PHYSICS 153 08W—term 2

Electricity, Magnetism, Electromagnetic Waves, Optics

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Office hours: Monday 10:30-11:30
Friday 10:30-11:30
or by appointment

Text: Young and Freedman "University Physics" 12th edition,
with Mastering Physics.

Course Outline: see listing at the following URL.
www.physics.ubc.ca/courses/2008/html/PHYS_153.phtml

The coordination of the three sections in term 2 will be done by Prof. Hasinoff (hasinoff@phas.ubc.ca) who will teach section 002.

I will be in charge of the lab.

Course website, as before: www.physics.ubc.ca/~phys 153

Marks assigned

Term 1		**Term 2**	
Midterm 1	10	Midterm 2	10
Midterm 2	10	Midterm 2	10
Assignments	10	Assignments	10
Dec. exam	70	Lab	30
Survey bonus	2	April exam	70

Note: Students must pass both the written part of the course, and the laboratory component, separately, in order to pass the course.

In order to pass the written part of the course, a student must obtain at least 40% in each of the December and April examinations, and overall 50% for both terms. If a student achieves this, then the other components (assignments, midterms) will be added in to obtain a total mark for the written part. If the lab has been passed, then that mark will be added to obtain on overall course mark.

Goals in term 2

--to have students learn the fundamentals of Electricityand Magnetism, and to put these ideas together to study Electromagnetism, and the production and propagation of electromagnetic waves.
-- continue working on solving multi-step problems.
--introduction to the use of integral calculus in Physics, and through problem solving, to reinforce the concepts learned in Math.

Tutorials

Tutorial sessions will continue to be held every week, starting Jan. 12.

In addition, Mastering Physics assignments will continue to be assigned.

Laboratory

Experiments will start in week 2, beginning Jan. 12. All experiments must be completed, and passed in order to pass the lab component.

Students must have a Physics laboratory notebook (yellow softcover). This can be obtained at the bookstore. You must have it for your first experiment. Sometimes it is convenient to have a second one, but make sure that you have one for your first experiment.

The notes for all experiments will be posted on the Phys. 153 web site. Read ahead of time, and come prepared.

Academic misconduct

Students are encouraged to work together, to share ideas, and to discuss possible solutions. But the work handed in by each student must be his or her own work. Plagiarism occurs when a student copies from someone else, whether it be an assignment, or a lab report, or an exam, and passes it off as his or her own work. This is a serious offence, and the University administration deals severely with anyone caught engaging in this activity.

Electric charge, electric force, electric fields

Only 4 basic forces in nature.
The electromagnetic force is one of them.

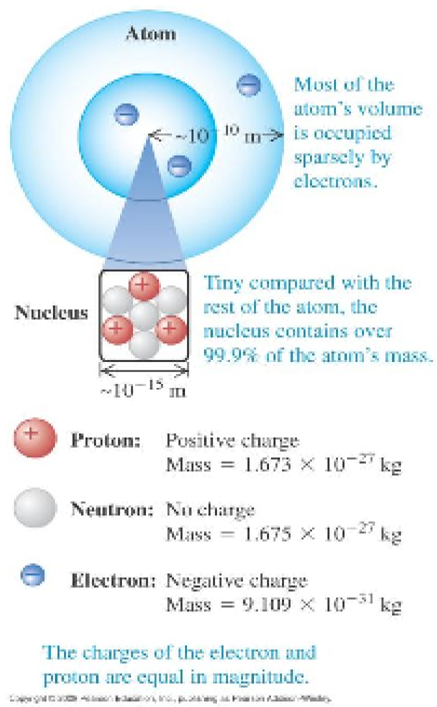


Fig. 21.3

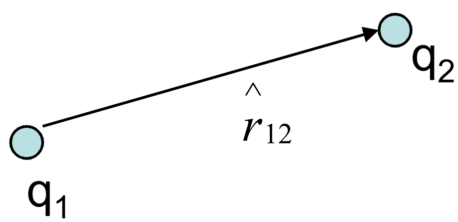
Basic charges

Electric charge is conserved.
The algebraic sum of all the charges in any closed system
Is constant.

<u>Coulomb's Law</u>

• discovered $F \propto \frac{1}{r^2}$

•Like charges repel, unlike charges attract.



q_1 and q_2 are the charges in coulombs (C)

$$\vec{F}_{12} = \frac{kq_1q_2}{r_{12}^{\,2}}\hat{r}_{12}$$

$$k = \frac{1}{4\pi\varepsilon_0} = 8.99x10^9 \frac{Nm^2}{C^2}$$

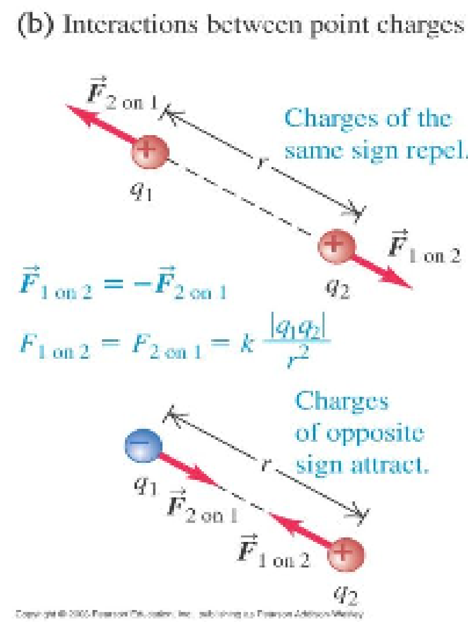


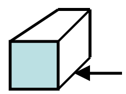
Fig. 21.10

$\hat{r}_{12}$ is a unit vector to give direction to $\vec{F}$

ε_0 is the permittivity of free space=8.85x10^{-12} C/N-m^2

Charge on the electron =1.602x10^{-19} C (= charge of the proton)

