5. (a) All the energy in the circuit resides in the capacitor when it has its maximum charge. The current is then zero. If Q is the maximum charge on the capacitor, then the total energy is

$$U = \frac{Q^2}{2C} = \frac{\left(2.90\times10^{-6}\,\mathrm{C}\right)^2}{2\left(3.60\times10^{-6}\,\mathrm{F}\right)} = 1.17\times10^{-6}\,\mathrm{J}.$$

(b) When the capacitor is fully discharged, the current is a maximum and all the energy resides in the inductor. If I is the maximum current, then $U = LI^2/2$ leads to

$$I = \sqrt{\frac{2U}{L}} = \sqrt{\frac{2\left(1.168\times10^{-6}\,\mathrm{J}\right)}{75\times10^{-3}\,\mathrm{H}}} = 5.58\times10^{-3}\,\mathrm{A}.$$

7. (a) The mass m corresponds to the inductance, so m = 1.25 kg.

(b) The spring constant k corresponds to the reciprocal of the capacitance. Since the total energy is given by $U = Q^2/2C$, where Q is the maximum charge on the capacitor and C is the capacitance,

$$C = \frac{Q^2}{2U} = \frac{\left(175 \times 10^{-6}\ \text{C}\right)^2}{2\left(5.70 \times 10^{-6}\ \text{J}\right)} = 2.69 \times 10^{-3}\ \text{F}$$

and

$$k = \frac{1}{2.69 \times 10^{-3}\ \text{m/N}} = 372\ \text{N/m}.$$

(c) The maximum displacement corresponds to the maximum charge, so $x_{\text{max}} = 1.75 \times 10^{-4}$ m.

(d) The maximum speed v_{max} corresponds to the maximum current. The maximum current is

$$I = Q\omega = \frac{Q}{\sqrt{LC}} = \frac{175 \times 10^{-6}\ \text{C}}{\sqrt{(1.25\ \text{H})\left(2.69 \times 10^{-3}\ \text{F}\right)}} = 3.02 \times 10^{-3}\ \text{A}.$$

Consequently, $v_{\text{max}} = 3.02 \times 10^{-3}$ m/s.

17. (a) We compare this expression for the current with $i = I\sin(\omega t+\phi_0)$. Setting $(\omega t+\phi) = 2500t + 0.680 = \pi/2$, we obtain $t = 3.56 \times 10^{-4}$ s.

(b) Since $\omega = 2500$ rad/s $= (LC)^{-1/2}$,

$$L = \frac{1}{\omega^2 C} = \frac{1}{(2500\,\text{rad/s})^2(64.0\times10^{-6}\,\text{F})} = 2.50\times10^{-3}\,\text{H}.$$

(c) The energy is

$$U = \frac{1}{2}LI^2 = \frac{1}{2}(2.50\times10^{-3}\,\text{H})(1.60\,\text{A})^2 = 3.20\times10^{-3}\,\text{J}.$$

18. (a) Since the percentage of energy stored in the electric field of the capacitor is $(1-75.0\%)=25.0\%$, then

$$\frac{U_E}{U}=\frac{q^2/2C}{Q^2/2C}=25.0\%$$

which leads to $q/Q=\sqrt{0.250}=0.500$.

(b) From

$$\frac{U_B}{U}=\frac{Li^2/2}{LI^2/2}=75.0\%,$$

we find $i/I=\sqrt{0.750}=0.866$.

25. Since $\omega \approx \omega'$, we may write $T = 2\pi/\omega$ as the period and $\omega = 1/\sqrt{LC}$ as the angular frequency. The time required for 50 cycles (with 3 significant figures understood) is

$$t = 50T = 50\left(\frac{2\pi}{\omega}\right) = 50\left(2\pi\sqrt{LC}\right) = 50\left(2\pi\sqrt{\left(220\times10^{-3}\,\text{H}\right)\left(12.0\times10^{-6}\,\text{F}\right)}\right)$$
$$= 0.5104\,\text{s}.$$

The maximum charge on the capacitor decays according to $q_{\max} = Qe^{-Rt/2L}$ (this is called the *exponentially decaying amplitude* in §31-5), where Q is the charge at time $t = 0$ (if we take $\phi = 0$ in Eq. 31-25). Dividing by Q and taking the natural logarithm of both sides, we obtain

$$\ln\left(\frac{q_{\max}}{Q}\right) = -\frac{Rt}{2L}$$

which leads to

$$R = -\frac{2L}{t}\ln\left(\frac{q_{\max}}{Q}\right) = -\frac{2\left(220\times10^{-3}\,\text{H}\right)}{0.5104\,\text{s}}\ln\left(0.99\right) = 8.66\times10^{-3}\ \Omega\,.$$

26. The charge q after N cycles is obtained by substituting $t = NT = 2\pi N/\omega'$ into Eq. 31-25:

$$\begin{aligned} q &= Qe^{-Rt/2L}\cos(\omega' t+\phi) = Qe^{-RNT/2L}\cos\left[\omega'(2\pi N/\omega')+\phi\right] \\ &= Qe^{-RN\left(2\pi\sqrt{L/C}\right)/2L}\cos(2\pi N+\phi) \\ &= Qe^{-N\pi R\sqrt{C/L}}\cos\phi. \end{aligned}$$

We note that the initial charge (setting $N = 0$ in the above expression) is $q_0 = Q\cos\phi$, where $q_0 = 6.2\ \mu$C is given (with 3 significant figures understood). Consequently, we write the above result as $q_N = q_0\exp\left(-N\pi R\sqrt{C/L}\right)$.

(a) For $N = 5$, $q_5 = (6.2\,\mu\text{C})\exp\left(-5\pi(7.2\,\Omega)\sqrt{0.0000032\,\text{F}/12\,\text{H}}\right) = 5.85\,\mu\text{C}$.

(b) For $N = 10$, $q_{10} = (6.2\,\mu\text{C})\exp\left(-10\pi(7.2\,\Omega)\sqrt{0.0000032\,\text{F}/12\,\text{H}}\right) = 5.52\,\mu\text{C}$.

(c) For $N = 100$, $q_{100} = (6.2\,\mu\text{C})\exp\left(-100\pi(7.2\,\Omega)\sqrt{0.0000032\,\text{F}/12\,\text{H}}\right) = 1.93\,\mu\text{C}$.