Early History – Is matter continuous or discrete

- **Empedocles** (490-430 BC): (air/earth/fire/water)
- **Democritus** (460-371 BC): tiny indivisible particles called “atomos”
- **Aristotle** (384-322 BC): Great philosopher, lousy chemist

The theory of Democritus and Leucippus held that everything is composed of “atoms”, which are physically, but not geometrically, indivisible; that between atoms, there lies empty space; that atoms are indestructible; have always been, and always will be, in motion; that there are an infinite number of atoms, and kinds of atoms, which differ in shape, and size.

**John Dalton** – Atomic Theory

1. Elements are composed of minute, indivisible particles called atoms.
2. Atoms of the same element are alike in mass and size.
3. Atoms of different elements have different masses and sizes.
4. Chemical compounds are formed by the union of two or more atoms of different elements.
5. Atoms combine to form compounds in simple numerical ratios such as 1:1, 1:2, 2:3 etc.
6. Atoms of two elements may combine in different ratios to form more than one compound. (Law of Multiple Proportions)
   - Law of Partial Pressures

**Flaws in Daltons Model:**

1. Atoms are chemically indivisible (but in nuclear reactions can be broken apart into protons, neutrons, electrons) (etc.)
2. Not all atoms of a specific element have the same mass (isotopes).

**Rule of Greatest Simplicity**

- When atoms combine in one ratio, it must be assumed to be binary
  - Water = OH
  - Ammonia = NH

Robert Boyle (1627-1691)

- Father of Chemistry
- Primarily studied gases (Ch. 12) → Boyle’s Law
- Atomic nature of matter (Elements)
- Compounds vs. Mixtures (Ch 3)

Joseph Priestly (1733-1804)

- Discovered O₂ and (NO, HCl, NH₃, N₂O, CO, SO₂)
- Invented Soda Water

Joseph Proust (1754-1826)

- Law of Definite Proportions: Substances always combine in constant and definite proportions
  - Natural vs. Artificial CuCO₃

Antoine Lavoisier (1743-1779)

- O₂ required for combustion
- Qualitative → Quantitative
- Disproved Phlogiston theory
- Conservation of Mass: matter is neither created nor destroyed in a chemical reaction
- Water = compound ≠ Element

Joseph Dalton (1766-1844)
History (II)
Structure of the Atom

Joseph John (JJ) Thomson
- 1906 Nobel Prize – Discovery of the Electron (Corpuscles)
- Plum-Pudding Model
- Mass Spectrometer and Isotopes
- Gifted Teacher (7 students won Nobel Prizes, and his son)

Joseph John (JJ) Thomson

Properties of Electrons
- Travel in straight lines
- 1/1000th mass of H
- Same mass no matter source (all electrons are the same) “Universal”
- Deflected by magnetic fields (attracted to positive field therefore negatively charged)
- Produce Shadows
- Have mass (capable of turning a paddle wheel)

Eugen Goldstein: “Discovered Proton”
- Canel Rays/Protons – emitted opposite cathode rays
- Different for each element
- Properties measured by Thomson

George Johnstone (GJ) Stoney
- Supporter of Metric System
- Theorized the fundamental unit of electricity “electron”

Michael Faraday
- Discovery of “ions” – certain substances when dissolved in water conduct electricity.
- Compounds decomposed electrically are attracted to different electrodes.
- Cathode (negative electrode)
- Anode (positive electrode)

G.J. Stoney (1826-1911)  
Eugen Goldstein (1850-1930)  
J.J. Thomson (1856-1940)

Rutherford’s Gold Foil Experiment

Ernst Rutherford (1871-1937)
- 1908 Nobel Prize
- Geiger-Marsden Experiment (Au Foil)
- Atoms are not inseparable
- α-particle, β-particle, γ-rays, ½ life,

Plum Pudding Model
- Corpuscles (electrons) distributed in an even field of positive charge

Crookes Tube
- William Crookes (1832-1911)
- Used to “discovery” electrons and x-rays

Ernst Rutherford

Svante Arrhenius
- Don’t need water
- NaCl → Na+ + Cl–
- Cations (+)
- Anions (–)
- Acids/Bases (Ch 15)
- Arrhenius Equation
- Noble Prize Committee (1903 Nobel Prize)

Svante Arrhenius (1859-1927)

James Chadwick
- Discovered Neutron
- 1935 Nobel Prize
- Student of Rutherford
- Manhattan Project

James Chadwick (1891-1974)