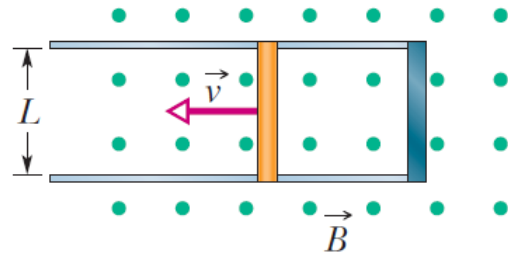3. The conducting rod shown in the figure has length L and is being pulled along horizontal, frictionless conducting rails at a constant velocity $\vec{v}$. The rails are connected at one end with a metal strip. A uniform magnetic field $\vec{B}$, directed out of the page, fills the region in which the rod moves. Assume that $L = 10$ cm, $v = 5.0$ m/s, and $B = 1.2$ T. What are the

(a) magnitude and   [1 mark]
(b) direction (up or down the page) of the emf induced in the rod?   [0.5 marks]
(c) magnitude and   [0.5 marks]
(d) direction of the current in the conducting loop?   [0.5 marks]

Assume that the resistance of the rod is 0.40 Ω and that the resistance of the rails and metal strip is negligibly small.

(e) At what rate is thermal energy being generated in the rod?   [1 mark]
(f) What external force on the rod is needed to maintain $\vec{v}$?   [1.5 marks]
(g) At what rate does this force do work on the rod?   [1 mark]