History (I)
Fundamental Nature of Matter

Early History – Is matter continuous or discrete
- Empedocles: (air/earth/fire/water)
- Democritus: tiny indivisible particles called “atomos”
- Aristotle: 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.”

Empedocles (490-430 BC)

Democritus (460-371 BC)

Aristotle (384-322 BC)

Robert Boyle (1627-1691)

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

Joseph Priestly
- Discovered O_2 and (NO, HCl, NH_3, N_2O, CO, SO_2)
- Invented Soda Water
- Phlogiston Theory

Antoine Lavoisier
- O_2 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 Priestly (1733-1804)

Antoine Lavoisier (1743-1779)

Joseph Proust (1754-1826)

John Dalton(1766-1844)

Joseph Proust
- Law of Definite Proportions: Substances always combine in constant and definite proportions
- Natural vs. Artificial $CuCO_3$

History (II)
First Theory of an Atom

John Dalton – (1766-1844) - 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)

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).

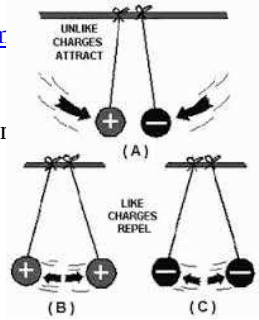
- Law of Partial Pressures
- Mentor of Joule
- Unit (Dalton)

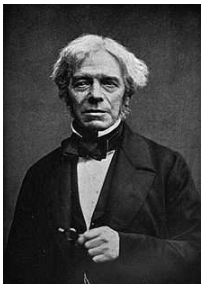
Rule of Greatest Simplicity

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

Study of Electricity and Magnetism

- Two types of charge (+/−)
- Opposites attract, Likes repel
- Charges may be transferred from object to object
- $F = \frac{kq_1q_2}{r^2}$

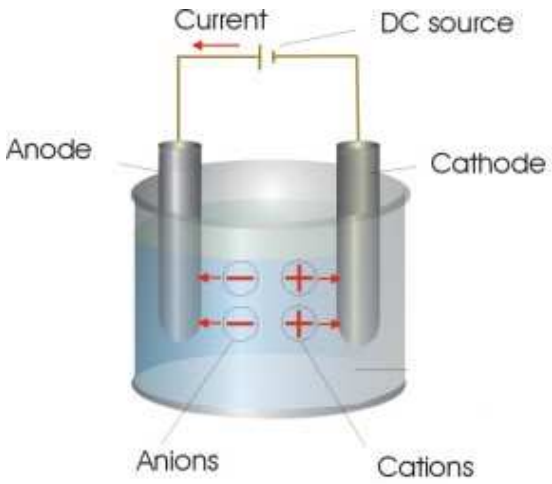




Michael Faraday (1791-1867)

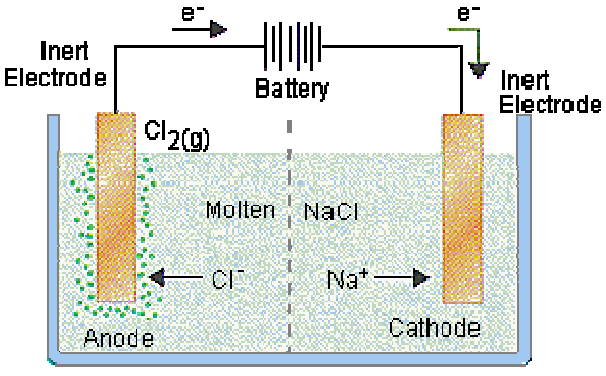
- Discovery of "ions" – certain substances when dissolved in water conduct electricity.
- Compounds decomposed electrically are attracted to different electrodes.
- Cathode (negative electrode)
- Anode (positive electrode)
- Two units named after him!

Physicist Ernest Rutherford stated; "When we consider the magnitude and extent of his discoveries and their influence on the progress of science and of industry, there is no honour too great to pay to the memory of Faraday, one of the greatest scientific discoverers of all time".

