALENCE ELECTRONS- OUTERMOST ELECTRONS – RESPONSIBLE FOR REACTIVITY OF THE ATOM

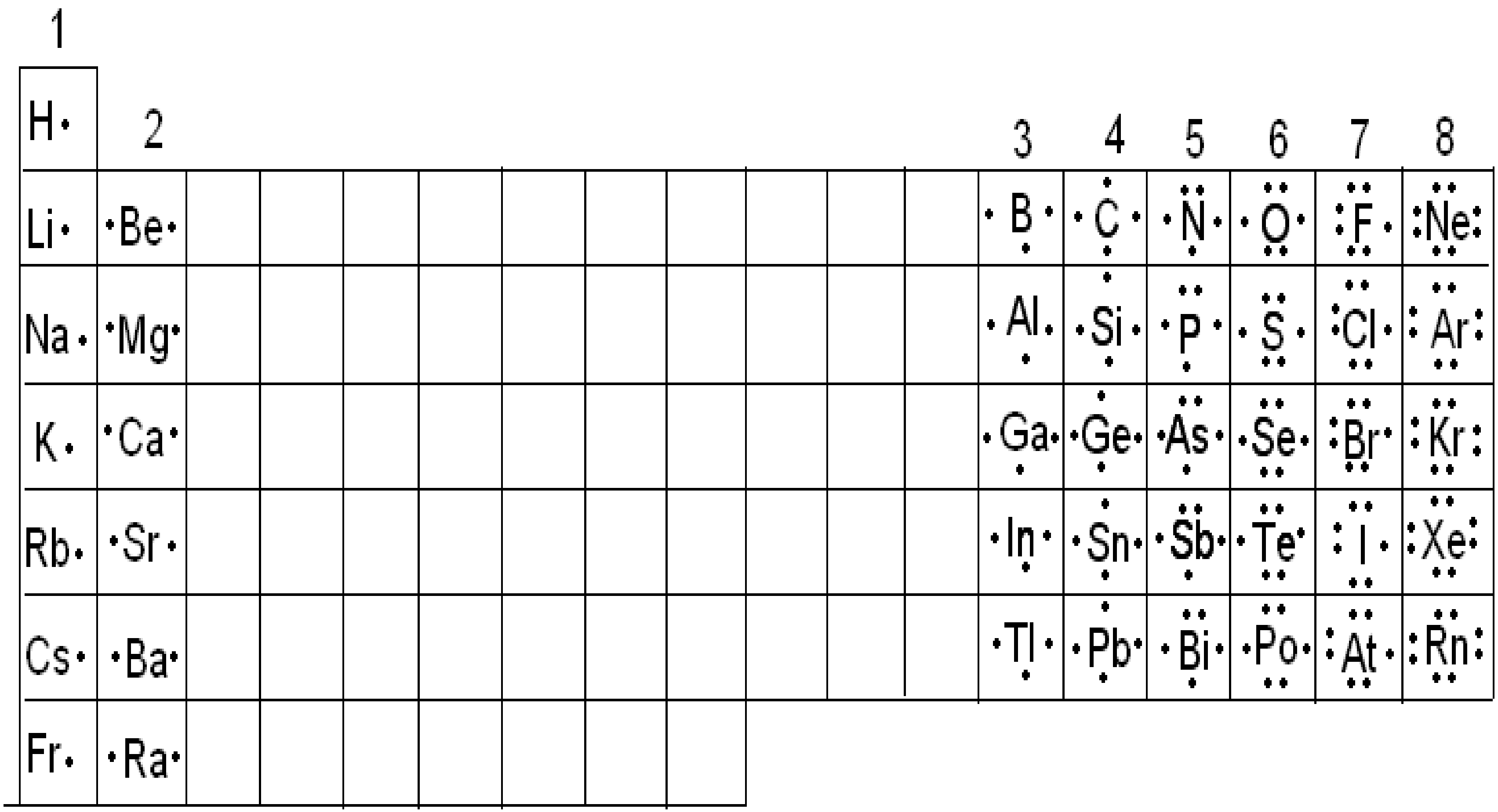


Note: all the elements in the same group have the same number of valence electrons!

Therefore they are physically and chemically similar!

LEWIS DOT DIAGRAMS

Shows the kernel of the atom (all inner shells and nucleus) as the symbol and dots represent the outer electrons- Valence Electrons

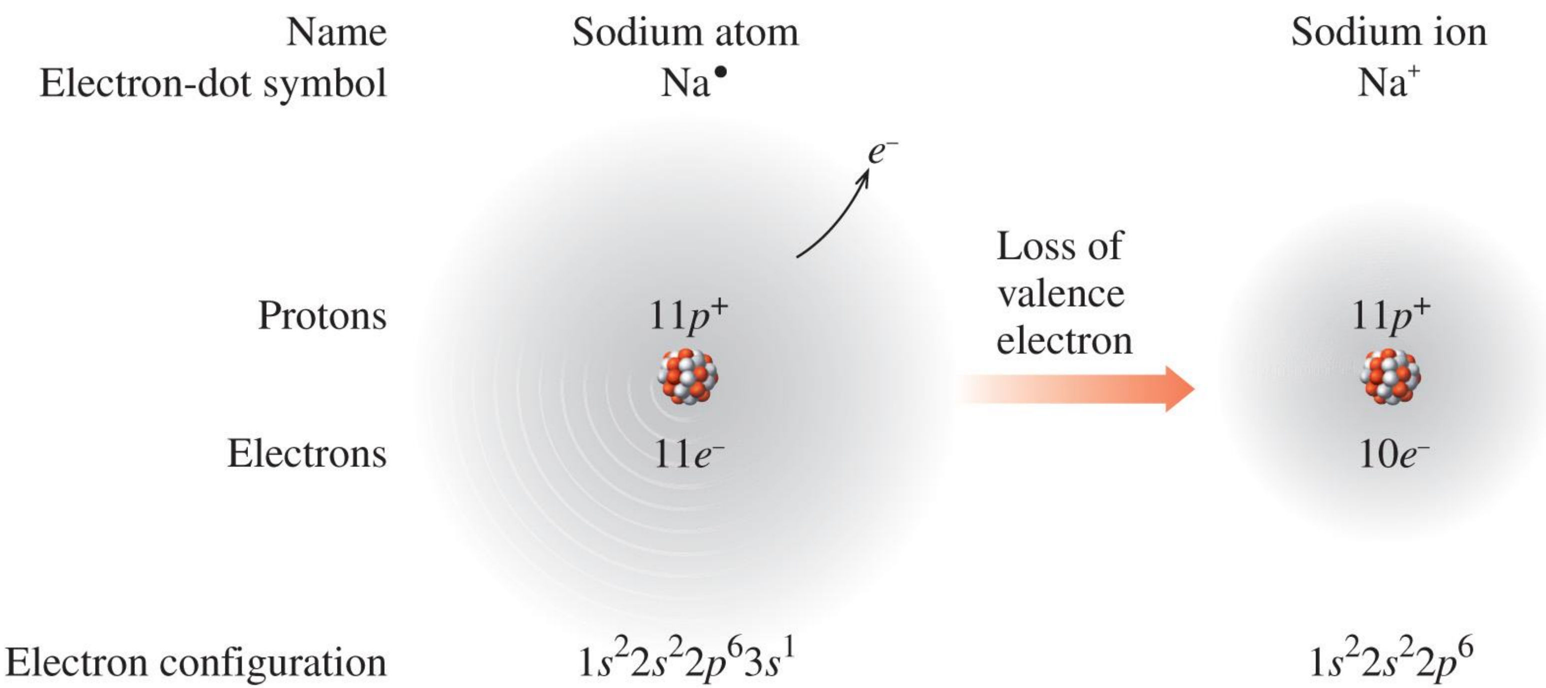


ION: AN ATOM THAT HAS A DIFFERENT NUMBER OF ELECTRONS AND RESULTS IN A CHARGE.

(RESULT OF TRYING TO BECOME MORE STABLE AND HAVE 8 VALENCE ELECTRONS)

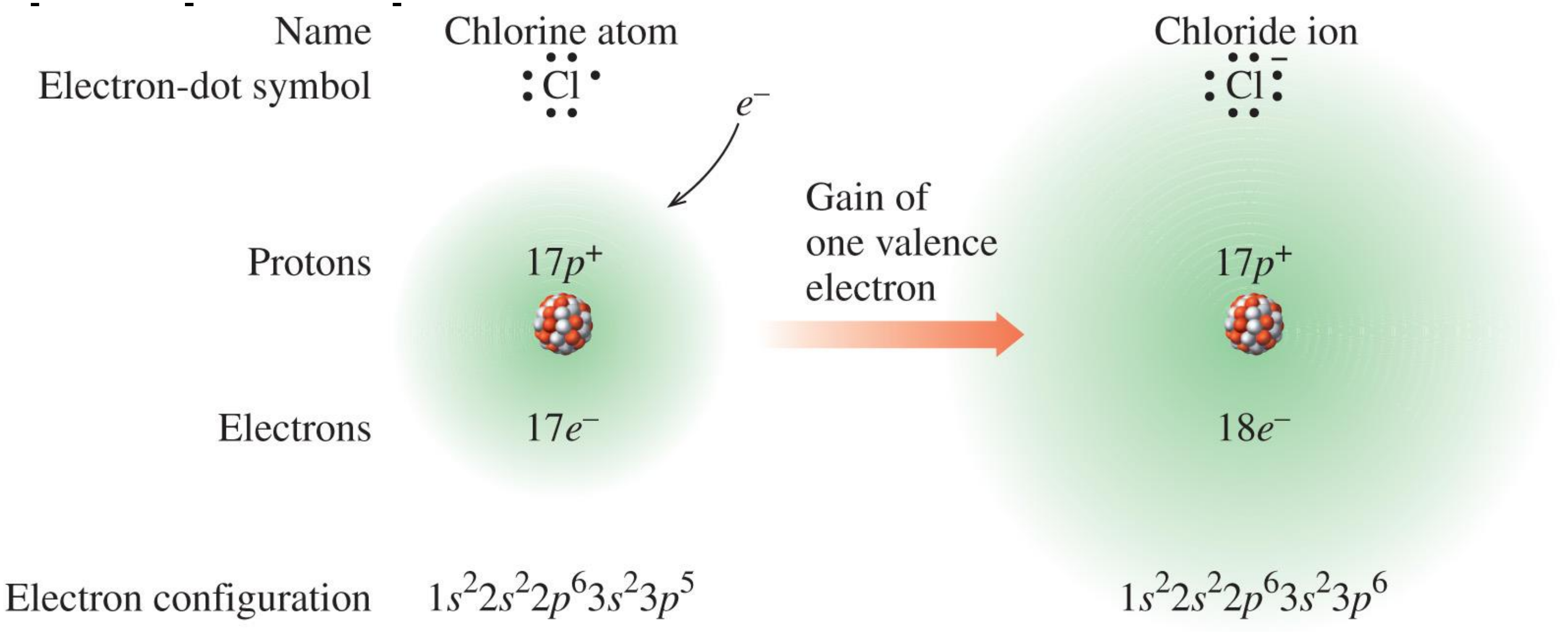
FORMATION OF A SODIUM ION, Na^{+1}

Sodium achieves an octet by losing its one valence electron.



