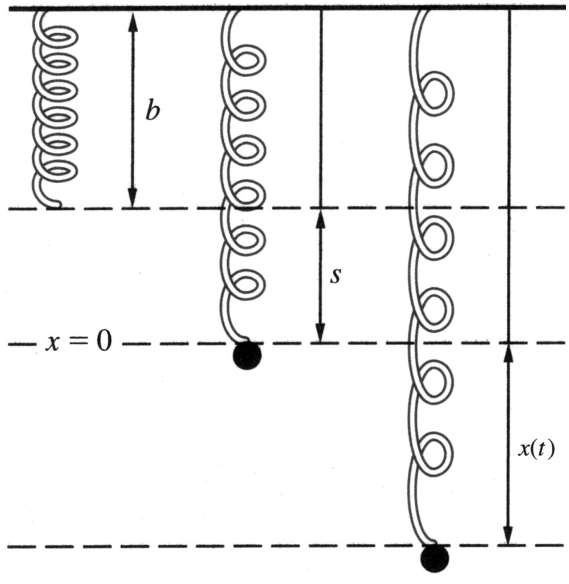

FIGURE 5.1 A spring-mass system.

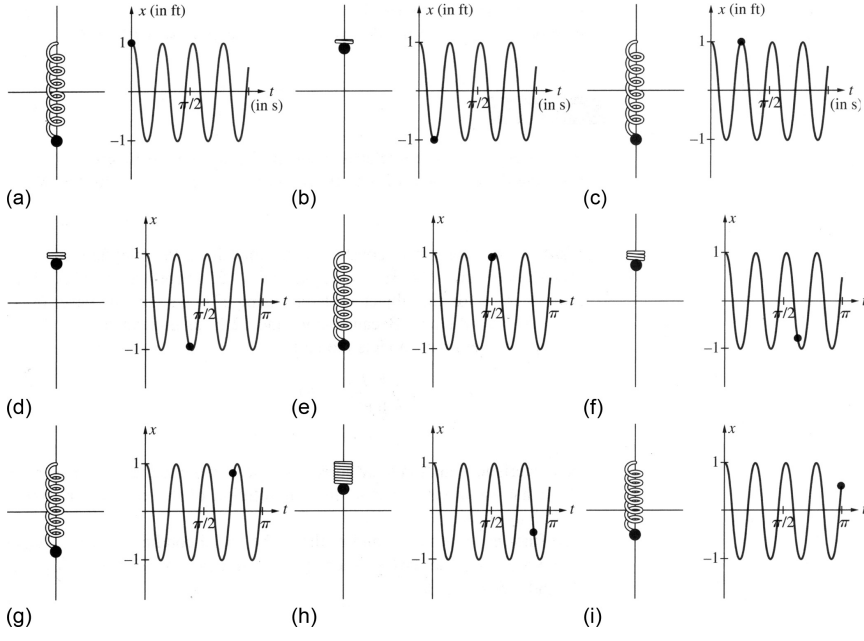

FIGURE 5.2 Simple harmonic motion.

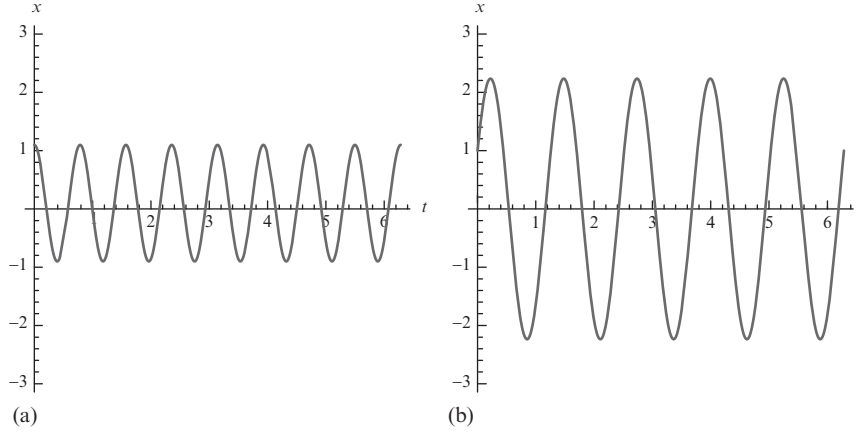

FIGURE 5.3 Two plots of simple harmonic motion. (a) (on the left) is for Example 5.1.5 while (b) (on the right) is for Example 5.1.5.

