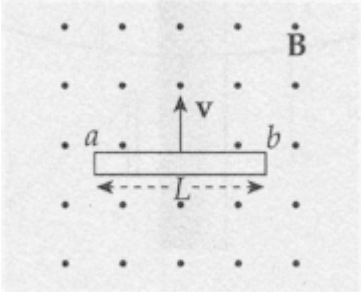
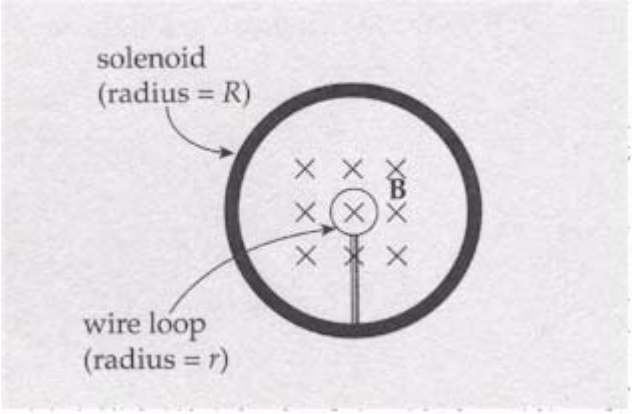
AP Physics C Review 19 Faraday's Law Name:

1. A metal rod of length L is pulled upward with a constant velocity v through a uniform magnetic field **B** that points out of the plane of the paper



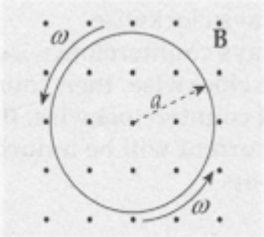
What is the potential difference between points a and b?

2. A small, circular loop of wire (radius r) is placed on an insulating stand inside a hollow solenoid of radius R. The solenoid has n turns per unit length and carries a current I. If the current in the solenoid is decreased at a steady rate of a (A/s), determine the induced emf, $\mathcal{E}$, and the direction of the induced current in the loop.

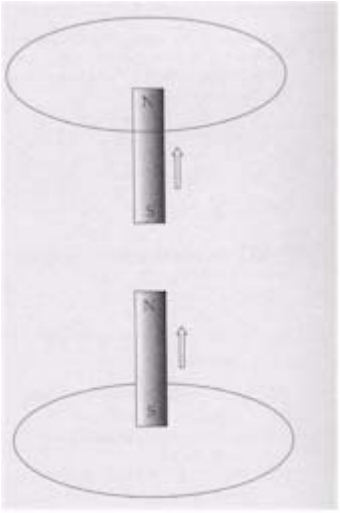


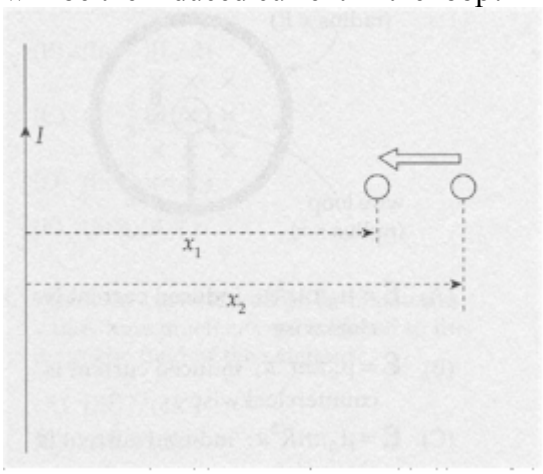
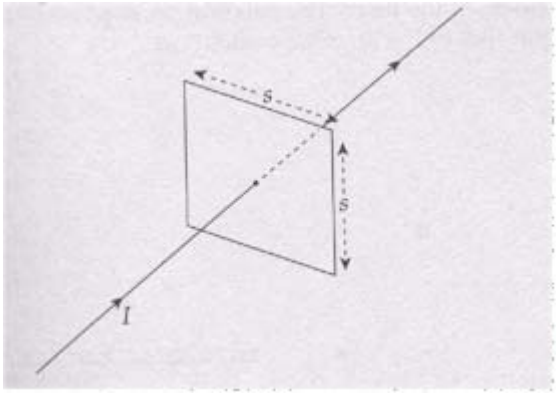
3. A circular disk of radius a is rotating at a constant angular speed ω in a uniform magnetic field, **B**, which is directed out of the page.

