Matter

What is the definition of Matter?

Anything that has mass and takes up space (volume)

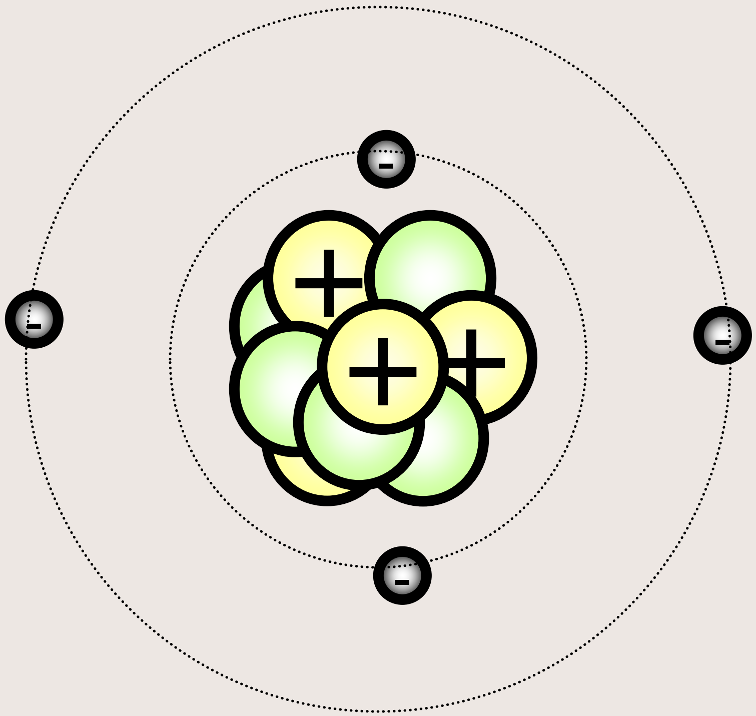
If it is not matter, what is it?

Energy!

How are matter and atoms related?

Atoms make up all matter

Atoms
Do you remember the parts?



Which model does this most closely match?

Bohr Model/
Planetary Model

How is the modern model different?