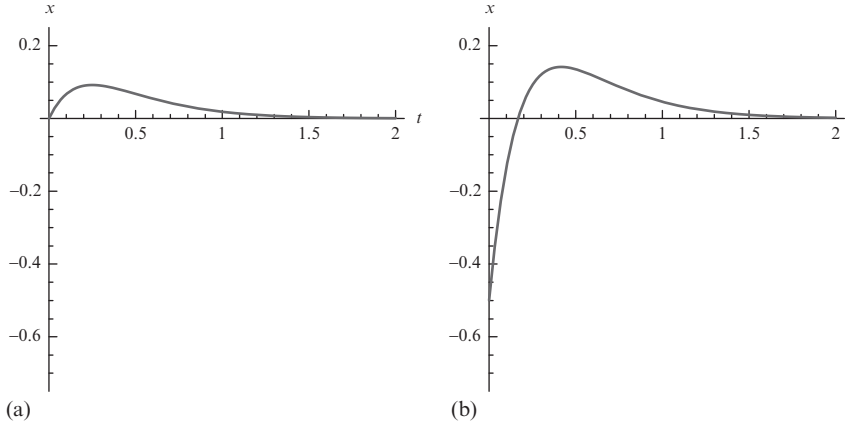

FIGURE 5.4 (a) On the left and (b) on the right illustrate critically damped motion.

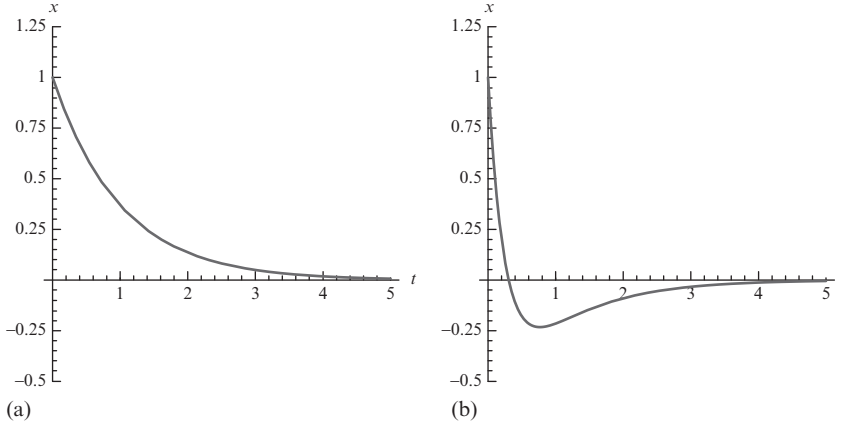

FIGURE 5.5 (a) On the left and (b) on the right illustrate overdamped motion.

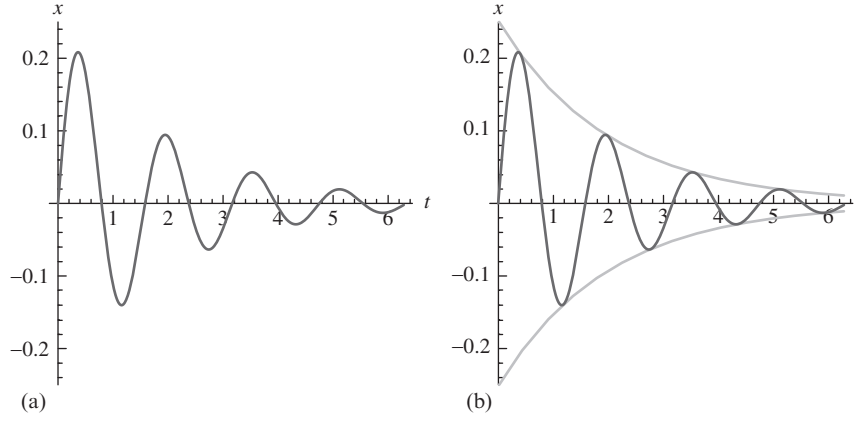

FIGURE 5.6 (a) On the left and (b) on the right illustrate overdamped motion.

