Dalton & The Law of Multiple proportions

$Cu + Cl \rightarrow CuCl$ 1:1

$Cu + Cl \rightarrow CuCl_2$ 1:2

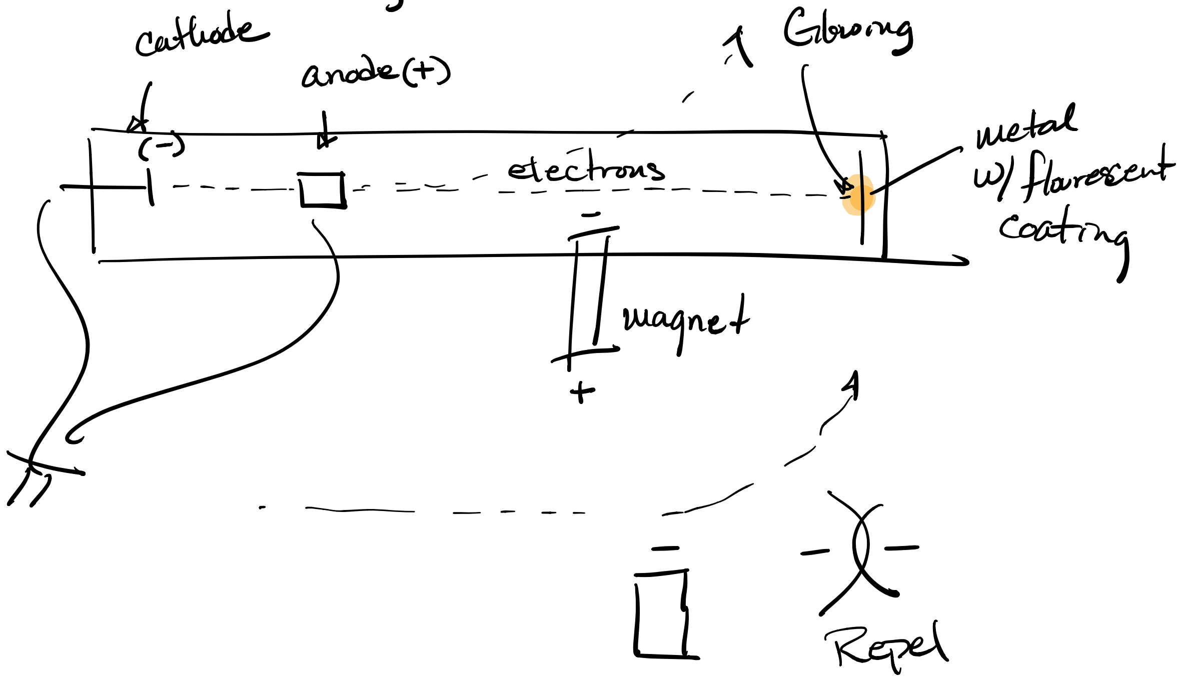
Small Whole #'s

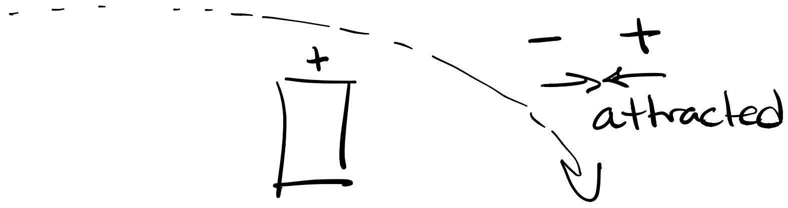
H_2O	H_2O_2	$H_{3.6}O_{2.7}$
water	Hydrogen peroxide	

