Practice Induction Problems

1.

A 0.75-m aluminum bar is held with its length parallel to the east-west direction and dropped from a bridge. Just before the bar hits the river below, its speed is 23 m/s, and the emf induced across its length is 6.40×10^{-4} V. Assume the horizontal component of the earth's magnetic field at the location of the bar points directly north.

(a) Determine the magnitude of the horizontal component of the earth's magnetic field.

[ ] 3.71e-05 T

(b) State whether the east end or the west end of the bar is positive.

- East end of the bar is positive.
- West end of the bar is positive.

2.

Near San Francisco, where the vertically downward component of the earth's magnetic field is 4.7×10^{-5} T, a car is traveling forward at 27 m/s. The width of the car is 1.8 m.

(a) Find the emf induced between the two sides of the car.

[ ] 0.00228 V

(b) Which side of the car is positive—the driver's side or the passenger's side?

- driver's side
- passenger's side

3.

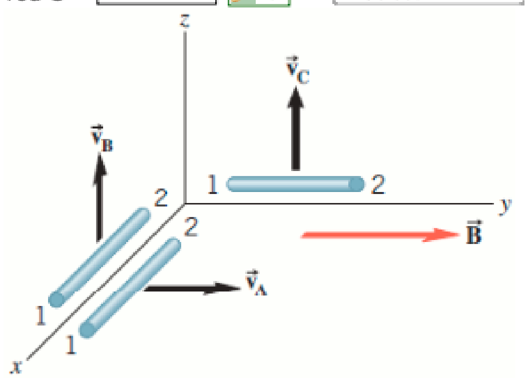
In 1996, NASA performed an experiment called the Tethered Satellite experiment. In this experiment a 1.90×10^{4}-m length of wire was let out by the space shuttle *Atlantis* to generate a motional emf. The shuttle had an orbital speed of 7.80×10^{3} m/s, and the magnitude of the earth's magnetic field at the location of the wire was 4.70×10^{-5} T. If the wire had moved perpendicular to the earth's magnetic field, what would have been the motional emf generated between the ends of the wire?

[ ] 6970 V

4.

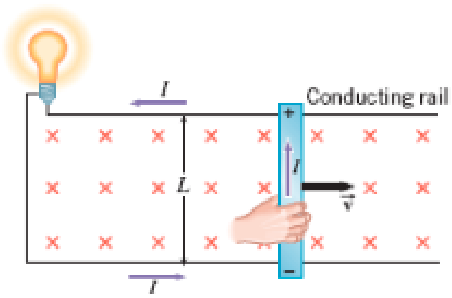
The drawing shows three identical rods (A, B, and C) moving in different planes. A constant magnetic field of magnitude 3.50 T is directed along the $+y$ axis. The length of each rod is L = 1.3 m, and the rods each have the same speed, $v_A = v_B = v_C$ = 2.6 m/s. For each rod, find the magnitude of the motional emf, and indicate which end (1 or 2) of the rod is positive.

rod A		0 V	---Select---	no emf in rod
rod B		11.8 V	---Select---	End 2 is positive.
rod C		0 V	---Select---	no emf in rod



5.

Two circuits contain an emf produced by a moving metal rod, like that shown in the drawing. The speed of the rod is the same in each circuit, but the bulb in circuit 1 has one-half the resistance of the bulb in circuit 2. The circuits are otherwise identical. The resistance of the light bulb in circuit 1 is 165 Ω, and that in circuit 2 is 330 Ω.



(a) Determine the ratio $\mathcal{E}_1/\mathcal{E}_2$ of the emfs.

$\frac{\mathcal{E}_1}{\mathcal{E}_2}$ = ______ 1

(b) Determine the ratio I_1/I_2 of the currents in the circuits.

$\frac{I_1}{I_2}$ = ______ 2

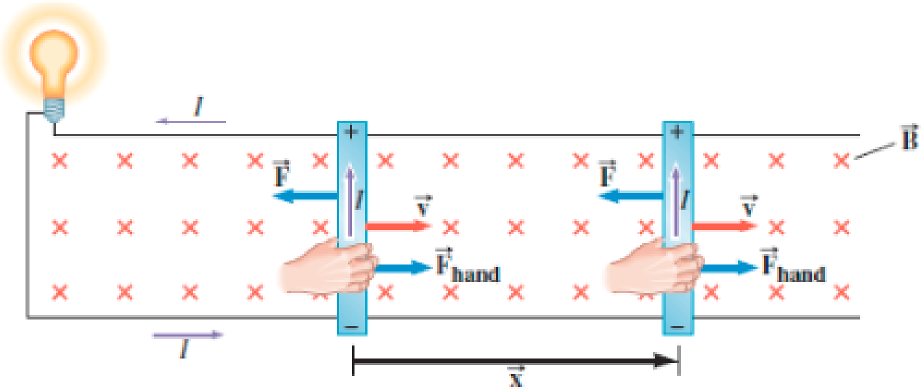
(c) If the speed of the rod in circuit 1 were twice that in circuit 2, what would be the ratio P_1/P_2 of the powers in the circuits?