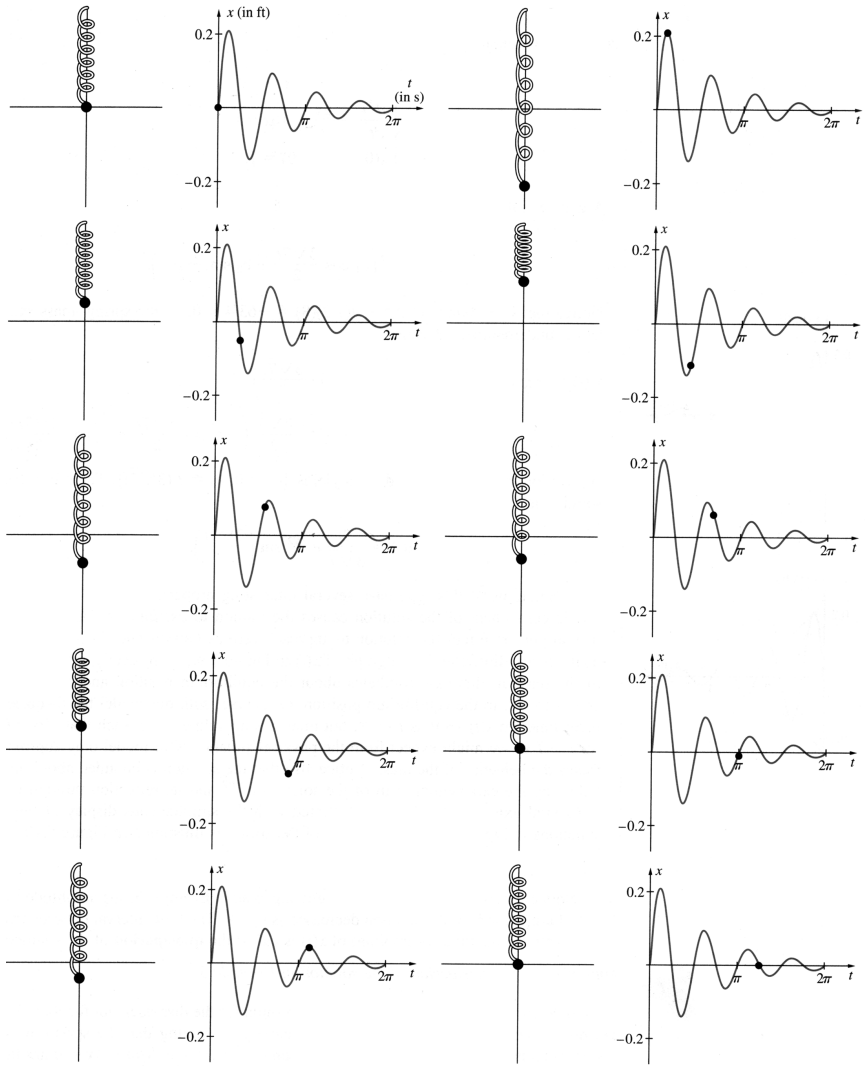

FIGURE 5.7 An underdamped spring.

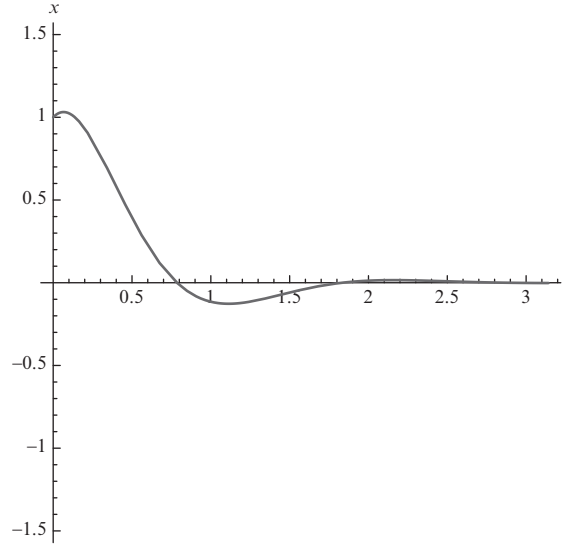

FIGURE 5.8 Plot of $x(t) = \sqrt{2}e^{-2t}\cos(3t - \phi)$, $\phi = \pi/4$.

