21.4. Set Up: $\mathcal{E} = \left|\frac{\Delta\Phi_B}{\Delta t}\right|$. $\Phi_B = BA\cos\phi$. $\phi = 0°$, A is constant and B is changing.

Solve: (a) $\mathcal{E} = A\frac{\Delta B}{\Delta t} = (0.0900\ \text{m}^2)(0.190\ \text{T/s}) = 0.0171\ \text{V}$.

(b) $I = \frac{\mathcal{E}}{R} = \frac{0.0171\ \text{V}}{0.600\ \Omega} = 0.0285\ \text{A}$.

21.10. Set Up: Apply Faraday's law. Since the loop initially rests on the table and the magnetic field is perpendicular to the table we may assume that the initial magnetic flux is simply $\Phi_B = EA\cos\phi = EA.$ The final flux is zero since the loop is removed from the field.

Solve: (a) $\mathcal{E} = \left|\frac{\Delta\Phi_B}{\Delta t}\right| = \left|\frac{0-(1.5\text{ T})\pi(0.120\text{ m})^2}{2.0\times10^{-3}\text{ s}}\right| = 34\text{ V}.$

(b) According to Lenz's law the induced current will attempt to maintain the upward magnetic field in the loop; thus, the induced current is counterclockwise.

Reflect: The shorter the removal time, the larger the average induced emf.

21.60. Set Up: Apply Faraday's law in the form $\mathcal{E}_{av} = -N\dfrac{\Delta\Phi_B}{\Delta t}$ to calculate the average emf. Apply Lenz's law to calculate the direction of the induced current. $\Phi_B = BA.$ The flux changes because the area of the loop changes.

Solve: (a) $\mathcal{E}_{av} = \left|\dfrac{\Delta\Phi_B}{\Delta t}\right| = B\left|\dfrac{\Delta A}{\Delta t}\right| = B\dfrac{\pi r^2}{\Delta t} = (0.950\text{ T})\dfrac{\pi(0.0650/2\text{ m})^2}{0.250\text{ s}} = 0.0126\text{ V}.$

(b) Since the magnetic field is directed into the page and the magnitude of the flux through the loop is decreasing, the induced current must produce a field that goes into the page to oppose this change. Therefore the current flows from point a through the resistor to point b (which is from point b through the coil to point a).

Reflect: According to Faraday's law there will be an induced emf whenever there is a change in the magnetic flux. This can occur due to a change in B, A, or to a change in the orientation between B and A.