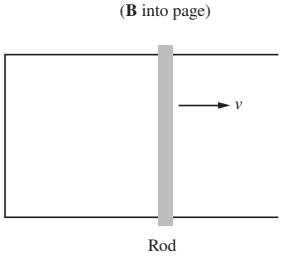
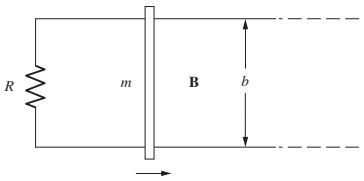
# PHY102 : Assignment 8

1. (P&M 7.2) In Figure a conducting rod is pulled to the right at speed v while maintaining contact with two rails. A magnetic field points into the page. From the reasoning in Section 7.3, we know that an induced emf will cause a current to flow in the counterclockwise direction around the loop. Now, the magnetic force $q\mathbf{u} \times \mathbf{B}$ is perpendicular to the velocity $\mathbf{u}$ of the moving charges, so it can't do work on them. However, the magnetic force $\mathbf{f}$ in Eq. (7.5) certainly looks like it is doing work. What's going on here? Is the magnetic force doing work or not? If not, then what is? There is definitely something doing work because the wire will heat up.




2. (P&M 7.26) A metal crossbar of mass $m$ slides without friction on two long parallel conducting rails a distance $b$ apart.; see Fig. A resistor $R$ is connected across the rails at one end; compared with $R$, the resistance of bar and rails is negligible. There is a uniform field $\mathbf{B}$ perpendicular to the plane of the figure. At time $t = 0$ the crossbar is given a velocity $v_0$ toward the right. What happens then?

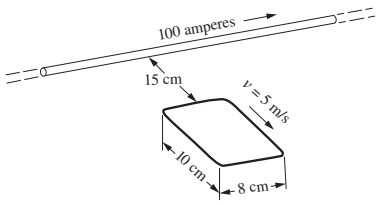



   (a) Does the rod ever stop moving?

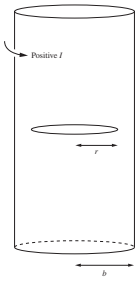
   (b) If so, when? How far does it go?

   (c) How about conservation of energy?

3. (P&M 7.29) Calculate the electromotive force in the moving loop in the figure at the instant when it is in the position there shown. Assume the resistance of the loop is so great that the effect of the current in the loop itself is negligible. Estimate very roughly how large a resistance would be safe, in this respect. Indicate the direction in which current would flow in the loop, at the instant shown.



4. (P&M 7.27) An infinite solenoid with radius $b$ has $n$ turns per unit length. The current varies in time according to $I(t) = I_0 \cos \omega t$ (with positive defined as shown in Fig. ). A ring with radius $r < b$ and resistance $R$ is centered on the solenoid's axis, with its plane perpendicular to the axis.

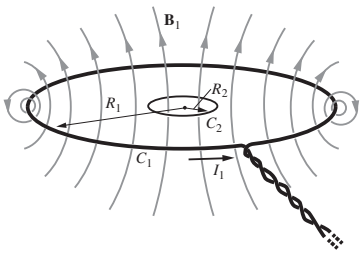



   (a) What is the induced current in the ring?

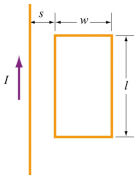
   (b) A given little piece of the ring will feel a magnetic force. For what values of $t$ is this force maximum?

   (c) What is the effect of the force on the ring? That is, does the force cause the ring to translate, spin, flip over, stretch/ shrink, etc.?

5. (P&M Example) Figure shows two coplanar, concentric rings: a small ring $C_2$ and a much larger ring $C_1$. Assuming $R_2 \ll R_1$, what is the mutual inductance $M_{21}$?




6. An infinite straight wire carries a current $I$ is placed to the left of a rectangular loop of wire with width $w$ and length $l$, as shown in the Figure.




   (a) Determine the magnetic flux through the rectangular loop due to the current $I$.

   (b) Suppose that the current is a function of time with $I(t) = a + bt$, where $a$ and $b$ are positive constants. What is the induced emf in the loop and the direction of the induced current?

7. Compute the self-inductance of a solenoid with $N$ turns, length $l$ , and radius $R$ with a current $I$ flowing through each turn.