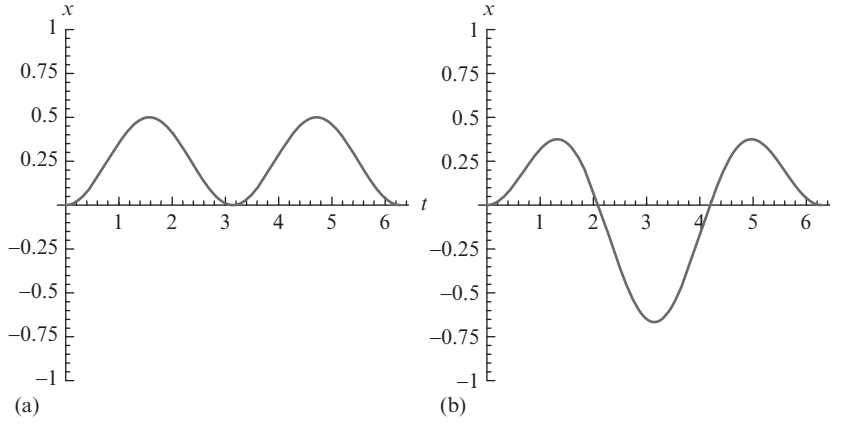

FIGURE 5.9 (a) Graph of $x(t) = \frac{1}{4}\cos t + \frac{1}{4}$. (b) Graph of $x(t) = -\frac{1}{3}\cos 2t + \frac{1}{3}\cos t$.

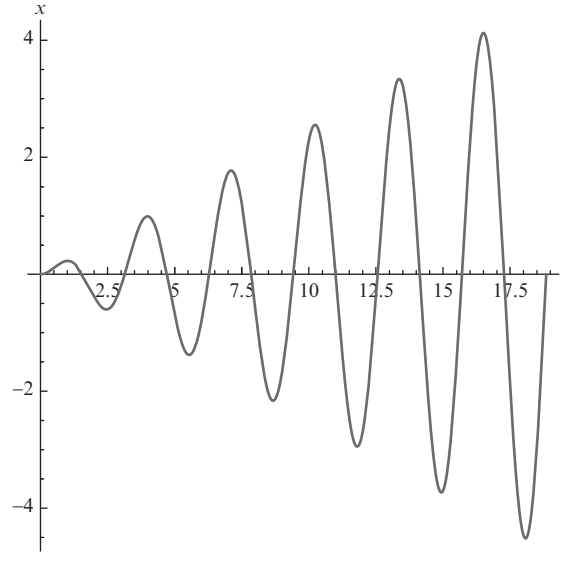

FIGURE 5.10 Resonance.

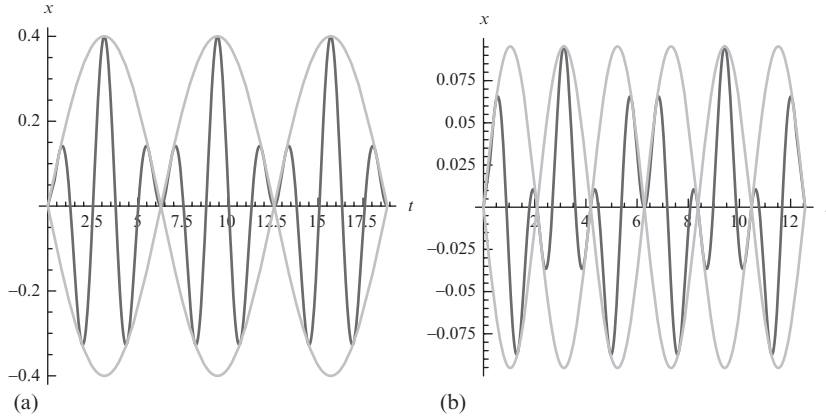

FIGURE 5.11 (a) On the left and (b) on the right. Envelope functions help us see oscillations that are called *beats* because of the periodic variation of amplitude. The plot of the solution is darkest; the plots of the envelope solutions are lighter.