Determine the induced emf, $\mathcal{E}$, between the center of the disk and the rim.

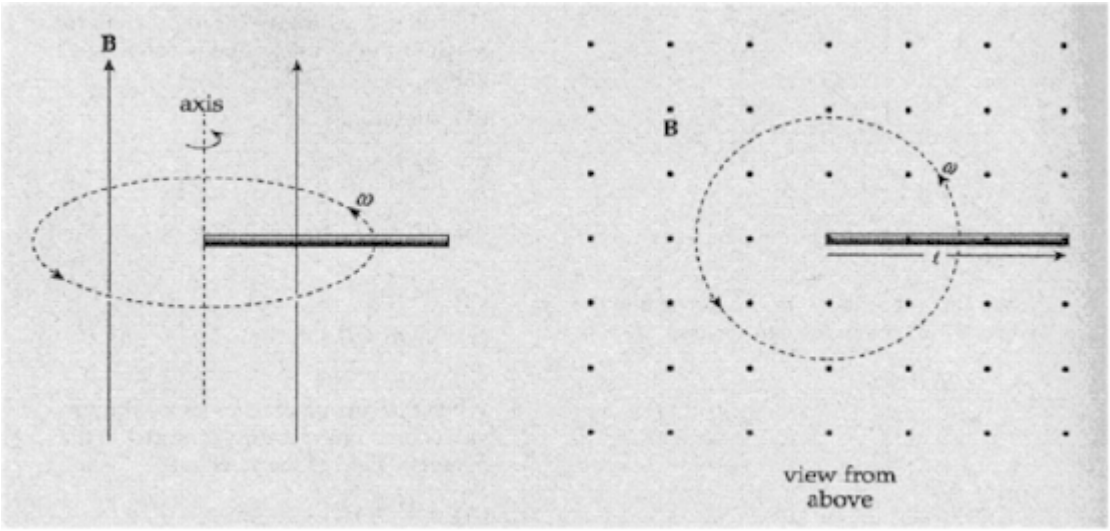


4. A permanent bar magnet is pulled upward with a constant velocity through a loop of wire. Describe the direction of the induced current.



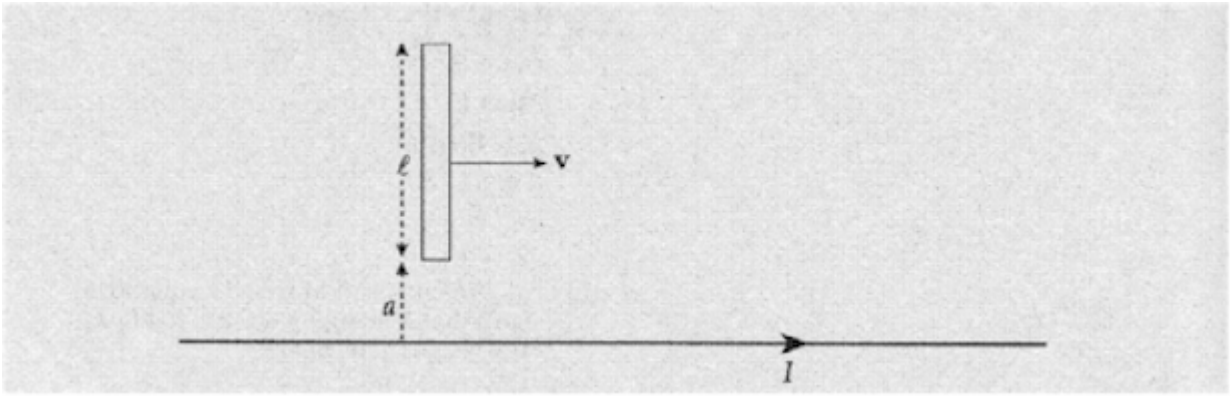
5. A small circular loop of wire (radius *r*) in the plane of a long, straight wire that carries a current *I*. The resistance of the loop is *R*. If the loop is moved from x_2 to x_1 in *t* seconds, what will be the induced current in the loop?  	6. A square loop of wire (side length = *s*) surround a long, straight wire such that the wire passes through the center of the square. Determine the current induced in the square loop 
A circuit contains a solenoid of inductance *L* in series with a resistor of resistance *R* and a battery with terminal voltage $\mathcal{E}$. At time *t=0*, a switch is closed and the circuit is completed. State your answers for 7-9 in terms of *L, R*, and $\mathcal{E}$.	7. How long does it take for the current to reach ¾ of its maximum (steady-state) value?
8. When the current reaches its maximum value, how much energy is stored in the magnetic field of the solenoid?	9. When the current reaches its maximum value, what is the total magnetic flux through the solenoid?

