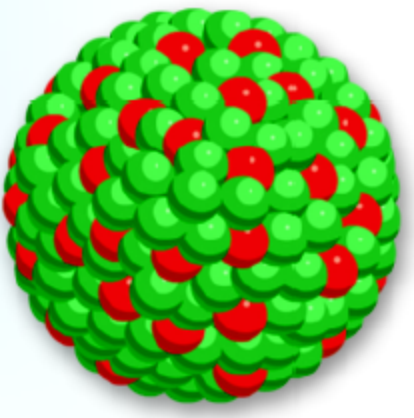


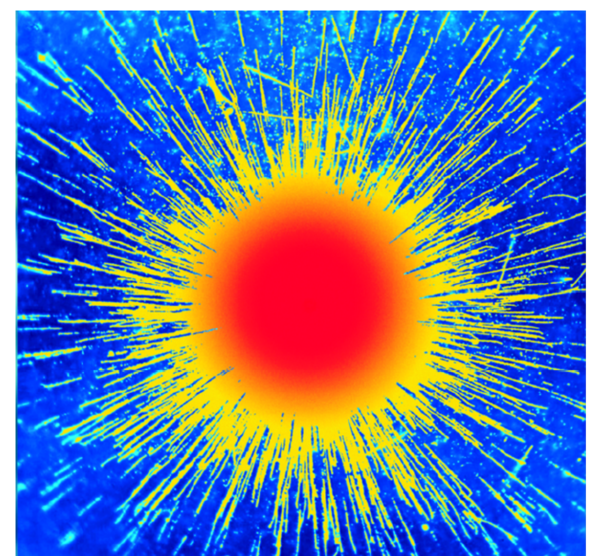
Ancient Greece

Democritus

If you cut a pure substance in half repeatedly, you would eventually get to an indivisible object — "atomos"

Atoms, Molecules and Ions

Chapter 2



Dalton's Atomic Theory (1808)

1. Elements are composed of extremely small particles called ***atoms***. Democritus idea

2. All ***atoms*** of a given element are identical, having the same size, mass and chemical properties. The atoms of one element are different from the atoms of all other elements.

   O_2 molecular oxygen (atom)

3. ***Compounds*** are composed of atoms of more than one element. In any compound, the ratio of the numbers of atoms of any two of the elements present is either an integer or a simple fraction. "sugar" C H O 1C : 2H : 1O

4. A ***chemical reaction*** involves only the separation, combination, or rearrangement of atoms; it does not result in their creation or destruction.

law of conservation of matter - matter cannot be created or destroyed

Dalton's Atomic Theory

$$2C_8H_{18} + 25O_2 \xrightarrow{heat} 18H_2O + 16CO_2$$

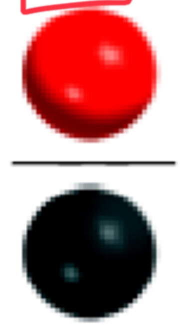
$\boxed{16C}$ 36H 50(O)

36 H 18(O)

32(O)

16C 50(O)

Carbon monoxide

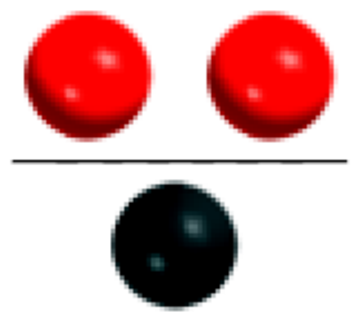
$\frac{O}{C} =$  $= \frac{\boxed{1}}{1}$