So, 1C=1/e = 6.24x10^{18} electrons.

example  1 cm cube contains $\approx 2.4x10^{24}\,electrons$

Cu

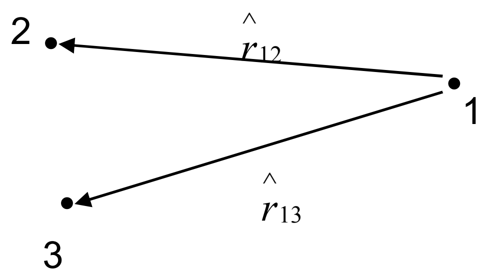
Example, for a 100 W light bulb, 5x10^{18} electrons pass through the glowing filament every sec.

How do the force of gravity and the electrostatic force compare in strength?

e.g. for two electrons $$\frac{F_g}{F_e} = \frac{\frac{Gmm}{r^2}}{\frac{kq_1q_2}{r^2}} = 2.4x10^{-43}$$

Why then are we so much more aware of the gravitational force than we are of the electrostatic force?

Superposition of forces.



Net force on charge 1 $\quad \vec{F}_{total} = \vec{F}_{12} + \vec{F}_{13}$

--similarly for charges 2 and 3.

Electric field

• q_2 • q_0 (test charge)

How does each charge know of the presence of the other?

•q_1

Definition $\quad \vec{E} = \dfrac{\vec{F}}{q_0}$ Electric field is the force per unit Positive test charge.

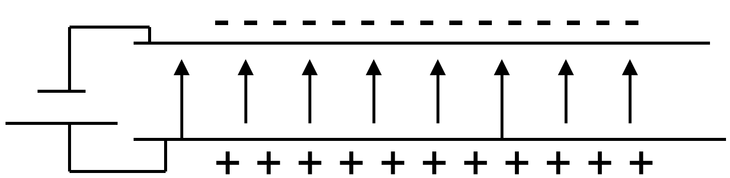
--or strictly speaking $\vec{E} = \lim_{q_0 \to 0} \frac{\vec{F}}{q_0}$ (so as not to change the charge distribution)

For a point charge q and a test charge q_0, $\vec{F} = \frac{1}{4\pi\varepsilon_0}\frac{qq_0}{r^2}\hat{r}$

Hence $\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\hat{r}$

Electric field lines can be mapped (in principle) with a unit positive test charge.

Uniform electric field



Example of a capacitor

--two parallel conducting plates.

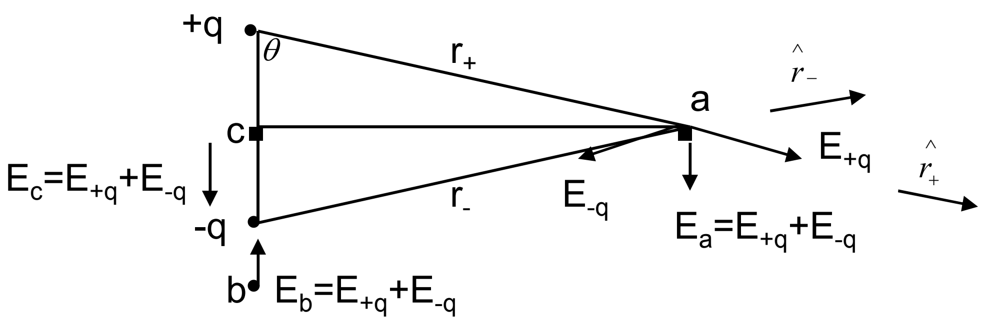
Opposite charges will be distributed evenly on top and bottom. The E lines will then be parallel, as shown i.e. the direction of force on a unit positive test charge.

As we will see later, for parallel plates, voltage V, and separation d, $E=V/d$.
If $V=500^V$, $d=1.0$ cm, $E=500/1.0\times10^{-2}=5\times10^4$ V/m.

See example 21.7 to calculate speed, acceleration, and time to reach bottom plate for an electron released from upper plate.
See example 21.8 to calculate the trajectory of an electron released in a direction paralled to the plates.

Superposition of electric fields.

(a) Field of an electric dipole.



An electric dipole is a combination of two charges of equal magnitude and opposite sign.

Resultant electric field at each of a, b, c, is found by the superposition of two fields.

e.g. at a $\vec{E}_{+q} = \frac{1}{4\pi\varepsilon_0}\frac{+q}{r_+^2}\hat{r}_+$

$$\vec{E}_{-q} = \frac{1}{4\pi\varepsilon_0}\frac{-q}{r_-^2}\hat{r}_-$$