EXAMPLE 2 **Finding *x*- and *y*-Intercepts**

Find the x- and y-intercepts of the graph of $y = x^3 - 4x$.

EXAMPLE 3 **Testing for Symmetry**

Test the graph of $y = 2x^3 - x$ for symmetry with respect to (a) the y-axis and (b) the origin.

EXAMPLE 4 **Using Intercepts and Symmetry to Sketch a Graph**

See LarsonCalculus.com for an interactive version of this type of example.

Sketch the graph of $x - y^2 = 1$.

70. Copper Wire The resistance y in ohms of 1000 feet of solid copper wire at 77°F can be approximated by the model

$$y = \frac{10{,}770}{x^2} - 0.37, \quad 5 \le x \le 100$$

where x is the diameter of the wire in mils (0.001 in.). Use a graphing utility to graph the model. By about what factor is the resistance changed when the diameter of the wire is doubled?

69. Break-Even Point Find the sales necessary to break even $(R = C)$ when the cost C of producing x units is $C = 2.04x + 5600$ and the revenue R from selling x units is $R = 3.29x$.

P.2

EXAMPLE 1 **Finding an Equation of a Line**

Find an equation of the line that has a slope of 3 and passes through the point $(1, -2)$. Then sketch the line.

EXAMPLE 2 **Using Slope as a Ratio**

The maximum recommended slope of a wheelchair ramp is $\frac{1}{12}$. A business installs a wheelchair ramp that rises to a height of 22 inches over a length of 24 feet, as shown in Figure P.16. Is the ramp steeper than recommended? *(Source: ADA Standards for Accessible Design)*

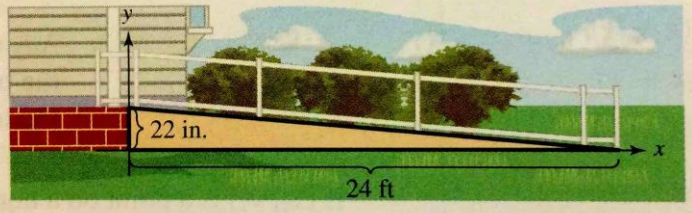


Figure P.16

EXAMPLE 3 **Using Slope as a Rate of Change**

The population of Colorado was about 4,302,000 in 2000 and about 5,029,000 in 2010. Find the average rate of change of the population over this 10-year period. What will the population of Colorado be in 2020? *(Source: U.S. Census Bureau)*

EXAMPLE 5 **Finding Parallel and Perpendicular Lines**

See LarsonCalculus.com for an interactive version of this type of example.

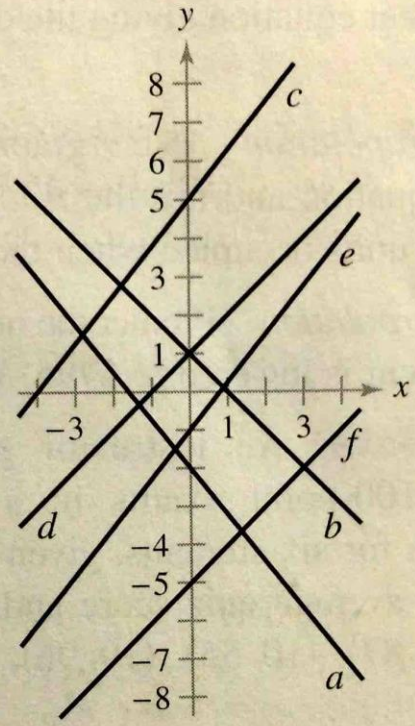
Find the general forms of the equations of the lines that pass through the point $(2, -1)$ and are (a) parallel to and (b) perpendicular to the line $2x - 3y = 5$.

✔ **92. Proof** Prove that if the slopes of two nonvertical lines are negative reciprocals of each other, then the lines are perpendicular.

Rate of Change **In Exercises 63–66, you are given the dollar value of a product in 2012 *and* the rate at which the value of the product is expected to change during the next 5 years. Write a linear equation that gives the dollar value V of the product in terms of the year t. (Let $t = 0$ represent 2010.)**

	2012 Value	Rate
63	$1850	$250 increase per year

74. HOW DO YOU SEE IT? Use the graphs of the equations to answer the questions below.



(a) Which lines have a positive slope?

(b) Which lines have a negative slope?

(c) Which lines appear parallel?

(d) Which lines appear perpendicular?

✓ **73. Analyzing a Line** A line is represented by the equation $ax + by = 4$.

(a) When is the line parallel to the x-axis?

(b) When is the line parallel to the y-axis?

✓ **81. Tangent Line** Find an equation of the line tangent to the circle $x^2 + y^2 = 169$ at the point $(5, 12)$.