CO

H_2O

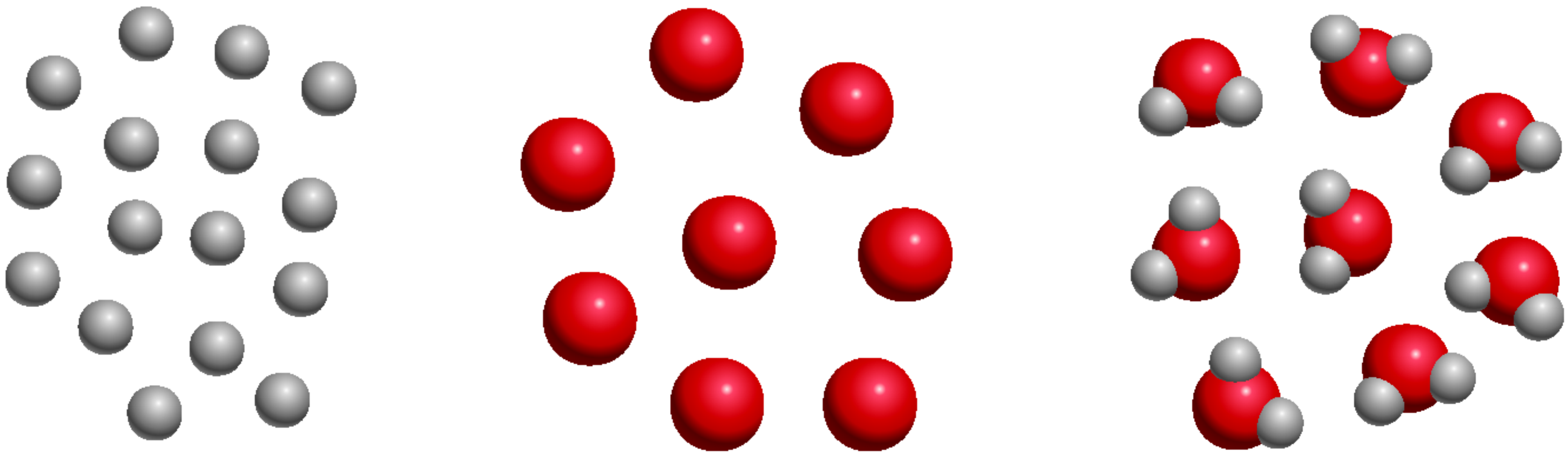
Carbon dioxide

H_2O_2

$\frac{O}{C} =$  $= \frac{\boxed{2}}{1}$

CO_2

Law of Multiple Proportions



Atoms of element X

Atoms of element Y

Compounds of elements X and Y

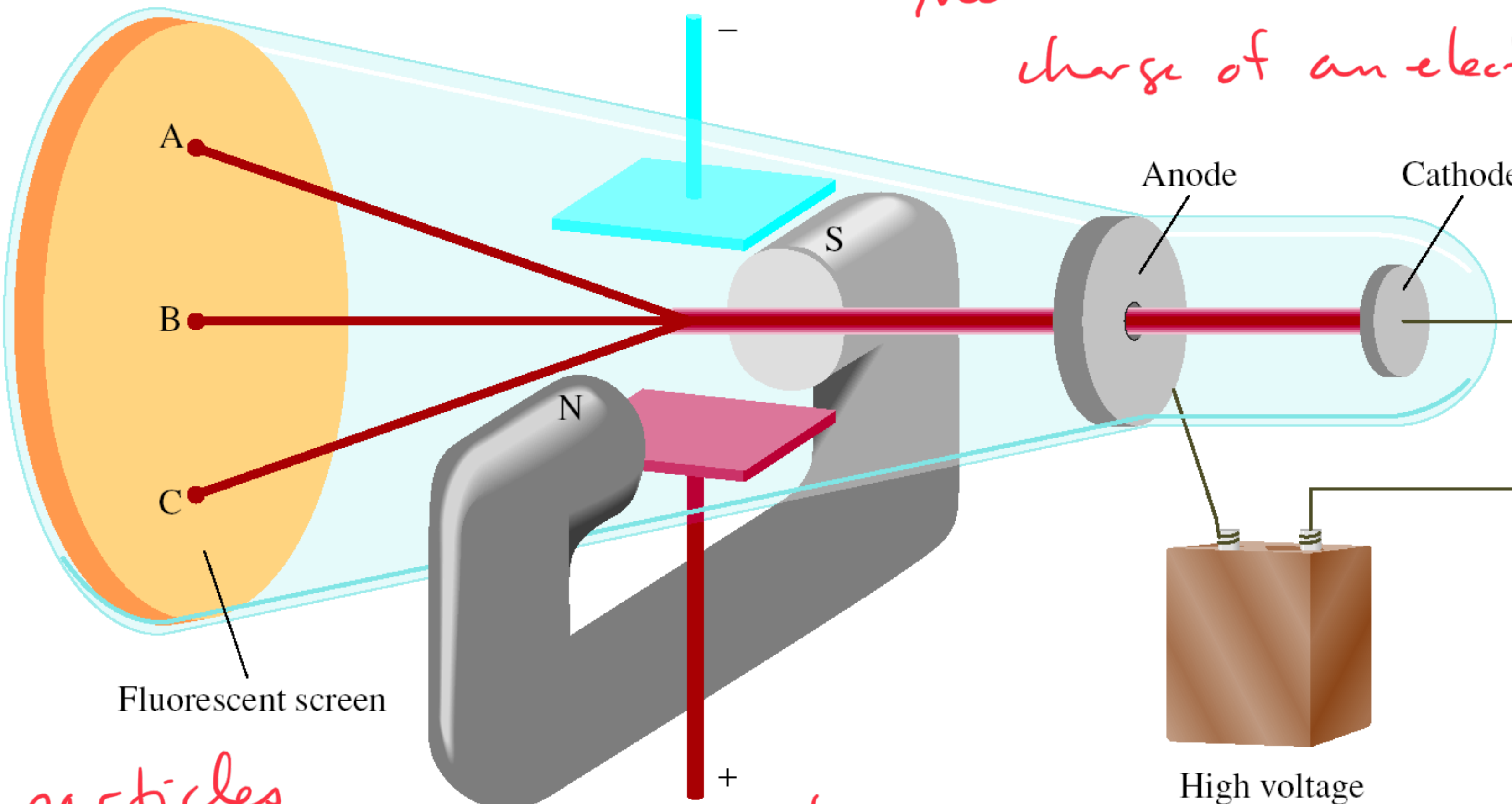
$$16\,X \quad + \quad 8\,Y \longrightarrow 8\,X_2Y$$

