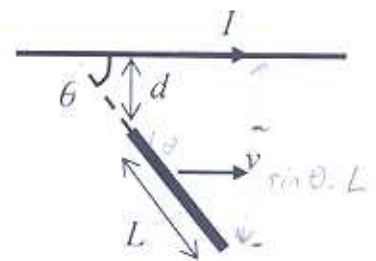**Closed book. No calculators are to be used for this quiz.**
Quiz duration: 10 minutes

Name: ANSWER   Student ID: Signature:

A straight wire is carrying a constant current, I, in the direction
as shown in the figure. A metal bar of length L is moving with
a constant velocity, v, parallel to the wire. The angle between
the wire and the metal bar's axis is θ. The distance between the
wire and the closer end of the bar is d. Find the induced emf
between the ends of the bar in terms of the given parameters.

$$\varepsilon = \int_{d}^{d+L\sin\theta} \sin\theta \cdot v \cdot B(r)\, dr$$

$$\sin\theta \cdot v \int_{d}^{d+L\sin\theta} B(r)\, dr = \sin\theta L v \int_{d}^{d+L\sin\theta} \frac{I\mu_0}{2\pi r}\, dr$$

$$\varepsilon = \frac{\sin\theta \cdot v\, I\mu_0}{2\pi} \ln\left(\frac{d+L\sin\theta}{d}\right)$$

$\varepsilon =$
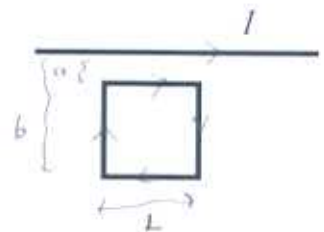
Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

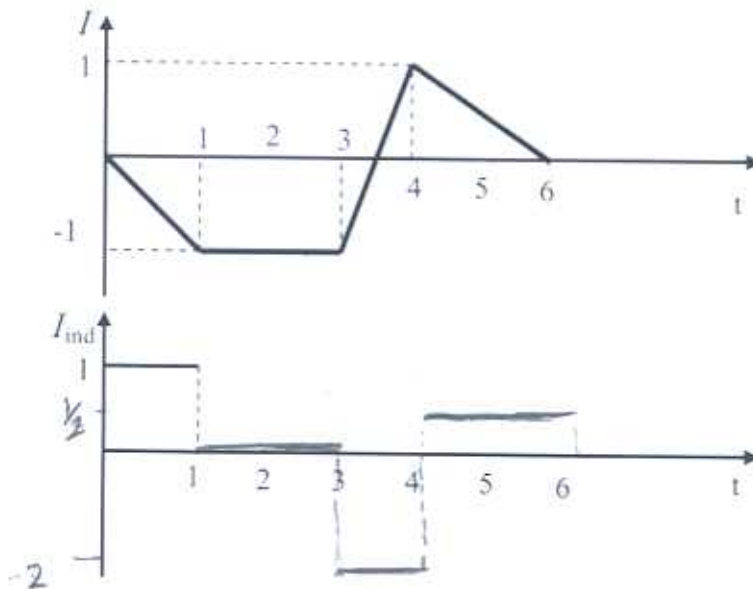Name: Student ID: Signature:

A straight wire is carrying a current, I. A square metal loop is located at a distance from the wire, as shown in the figure. The current in the wire is changing as a function of time as shown in the graph below. Assume that the positive direction of the current in the wire is to the right and the positive direction of the current in the loop is clockwise. The induced current is shown between $t = 0$ and $t = 1$. Using this information and Lenz's Law, complete the plot of the induced current as accurately as possible. The magnitude of the induced current in different time intervals must be consistent.

$$\mathcal{E} = \frac{\mu_0 L}{2\pi} \ln\left(\frac{b}{a}\right) \frac{dI}{dt}$$
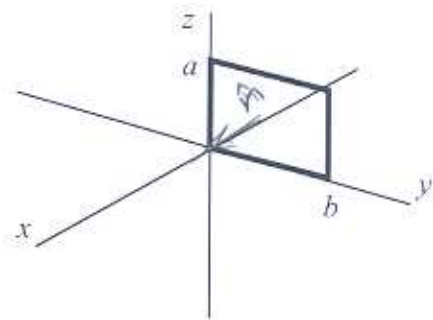
from problem 29.7

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:**   **Signature:**

A rectangular loop is located in the y-z plane with one corner at the origin as shown in the figure. A magnetic field is present in space that is given by $\vec{B}(y,t) = B_0 y \sin(\omega t)\hat{x}$. If the resistance of the loop is equal to R, calculate the time-dependent induced current in the loop using Lenz's Law. Note: The magnetic field depends on y!

