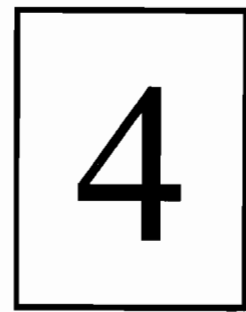


FOURTH MIDTERM



Name: _____ Student ID #: _____

Discussion Instructor (circle): Barcikowski El-Gendy Johnson Rodriguez

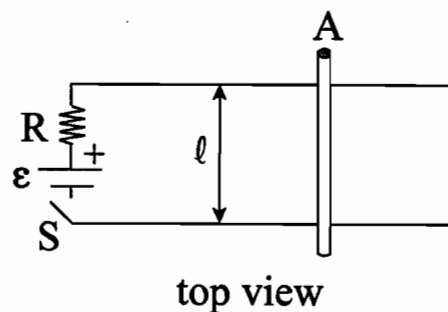
SHOW ALL WORK!!!!

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!

Use the conversion constants and data given on the front page.

Points
↓
4
4
4
6
7

In the drawing, the horizontal lines represent conducting rails. The rod, A, has a mass of 75.0 g. The switch A is closed at $t = 0$. There is a magnetic field perpendicular to the paper, and INTO the paper, whose strength is $B = 0.930$ T.



$\epsilon = 75.0$ V; $R = 2.00$ Ω ; $l = 9.50$ cm

- Which direction, right or left, would the rod move?
- Just after $t = 0$, what is the force on the rod?
- Just after $t = 0$, what is the acceleration of the rod?
- If the rod moves without friction, what is its maximum speed?
- What is the time constant for the approach to this maximum speed?

a) $\vec{F} = I \vec{L} \times \vec{B}$ RHR Rule gives F_B to the Right

b) $\vec{F} = I l B \hat{i} = \frac{\epsilon}{R} l B \hat{i} = \boxed{3.31 \text{ N } \hat{i}}$

c) $a = \frac{\vec{F}}{m} = \frac{\epsilon l B}{R m} \hat{i} = \boxed{44.2 \frac{\text{m}}{\text{s}^2} \hat{i}}$

d) V_{max} when $\epsilon - \frac{d\Phi_B}{dt} = 0$ $\epsilon - Bl \frac{dx}{dt} = 0$

$V_{\text{max}} = \frac{\epsilon}{Bl} = \boxed{849 \text{ m/s}}$

e) $F = m \frac{dv}{dt} = I l B \rightarrow \frac{\epsilon}{R} l B - \frac{(lB)^2}{R} v$

$\frac{dv}{dt} + \frac{(lB)^2}{mR} v = \frac{\epsilon l B}{mR}$

$\underbrace{\left[\frac{mR}{(lB)^2} \right]}_{\tau} \frac{dv}{dt} + v = \frac{\epsilon}{lB}$

$v(t) = \frac{\epsilon}{Bl} \left(1 - e^{-\frac{t}{\tau}} \right)$

$\tau = \frac{mR}{(lB)^2} = \boxed{19.2 \text{ s}}$