20.17 To produce a 0.50 A current through 6.0 Ω of resistance, the induced emf in the bar must be: $\mathcal{E} = IR = (0.50 \text{ A})(6.0 \text{ Ω}) = 3.0 \text{ V}$.

But, $v = \frac{\mathcal{E}}{Bl}$, so $v = \frac{3.0 \text{ V}}{(2.5 \text{ T})(1.2 \text{ m})} = 1.00 \text{ m/s}$.

20.21 (a) The top of the loop must behave as a south pole in order to oppose the approaching south pole of the bar magnet. Thus, the current must be clockwise as viewed from above.

(b) After the magnet falls through the loop, the lower side of the loop must act as a south pole to oppose the movement of the north pole of the falling magnet. Thus, the current is counterclockwise as viewed from above.

20.22 The current is left to right.

20.31 (a) Using $\mathcal{E}_{\text{max}} = NBA \omega$, we get:

$$\mathcal{E}_{\text{max}} = (1000)(0.20 \text{ T})(0.10 \text{ m}^2)(120\pi \text{ rad/s}) = 7.5 \times 10^3 \text{ V}.$$ 

(b) $\mathcal{E}_{\text{max}}$ occurs when the flux through the loop is changing the most rapidly. This is when the plane of the loop is parallel to the magnetic field.

20.33 The inductance of a solenoid is $L = \frac{\mu_0 N^2 A}{l}$, where $N$ is the number of turns, $A$ is the cross-sectional area, and $l$ is the length. In this case,

$$L = \frac{(4\pi \times 10^{-7} \text{ N/A}^2)(510)^2[\pi(8.00 \times 10^{-2} \text{ m})^2]}{1.40 \text{ m}} = 4.69 \times 10^{-3} \text{ H} = 4.69 \text{ mH}.$$

20.37 From $\mathcal{E} = \frac{\Delta I}{\Delta t}$, we have: $L = \frac{\mathcal{E}}{\Delta I} = \frac{24.0 \times 10^{-3} \text{ V}}{10.0 \text{ A/s}} = 2.40 \times 10^{-3} \text{ H},$

and from $L = \frac{N \Phi}{I}$, we have: $\Phi = \frac{LI}{N} = \frac{(2.40 \times 10^{-3} \text{ H})(4 \text{ A})}{500}$, or

$$\Phi = 1.92 \times 10^{-5} \text{ T m}^2.$$

20.43 $W = \frac{1}{2} LI^2 = \frac{1}{2}(70.0 \times 10^{-3} \text{ H})(2.00 \text{ A})^2 = 0.140 \text{ J}.$
When the wire is moving downward at speed $v$, an emf, $\mathcal{E} = Blv$, is induced in the wire. The left end of the wire is at a higher potential than the right end. Thus, an induced current, $I = \frac{\mathcal{E}}{R} = \frac{Blv}{R}$, flows counterclockwise around the circuit and right to left through the wire. The magnetic field exerts an upward force of

$$F_m = BIl = \frac{B^2l^2v}{R}$$

on the wire. The wire will reach terminal speed when this force equals the downward gravitation force on the wire. When this occurs, $F_m = mg$,

or

$$\frac{B^2l^2v_t}{R} = mg.$$  

Thus, $v_t = \frac{mgR}{B^2l^2}$. 
