Atom
Topic#4
AMSAT
Chem 1H

Student Edition

Finish flipchart by adding movies/animations/phet demonstrations and pictures

Atom
Quotes

“The nitrogen in our DNA, the calcium in our teeth, the iron in our blood, the carbon in our apple pies were made in the interiors of collapsing stars. We are made of starstuff.”
— Carl Sagan, Cosmos

“Protons give an atom its identity, electrons its personality.”
— Bill Bryson, A Short History of Nearly Everything

“Nothing is forever. Except atoms.”
— Dannika Dark, Gravity

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Identify the element or Symbol.

1. O
2. nitrogen
3. chlorine
4. Fe
5. mercury
6. Au
7. C
8. Cu
9. Cs
10. aluminum
11. sodium
12. K
13. F
14. neon
15. lithium
16. Ca
17. H
18. Ni
19. chromium
20. platinum
21. Cd
22. silver
23. zinc
24. lead
25. Sn
26. Sb
27. selenium
28. As
29. germanium
30. Si
31. P
32. sulfur
33. I
34. Br
35. barium
36. Mg
37. strontium
38. Rb
39. cobalt
40. osmium
41. Mn
42. Mo
43. tungsten
44. U
45. vanadium
46. I am Titanium!
47. Sc
48. plutonium
49. Fr
50. gallium

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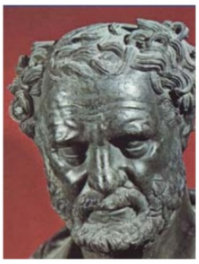
Foundations

History of the Atom

- Democritus - atomos
- Aristotle
  - did not believe in the idea of atoms
- 1700
  - Modern definition of an element was accepted
    - cannot be broken down by ordinary chemical means
    - chemical reaction produces NEW substance(s) with NEW properties
- Antoine Lavoisier
  - Law of Conservation of Matter
    - Matter cannot be created or destroyed



Democritus was an influential Ancient Greek pre-Socratic philosopher primarily remembered today for his formulation of an atomic theory of the universe. Democritus was born in Abdera, Thrace around 460 BC.

Antoine-Laurent de Lavoisier was a French nobleman and chemist central to the 18th-century Chemical Revolution and a large influence on both the histories of chemistry and biology. He is widely considered to be the "Father of Modern Chemistry."

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Foundations

- Joseph Proust
  - Law of constant composition
    - Any given compound will AWAYS contain the same proportion of elements by mass
- John Dalton
  - Law of Multiple proportions
    - the ratio of the masses of an element that exists in two similar compounds will be a whole number
      - consider CO_2 and CO

        1g C with 2.66g O (CO_2) and

        1g C with 1.33g O (CO)

        2.66/1.33 = 2

      thus the ratio of O in CO_2 and CO is in a ration of 2:1 by mass

Joseph Louis Proust was a French chemist. He was best known for his discovery of the law of constant composition in 1799, stating that in chemical reactions matter is neither created nor destroyed.

John Dalton FRS was ar English chemist, meteorologist and physicist. He is best known for his pioneering work in the development of modern atomic theory, and his research into colour blindness.

Foundations

Nitrogen Monoxide (NO)

mass of N: mass of O

↓

14:16

↓

$^{14}/_{14} : ^{16}/_{14}$

↓

1: 1.143

Nitrogen Dioxide (NO_2)

mass of N: mass of O

↓

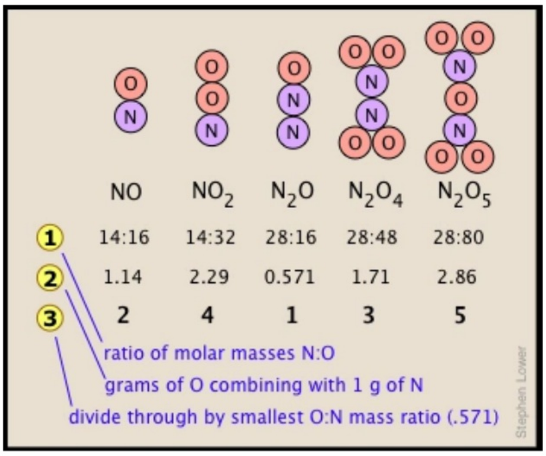
14:32

↓

$^{14}/_{14} : ^{32}/_{14}$

↓

1: 2.286



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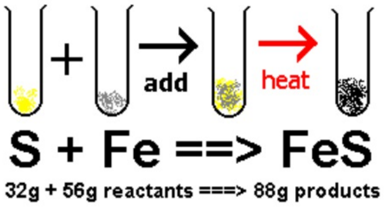
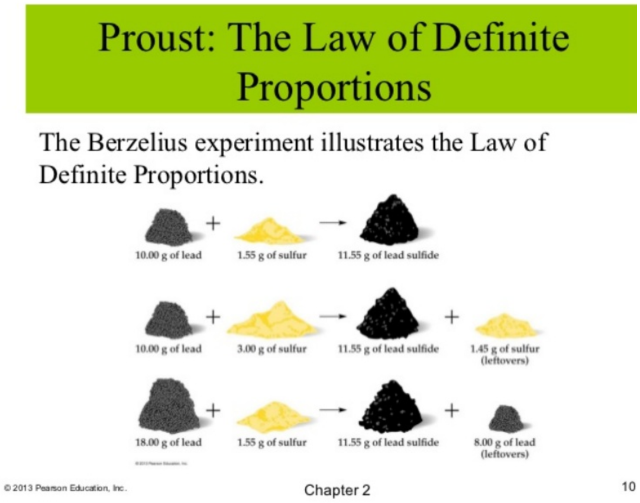
Atomic Theory

John Dalton and Atomic Theory

- ○ matter composed of atoms; smallest part of an element is an atom
- ○ element's atoms are the same in size, mass and properties; different atoms have different sizes, masses, and properties.
- ○ atoms can not be created or destroyed
- ○ atoms combine in simple whole number ratios to form compounds. A given compound has the same relative number and types of atoms: Law of Definite Proportions and Law of Multiple Proportions
- ○ Chemical reactions involve the rearrangement of atoms to form new substances with new properties. The mass of the reactants equals the mass of the products: Law of Conservation of Mass.





Proust: The Law of Definite Proportions

The Berzelius experiment illustrates the Law of Definite Proportions.

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Chapter 2

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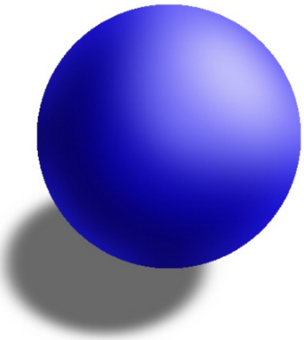
Atomic Theory

John Dalton

- BB Model - hard indestructible sphere



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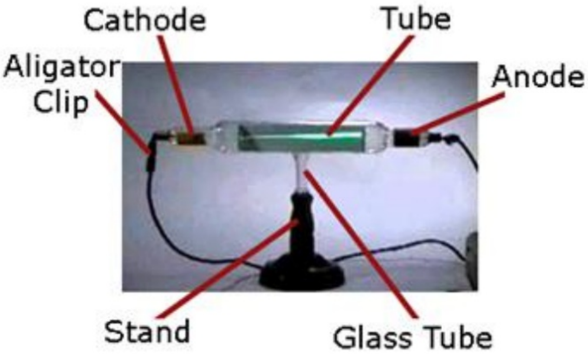
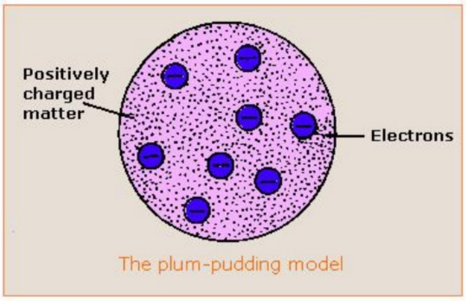
Electron

