Circuits Problem Set

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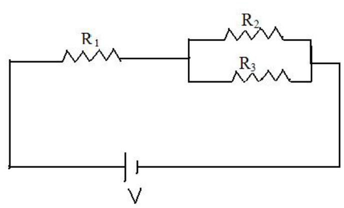
1 Equations Review

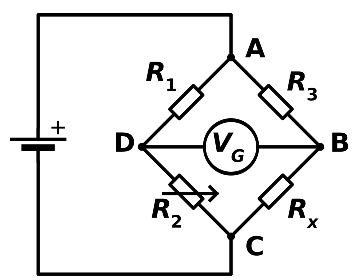
Ohm's Law - $V = IR$
Capacitance - $C = \frac{Q}{V}$
Capacitance for Parallel Plate Capacitor - $C = \frac{\epsilon_0 A}{d}$
Energy in Capacitor - $U = \frac{1}{2}CV^2 = \frac{1}{2}QV = \frac{Q^2}{2C}$
Power Dissipation for Resistor - $P = IV = I^2R = \frac{V^2}{R}$

2 Problems

1. Below is a diagram of a circuit with resistors of resistance R_1, R_2, and R_3, and it has a voltage source with potential V. For each resistor determine the voltage across it, the current through it, and the power dissipated by it.



2. The circuit arrangement below is known as a *Wheatstone bridge*. It consists of a battery with a potential ϵ, two resistors with known resistance (R_1 and R_3), a variable resistor R_2, and a resistor with unknown resistance R_x. If no current flows in the wire connecting points B and D, show that $R_1R_x = R_2R_3$.



3. We can specifically control the capacitance of a specific capacitor by introducing a *dielectric* with dielectric constant κ, a material that is inserted into the empty space between the plates and increases its capacitance by a factor of κ. Say we are interested in inserting two dielectrics into a capacitor in the configurations shown below. Find the final capacitance of the capacitor in each scenario.