**P31.1** $\varepsilon = \left|\frac{\Delta\Phi_B}{\Delta t}\right| = \frac{\Delta(NBA)}{\Delta t} = \boxed{500 \text{ mV}}$

**P31.3** $\varepsilon = -N\frac{\Delta BA\cos\theta}{\Delta t} = -NB\pi r^2\left(\frac{\cos\theta_f - \cos\theta_i}{\Delta t}\right) = -25.0\left(50.0\times10^{-6}\text{ T}\right)\left[\pi(0.500\text{ m})^2\right]\left(\frac{\cos 180° - \cos 0°}{0.200\text{ s}}\right)$

$\varepsilon = \boxed{+9.82 \text{ mV}}$

**P31.5** Noting unit conversions from $\mathbf{F} = q\mathbf{v}\times\mathbf{B}$ and $U = qV$, the induced voltage is

$$\varepsilon = -N\frac{d(\mathbf{B}\cdot\mathbf{A})}{dt} = -N\left(\frac{0 - B_i A\cos\theta}{\Delta t}\right) = \frac{+200(1.60\text{ T})\left(0.200\text{ m}^2\right)\cos 0°}{20.0\times10^{-3}\text{ s}}\left(\frac{1\text{ N}\cdot\text{s}}{1\text{ T}\cdot\text{C}\cdot\text{m}}\right)\left(\frac{1\text{ V}\cdot\text{C}}{\text{N}\cdot\text{m}}\right) = 3\,200\text{ V}$$

$$I = \frac{\varepsilon}{R} = \frac{3\,200\text{ V}}{20.0\ \Omega} = \boxed{160\text{ A}}$$

**P31.10** $\Phi_B = (\mu_0 n I)A_{\text{solenoid}}$

$$\varepsilon = -N\frac{d\Phi_B}{dt} = -N\mu_0 n\left(\pi r_{\text{solenoid}}^2\right)\frac{dI}{dt}$$

$$\varepsilon = -15.0\left(4\pi\times10^{-7}\text{ T}\cdot\text{m/A}\right)\left(1.00\times10^3\text{ m}^{-1}\right)\pi(0.020\,0\text{ m})^2(600\text{ A/s})\cos(120t)$$

$$\boxed{\varepsilon = -14.2\cos(120t)\text{ mV}}$$

**P31.13** $B = \mu_0 n I = \mu_0 n(30.0\text{ A})\left(1 - e^{-1.60t}\right)$

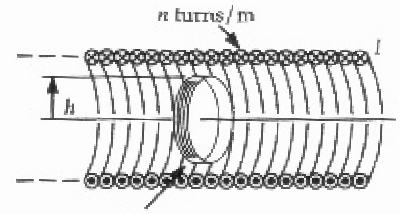

FIG. P31.13

$$\Phi_B = \int B\,dA = \mu_0 n(30.0\text{ A})\left(1 - e^{-1.60t}\right)\int dA$$

$$\Phi_B = \mu_0 n(30.0\text{ A})\left(1 - e^{-1.60t}\right)\pi R^2$$

$$\varepsilon = -N\frac{d\Phi_B}{dt} = -N\mu_0 n(30.0\text{ A})\pi R^2(1.60)e^{-1.60t}$$

$$\varepsilon = -(250)\left(4\pi\times10^{-7}\text{ N/A}^2\right)\left(400\text{ m}^{-1}\right)(30.0\text{ A})\left[\pi(0.060\,0\text{ m})^2\right]1.60\text{ s}^{-1}e^{-1.60t}$$

$$\varepsilon = \boxed{(68.2\text{ mV})e^{-1.60t}\text{ counterclockwise}}$$

**P31.20** $I = \frac{\varepsilon}{R} = \frac{B\ell v}{R}$

$\boxed{v = 1.00\text{ m/s}}$

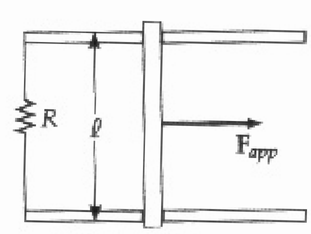

FIG. P31.20

**P32.1** $|\varepsilon| = L\frac{\Delta I}{\Delta t} = \left(3.00\times10^{-3}\text{ H}\right)\left(\frac{1.50\text{ A} - 0.200\text{ A}}{0.200\text{ s}}\right) = 1.95\times10^{-2}\text{ V} = \boxed{19.5\text{ mV}}$