P.3

EXAMPLE 1 **Evaluating a Function**

For the function f defined by $f(x) = x^2 + 7$, evaluate each expression.

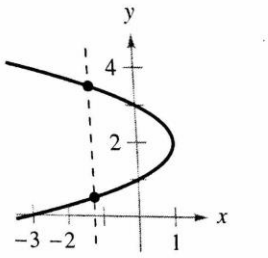
a. $f(3a)$ **b.** $f(b - 1)$ **c.** $\dfrac{f(x + \Delta x) - f(x)}{\Delta x}$

7. $f(x) = x^3$

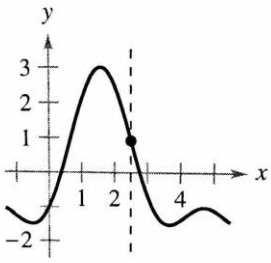
$$\frac{f(x + \Delta x) - f(x)}{\Delta x}$$

Answer To Question 7:

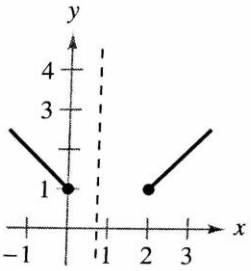
7. $$\frac{f(x+\Delta x)-f(x)}{\Delta x}=\frac{(x+\Delta x)^3-x^3}{\Delta x}=\frac{x^3+3x^2\Delta x+3x^2(\Delta x)^2+(\Delta x)^3-x^3}{\Delta x}=3x^2+3x\Delta x+(\Delta x)^2,\ \Delta x\neq 0$$