FORMATION OF A CHLORIDE ION, Cl^{-1}

Chlorine achieves an octet by adding an electron to



OXIDATION NUMBERS

Oxidation numbers are the charges on ions

General trend

- Group 1 = +1
- Group 2 = +2
- Group 3 = +3
- Group 4 = +/- 4
- Group 5 = -3
- Group 6 = -2
- Group 7 = -1
- Group 8 = 0

IONS – ATOMS THAT HAVE AN UNBALANCED NUMBER OF ELECTRONS AND PROTONS

Ion	Atomic Number	Mass Number	$\#p^+$	$\#n^0$	$\#e^-$	Oxidation Number
O^{-2}						
Na^{+1}						
Cl^{-1}						
Fe^{+3}						

NUCLEAR SYMBOLS

Mass number
($p^+ + n^o$)

$$^{235}_{92}U$$

Element symbol

Atomic number
(number of p^+)

TYPES OF RADIOACTIVE DECAY

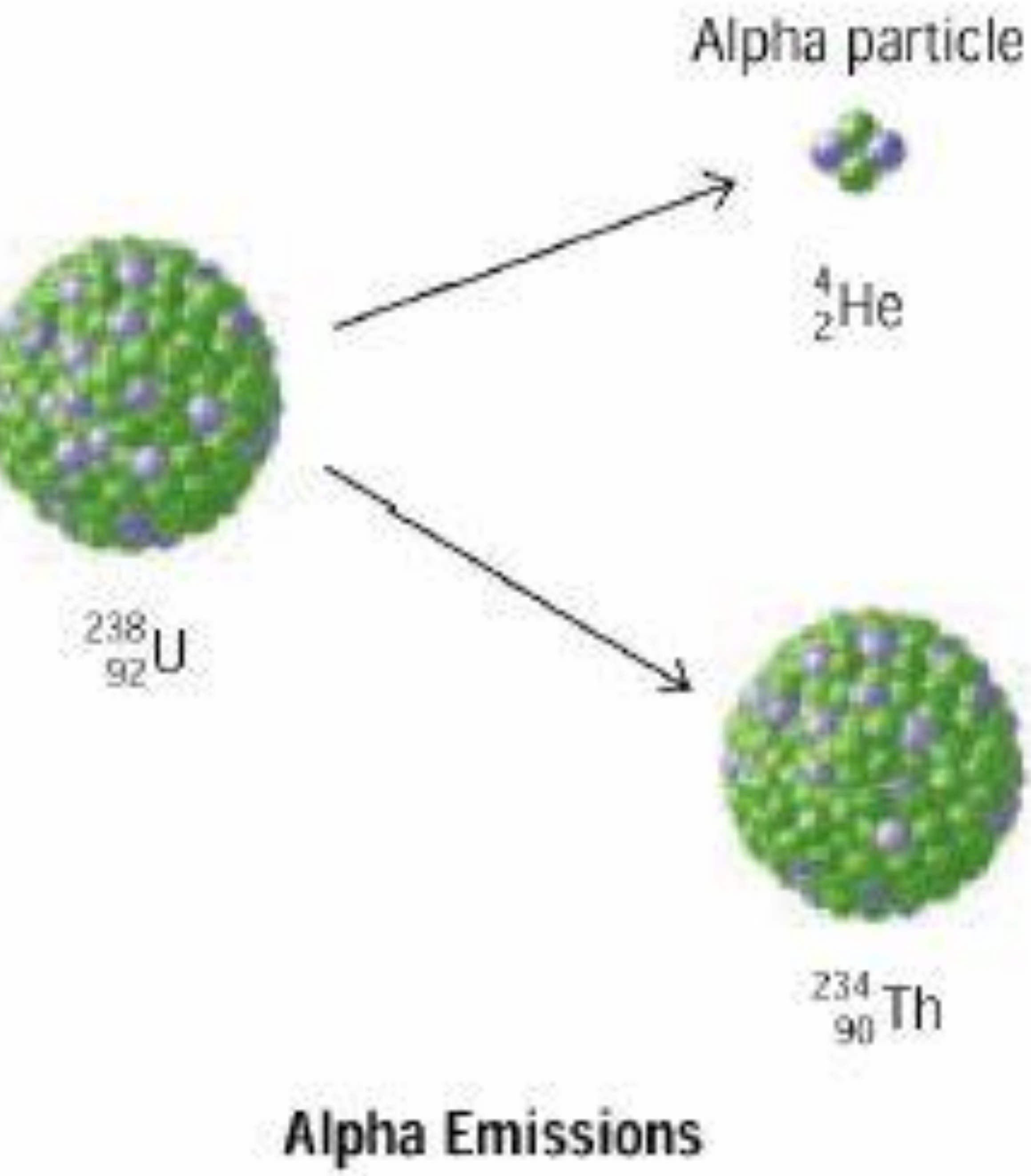
- **alpha production (α): helium nucleus** $^{2+}$

$$^{238}_{92}\text{U} \rightarrow\ ^{4}_{2}\text{He} +\ ^{234}_{90}\text{Th}$$

- **beta production (β):**

$$^{234}_{90}\text{Th} \rightarrow\ ^{234}_{91}\text{Pa} +\ ^{0}_{-1}\text{e}$$

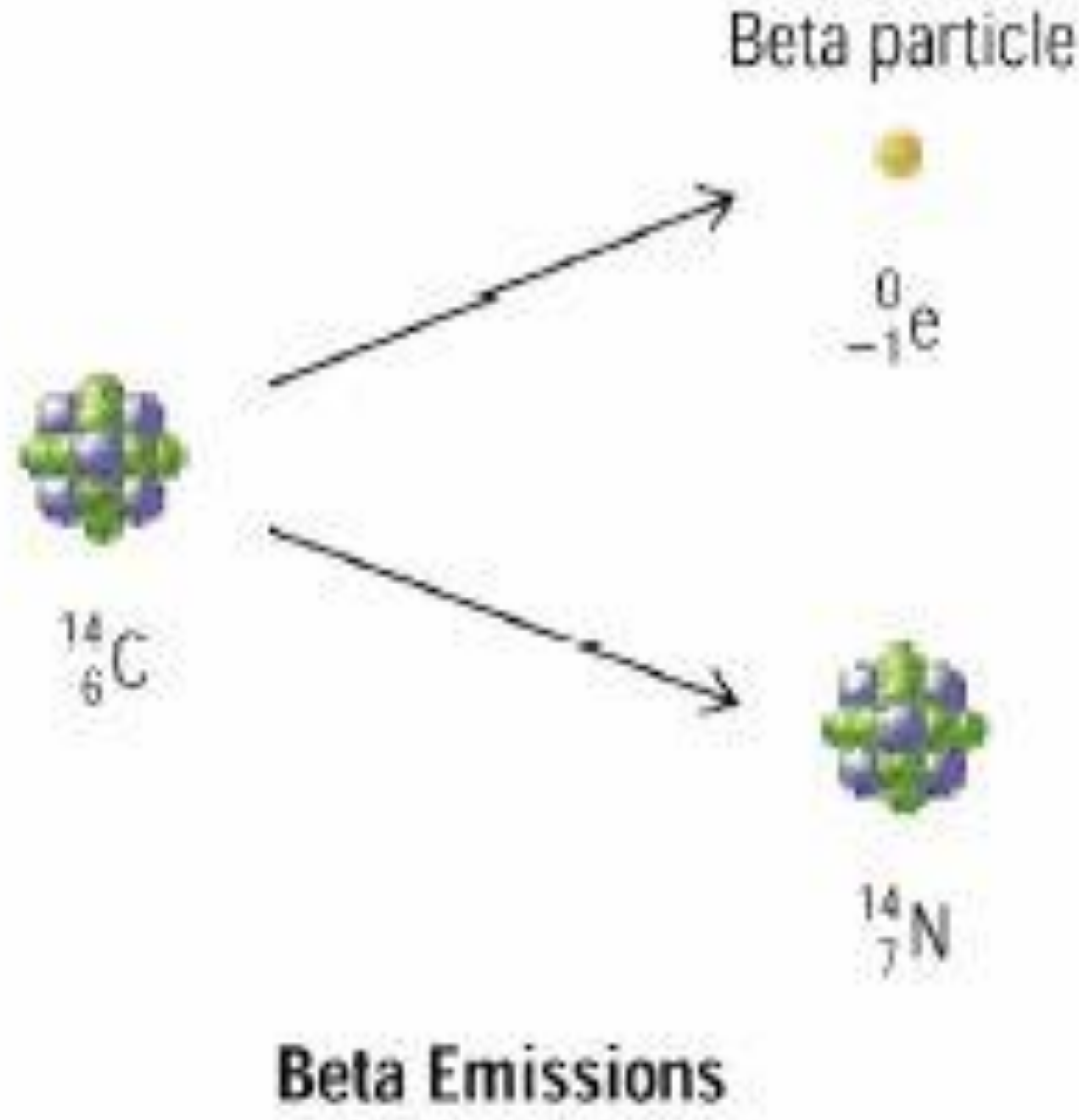
ALPHA RADIATION



Limited to VERY large nucleii.

BETA RADIATION

Converts a neutron into a proton.



