Physics 2220
Spring 2007
George A. Williams

FOURTH MIDTERM

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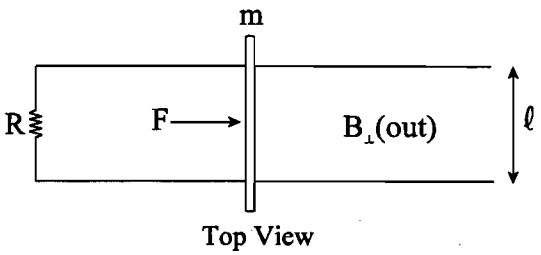
Name:_____ Student ID #:_____

Discussion Instructor (circle): Eric Gary Jose Monica

SHOW ALL WORK!!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.



Top View

In the drawing the horizontal lines represent conducting rails that are very long. The conducting rod, mass m, slides (no rolling) without friction along the rails. It is acted on by a constant horizontal force, F.

(a) When the speed of the rod is v, calculate the current in the resistor.
(b) Obtain an expression for the limiting speed at which the rod will move.
(c) Obtain an expression for the time constant for the approach to the limiting speed.

(a) 10 points

Motional $\mathcal{E}mf = \mathcal{E} = B\ell v$ $\quad I = \frac{V}{R} = \frac{\mathcal{E}}{R} = \boxed{\frac{B\ell v}{R}}$

(b) 5 points

At max speed acceleration = 0

$\Sigma F = 0$

$F = F_b$

$F_b = I\ell B = \frac{(B\ell)^2 v}{R}$

$F = \frac{(B\ell)^2 v}{R} \Rightarrow \boxed{V_\infty = \frac{FR}{(B\ell)^2}}$

(c) 10 points

$\Sigma F = m\frac{dv}{dt}$

$F - \frac{(B\ell)^2 v}{R} = m\frac{dv}{dt}$

note: V_∞ is here too!

$\frac{mR}{(B\ell)^2}\frac{dv}{dt} + v = \frac{FR}{(B\ell)^2}$

$\boxed{\tau = \frac{mR}{(B\ell)^2}}$

$V(t) = V_\infty\left(1 - e^{-\frac{t}{\tau}}\right)$