PHYSICS 1E3

Dr. N. McKay, Sections C01 and 5
Office: ABB-261
e-mail: *mckay@physics.mcmaster.ca*
Office Hours: to be posted with lecture notes

Course web page (all sections):
www.physics.mcmaster.ca/PHYS1E03

Avenue to Learn: *avenue.mcmaster.ca*
lecture notes, announcements, lab schedules,…

-Labs: *no labs this week (labs begin Jan. 19)*
(apply for exemption if you are repeating the course)

-Tutorials: *no tutorials this week (tutorials begin Fri. Jan. 16)*

-LONCAPA: Assignment 1 will be posted, due Thursday, Jan. 15

Homework

Before each lecture, download and print the lecture slides from the course web page or Avenue. Add notes directly onto the slides during the lecture. ***Read the text****, either just before or just after the lecture, and add to your notes as you read.*

For most lectures, I will list a few suggested practice problems from the text. For this first lecture, simply read sections 23.1 and 23.2 carefully. Read 23.3 and 23.4 to prepare for the next lecture.

New Student?

If you **weren't** in Physics 1D3 last term:

-Read the 1E3 course outline.

-Read the preliminary chapters of the Lab Manual carefully. You must hand in the completed pre-lab quiz on entering the lab, and you must be on time.

-Read the "CAPA Help" page on Avenue, to understand how to enter answers and units.

Grades

20%: Midterm tests (Feb. 5 and March 11, 7:00 p.m.)
15%: Labs
6%: Tutorials
3%: CAPA

Up to 5%: i>clicker
Up to 56%: Exam (3 hours)
(Exam plus clicker combined will be 56%)

PHYSICS 1E3

I. Electrostatics (4 weeks)

II. DC Circuits (2 weeks, plus labs)

III. Magnetism (3 weeks)

IV. Waves (3 weeks)

-includes electromagnetic waves

Introduction (Text 23.1—23.2)

How do things interact?

1) **Gravity**
   - a force between masses
   - holds planets, stars, galaxies together
2) **Electromagnetism**
   - a force between charges
   - responsible for all *familiar* forces (except gravity)
3) **"Weak Nuclear Force"**
4) **"Strong Nuclear Force"**
   - holds nuclei together

ELECTROMAGNETISM: the interaction between **charges**

"*Electric*": for stationary or moving charges

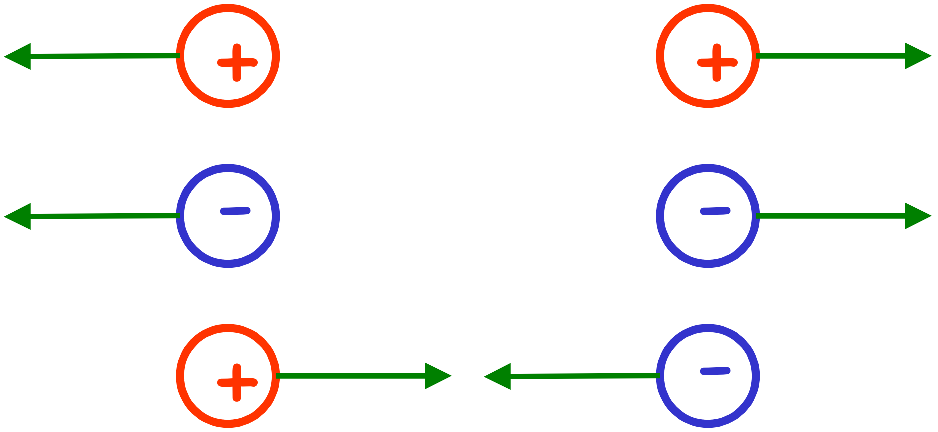
"*Magnetic*": for moving charges only

However: To a *moving* observer, a "purely electric" field will appear to be a ***mixture*** of electric and magnetic fields.

$\therefore \quad \Rightarrow$ Special Relativity (1905)

Electric Charge

- *A scalar*
- **Comes in “positive” and “negative” types**



REPEL

REPEL

ATTRACT

Units: coulomb, *C*

and also “electronic charge unit”, $e \approx +1.602\times10^{-19}$ *C*

Electric Charge (continued)

- **Charge is "quantized":** appears in nature only* in units of "e".

eg:

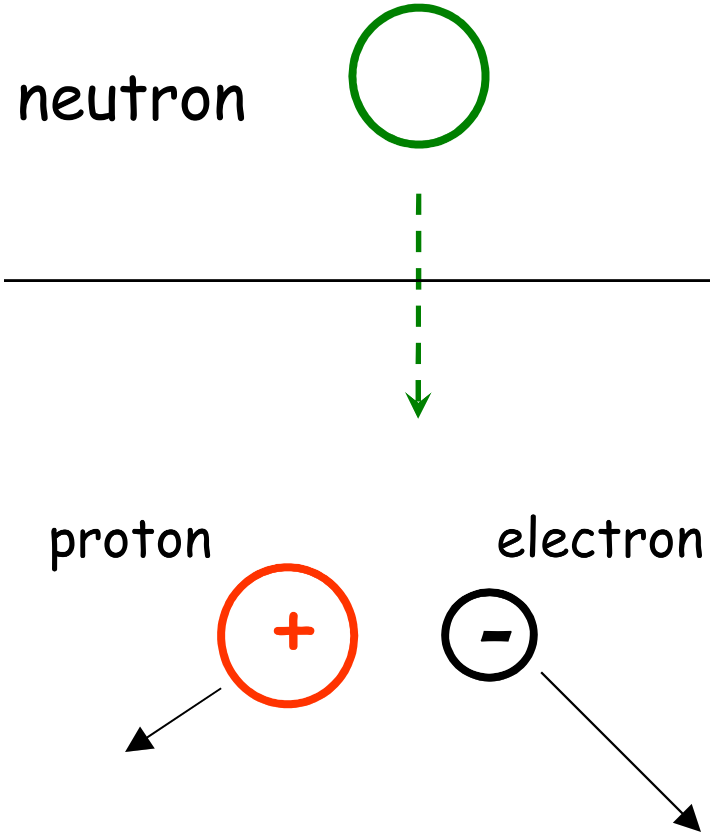
Particle	Charge
electron	-e
proton	+e
alpha particle	+2e

