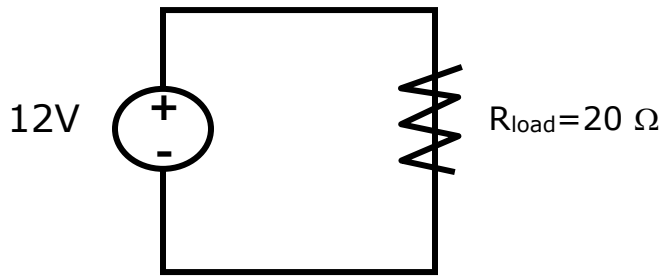
Internal Resistance

1. A real battery has a potential difference of 12V when no load is attached. A 20 Ω load circuit is then attached to the battery, drawing 5 W of power.

   a. What is the current that flows through the load circuit?

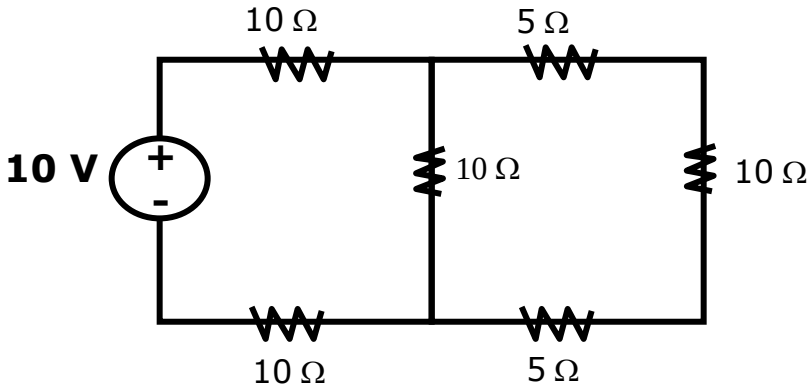


   b. What is the potential difference across the load circuit?

   c. What is the internal resistance of the battery?

2. Consider the following circuit:

   a. What is the equivalent resistance of this circuit?



   b. How much total current is drawn from the battery?

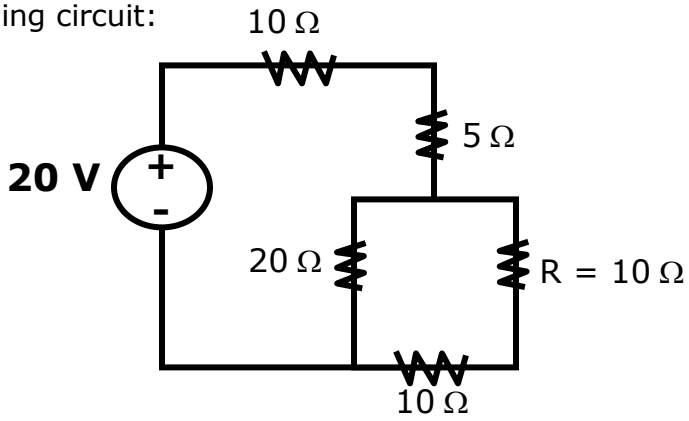
   c. How much total power is drawn from the power source?

   d. If the circuit is connected for 10 minutes, how much energy is drawn from the battery?

   e. How much charge?

f. How many electrons?

3. Consider the following circuit:



a. What is the equivalent resistance of this circuit?

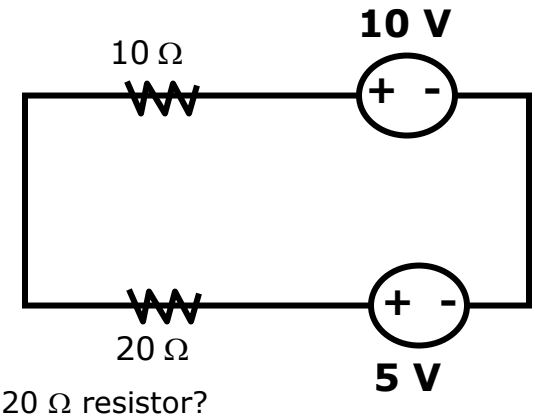
b. How much total current is drawn from the battery?

c. How much current is flowing through each resistor?

d. How much power is dissipated across resistor R?

4. Consider the following circuit:

(hint: use Kirchhoff)



a. What is the current through the 20 Ω resistor?

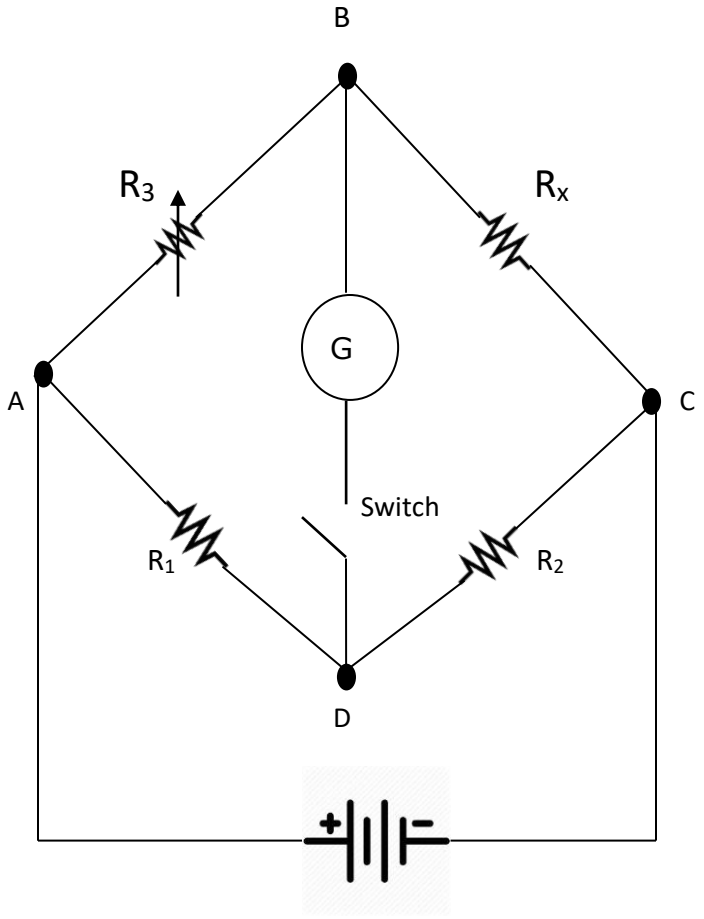
b. What is the current through the 10 Ω resistor?

