Course Intro

http://www.phys.hawaii.edu/~varner/PHYS272-Spr10/physics272.html

- First day of instruction: January 11, 2010 (today) in Watanabe Hall room 112
- No labs first week of class (begin week of Jan. 18 - 22)
- In order to complete the online homework, you must register for a Mastering Physics account
- Please refresh link regularly to get updated assignments
- Homework I (VARNERPHYS272) in Mastering Physics **due Monday, Jan. 18, 2009**

Physics 272

Motivation:

Physics of E&M allows wide range of technologies:

- Radios and TV
- Computers
- Cell phones
- iPODS
- Hard drives
- Washing machines
- Microwave ovens
- Light bulbs
- Laser copiers
- MRIs
- etc.

Even a Prius

Important to understand.

Electric Charge

Source of electric and magnetic phenomena.

Will study E&M much of the semester.

A.) Generating: rubbing transfers charge.

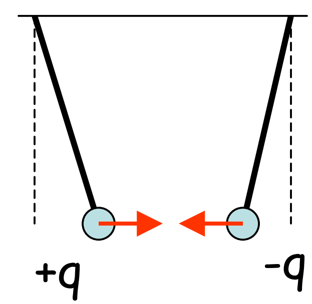
- glass with silk
- lucite with fur

Two types of charge (+ and -).

Ben Franklin (1706 – 1790): charge on glass rod is +.

Like charges repel.

Unlike charges attract.



What if both +?

Electric Charge

B. Charge is quantized. Not continuous as Franklin thought.

charge of electron = -e

charge of proton = +e

e is fundamental unit of charge

Can write $Q = \pm Ne$

(Q is any charge in nature; quarks not found isolated)

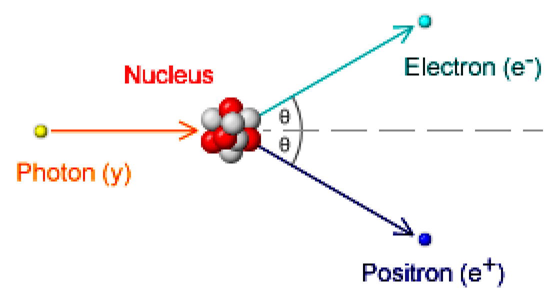
$e = 1.6 \times 10^{-19}\ C$ (SI unit - Coulomb)

Coulomb defined in terms of Ampere (current).

C. Charge is conserved. Glass charged by transfer of charge; no charge is created.

$\gamma \rightarrow e^+ e^-$ pair production

$\gamma \not\rightarrow e^+$ single positron production not allowed



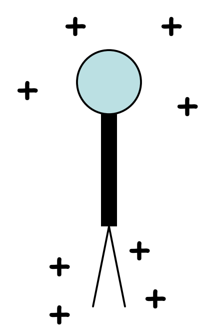
pair production

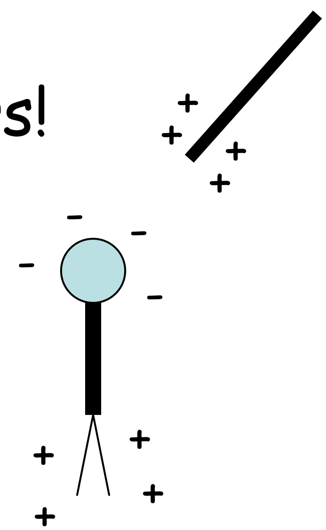
Conductors and Insulators

Insulators – charge (electrons) not free to move.
Examples: glass, porcelain.

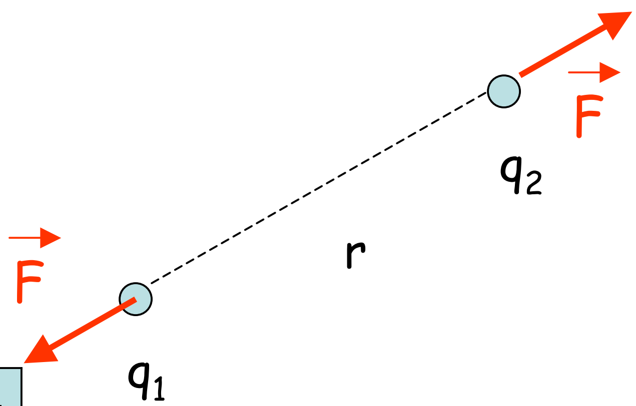
Conductors – electrons free to move.
Example: Copper – 1 free electron per atom.

There are no perfect insulators or conductors!