Please know

Law of Conservation of Mass

Cathode Ray Tube

measured mass and charge of an electron

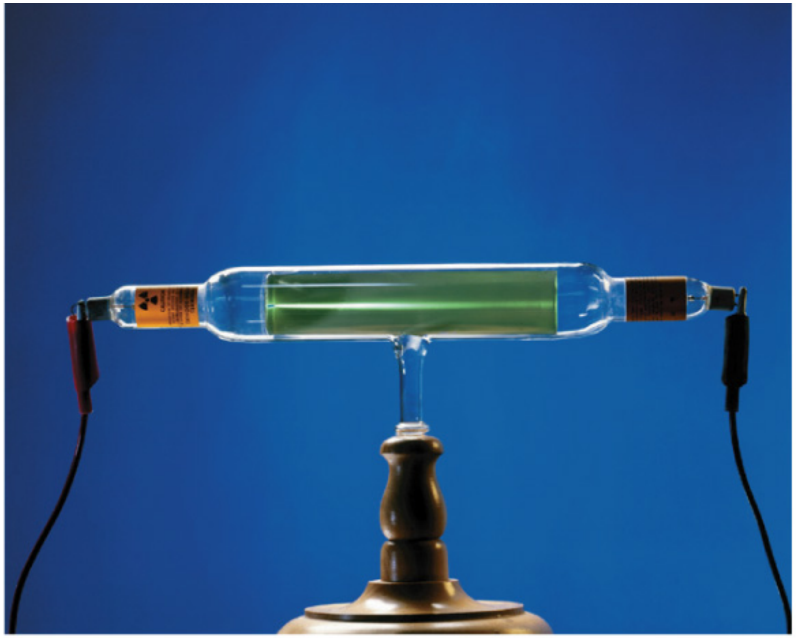


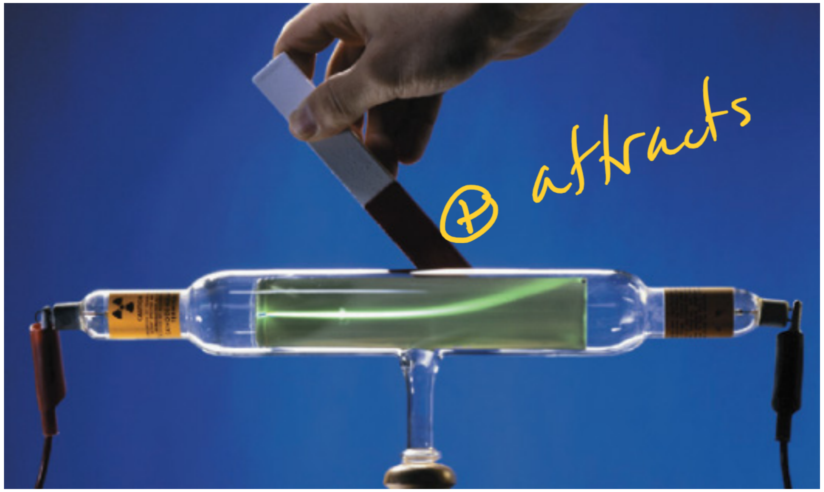
particles have charged components

J.J. Thomson, measured mass/charge of e-

(1906 Nobel Prize in Physics)