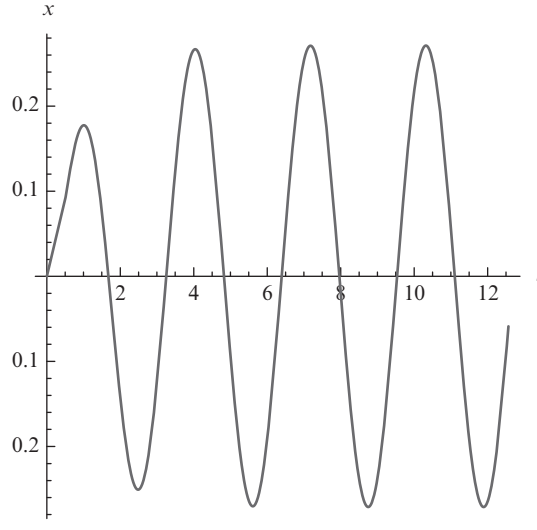

FIGURE 5.12 As t increases, the solution approaches that of the corresponding homogeneous problem.

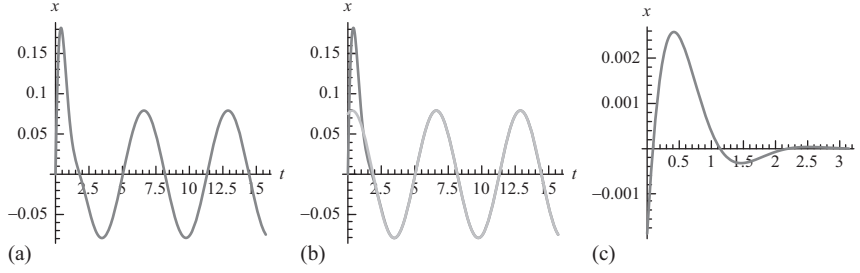

FIGURE 5.13 The transient solution (in (c)) approaches 0 as $t \to \infty$.

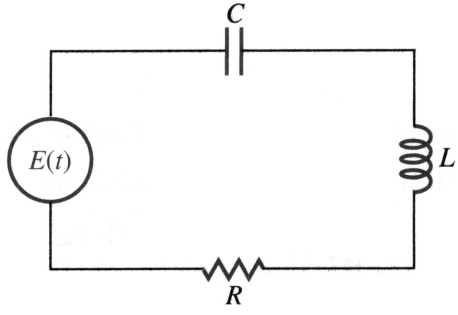

FIGURE 5.14 An *L*-*R*-*C* circuit.

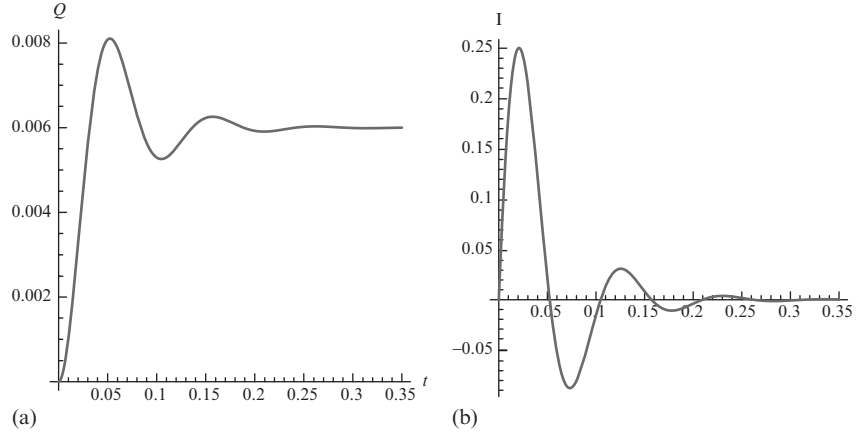

FIGURE 5.15 Plots of the charge and current in an *L*-*R*-*C* circuit.

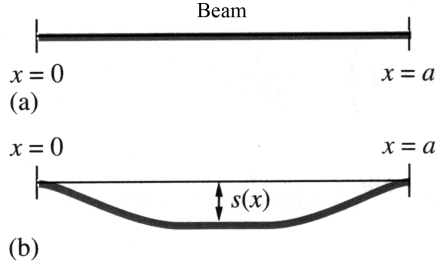

FIGURE 5.16 Modeling the deflection of a beam.