Discovery of the Electron

- JJ Thomson
  - discovered electron (1st particle discovered, why?)
    - cathode ray tube
    - cathode ray (stream of particles)
      - deflected by a magnet field
        - particles were negative
    - JJ measured the charge to mass ratio of the cathode ray particles (very large charge to mass)
    - ratio was always the same, regardless of the metal used to make the cathode or the nature of the gas
      - electrons present in all atoms
      - proved atoms were divisible
    - since atoms are electrically neutral, a positive charge is present to balance negative charge
      - these positive particles must be very massive in relationship to electrons due to the very low mass of electrons and the relative heavy mass of an atom
    - plum pudding model (pudding with raisins)
      - think of a chocolate chip cookie





The plum-pudding model

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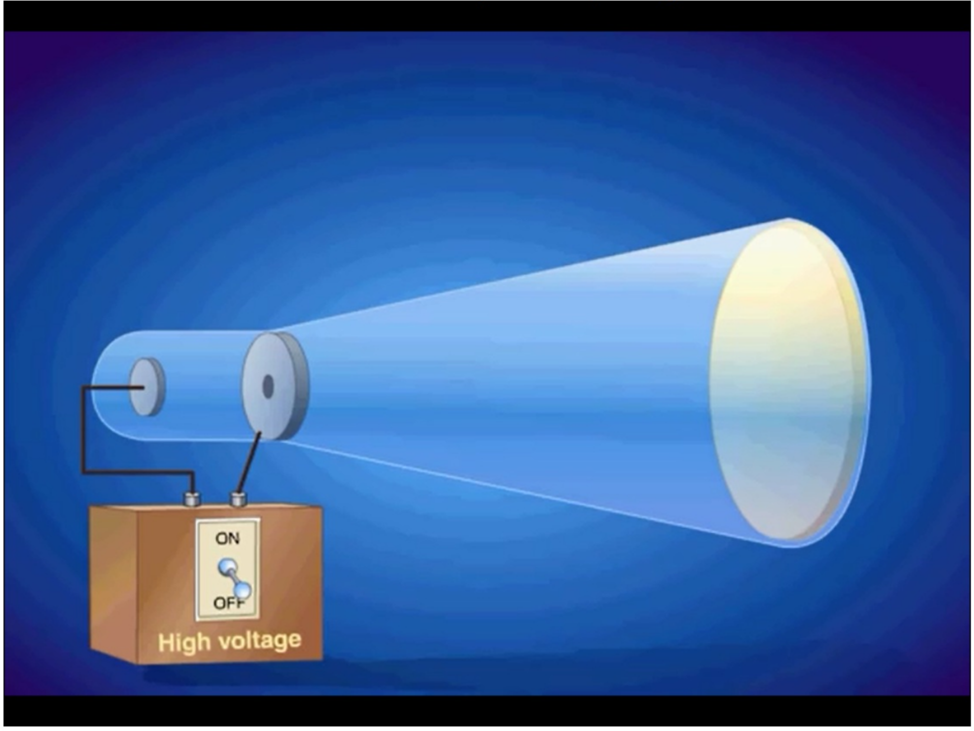
Electron

Cathode Ray Tube (CRT)



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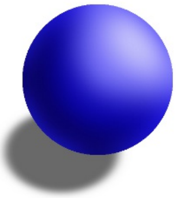
Electron

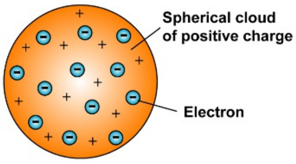
John Dalton

- BB Model - hard indestructible sphere



J.J. Thomson

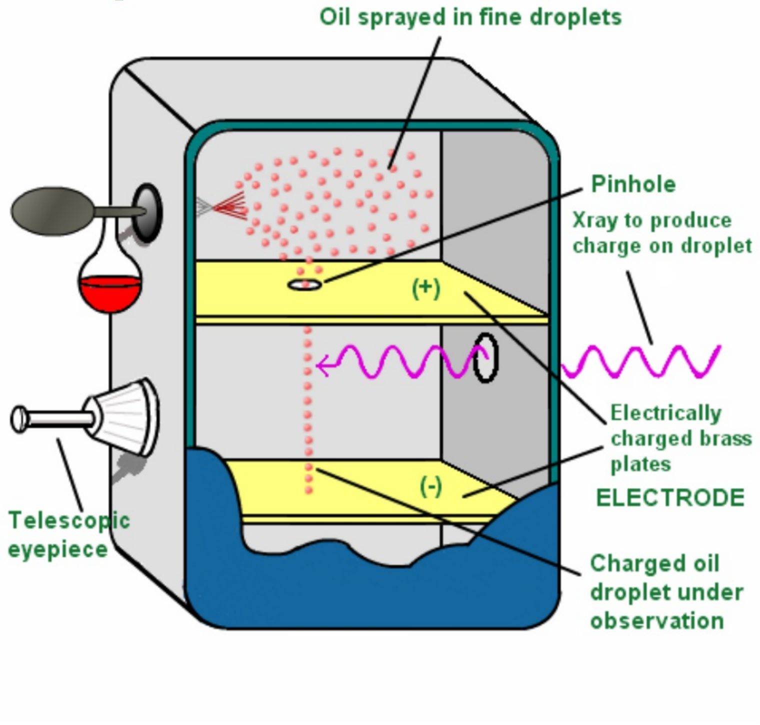
- Plum Pudding Model



Electron

Charge on an Electron

- Robert Millikan
  - oil drop experiment
  - determined charge of an elelctron
    - (-1.602x10^{-19} coulombs)
  - Scientists have since used this charge to calculate the mass of an electron
    - mass of e^- = 9.109x10^{-31}kg
    - 1/1837 the mass of H atom



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Electron

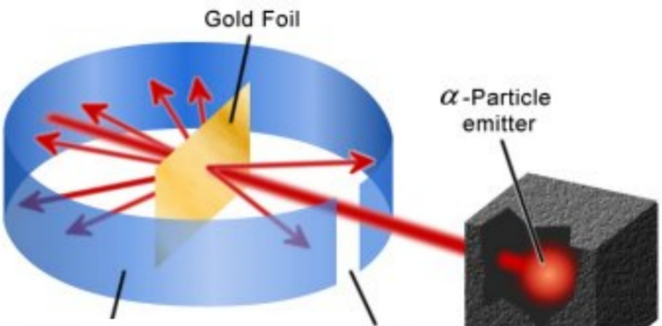
Millikan Oil Drop Experiment

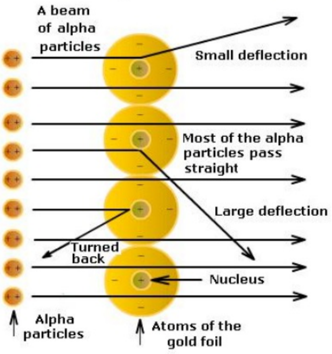
Millikan Oil Drop
Experiment

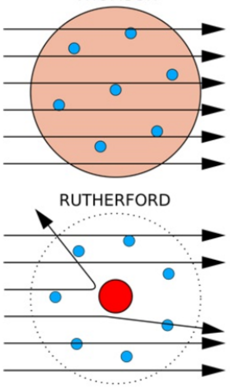
Nucleus

Discovery of the Atomic Nucleus

- Ernest Rutherford
  - discovered the nucleus, proton, and that the nucleus was condensed and very small
  - gold foil experiment
    - used alpha particles ${}^{4}_{2}He^{2+}$
    - wide angle deflections led to the conclusion that the atom must contain a very densely packed bundle of matter with a positive charge
    - volume of the nucleus was very small compared to the total volume of the atom
    - Still did not answer the question, "Where were the electrons?