$$d\vec{A} = dz\, dy\, \hat{j}$$
$$\int dz = a$$

$$\mathcal{E} = -\frac{d\Phi}{dt} = -\frac{d}{dt} \int \vec{B}\cdot d\vec{A} = -\frac{d}{dt} \int_0^b a\, dy\, B_0 y \sin(\omega t)$$

$$= -\frac{d}{dt}\left(a B_0 \sin \omega t\right) \frac{b^2}{2} = -\frac{a b^2}{2} B_0\, \omega \cos \omega t$$

$$I = \frac{\mathcal{E}}{R} = -\frac{a b^2}{2R} B_0\, \omega \cos \omega t$$
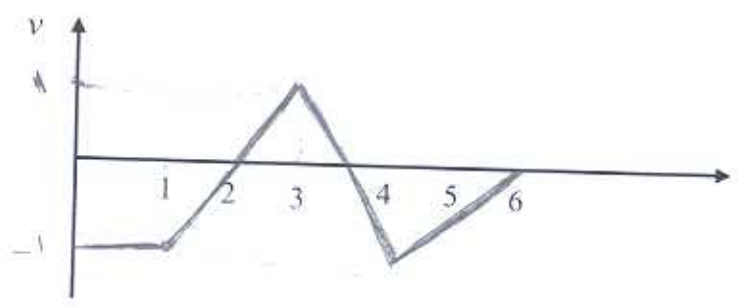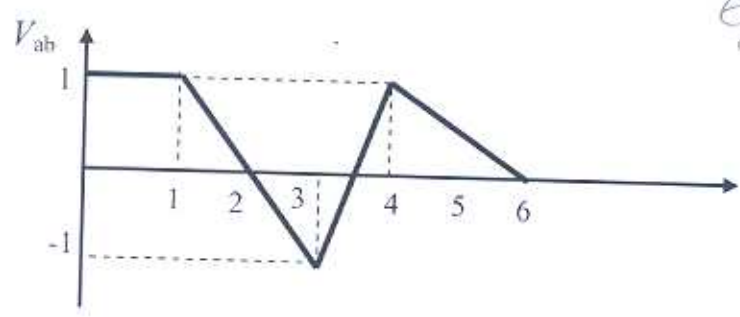
Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: Student ID: Signature:

A straight wire is carrying a constant current, I to the right. A square metal bar is located at a distance from the wire, as shown in the figure. The bar is perpendicular to the wire axis. The induced voltage V_{ab} between the ends of the wire is plotted as a function of time in the graph below. Using this information plot the velocity of the bar as a function of time as accurately as possible. The magnitude of the velocity at different time intervals must be consistent.

$$\mathcal{E}_{ab} = -\frac{d\Phi}{dt} = -\frac{d}{dt}\int dx \frac{ds}{2\pi y}$$

$$\Rightarrow \mathcal{E}_{ab} \propto -V$$
velocity

if the direction of velocity to the left

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: Student ID: Signature:

A metal bar can move without friction on two parallel
metal railings horizontally. The bar has length L, mass m,
and resistance R. The railings are connected through a
switch to a capacitor with capacitance C. Initially, the
switch is off, and the total charge of the capacitor is Q. The
resistance of the railings are negligible. The bar and the
railings are located within a uniform magnetic field, that is
directed out of the page.
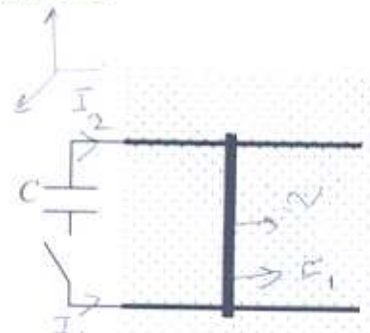
   a) Suppose that when the switch is closed, the bar
      starts to move to the right. Which plate of the
      capacitor is at a higher potential, top or bottom?
   b) Determine the acceleration of the bar just after the switch has been closed, in
      terms of the given parameters.

a) The current (I_1), is counterclockwise therefore bottom plate
   is at higher potential.
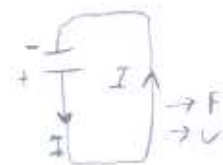
b) $\vec{F}_1 = I_1 \vec{L} \times \vec{B} = I_1 L B$,

   $\uparrow \vec{F}_2 = I_2 \vec{L} \times \vec{B} = I_2 L B$

   $I_2 = \frac{V_2}{R}$, $V_2 = -BL v$

   This current is clockwise

   $I_1 = \frac{V}{R}$

   $V_1 = \frac{Q}{C}$

   $I_1 = \frac{Q}{RC}$

   Just after switch closed

   $|\vec{a}| = \frac{|\vec{F}_1|}{m} = L B \frac{Q}{RC}$