11/15–Ohm's Law and Ampere's Law

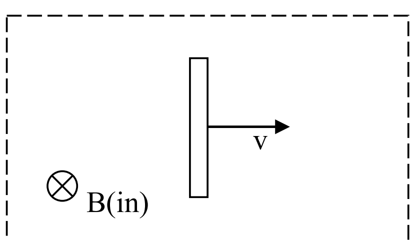
1. An ideal 12-V battery is connected to two 3kΩ resistors in series.
   (a) What is the current through each resistor?
   (b) What is the voltage drop across each resistor?
   (c) What is the power dissipated by each resistor?
   (d) What is the power supplied by the battery?
   (e) Do your answers to the power questions "add up" as you'd expect?

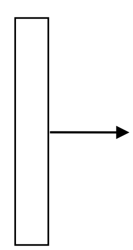
2. Two 4kΩ resistors are connected to an ideal 12-V battery, this time in parallel.
   (a) What is the current through each resistor?
   (b) What is the voltage drop across each resistor?
   (c) What is the power dissipated by each resistor?
   (d) What is the power supplied by the battery?
   (e) Do your answers to the power questions "add up" as you'd expect?

3. Do Griffiths 7.2

4. When a resistor of resistance R is connected to a battery of emf $\mathcal{E}$ and internal resistance r, the terminal voltage is $V = \mathcal{E}/3$. What is the value of the internal resistance in terms of the resistance R?

5. Motional emf:
   A neutral metal bar is being pulled at constant velocity, speed v, to the right through a uniform magnetic field of magnitude B, into the page, as shown. The bar has been moving for some long time, and has achieved a dynamic steady-state.

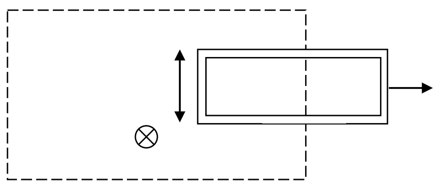




   (a) What is the magnetic force on charges in the bar (direction and magnitude)?
   (b) In the diagram at right, sketch the distribution of charges in the bar.
   (c) What is the electric field in the bar (direction and magnitude)? Hint: remember that the bar has reached a dynamic steady-state.
   (d) What is the potential difference between the ends of the bar?

6. Another case of motional emf:
   Now consider a rectangular metal loop of height L, moving to the right with speed v, which is exiting a region with a constant magnetic field, magnitude B into the page.

   (a) What is the emf around the metal loop?
   (b) If the wire loop has a resistance of R, what is the current around the loop? (magnetude and direction)
   (c) Compare your answer to this problem with the last one. What do you notice? Can you explain it?



7. A very long solenoid
   Consider a very long solenoid of radius R with n turns per length and current I.

   (a) Compute the B-field everywhere (meaning, both inside and outside the solenoid.)
   (b) Suppose the current I in the solenoid is increasing at a steady rate $I(t) = Ct$, where C is a constant. Use Faraday?s Law in integral form to compute the electric field inside the solenoid. Specify the loop you chose for the integral.
   (c) Do the same thing for the electric field outside the solenoid.