Nucleus

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Rutherford Gold Foil Experiment

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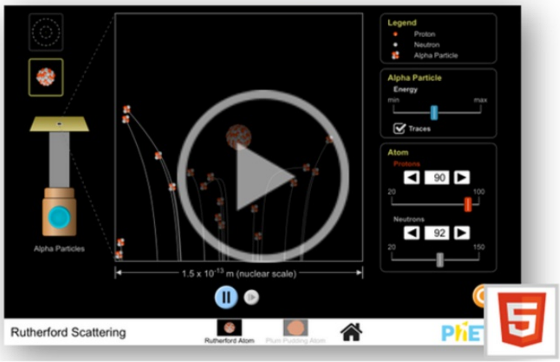
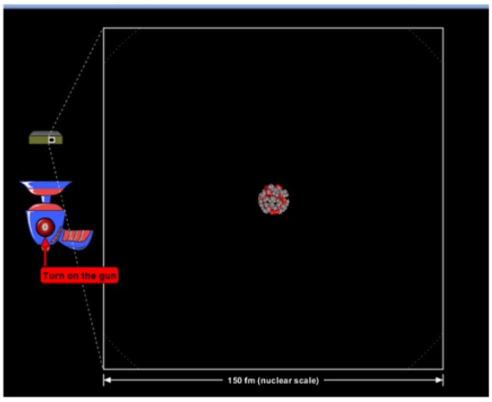
Nucleus

New (Internet)

Rutherford Scattering



Old (Without Internet)



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Nucleus

Composition of the Nucleus

	Symbols	Charge	Mass Number	Relative Mass (amu)	Actual Mass (kg)
- protons	p^+, $^{1}_{+1}p$	+1	1	1.007 276	$1.673\text{x}10^{-27}$
- neutrons	n^0, $^{1}_{0}n$	0	1	1.008 665	$1.675\text{x}10^{-27}$

$$^{1}_{0}\mathbf{n} \rightarrow {}^{1+}_{1}\mathbf{p} + {}^{0}_{-1}\mathbf{e}$$

Outside Nucleus

- electrons	e^-, $^{0}_{-1}e$	-1	0	0.000 549	$9.109\text{x}10^{-31}$

*1 amu (atomic mass unit) = $1.660\ 540\text{x}10^{-27}$kg

Nuclear Forces

strong and weak force

- the attraction between extremely close neutrons and protons

- Robert Moseley
  - discovered atomic number
    - the whole number of protons (+ charge) in nucleus
    - unique number for each of the elements

- James Chadwick
  - discovered the neutron

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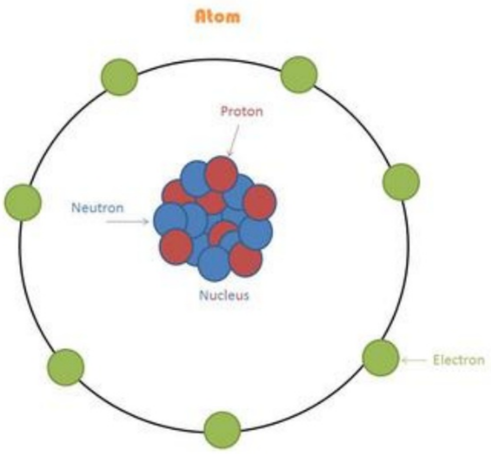
Nucleus

- compose of protons and neutrons
- <1% of the volume of an atom
- >99% of the mass of an atom
- protons and neutrons are called nucleons (related to klingons)
- $e^- + p^+ = n^0$
- holds nucleus together - weak and strong nuclear forces
- atom is neutral (no charge)
  - ion is charged (+ or -)
- coulombic force - an attractive/repulsive force between two charged particles (also called electrostatic force).
- Coulombic forces keep electrons around nucleus
  - gravity also plays a part in keeping electron around nucleus, but not nearly as strong as coulombic force



Isotopes

Isotopes

- same atoms with different number of neutrons
    - Hyphen-notation for an isotope (element name - mass number)
    - mass number (*A*) = protons + neutrons (the number of nucleons in an atom; mass of nucleus)
        - For example:

(1) a potassium atom with 19 protons and 20 neutrons

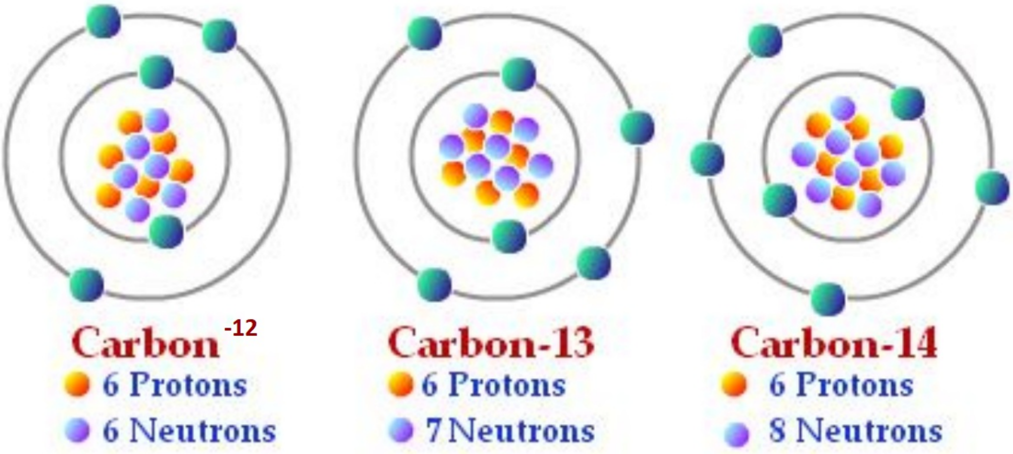
mass number = 19 + 20 = 39
element name - mass number
potassium - 39

(2) a potassium atom with 19 protons and 21 neutrons

mass number = 19 + 21 = 40
element name - mass number
potassium - 40

- nuclide is general term for isotope

Isotopes



$^{14}_{6}C$ $^{14}_{7}N$

$n \to p^+ + e^-$

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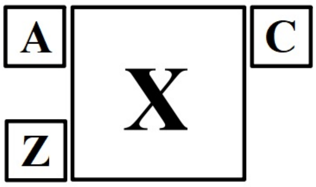
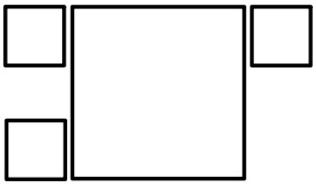
Isotopes

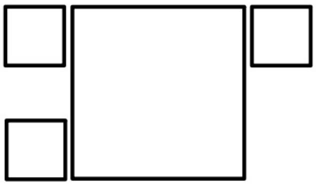
- nuclear (atomic) symbol - element symbol, mass number, and atomic number
  - General Form: ${}^{A}_{Z}\mathbf{X}$
    - A is mass number
    - Z is atomic number
    - **X** is the element symbol
  - mass number (A) is the mass of the nucleus ($A = p^+ + n^0$)
    - $\#n^0 = A - Z$ (Z = protons and electrons in an atom (neutral))
      - for potassium - 39; $\#n^0 = 39 - 19 = 20$
  - Example: potassium - 39; $A = 39$, $Z = 19$, and X is K
- complete chemical symbol - element symbol (**X**), mass number (A), atomic number (Z), and charge of the ion (**C**)
  - charge on ion: **C** = protons - elecctrons
    - the sodium ion has $11p^+$ and $10e^-$, so **C** = 11 - 10 = +1
    - the chlorine ion (chloride) has $17p^+$ and $18e^-$, so **C** = 17 - 18 = -1



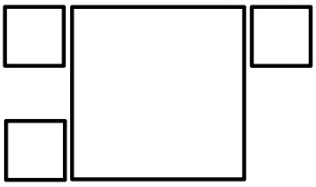
potassium - 39



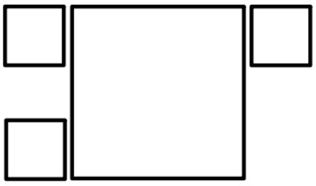
sodium - 22



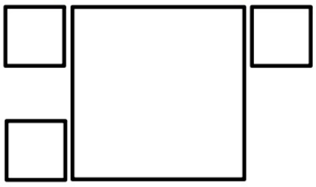
sodium - 22 (ion)



