A few important laws… (what is a scientific law?)

Law of conservation of mass: in a chemical reaction, matter is neither

Antoine Lavoisier, 1743-1794 (France)

Law of definite proportions: any sample of a **compound** will have the same proportions of elements

Two different samples of CO_2:

Sample 1: 25.6 g O; 9.6 g C

Sample 2: 21.6 g O; 8.10 g C

Law of multiple proportions: Different compounds of the same elements have whole number proportions of elements.

Water and hydrogen peroxide: both have H and O

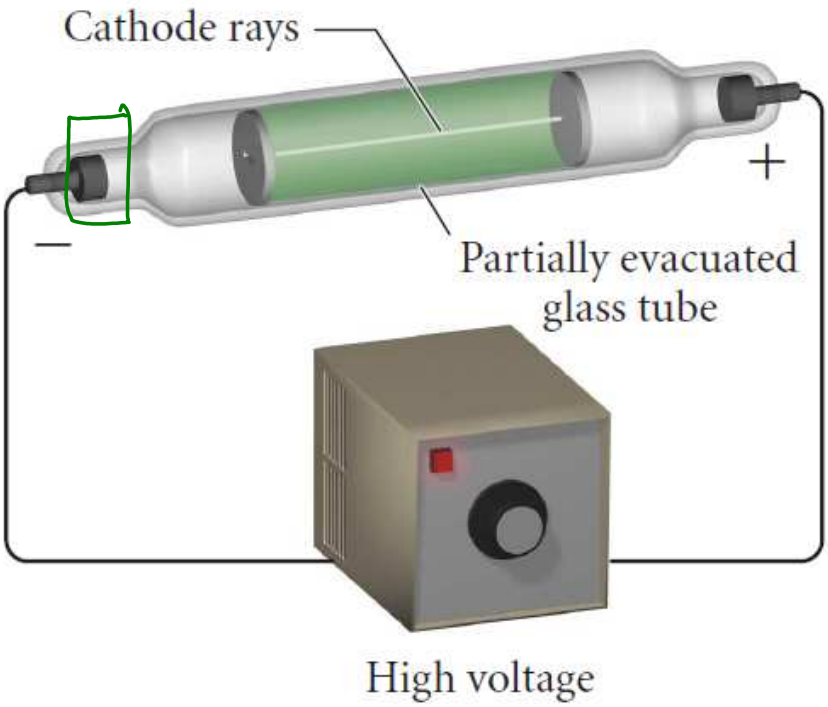
Water: 0.136 g H for every 1 g O
Hydrogen peroxide: 0.0630 g H for every 1 g O

Atomic theory: John Dalton, 1808

1. Atoms = indestructible, smallest unit of element to retain identity
2. An element has all the same type of atoms
3. A compound contains atoms of 2 or more elements in a fixed ratio