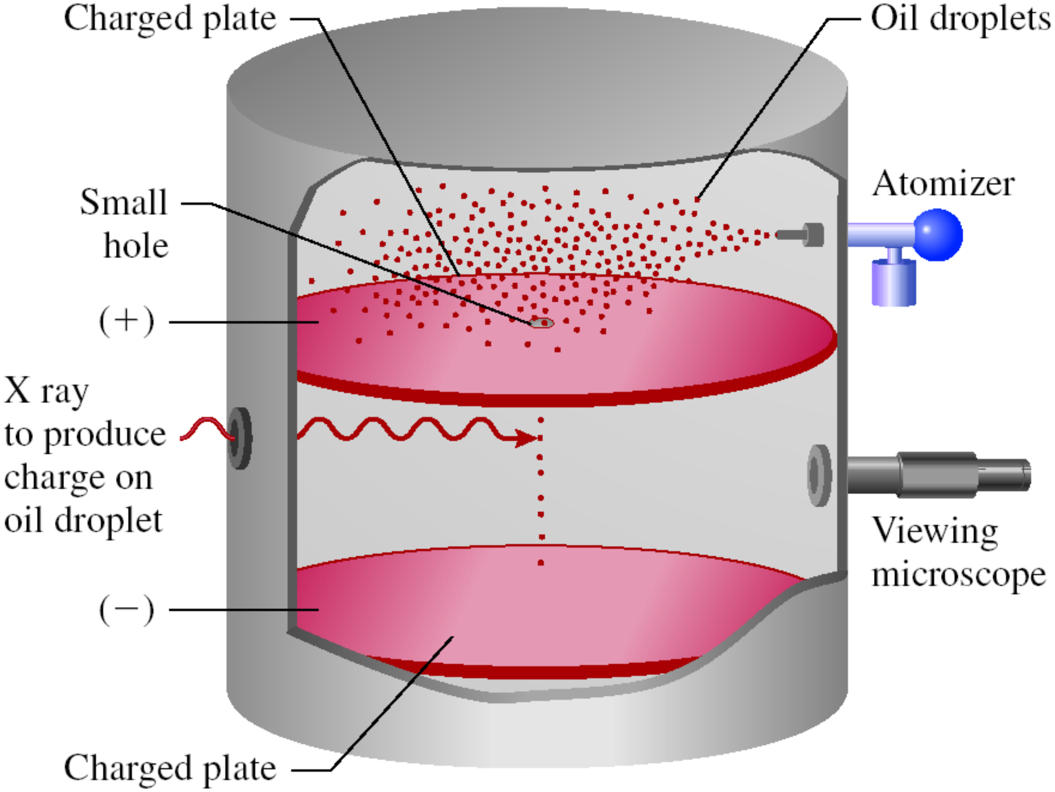
Cathode Ray Tube





Millikan's Experiment

measure mass of an electron