The electrons move in a random pattern in levels making clouds

Let's Compare

Sentence

Word

Letters

Paragraph

Atom

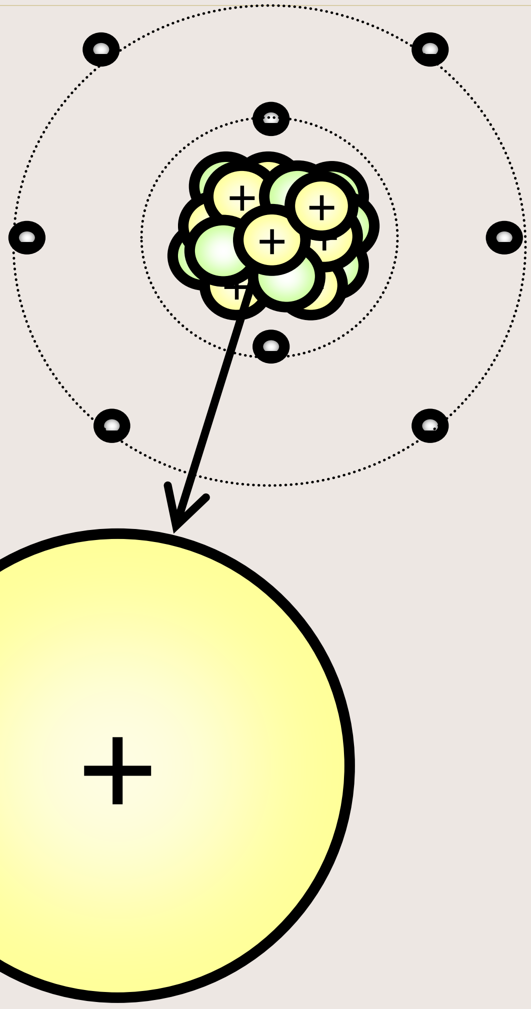
Subatomic Particles

Compound

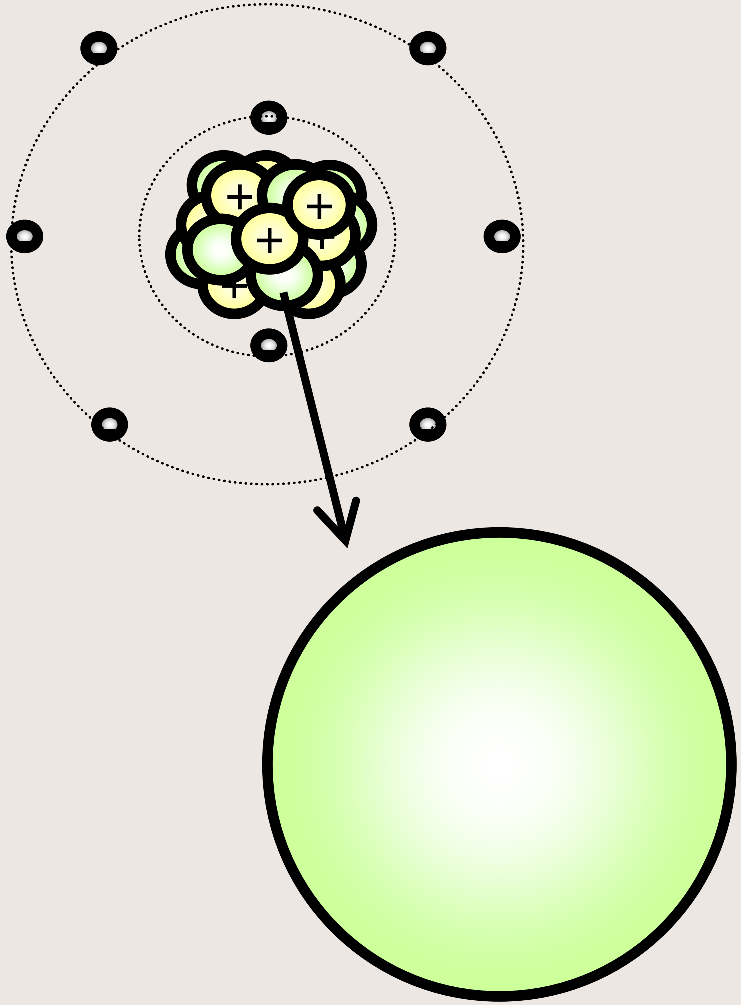
Cheeseburger

Protons (+)

- Positively charged particles
- Help make up the nucleus of the atom
- Help identify the atom (could be considered an atom's DNA)
- Equal to the atomic number of the atom
- Contribute to the atomic mass
- Equal to the number of electrons



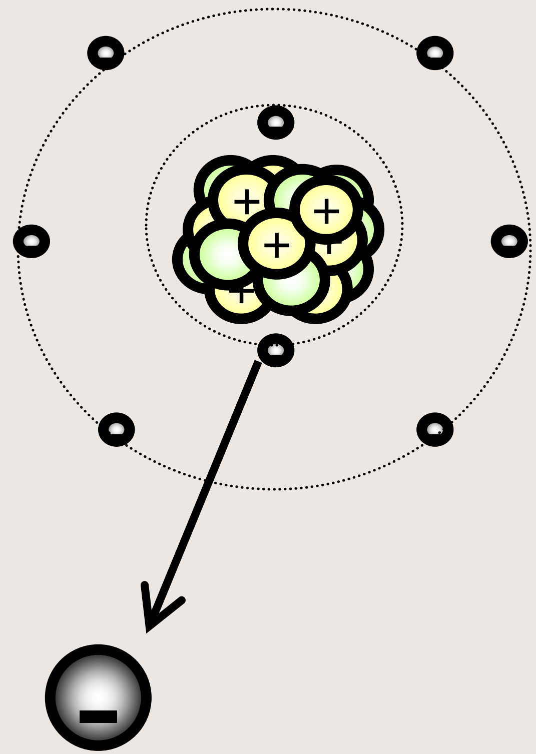
Neutrons



- Neutral particles; have **no** electric charge
- Help make up the nucleus of the atom
- Contribute to the atomic mass

Electrons (-)

- <u>Negatively</u> charged particles
- Found <u>outside</u> the nucleus of the atom, in the electron <u>cloud levels</u>; each cloud level can hold a maximum number of electrons (1^{st} = **<u>2</u>**, 2^{nd} = 8, 3^{rd} = **<u>8</u>** or 18, etc…)
- Move so rapidly around the nucleus that they create an <u>electron cloud</u>
- Mass is <u>insignificant</u> when compared to protons and neutrons ($1/2000^{th}$ the size)
- Equal to the number of <u>protons</u>
- Involved in the formation of chemical bonds