4. In a chemical reaction, atoms rearrange to form new substances

J. J. Thomson, 1897: cathode ray tube

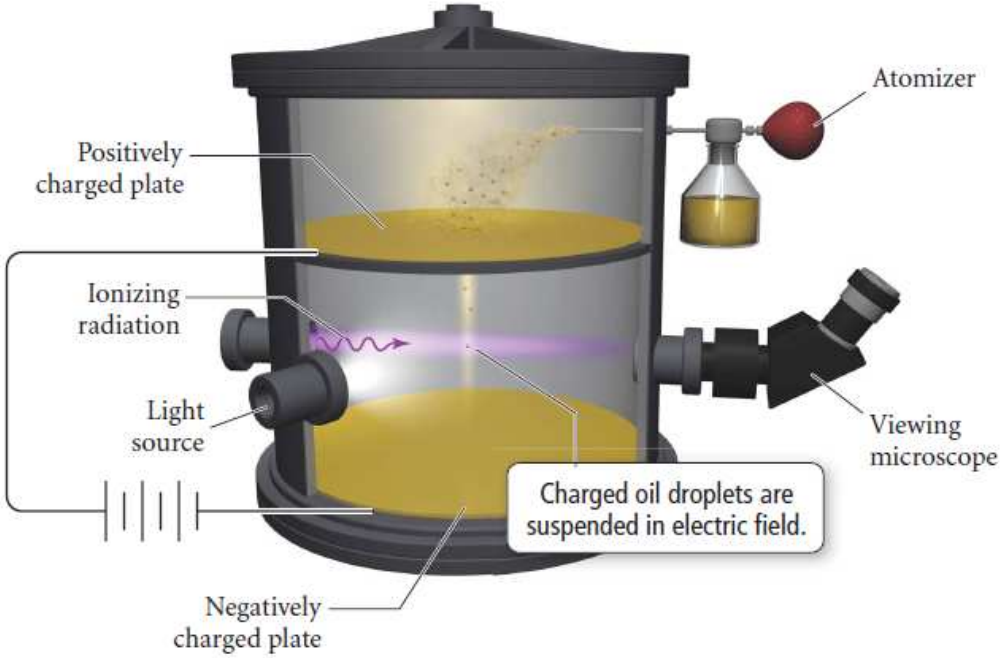


Cathode rays contain a single type of particle:

- Negatively charged
- The same from any element
- Calculated mass/charge ratio

Thomson called it the **electron**.

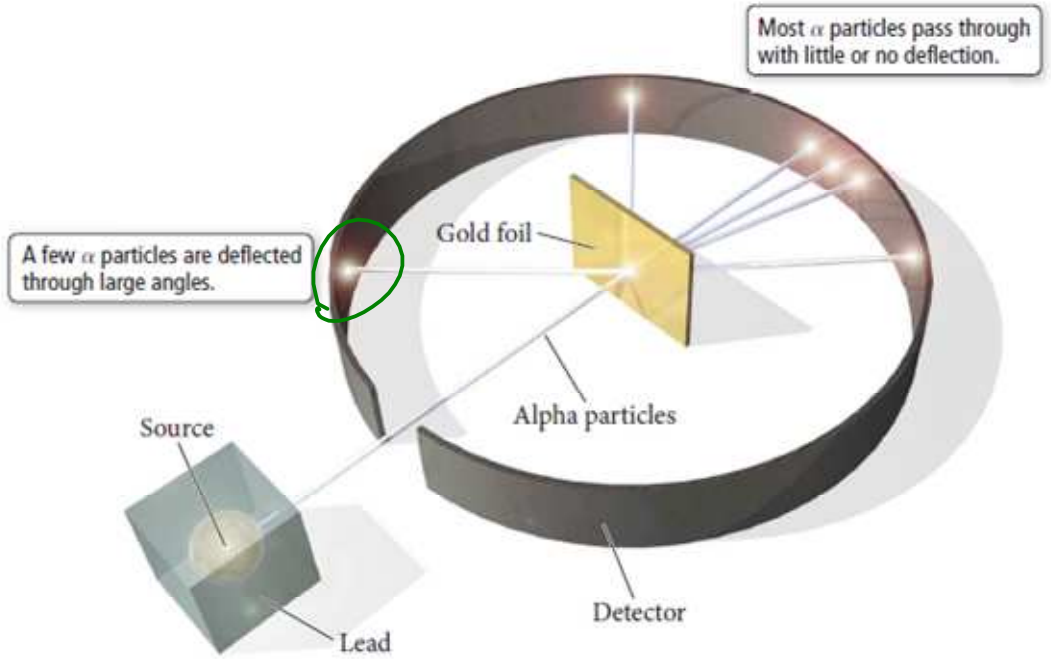
Robert Millikan: 1909 Oil drop experiment

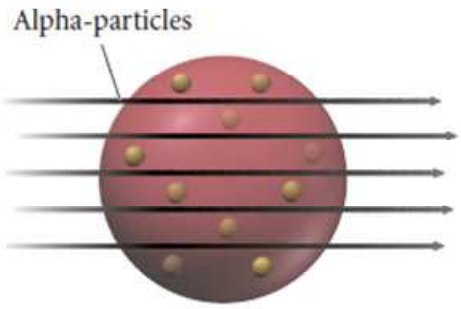


Charge of an electron: 1.602×10^{-19} coulombs (C)