Measured mass of e-

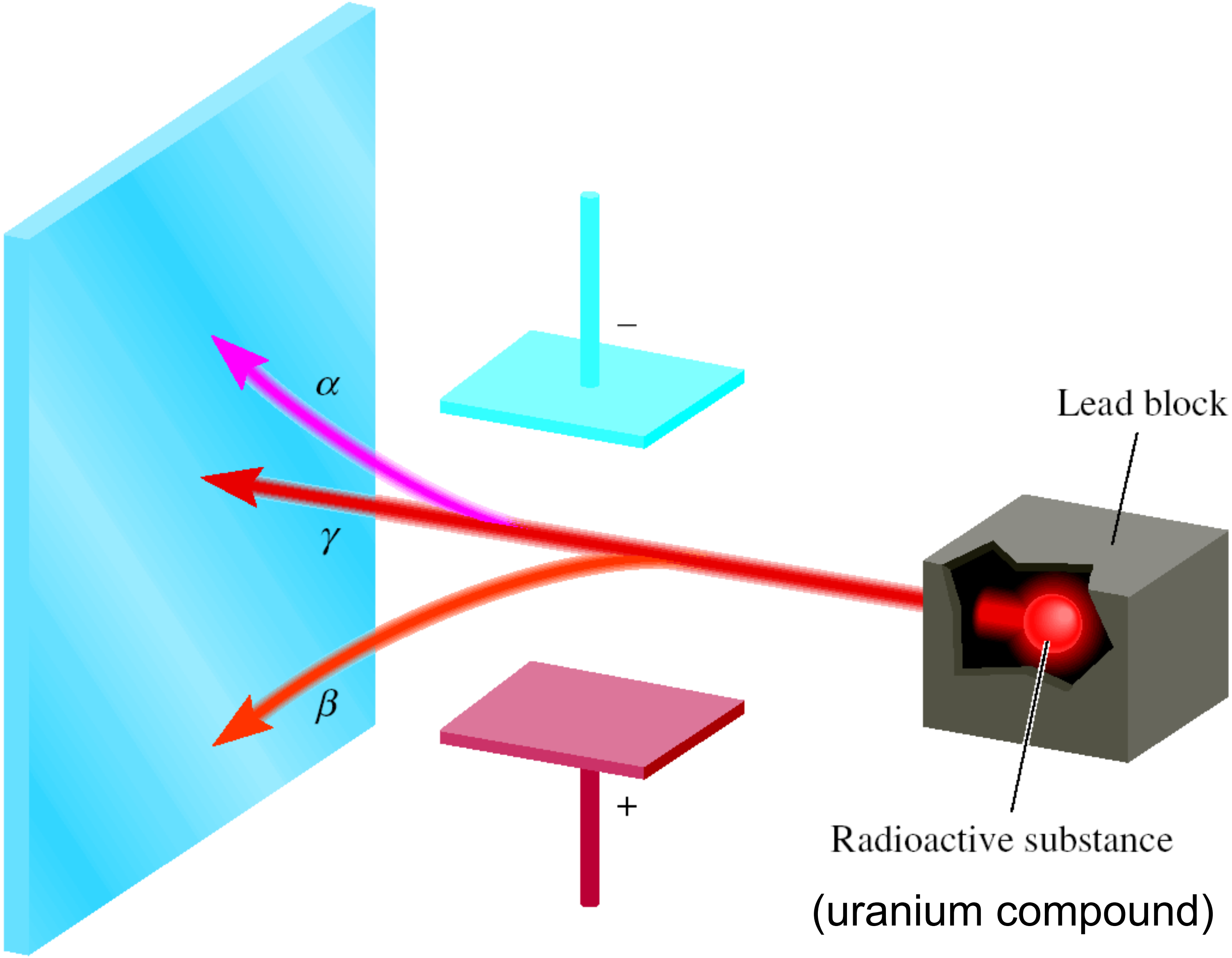
(1923 Nobel Prize in Physics)

