

FIFTH MIDTERM

3

Name: _____

Discussion Instructor (circle): Gillman Rodriguez Shepherd Webb

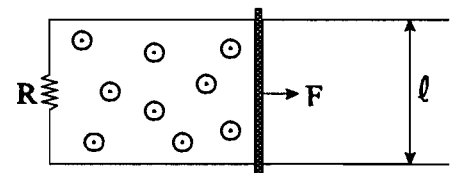
Student ID #: _____

SHOW ALL WORK!!!!

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!

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

Two long conducting rails are in the horizontal plane. There is a uniform magnetic field, B , perpendicular to the paper and out of the page. Starting at rest, a constant force F is applied to a conducting rod of mass M , as shown. The rails are as long to the right as needed.



Top View

- Find the direction, clockwise or counter clockwise, for the induced current.
- Determine the final velocity of the rod.
- Obtain a formula for the velocity of the rod as a function of time. Show all details.

a. clockwise

b. $\sum F_x = 0$ $F_B = Il \times B = IlB$

$$IlB - F = 0 \quad \Rightarrow \quad I = \frac{Bl}{R} v \quad \Rightarrow \quad \frac{(Bl)^2}{R} v - F = 0$$

$$v = \frac{RF}{(Bl)^2} = v_{\infty}$$

c. $v(t) = v_{\infty} (1 - e^{-t/\tau})$

$$\frac{F}{m} - \frac{(Bl)^2}{mR} v = \frac{dv}{dt}$$

$$\tau = \frac{1}{\frac{(Bl)^2}{mR}} = \frac{Rm}{B^2 l^2}$$

$$v(t) = \frac{FR}{B^2 l^2} (1 - e^{-t/Rm/B^2 l^2}) = \frac{FR}{B^2 l^2} (1 - e^{-\frac{B^2 l^2 t}{Rm}})$$

the solution may also be found by directly solving the D.E.