

8.02X Electricity and Magnetism

Problem Set 1 and Experiment Problem MI

Issued: Wed, Feb 2

Due: Problem set: Fri, Feb 11, 4PM in 4-337

MI experiment check-off: Fri, Feb 11, 3PM in 4-355

Please note that in general both students for each partnership must submit an experiment write-up, answering the questions regarding the experiment. For experiment MI however, no write-up is necessary. You should be able to demonstrate the answers to the questions during experiment check-off!

Reading suggestions (from Young + Freedman, *University Physics*, 11th edition)

Fri: Electric Charge, Electric Induction 21-1, 21-2

Mon: Coulomb's Law: 21-3

Wed: Electric Field: 21-4, 21-6

Fri: Electric Field cntd, Dipoles: 21-5, 21-7

Homework Problems (30 points)

Problem 1 (5 Points) : Consider an electron and a proton in a hydrogen atom.

- (a) What is the ratio of the electric force to the gravitational force between them?
- (b) If we move the electron and proton either closer together or farther apart, can we find a configuration at which the gravitational force is bigger than the electric force? Explain your answer in one or two sentences.
- (c) Given your answer to (a) and (b), why does gravity dominate for astronomical distances?

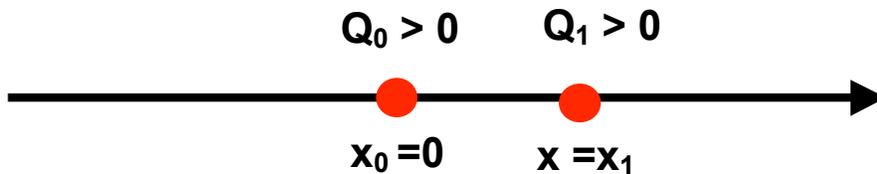
Problem 2 (5 Points): Suppose the charge of an electron was $10^{-9}\%$ smaller than it is in nature (i.e. multiplied by a factor $(1 - 10^{-11})$), while the charge of the proton was the same.

- (a) Under these circumstances, what would be the ratio of the electrostatic force between Earth and Moon to the gravitational force between them?
- (b) Would they still form a stable system?

Problem 3 (5 points):

Consider the configuration shown below, with a positive charge Q_0 at position $x_0=0$ and another positive charge Q_1 at position x_1 along the x-axis.

- (a) At which position x_2 could a third positive charge Q_2 be added, such that the total force on Q_0 is 0? Give two examples of x_2 and corresponding Q_2 , in terms of x_0 , x_1 , Q_0 and Q_1 (or a subset of these variables).
- (b) Qualitatively, describe what would happen if Q_0 was displaced by a small distance Dx from $x_0=0$ to $x=Dx$ and then released (two sentences max.)?



Problem 4 (5 Points): Young + Freedman, Exercise 21.9

Problem 5 (5 Points): Young + Freedman, Exercise 21.25

Problem 6 (5 Points): Young + Freedman, Exercise 21.31

Experiment Meter Introduction

Due Date: Check-off by Friday 3PM Feb 11 in lab 4-355. To satisfy the check-off for the Experiment Meter Introduction you must do the following tasks. Please read the **Check-off and Grading Policy handout**

Lab Hours: Mondays: 3-5 pm, Tuesday: 7:30-9:30 pm, Wednesday: 7:30-9:30 pm, Thursday: 3-5 pm, Fridays: 12-3 pm

Soldering, and Clip Leads:

- **Make Two Clip Leads**
- **Solder Alligator Clips to your Multimeter Leads for each Multimeter**
- **Solder Alligator Clips on your Transformer Leads**
- **Put Battery in Multimeter**

Measuring Voltage, Resistance and Current with the Multimeter:

- **Measure the resistance of the 20 Ω resistor**
- **Measure the voltage of the AA cell**
- **Measure the current in a simple circuit**

Measure the resistance of the 20 Ω resistor: In order to zero the meter, short the test leads by connecting them together. Then adjust the OHMS ADJUST knob (located to the left of center of the MMM) so that the meter reads 0 ohms; the needle is then at its maximum deflection.

Set the range selector switch on the MMM to the RX1 range. Connect the test leads to the resistor. Measure the resistance. You may want to make other resistance measurements. For example make a thick line with a lead pencil and measure the resistance of the mark.

Measure the voltage of the AA cell: Set the range selector switch on the MMM to the 5 DCV range. Place the AA cell in the battery holder. Connect the test leads to the leads from the holder. Measure the voltage.

Measure the current in a simple circuit: First set the range selector switch on the MMM to the 250m DCA range. Make a simple circuit consisting of the 20 Ω resistor, the AA cell, and the MMM. You can do this by connecting the red lead of the MMM to the red lead (plus,+) of the AA cell holder. Use a clip lead to connect the black lead (minus,-) of the AA cell holder to one end of the 20 Ω resistor. Connect the black lead of the MMM to the other end of the 20 Ω resistor. Measure the current in the circuit. What effect do you think the MMM has on the circuit?