

Name: _____

CWID: _____

Calculators Not Allowed
No Work = No Credit
Write Legibly

Question	Points	Score
1	6	
2	14	
Total:	20	

1. Quickies:

- (a) 3 points Consider a semi-infinite wire carrying current I , see Fig. 1(a) and an infinite wire carrying current I , see Fig. 1(b). Where does the magnetic field due to a semi-infinite wire equal one half the magnetic field of an infinite wire, i.e., $\vec{B}_{\text{semi-infinite}} = \vec{B}_{\text{infinite}}/2$?

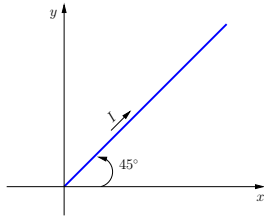
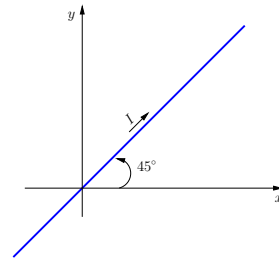
(a) A semi-infinite wire carrying current I is shown.(b) An infinite wire carrying current I is shown.

Figure 1: A semi-infinite wire and an infinite wire are shown.

- (b) 3 points Consider a conducting rod sitting on top of an incline. The top of the incline is made from a pair of frictionless conducting rails. There is a resistor, R , that connects the two rails, and a constant magnetic field directed vertically upward with a magnitude B_o , (same as the recitation problem). The separation distance between the two frictionless conducting rails is L . If at time $t = 0$, the rod is released from rest, explain physically why there is a flat region in Fig. 2.

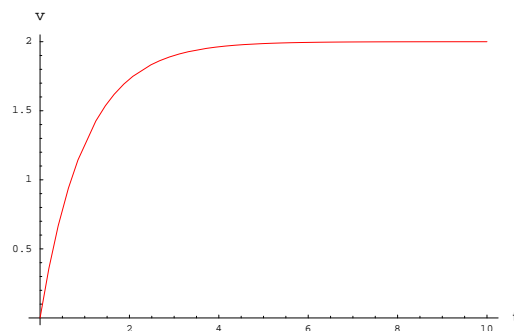


Figure 2: The velocity of the rod is shown for the following parameter values: $\frac{B_o^2 L^2 \cos^2 \theta}{Rm} = 1$ and $g \sin \theta = 2$. Notice that the graph is flat for roughly $t > 5$.

2. 14 points A blue wire carrying current $I = I(t)$ is wound evenly on a torus of rectangular cross section. There are N turns of the blue wire in all. A red wire is thrown over the torus and is connected to a resistor, R , see Fig. 3. The current in the red wire, $I_{\text{red wire}}$, is related to the current $I = I(t)$ via

$$|I_{\text{red wire}}| = \frac{M}{R} \left| \frac{dI}{dt} \right|. \quad (1)$$

Find the constant M in (1).

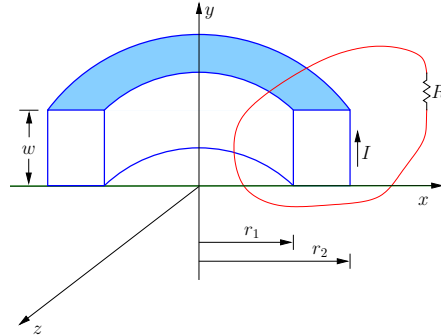


Figure 3: A blue wire carrying current $I = I(t)$ is wound evenly on a torus of rectangular cross section, with inner radius r_1 and outer radius r_2 . There are N turns of the blue wire in all. A red wire is thrown over the torus and is connected to a resistor, R .