# The Atom

**Atoms are the building blocks of the universe**

## Charged Particles

Like charges repel
Opposite charges attract

## Attract or Repel?

| Particle 1 | Particle 2 | Behavior |
|---|---|---|
| +1 | +1 | Repel |
| +1 | -1 | Attract |
| -1 | +1 | Attract |
| -1 | -1 | Repel |

## Dalton's Atomic Theory

Each element composed of tiny particles called atoms.

Atoms are indivisible; they cannot be created or destroyed (No!)

Element atoms are identical in every respect. (No!)

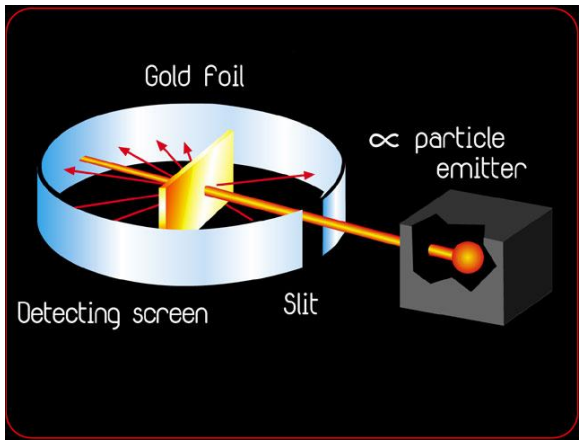
Element atoms are unique

All atoms of one element have the same mass.
Atoms of two different elements have different masses

Atoms of one element combine with atoms of another element to form chemical compounds (ratio of small, whole numbers) (Law of Multiple Proportions)

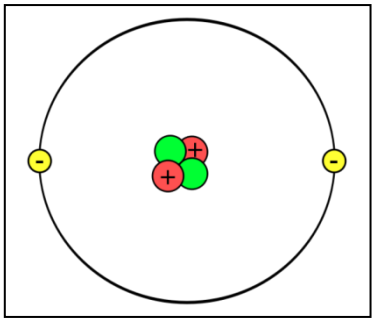
## Nuclear Atom

Rutherford's Experiments (Alpha Scattering)



**Rutherford's Model Atom**

Most mass concentrated in a small, dense core
Positive charge located at core
Thinly populated outer region carries negative charge
Same number of positive and negative charges
**For He atom: If Nucleus the size of a penny,**
**Atom sphere = the size of the pentagon**




Helium Atom:
2 protons
2 neutrons
2 electrons

**Primary Subatomic Particles**

| Particle | Location (Nucleus) | Charge | Mass (g) | Mass (amu) |
|---|---|---|---|---|
| **Neutron ($n^0$)** | **Inside** | **0** | **$1.675 \times 10^{-24}$** | **1.00867 (~1)** |
| **Proton ($p^+$)** | **Inside** | **+1** | **$1.673 \times 10^{-24}$** | **1.00728 (~ 1)** |
| **Electron ($e^-$)** | **Outside** | **-1** | **$9.11 \times 10^{-28}$** | **0.000549 (~0)** |

**Mass Order: n > p >> e**

**Rutherford's Planetary Model Atom**
Nucleus at the center
Electrons "orbit" the nucleus
No longer accepted 'cause it does not adequately describe behavior

**Current belief:**

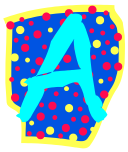
Electrons don't "orbit" the nucleus (Planetary Model)
Electrons exist in regions of space called Orbitals
(Orbitals are probability math functions of finding an electron)
It is not possible to measure the path of an electron

**Element Nomenclature**

**Atomic Number (Z)**

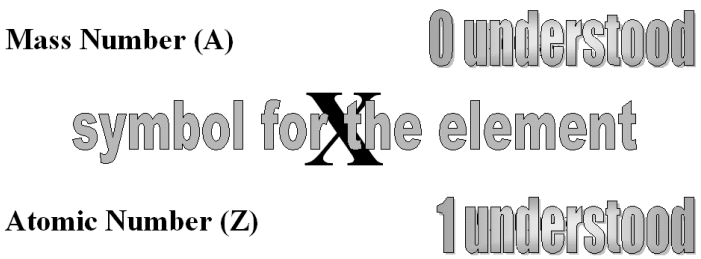

# of protons in the nucleus
Determines identity
Atoms of the same element have same Z
Z = # of p & # of e in an uncharged atom

**Mass Number (A)**




Sum of the # of protons + # of neutrons
# neutrons = A - Z
# neutrons = A ($\#p^+ + \#n^0$) - Z ($\#p^+$)
No relationship between number of n & p
(knowing Z, does not imply A or number of neutrons)