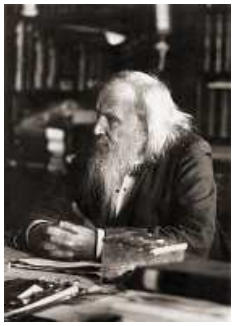


Svante Arrhenius (1859-1927)

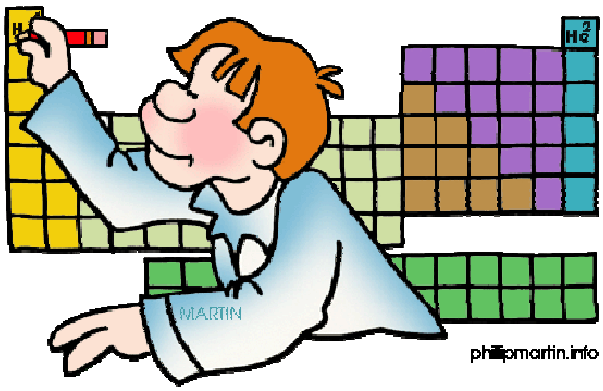
- Don't need water
- $NaCl \rightarrow Na^+ + Cl^-$
- Cations (+)
- Anions (−)
- Acids/Bases (Ch 15)
- Arrhenius Equation
- Noble Prize Committee (1903 Nobel Prize)

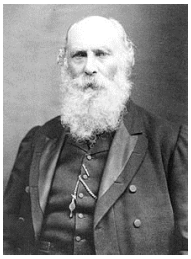


History (III)
First Theory of an Atom



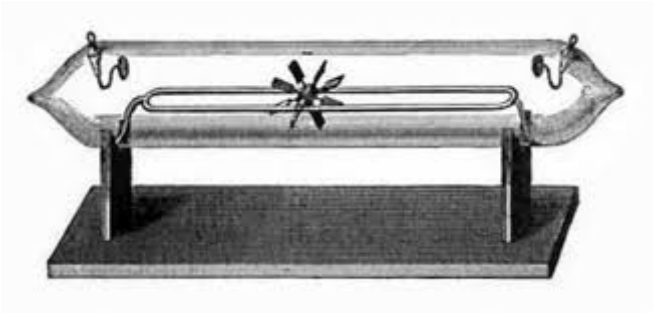
Dmitri Mendeleev (1834-1907)
- Periodic Table (1869)
- Wrote definitive textbook on Chemistry
- Rows = atomic mass
- Columns = similar Chemical and Physical properties
- Denied Nobel Prize because Arrhenius disliked him.

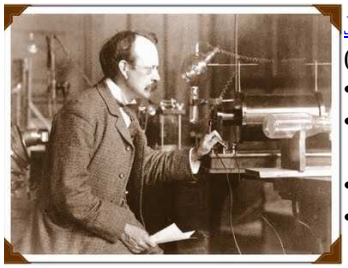




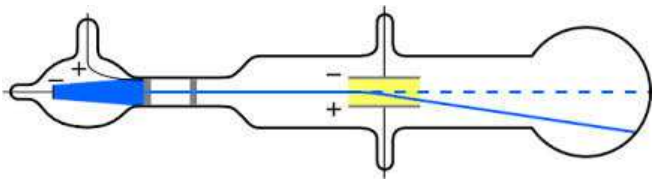
George Johnstone (GJ) Stoney (1826-1911)
- Supporter of Metric System
- Theorized the fundamental unit of electricity "electron"

William Crookes (1832-1911)
- Crookes Tube
- William Crookes
- Used to "discovery" electrons and x-rays
- Believed in "Psychic Abilities"

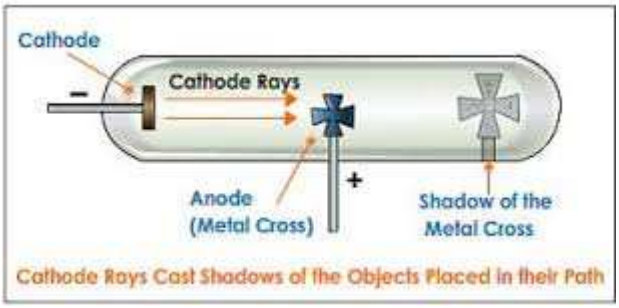


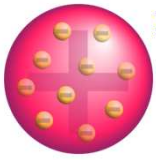


Joseph John (JJ) Thomson (1856-1940)
- 1906 Nobel Prize
- Discovery of the Electron (Corpuscles)
- Plum-Pudding Model
- Mass Spectrometer and Isotopes
- Gifted Teacher (7 students won Nobel Prizes, and his son)



