# Atomic structure

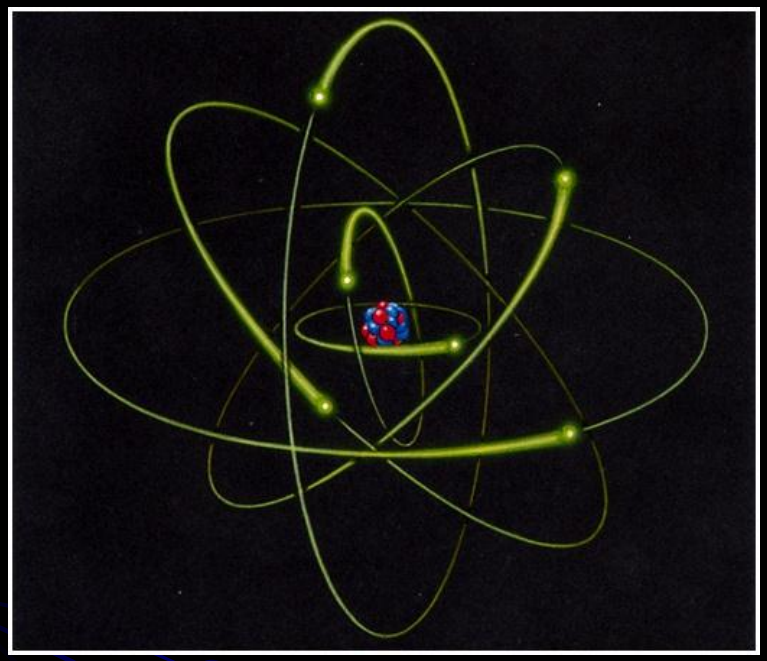
Topics covered

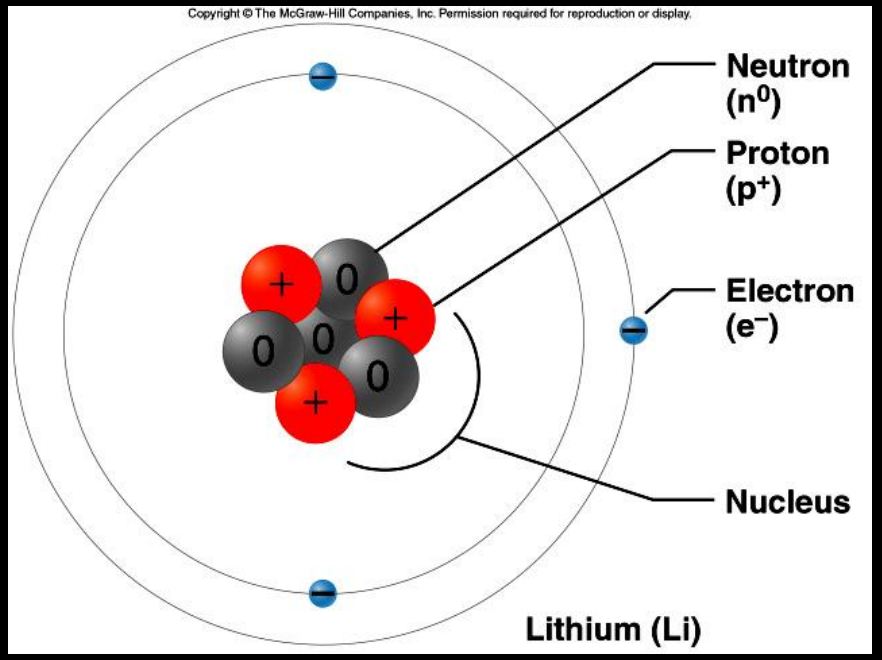
- Atomic structure
- Subatomic particles
- Atomic number
- Mass number
- Charge
- Cations
- Anions
- Isotopes
- Average atomic mass
- Practice questions atomic structure

# Sub atomic particles

| Name | charge | Mass | Location |
|---|---|---|---|
| Proton | +1 | 1 amu | Nucleus |
| Electron | -1 | 0 | Electron cloud |
| Neutron | 0 | 1 amu | Nucleus |