OTHER TYPES OF RADIOACTIVE DECAY

- **gamma ray production (γ):**

$$ {}^{238}_{92}\mathrm{U} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{234}_{90}\mathrm{Th} + 2\,{}^{0}_{0}\gamma $$

- **positron production :**

$$ {}^{22}_{11}\mathrm{Na} \rightarrow {}^{0}_{1}\mathrm{e} + {}^{22}_{10}\mathrm{Ne} $$

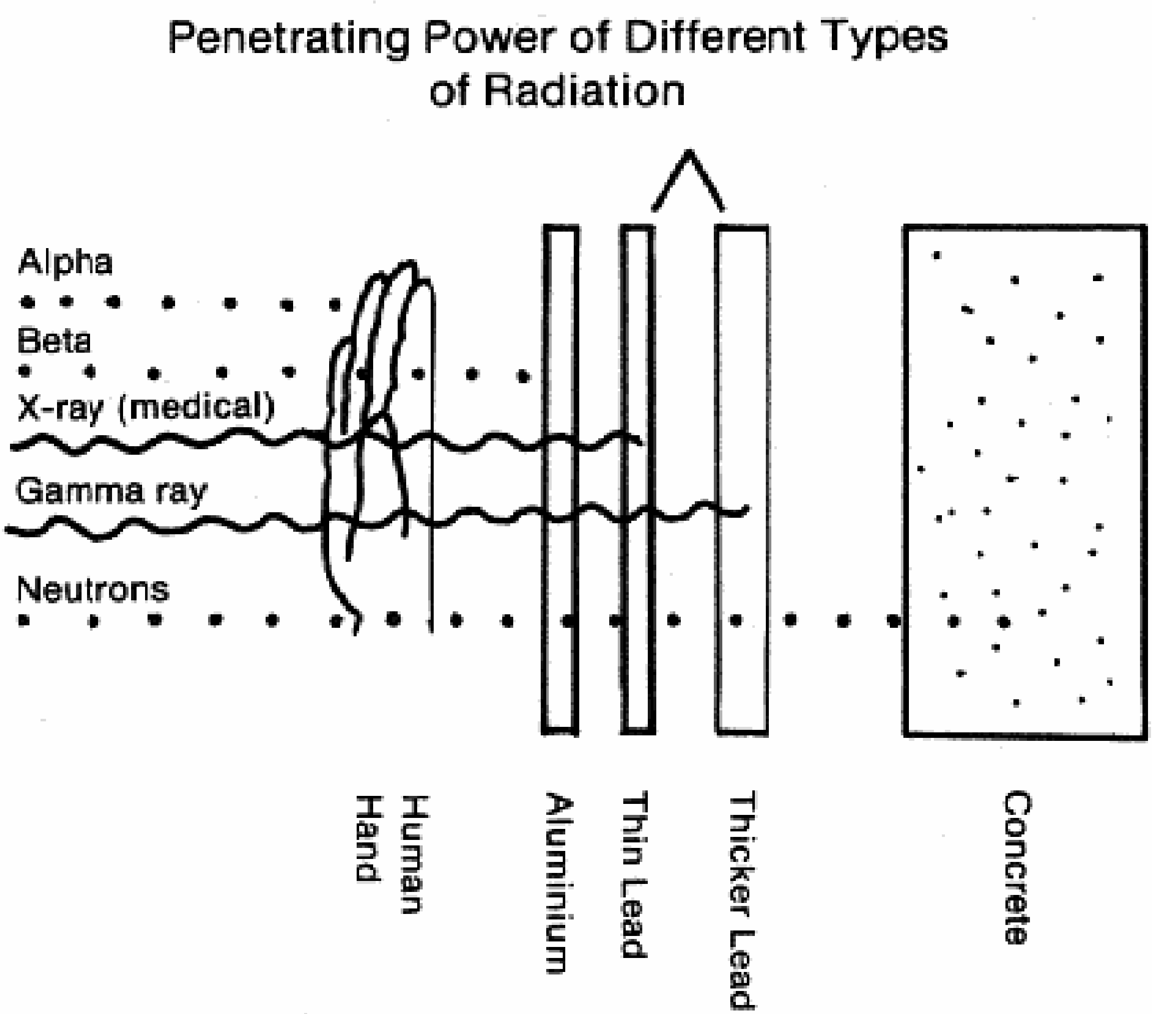
- **electron capture: (inner-orbital electron is captured by the nucleus)**

$$ {}^{201}_{80}\mathrm{Hg} + {}^{0}_{-1}\mathrm{e} \rightarrow {}^{201}_{79}\mathrm{Au} + {}^{0}_{0}\gamma $$

Characteristics of Some Ionizing Radiations

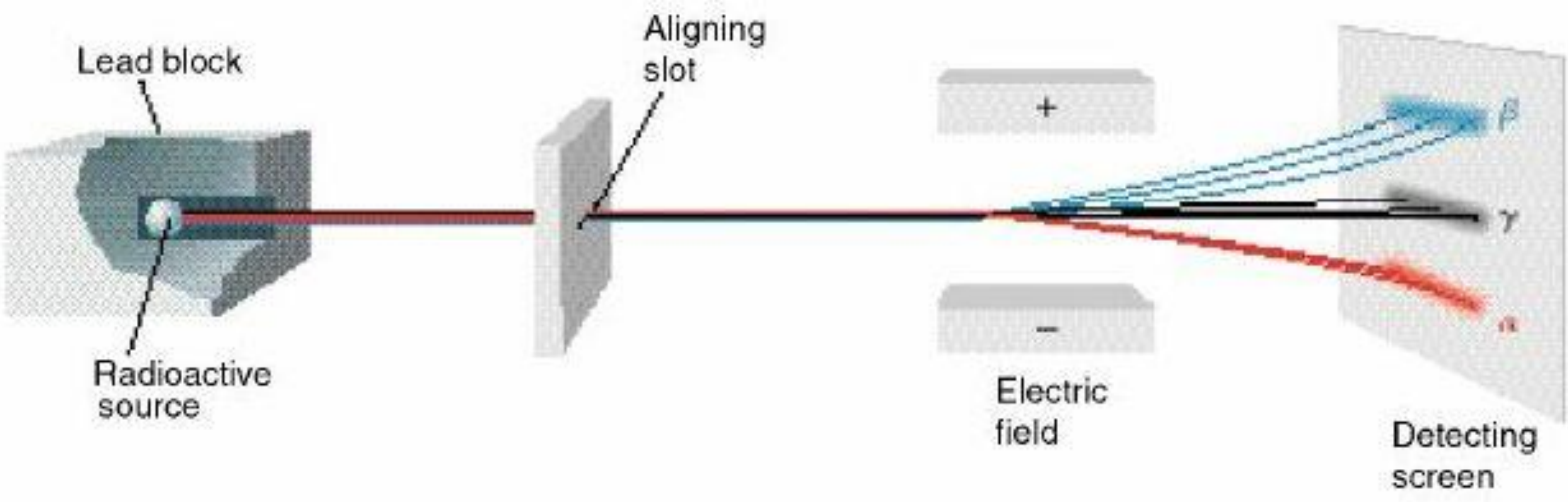
Property	Alpha radiation	Beta radiation	Gamma radiation
Composition	Alpha particle (helium nucleus)	Beta particle (electron)	High-energy electro-magnetic radiation
Symbol	α, ${}^{4}_{2}He$	β, ${}^{0}_{-1}e$	γ
Charge	2+	1−	0
Mass (amu)	4	1/1837	0
Common source	Radium-226	Carbon-14	Cobalt-60
Approximate energy	5 MeV*	0.05 to 1 MeV	1 MeV
Penetrating power	Low (0.05 mm body tissue)	Moderate (4 mm body tissue)	Very high (penetrates body easily)
Shielding	Paper, clothing	Metal foil	Lead, concrete (incompletely shields)

*(1 MeV = 1.60×10^{-13} J)



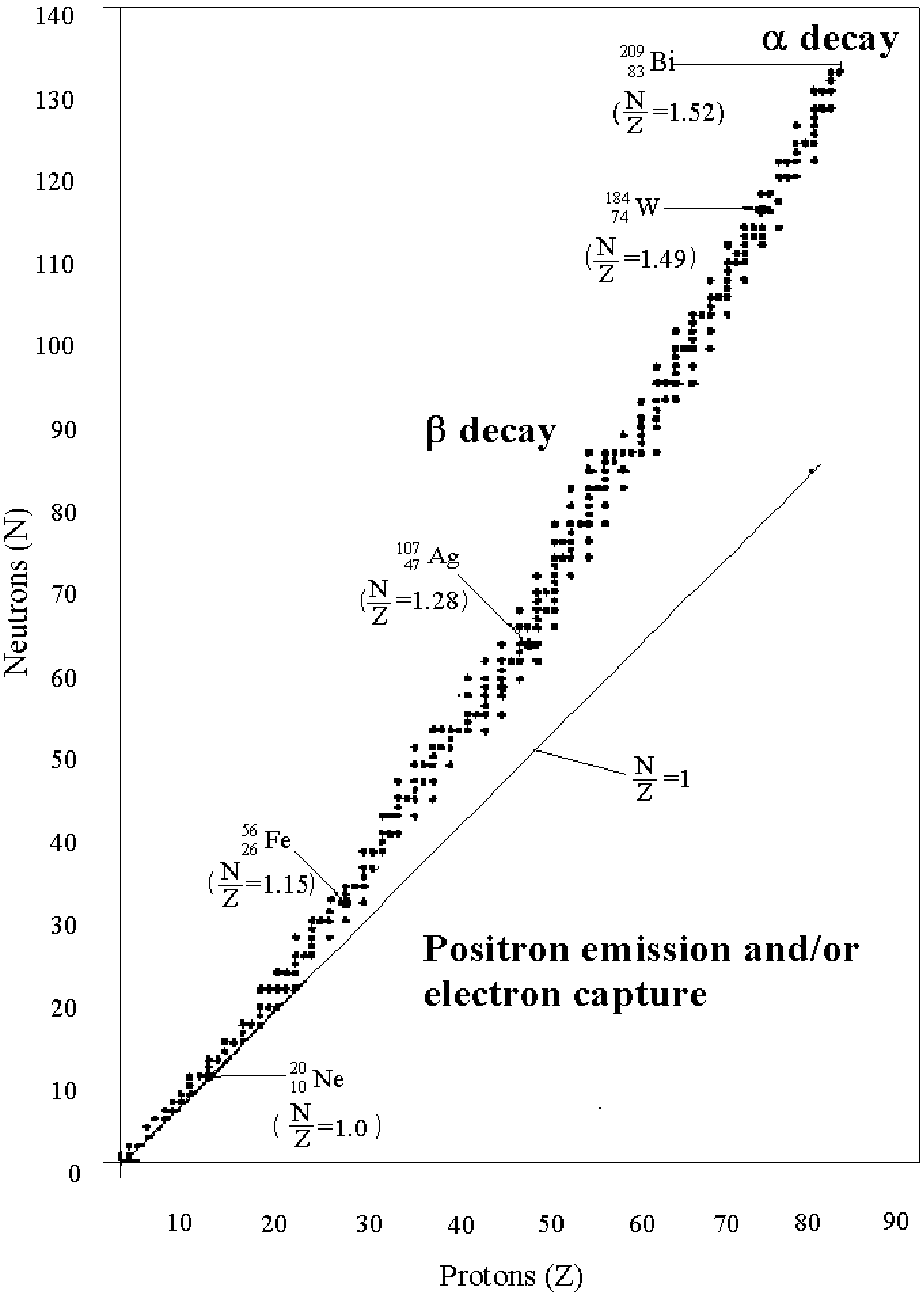
The more massive the particle, the less the penetrating power.