e^- charge = -1.60×10^{-19} C

Thomson's charge/mass of e^- = -1.76×10^{8} C/g

e^- mass = 9.10×10^{-28} g

Types of Radioactivity

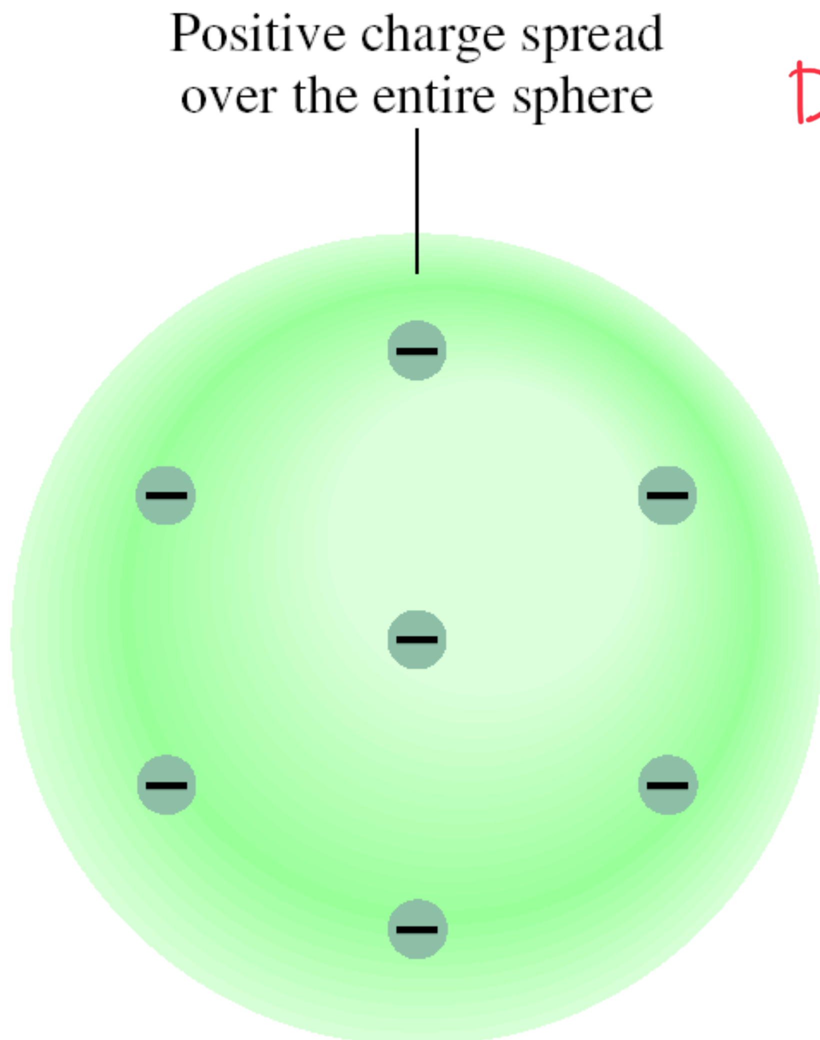


(uranium compound)

Thomson's Model

Atomic Model

"Plum Pudding Model"



Dense region of positive

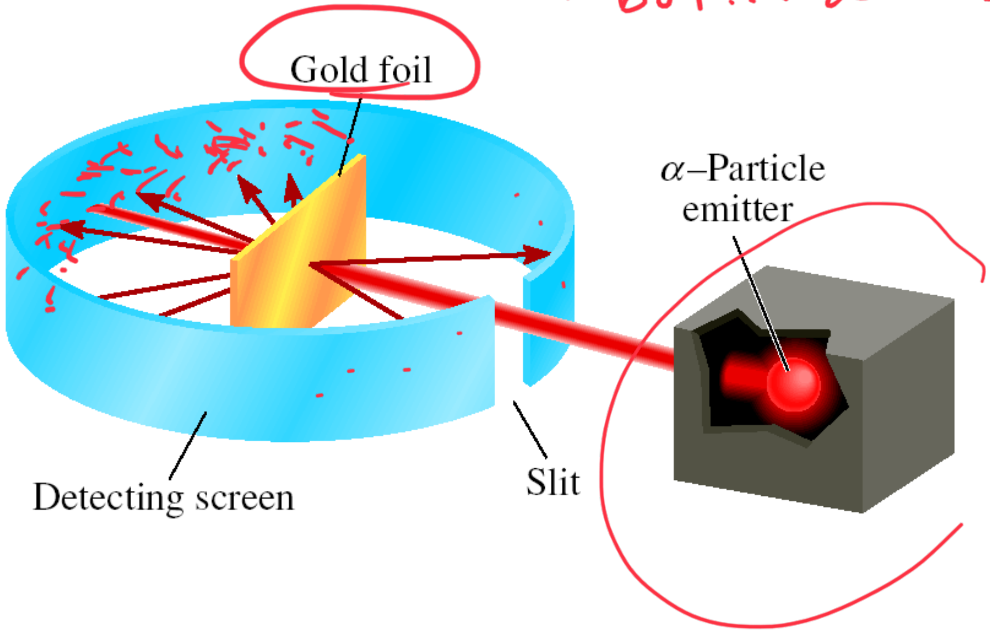
small particles of negative charge

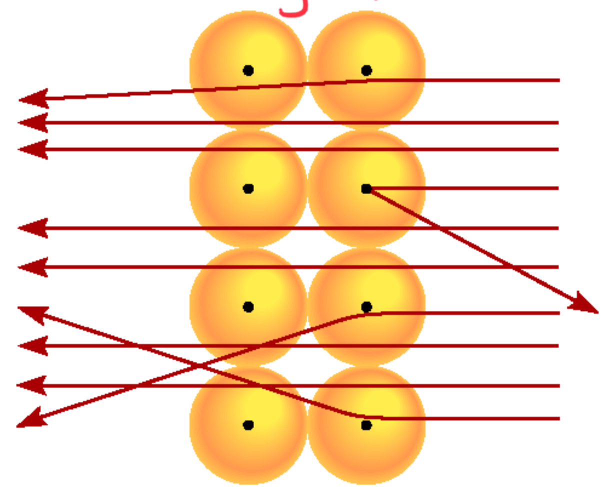
Atoms have a dense positive nucleus

Rutherford's Experiment

(1908 Nobel Prize in Chemistry)

but... atoms are mostly space.

