Winter Quarter 1989
March 13, 1989
George Williams

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FINAL EXAM

Name (print)_____ Name (signed)_____

Discussion Instructor (circle one): An Chen Emerson Iguchi Stoops

Discussion Section #:_____

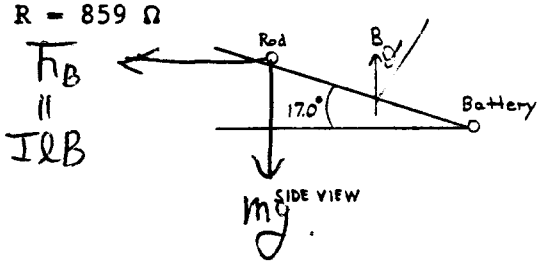
SHOW ALL WORK!!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

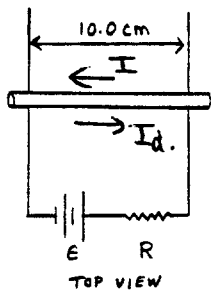
A conducting rod moves on two parallel frictionless conducting rails. The only resistance is that shown as R. There is a battery in series with R. The rod has a mass m of 1.35×10^{-2} kg. The magnetic field is in the vertical direction, and has the magnitude of B = 4.75 T. ϵ and R have the values shown. The rod starts at rest (t = 0).

(a) At t = 0, what is the acceleration of the rod? Take the direction up the incline as positive.
(b) Assume the rails are infinitely long in both direction and B is the same everywhere. What is the velocity of the rod at very long times?
(c) what is the time constant for the approach of this system to the steady state?

ϵ = 174 V

R = 859 Ω





(10) (a) Net force = $F_B \cos 17° - mg \sin 17° = 5.34 \times 10^{-2}$ N (+8)

$a = \frac{\text{Force}}{m} = 3.96\ m/sec^2$ (+2)

$\Phi = BA\cos\theta$

(+3) (b) Induced current $I_d = \frac{\mathcal{E}}{R} = \frac{\left|\frac{d\Phi_m}{dt}\right|}{R} = \frac{Bl v \cos\theta}{R}$ (opposite direction to I)

(+13) Net force = $(I - I_d)Bl\cos\theta - mg\sin\theta$ (+5)

$= 5.34 \times 10^{-2} - \frac{2.40}{222} \times 10^{-4} v$ (+2)

At the terminal velocity, Net force = 0

(+3) $\therefore v_t = 222$ m/sec

(+4) (c) $m\frac{dv}{dt} = 5.34 \times 10^{-2} - \frac{2.40}{222} \times 10^{-4} v$

(+7) $\frac{dv}{dt} = \text{constant} - \frac{1}{\tau} v$ $\therefore \tau = \frac{m}{2.40 \times 10^{-4}} = 56.3$ sec (+3)