DEFLECTION OF DECAY PARTICLES



Opposite charges___attract___ each other.

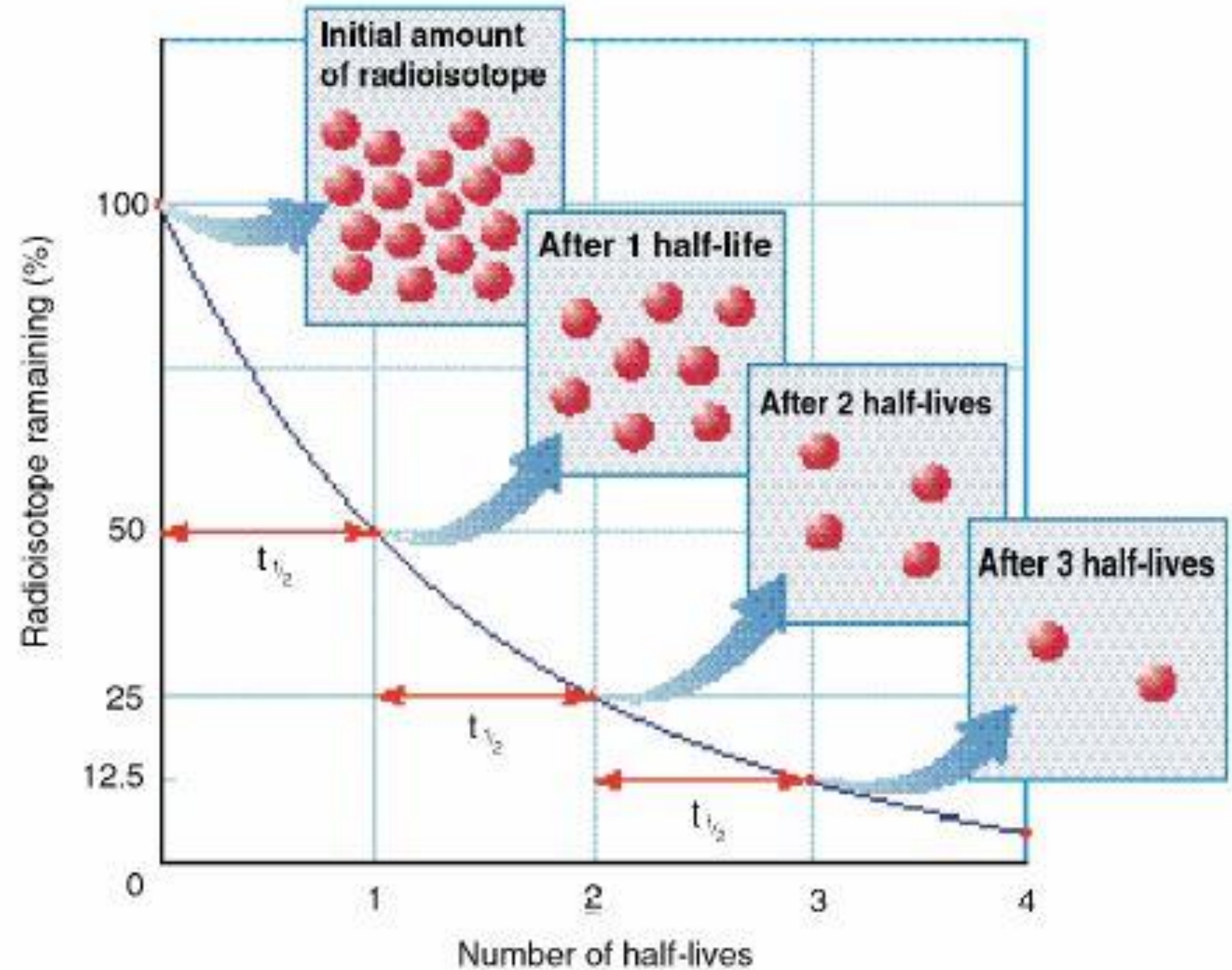
Like charges___repel___ each other.



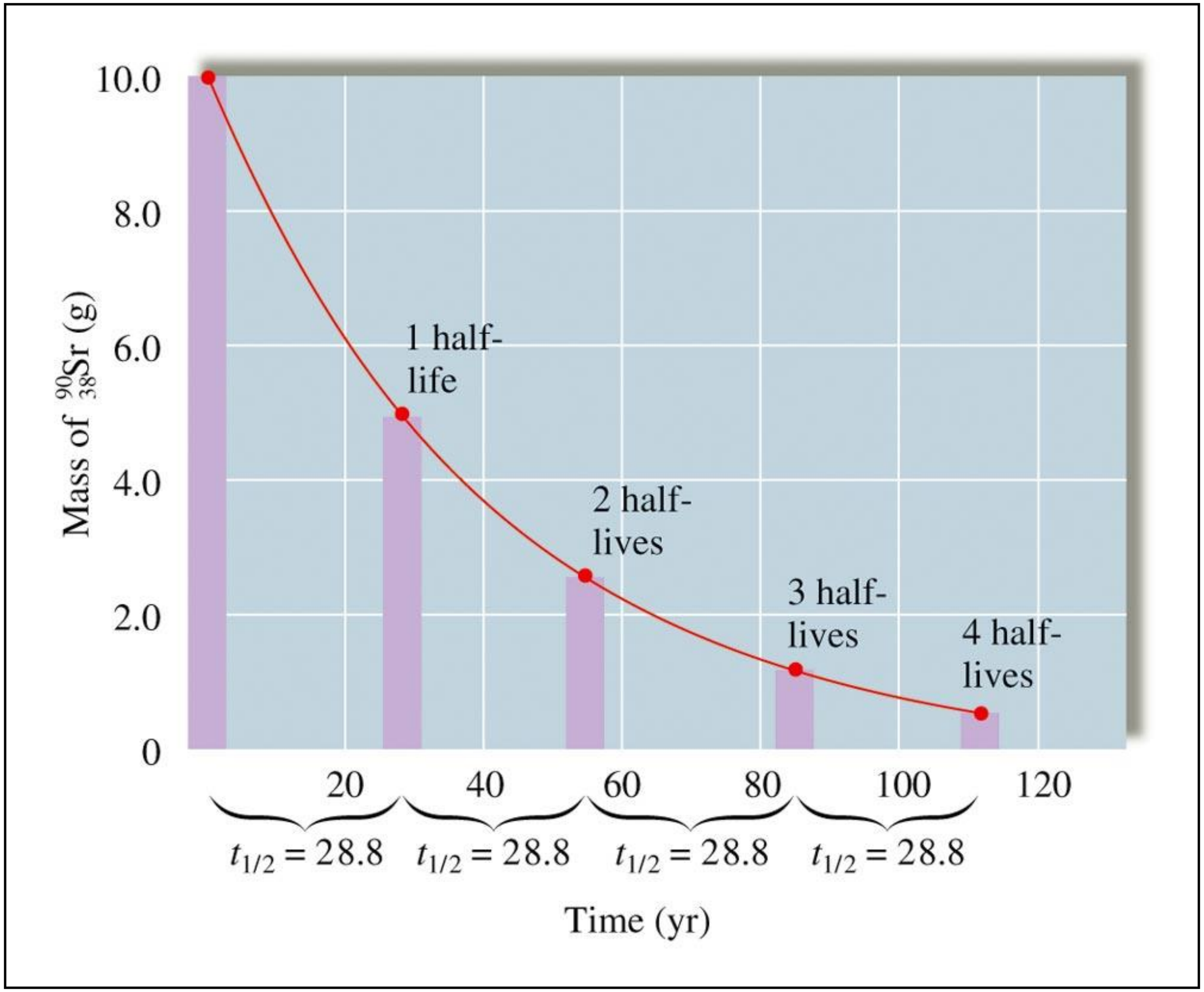
NUCLEAR STABILITY

Decay will occur in such a way as to return a nucleus to the band (line) of stability.

HALF-LIFE CONCEPT

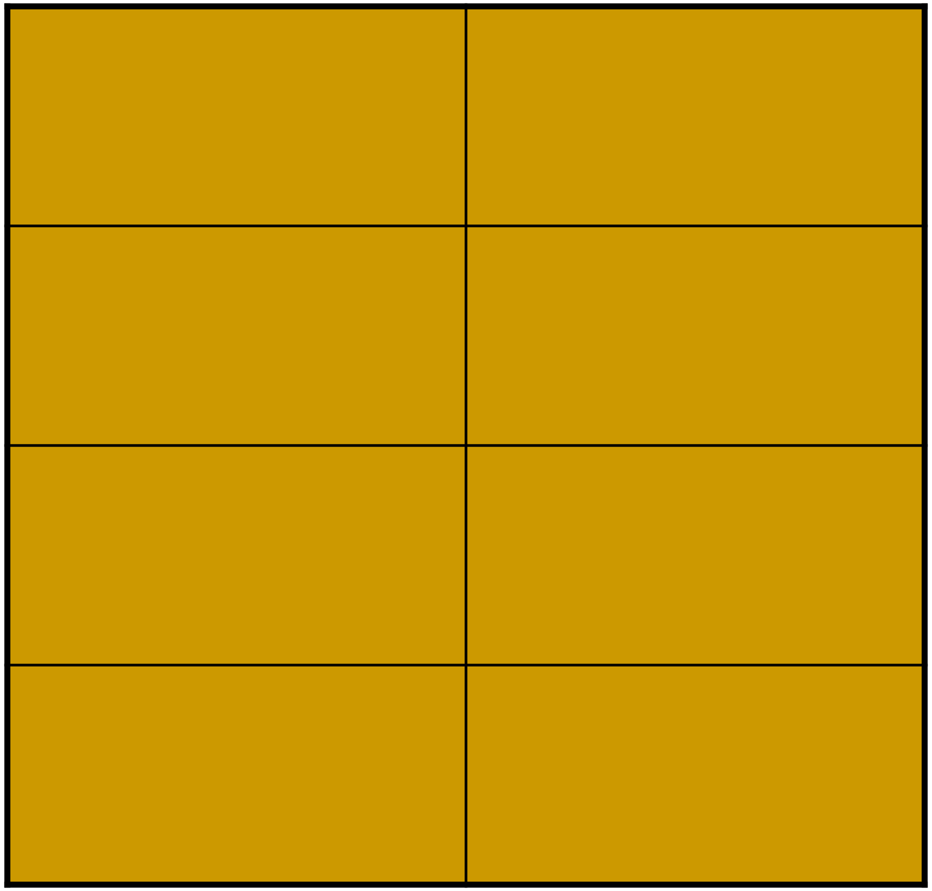


DECAY OF A 10.0-G SAMPLE OF STRONTIUM-90



The grid below represents a quantity of C^{14}. Each time you click, one half-life goes by. Try it!

