The Atom:
Chapter 12

STRUCTURE OF THE ATOM

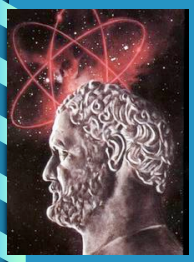
Obsertainers Lab:
How do you determine how something is designed, if you can't see in it?

- **Lab: Take one Obsertainers**
- **You have 4 circles on your paper:**
- **Write the number which is on the back next to a circle**
- **Make a Hypothesis, retest, DO NOT OPEN!**
- **You will learn the "key" next period**
- **Complete: you have 3 minutes**

Atomic Structure & Its History

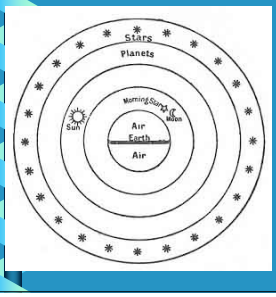
- Much of what we know about **atomic structure** today is the result of **indirect observation** of atoms and the particles of which they are composed.

Atomic Structure & Its History



- The Greek philosopher **Democritus** was the first to propose that matter was composed of atoms,
- and that was over **2,300 years ago**.

Atomic Structure & Its History



- He believed that atoms were those parts of nature that could not be cut down any further.

Atomic Structure & Its History

- He was correct in one part: **the forces that hold together the nucleus of an atom**
- are the most powerful in the entire universe making atoms indivisible in all but extremely powerful reactions.

The Dalton Model: 1803

- English chemist John Dalton developed the first model in 1803.
- He saw them as **indestructible, indivisible and spherical.**
- His theories were based on what had been observed in chemical reactions and was widely accepted until the development of the Crooks tube

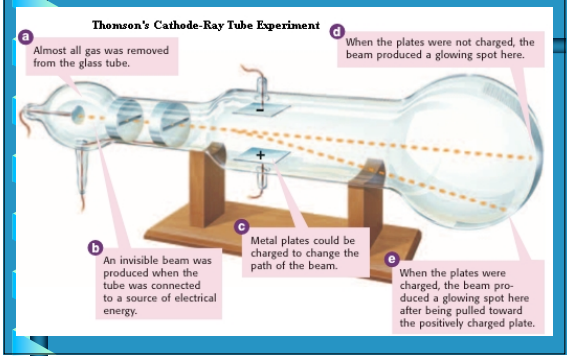
John Dalton developed his atomic theory from observations gathered from many experiments.

- All substances are made of atoms. Atoms are small particles that cannot be created, divided, or destroyed.
- Atoms of the same element are exactly alike, and atoms of different elements are different.
- Atoms join with other atoms to make new substances.

The Crooks Tube

- The **Crooks tube** is the ancestor to **television tubes**.
- English scientist JJ Thompson noticed that a stream of negatively charged particles would flow through the tube no matter what gas was used.
- He theorized that **negatively charged particles** were present in the atoms of all elements.
- His final theory was that atoms were made up of **positively and negatively** charged particles evenly distributed and that the atoms was a solid mass.

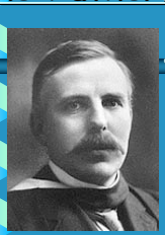
The Crooks Tube



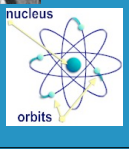
Crooks Tube Shown & Explained

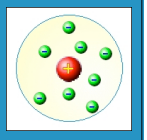
You will find the videos in the Video library for this powerpoint

The Rutherford Model: 1909

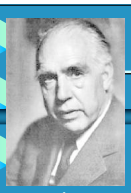


- British physicist Lord Rutherford's experiments in 1909 indicated that atoms were **largely empty space**.





