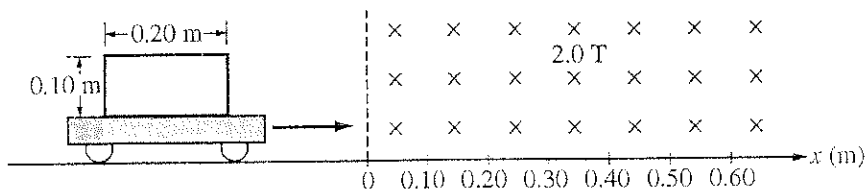


B Induction Problems ^{FR}

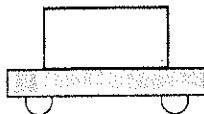
2010 AP[®] PHYSICS B FREE-RESPONSE QUESTIONS



6. (10 points)

The plastic cart shown in the figure above has mass 2.5 kg and moves with negligible friction on a horizontal surface. Attached to the cart is a rigid rectangular loop of wire that is 0.10 m by 0.20 m, has resistance 4.0Ω , and has a mass that is negligible compared to the mass of the cart. The plane of the rectangular loop is parallel to the plane of the page. A uniform magnetic field of 2.0 T, perpendicular to and directed into the plane of the page, starts at $x = 0$, as shown above.

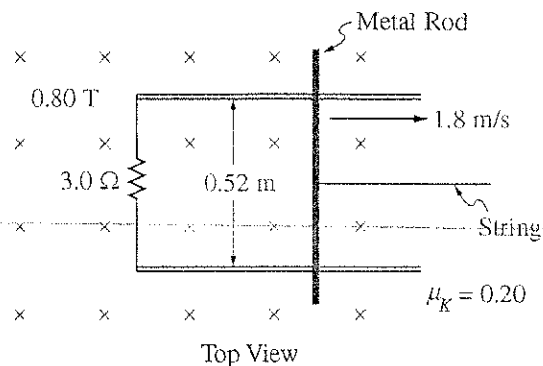
- (a) On the figure below, indicate the direction of the induced current in the loop when its front edge is at $x = 0.12$ m.



Justify your answer.

- (b) When the front edge of the rectangular loop is at $x = 0.12$ m, its speed is 3.0 m/s. Calculate the following for that instant.
- The magnitude of the induced current in the rectangular loop of wire
 - The magnitude of the net force on the loop
- (c) At a later time, the cart and loop are completely inside the magnetic field. Determine the magnitude of the net force on the loop at that time. Justify your answer.

2009 AP[®] PHYSICS B FREE-RESPONSE QUESTIONS



3. (15 points)

A metal rod of mass 0.22 kg lies across two parallel conducting rails that are a distance of 0.52 m apart on a tabletop, as shown in the top view above. A 3.0Ω resistor is connected across the left ends of the rails. The rod and rails have negligible resistance but significant friction with a coefficient of kinetic friction of 0.20. There is a magnetic field of 0.80 T perpendicular to the plane of the tabletop. A string pulls the metal rod to the right with a constant speed of 1.8 m/s.

- Calculate the magnitude of the current induced in the loop formed by the rod, the rails, and the resistor.
- Calculate the magnitude of the force required to pull the rod to the right with constant speed.
- Calculate the energy dissipated in the resistor in 2.0 s.
- Calculate the work done by the string pulling the rod in 2.0 s.
- Compare your answers to parts (c) and (d). Provide a physical explanation for why they are equal or unequal.