C^{14} – Yellow **N^{14} - red**



Half lives	% C^{14}	%N^{14}	Ratio of C^{14} to N^{14}
0	100%	0%	no ratio

As we begin notice that no time has gone by and that 100% of the material is C^{14}

Age = 0 half lives (5700 x 0 = 0 yrs)

The grid below represents a quantity of C^{14}. Each time you click, one half-life goes by. Try it!

C^{14} – Yellow **N^{14} - red**

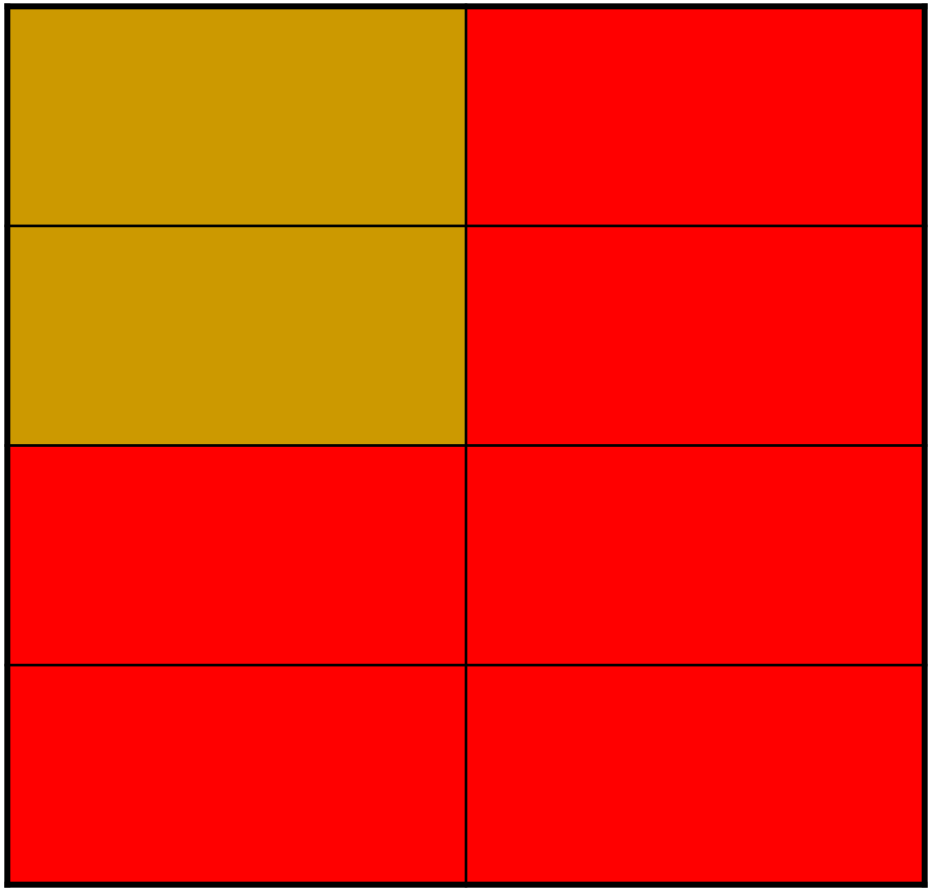
Half lives	% C^{14}	%N^{14}	Ratio of C^{14} to N^{14}
0	100%	0%	no ratio
1	**50%**	**50%**	**1:1**

After 1 half-life (5700 years), 50% of the C^{14} has decayed into N^{14}. The ratio of C^{14} to N^{14} is 1:1. There are equal amounts of the 2 elements.

Age = 1 half lives (5700 x 1 = 5700 yrs)

The grid below represents a quantity of C^{14}. Each time you click, one half-life goes by. Try it!

C^{14} – Yellow **N^{14} - red**



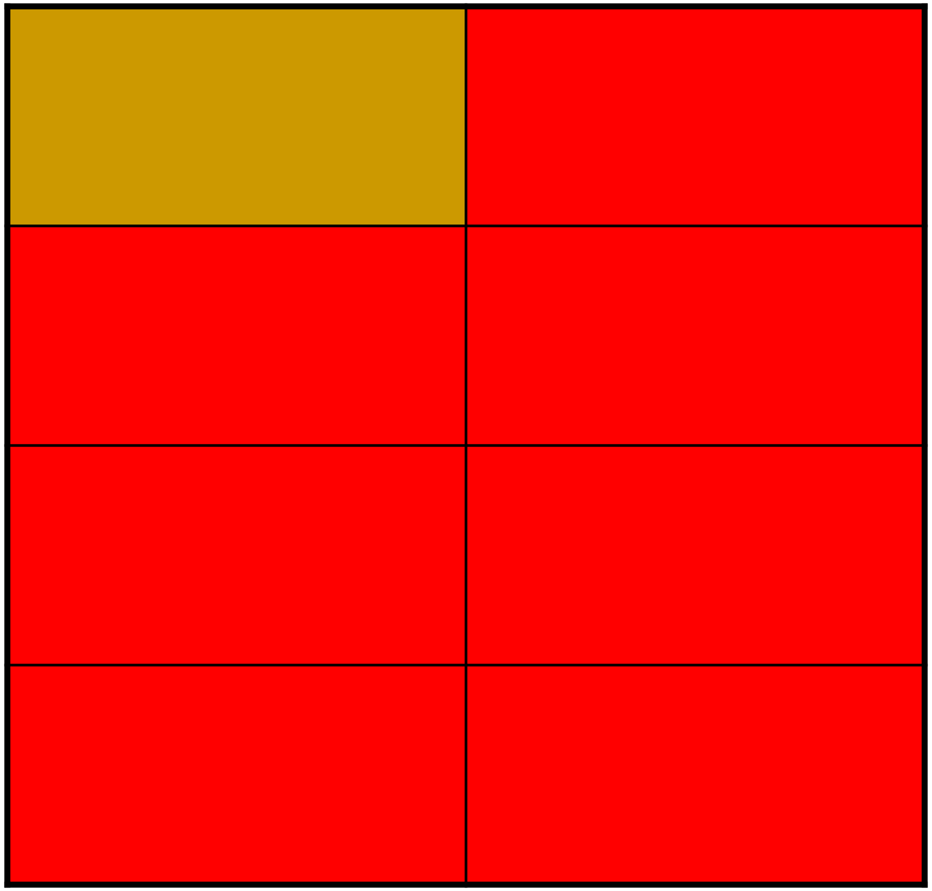
Half lives	% C^{14}	% N^{14}	Ratio of C^{14} to N^{14}
0	100%	0%	no ratio
1	50%	50%	1:1
2	**25%**	**75%**	**1:3**

Now 2 half-lives have gone by for a total of 11,400 years. Half of the C^{14} that <u>was</u> present at the end of half-life #1 has now decayed to N^{14}. Notice the C:N ratio. It will be useful later.

Age = 2 half lives (5700 x 2 = 11,400 yrs)

The grid below represents a quantity of C^{14}. Each time you click, one half-life goes by. Try it!

C^{14} – Yellow **N^{14} - red**

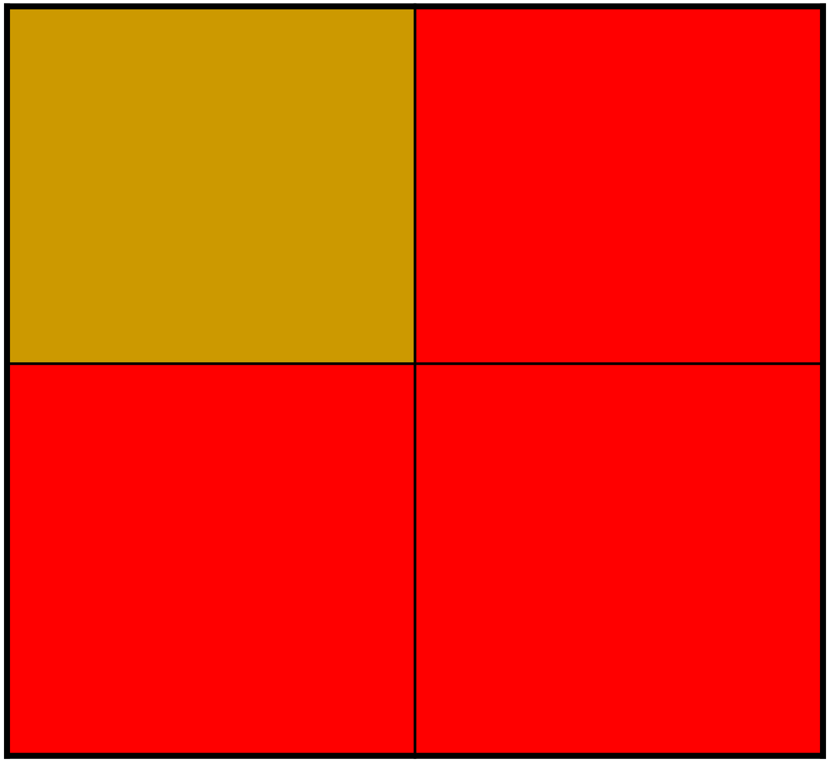


Half lives	% C^{14}	% N^{14}	Ratio of C^{14} to N^{14}
0	100%	0%	no ratio
1	50%	50%	1:1
2	25%	75%	1:3
3	**12.5%**	**87.5%**	**1:7**

After 3 half-lives (17,100 years) only 12.5% of the original C^{14} remains. For each half-life period half of the material present decays. And again, notice the ratio, 1:7

Age = 3 half lives (5700 x 3 = 17,100 yrs)

C^{14} - blue N^{14} - red



How can we find the age of a sample without knowing how much C^{14} was in it to begin with?

