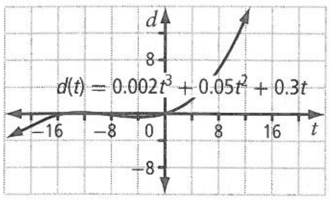
3. a) degree 3

b) leading coefficient: 0.002; constant: 0; The constant represents the distance that the boat is from the shore at time 0 s (the initial position of the boat).

c) degree: 3; positive leading coefficient; extends from quadrant III to I

d) domain: $\{t \mid t \geq 0, t \in R\}$; it is impossible to have negative time

e) When $t = 15$, $d(15) = 22.5$. After 15 s, the boat is 22.5 m from the shore.

f) 

4. a) $\frac{5x^3 - 7x^2 - x + 6}{x - 1} = 5x^2 - 2x - 3 + \frac{3}{x - 1}$

b) $x \neq 1$

c) $(x - 1)(5x^2 - 2x - 3) + 3 = 5x^3 - 7x^2 - x + 6$

5. a) $R = 9$ b) $R = 15$

c) $R = 41$ d) $R = 595$

6. a) $m = 4$ b) 28

7. $P(x) = x^3 + 2x^2 - 15x + 10$

8. a) $x - 7$ b) $x + 6$ c) $x - c$

9. a) Yes b) No

10. a) $\pm1, \pm3, \pm9, \pm27$

b) $\pm1, \pm2, \pm3, \pm4, \pm6, \pm9, \pm12, \pm18, \pm36$

11. a) $(x - 3)(x - 2)(x + 1)$

b) $(x - 4)(x + 2)(3x + 1)$

c) $(x - 3)(x - 1)(x + 6)(5x + 2)$

d) $x(x - 2)(x + 2)(2x + 5)$

12. $x - 1$, $x + 2$, and $5x + 2$

13. a) degree 5; negative leading coefficient; −3 (multiplicity 2) and 1 (multiplicity 3); the function changes sign at $x = 1$, but not at $x = -3$; positive for $x < -3$ and $-3 < x < 1$; negative for $x > 1$; $f(x) = -0.25(x + 3)^2(x - 1)^3$

b) degree 4; positive leading coefficient; −2 (multiplicity 1), −0.5 (multiplicity 1), and 2 (multiplicity 2); the function changes sign at $x = -2$ and at $x = -0.5$, but not at $x = 2$; positive for $x < -2$, $-0.5 < x < 2$, and $x > 2$; negative for $-2 < x < -0.5$; $f(x) = 0.5(x + 2)(2x + 1)(x - 2)^2$

14. a) $a = -2$; vertical stretch by a factor of 2 and reflection in the x-axis

$b = \frac{1}{3}$; horizontal stretch by a factor of 3

$h = 1$; translation of 1 unit to the right

$k = 4$; translation of 4 units up

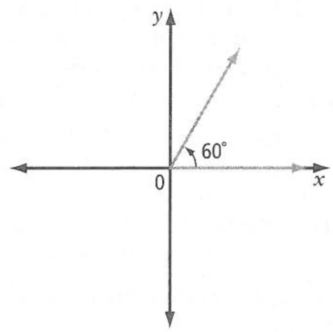
b) domain: $\{x \mid x \in R\}$; range: $\{y \mid y \in R\}$