**Nuclide Notation**




**Nuclide Nomenclature**

**Carbon**

**12**
**C**
**6**

Number Protons = 6
Number Neutrons (12 – 6) = 6
Number Electrons = 6

**Oxygen**

**16**
**O**
**8**

Number Protons = 8
Number Neutrons (16 – 8) = 8
Number Electrons = 8

**Gold**

**197**
**Au**
**79**

Number Protons = 79
Number Neutrons (197 – 79) = 118
Number Electrons = 79

**Sodium**

**23**
**Na**
**11**

Number Protons = 11
Number Neutrons (23 – 11) = 12
Number Electrons = 11

**82**
**Kr** **Krypton**
**36** Number Protons = 36
Number Neutrons (82 – 36) = 46
Number Electrons = 36

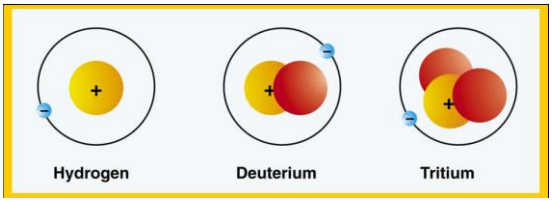
**84**
**Kr** **Krypton**
**36** Number Protons = 36
Number Neutrons (84 – 36) = 48
Number Electrons = 36

**Isotopes**

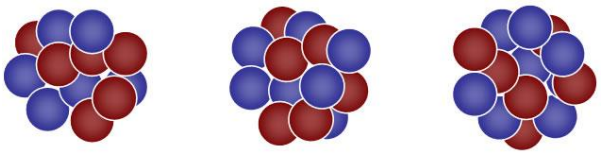
Atoms having the same atomic number (Z),
but different mass numbers (A)

Atoms with the same # protons, but different # neutrons
Atoms of the same element, but different masses

**Isotopes of Hydrogen**




**Isotopes of Carbon**

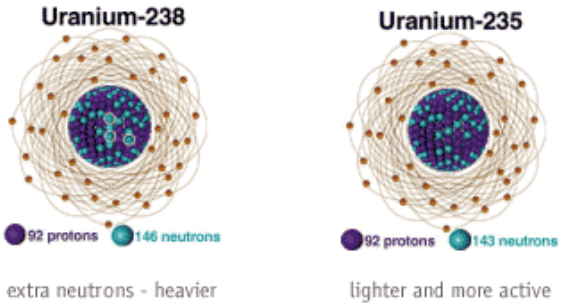


carbon-12
98.9%
6 protons
6 neutrons

carbon-13
1.1%
6 protons
7 neutrons

carbon-14
<0.1%
6 protons
8 neutrons

## Isotopes of Uranium




## Isotopes?

| | | |
|---|---|---|
| $^{23}_{11}Na$ | $^{24}_{11}Na$ | Yes |
| $^{238}_{92}U$ | $^{235}_{92}U$ | Yes |
| $^{238}_{92}U$ | $^{238}_{94}Pu$ | No |

## Naming Isotopes

Element name - mass number
Carbon-12, Carbon-13 and Carbon-14
Uranium- 235 & Uranium-238

What is the nuclide symbol for iron-56?

$^{56}_{26}Fe$

How many neutrons in this atom?
30 (56 – 26)

**Naming Nuclide Symbols**

| Nuclide | Protons | Electrons | Neutrons | |
|---|---|---|---|---|
| $^{9}_{4}Be$ | 4 | 4 | 5 | Beryllium-9 |
| $^{82}_{36}Kr$ | 36 | 36 | 46 | Krypton-82 |
| $^{84}_{36}Kr$ | 36 | 36 | 48 | Krypton-84 |

**Atomic Mass Units (AMU or Daltons)**

Mass of atoms in grams is small
Unit of mass (AMU) was defined (also called Da , for Daltons)
Mass of carbon-12 atom = exactly 12 amu
Newer term: Unified Mass Unit (u)

Both amu and u defined as mass exactly 1/12 of carbon-12 atom

**Atomic Mass (Weighted Average)**
**For Carbon**

**Carbon -12 (12.00000 amu) 98.13%**
**Carbon -13 (13.00354 amu) 1.07%**
**Carbon- 14 (14.00324 amu) trace (~ $10^{-10}$ %)**

**Atomic Mass = 12.01 amu (weighted average)**
**There is no actual atom with mass of 12.01 am**

Radioactive isotope decay alters amounts of isotopes

Over generations, atomic weights will change

**Periodic Tables Beginning to Reflect Different Global Distributions**

| Element | Range |
|---|---|
| Hydrogen | 1.00784 - 1.00811 |
| Lithium | 6.938 - 6.970 |
| Boron | 10.806 - 10.824 |
| Carbon | 12.0096 - 12.0116 |
| Nitrogen | 14.00643 - 14.00728 |
| Oxygen | 15.99903 - 15.99977 |
| Silicon | 28.084 0 - 28.0855 |
| Sulfur | 32.059 - 32.076 |
| Chlorine | 35.446 - 35.457 |
| Thallium | 204.382 - 204.385 |

## Assignment

Start Taking Unit 4 Practice Test
Blackboard only records highest score
Take until multiple 100's have been scored (questions are variable)
(Gives sense of test exam format and content)

**The Practice Quiz is very similar to the Unit Exam**

**Success on Unit exam is directly related to practice exam experiences**

Continue memorizing:
Polyatomic Ions
Elemental Symbols