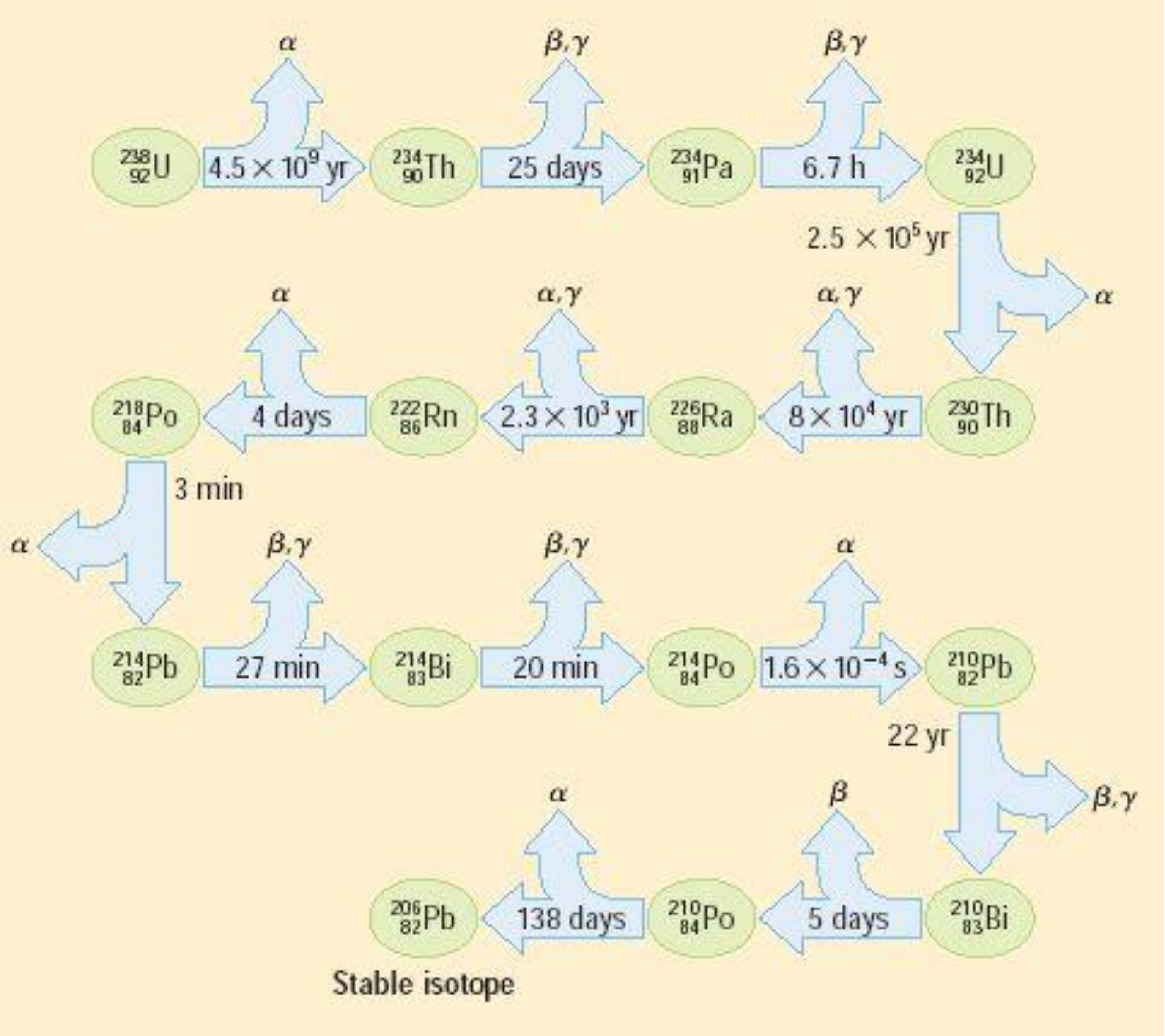
1) **Send the sample to a lab which will determine the C^{14} : N^{14} ratio.**
2) **Use the ratio to determine how many half lives have gone by since the sample formed.**

Remember, 1:1 ratio = 1 half life
1:3 ratio = 2 half lives
1:7 ratio = 3 half lives

In the example above, the ratio is 1:3.

If the sample has a ratio of 1:3 that means it is 2 half lives old. If the half life of C^{14} is 5,700 years then the sample is 2 x 5,700 or 11,400 years old.

A radioactive nucleus reaches a stable state by a series of steps



A DECAY SERIES

NUCLEAR FISSION AND FUSION

Fusion: Combining two light nuclei to form a heavier, more stable nucleus.

$$^{3}_{2}\text{He} + ^{1}_{1}\text{H} \rightarrow ^{4}_{2}\text{He} + ^{0}_{1}\text{e}$$

Fission: Splitting a heavy nucleus into two nuclei with smaller mass numbers.

$$^{1}_{0}\text{n} + ^{235}_{92}\text{U} \rightarrow ^{142}_{56}\text{Ba} + ^{91}_{36}\text{Kr} + 3\,^{1}_{0}\text{n}$$

ENERGY AND MASS

Nuclear changes occur with small but measurable losses of mass. The lost mass is called the mass defect, and is converted to energy according to Einstein's equation:

$$\Delta E = \Delta m c^2$$

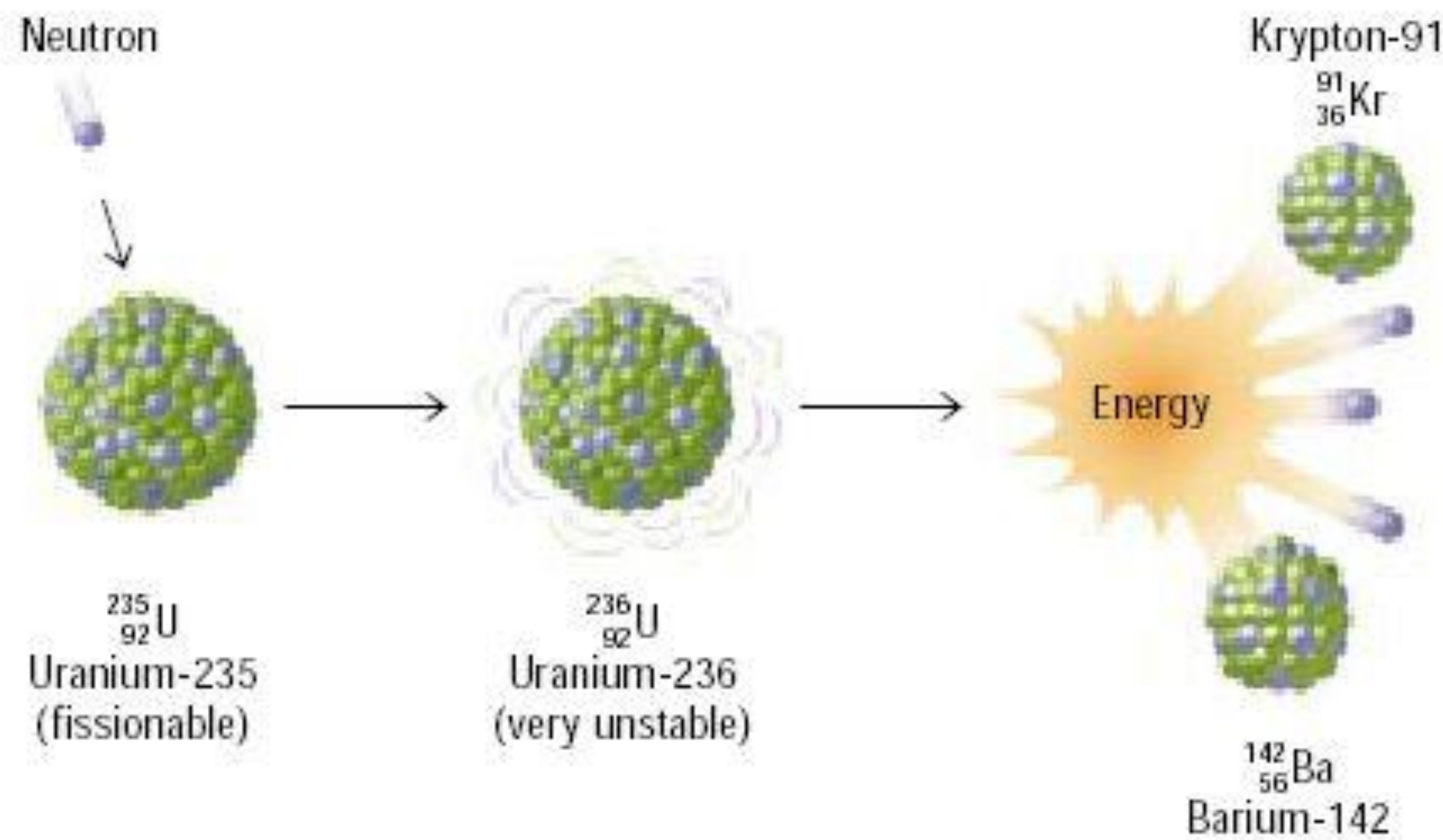
Δm = mass defect

ΔE = change in energy

c = speed of light

Because c^2 is so large, *<u>even small amounts of mass are converted to enormous amount of energy.</u>*