# Atomic structure

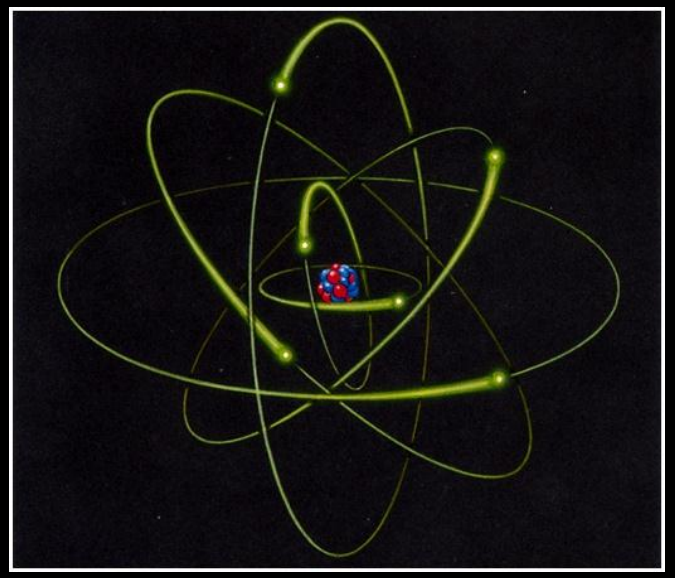





- Protons and neutrons are located in a small area in the center of the atom called the Nucleus. Electrons are located around the outside called clouds.

# Truth vs. Myth

- Truth
  - Nucleus is located in the center but much smaller
  - Electrons have energy levels



- Myth
  - Electrons do not travel around the nucleus like planets.

# Atomic structure: Atomic number

- Atomic number:  Represents the number of Protons in an atom.
- Why is the Atomic number important?
  - The number of protons determines the element.
  - The periodic table is ordered by increasing protons.

# Atomic structure: Atomic number

- Example:
- Oxygen has 8 protons
- The number of neutrons and electrons can and will vary.
- Altering the neutrons will change the overall mass.
- Altering the electrons will change the charge.

# Atomic Characteristics: Mass number

- Mass Number
  - Describes the mass of an individual atom.
  - Since only Protons and Neutrons have mass all the mass is located in the nucleus.
  - Each neutron and proton has a mass of 1 amu therefore the addition these particles will give the total mass.
  - Mass number = protons + neutrons

# Atomic Characteristics: Mass number

- Why is the mass number is not located on the periodic table.  Why?

# Atomic characteristics: mass number

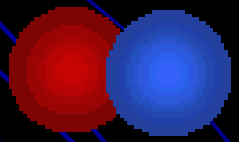
- Why is the mass number not located on the periodic table.  Why?

- Because this describes a SINGLE atom and we are always dealing with many more atoms then just one.

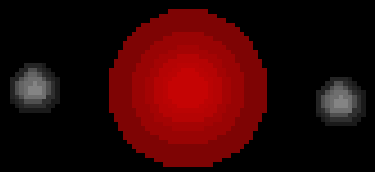
# Isotopes

2 atoms with the same number of protons but different number of neutrons

- Atoms of a single element can vary in weight.
  - Protons must stay constant.
  - Neutrons can vary.
  - The first drawing has one proton (red) and one neutron for a mass of 2.
  - The next picture only has a proton form a mass of 1



Hydrogen (Deuterium)
Atomic Mass = 2
Atomic Number = 1



Hydrogen
Atomic Mass = 1
Atomic Number = 1

# Average atomic mass

- The Atomic mass of Chlorine is 35.45.

- Q:  Is there actually an atom of Chlorine with a mass of 35.45?

# Average atomic mass

- The Atomic mass of Chlorine is 35.45.

- Q:  Is there actually an atom of Chlorine with a mass of 35.45?
- Nope only 35 and 36.  So why the decimal?

# Let's take a look

- Chlorine:  How many Protons?