Chapter 2.2

1890's Thompson

Cathode Ray Tube

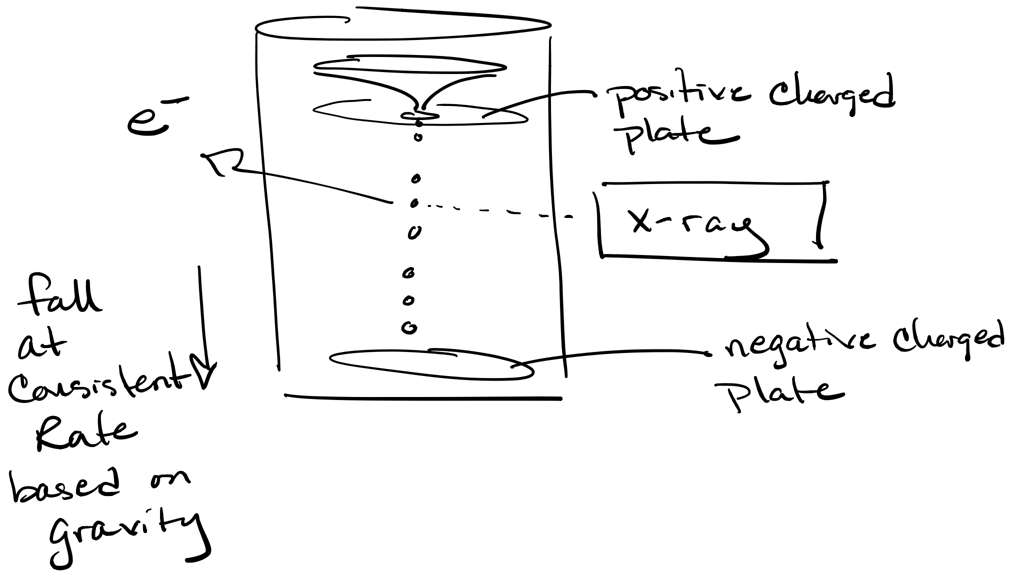




⟹ electrons (−) charged

e^-

1909 Robert Millikan "oil drop"



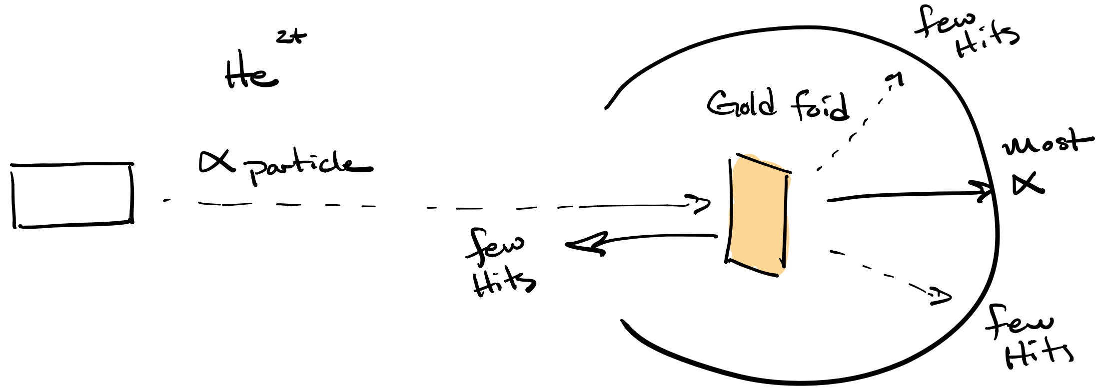
⟹ Measuring Charge on oil drop always a factor of 1.6×10^{-19} Coulumbe

⟹ e^- charge $= 1.6 \times 10^{-19}$ C

⇒ Size (mass) of e^-

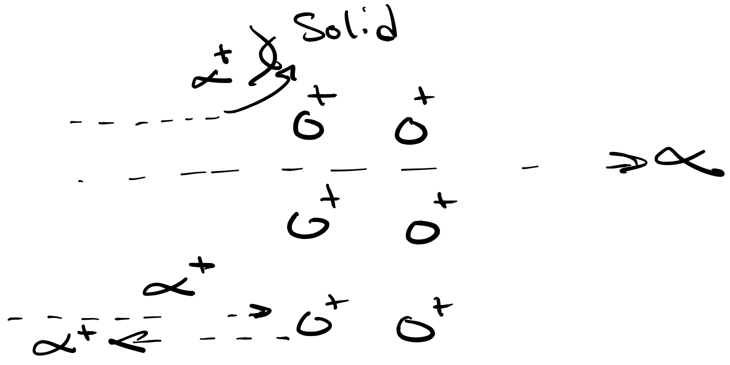
9.107×10^{-31} kg

Early 1900's Rutherford

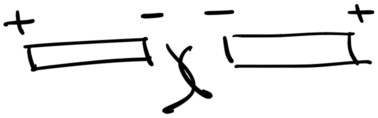


1) Volume of solid mostly empty

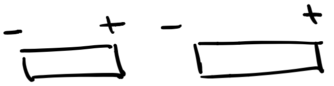
2) Because α^{2+} there must be small positively charged particles inside the solid