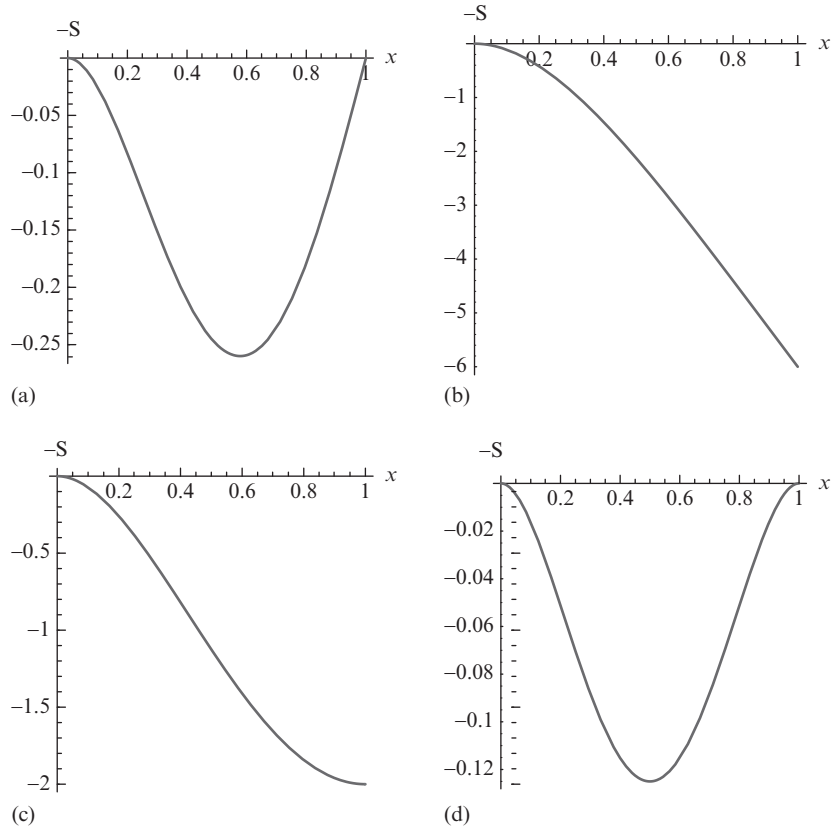

FIGURE 5.17 The shape of the beam for various boundary conditions.

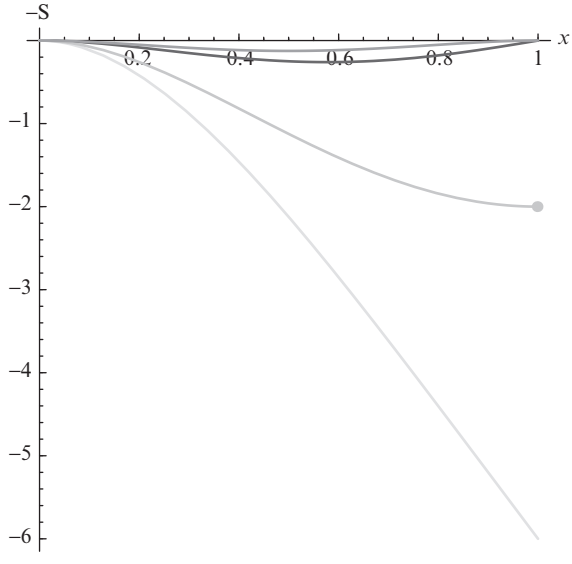

FIGURE 5.18 How the shape of a beam might vary based on different boundary conditions.

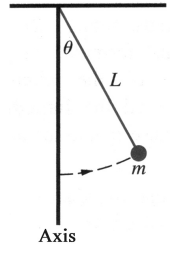

FIGURE 5.19 A swinging pendulum.

