Atoms and Elements

- An essential feature of atomic theory is that atoms combine in whole-number ratios to make compounds.
- Examples:

NaCl

H_2O

H_2O_2

Atoms and Elements

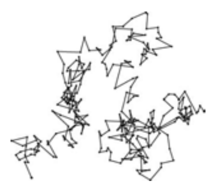
- Remember, chemists try to visualize chemical reactions at the molecular level. This molecular view is so ingrained that chemists often take it for granted. As you study chemistry, strive to attain this molecular point of view.

Atoms are Constantly in Motion

- Atomic theory states that matter is made up of tiny atoms. Solids occupy definite locations in materials; liquids and gases flow easily from one place to another.
- A phenomenon called **Brownian motion** provides evidence for the movement of molecules.

Brownian Motion

- Robert Brown (1828) noticed that spores moved about continuously and underwent irregular changes of direction.



Brownian Motion

- The spores seemed to dance about on the water's surface.
- Caused by collisions between the particles and the molecules of the fluid in which they are suspended. Spores move about because they collide constantly with water molecules. Occasionally, a collision with a particularly fast-moving water molecule causes the spore to change its direction abruptly.

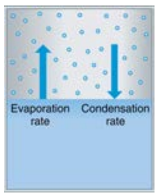
Dynamic Equilibrium

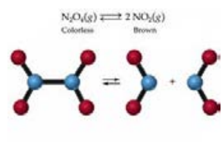
- Atoms and molecules are always moving.

- The condition of balanced motion is called **dynamic equilibrium**.

Dynamic Equilibrium

- A system at equilibrium shows no change in its observable properties. A dynamic system contains objects that move continuously.



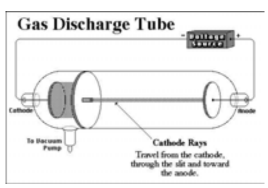


Dynamic Equilibrium

- The ink example is dynamic because when the color of the liquid is uniform and unchanging, the water and ink molecular move about.
- Dynamic equilibria occur frequently in chemical systems. All chemical processes reach a state of equilibrium if allowed to continue for a sufficient time but molecular activity always goes on after equilibrium has been reached.

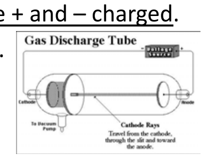
Electrons

- Early experiments provided extensive information on the composition of the atom.
- Gas discharge tube experiment.



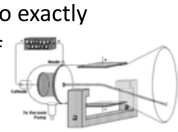
Electrons

- Two electrodes; at high charges a bolt shoots across the electrodes causing some atoms to break apart into charged particles; + charges move to the – electrode and – charges to the + electrode; <u>exp. showed that atoms consisted of smaller fragments that are + and – charged</u>.
- Hence, species are <u>electrons</u>.

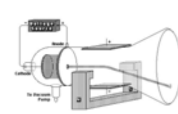


Cathode Ray Tube Experiment

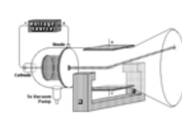
- J. J. Thomson (1906 Nobel Prize). Seven of his students won Nobel Prizes.
- Beam of electrons.
- e^-s are affected by both electrical and magnetic forces.
- Measured amt. of B required to exactly counterbalance the deflection of the beam by a known E.



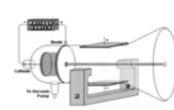
Cathode Ray Tube Experiment



Cathode ray tube and applied external magnetic field.



Cathode ray tube and applied external magnetic field.



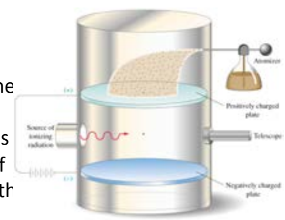
Cathode ray tube and both fields applied.

Cathode Ray Tube Experiment

- Calculated the ratio of the electrons charge to its mass
- Charge / mass = e / m = 1.76 X 10^{11} C / kg

Oil Drop Experiment

- Schematic view of Millikan's oil drop exp. Inside the chamber an atomizer generated a fine mist of oil droplets. Bombarding the droplets with x-rays gave some of them extra – charge. In the presence of sufficient E force, these negatively charged droplets could be suspended in space.



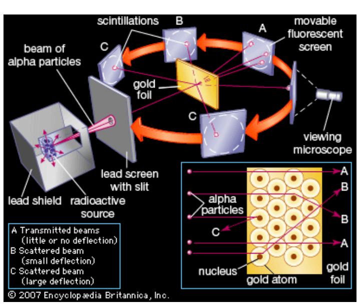
Oil Drop Experiment

- In other words, the gravitational force and E force were counterbalanced.
- Knowing the E field, the charge on the oil droplet could be determined.
- e = -1.6 X 10^{-19} C.
- It follows that since Charge / mass = e / m = 1.76 X 10^{11} C / kg
- Then, e / e / m = 9.1 X 10^{-31} kg, mass of electron

The Nucleus

- By the early 20th century, scientists had discovered that atoms contains electrons and positively charged particles. The nature of electrons had been elucidated by the exps. of Thomson and Millikan as just described, but the nature of the positive particles was entirely unknown. Also, it was not known how the particles fit together to make up an atom.

Ernest Rutherford's Experiment



Atomic Building Blocks

Name	Symbol	Charge	Mass
Electron	e	-1.6022 X 10^{-19} C	9.1094 X 10^{31} kg
Proton	p	+1.6022 X 10^{-19} C	1.6726 X 10^{-27} kg
Neutron	n	0	1.6749 X 10^{-27} kg

Our picture of atomic architecture is now complete. Three particles – electrons, protons and neutrons – combine in various numbers to make the different atoms of all the elements of the periodic table.