Magnetic



Repulsive



attraction

Dalton ⇒ indivisibility of atoms

Thoupson ⇒ found e^- negatively charged

Millikan ⇒ Indivisibility of e^-

charge on e^-

mass on e^-

Rutherford ⇒ matter has mostly empty space

Small dense positive charge at the center of atoms

$$Cu + Cl \longrightarrow CuCl$$

$$CuCl_2$$

but not

$$C_{1.6}Cl_{5.2}$$

1921 Soddy nobel prize for discovery of Isotope

Isotope are different versions of an element

Isotope

$$\underbrace{{}^{1}_{1}H \qquad \underset{\substack{\text{weighs} \\ 2x\ {}^{1}H}}{{}^{2}_{1}H} \qquad \underset{\substack{\text{weigh} \\ 3x\ {}^{1}H}}{{}^{3}_{1}H}}_{\text{different mass}}$$

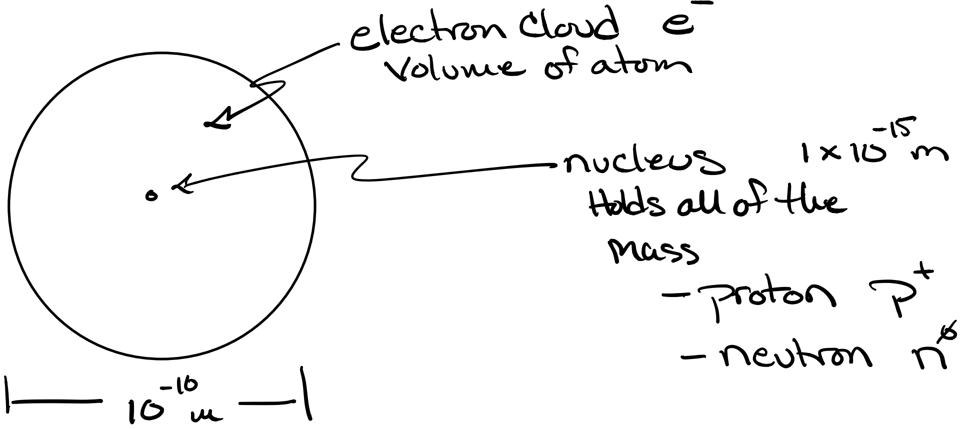
1932 Chadwick ½ mass of an atom

from Rutherford

protons (p^+) and the other half

from neutral particles ⇒ neutrons

Chapter 2.3 Atomic Structure



Atom

mass

$1p^+ = 1n^0$ $e^- = 1/2000\, p^+$ or n^0

If blow a atom up to the size of a football field (diameter) ⇒ nucleus would be the size of a blueberry.

Because atoms are so small (Carbon atom = 2×10^{-23} g) we introduce a new unit of mass

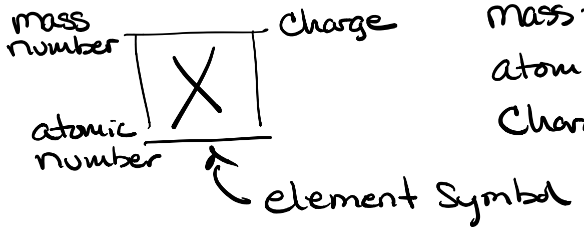
atomic mass unit = amu

$1 \text{ amu} = \frac{1}{12}$ the mass of a $\text{Carbon}-\underbrace{12}_{\text{Specific Isotope}}$

	Symbol	Mass
proton	p^+	1.0073 amu ≈ 1 amu
neutron	n^0	1.0087 amu ≈ 1 amu
electron	e^-	0.00055 amu ≈ 1/2000 amu

$1 \text{ amu} = 1.6605 \times 10^{-24}$ g

Nuclide Symbol



mass number = sum $p^+ + n^0$
atomic number = # of p^+
Charge = difference between p^+ & e^-