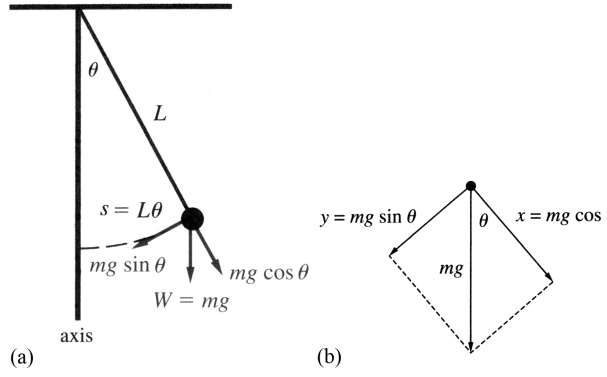

FIGURE 5.20 Two force diagrams for the swinging pendulum.

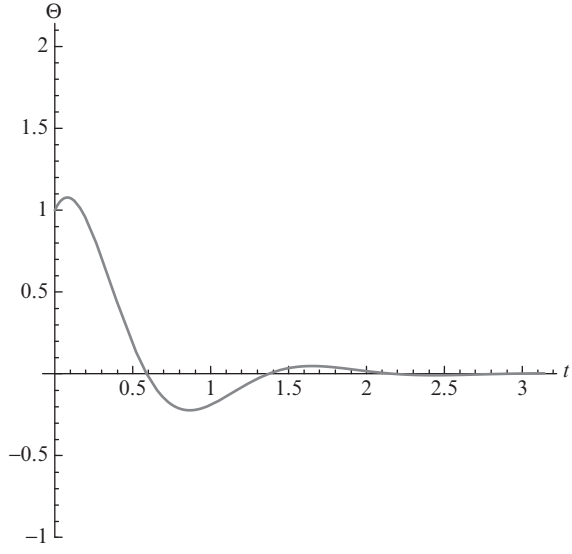

FIGURE 5.21 Plot of $\theta(t) = e^{-2t}(\cos 4t + \sin 4t)$.

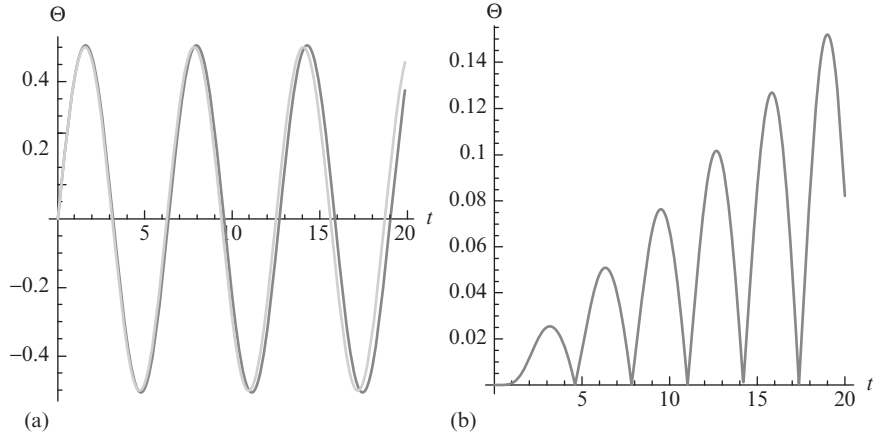

FIGURE 5.22 (a) The numerical solution to the nonlinear problem is in dark red (dark gray in print versions) and the exact solution to the linear approximation is in light red (light gray in print versions). (b) The absolute value of the difference between the two approximations.