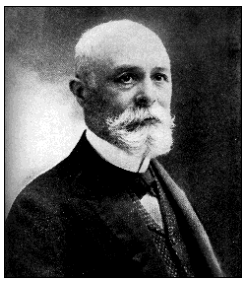
Properties of Electrons
- Travel in straight lines
- 1/1000th mass of H
- Same mass no matter source (all electrons are the same) "Universal"
- Deflected by magnetic fields (attracted to positive field therefore negatively charged)
- Produce Shadows
- Have mass (capable of turning a paddle wheel)



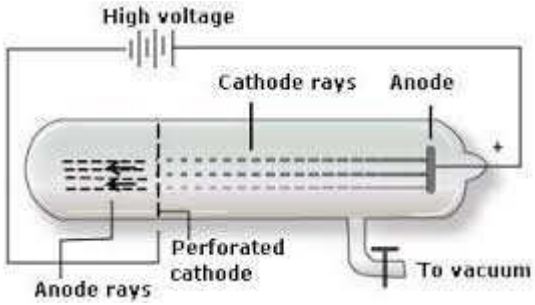


Plum Pudding Model
- Corpuscles (electrons) distributed in an even field of positive charge

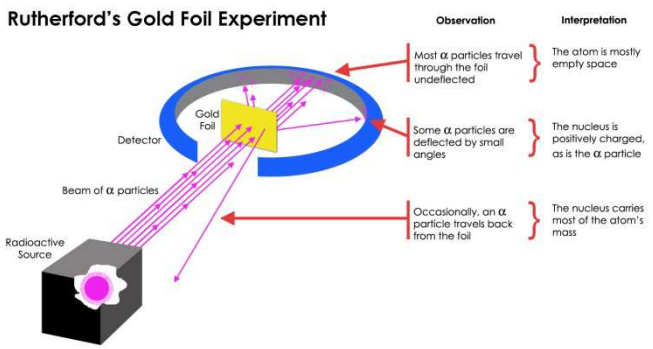
History (IV)
Structure of the Atom



Eugen Goldstein: (1850-1930)
"Discovered Proton"
- Canel Rays/Protons – emitted opposite cathode rays
- Different for each element
- Properties measured by Thomson

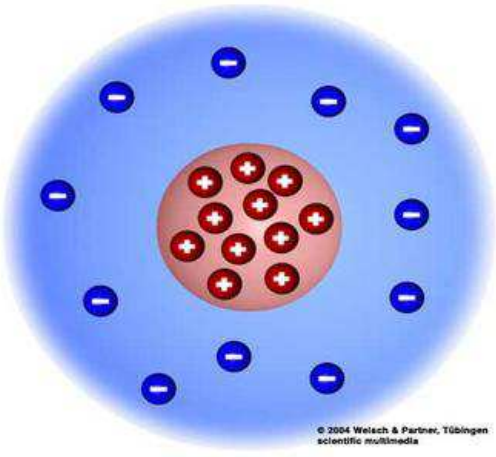


Ernst Rutherford (1871-1937)
- Rutherford Model
- 1908 Nobel Prize
- Geiger-Marsden Experiment (Au Foil)
- Atoms are not inseparable
- α-particle, β-particle, γ-rays, ½ life,



"It was quite the most incredible event that has ever happened to me in my life. It was almost as incredible as if you fired a 15-inch shell at a piece of tissue paper and it came back and hit you. On consideration, I realized that this scattering backward must be the result of a single collision, and when I made calculations I saw that it was impossible to get anything of that order of magnitude unless you took a system in which the greater part of the mass of the atom was concentrated in a minute nucleus. It was then that I had the idea of an atom with a minute massive centre, carrying a charge."
—Ernest Rutherford

Rutherford Model of the Atom



James Chadwick (1891-1974)
- Discovered Neutron
- 1935 Nobel Prize
- Student of Rutherford
- Manhattan Project