# Let's take a look

- Chlorine: How many Protons? 17
  How many Neutrons?

If the mass number = 35

If the mass number of 36

# Let's take a look

- Chlorine: How many Protons? 17
  How many Neutrons?

If the mass number = 35

Neutrons = 18

If the mass number of 36

Neutrons = 19

# Average atomic masses

1st – When we mass out a sample we are getting a mixture of different isotopes. Some heavier… some lighter

2nd – Scientists have actually measured in the abundance of different isotopes and determined the average mass for Cl is 35.47.

| Isotope | Half Life |
|---|---|
| Cl-35 | Stable |
| Cl-36 | 301000 years |
| Cl-37 | Stable |
| Cl-38 | 37.2 minutes |

Find the element Te on the periodic table. Atomic #43 What is different about this element as apposed to its neighbors?

# Every day example

- A student receives a 84.6% This is a B but the student never actually scored a B on any assignments.

How is this possible?

# Everyday example cont.

- The student scored on many assignments. Some where higher then a B and others where lower then a B. The average score is a B

| assignment | grade |
|---|---|
| 1 | 100%/A+ |
| 2 | 50%/F |
| 3 | 75%/C |
| 4 | 98%/A |
| 5 | 100%/A+ |
| average | 84.6/B |

# Atomic Characteristics: Charge

- What two subatomic particles contain a charge?

# Atomic Characteristics: Charge

- What two subatomic particles contain a charge?

- Protons = +1
- Electrons = -1

# Atomic Characteristics: Charge

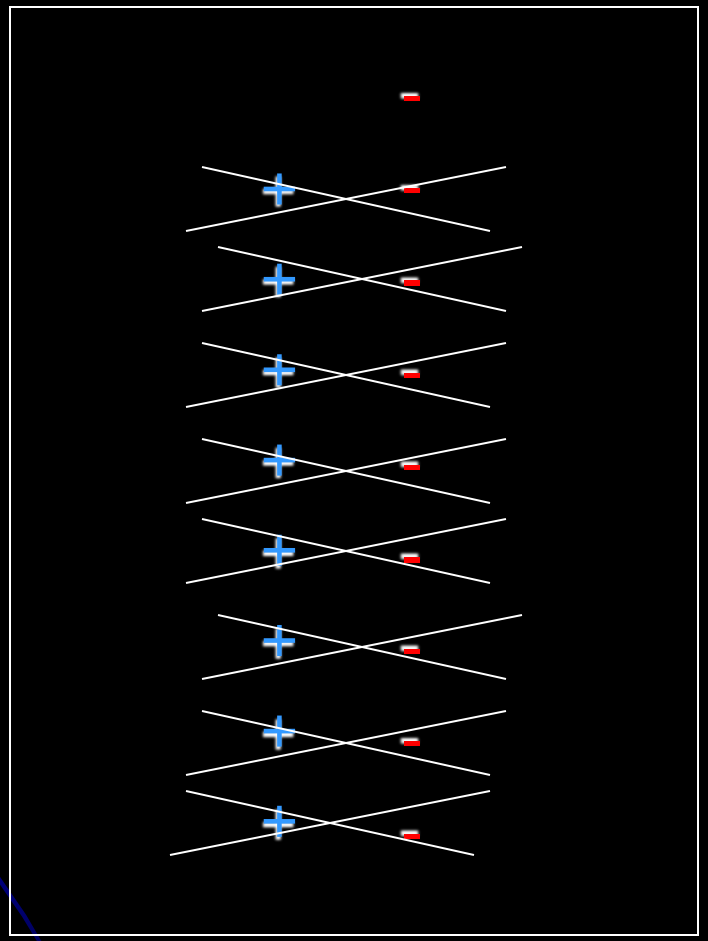
- How do you figure out the charge on an atom?
  - If the protons = electrons the charge is zero.
    - Each + cancels out a –
  - Charge = p – e

# Atomic Characteristics: Charge

- An atom of oxygen has 9 electrons what is the charge?
  - Oxygen
    - Protons = 8 +'s
    - Electrons = 9 –'s
      - 8 + protons cancel out the charge of 8 – electrons.
      - Resulting in a left over 1 – electron not canceled out.
      - Therefore this atom is -1 in charge.