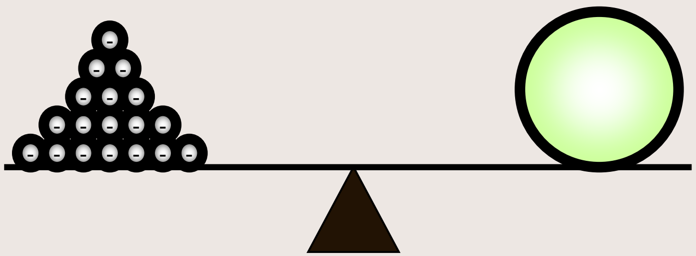


Sub-Atomic Particles

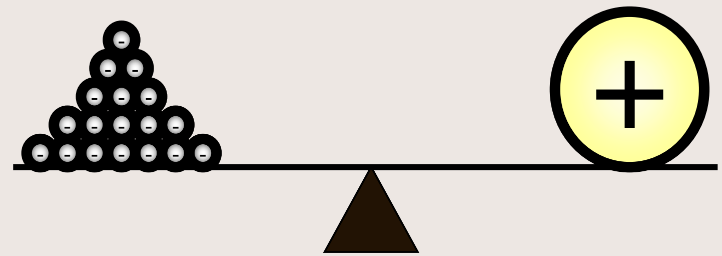
MassComparison

(protons, neutrons, electrons)

Neutron = 1.6749286 $\times 10^{-27}$ kg
Proton = 1.6726231 $\times 10^{-27}$ kg
Electron = 9.1093897 $\times 10^{-31}$ kg



1839 electrons = 1 neutron



1836 electrons = 1 proton

How do you think the mass of a neutron compares to that of a proton?

1 neutron ≈ 1 proton

1 proton = 1u (unified atomic mass unit)

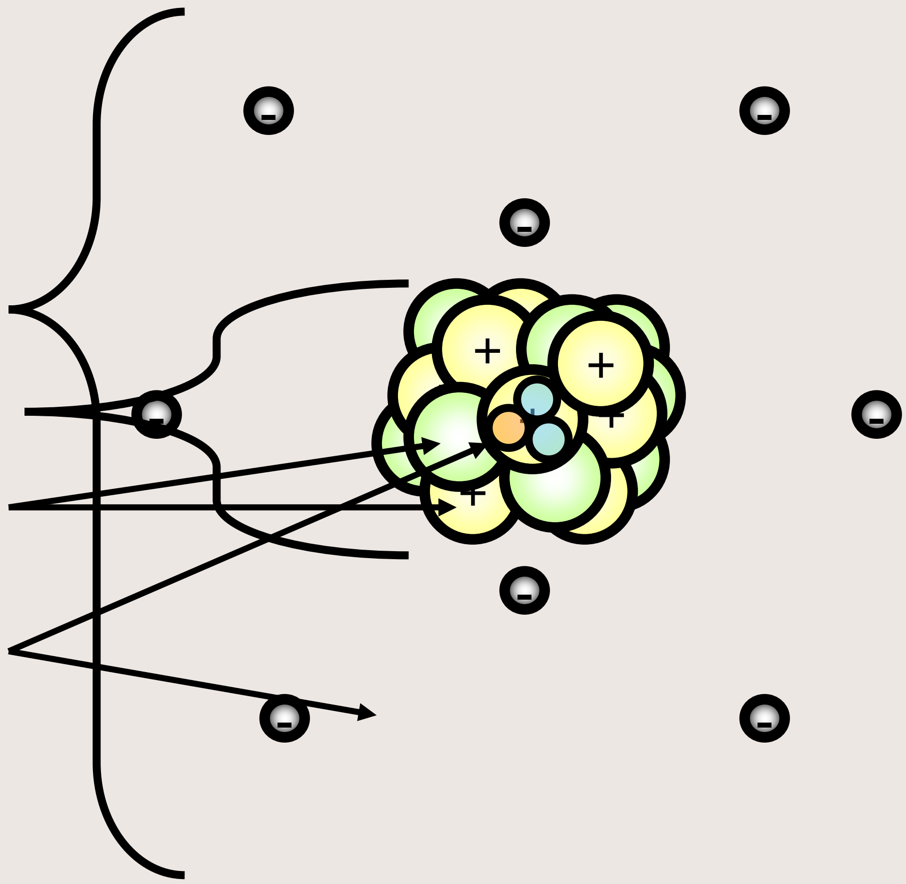
1 electron = ~ 0 u (unified atomic mass unit)

Sub-atomic Particles

Size Comparison

(protons, neutrons, electrons, & quarks)

