 Phys 1402 2017-07-03 Lec 1

MTWR ~~Hell~~ Noon - 2pm

Blackboard - main web hub.
Course Web Folder
Lab Folder

Why Study Electricity & Magnetism?
- Our Society is electric.
  - Energy
  - Info / Comm
- Fundamentals behind Light & Optics
- Behind Chemistry & matter
- Math & Learning Practice

Electrostatics
Matter is made of atoms
Atoms are made of particles
- Electrons
- Protons
- Neutrons

The particles have charge (q).
Charge is measured in coulombs (C).

A coulomb is HUGE.

(2)

Basic interaction of charges - Coulomb's Law

Direction: Opposites Attract

$q_1 = -5\ nC$ $\qquad$ $q_2 = +8\ nC$

Like Charges Repel

$+3\ nC$ $\qquad$ $+7\ nC$

Strength: $F_E = k\dfrac{qQ}{r^2}$ (All magnitudes)

Q = "source" or cause of force
q = "our charge" that "feels" the force
r = center-to-center distance
$k = 9\times10^9\ Nm^2/C^2$ = coulomb constant

Let's say $r = 0.25\ m$ from q_1 to q_2.

(q_1: nano)

$$F_E = \frac{(9\times10^9)(5\times10^{-9})(8\times10^{-9})}{(0.25)^2} = 5.76\times10^{-6}\ N$$

(3)

Styrofoam has a density of $0.05\ g/cm^3$

What is the mass of a ball w/ $r = 0.2$ cm?

$V = \frac{4}{3}\pi r^3$

$$m = \rho V = (0.05\ g/cm^3)\frac{4}{3}\pi (0.2\ cm)^3 = 1.68\ mg$$

What is the weight?

$F_g = mg$ ← mass * gravity

$$F_g = mg = (1.68 \times 10^{-6}\ kg)(9.8\ N/kg) = \boxed{1.65 \times 10^{-5}\ N}$$

(1.68 mg ↑ milligram)

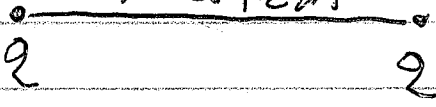
How much charge can generate an equal electric force (to the weight) at a distance of 0.4 cm, to an equal charge? (~~0.17 nC~~ 0.17 nC)

Conversion: $1.68\ mg = 1.68 \times 10^{-3}\ g$

$= 1.68 \times 10^{-6}\ kg$

← 1000 x bigger

1000 x smaller →



$$F_E = \frac{k q^2}{r^2}$$

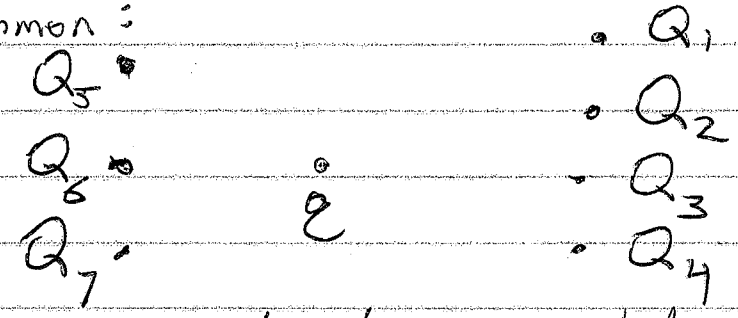
$$(1.65 \times 10^{-5}\ N) = \frac{(9 \times 10^9\ N)\ q^2}{(0.004\ m)^2}$$

$$q = \sqrt{\frac{(1.65 \times 10^{-5})(0.004^2)}{(9 \times 10^9)}} = 1.71 \times 10^{-10}\ C$$

$= 0.171\ n\ C$

Coulomb's Law as a force law is limited.

More common:



Easier Way: Electric Field

$$F_E = q \frac{kQ}{r^2}$$

q: What our charge is.

$\frac{kQ}{r^2}$: Where our charge is (Environment)

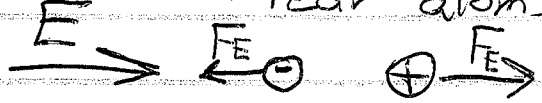
$$F_E = qE$$

E ≙ Electric Field at location of q.

Compare to gravity

$$F_g = \frac{GmM}{r^2} \qquad F_g = mg$$

Now we don't care what Q's cause E.
Acts as a mediator of F_E between Q and q.
Effects of E: • F_E on q's
• Tear atoms apart



$\sim 2 \times 10^6$ N/C

Fundamental Particles

Name	Mass	Charge
Proton	$m_p = 1.67 \times 10^{-27}$ kg	1.6×10^{-19} C $= +e$
Neutron	$m_n = 1.67 \times 10^{-27}$ kg	0
Electron	$m_e = 9.11 \times 10^{-31}$ kg	-1.6×10^{-19} C $= -e$

Neutral Stuff: $q = 0$

Charge adds: $q = q_1 + q_2 + q_3 + \dots$

Abbreviation $e = 1.6 \times 10^{-19}$ = magnitude of electron charge

For an object:

$$q = (+e + e + \dots) + (-e - e - \dots)$$
$$= +eN_p - eN_e$$
$$0 = e(N_p - N_e)$$

Result: $N_p = N_e$ for most stuff.

Electrons are mobile & fleeting. Most electric effects are from moving electrons.