Physics 208: Electricity and Magnetism.
Exam 2, Secs. 526–528 15 October 2010
Instructor: Dr. George R. Welch, 553 Mitchell Physics Building, 845-1571

Print your name neatly:

Last name: ___________________________ ___________________________ ___________________________
First name: ___________________________ ___________________________ ___________________________

Sign your name: ________________________________________________________________

Please fill in your Student ID number (UIN): __ __ __ __ __ __ __ __ __ __ __ __ __ __

IMPORTANT

Read these directions carefully:

• There are 5 problems totaling 100 points. Check your exam to make sure you have all the pages. Work each problem on the page the problem is on. You may use the back. If you need extra pages, I have plenty up front.

• Indicate what you are doing! We cannot give full credit for merely writing down the answer. Neatness counts! I will give generous partial credit if I can tell that you are on the right track. This means you must be neat and organized.

• Each problem with its associated figure is self explanatory. If you must ask a question, then come to the front, being as discrete as possible so as not to disturb others.

• Put your name on each page it is asked for. You will lose credit if you fail to print your name on each page it is asked for.

• A separate page of reference data, indefinite integrals, and some useful formulæ is provided. DO NOT TURN IT IN.
Problem 1. (20 points.)

(a) (10 points) Two capacitors $C_1$ and $C_2$ are connected in series as shown. The potential difference between points a and b is given as $V_{ab}$. Calculate the charge on each capacitor and the potential difference across each capacitor. Express your answers in terms of $C_1$, $C_2$, and $V_{ab}$.

$$Q_1 = \quad \quad \quad Q_2 = \quad \quad \quad V_1 = \quad \quad \quad V_2 = \quad \quad \quad$$

(b) (10 points) Two capacitors $C_1$ and $C_2$ are connected in parallel as shown. The potential difference between points a and b is given as $V_{ab}$. Calculate the charge on each capacitor and the potential difference across each capacitor. Express your answers in terms of $C_1$, $C_2$, and $V_{ab}$.

$$Q_1 = \quad \quad \quad Q_2 = \quad \quad \quad V_1 = \quad \quad \quad V_2 = \quad \quad \quad$$

Be neat. Neatness helps. Work neatly.
Problem 2. (20 points.)

(a) (10 points) Two resistors $R_1$ and $R_2$ are connected in parallel as shown. The potential difference between points a and b is given as $V_{ab}$. Calculate the current in each resistor and the potential difference across each resistor. Express your answers in terms of $R_1$, $R_2$, and $V_{ab}$.

\[ I_1 = \quad \]
\[ I_2 = \quad \]
\[ V_1 = \quad \]
\[ V_2 = \quad \]

(b) (10 points) Two resistors $R_1$ and $R_2$ are connected in series as shown. The potential difference between points a and b is given as $V_{ab}$. Calculate the current in each resistor and the potential difference across each resistor. Express your answers in terms of $R_1$, $R_2$, and $V_{ab}$.

\[ I_1 = \quad \]
\[ I_2 = \quad \]
\[ V_1 = \quad \]
\[ V_2 = \quad \]

Make sure you are being neat. Working neatly will help you get it right.
Problem 3. (20 points.)

A resistor is made in the shape of a rectangular prism as shown below. The resistivity of the material is $\rho$. The width of the prism is $w$ and the length is $L$. Current enters from the left as shown, on a face whose height is $a$. Current leaves from the right, from a face whose height is $b$.

Assume that $L \gg (b - a)$ so that current is always flowing horizontally through the resistor.

Calculate the resistance of this resistor. Express your answer in terms of $\rho$, and the dimensions $L$, $w$, $a$, and $b$. 

If you work neatly I will find more partial credit for you!
Problem 4. (20 points.)

The DC circuit shown below consists of three batteries, with EMF $V_1$, $V_2$, and $V_3$. Neglect the internal resistance of the batteries. Each battery is connected to a resistor, labeled $R_1$, $R_2$, and $R_3$ as shown. I have labeled the current in each segment by $I_1$, $I_2$, and $I_3$.

Derive three equations which can be solved for these three currents. Clearly circle the three equations you are presenting as the answer, and simplify them algebraically so that they do not have superfluous numerical factors or signs. You do not need to solve the equations, but you must use the given convention for the directions of the currents.
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Problem 5. (20 points.)

The circuit shown below consists of two identical batteries, both with EMF given by $V$ and with negligible internal resistance, two identical resistors $R$, a capacitor $C$, and a switch $S$.

(a) Suppose the switch has been open a long time. Calculate the charge on the capacitor. Express your answer in terms of the given quantities.

(b) Suppose the switch is closed, and you wait a long time. Calculate the charge on the capacitor. Express your answer in terms of the given quantities.

Don’t forget to be neat!