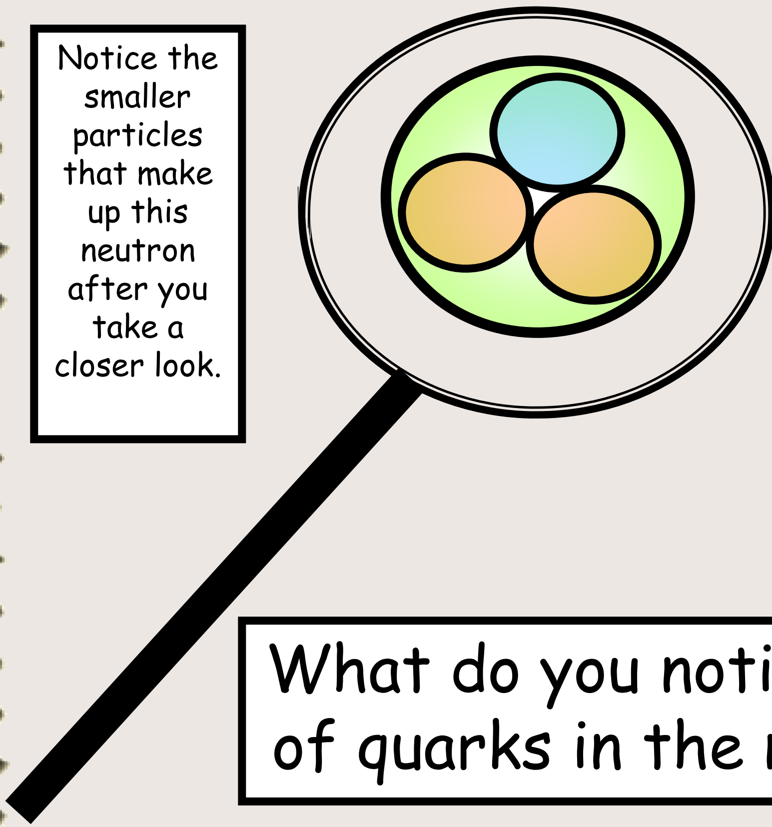
	Size in atoms	Size in meters (m)
Atom	1	10^{-10}
Nucleus	$\frac{1}{10{,}000}$	10^{-14}
Proton or Neutron	$\frac{1}{100{,}000}$	10^{-15}
Electron or Quark	$\frac{1}{100{,}000{,}000}$	10^{-18} (at largest)

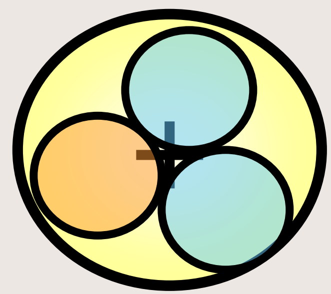


QUARKS

- Particles that make up protons and neutrons

Notice the smaller particles that make up this neutron after you take a closer look.

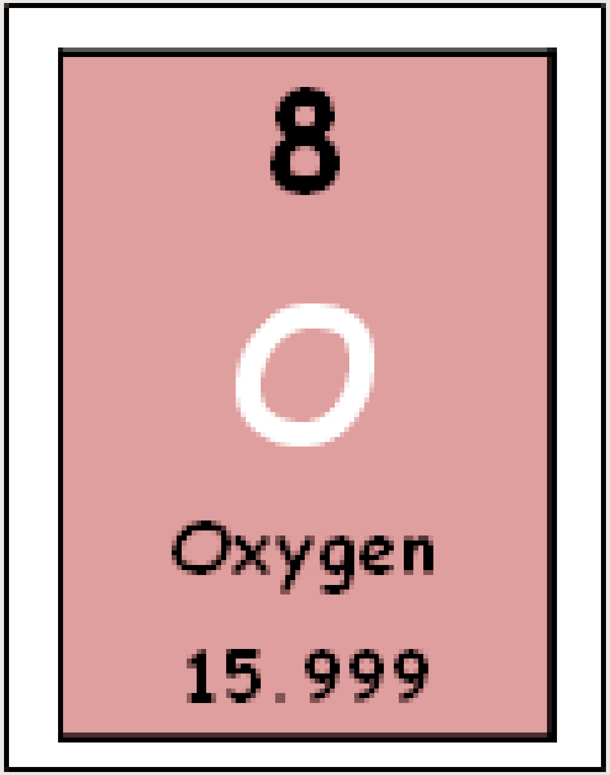




Notice the smaller particles that make up this proton after you take a closer look.