10. The diagram shows two views of a metal rod of length l rotating with constant angular speed ω about an axis that is in the plane of the page. The rotation takes place in a uniform magnetic field **B** whose direction is parallel to the angular velocity.



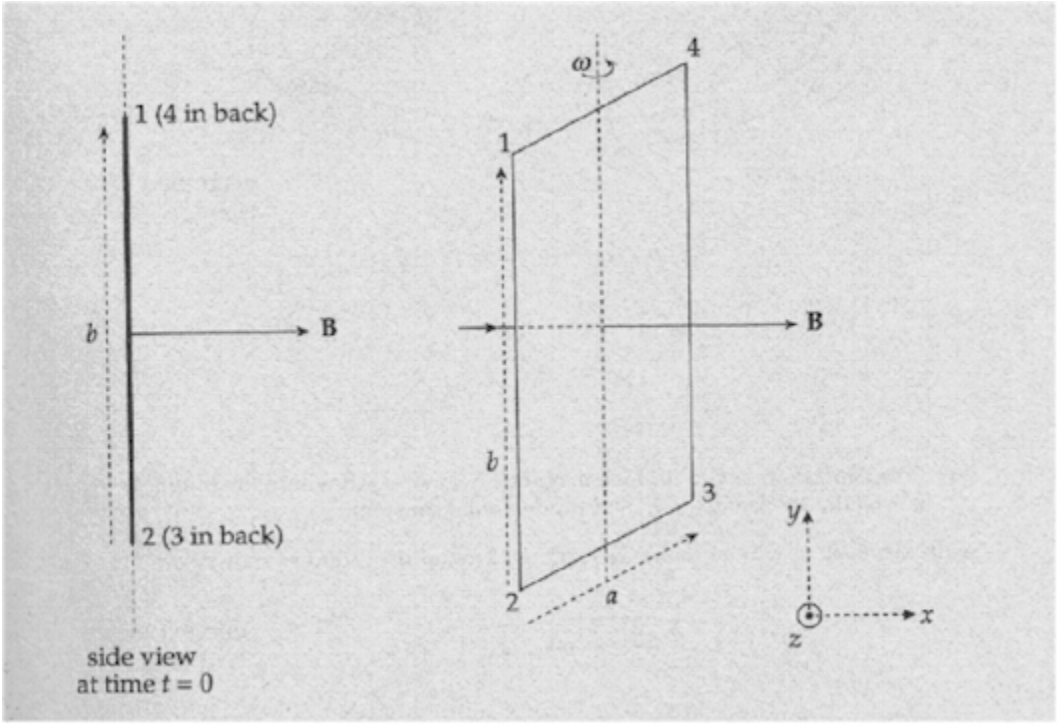
a) What is the emf induced between the ends of the rod?
b) What is the polarity (+ or -) of the rotating end?

In the following diagram, a metal rod of length l moves with constant velocity **v** parallel to a long, straight wire carrying a steady current I. The lower end of the rod maintains a distance of a from the straight wire.



c) What is the emf induced between the ends of the rod?
d) What is the polarity (+ or -) of the end that is farther from the straight wire?

11. A rectangular loop of wire (sides length a and b) rotates with constant angular speed ω in a uniform magnetic field **B**. At time $t=0$, the plane of the loop is perpendicular to **B**. The magnetic field **B** is directed to the right (in the $+x$ direction), and the rotation axis is the y axis (with ω in the $+y$ direction) and the four corners of the loop are labeled 1, 2, 3, and 4. Express your answers in terms of a, b, ω, **B**, and fundamental constants.



(a) Find the formula that gives the magnetic flux through the loop as a function of time, t.

(b) Find a formula that gives the emf induced in the loop as a function of time, t.

(c) If the total resistance of the loop is R, what is the current induced in the loop?

(d) When $\omega t = \frac{1}{2}\pi$, is the induced current in the loop directed from Point 1 to Point 2 ($-y$ direction) or from Point 2 to Point 1 ($+y$ direction)?

(e) Find the rate at which energy is dissipated (as joule heat) in the wires that comprise the loop, and the amount of energy dissipated per revolution.

(f) Find the external torque required to keep the loop rotating at the constant angular speed ω.