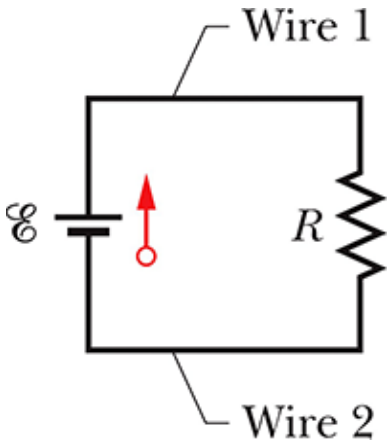
Phyx 135-2, Fall 2016, Quiz #3 **Name** _____
Section 01 (10 am)

1) An ideal 9-volt battery is connected across a resistor of 10 Ω. The two wires which connect the battery to the resistor are NOT ideal: they are each 1.5 m long, 0.5 mm in radius, and made of iron.



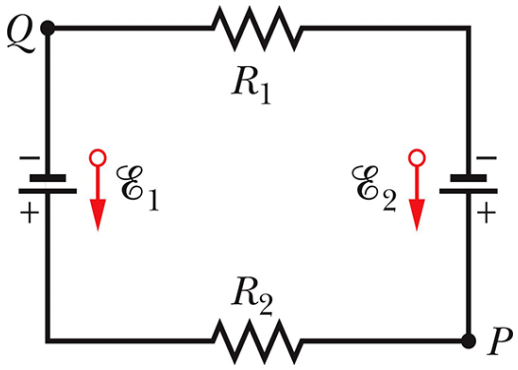
1a) (3 points) If the resistivity of iron is 9.68 x 10^{-8} Ω m, what is the resistance of each wire?
Solution: Using R = ρ L / A, and A = πr^2, we have:
R = (9.68 x 10^{-8})(1.5) / π(5 x 10^{-4})^2 = 0.185 Ω.

1b) (3 points) What is the current flowing in this circuit?
Solution: From V = iR, we have 9 v = i(0.185 + 10 + 0.185), or i = 0.868 A.

1c) (3 points) What is the total power being consumed by this circuit?
Solution: Using P = i^2R, we see that the total power being used is (0.868)^2(10.37) = 7.81 W.

1d) (3 points) Of the total power being consumed by this circuit, what percentage of it is being "wasted" as heat energy in the iron wires?
Solution: Since P = i^2R, and the current is the same throughout the circuit, the fraction of the power being used by the wires is simply (2 x 0.185) / 10.37 = 3.6%.

2) (8 points) In the little circuit shown at right, suppose $\mathcal{E}_1$ = 9 v, $\mathcal{E}_2$ = 6 v, R_1 = 10 Ω, and R_2 = 20 Ω. If point P is held at ground, what will be the voltage at point Q?



Solution
The current flowing in this circuit is:
(9 v – 6 v) = i(10 + 20), or i = 0.1 amp.

There are several ways to calculate the voltage at Q.
Possibly the easiest is just to start at Q and follow the current to P. Going across the first battery raises the voltage by 9, then going across resistor 2 lowers it by iR = 2 volts. Thus P is at 7 volts *above* Q, which means that Q must be at -7 volts (since P is at V = 0).

You could also start at P, then go across battery 2. This will *lower* the voltage by 6 volts, because you are going backwards across the battery. You lose another volt going across resistor 1, and that places you at -7 volts, as before.