What do you notice about the number of quarks in the neutron and proton?

Reading the Periodic Table



Atomic Number ________

Atomic Mass ___________

Element Symbol ___________

# of Electrons ___________

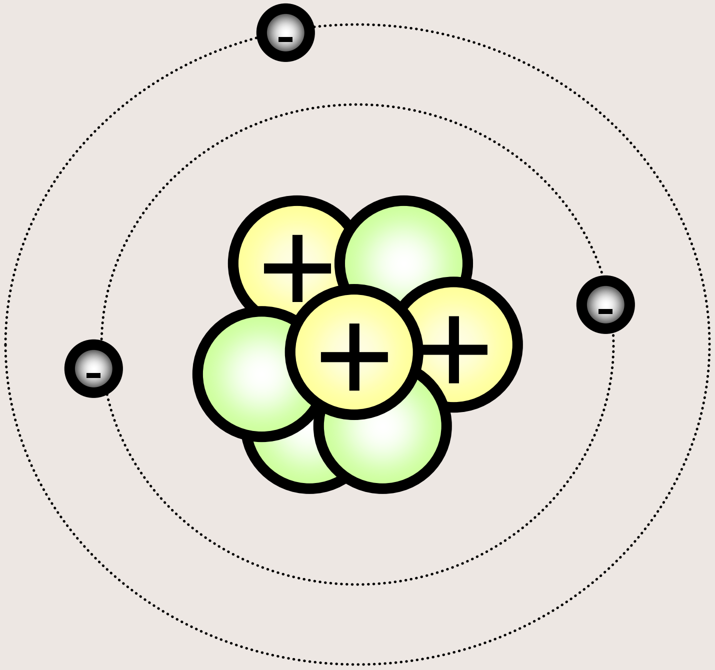
# of Protons ___________

# of Neutrons ___________

Element Name ________________

Atomic Number

- The number of protons in the nucleus of an atom

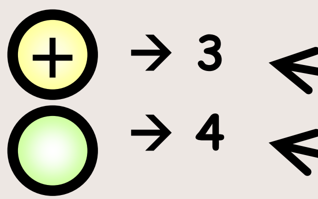


What would be the atomic number of this atom?

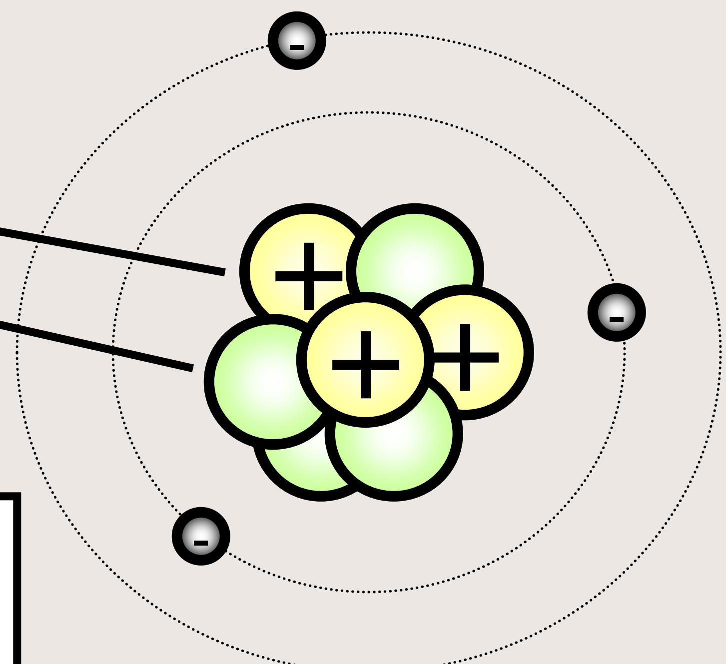
Mass Number

- The total number of protons and neutrons in an atom's nucleus
- Expressed in Atomic Mass Units (amu)
  - Each proton or neutron has a mass of 1 amu

What would be the mass number of this atom?