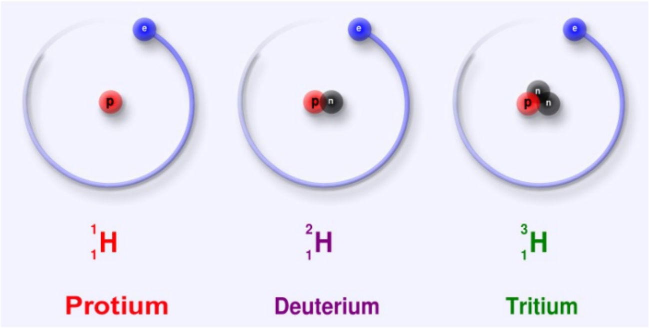
chlorine - 35



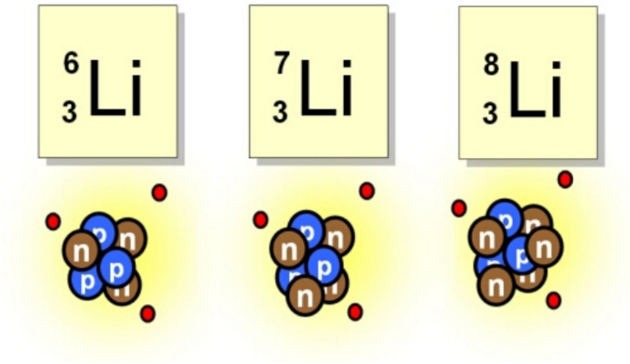
chlorine - 35
(ion: chloride)



Isotopes



D_2O - heavy water



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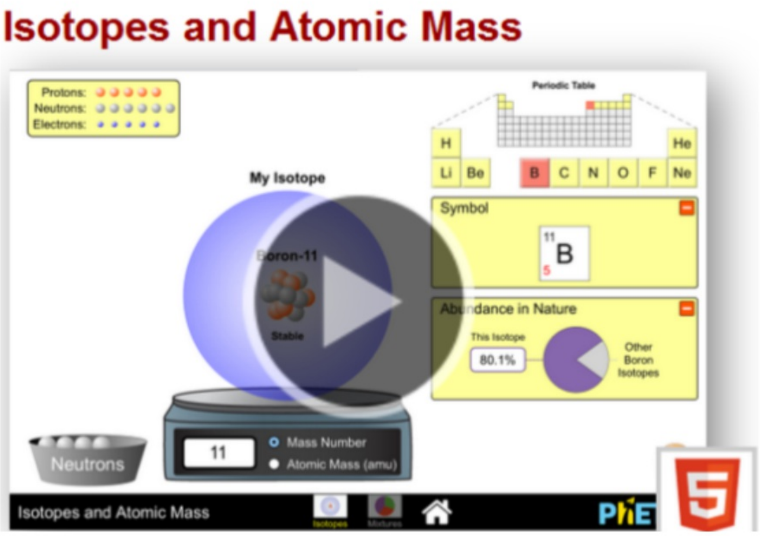
Isotopes



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Isotopes

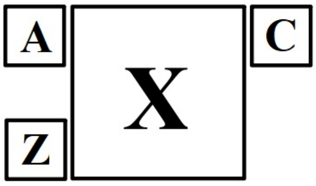
Sample WS#1 - Isotopes/Atomic Symbols/Complete Atomic Symbol

1. How many protons, electrons, and neutrons are in chlorine – 37? Write the atomic symbol for chlorine – 37. 2

#p =

#e = 3

#n =



A (mass#) = #p + #n = 5

Z (atomic#) = #p = 6

charge = #p - #e =

4. Write the complete chemical symbol for an ion with 8 protons, 10 electrons, and 8 neutrons.

#p =

#e =

#n =

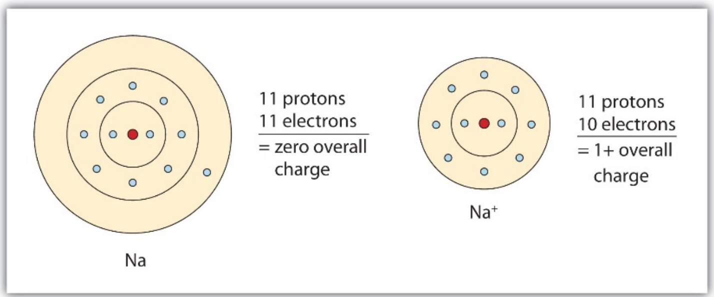
A (mass#) = #p + #n =

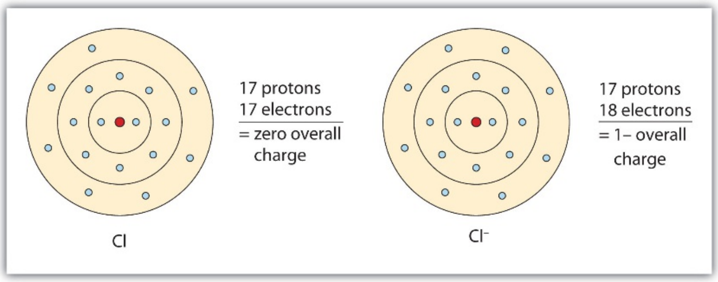
Z (atomic#) = #p =

charge = #p - #e =

Electrons and Ions

- Found in the space around the nucleus
- an atom can gain or lose electrons to form an **ion**.
- An ion with **more** electrons than the atom is an **anion** (negative ion since $e^- > p^+$)
- An ion with less **less** electrons than the atom is a **cation** (positive ion since $e^- < p^+$)





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Average Atomic Mass

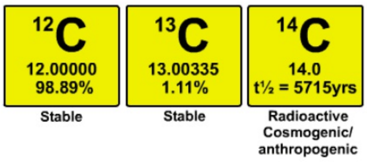
Average Atomic Mass/Relative Atomic Mass/Atomic Mass

- Atomic mass is the mass of 1 atom of an element
    - measured in atomic mass units (amu)
- Average (Relative) atomic mass is the average of all the isotopes of an element by mass
    - for a 100 g sample of copper, Cu
        - 69.17% is copper-63 (so copper-63 is 69.17 grams of the 100 gram sample)
        - 30.83% is copper-65 (so copper-65 is 30.83 grams of the 100 gram sample)
            - average atomic mass of copper is 63.55amu

Sample WS#1 - Average Atomic Mass

7. Using the oxygen data, determine the average atomic mass for oxygen.

8. Using the carbon data, determine the average atomic mass for carbon.



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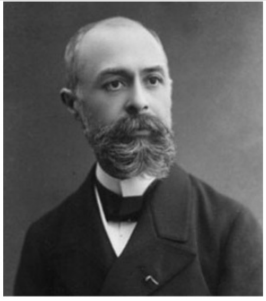
The Nuclear Atom

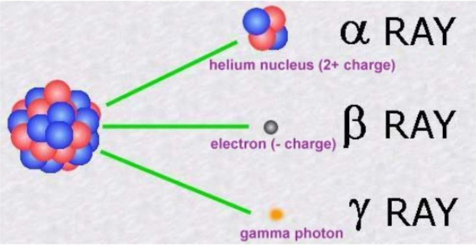


Henri Bequerel

- discovered radioactivity
- placed uranium on a photographic plate
  - showed image when developed

Marie and Pierre Curie

- worked with Bequerel
- discover radium and polonium



Radioactivity

- fundamental change to nucleus of atom
  - physical/chemical properties change too

Ernest Rutherford

- did experiement by placing a radioactive substance between charged plates
  - alpha radiation (+) bent towards negative plate and away from positive plate
  - beta radiation (-) bent towards positive plate and away from negative plate
  - gamma discovered later

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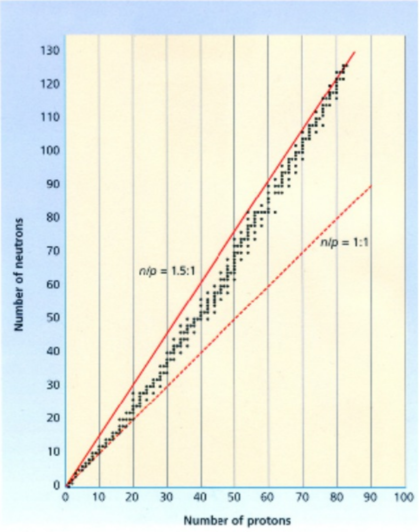
The Nuclear Atom



