# Outline

- Atomic Theory
- Atomic Structure
- Periodic Table

# Atomic Theory

400 B.C.

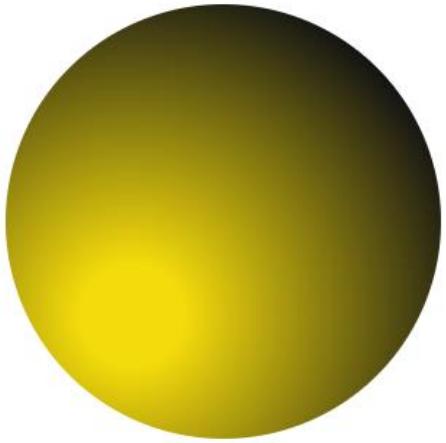
Democritus proposed matter composed of indivisible particles called atoms (atomos)

1808

First atomic theory was published Dalton…

- Atoms are indivisible
- Atoms are the same for a given element
- Atoms combine to form compounds
- Atoms not changed in reactions

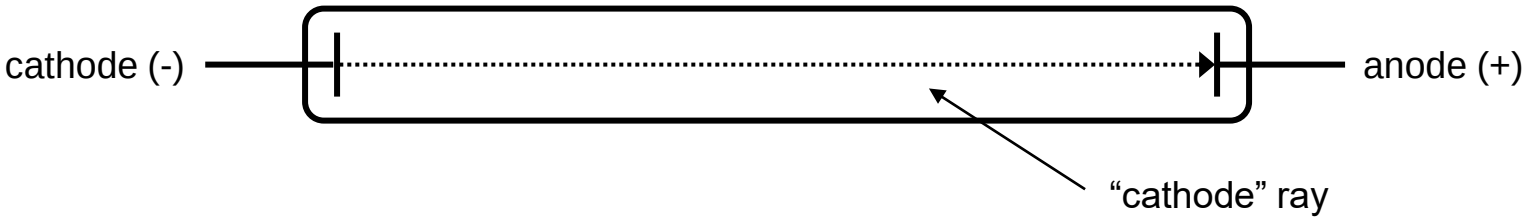
Daltons “Atom”



# Atomic Structure

1897

Thomson discovered the first sub-atomic particle




“Cathode” ray composed of particles: <u>electrons</u>

Electrons are very small particles with negative charge…

mass: $9.110 \times 10^{-28}$ g

charge: $-1.60 \times 10^{-19}$ C (-1)

Thomson studied larger particles with positive charge: <u>protons</u>

mass: $1.673 \times 10^{-24}$ g
charge: $+1.60 \times 10^{-19}$ C (+1)

Thomson model of atom…

Charged particles in "atomic sphere"

Numbers of protons and electrons…

Equal for neutral atoms

Unequal for charged atoms

# Plum-Pudding Model

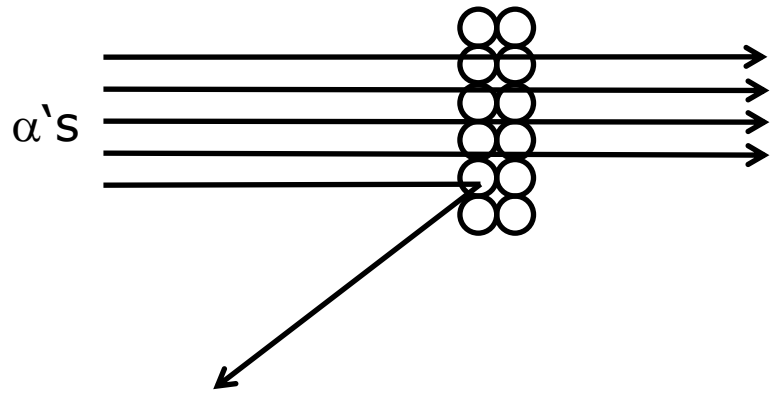
# Plum-Pudding Model

1910

Rutherford disproved Thomson's model of the atom

Small, positively charged particles shot at thin, gold foil

Particles should pass right through "Thomson" atoms



Most alpha particles passed right through the gold foil…

some alpha particles bounced almost directly backwards

Rutherford model of the atom

Atoms contain extremely dense, positively charged nucleus

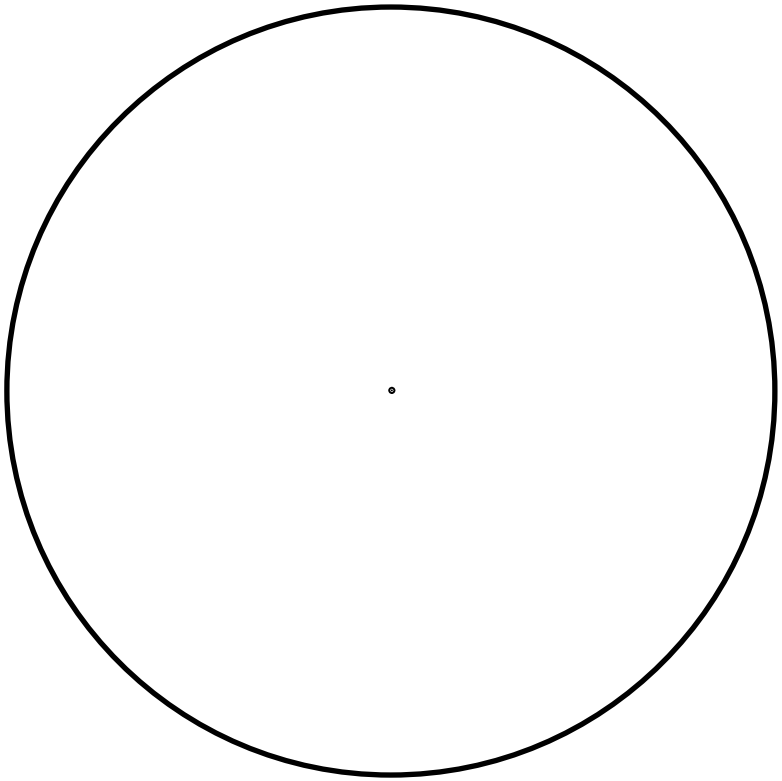
diameter of atom: $10^{-10}$ m
diameter of nucleus: $10^{-15}$ m