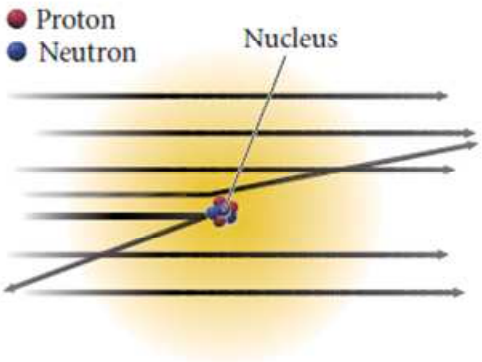
Mass of an electron: 9.109×10^{-28} g

Ernest Rutherford: 1911 gold foil experiment





Plum-pudding model



Nuclear model

Rutherford's nuclear model:

1. Most of atom's mass is in a tiny dense nucleus
2. Most of the volume is empty space, with tiny electrons around the nucleus
3. In a neutral atom, the number of protons equals the number of

Atomic number (Z):

Mass number (A):

A certain nucleus contains 11 protons and 12 neutrons.

Z =

A =

Nuclide: a nucleus with a certain atomic and mass number (a given number of protons and neutrons)

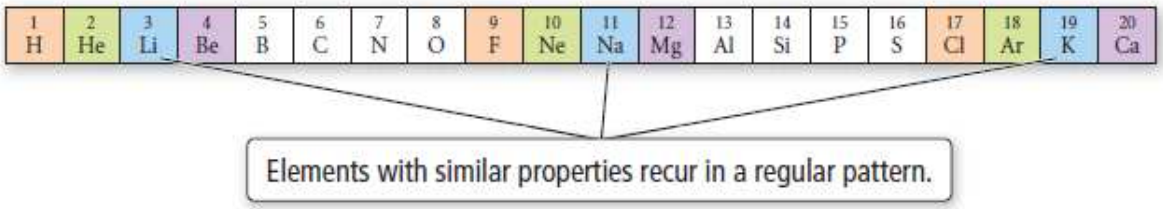
Isotopes: have same atomic number, different mass #'s (same number of _____, different number of _____)

Nuclide symbol:

Isotope name:

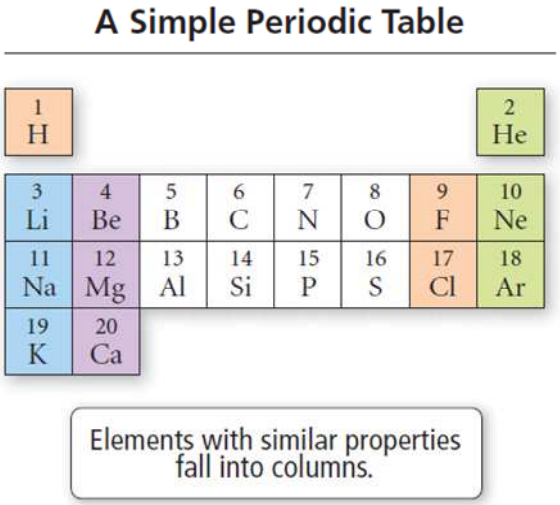
Dimitiri Mendeleev, 1869
Originally arranged elements in order of atomic weight
(now use atomic # to order)

Periodic law: elements with similar properties recur in a regular pattern



Periodic table:

- Columns = groups or families (18 groups)
- Rows = periods (7)



