107. (Second problem of **Cluster**)

(a) With $L = 0.50$ m and $R = 5.00\ \Omega$, we combine Ohm's and Faraday's laws, so that the current magnitude is

$$i = \frac{|\mathcal{E}|}{R} = \frac{BLv}{R} = 0.240 \text{ A} \quad .$$

The direction is counterclockwise, as explained in the solution to the previous problem.

(b) The area in the loop is $A = \frac{1}{2}(L_0 + L)x$ where $x = vt$ and $L_0 = 0.300$ m. But the value of L depends on the distance from the resistor x:

$$\begin{aligned} L &= 30 \text{ cm} + \left(\frac{20 \text{ cm}}{1 \text{ m}}\right) x \\ &= L_0 + 0.200(vt) \end{aligned}$$

where $x = vt$ has been used. Therefore, the area becomes

$$A = L_0\, vt + 0.100\, v^2 t^2 \quad .$$

The induced emf is, from Faraday's law,

$$\mathcal{E} = \frac{d\Phi}{dt} = B\,\frac{dA}{dt} = B\left(L_0\, v + 2(0.100)v^2 t\right)$$

and the induced current is

$$i = \frac{\mathcal{E}}{R} = 0.144 + 1.152t$$

in SI units and is counterclockwise (for reasons given in previous solution).