# Charges Cancel out
# Net charge = -1

Cation = positive ion
Pronounced: “cat + ion”



Anion = negative ion

# Charged particles

- Ion:  Charged particle
- Anion:  Negativly charged particle
- Cation:  Positivly charged particle.

# Behavior of protons and electrons

- Very important:
  - Atoms can easily lose or gain electrons and this will alter the charge.
  - Atoms can NOT easily gain or lose protons. This would require a nuclear reaction.

  - If an atom is to acquire a negative charge it will need to do this?
  - If an atom is to acquire a positive charge it is going to have to do this?

# Practice making ions

Protons NEVER move any change of charge is relative to the number of electrons!

$$Zn^{o} \rightarrow Zn^{2+}$$

What happened here?

$$Zn^{o} \rightarrow Zn^{2+} + 2e^{-}$$

$$2F^{-} \rightarrow F_2$$

What happened here?

$$2F^{-} \rightarrow F_2 + 2e^{-}$$

# Atomic Structure Practice

| Symbol | atomic # | Mass # | p | n | e | Charge | Avg. atomic |
|---|---|---|---|---|---|---|---|
| O | | | | 8 | | 0 | |
| | 12 | 22 | | | 13 | | |
| | | | 5 | 4 | | -2 | |

Same value

Mass number = P + n

Charge = p - e

| Symbol | atomic # | Mass # | p | n | e | Charge | Avg. atomic |
|---|---|---|---|---|---|---|---|
| O | 8 | 16 | 8 | 8 | 8 | 0 | 15.99 |
| | 12 | 22 | | | 13 | | |
| | | | 5 | 4 | | -2 | |

Give the rest a try!

# Answers

| Symbol | atomic # | Mass # | p | n | e | Charge | Avg. atomic |
|---|---|---|---|---|---|---|---|
| O | 8 | 16 | 8 | 8 | 8 | 0 | 15.99 |
| Mg | 12 | 22 | 12 | 10 | 13 | -1 | 24.31 |
| B | 5 | 9 | 5 | 4 | 7 | -2 | 10.81 |

# Practical application
## Enriching uranium for nuclear weapons

- Uranium and plutonium are the only two radio active materials known today that can react to create a mushroom cloud like explosion.
- Plutonium is so highly radioactive it is hard to handle.
- Uranium is found in nature
- Hence Uranium is the material of choice.

# Practical application
# Enriching uranium for nuclear weapons

- Uranium – 238  Fairly stable isotope found in nature.
- Uranium -235
  - U-235 is said to be very fissile or it spits very easily.  It breaks down when energy is applied this energy that is given off hits other U-235 atoms and which sets off other reactions.
  - Chain reaction.
  - This amount of energy can be produced by simply slamming two pieces of uranium together. (Hiroshima)
  - US government considers uranium of 20% U-235 enriched.
  - 90% or highly enriched uranium is needed for nuclear weapons.

# Practical application
## Enriching uranium for nuclear weapons

- How do you enrich uranium.
  - 1st Isotopes of an element react chemically the same. Meaning that chemical reactions can not distinguish between isotopes.
  - 2nd since the mass is larger it can be separated via a centrifuge.

# Practical application
# Enriching uranium for nuclear weapons

- How does a centrifuge work?
- Spins item in circles.
- Ever been on the carnival ride the Gravitron or Cajun Cliffhanger at Six flags.
- Since F = mass * acceleration the particle with larger mass is pulled on with a greater force.

# Alexander Litvinenko poisioned by polonium -210

- Polonium-210 is highly radioactive with a half life of 138 days. A very small amount, about the size of a pin head, would be enough to kill an exposed person.

- Exposure means swallowing or inhaling; although polonium-210 releases large amounts of alpha particles as it decays, these particles would not for example be able to penetrate your skin.