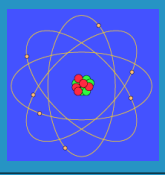
The Rutherford Model



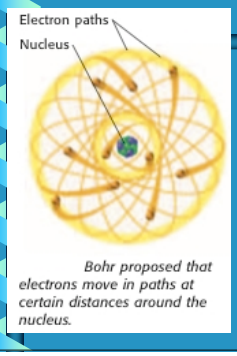
The Bohr Model

Danish scientist Neils Bohr developed a model of the atom that proposed **definite orbits** in which **electrons traveled.**

- Bohr proposed **7 different** levels, or distances that occur around the nucleus.
- **The greater the radius of the level, the greater the energy** of the electrons at that level



The Bohr Model



Bohr proposed that electrons move in paths at certain distances around the nucleus.

- His models suggested that in an atom's normal state, all electrons are in the lowest energy levels, and because of this cannot move to a lower level.
- The **atom is stable** and said to be at its **ground level** state.

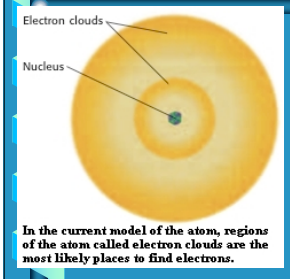
The Bohr Model

The Excited State

- If energy is added to the atom by heat or electrical energy, the absorbed energy can cause one or more of the electrons within the atom to move to a **higher energy level.**
- When this happens the atoms are said to be in an **excited state.**
- The atom at the **excited state is unstable** and makes efforts to return to **ground level** state.
- As the electrons return to this level **they release energy**.
- The energy given off exactly equals the amount absorbed when the electrons moved to the higher energy levels.

The Modern Model of the Atom

This is the drawing for your Little Bk Cover. Be sure to label



In the current model of the atom, regions of the atom called electron clouds are the most likely places to find electrons.

Charge Cloud Model:

- this shows electrons as being part of a diffused cloud of varying densities .
- (Be sure to include labeling of electrons in the electron cloud and protons & neutrons in the nucleus)

BrainPop: Atomic Models

- BrainPops

Brainpop quiz
How did you do?

- 1. B
- 2. A
- 3. B
- 4. D
- 5. A
- 6. C
- 7. D
- 8. B
- 9. B
- 10. B

A Musical Review

The Atom!!!
Chapter 12, Section 2

Atomic Basics, Atomic Math

In The beginning…

- Matter has mass and takes up space.
- Atoms are **basic building blocks** of matter, and cannot be chemically broken down by ordinary means.
- The word atom is derived from the Greek word *atomos,* which means indivisible or uncuttable. The Greeks concluded that matter could be broken down into particles too small to be seen.
- These particles were called atoms. The smallest piece of an element, which still has the properties of that **element** is called an atom.

Pollen , the Atom & Einstein

You will find this video and
All the videos for this powerpoint
In the video library

How small is an atom?

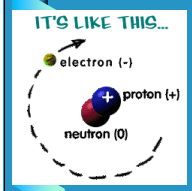
- Really really really small!

- It would take 50,000 stacked aluminum atoms to equal the thickness of a sheet of aluminum foil.
- There is a wonderful TedEx video on my web page that goes into a bit more detail about how small is an atom!
- It's about 10 minutes long- but VERY interesting!

What's an atom made of?

- Even though an atom is really small, it is made of even smaller particles.
- It's **basically** made of 3 tiny subatomic particles (there are more, but we'll talk about those later!)
  - **Protons**
  - **Neutrons**
  - **Electrons**

An Atom's Parts



- The center of an atom is called the **nucleus**. The nucleus contains 2 types of particles and is responsible for 99.9% of the atom's mass!
  - **Protons** = **positive (+)** charge
  - **Neutrons** = **no** charge, neutral
- This means the nucleus is always positive.