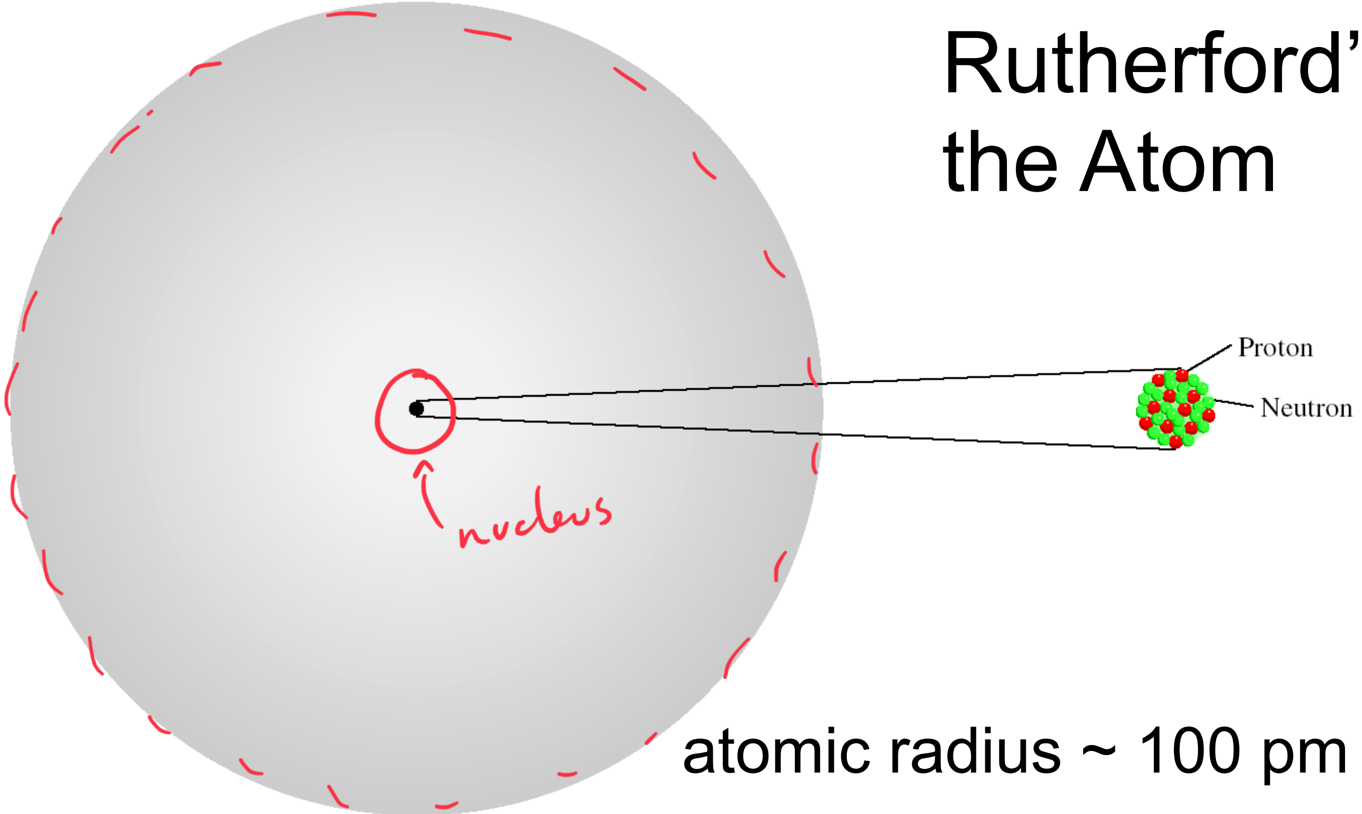




α particle velocity ~ 1.4×10^7 m/s
(~5% speed of light)

1. atoms positive charge is concentrated in the nucleus
2. proton (p) has opposite (+) charge of electron (-)
3. mass of p is 1840 x mass of e^- (1.67×10^{-24} g)

Rutherford’s Model of the Atom



atomic radius ~ 100 pm = 1×10^{-10} m

nuclear radius ~ 5×10^{-3} pm = 5×10^{-15} m

“If the atom is the Houston Astrodome, then the nucleus is a marble on the 50-yard line.”