- **Charge is a conserved quantity:**

$Q_{TOTAL} \equiv |\text{positive charge}| - |\text{negative charge}|$

and Q_{TOTAL} never changes.

Example: a neutron explodes



initial: Total charge = 0

final:

$$Q_{TOTAL} = \underset{\substack{\uparrow\\ \text{proton}}}{(+e)} + \underset{\substack{\uparrow\\ \text{electron}}}{(-e)} = 0$$

Movement of charge

Insulators: *charges do NOT move (much)*

Conductors: *(some) charges move freely*

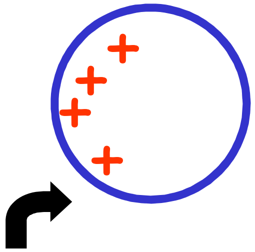
Add negative charge to a ball…

Insulator: charges remain in place

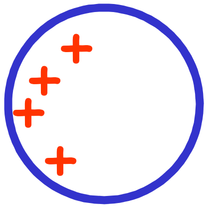
Conductor: charges move

Quiz

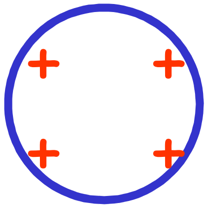
Suppose, in a particular **conducting** material, *ONLY the negative charges can move*. What is the final picture of the **net** charge if excess POSITIVE charge is sprayed onto one side?



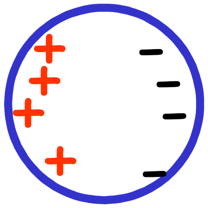
Conductor



A)



B)



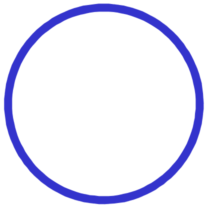
C)

Questions:

1) Some conductors have mobile positive charges, some have mobile negative charges, some have both. How would this affect their behaviour?

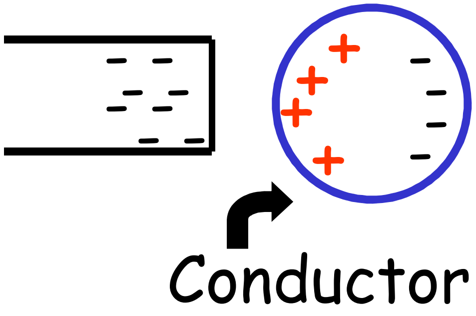
2) What happens when a conductor is connected to the earth (“grounded”)? Can a grounded conducting object have a net charge?

Quiz



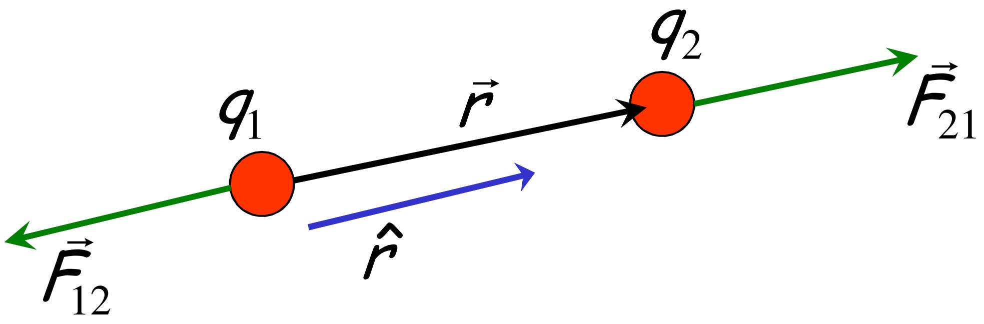
The conductor is neutral (no net charge). When a charged rod is brought close to it (without touching) the **net force** on the conductor will be:

A) attractive
B) repulsive
C) zero
D) it depends whether the rod is positive or negative



Coulomb's Law

Point charges q_1, q_2 exert forces on each other:



$$\boxed{\vec{F}_{21} = k_e \frac{q_1 q_2}{r^2} \hat{\mathbf{r}}}$$

$\hat{\mathbf{r}}$ is a unit vector parallel to **r**

$k_e = 8.988 x 10^9 N \bullet m^2 / C^2$ (Coulomb's Law constant)

Notes:

- for point charges *only*
- $\vec{F} \,||\, \vec{r}$
- $\left|\vec{F}\right| \propto q_1$

  $\left|\vec{F}\right| \propto q_2$

  $\left|\vec{F}\right| \propto \frac{1}{r^2}$
- Also define $\varepsilon_0 \approx 8.85x10^{-12} \frac{C^2}{N \bullet m^2}$ ("permittivity of vacuum")

$$\Rightarrow k_e \equiv \frac{1}{4\pi\varepsilon_o}$$