Parts of an Atom

Particle Profile	
Name:	proton
Charge:	positive
Mass:	1 amu
Location:	nucleus

- **Proton**
- in the nucleus
- + (positive) charge
- **1 amu**

Parts of an Atom

Particle Profile	
Name:	neutron
Charge:	none
Mass:	1 amu
Location:	nucleus

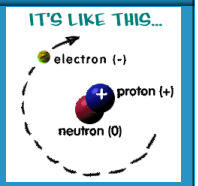
- **Neutron** in the nucleus
- 0 (no) charge
- **1 amu**

Parts of an Atom

Particle Profile	
Name:	electron
Charge:	negative
Mass:	almost zero
Location:	electron clouds

- **Electron**
- in the electron cloud
- - (negative) charge
- **0 amu**

These things are teeeeny tiny



- The mass of a proton is really small, so small in fact, that scientists created a whole new unit for it.
- A proton has a mass of 1 atomic mass unit (AMU).
- A neutron is actually a little bigger than a proton, but not enough to notice the difference, so we say it also has a mass of 1 AMU.

The Outside of the Atom

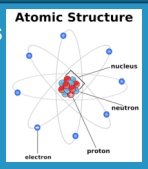
•Around the center of the atom we find an electron cloud. The electrons are:

–Are **negatively (-) charged** particles that orbit around the nucleus.

–Electrons are very small, so small that it takes over 1,800 electrons to equal the mass of 1 proton.

–Therefore we usually consider an electron's mass to be 0.

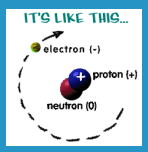
–So an electron has a mass of **0 AMU.**



Structure of an Atom

Overall Balance

- To review, an atom is made up of 3 types of particles which are:
  - Protons (+)
  - Neutrons (0)
  - Electrons (-)



Notice that the protons and electrons have opposite charges…what does this mean about the overall balance of an atom?

Nucleus (+ charge) = Electron (- charge)

Awful Science Humor

A **neutron** walks into a diner and orders a glass of orange juice at the counter. When the waiter brings the juice, the neutron asks, "How much do I owe you?"

The waiter replies, "For you, **no charge**!"

They're totally equal

- It means that these two parts of the atom balance each other out
- The atom is electrically **neutral**, or has no overall charge.
- As long as there are an equal number of electrons and protons, the charges cancel.
- What is (-2) + (+ 2) --> 0 (no charge!)

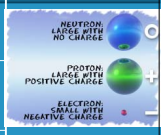
What is an atom?

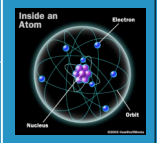
- Brainpop

- **BrainPop Atom Answers:**
- **1. B**
- **2. A**
- **3. C**
- **4. B**
- **5. A**
- **6. C**
- **7. B**
- **8. A**
- **9. B**
- **10. C**

Summary

	Position	Charge	Mass
Proton	nucleus	+	1 amu
Neutron	nucleus	none	1 amu
Electron	Electron cloud	-	0 amu





How can I remember all of this?

- **Protons = Positive (+)**
- **Neutrons = None, Neutral (0)**
- **Electrons = Negative (-).**

Bill Nye: Part 1: The Atom

- The number of protons in an atom is called the **atomic number.**
- The elements in the periodic table are arranged according to **increasing atomic number.**
- It is the number of protons that determines the atomic number: H (element hydrogen) = 1.
- The number of protons in an element is constant (H=1, for 1 proton, 2= He helium, for 2 protons… and so on)

- This procedure NEVER changes.
- The protons are the atomic number.
- They identify the element.
- The number of protons is equal to the number of electrons so that the element is electrically stable (or balanced)

- **Mass Number** :
- the number of **protons ADDED to the neutrons**.
- Mass number can vary for the same element, if the element has different numbers of neutrons.
- When this happens, these forms of an element are called **isotopes.**

What's an isotope??

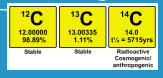
- **Brainpop**

- **Chemical properties of isotopes are the same**,
- although the physical properties of some isotopes may be different.
- Some isotopes are radioactive- meaning they "radiate" energy as they decay to a more stable form,
- perhaps another element half-life: time required for half of the atoms of an element to decay into stable form.

