Evolution of Atomic Model

- Greeks, up to 19th century: like hard balls, with varying chemical properties.

- 1900 - radioactive decay discovered
  - alpha rays = charge +2, mass = 1 = He nucleus
  - beta rays = charge ±, mass small = electron/positron
  - gamma rays = charge 0, mass 0 = photon
  - 1911 'Rutherford gold foil experiment'
  - alpha rays (the nuclei) mainly pass through gold foil
  - atoms/matter almost completely empty!
  - 99.99999% empty space

- Geiger-Marsden experiment

  - Planetary Model
    - electrons
    - nucleus

- 1920s - electrons don't act like orbiting charges, act more like electrons clouds of charge when in atom with discrete states

  - Quantum Model

SOLID, LIQUID, GAS all have intact atoms in various arrangements

PLASMA is ionized, some electrons leave atoms and move freely
Units of Measure

Contrast between arbitrary units based on human decisions and "natural" units

Good example: units of angle $0 \leq \theta \leq \text{full circle}$

- $\text{Degrees}$
  - full circle: $360^\circ$
- $\text{Grad/Gen}$
  - full circle: $400 \text{ gen}$
- $\text{Radians}$
  - full circle: $2\pi$
  - arc lengths:
    - $\theta$ in $\text{mrad}$
    - $\frac{\theta}{360^\circ}$ in $\frac{\text{rad}}{\text{rad}}$
    - $\frac{\theta}{400 \text{ gen}}$ in $\frac{\text{rad}}{\text{rad}}$

Radians are "natural" units, $\pi = \frac{\text{circumference}}{\text{diameter}}$
same ratio in any society, planet, etc.

So what about length, mass, time?

- $\text{MKS}$
  - length: meter ($\text{m}$) * centimeter ($\text{cm}$) * foot ($\text{ft}$)
- English
  - mass: kilogram ($\text{kg}$) * gram ($\text{g}$) * slug (not used)
  - time: second ($\text{s}$)

- force: Newton ($\text{N}$) * dyne ($\text{dyn}$) * pound ($\text{lb}$)
  - $1 \text{N} = 1 \frac{\text{kg-m}}{\text{s}^2}$
  - $1 \text{dyn} = 1 \frac{\text{g-cm}}{\text{s}^2}$

- charge: Coulomb ($\text{C}$) * stat-Coulomb ($\text{esu}$) * none

NONE are "natural" units: $K/\circ C$

$m$ based on Earth size, $\text{kg} \sim$ liter of water, $s = \frac{1}{86,400}$ day