

① Phys 1402

2017-09-05

Bb / Syllabus / Web pages

Why study E&M?

- Our society is electric
 - Energy
 - Communication
 - Information
- Fundamental behind Light & Optics
- Chemistry
- Math & Learning Practice

Electrostatics

- Matter is made of atoms
- Atoms are made of particles
 - Electrons, Protons, Neutrons
- Particles have charge (q)
- Charge is measured in coulombs (C)
- Charge is a "value" of "how electric" a particle or object is.
- Charge is conserved.
 - Can't create or destroy.
 - Combine charge via addition
- Two types - opposites - \oplus and \ominus
- A coulomb is HUGE!

②

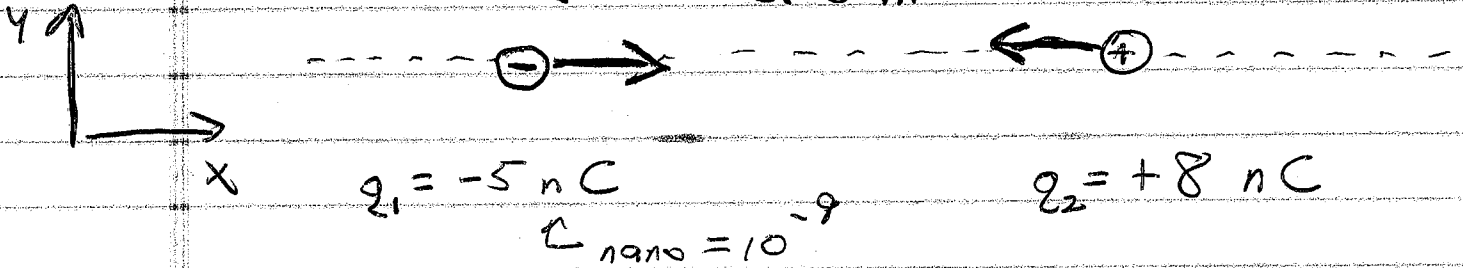
Basic Interaction - Coulomb Force

Force is a vector.

- Magnitude or strength
- Direction

Direction: Like charges repel, opposites attract

← 0.25 m →



Force on q_1 is in $+x$ direction.

Force on q_2 is in $-x$ direction.

Strength: Coulomb's Law

$$k = 9 \times 10^9 \text{ Nm}^2/\text{C}^2$$

$$F_E = \frac{k q_1 q_2}{R^2}$$

magnitudes! $q_1, q_2 =$ charges

$R =$ center-to-center distance

$$\text{Ex: } F = \frac{(9 \times 10^9 \text{ Nm}^2/\text{C}^2) (5 \times 10^{-9} \text{ C}) (8 \times 10^{-9} \text{ C})}{(0.25 \text{ m})^2}$$

$$= 5.76 \times 10^{-6} \text{ N} = 5.76 \text{ } \mu\text{N}$$

③

Combining charges

$$Q = q_1 + q_2$$

If $Q=0$, the object is "neutral".
The object is still made of charges, but they cancel.

What is Coulomb Force if $q_1 = 0$? Zero.
Can a neutral object "feel" static electricity?

Charge-neutral Attraction

Ex: Balloon-and-wall

Like charges further - Less repulsion

Opp. Charges closer - More attraction

Net Force is attractive.

Fundamental Charges

Proton $q_p = +1.6 \times 10^{-19} \text{ C} = +e$

Electron $q_e = -1.6 \times 10^{-19} \text{ C} = -e$

Neutron $q_n = 0$

$$Q = (N_p)(+e) + (N_e)(-e) \\ = (N_p - N_e)e$$

If $Q=0$, then $N_p = N_e$

(A)

Charge Density vs. Mass Density

$$\rho = \frac{Q}{V}$$

$$\rho = \frac{M}{V}$$

$$Q = \rho V$$

$$M = \rho V$$

↑
charge density

↑
mass density