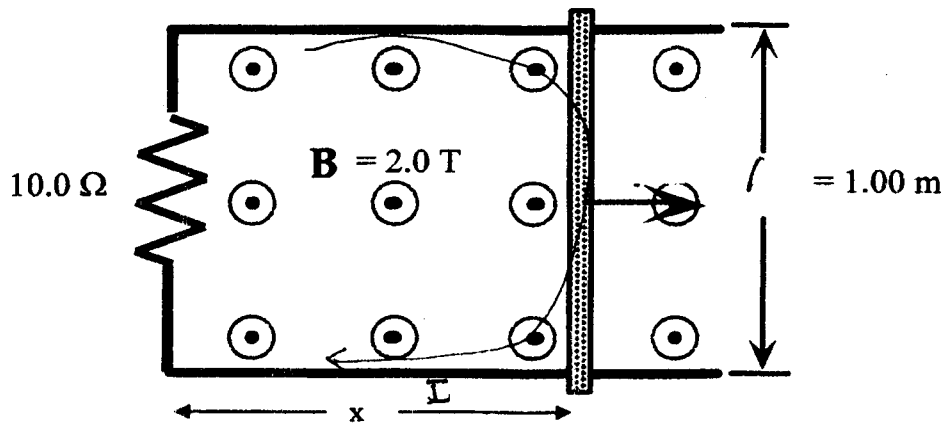
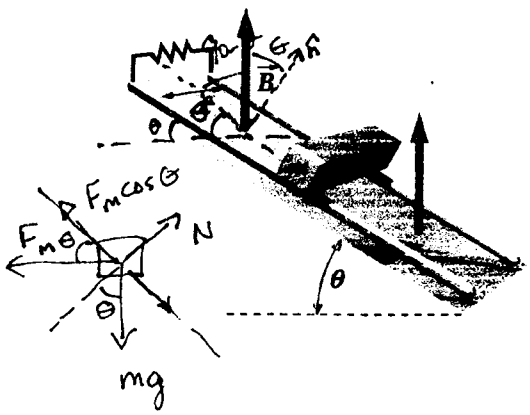
Name_____ SP222 Exam III

9. (30 points) In the following frictionless system seen from above, a 1.50 kg bar slides down the incline plane with an angle $\theta = 30°$.





a. (4) When the bar is at the position, x, as shown, what is the flux through the loop formed by the moving bar (in terms of x)?

$\Phi = BA\cos\theta = (2\,T)(1\,m)\,x\cos 30$

$= 2\,(.866)\,T\,m\;x$

$= (1.73\,T\cdot m)\,x = 1.73\,\frac{N}{A}\,x$

b. (4) What is the EMF developed across the bar in terms of the velocity of the bar as it slides down the incline?

$\mathcal{E} = \frac{d\Phi}{dt} = \left(1.73\,\frac{N}{A}\right)\frac{dx}{dt} = 1.73\,\frac{N}{A}\,v$

c. (4) What is the current in the bar in terms of the velocity of the bar? Unambiguously show the direction of the current on the diagram.

$I = \frac{\mathcal{E}}{R} = \frac{1.73\,\frac{N}{A}}{10\,\Omega}\,v = .173\,\frac{N}{A\cdot\Omega}\,v$

d. (6) Draw a free body diagram for the sliding bar? SHOW θ ON THIS DIAGRAM

e. (4) Calculate the magnitude of the magnetic force on the bar in terms of the velocity of the bar.

$\vec{F}_M = I\vec{l}\times\vec{B} \Rightarrow F_M = IlB = \left(.173\,\frac{N}{V}\,v\right)(1\,m)(2\,T)$

$= .346\,\frac{N}{V}\,\frac{N}{A\cdot m}\,v = .346\,\frac{N^2}{V\cdot A}\,v$

f. (8) Find the components of the forces acting along the incline plane and from this calculate the terminal velocity of the bar. Assume the incline is long enough for the bar to reach a terminal velocity.

$\Sigma F = mg\sin\theta - F_M\cos\theta = ma = 0$

$(1.5\,kg)(9.8\,m/s^2)\sin 30 - .346\,\frac{N^2}{V\cdot A}\,v\cos 30 = 0$

$7.35\,N - .3\,\frac{N^2}{V\,A}\,v = 0 \Rightarrow v = \frac{7.35\,\frac{N\cdot s}{C}\,\frac{C}{s}}{.3\,\frac{kg\cdot m}{s\,C}} = \boxed{24.5\,m/s}$

$\frac{b}{\tau_M} = \frac{.346\cos 30}{1.5} = .1997\,s^{-1}$

$\tau = 5\,s$