1. Use Lenz’s law to answer the following questions concerning the direction of induced currents:

   (a) What is the direction of the induced current in resistor R shown in Figure (a) when the bar magnet is moved to the left? (0.5/5)

   (b) What is the direction of the current induced in the resistor R right after the switch S in Figure (b) is closed? (0.5/5)

   (c) What is the direction of the induced current in R when the current I in Figure (c) decreases rapidly to zero? (0.5/5)

   (d) A copper bar is moved to the right while its axis is maintained in a direction perpendicular to a magnetic field, as shown in Figure (d). If the top of the bar becomes positive relative to the bottom, what is the direction of the magnetic field? (0.5/5)

Solution:
The solutions are drawn in green color.
2. A conducting rod of length \( l = 35.0 \text{ cm} \) is free to slide on two parallel conducting bars, as shown in Figure. Two resistors \( R_1 = 2.00 \Omega \) and \( R_2 = 5.00 \Omega \) are connected across the ends of the bars to form a loop. A constant magnetic field \( B = 2.50 \text{ T} \) is directed perpendicular into the page. An external agent pulls the rod to the left with a constant speed of \( v = 8.00 \text{ m/s} \). Find

(a) the currents and their directions in both resistors. Draw the directions of currents with arrows. (directions: 0.5/5; magnitudes of currents: 1/5 )

(b) the total power delivered to the resistance of the circuit. (0.5/5)

(c) the magnitude of the applied force that is needed to move the rod with this constant velocity. (0.5/5)

(d) the power delivered by the magnetic force. (0.5/5)

Solution:

(a) The currents are drawn in green arrows.

\[
\varepsilon = lvB = 0.35 \times 8 \times 2.5 = 7(V).
\]

\[
I_1 = \frac{\varepsilon}{R_1} = \frac{7}{2} = 3.5(A)
\]

\[
I_2 = \frac{\varepsilon}{R_2} = \frac{7}{5} = 1.4(A)
\]

(b)

\[
P_{\text{dissipation}} = I_1^2R_1 + I_2^2R_2 = 3.5^2 \times 2 + 1.4^2 \times 5 = 34.3(W)
\]

(c) There are two different approaches.

i. Method 1 (energy conservation):

\[
F_{\text{app}}v = P_{\text{dissipation}} \Rightarrow F_{\text{app}} = P_{\text{dissipation}}/v = 34.3/8 = 4.2875(N)
\]

ii. Method 2 (force equilibrium):

\[
F_{\text{app}} = F_{\text{mag}} = (I_1 + I_2)lB = 4.9 \times 0.35 \times 2.5 = 4.2875(N)
\]

(d) Zero. Magnetic force can not do any work.