Three Types of Radiation

- alpha - helium nuclei ($^{4}_{2}\mathrm{He}^{2+}$)
- beta - high speed electron created from the breakdown of a neutron into a proton and en electron
  - increases the atomic number by 1 but mass number stays the same
- gamma - energy from nuclear reaction transformed into light
  - very high energy light
- Nucleons - protons and neutrons in the nucleus
- Nuclide - the actual isotope undergoing a nuclear reaction
- Nuclei
  - stable - do not undergo nuclear decay
  - unstable - any element over 83 and certain isotopes under 83
  - radioactive
  - above 83, no amount of neutrons (glue) can hold nuclei together
- Band of stability
  - nuclides with more/less neutrons than the most stable isotope are unstable

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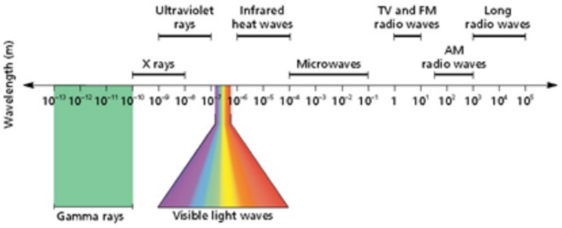
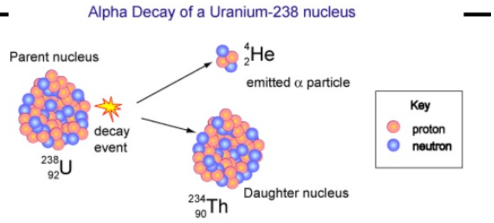
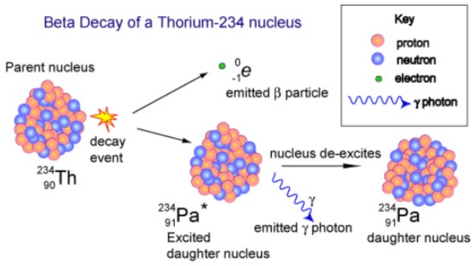
The Nuclear Atom

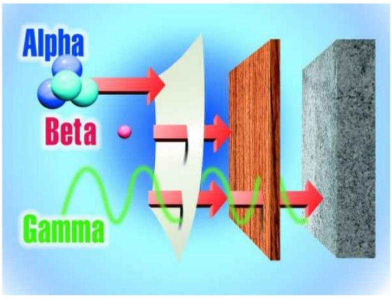
Types of Nuclear Decay

- ○ alpha (α)
  - emits an $^{4}_{2}He^{2+}$ particle
  - low penetrating power
  - source: nuclei splits into two daughter nuclei, one is the alpha particle
- ○ beta (β)
  - emits a $^{0}_{1-}e$ from the decay of a neutron into a proton and electron
  - medium penetrating power, stopped by heavy clothing
  - source: neutron in nucleus: $^{1}_{0}n \rightarrow {}^{1}_{1+}p + {}^{0}_{1-}e$
- ○ gamma (γ)
  - matter converted into energy and energy transmitted as light
  - high energy, high frequency, very short wavelength
  - high penetrating power, stopped by thick lead or concrete









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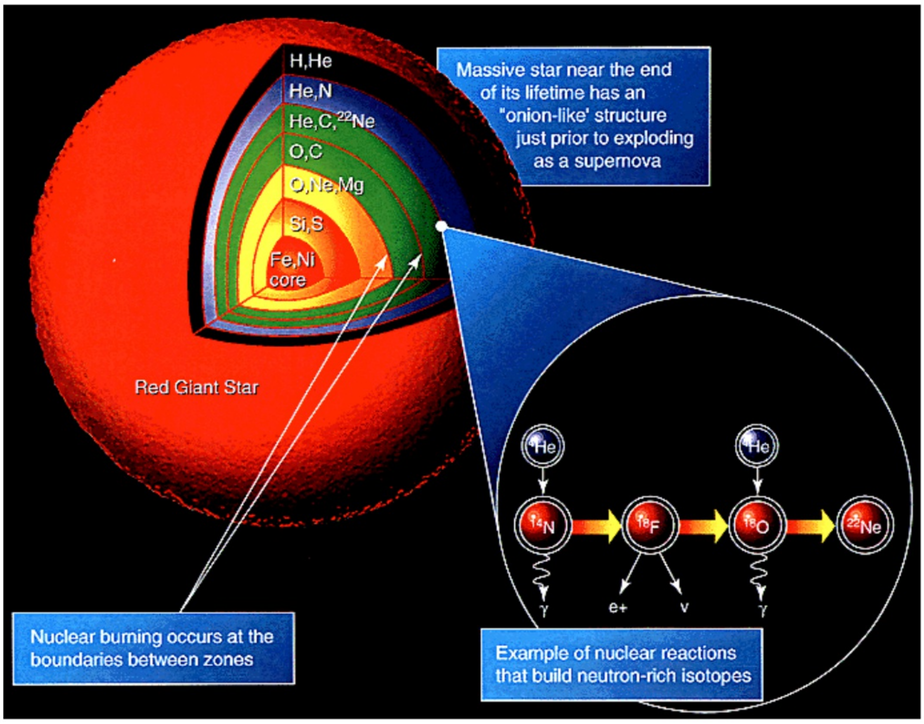
Nuclear Equations

Writing/Balancing Nuclear Reactions

- ○ alpha (α, $^{4}_{2}He^{2+}$) emission: $^{210}_{84}Po \rightarrow {}^{206}_{82}Pb + {}^{4}_{2}He^{2+}$
- ○ alpha (α, $^{4}_{2}He^{2+}$) capture (fusion): $^{12}_{6}C + {}^{4}_{2}He^{2+} \rightarrow {}^{16}_{8}O$
- ○ beta emission ($^{0}_{-1}\beta$ or $^{0}_{-1}e$): $^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}\beta$
- ○ positron emission ($^{0}_{+1}\beta$): $^{38}_{19}K \rightarrow {}^{38}_{18}Ar + {}^{0}_{+1}\beta$
- ○ electron capture: ($^{0}_{-1}e$): $^{106}_{47}Ag + {}^{0}_{-1}e \rightarrow {}^{106}_{46}Pd$

Nuclear Equations



Nuclear Reactions

Sample WS#2 – Balancing Nuclear Reactions

1. ${}^{230}_{93}\mathrm{Np} \rightarrow {}^{0}_{-1}\beta +$ _____
2. ${}^{9}_{4}\mathrm{Be} + {}^{4}_{2}\mathrm{He}^{2+} \rightarrow$ _____
3. ${}^{32}_{15}\mathrm{P} +$ _____ $\rightarrow {}^{33}_{15}\mathrm{P}$
4. ${}^{236}_{92}\mathrm{U} \rightarrow {}^{94}_{36}\mathrm{Kr} +$ _____ $+ 3{}^{1}_{0}n$
5. ${}^{43}_{19}\mathrm{K} \rightarrow {}^{43}_{20}\mathrm{Ca} +$ _____
6. ${}^{233}_{92}\mathrm{U} \rightarrow {}^{229}_{90}\mathrm{Th} +$ _____
7. ${}^{11}_{6}\mathrm{C} +$ _____ $\rightarrow {}^{11}_{5}\mathrm{B}$
8. ${}^{13}_{7}\mathrm{N} \rightarrow {}^{0}_{+1}\beta +$ _____

Nuclear Reactions

9. Write the nuclear equation for the release of an alpha particle by $^{210}_{84}Po$.

10. Write the nuclear equation for the release of a beta particle by $^{210}_{82}Pb$.

The Atom

Topic#4

Decay Series

- Series of radioactive nuclides produced by successive radioactive decay until a stable nuclide is produced.
- Heaviest nuclide of a decay series is called the parent nuclide
- Daughter nuclides are produced from a decay.
- All nuclides with a $Z > 83$ are unstable, therefore radioactive.
- Half-life is the amount of time for 50% of a given sample to decay.

