8.02X Electricity and Magnetism

Problem Set 6

Issued: Thu, Mar 10
Due: Fri, Mar 18, 4PM <- note Date + Time!

Note that the VI write-up from both lab partners is due on 3/18 4PM!

Reading suggestions (from Young & Freedman)
Mon, 3/14: Quiz #2
Wed, 3/16: RC Circuits, chapter 26-4
Fri, 3/18: Magnetism, chapter 27-1

This problem set only consists of the write-up for the VI experiment
You will be graded according to the following criteria:

1. You have completed all the measurements in the experiment. Your understanding of the underlining physical principles involved in the experiment. You may be asked a question during the check-off.

2. The results of your data analysis.

**Problem 1: Experiment VI: Voltage and Current**

Arrange experimental apparatus as directed in the Experiment VI: Voltage and Current write-up and record measurements on the appropriate tables below.

1. **Resistors and Lamps (all values in ohms)**
   Resistance of three 43 Ω resistors:
   \[ R_1 = \quad, \quad R_2 = \quad, \quad \text{and} \quad R_3 = \quad. \]
   \[ R_{AB} = \quad, \quad R_{BC} = \quad, \quad \text{and} \quad R_{AC} = \quad. \]

   Resistance of Lamps:
   \#47 = \quad, \quad \#1157, 8W = \quad, \quad \#1157, 27W = \quad.

2. **Voltage Measurements:**
2a. **Voltage Divider**
   Voltages (in volts):
   \[ V_{AB} = \quad, \quad V_{BC} = \quad, \quad V_{AC} = \quad. \]
   Current (in amperes) through Resistors:
   \[ I_1 = \quad, \quad I_2 = \quad, \quad I_3 = \quad. \]
   Power (in watts) dissipated by Resistors:
   \[ P_1 = \quad, \quad P_2 = \quad, \quad P_3 = \quad. \]

2b. **Voltage and Current**
   Current (in amperes) through Resistor \( R_1 \):
   \[ I_1 = \quad. \]
   Power (in watts) dissipated by Resistor \( R_1 \):
   \[ P_1 = \quad. \]

2c. **Voltage and Current**
   Current (in amperes) through Resistors \( R_2 \) and \( R_3 \):
   \[ I_2 = \quad, \quad I_3 = \quad. \]
   Power (in watts) dissipated by Resistors \( R_2 \) and \( R_3 \):
   \[ P_2 = \quad, \quad P_3 = \quad. \]
3---Voltage-Current (V-I) Characteristics

<table>
<thead>
<tr>
<th>3a) 43 Ω</th>
<th>3a) 43 Ω</th>
<th>3b) #47</th>
<th>3b) #47</th>
<th>3c) #1157 8W</th>
<th>3c) #1157 8W</th>
<th>3c) #1157 8W</th>
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<tbody>
<tr>
<td>Voltage (V) across 43</td>
<td>Current (A)</td>
<td>Voltage (V) across #47</td>
<td>Current (A)</td>
<td>Voltage (V) across #1157</td>
<td>Res. Wire (mV)</td>
<td>Current (A)</td>
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Length of resistance wire (in mm) = ____________.
Resistance of wire (in Ω) = ____________.

4--- Some LVPS Properties

<table>
<thead>
<tr>
<th>No Load Voltage $V_{\text{no load}}$ (V)</th>
<th>Voltage with Load $V_{\text{load}}$ (V)</th>
<th>$V_{\text{no load}} - V_{\text{load}}$ (V)</th>
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4b--- LVPS Short Circuit Current (in amperes) $I_{\text{sc}} = ____________.$

5--- Charging a Capacitor

<table>
<thead>
<tr>
<th>MMM reading</th>
<th>Time (s)</th>
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Problem 2: Electrostatic Force Measurements:
In the Electrostatic Force Experiment, you measured the voltage difference across the washers when the aluminum foil just started to jump up. When the foil jumps up, it connects the two plates, short-circuiting the capacitor. Suppose that just when the current starts to flow, the voltage difference across the HVPS drops from 340V to 300V. The HVPS has an internal resistance \( r_{int} = 3.1 \times 10^5 \Omega \). When the foil jumps, current now flows through the second multimeter as well as the first. The second multimeter registers a value of 300V as well. The multimeters when set on the +DC 1000 V scale have a resistance, \( R = 20.0 \times 10^5 \Omega \).

a) Just before the aluminum foil jumps, calculate the current that flows through the multimeter connected to the output of the HVPS.

b) What is the electromotive force supplied by the HVPS?