Mass of an atom is primarily due to nucleus

Nucleus is surrounded by electrons

Rutherford’s Nuclear Model

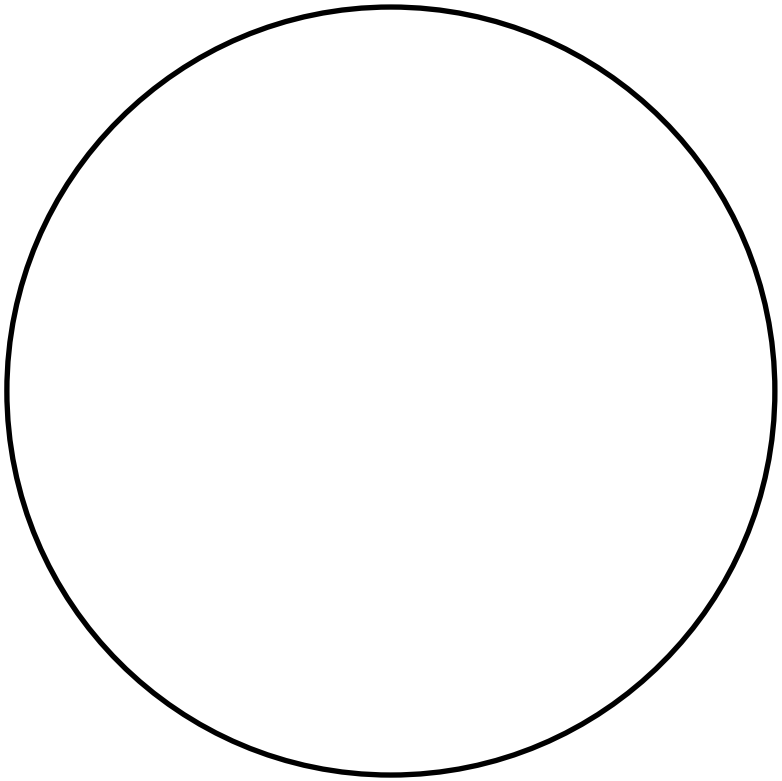
(Atom’s are pretty much empty space!)



400x smaller…

Rutherford’s Nuclear Model

(Atom’s are pretty much empty space!)



100,000x smaller…

Rutherford’s Nuclear Model

Actual appearance of the atom!

100,000x smaller…

1932

Chadwick discovered the neutron

Neutrons have no charge (neutral), and are slightly larger than protons

mass: $1.675 \times 10^{-24}$ g

The nucleus contains both neutrons and protons

Atoms of a given element contain the same number of protons…

Given by the atomic number (Z)

# Periodic Table

The periodic table lists the elements in order of atomic number

Most basic division of periodic table is into metals and nonmetals

- metals
  - metallic luster, conduct heat and electricity, malleable and ductile
- nonmetals
  - opposite properties of metals
- metalloids
  - both metallic and nonmetallic properties

Arranged so elements in same column have similar properties

Columns: Group or Family
Rows: Period or Series

Group I, Alkali Metals: soft, silvery, very reactive metals

Group II, Alkaline Earth Metals: soft, silvery, reactive metals

Group VII, Halogens: very reactive nonmetals of varying states

Group VIII, Noble Gases: non-reactive gases

Atoms can lose or gain electrons in chemical reactions

Ions are formed when electrons are transferred…

If given up, positively-charged ion is formed: <u>cation</u>

$$K \rightarrow K^{+} + e^{-}$$

If gained, negatively-charged ion is formed: <u>anion</u>

$$F + e^{-} \rightarrow F^{-}$$

Number of electrons lost or gained is predicted by position on the period table

Sum of the protons and neutrons is the mass number (A)

$^{35}_{17}Cl$ 17 protons and (35 – 17) = 18 neutrons

$^{37}_{17}Cl$ 17 protons and (37 – 17) = 20 neutrons

Atoms of an element can have different numbers of neutrons

Atoms of the same element with different numbers of neutrons are called isotopes

Isotopes are identified by their mass number

chlorine-35 and chlorine-37

Atomic mass is the mass of an individual atom

measured in atomic mass units (amu)

1 amu is 1/12$^{th}$ the mass of a C atom (= 1.6606 x 10$^{-24}$ g)

Elements can exist in several isotopic forms, each with own mass

| | | |
|---|---|---|
| $^{35}$Cl | 34.96885 amu | (75.53%) |
| $^{37}$Cl | 36.96590 amu | (24.47%) |

Atomic mass found on periodic table is average atomic mass of the element's naturally occurring isotopes

(0.7553)(34.96885 amu)+(0.2447)(36.96590 amu) = <u>35.46 amu</u>