Representative Radioactive Nuclides

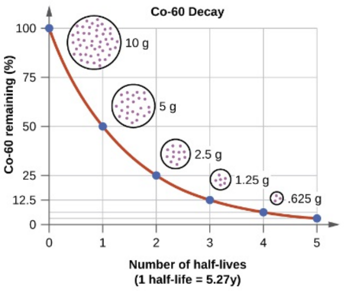
Nuclide	Half-Life	Nuclide	Half-Life
${}^{3}_{1}H$	12.32 years	${}^{214}_{84}Po$	163.7μs
${}^{14}_{6}C$	5715 years	${}^{218}_{84}Po$	3.0 min
${}^{32}_{15}P$	14.28 days	${}^{218}_{85}At$	1.6s
${}^{40}_{19}K$	1.3×10^{9} years	${}^{238}_{92}U$	4.46×10^{9} years
${}^{60}_{27}Co$	5.27 years	${}^{239}_{94}Pu$	2.41×10^{4} years

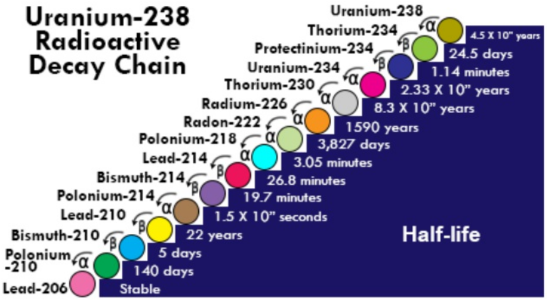
Topic#4

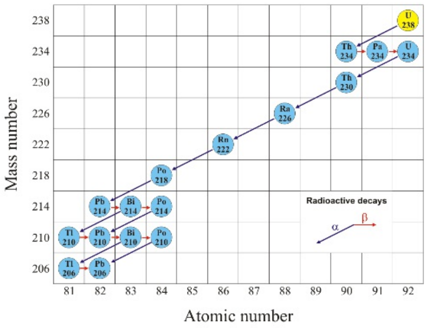
Stromatolites (Greek; layer, stratum)

Layered Ancient Accumulation of Cemented Biofilms

Decay Series







The Atom
Topic#4

Half-Life

m_i = initial mass
m_f = final mass
$t_{1/2}$ = half-life
$n_{1/2}$ = number of half-lives

$n_{1/2}$ = total time/half-life
$(1/2)^{n1/2}$ = % left (dec form or fraction)
% x $m_i = m_f$ or $m_f = m_i$ x $(1/2)^n$
$t_T = n_{1/2}$ x $t_{1/2}$

Sample WS#2 - Half-Life

11. Phosphorus-32 has a half-life of 14.3 days. How many milligrams of phosphorus-32 remain after 57.2 days if you start with 4.0mg of the isotope? (Ans: 0.25mg)

The Atom
Topic#4

Half-Life

m_i = initial mass
m_f = final mass
$t_{1/2}$ = half-life
$n_{1/2}$ = number of half-lives

$n_{1/2}$ = total time/half-life
$(1/2)^{n1/2}$ = % left (dec form or fraction)
% x $m_i = m_f$ or $m_f = m_i$ x $(1/2)^n$
$t_T = n_{1/2}$ x $t_{1/2}$

12. Assuming a half-life of 1599 years, how many years will be needed for the decay of 15/16 of a given amount of radium-226? (Ans: 6396 years)

The Atom
Topic#4

Half-Life

m_i = initial mass
m_f = final mass
$t_{1/2}$ = half-life
$n_{1/2}$ = number of half-lives

$n_{1/2}$ = total time/half-life
$(1/2)^{n1/2}$ = % left (dec form or fraction)
% x $m_i = m_f$ or $m_f = m_i$ x $(1/2)^n$
$t_T = n_{1/2}$ x $t_{1/2}$

13. What is the half-life of a radioactive isotope if a 500.0g sample decays to 62.5g in 24.3 hours? (Ans: 8.1 hours)

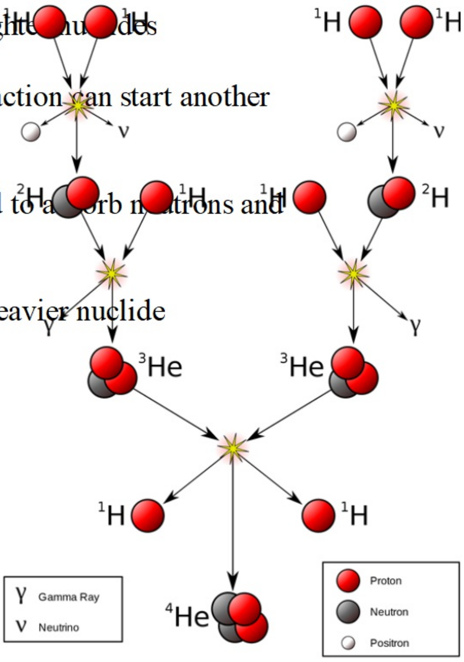
Nuclear Fission and Fusion

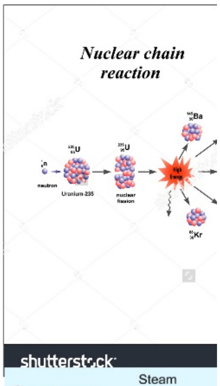
Fission

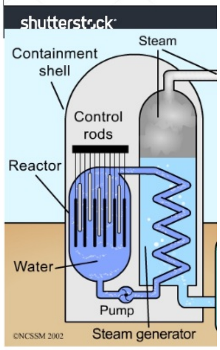
- Heavy nuclide splits into smaller daughter nuclides
- Nuclear chain reaction
    - a reaction where a product of a reaction can start another reaction (neutrons)
    - used in nuclear power plants
        - Moderator (control rod) is used to absorb neutrons and control the chain reaction

Fusion

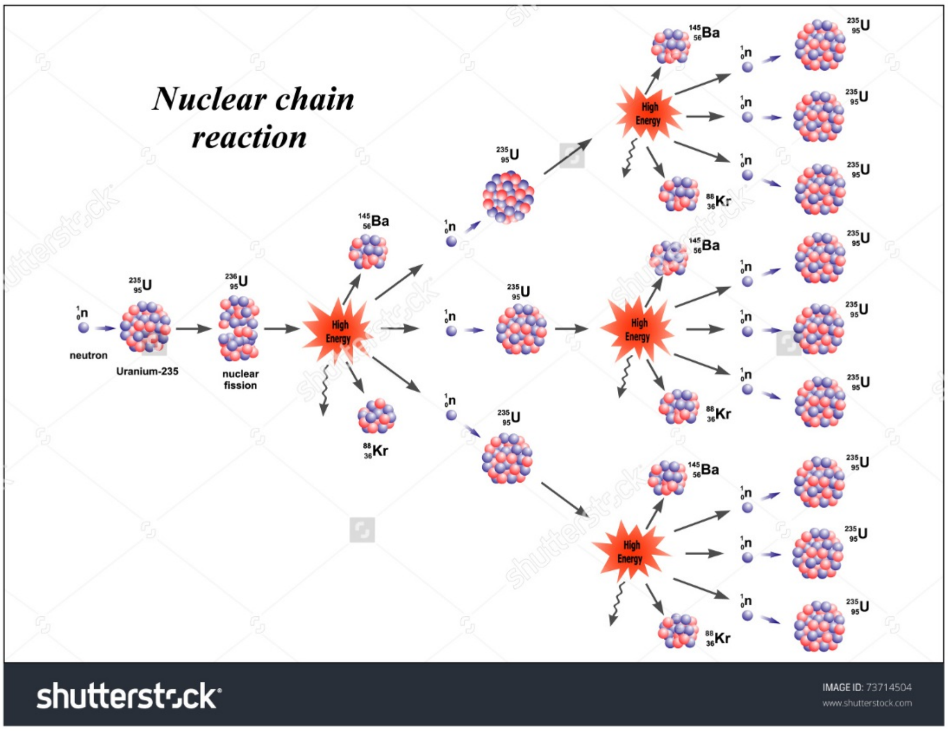
- Smaller nuclides combine to form a heavier nuclide