Chadwick's Experiment (1932)
(1935 Noble Prize in Physics)

H atoms - 1 p; He atoms - 2 p

mass He/mass H should = 2

measured mass He/mass H = 4

$$\alpha + {}^{9}\text{Be} \longrightarrow {}^{1}\text{n} + {}^{12}\text{C} + \text{energy}$$

neutron (n) is neutral (charge = 0)

n mass ~ p mass = 1.67×10^{-24} g subatomic particles

TABLE 2.1 Mass and Charge of Subatomic Particles

		Charge	
Particle	**Mass (g)**	**Coulomb**	**Charge Unit**
Electron*	9.10938×10^{-28}	-1.6022×10^{-19}	-1
Proton	1.67262×10^{-24}	$+1.6022 \times 10^{-19}$	$+1$
Neutron	1.67493×10^{-24}	0	0

*More refined measurements have given us a more accurate value of an electron's mass than Millikan's.

mass proton ≈ mass neutron

mass proton 2000x bigger than mass of electron

mass p ≈ mass n ≈ 1840 x mass e-

Atomic number, Mass number and Isotopes

Atomic number (Z) = number of protons in nucleus

Mass number (A) = number of protons + number of neutrons

= atomic number (Z) + number of neutrons

Isotopes are atoms of the same element (X) with different numbers of neutrons in their nuclei

Elements are identified by number of protons

atomic number

Mass Number → A

Atomic Number → Z

$^{A}_{Z}X$ ← Element Symbol

83

Bi

Bismuth

atomic number = # of protons (and in neutral atom # of electrons)

$^{1}_{1}H$ $^{2}_{1}H$ (D) $^{3}_{1}H$ (T)

atomic mass = protons + neutrons

208.98 ≈ 209

atomic mass

$83 p^{\oplus}$

$83 e^{\ominus}$

$126 n^{0}$

$^{235}_{92}U$ $^{238}_{92}U$

209 − 83 = 126

The Isotopes of Hydrogen

47 atomic number

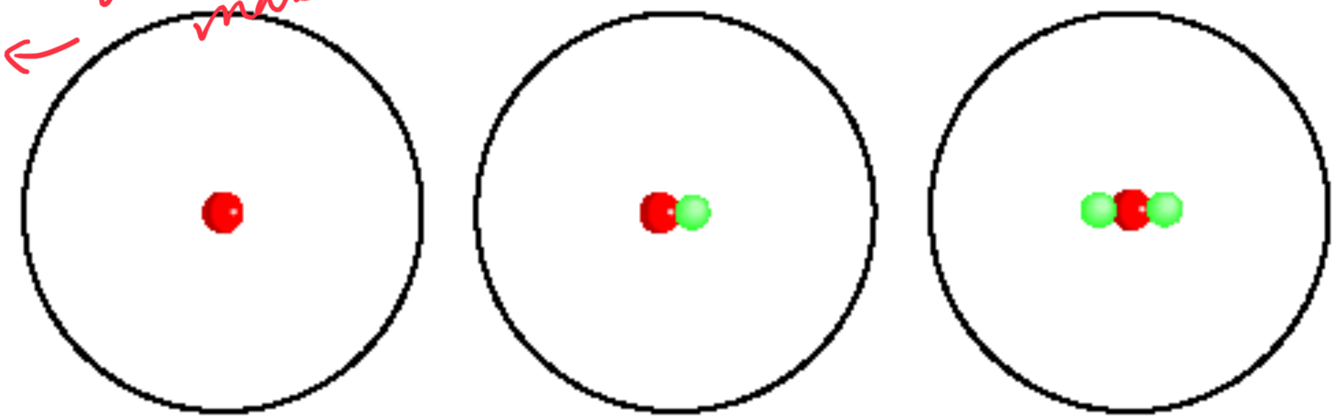
Ag

107.87 atomic mass

≈108

protons: 47
electrons: 47
neutrons: 61

$$\begin{array}{r} 108 \\ -\ 47 \\ \hline 61 \end{array}$$



$^{1}_{1}H$ $^{2}_{1}H$ $^{3}_{1}H$

How many protons, neutrons, and electrons are in $^{14}_{6}C$?

6 protons, 8 (14 - 6) neutrons, 6 electrons

How many protons, neutrons, and electrons are in $^{11}_{6}C$?

6 protons, 5 (11 - 6) neutrons, 6 electrons