Coulombs Law



Charles Coulomb (1736 - 1806)

Applies to point charges.

magnitude

$$F = \frac{k\,|q_1 q_2|}{r^2} = \frac{1}{4\pi\varepsilon_0}\frac{|q_1 q_2|}{r^2}$$

$k = 8.99 \times 10^9 \ \mathrm{N\,m^2/C^2}$

$\approx 9 \times 10^9 \ \mathrm{N\,m^2/C^2}$

$\varepsilon_0 = 8.85 \times 10^{-12} \ \mathrm{C^2/Nm^2}$

direction: along line between two charges
attractive if unlike charges
repulsive if like charges

F is a vector! F is a vector!

Note forces are equal and opposite (Newton's Third Law)

Looks like:

$$F_G = \frac{G m_1 m_2}{r^2}$$

Difference?

Example: Coulomb Force

- Two paperclips are separated by 10 meters. Then you remove 1 electron from each atom on the first paperclip and place it on the second one.

$$\vec{F} = k\frac{q_1 q_2}{r_{12}^2}\hat{r}_{12}$$

$k = 9 \times 10^9\ N\ m^2 / C^2$

electron charge = 1.6×10^{-19} Coulombs

$N_A = 6.02 \times 10^{23}$

What will the direction of the force be?

A) Attractive

B) Repulsive

Example: Coulomb Force

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$$\vec{F} = k\frac{q_1 q_2}{r_{12}^2}\hat{r}_{12}$$

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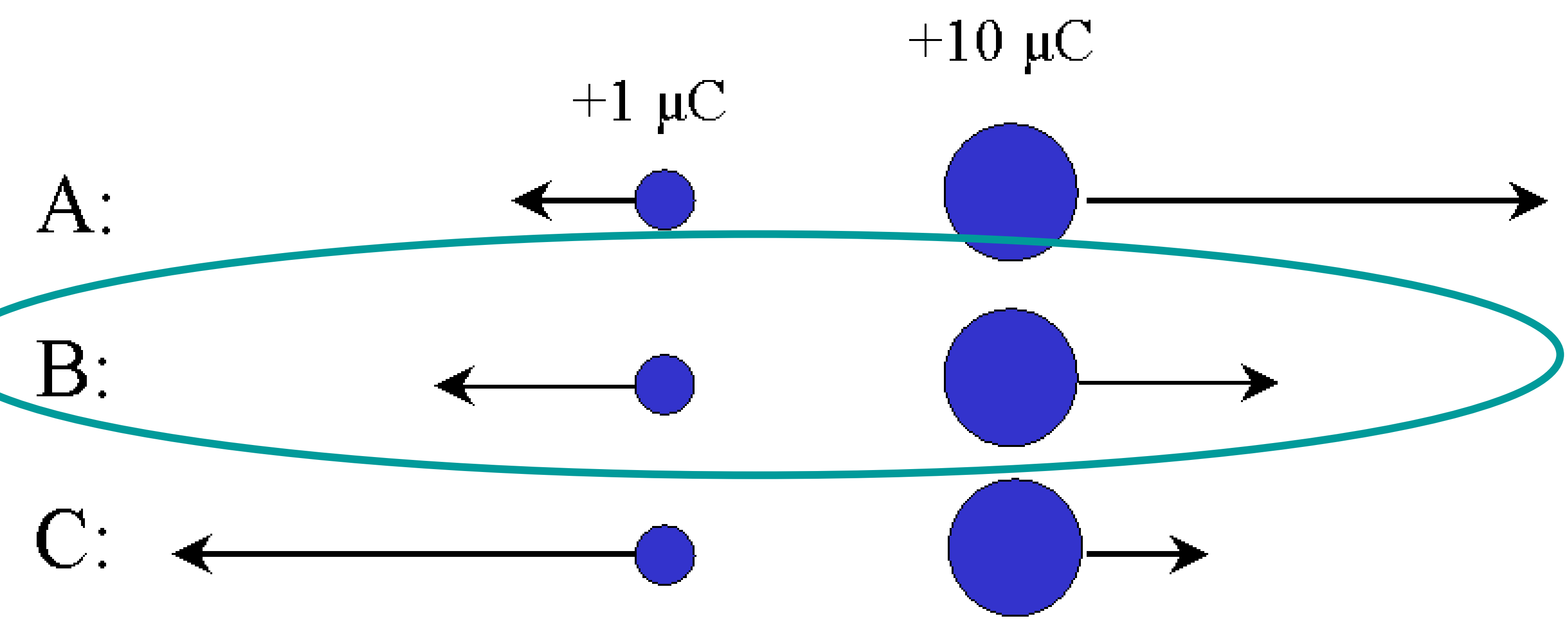
A) Paperclip (1g x g)
B) Text book (1kg x g)
C) Truck (10^4 kg x g)
D) Aircraft carrier (10^8 kg x g)
E) Mt. Everest (10^{14} kg x g)

$$F = \frac{9(10^9)}{100}\left[1.6(10^{-19})10^{22}\right]^2$$

$$\frac{10^{10} \times 10^6}{10^2} = 10^{14}$$

1) Two charges $q = +1\ \mu C$ and $Q = +10\ \mu C$ are placed near each other as shown in the figure. Which of the following diagrams depicts the forces acting on the charges:



"Since Q is much larger in magnitude, it will have a much larger force on q than q will have on Q."