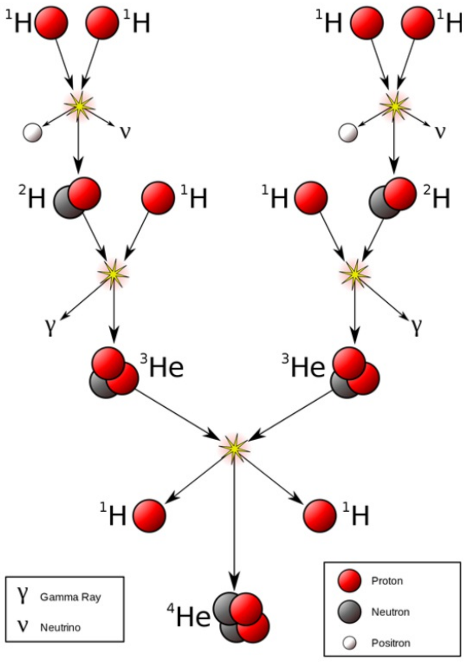


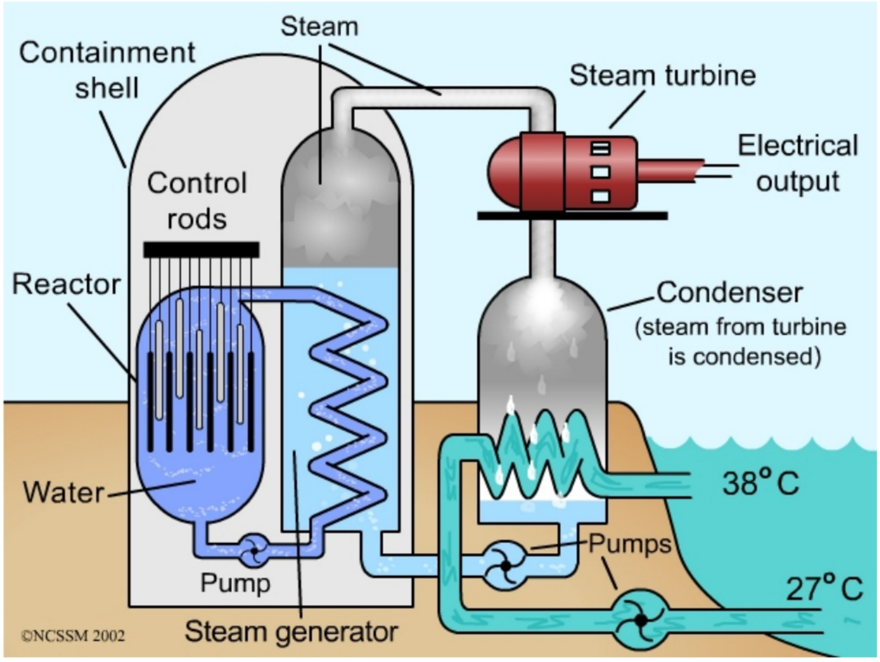


Nuclear Fission and Fusion



Nuclear Fission and Fusion




Steam
Containment shell
Steam turbine
Electrical output
Control rods
Reactor
Condenser (steam from turbine is condensed)
Water
38°C
Pumps
27°C
Pump
Steam generator
©NCSSM 2002

The Mole

Intro To Moles

12 items in a dozen and 12 dozen in a gross

5280ft = 1 mile

200carats = 1g

1. How many inches in 0.2500miles? Ans: 15,840 inches

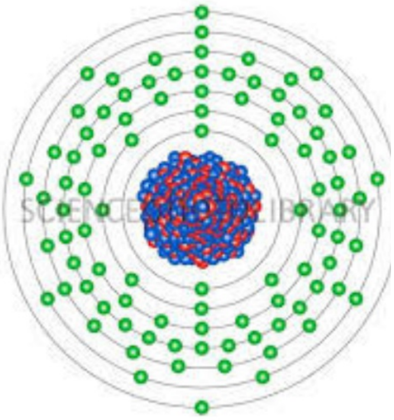
2. How many carats in .0045kg? Ans: $9.0\text{x}10^2$ carats

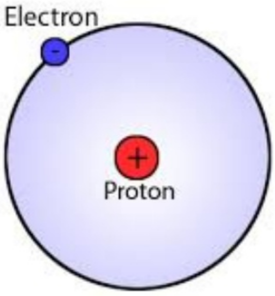
3. How many eggs are in 44 gross of eggs? Ans: 6300 eggs

The Mole

Demo

- illustrate mass vs mole using 1g of H vs. 1g of U
    - why can't we compare them by mass?
        - many more parts of H in 1 gram H than U
            - U is about 238 times bigger than H
    - whereas 1 mole of H and 1 mol of U have the same number of particles
- What is the mass of the iron in this erlenmeyer flask?
    - The Fe atom has an average atomic mass of 55.85amu
    - A mole of Fe atoms has a mass of 55.85g
        - direct conversion between amu and grams
- What is the mass of 1 mole of water here in this flask?
- 4 particles in chemistry (ion, atom, molecule, and formula unit (f.u.))
- What is the particle of NaCl?
    - Always has a metal in it
- What is the particle in carbon?
- What is the particle in dextrose? Water?





The Atom
Topic#4

The Mole

- The mole is the SI unit for amount
- It represents 6.022×10^{23} particles (Avogadro's number)
- Particles in chemistry: ions, atoms, molecules, and formula units

1g of H	vs.	1g of U
1.01amu		238.03amu
small atom		very large atom

1g of H has 238 times more atoms than 1g of U

1mol of H	vs.	1mol of U
1.01g		238.03g
6.022×10^{23} atoms H		6.022×10^{23} atoms U

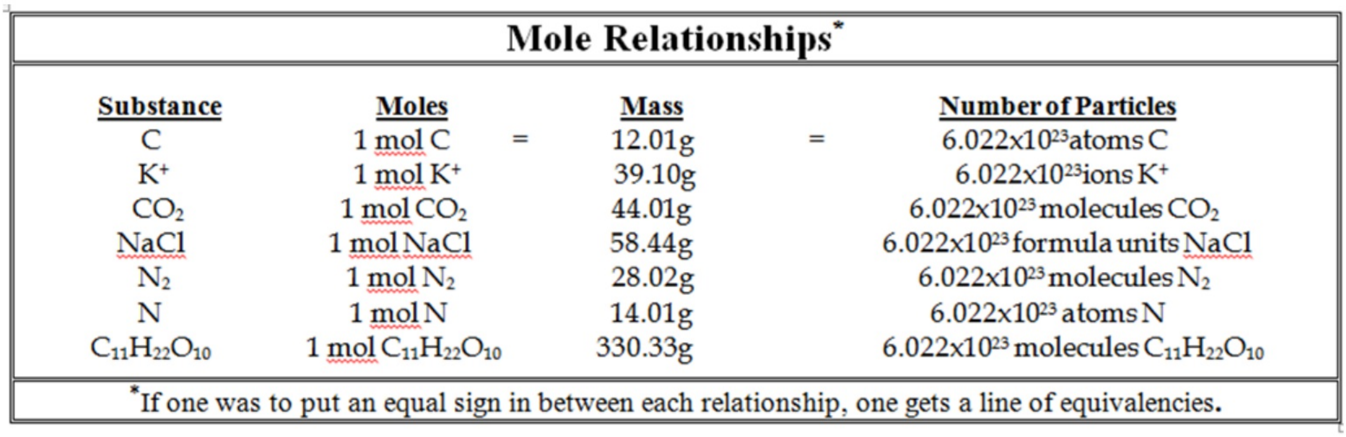
(Demo: Erlenmeyer flasks with various moles of substances)

602,200,000,000,000,000,000,000

6.022×10^{23}

The Atom
Topic#4

The Mole



Mole Relationships*

Substance	**Moles**		**Mass**		**Number of Particles**
C	1 mol C	=	12.01g	=	6.022×10^{23} atoms C
K^+	1 mol K^+		39.10g		6.022×10^{23} ions K^+
CO_2	1 mol CO_2		44.01g		6.022×10^{23} molecules CO_2
NaCl	1 mol NaCl		58.44g		6.022×10^{23} formula units NaCl
N_2	1 mol N_2		28.02g		6.022×10^{23} molecules N_2
N	1 mol N		14.01g		6.022×10^{23} atoms N
$C_{11}H_{22}O_{10}$	1 mol $C_{11}H_{22}O_{10}$		330.33g		6.022×10^{23} molecules $C_{11}H_{22}O_{10}$

*If one was to put an equal sign in between each relationship, one gets a line of equivalencies.