$\frac{P_1}{P_2}$ = ______ 8

6.

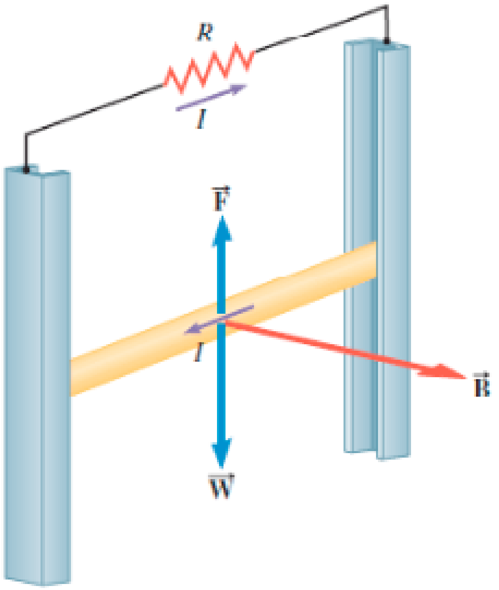
Suppose that the magnetic field in the figure below has a magnitude of 1.1 T, the rod has a length of 0.83 m, and the hand keeps the rod moving to the right at a constant speed of 3.9 m/s. If the current in the circuit is 0.039 A, what is the average power being delivered to the circuit by the hand?

[ ] 0.139 W



7.

A conducting rod slides down between two frictionless vertical copper tracks at a constant speed of 3.8 m/s perpendicular to a 0.49-T magnetic field. The resistance of the rod and tracks is negligible. The rod maintains electrical contact with the tracks at all times and has a length of 1.5 m. A 0.69-Ω resistor is attached between the tops of the tracks.



(a) What is the mass of the rod?

[ ] 0.304 kg

(b) Find the change in the gravitational potential energy that occurs in a time of 0.20 s.

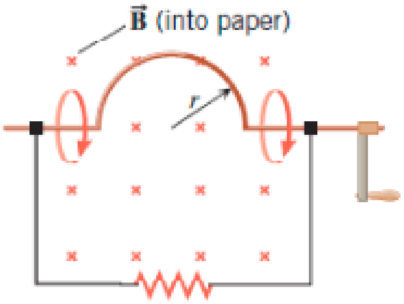
[ ] -2.26 J

(c) Find the electrical energy dissipated in the resistor in 0.20 s.

[ ] 2.26 J

8.

Starting from the position indicated in the drawing, the semicircular piece of wire rotates through half a revolution in the direction shown.



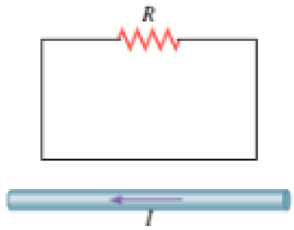
Which end of the resistor is positive—the left or the right end?

- the left end
- the right end

9.

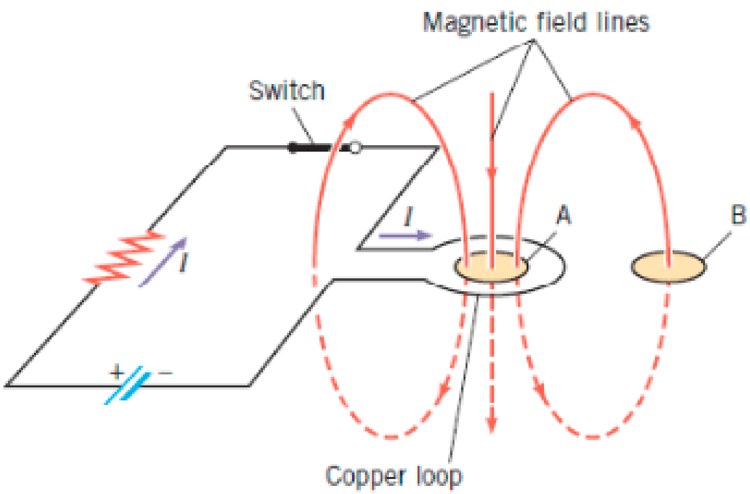
The drawing shows a straight wire carrying a current I. Above the wire is a rectangular loop that contains a resistor R. If the current I is decreasing in time, what is the direction of the induced current through the resistor R—left-to-right or right-to-left? If the induced current goes from left to right through the resistor, type the letters "LTR" in the box below. If the current goes from right to left through the resistor, type the letters "RTL" in the box.

Direction of induced current = LTR



10.

The drawing depicts a copper loop lying flat on a table (not shown) and connected to a battery via a closed switch. The current I in the loop generates the magnetic field lines shown in the drawing. The switch is then opened and the current goes to zero. There are also two smaller conducting loops A and B lying flat on the table, but not connected to batteries.



Determine the direction of the induced current in loop A and loop B. Specify the direction of each induced current to be clockwise or counterclockwise when viewed from above the table.

loop A ---Select--- clockwise

loop B ---Select--- counterclockwise