# Physics 102– Pledged Problem 7

Time allowed: **2 hours at a single sitting**
**Due 5PM Monday, March 19, 2007**, in the boxes marked Phys 101-102 in the physics lounge. You may use your own textbook, your notes, and a non-programmed calculator. You may also consult the on-line solutions to the corresponding suggested problems. You should consult no other help. Show how you arrived at your answer; the correct answer by itself may not be sufficient.
Further instructions:
(a) Write legibly on **one** side of 8.5" x 11" white or lightly tinted paper.
(b) Staple all sheets together, including this one, in the upper left corner. Make one vertical fold.
(c) On the outside, print your name in capital letters, your LAST NAME followed by your FIRST NAME.
(d) Below your name, print the phrase "Pledged Problem 7", followed by the due date.
(e) Write and sign the pledge, with the understanding that you may consult the materials noted above.
(f) Indicate your **start time** and **end time**.

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I. A metal crossbar of mass $M$ slides without friction on a pair of long, horizontal conducting rails separated by a distance $L$. The rails are connected to a device that supplies a constant current $I$ to the circuit. A uniform magnetic field $B$ points into the page as shown in the figure below.

(a) In what direction will the bar move when the current source is turned on?
(b) If the bar starts from rest at $t = 0$, determine its velocity at a time $t$ later. Express your answer in terms of $M$, $L$, $I$, $B$, and $t$.

Now suppose the rails are tilted upward so that they make an angle $\theta$ with the horizontal, as shown below. The magnetic field $B$ is still in the vertical direction.

(c) For this configuration, what magnitude of magnetic field $B$ is needed to keep the bar from sliding down the rails?
(d) If $B$ has twice the value found in (c), what is the acceleration of the bar?

II. Protons and deuterons (each with charge $+e$) and alpha ($\alpha$) particles (with charge $+2e$) of the same kinetic energy enter a uniform magnetic field $\vec{B}$ that is perpendicular to their velocities. Make the approximation that $m_\alpha = 2m_d = 4m_p$.

(a) Let $r_p, r_d$ and $r_\alpha$ be the radii of their circular orbits. Determine expressions for the ratios $r_d/r_p$ and $r_\alpha/r_p$.
(b) Let $T_p$, $T_d$, and $T_\alpha$ be the periods of rotation for the particles. Determine expressions for the ratios $T_d/T_p$ and $T_\alpha/T_p$.