The Atom
Topic#4

The Mole

- Formula mass (*FM*) - mass of part in amu's
  - formula mass for hydrogen is 1.00794 amu, round all formula masses to the hundreth, 1.01am
  - formula mass for oxygen is 15.9994amu, or 16.00amu
  - formula mass for $H_2O = 2H + O = 2(1.01\text{amu}) + 16\text{amu} = 18.02\text{amu}$
- Molar mass (*MM*) - the mass of 1 mole (6.022×10^{23} particles) of a substance in grams
  - To calculate molar mass, convert formula mass into grams, for H the 1.10amu becomes 1.01grams and oxygen 16.00amu becomes 16.00 grams
  - $H_2O = 2H + O = 2(1.01\text{g}) + 16\text{g} = 18.02\text{g/mol}$
  - can be used as a conversion factor; $\frac{18.02\text{g}}{1\text{ mole}}$ or $\frac{1\text{ mole}}{18.02\text{g}}$

- $CuSO_4 \bullet 5H_2O = Cu + S + 4O + 10H + 5O = 63.55+32.07+4(16)+10(1.01)+5(16) = 249.69\text{g}$
- $Fe(NO_3)_3 = Fe + 3N + 9O = 55.85 + 3(14.01) + 9(16) = 241.88\text{g}$

The Atom
Topic#4

The Mole

Sample WS #3: Molar Mass Sample Problems

1. What is the formula mass for H^{1+}, Cl^{1-}, H_2, HCl, $C_6H_{12}O_6$, and $Ni_3(PO_4)_2$?

2. What is the molar mass of HCl?

3. What is the molar mass of $C_6H_{12}O_6$?

4. (OYO) What is the molar mass of $Ca_3(PO_4)_2$?

5. (OYO) What is the molar mass of $Ni_3(PO_3)_2$ ● $7H_2O$?

The Atom
Topic#4

The Mole

moles to mass: multiply by MM

mass to moles: divide by MM

moles to particles: multiply by Avogadro's number ($6.022x10^{23}$)

particles to moles: divide by Avogadro's number ($6.022x10^{23}$)

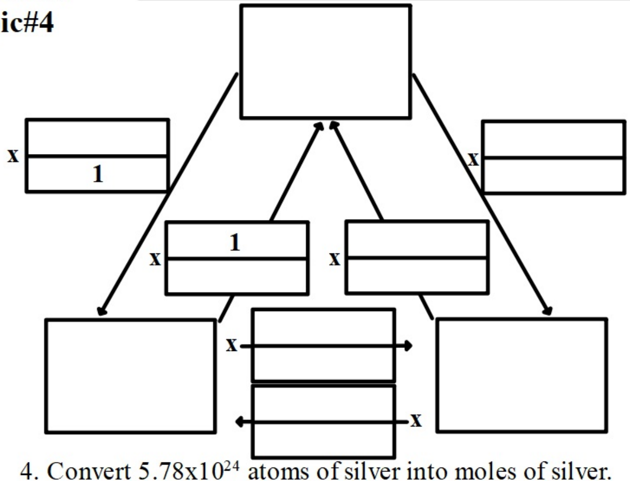
mass to particles: divide by MM, multiply by Avogadro's number ($6.022x10^{23}$)

particles to mass: divide by Avogadro's number ($6.022x10^{23}$), multiply by MM

The Mole

Using the terms below, create a conversion chart for mole conversions.

ions 6.022×10^{23}parts atoms
Moles formula units **Mass**
MM **Parts** molecules
6.022×10^{23} parts 6.022×10^{23} parts
MM 6.022×10^{23} parts *MM*
MM 1 mol
1 mol



1. Convert 2.78 moles of silver into grams of silver.
(given) (conversion) (answer/label)
=

2. Convert 45.6 grams of silver into moles of silver.
(given) (conversion) (answer/label)
=

3. Convert 2.78 moles of silver into atoms of silver.
(given) (conversion) (answer/label)
=

4. Convert 5.78×10^{24} atoms of silver into moles of silver.
(given) (conversion) (answer/label)
=

5. Convert 45.6 grams of silver into atoms of silver.
(given) (conversion) (answer/label)
=

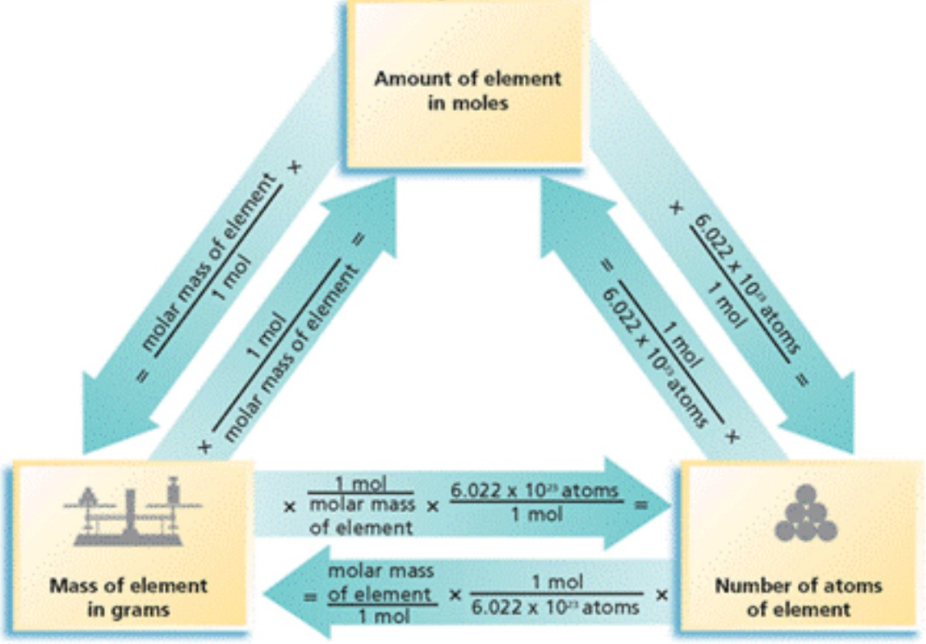
6. Convert 5.78×10^{24} atoms of silver into grams of silver.
(given) (conversion) (answer/label)
=

The Mole

Using Moles:

1 mol = 6.022×10^{23} parts

MM = grams/moles



The Atom
Topic#4

The Mole

Using Moles:
1 mol = 6.022×10^{23} parts
***MM* = grams/moles**

Moles/Grams/Parts Conversions

6. (OYO) What is the mass in grams of 3.50mol of the element copper? (Ans: 222g)

7. (OYO) How many moles of calcium nitrate, $Ca(NO_3)_2$, are in 50.0g? (Ans: 0.305mol)

The Mole

Using Moles:
1 mol = 6.022x10^{23}parts
***MM* = grams/moles**

8. (OYO) How many moles of Ag are in 3.01x10^{23} atoms of Ag? (Ans: 0.500 mol Ag)

9. (OYO) How many molecules of CH_2O are in 0.928mol of CH_2O? (Ans: 5.59x10^{23}molecules)

The Atom
Topic#4

The Mole

Using Moles:
1 mol = 6.022×10^{23}parts
***MM* = grams/moles**

10. (OYO) How many formula units are in 35.5g of $MgCl_2$? (Ans: 2.25×10^{23} f.u.'s)

11. (OYO) What is the mass in grams of 9.65×10^{25} molecules of H_2O? (Ans: 2.89×10^{3} grams)