Print your name **neatly**:

Last name: ____________________________

First name: __________________________

Sign your name: ____________________________

Please fill in your Student ID number: ____________

**IMPORTANT**

Read these directions carefully:

- There are 5 problems totalling 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.
Problem 1. 20 points.

In the capacitor network shown below, all capacitors have the same capacitance $C$.
(a) Calculate the capacitance between points $A$ and $B$.
(b) Calculate the capacitance between points $A$ and $C$.
Express both answers in terms of $C$. Circle your answers.

In the resistor network shown below, all resistors have the same resistance $R$.
(c) Calculate the resistance between points $A$ and $B$.
(d) Calculate the resistance between points $A$ and $C$.
Express both answers in terms of $R$. Circle your answers.
Problem 2. 20 points.

The switch $S$ in the Figure below is connected to the right so that capacitor $C_1$ becomes fully charged by the battery of voltage $V$. Capacitor $C_2$ is uncharged.

(a) (5 points) How much energy is stored in capacitor $C_1$?

(b) (15 points) The switch is then moved to the left, and the charge that was on $C_1$ is redistributed (some goes on to capacitor $C_2$). Calculate the total energy stored in both $C_1$ and $C_2$.

*Hint:* Find the charge on each capacitor after the switching.

*Note:* The answer to part (b) is less than the answer to part (a). This may seem strange to you! Where does the energy go? Do not be concerned about that here — we will discuss it later in the course.
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 $b$.
Problem 4. 20 points.

A DC circuit is constructed with three batteries and three resistors as shown. Two of the batteries maintain 10 V and one maintains 30 V. All three resistors are the same with resistance 10 Ω.

Calculate the current supplied by each battery. For consistency, I have indicated how you should label each current. The current in the top segment is $I_1$ and is taken to be positive to the left; the current in the middle segment is $I_2$ and is taken to be positive to the right; the current in the lower segment is $I_3$ and is taken to be positive to the right.

Remember, more points if you are neat.
Problem 5. 20 points.

Consider the circuit shown below. When the switch $S$ is in the “up” position (as shown) there will be a potential difference across the capacitor.

(a) Calculate the charge on the capacitor after the switch has been in the up position for a very long time. Express your answer in terms of $V$, $R_1$, $R_2$, and $C$.

(b) Suppose the switch is moved down. How long will it take before the charge on the capacitor drops to one third of the value found in part (a)? Express your answer in terms of $R_1$, $R_2$, $C$ and numerical quantities, such as $\ln 3$. Do not use approximate decimal expressions.