HW 9 – Ohm's Law and EMF

Due November 06, 2009, 5 pm

1. Griffiths 7.1, (p. 290).
2. Griffiths 7.2, (p. 291).
3. Griffiths 7.8, (p. 300).
4. Griffiths 7.10, (p. 300).
5. Consider Figure 7.16 on page 299 of Griffiths, only I want you to imagine we are looking straight down on an apparatus that is actually lying on an inclined plane that slopes down to the right, making an angle θ with the horizontal (if you could lift the left side of the page up while leaving the right end on the table, you would get the situation I am describing). Assume the bar starts from rest. You may assume that $\ell/R = \sigma A$.

(a) What is the component parallel to the rails of the gravitational force $\vec{F}_g$ on the bar if it has a mass m?

(b) As the bar is sliding to the right, at some speed v, what is the Lorentz force $\vec{F}_\ell$ on the electrons in the bar?

(c) Using this force and the conductivity of the bar (σ), what is the current density in the bar at time t?

(d) What is the magnetic force $\vec{F}_B$ on the total current in the bar at time t, if the cross-sectional area of the bar is A?

(e) What is $\vec{v}(t)$? What is $v_{\max}$, the maximum speed the bar can achieve? Make sure to examine and justify the role each variable plays in your answer. Remember to check your units.

(f) Using the flux rule, what is the EMF around the loop at time t?

(g) What is the current in the resistor from this EMF?

(h) Over some time interval Δt, starting after $v \approx v_{\max}$, how much energy is lost in the form of heat from the resistor? Cast your final answer in terms of $v_{\max}$.

(i) How much work is done on the bar by gravity during this time interval?