3 protons + 4 neutrons = a mass number of 7 amu

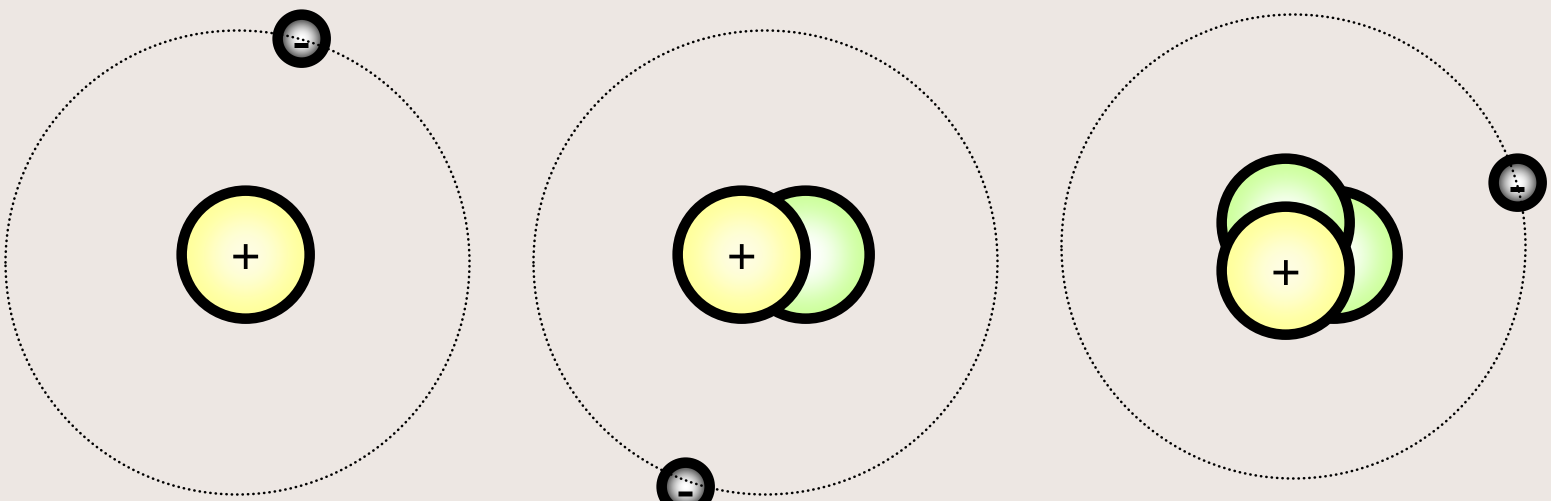


Why did we not account for the electrons when calculating the mass number?

Isotopes

- Atoms that have the same number of protons, but have different numbers of neutrons
- Examples

Notice that each of these atoms have one proton; therefore they are all types of hydrogen. They just have a different mass number (# of neutrons).

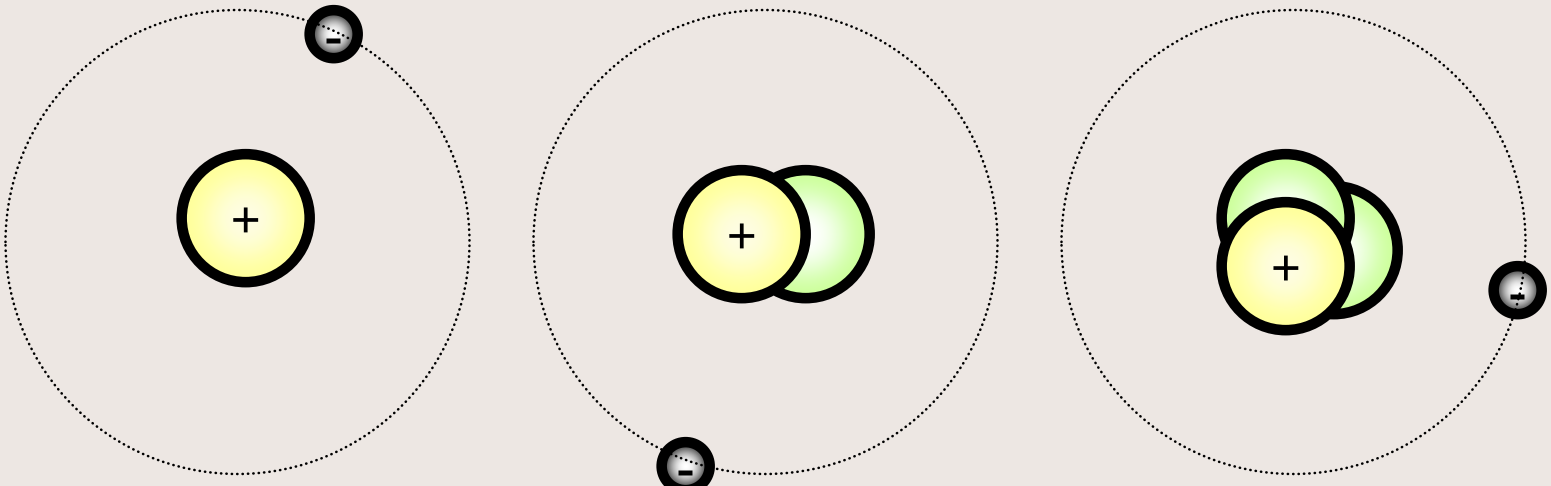


Hydrogen (Protium) Hydrogen (Deuterium) Hydrogen (Tritium)

