PHYS 1304 Ch 31 solutions, 7th Ed.

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

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

P31.7 Noting unit conversions from $\mathbf{F} = q\mathbf{v}\times\mathbf{B}$ and $U = qV$, the induced voltage is

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

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

P31.11 $\Phi_B = (\mu_0 n I)A_{\text{solenoid}}$

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

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

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

P31.15 $B = \mu_0 n I = \mu_0 n(30.0\ \text{A})\left(1 - e^{-1.60t}\right)$

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

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

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

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

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

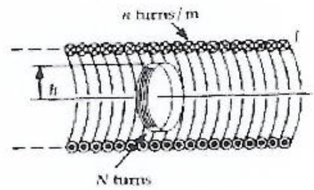

FIG. P31.13

P31.21 $I = \dfrac{\varepsilon}{R} = \dfrac{B\ell v}{R}$

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

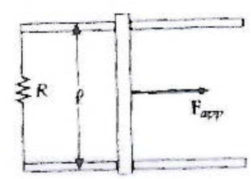

FIG. P31.20

P31.29 (a) The force on the side of the coil entering the field (consisting of N wires) is

$$F = N(ILB) = N(IwB).$$

The induced emf in the coil is

$$|\varepsilon| = N\frac{d\Phi_B}{dt} = N\frac{d(Bwx)}{dt} = NBwv.$$

so the current is $I = \dfrac{|\varepsilon|}{R} = \dfrac{NBwv}{R}$ counterclockwise.

The force on the leading side of the coil is then:

$$F = N\left(\frac{NBwv}{R}\right)wB = \boxed{\frac{N^2B^2w^2v}{R}\ \text{to the left}}.$$

(b) Once the coil is entirely inside the field, $\Phi_B = NBA = \text{constant}$,

so $\varepsilon = 0$, $I = 0$, and $F = \boxed{0}$.

(c) As the coil starts to leave the field, the flux *decreases* at the rate Bwv, so the magnitude of the current is the same as in part (a), but now the current is clockwise. Thus, the force exerted on the trailing side of the coil is:

$$F = \boxed{\frac{N^2B^2w^2v}{R}\ \text{to the left again}}.$$

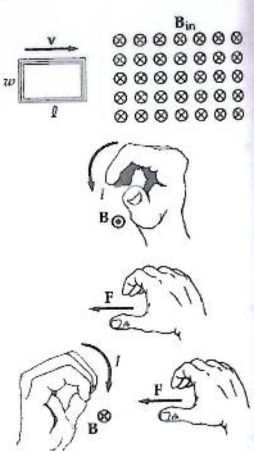

FIG. P31.29

P31.32 (a) $\frac{dB}{dt} = 6.00t^2 - 8.00t$ $\qquad |\varepsilon| = \frac{d\Phi_B}{dt}$

At $t = 2.00$ s, $\qquad E = \frac{\pi R^2 (dB/dt)}{2\pi r_2} = \frac{8.00\pi(0.025\,0)^2}{2\pi(0.050\,0)}$

$F = qE = \boxed{8.00 \times 10^{-21}\ \text{N}}$

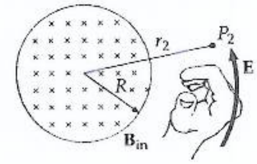

FIG. P31.32

(b) When $6.00t^2 - 8.00t = 0$, $\quad t = \boxed{1.33\ \text{s}}$

P31.36 For the alternator, $\omega = (3\,000\ \text{rev/min})\left(\frac{2\pi\ \text{rad}}{1\ \text{rev}}\right)\left(\frac{1\ \text{min}}{60\ \text{s}}\right) = 314\ \text{rad/s}$

$$\varepsilon = -N\frac{d\Phi_B}{dt} = -250\frac{d}{dt}\left[\left(2.50 \times 10^{-4}\ \text{T}\cdot\text{m}^2\right)\cos(314t/\text{s})\right] = +250\left(2.50 \times 10^{-4}\ \text{T}\cdot\text{m}^2\right)(314/\text{s})\sin(314t)$$

(a) $\boxed{\varepsilon = (19.6\ \text{V})\sin(314t)}$

(b) $\boxed{\varepsilon_{\max} = 19.6\ \text{V}}$

P31.38 As the magnet rotates, the flux through the coil varies sinusoidally in time with $\Phi_B = 0$ at $t = 0$. Choosing the flux as positive when the field passes from left to right through the area of the coil, the flux at any time may be written as $\Phi_B = -\Phi_{\max}\sin\omega t$ so the induced emf is given by

$$\varepsilon = -\frac{d\Phi_B}{dt} = \omega\Phi_{\max}\cos\omega t.$$

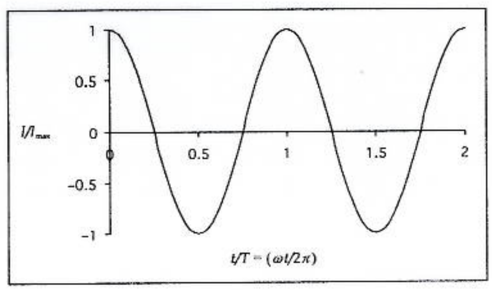

FIG. P31.38

The current in the coil is then $I = \frac{\varepsilon}{R} = \frac{\omega\Phi_{\max}}{R}\cos\omega t = \boxed{I_{\max}\cos\omega t}$.

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