5. The Wheatstone bridge is a circuit used to make precise measurements of resistance. The unknown resistance to be measure, R_x, is placed in the bridge circuit as shown below. And the variable resistor R_3 is adjusted until the galvanometer does not deflect when the switch is closed. For this setting, no current flows from B to D, so B and D are at the same potential.

   a. Show that the unknown resistance R_x is given by the formula: $R_x = \frac{R_2}{R_1} R_3$

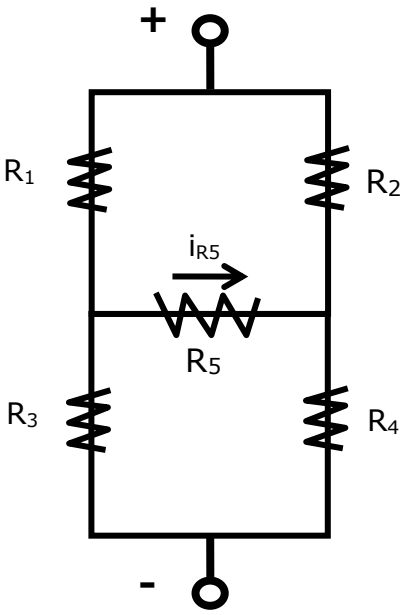
   when R_1 , R_2 , and R_3 are known values.

   b. If in the below Wheatstone Bridge the Bridge is balanced, i.e. G=0 and $R_1 = 630\ \Omega$, $R_2 = 972\ \Omega$, and $R_3 = 42.6\ \Omega$. What is the value of the unknown resistance (R_x)?



6. A "Wheatstone Bridge" circuit is shown in the following diagram. The voltage from the top terminal to the bottom terminal is 120 V and the resistor values are:

R_1=20 Ω R_2=??
R_3=50 Ω R_4=40 Ω
R_5=10 Ω



a. Determine the value of R_2 when the current through R_5 is zero, (i_{R5}= 0 A).

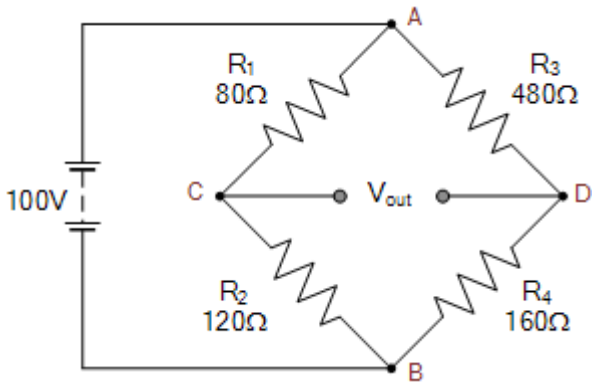
b. What is the equivalent resistance for this circuit?

c. What is the current through R_2?

d. Calculate the rate of resistive heat loss (power) through R_2.

e. Determine the value of R_2 when the current through R_5 is zero, i_{R5}= 0.1 A.

7. The following unbalanced Wheatstone Bridge is constructed. Calculate the output voltage across points C and D and the value of resistor R_4 required to balance the bridge circuit.



For the first series arm, ACB

For the second series arm, ADB

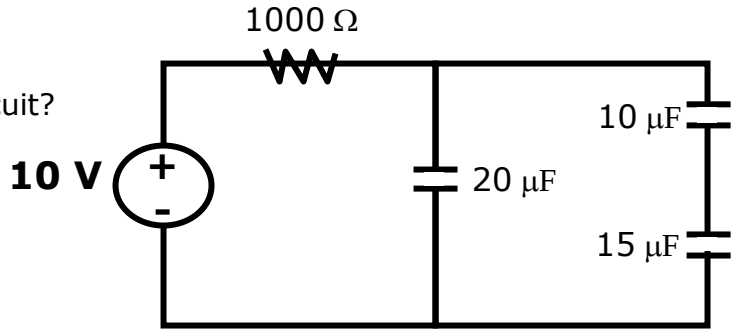
The voltage across points C-D is given as:

The value of resistor, R_4 required to balance the bridge is given as:

We have seen above that the **Wheatstone Bridge** has two input terminals (A-B) and two output terminals (C-D). When the bridge is balanced, the voltage across the output

terminals is 0 volts. When the bridge is unbalanced, however, the output voltage may be either positive or negative depending upon the direction of unbalance.

8. Consider the following RC circuit.



a) What is the equivalent capacitance for this circuit?

b) What is the RC time constant for this circuit?

c) What is the significance of this RC constant?

d) If the battery is removed from the circuit and the capacitors are allowed to discharge, how long would it take for the charge in the capacitor to be 20% of the fully charged value?

e) What would be the potential difference across the discharged capacitor in (d)?