Atomic Mass

- The weighted average of the masses of all the naturally occurring isotopes of an element
- The average considers the percent abundance of each isotope in nature
- Found on the periodic table of elements
- Example

What would be the atomic mass (≈) of Hydrogen if these three isotopes were found in the following percentages (99.9, 0.015, 0) respectively?



Hydrogen (Protium)
Mass # = 1 amu

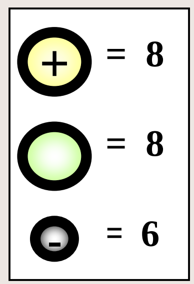
Hydrogen (Deuterium)
Mass # = 2 amu

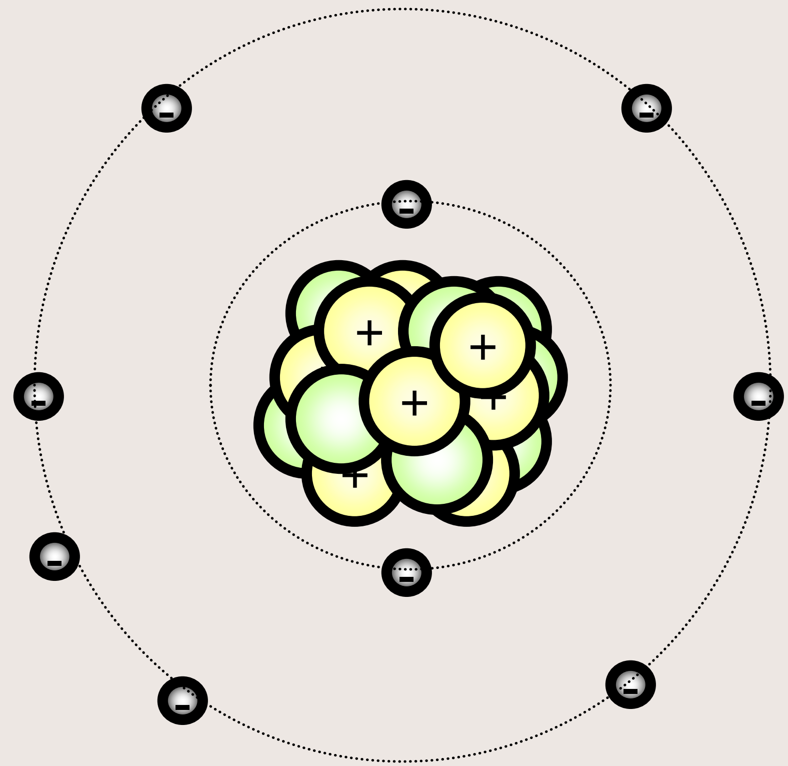
Hydrogen (Tritium)
Mass # = 3 amu

If you simply average the three, 2 amu (1 amu + 2 amu + 3 amu/3) would be the atomic mass, but since 99.9% of the Hydrogen is Protium, the atomic mass is around 1 amu (.999 x 1 amu)

Ion

- <u>Charged</u> particle that typically results from a loss or gain of <u>electrons</u>
- Two types:
  - <u>Anion</u> = <u>negatively</u> charged particle
  - <u>Cation</u> = <u>positively</u> charged particle





Currently, this atom of oxygen is neutral because it has an equal number of electrons (8) and protons (8).