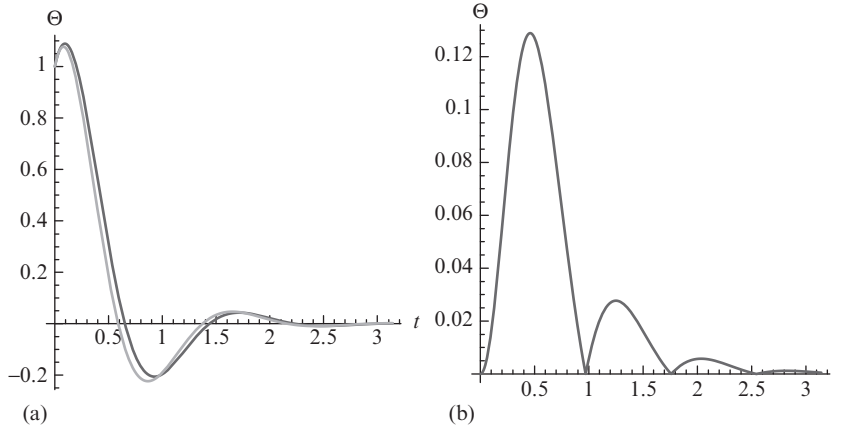

FIGURE 5.23 (a) The numerical solution to the nonlinear problem is in dark red (dark gray in print versions) and the exact solution to the linear approximation is in light red (light gray in print versions). (b) The absolute value of the difference between the two approximations.

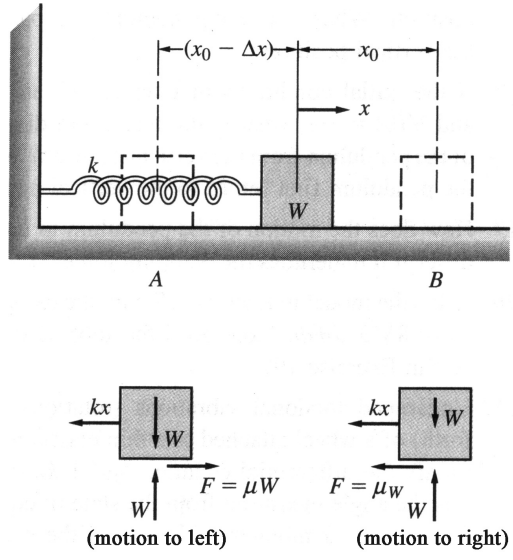

FIGURE 5.24 A system with coulomb (dry-friction) damping.

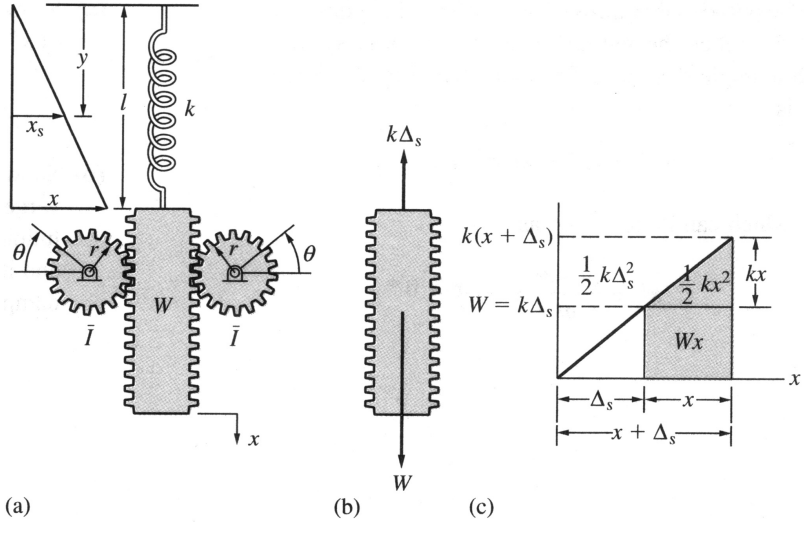

FIGURE 5.25 (a) A rack-and-gear system. (b) Static-equilibrium position. (c) Spring-force-diagram.

TABLE 5.1 Units Encountered When Solving Spring-Mass Systems Problems

System	Force	Mass	Length	*k* (Spring Constant)	Time
English	pounds (lb)	slugs (lbs-s^2/ft.)	feet (ft.)	lb/ft.	seconds (s)
Metric	Newton (N)	kilograms (kg)	meters (m)	N/m	seconds (s)

TABLE 5.2 Voltage Drops Across an *L-R-C* Circuit

Circuit Element	Voltage Drop
Inductor	$L\frac{dI}{dt}$
Resistor	RI
Capacitor	$\frac{1}{C}Q$

TABLE 5.3 Terminology Used in Section 5.4

Electrical Quantities	**Units**
Inductance (L)	Henrys (H)
Resistance (R)	Ohms (Ω)
Capacitance (C)	Farads (F)
Charge (Q)	Coulombs (C)
Current (I)	Amperes (A)