- An example of an isotope is oxygen, with atomic number of 8 which can have 8, 9, or 10 neutrons.
- **Carbon 14** is another example. If you take the atomic number 6 and subtract is from the AMU of 14 you find that there are **8 neutrons in the nucleus**.
- This is an isotope of Carbon and is a radioactive isotope known as Carbon-14.
- This radioactive isotope is critical in helping scientists **date plant and animal fossils** and occurs in every 100,000,000 carbon atoms.

ISOTOPES:
Atoms of the same element with different number of neutrons.

- 6 <-------- **atomic number**
- C <-------- **Element symbol**
- Carbon <-------- **element name**
- 12.011 <-------- **Avg. Atomic mass**



Isotope of Carbon would have a **different** Atomic Mass because the number of neutrons is not equal to the number of protons.

Remember:

- **number of protons = number of electrons**
- **The atom is electrically neutral**

Electron Clouds:

- The region around the nucleus is called the electron cloud.
- The electrons occupy certain energy levels.
- The farther an energy level from the nucleus, the more energy the electrons will have in it.
- 1st level = 2 electrons
- 2nd level= 8 electrons
- 3rd level = 18 electrons

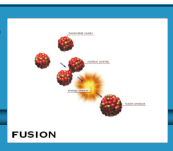
Eureka: The Electron

Quick Review:

- **ATOMIC MASS**: The mass of an atom depends on the number of protons & neutrons it contains
- **AMU** = Atomic mass unit
- **Mass number** is the sum of the protons and neutrons.
- **Neutrons** = mass number - atomic number
- (remember: **Atomic Number** = NUMBER of **protons**, which = NUMBER of **electrons**)

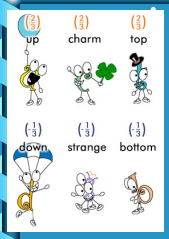
The next few slides are NOT in your lecture notes, but are still pretty interesting! So.... Listen up!

Harness that Energy



- Nuclear energy is the energy released when the nuclei of atoms split or are fused.
- **Fusion** is when two nuclei come together.
- **Fission** is when one nucleus is split into two or more parts, causing a chain reaction.
- Huge amounts of energy are released when either of these reactions occurs.
- Fusion reactions create much of the energy given off by the Sun. Nuclear power involves uranium-235 and nuclear fission.

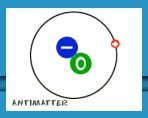
Really Complex Stuff



- Protons & neutrons are made of smaller bits called **quarks**.
- There are 6 quarks, but physicists usually talk about them in terms of three pairs.
- A quark has a fractional electric charge, unlike the proton and electron

8. Quarks, Inside the Atom

Really Complex Stuff

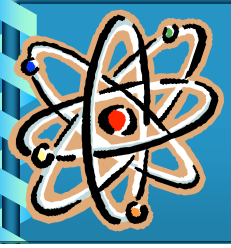


- Then there's **antimatter**.
- Scientists have proved that it is real, it's not just in movies.
- While a regular atom has positive and neutral pieces (protons/neutrons) in the nucleus and negative pieces in orbiting clouds (electrons), antimatter is just the opposite.
- Antimatter has a nucleus with a negative charge and little positive pieces in the orbits.
- Those positively charged pieces are called **positrons**.

Really Complex Stuff

- **And that's not all!**
- **Atoms are also made out of hadrons, baryons, mesons, leptons, neutrinos!**
- **The list goes on & we're discovering more about atoms every day.**
- **It's not a bad time to be a particle physicist!**
- **Want more info: http://www.particleadventure.org**

The Atom Review



What makes one atom different from another?

- **Answer: the amount of protons, neutrons and electrons present in each atom.**
- **The amount of these particles present determines the type of element.**

Of Elements and Atoms

- **The number of protons in an atom is also the atomic number.**

  ATOMIC # = # OF PROTONS!!!
- **Also, since there is almost always an equal # of protons & electrons in an atom:**

  atomic # = # of electrons

Tomorrow we officially begin
The Periodic Table