FISSION

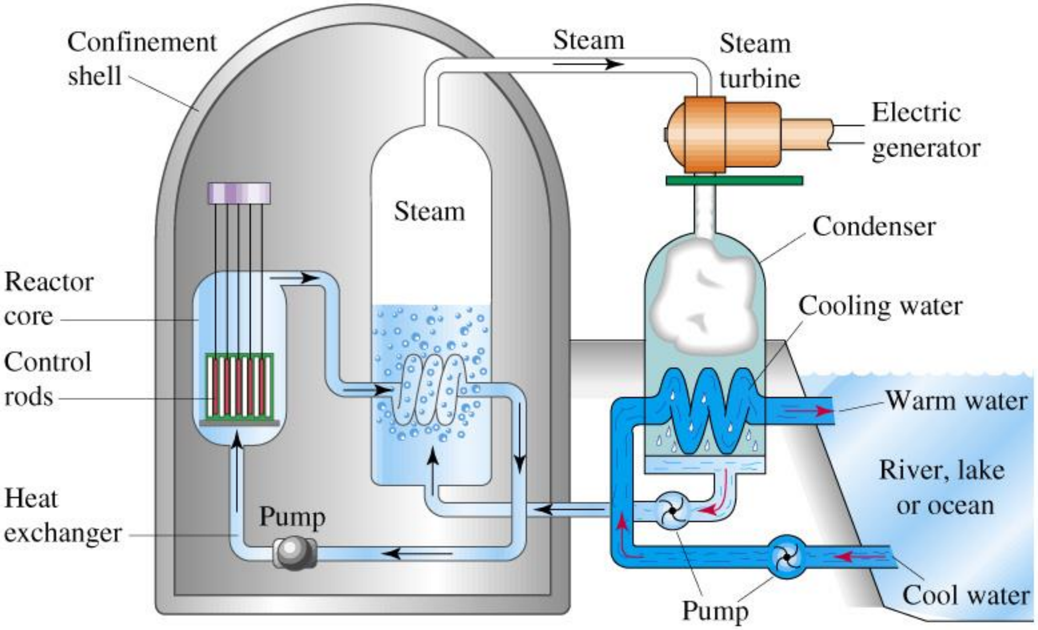

Neutron
Krypton-91
$^{91}_{36}Kr$
Energy
$^{235}_{92}U$
Uranium-235
(fissionable)
$^{236}_{92}U$
Uranium-236
(very unstable)
$^{142}_{56}Ba$
Barium-142

FISSION PROCESSES

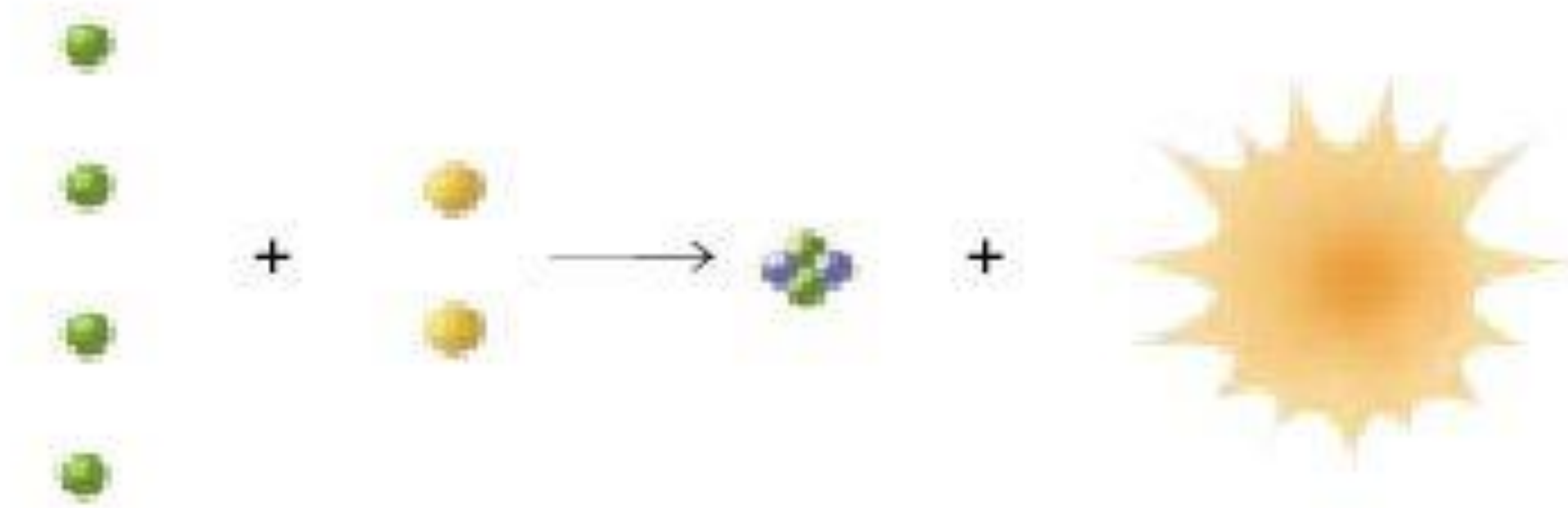
A self-sustaining fission process is called a chain reaction.

Event	Neutrons Causing Fission	Result
subcritical	< 1	reaction stops
critical	= 1	sustained reaction
supercritical	> 1	violent explosion

A FISSION REACTOR



FUSION

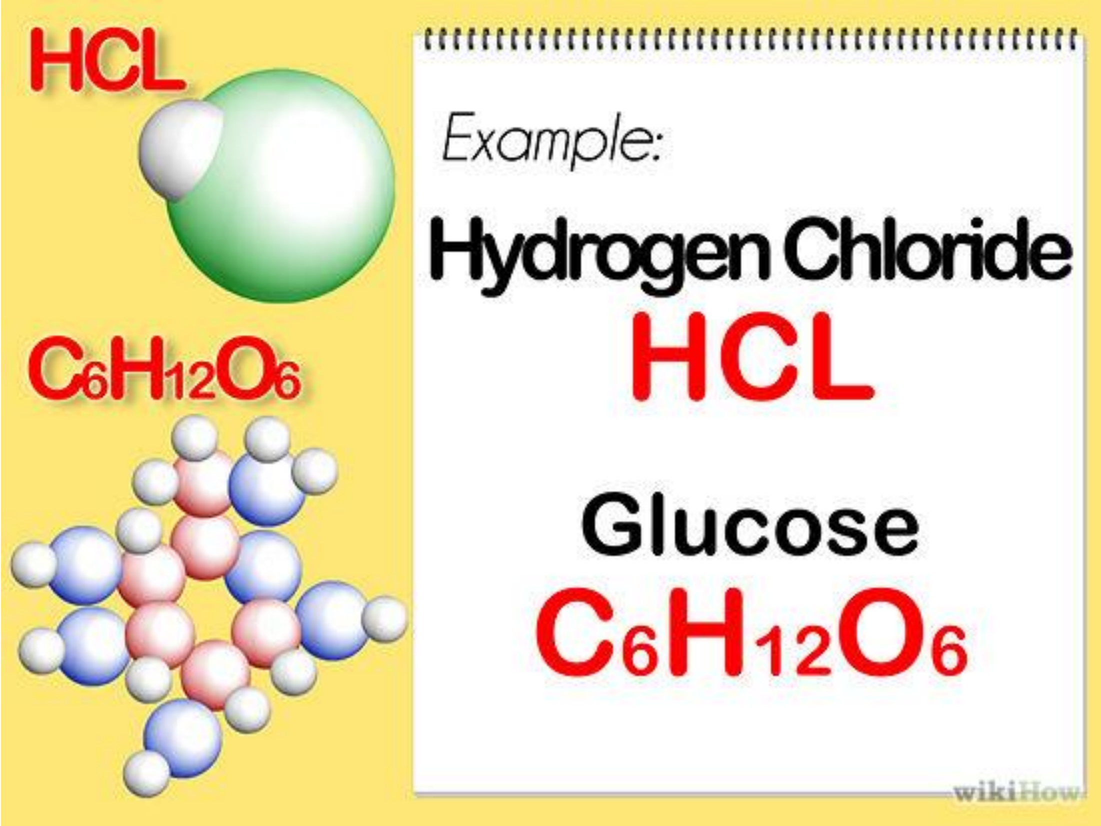


$$4\,{}^{1}_{1}H + 2\,{}^{0}_{-1}e \longrightarrow {}^{4}_{2}He + \text{Energy}$$

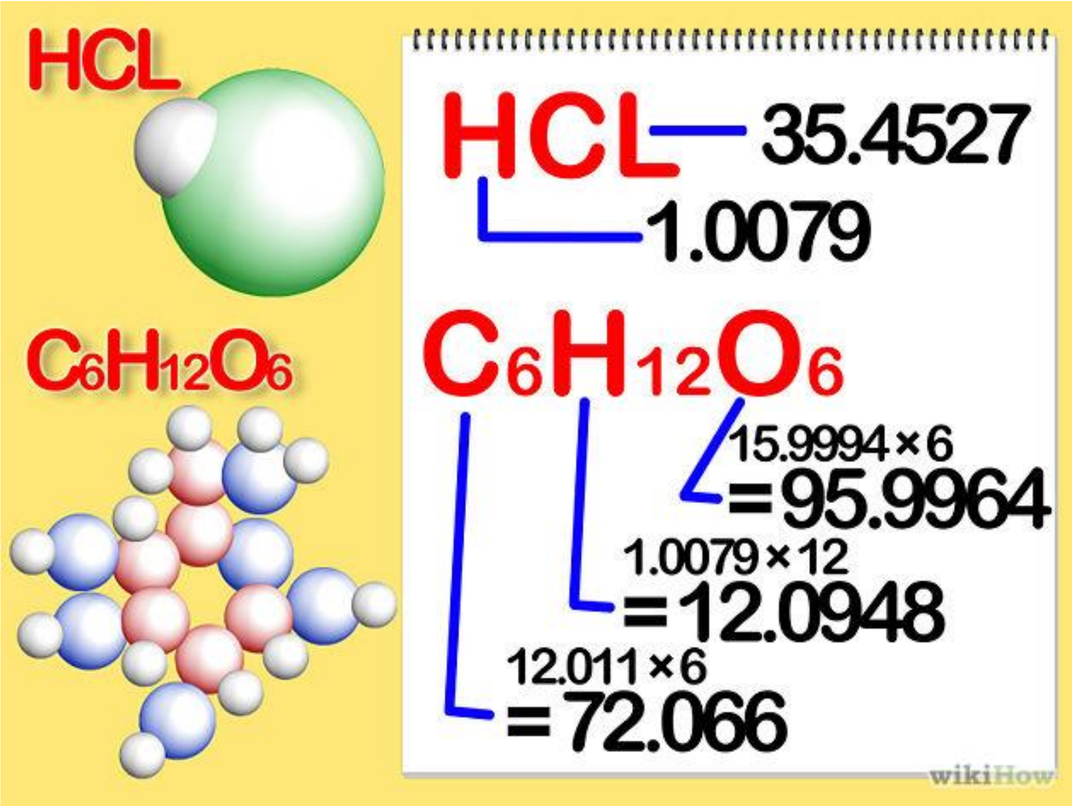
Four hydrogen nuclei (protons)	+	Two beta particles (electrons)	One helium nucleus	+ Energy

CALCULATING THE MOLAR MASS OF A COMPOUND

1 Find the chemical formula for the compound. This is the number of atoms in each element that makes up the compound. For example, the formula for hydrogen chloride (hydrochloric acid) is HCl; for glucose, it is $C_6H_{12}O_6$. This means that glucose contains 6 carbon atoms, 12 hydrogen atoms, and 6 oxygen atoms.