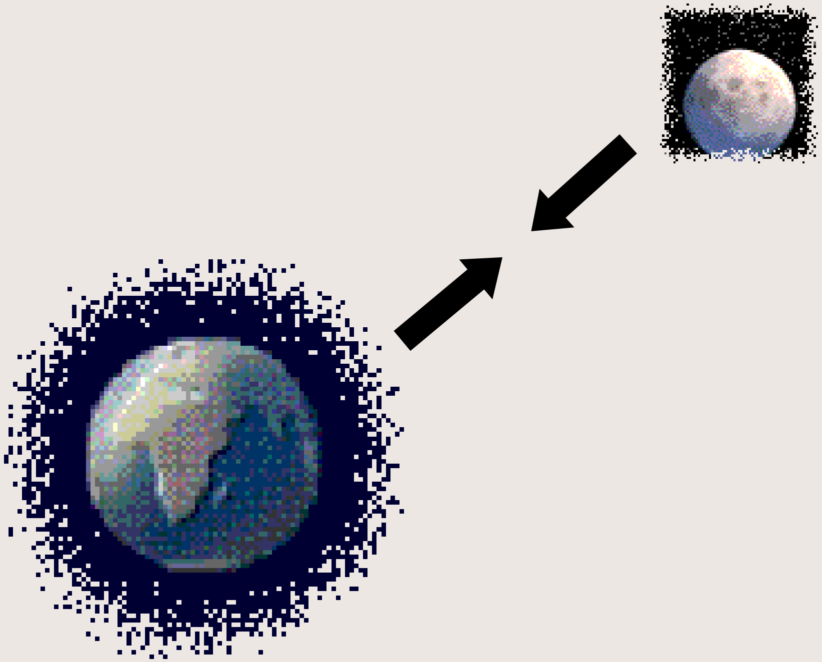
Symbol = O

FORCES IN THE ATOM

- Gravitational Force
- Electromagnetic Force
- Strong Force
- Weak Force

Gravitational Force

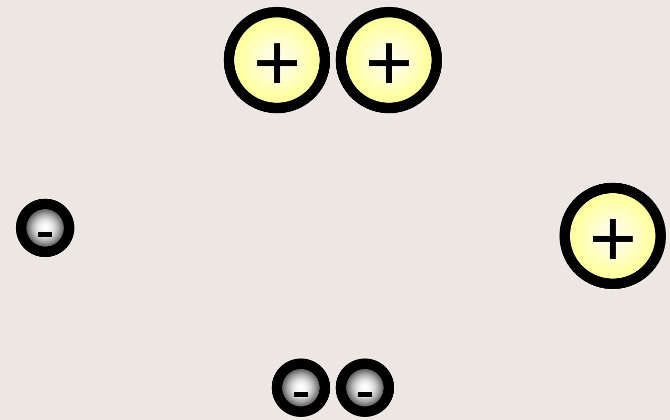
- The force of attraction of objects due to their masses
- The amount of gravity between objects depends on their masses and the distance between them



Do you think this force plays a significant role in holding the atom together?

Electromagnetic Force

- The force that results from the repulsion of like charges and the attraction of opposites
- The force that holds the electrons around the nucleus



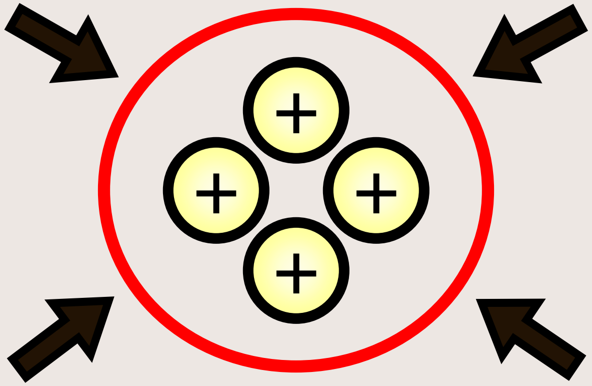
Notice how the particles with the same charge move apart and the particles with different charges move together.

Why are neutrons not pictured above?

Strong Force

- The force that holds the atomic <u>nucleus</u> together
- The force that <u>counteracts</u> the electromagnetic force

Notice how the electromagnetic force causes the protons to repel each other but, the strong force holds them together.



If ou need help remembering strong force, just think of…

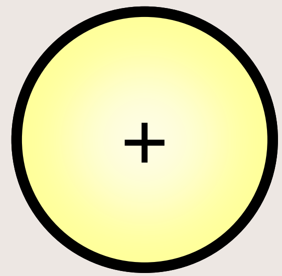
Mrs. Harmon

Would an atom have a nucleus if the strong force did not exist?

Weak Force

- This force plays a key role in the possible change of sub-atomic particles.
  - For example, a neutron can change into a proton(+) and an electron(-)
- The force responsible for radioactive decay.
  - Radioactive decay → process in which the nucleus of a radioactive (unstable) atom releases nuclear radiation.

Notice how the original particle changes to something new.



If you need help remembering weak force, just think of…

Mike N.