(a) Not a function of x

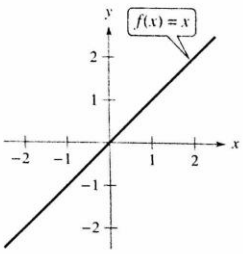


(b) A function of x

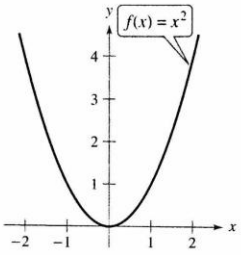


(c) A function of x

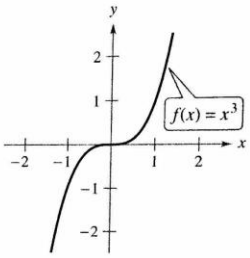
Figure P.26



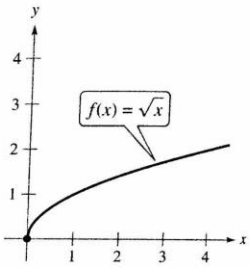
Identity function



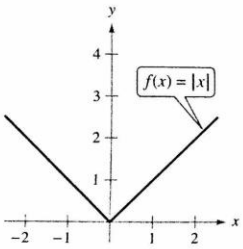
Squaring function



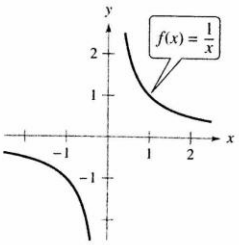
Cubing function



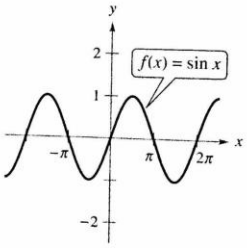
Square root function



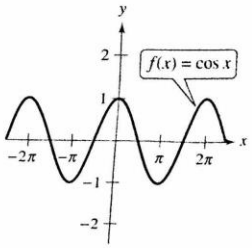
Absolute value function



Rational function



Sine function



Cosine function

The graphs of eight basic functions

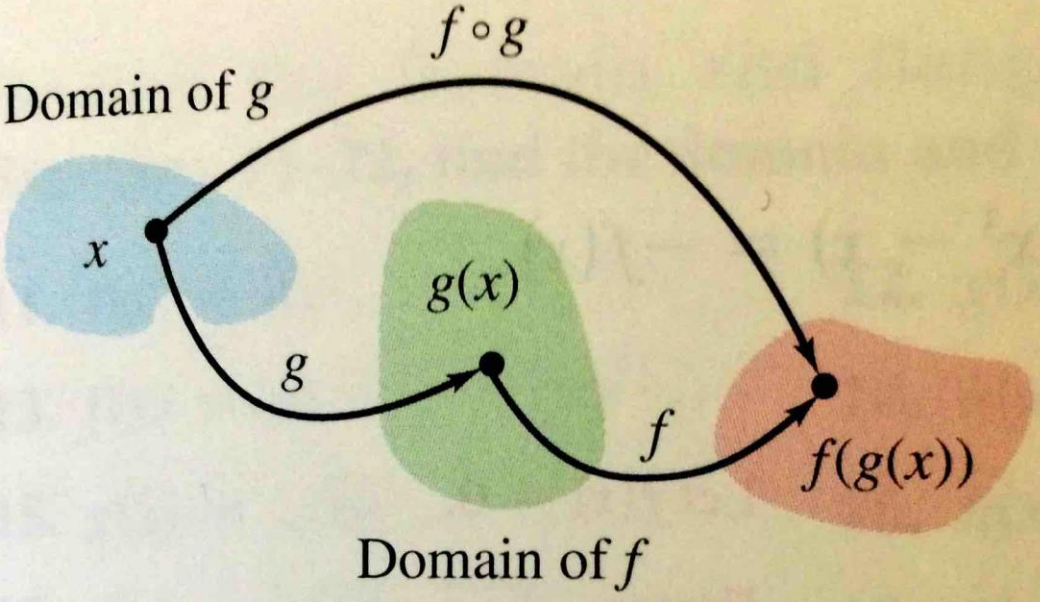
Figure P.27

Basic Types of Transformations $(c > 0)$

Original graph:	$y = f(x)$
Horizontal shift c units to the **right:**	$y = f(x - c)$
Horizontal shift c units to the **left:**	$y = f(x + c)$
Vertical shift c units **downward:**	$y = f(x) - c$
Vertical shift c units **upward:**	$y = f(x) + c$
Reflection (about the x-axis):	$y = -f(x)$
Reflection (about the y-axis):	$y = f(-x)$
Reflection (about the origin):	$y = -f(-x)$

Definition of Composite Function

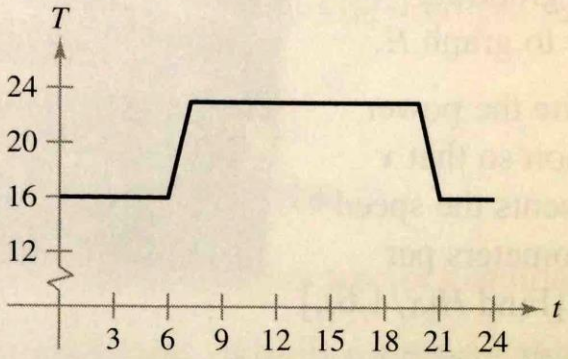
Let f and g be functions. The function $(f \circ g)(x) = f(g(x))$ is the **composite** of f with g. The domain of $f \circ g$ is the set of all x in the domain of g such that $g(x)$ is in the domain of f (see Figure P.30).



The domain of the composite function $f \circ g$

Figure P.30

93. Graphical Reasoning An electronically controlled thermostat is programmed to lower the temperature during the night automatically (see figure). The temperature T in degrees Celsius is given in terms of t, the time in hours on a 24-hour clock.



(a) Approximate $T(4)$ and $T(15)$.

(b) The thermostat is reprogrammed to produce a temperature $H(t) = T(t - 1)$. How does this change the temperature? Explain.

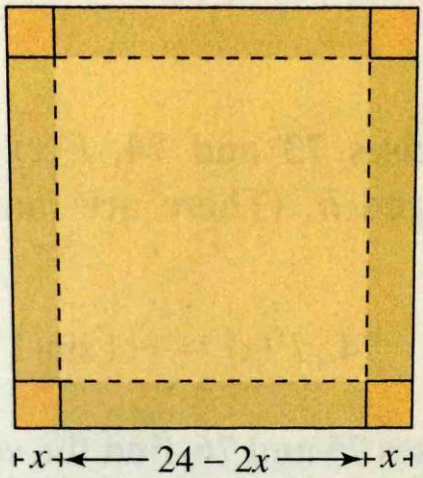
(c) The thermostat is reprogrammed to produce a temperature $H(t) = T(t) - 1$. How does this change the temperature? Explain.

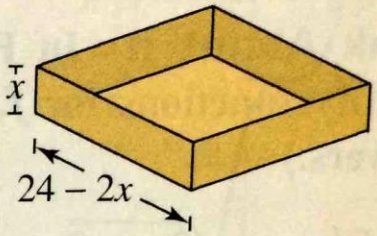
92. Domain Find all values of c such that the domain of

$$f(x) = \frac{x + 3}{x^2 + 3cx + 6}$$

is the set of all real numbers.

104. Volume An open box of maximum volume is to be made from a square piece of material 24 centimeters on a side by cutting equal squares from the corners and turning up the sides (see figure).





(a) Write the volume V as a function of x, the length of the corner squares. What is the domain of the function?

(b) Use a graphing utility to graph the volume function and approximate the dimensions of the box that yield a maximum volume.

(c) Use the *table* feature of a graphing utility to verify your answer in part (b). (The first two rows of the table are shown.)

Height, x	Length and Width	Volume, V
1	$24 - 2(1)$	$1[24 - 2(1)]^2 = 484$
2	$24 - 2(2)$	$2[24 - 2(2)]^2 = 800$