Find the molar mass of each element in the compound. Multiply the element's atomic mass by the molar mass constant by the number of atoms of that element in the compound. Here's how you do it:

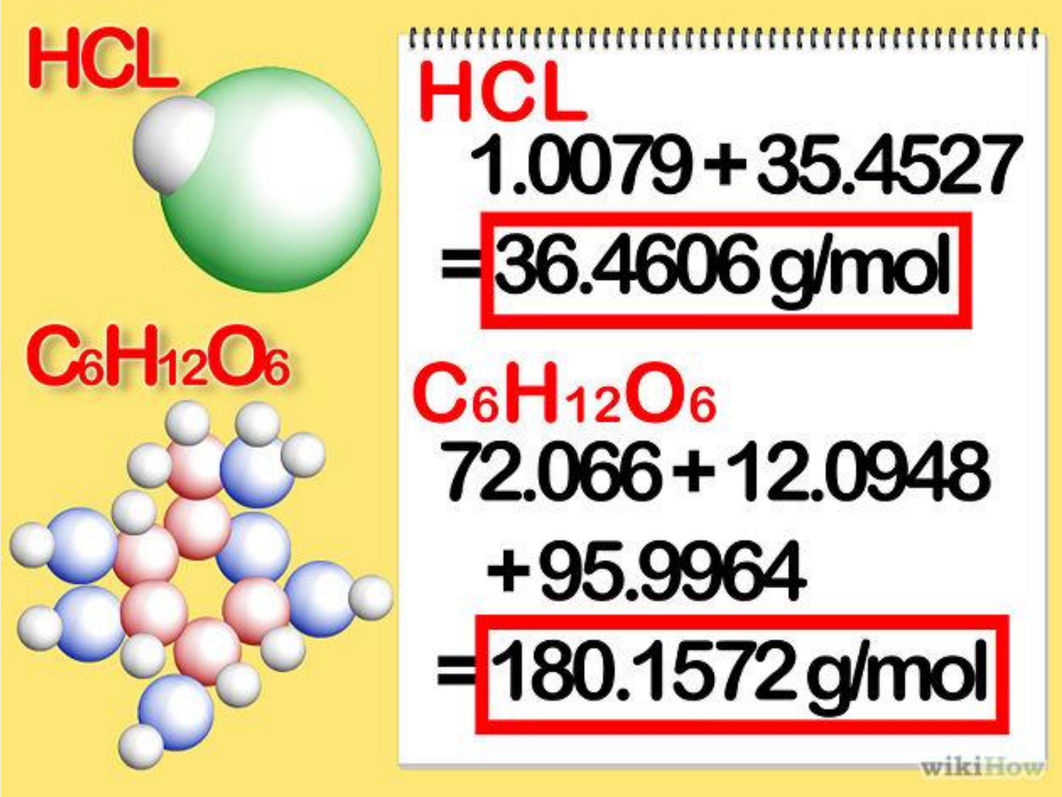


For hydrogen chloride, HCl, the molar mass of each element is 1.007 grams per mole for hydrogen and 35.453 grams per mole for chlorine.

For glucose, $C_6H_{12}O_6$, the molar mass of each element is 12.0107 times 6, or 72.0642 grams per mole for carbon; 1.007 times 12, or 12.084 grams per mole for hydrogen; and 15.9994 times 6, or 95.9964 grams per mole for oxygen.

MOLAR MASS

Add the molar masses of each element in the compound. This determines the molar mass for the compound. Here's how you do it:



For hydrogen chloride, the molar mass is 1.007 + 35.453, or 36.460 grams per mole.

For glucose, the molar mass is 72.0642 + 12.084 + 95.9964, or 180.1446 grams per mole.

CALCULATING ATOMIC MASS

Suppose you had 25, 2.00g marbles and 75, 3.00g marbles. What is the average mass of your marbles?

25marbles x 2.00g = 50g
75marbles x 3.00g = 225g

Total weight of Marbles = 275g

Average weight =275g/100 = 2.75g

OR simpler method is to multiple mass of marble by it's decimal percentage of the total and adding them up.

25% = .25 75% =.75

(2.00g x1.25) + (3.00 x 0.75) = 2.75g

Calculating Percent by Mass

- What is the percent by mass of metal in the compound copper II phosphate? ($Cu_3(PO_4)_2$)
- Find total mass
- Find mass due to the part
- Divide mass of part by total
- Multiply by 100

($Cu_3(PO_4)_2$)

subscript from P.T.

Cu 3 x 63.55 +

P 2 X 30.97 +

O 8 x 16.00 =

Total mass= 380.59 amu

Mass of metal = 190.7 amu

$$\frac{190.7}{380.59} \times 100 = 50.1\%$$

THE MOLE

1 dozen = 12

1 gross = 144

1 ream = 500

1 mole = 6.02×10^{23}

There are exactly 12 grams of carbon-12 in one mole of carbon-12.

DIATOMIC ELEMENTS

In nature these elements exist in pairs.

Therefore the atomic mass is doubled

The SUPER SEVEN- There are seven of them, It starts with element 7- nitrogen- forms a seven and has a superhero hat of hydrogen!

Diatomic elements	
H_2	Hydrogen
N_2	Nitrogen
O_2	Oxygen
F_2	Fluorine
Cl_2	Chlorine
Br_2	Bromine
I_2	Iodine

AVOGADRO'S NUMBER

6.02×10^{23} is called "Avogadro's Number" in honor of the Italian chemist Amadeo Avogadro (1776-1855).

Amadeo Avogadro

I didn't discover it. Its just named after me!

Points to Remember:

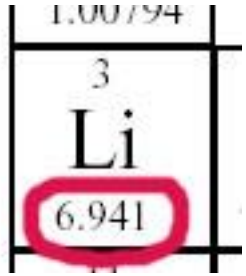
The elements mass taken in grams is equal to one mole

Every mole regardless of mass has

6.022×10^{23} particles in it

CALCULATIONS WITH MOLES:
CONVERTING MOLES TO GRAMS

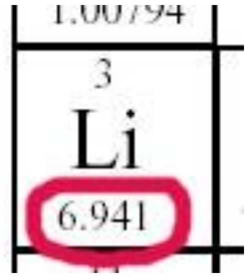
How many grams of lithium are in 3.50 moles of lithium?



3.50 ~~mol~~ Li	6.94 g Li	= 45.1 g Li
	1 ~~mol~~ Li	

CALCULATIONS WITH MOLES: CONVERTING GRAMS TO MOLES

How many moles of lithium are in 18.2 grams of lithium?



18.2 g Li	1 mol Li	=	2.62 mol Li
	6.94 g Li		

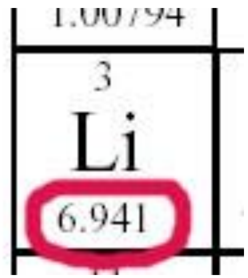
CALCULATIONS WITH MOLES:
USING AVOGADRO'S NUMBER

How many atoms of lithium are in 3.50 moles of lithium?

$$\frac{3.50\ \text{mol Li}}{} \left| \frac{6.022 \times 10^{23}\ \text{atoms Li}}{1\ \text{mol Li}} \right. = 2.11 \times 10^{24}\ \text{atoms Li}$$

CALCULATIONS WITH MOLES: USING AVOGADRO'S NUMBER

How many <u>atoms</u> of lithium are in 18.2 g of lithium?



18.2 ~~g~~ Li	1 ~~mol~~ Li	6.022×10^{23} atoms Li
	6.94 ~~g~~ Li	1 ~~mol~~ Li

$(18.2)(6.022 \times 10^{23})/6.94 = 1.58 \times 10^{24}$ atoms Li

DIATOMIC ELEMENTS

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Diatomic elements	
H_2	Hydrogen
N_2	Nitrogen
O_2	Oxygen
F_2	Fluorine
Cl_2	Chlorine
Br_2	Bromine
I_2	Iodine

CALCULATIONS DIATOMIC ELEMENTS:
CONVERTING GRAMS TO MOLES

How many moles of oxygen are in 18.2 grams of oxygen?

$$\frac{18.2\ \cancel{g}\ O_2}{} \times \frac{1\ mol\ O_2}{32.0\ \cancel{g}\ O_2} = 0.569\ mol\ O_2$$

CALCULATIONS DIATOMIC ELEMENTS:
CONVERTING MOLES TO GRAMS

How many grams of nitrogen need to be mass out if a 3.50 moles are required for a reaction?

3.50 ~~mol~~ Li	28.0 g N_2
	1 ~~mol~~

=98.0 g N_2

EXAMPLE #1

How many atoms of Carbon are in 2.25 moles of C?

$$2.25\,\text{mol C}\left(\frac{6.022\text{x}10^{23}\text{ atoms C}}{1\,\text{mol C}}\right) = 1.35\text{x}10^{24}\text{ atoms C}$$

EXAMPLE #2

How many grams are in 3.456 moles of Calcium?

$$3.456\ \text{mol Ca}\left(\frac{40.08\ \text{g Ca}}{1\ \text{mol Ca}}\right) = 138.1648 = 138.2\text{g Ca}$$

EXAMPLE #3

How many atoms are in 340g of Magnesium?

$$340\text{ g Mg}\left(\frac{1\text{ mol Mg}}{24.30\text{g Mg}}\right)\left(\frac{6.022\text{x}10^{23}\text{ atoms Mg}}{1\text{ mol Mg}}\right)=8.4\text{x}10^{24}\text{ atoms Mg}$$