Group numbers: roman numeral then A/B

- A: main-group
- B: transition

Parts of the periodic table

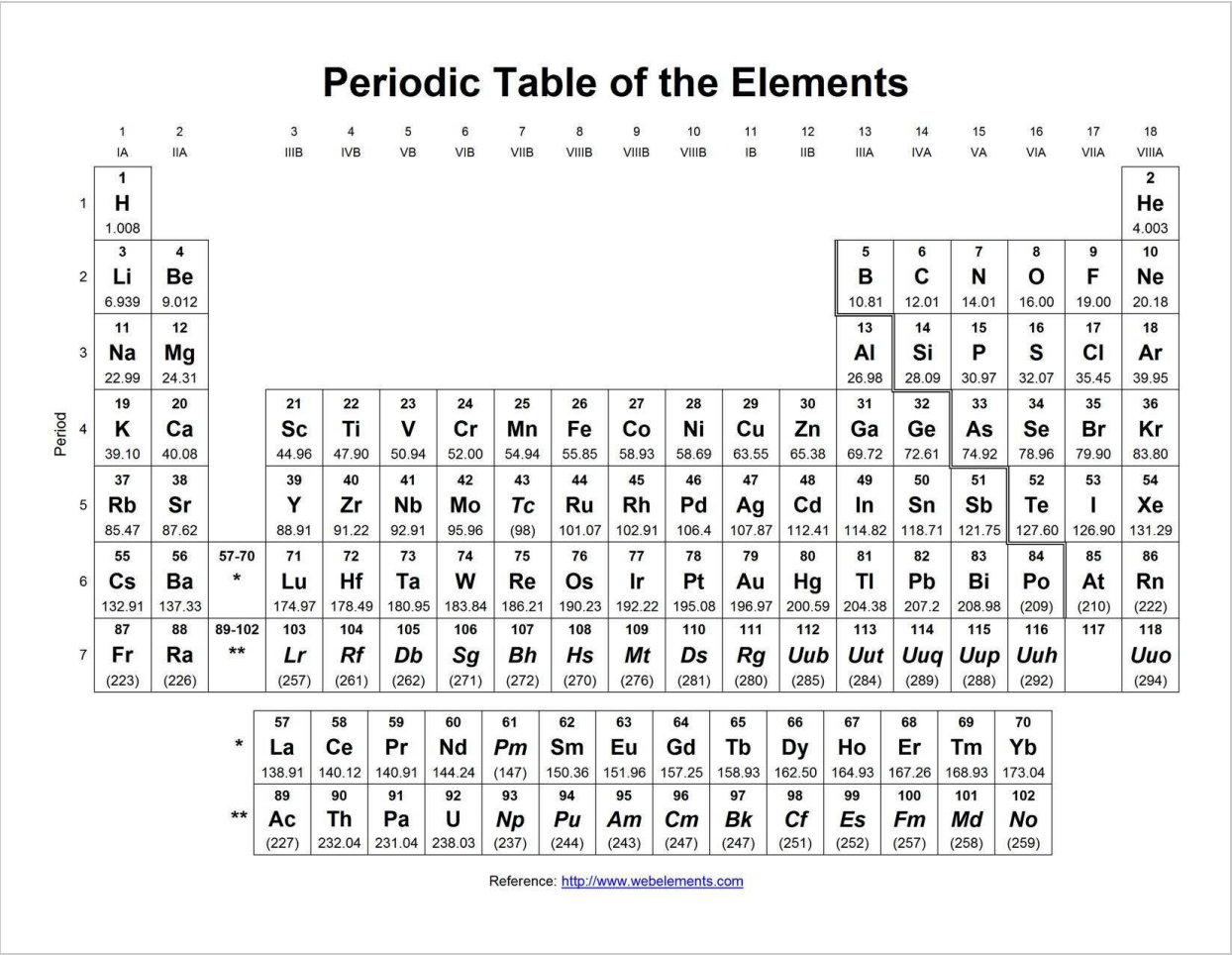
Some important groups:

- IA: alkali metals
- IIA: alkaline earth metals
- VIIA: halogens
- VIIA: noble gases

Metals:

Nonmetals:

Metalloids (semimetals):



Neutral atoms have the same number of protons and electrons

Ions have a different number of p^+ and e^-.

Metals usually lose electrons to form positively charged cations:

Nonmetals usually gain electrons to form negatively charged anions:

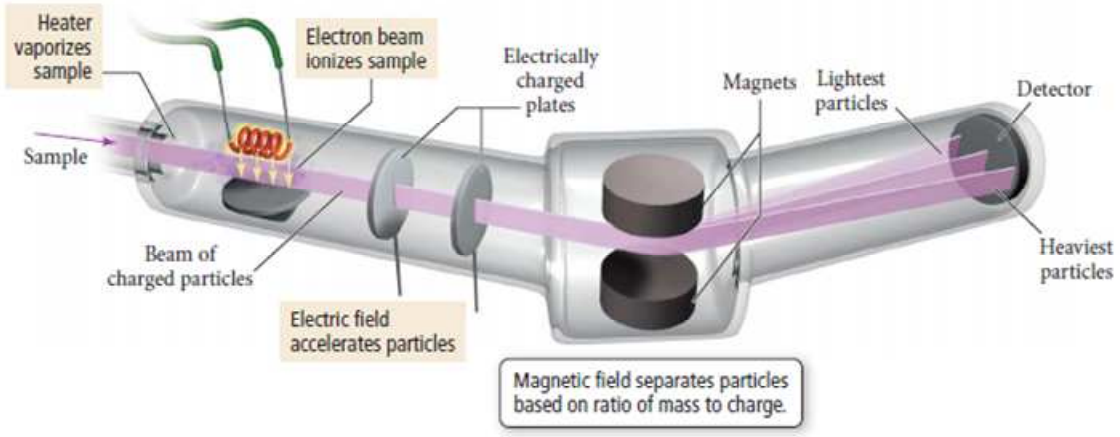
Main group elements tend to form stable ions with the same # electrons as the nearest noble gas.

Atomic mass: relative mass of an atom

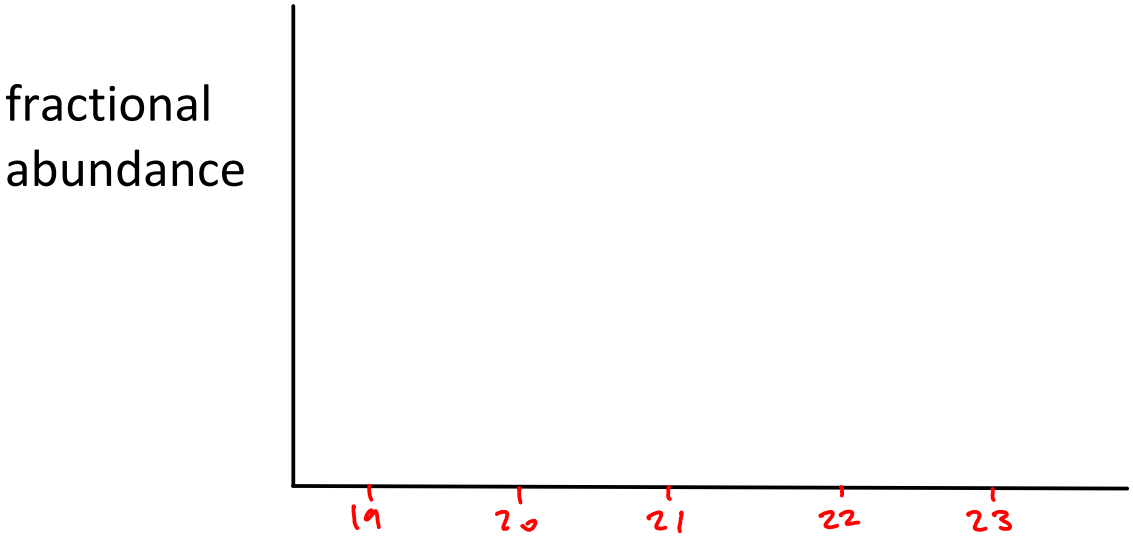
Unit = amu (atomic mass unit),
(also called Dalton, abbrev u)

Definition of amu: 12 amu = mass of 1 carbon-12 atom

Mass spectrometry: measures mass/charge ratio of particles deflected by magnetic field



Sample of natural neon:



m/z = atomic mass (amu)

Atomic mass

isotope	atomic mass	abundance
neon-20	19.992 amu	0.9051
neon-21	20.994 amu	0.0027
neon-22	21.991 amu	0.0922

The mole = the chemist's dozen

1 pair = 2 objects
1 dozen = 12 objects
1 mole = 6.022×10^{23} objects

6.022×10^{23} particles/mol = Avogadro's number

1.38 mol Al = ? Al atoms

9.23×10^{25} Pb atoms = ? mol Pb

	Atomic mass	Molar mass
carbon-12	12 amu exactly	12 g/mol exactly
carbon	12.01 amu	12.01 g/mol
neon	20.18 amu	20.18 g/mol

12.5 g Si = ? mol Si

2.6 mol Ag = ? g Ag