Charge = $6p^+ + 6e^- = 0$

$6p^+ + 7e^- = -1$

$6p^+ + 5e^- = +1$

Isotope

$p^+ + n^\circ$

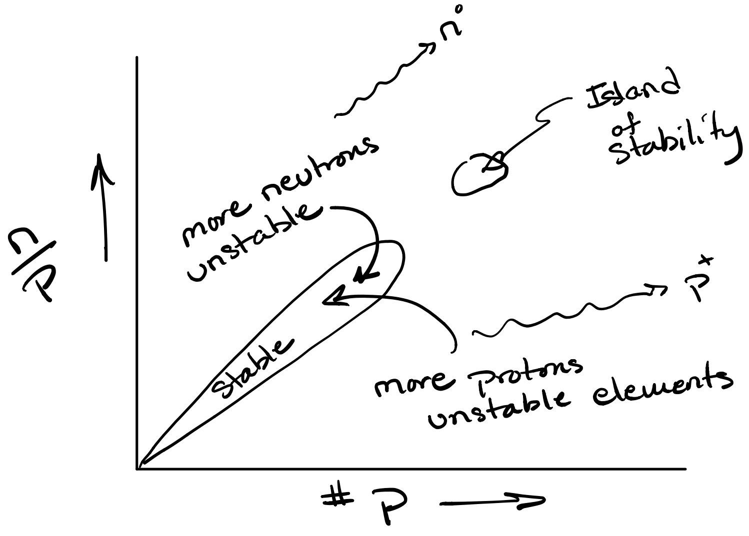
no charge + = −

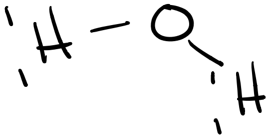
$^{1}_{1}H$ $\quad$ $^{2}_{1}H$ $\quad$ $^{3}_{1}H$ $\quad$ H = hydrogen

p^+

# p	1	1	1
# n	1-1 = 0	2-1 = 1	3-1 = 2
# e^-	1	1	1
amu	1 amu	2 amu	3 amu

⇐ # of protons that determins the element



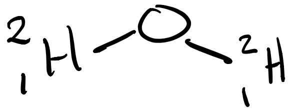


water w/ ${}^{1}_{1}H$

18 amu

16 from Oxygen

2 (1 each from H)



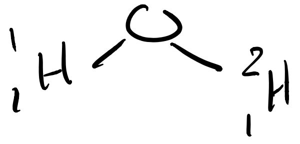
water w/ ${}^{2}_{1}H$

20 amu

16 from oxygen

4 from ${}^{2}_{1}H$ (2 from each)

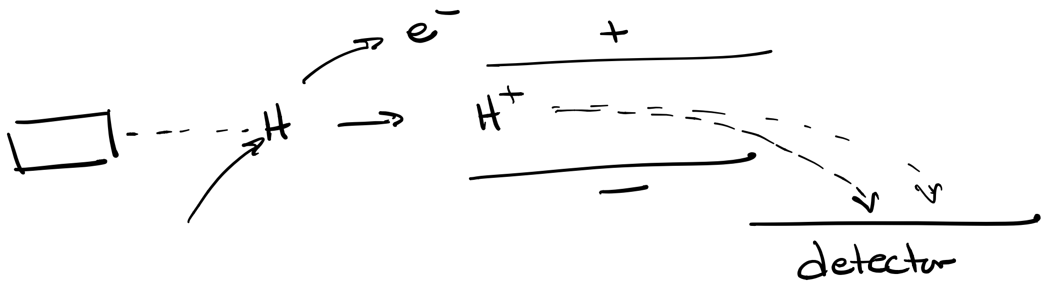
Heavy water



19 amu

${}^{1}_{1}H$	${}^{2}_{1}H$	${}^{3}_{1}H$
Hydrogen	Deuterium	Tritium
99.9850%	0.0150%	0.000% to 3 sig fig

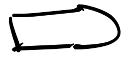
Measured w/ mass spectroscopy



of isotopes for different elements

	Istopes
Hydrogen	3
Carbon	3
Nitrogen	2
Oxygen	3
Fluorine	1
Tin (Sn)	10
Iron	4
Gold	1
Silver	2
Copper	2

Pb



Bullet

$$\begin{array}{cccc} {}^{204}\mathrm{Pb} & {}^{206}\mathrm{Pb} & {}^{207}\mathrm{Pb} & {}^{208}\mathrm{Pb} \end{array}$$

$$\underbrace{1.40\% \quad 24.1\% \quad 22.1\% \quad 52.4\%}_{\text{vary depending on location \& factory \& specific lot of bullets}}$$

$$\begin{array}{cccc} {}^{204}\mathrm{Pb} & {}^{206}\mathrm{Pb} & {}^{207}\mathrm{Pb} & {}^{208}\mathrm{Pb} \end{array}$$

$$\underbrace{204\text{ amu} \quad 206\text{ amu} \quad 207\text{ amu} \quad 208\text{ amu}}_{\text{Ave Pb atom} = \text{? amu}}$$

Weighted Average

Pb
207.2 ← Ave amu