Massachusetts Institute of Technology - Physics Department

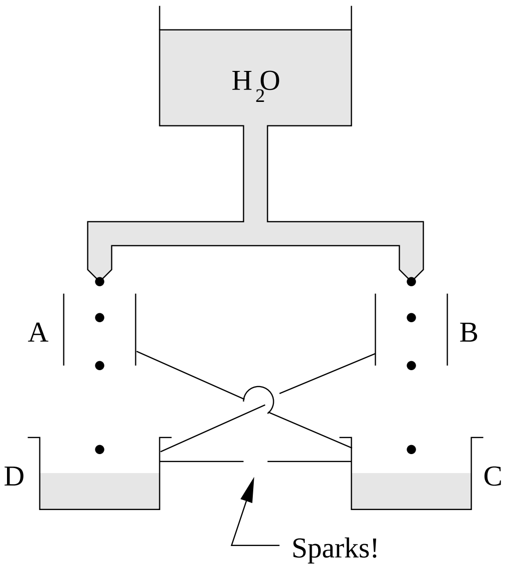
Physics - 8.02 **Assignment #4** March 1, 2002.

We strongly recommend that you read about a topic before it is covered in lectures.

Lecture Date	**Topics Covered**	**Reading from Giancoli**
#12 Mon 3/4	Review Exam 1	
Wed 3/6	**Exam 1** covering the first 3 assignments, and all material covered in reading assignments and in lectures through Wed 2/27 **(last names A-K in 26-100, L-Z in Walker)**	
#13 Fr 3/8	Moving charges in $\vec{B}$-fields - Cyclotron Synchrotron - Mass Spectrometer Cloud Chamber (discovery positron)	Sect. 27-8 & 27-9 Page 1116, 1117 Page 1120
#14 Mon 3/11	Biot-Savart law - Gauss' law for magnetism Revisit the "Leiden Jar" High-voltage power lines	Chapter 28 through Sect. 28-3 Sect. 28-6, 29-6 & 32-2
#15 Wed 3/13	Ampere's law - Solenoids Revisit the *Kelvin Water Dropper (take notes)*	Sect. 28-4, 28-5 & 28-8
#16 Fri 3/15	Electromagnetic Induction - Faraday's Law Lenz Law - Complete Breakdown of Intuition Non-Conservative Field	Chapter 29 through Sect. 29-4 Sect. 29-7 & 29-8 *Lecture Supplement* (on the web)

Due before 4 PM, Friday, March 15 in 4–339B.

Problem 4.1
Kelvin Water Dropper.



The above diagram shows the famous "mysterious" Kelvin Water Dropper which, as demonstrated in lectures, is capable of creating a large electric potential difference between the conducting cups D (at the same potential as B) and C (at the same potential as A). The cylinders A and B are also conductors and so are the wires that connect D with B, and C with A (these wires do not touch each other). The "tubing" at the top is all glass. Sparks (at more or less regular intervals, depending on the water flow) were observed between the cups.

Try to explain this bizarre phenomenon.

Hint: Assume that there is a minute asymmetry and that, e.g., cylinder A is slightly positively charged when the water starts dripping. Draw carefully the field lines between the water drop and the cylinder as the drop is formed. Compare charge densities at the top and the bottom of the drop (tap water is a fair conductor), and evaluate what effect that has on the net charge of the drop as it breaks (pinches) off, and falls down. You are now well on your way!

Problem 4.2
Force on current loop.
Ginacoli 27-12.

Problem 4.3
Lorentz force on an electron.
Giancoli 27-20.

Problem 4.4
Spiraling electrons.
Giancoli 27-29.

Problem 4.5
Torque on one winding of the rotor of your motor!
Giancoli 27-33.

Problem 4.6
Mass Spectrometer.
Giancoli 27-49.

Problem 4.7
Acceleration of deuterons in a cyclotron.
Giancoli 44-10 (page 1137)

Problem 4.8
Force on wire loop.
Giancoli 28-14. Use Ampere's Law (Sect. 28-4 but see also Sect. 28-1).

Problem 4.9
Biot-Savart in action.
Giancoli 28-30.

Recitations.

There are 28 recitation sections (see the 8.02 Website). If *for any reason* you want to change section, please see Maria Springer in 4-352.