**P32.12** $L = \frac{N\Phi_B}{I} = \frac{NBA}{I} \approx \frac{NA}{I} \cdot \frac{\mu_0 NI}{2\pi R} = \boxed{\frac{\mu_0 N^2 A}{2\pi R}}$

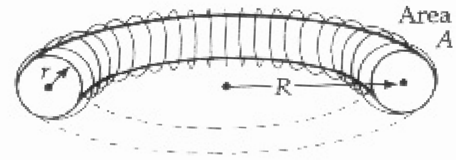


FIG. P32.12

**P32.15** (a) At time $t$, $I(t) = \frac{\varepsilon\left(1 - e^{-t/\tau}\right)}{R}$

where $\tau = \frac{L}{R} = 0.200 \text{ s}$.

After a long time, $I_{max} = \frac{\varepsilon\left(1 - e^{-\infty}\right)}{R} = \frac{\varepsilon}{R}$.

At $I(t) = 0.500 I_{max}$ $(0.500)\frac{\varepsilon}{R} = \frac{\varepsilon\left(1 - e^{-t/0.200 \text{ s}}\right)}{R}$

so $0.500 = 1 - e^{-t/0.200 \text{ s}}$.

Isolating the constants on the right, $\ln\left(e^{-t/0.200 \text{ s}}\right) = \ln(0.500)$

and solving for $t$, $-\frac{t}{0.200 \text{ s}} = -0.693$

or $t = \boxed{0.139 \text{ s}}$.

(b) Similarly, to reach 90% of $I_{max}$, $0.900 = 1 - e^{-t/\tau}$

and $t = -\tau \ln(1 - 0.900)$.

Thus, $t = -(0.200 \text{ s})\ln(0.100) = \boxed{0.461 \text{ s}}$.

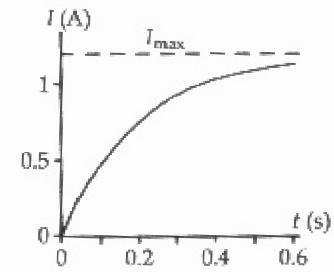


FIG. P32.15

**P32.29** $L = \frac{N\Phi_B}{I} = \frac{200\left(3.70 \times 10^{-4}\right)}{1.75} = 42.3 \text{ mH}$ so $U = \frac{1}{2}LI^2 = \frac{1}{2}(0.423 \text{ H})(1.75 \text{ A})^2 = \boxed{0.0648 \text{ J}}$.

**P32.48** When the switch has been closed for a long time, battery, resistor, and coil carry constant current $I_{max} = \frac{\varepsilon}{R}$. When the switch is opened, current in battery and resistor drops to zero, but the coil carries this same current for a moment as oscillations begin in the $LC$ loop.

We interpret the problem to mean that the voltage amplitude of these oscillations is $\Delta V$, in $\frac{1}{2}C(\Delta V)^2 = \frac{1}{2}LI_{max}^2$.

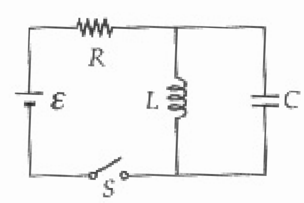


FIG. P32.50

Then, $L = \frac{C(\Delta V)^2}{I_{max}^2} = \frac{C(\Delta V)^2 R^2}{\varepsilon^2} = \frac{\left(0.500 \times 10^{-6} \text{ F}\right)(150 \text{ V})^2 (250 \ \Omega)^2}{(50.0 \text{ V})^2} = \boxed{0.281 \text{ H}}$.

**P32.51** (a) $f = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{(0.0820 \text{ H})\left(17.0 \times 10^{-6} \text{ F}\right)}} = \boxed{135 \text{ Hz}}$

(b) $Q = Q_{max} \cos \omega t = (180 \ \mu\text{C}) \cos(847 \times 0.00100) = \boxed{119 \ \mu\text{C}}$

(c) $I = \frac{dQ}{dt} = -\omega Q_{max} \sin \omega t = -(847)(180) \sin(0.847) = \boxed{-114 \text{ mA}}$