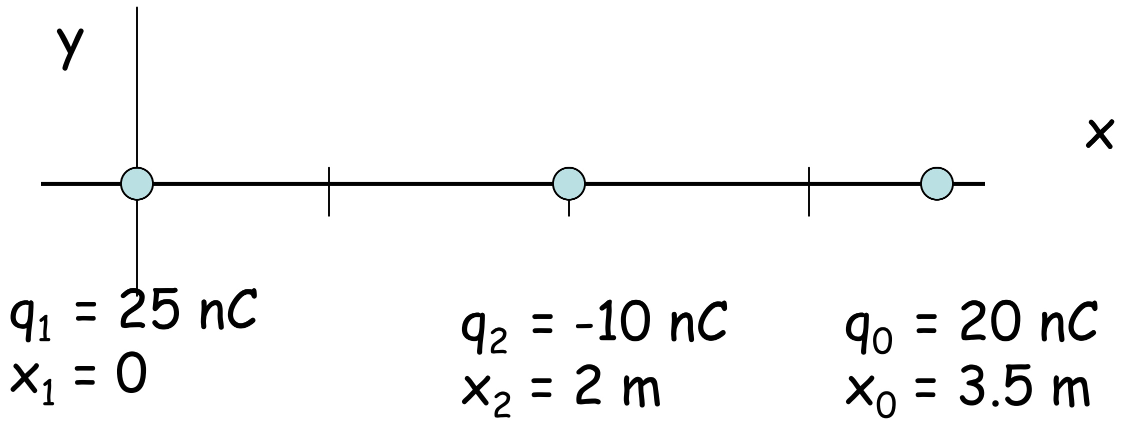
"The force on each must be equal and opposite to satisfy Newton's third law."

Coulombs Law

What if more than one charge?

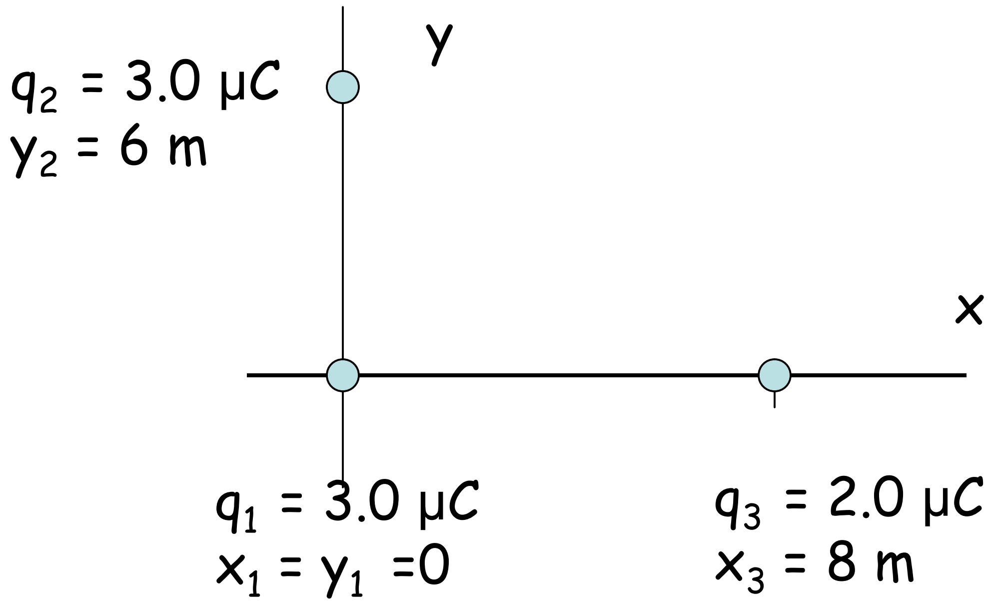
Use superposition.

Example 1: Three point charges on x-axis. Force on q_0?



Coulombs Law

Example 2: Force on q_3 ?



Up in the Sky… it's Coulomb Man!

100kg -- how much to levitate 100 meters skyward ?

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