15. $y = -3(x + 2)^2(x - 3)$

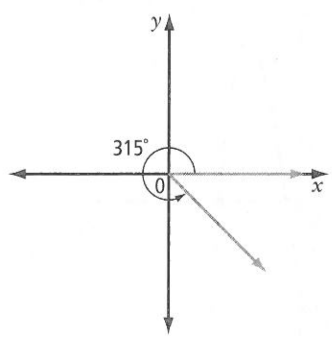
Chapter 4

4.1 Angles and Angle Measure, pages 109–119

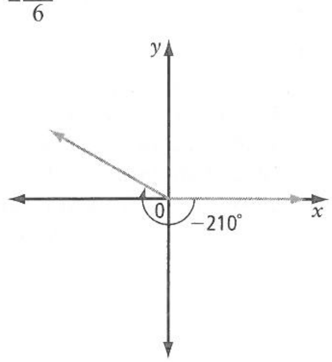
1. a) $\frac{\pi}{3}$



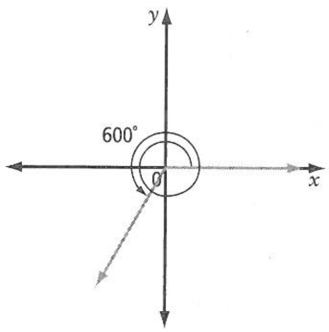
b) $\frac{7\pi}{4}$



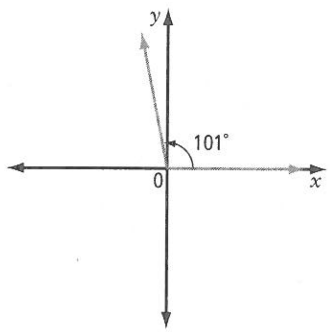
c) $-\frac{7\pi}{6}$



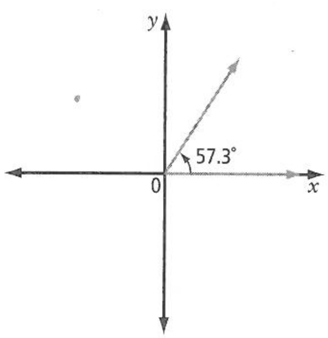
d) $\frac{10\pi}{3}$



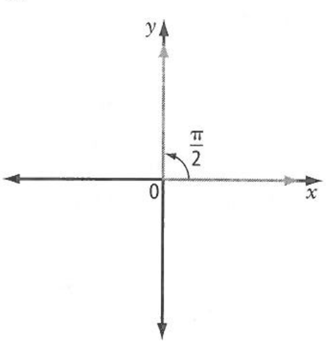
2. a) 1.76



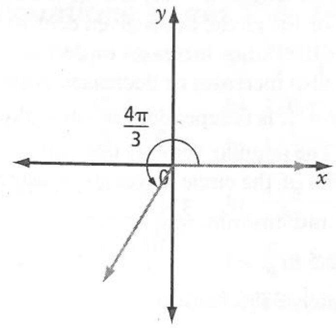
b) 1.00



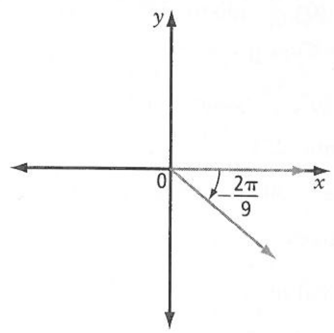
3. a) 90°



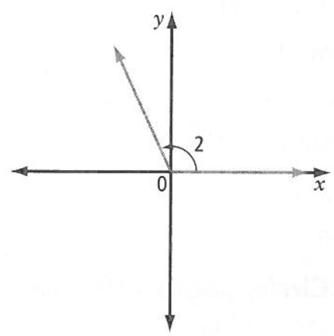
b) 240°



c) −40°



d) 114.59°



4. Examples: **a)** −11°, 709° **b)** −127°, 233°

c) $\frac{8\pi}{3}, -\frac{4\pi}{3}$ **d)** $\frac{\pi}{4}, -\frac{7\pi}{4}$

5. a) −465°, −105°, 615°; 255° ± 360°n, $n \in$ N

b) $-3\pi, -\pi, 3\pi; \pi \pm 2\pi n, n \in$ N

c) $-\frac{7\pi}{6}, \frac{17\pi}{6}, \frac{29\pi}{6}; \frac{5\pi}{6} \pm 2\pi n, n \in$ N

6. a) 41.89 cm **b)** 51.05 mm

7. **a)** Example: Arc length, $a = \theta r$, is dependent on the radius of the circle. For a given central angle, θ, as the radius increases or decreases, the arc length also increases or decreases. Angular velocity, $\omega = \frac{\theta}{t}$, is independent of the radius of the circle. The angular velocity does not change as the radius of the circle increases or decreases.
   b) $\frac{\pi}{10}$ or 0.31 radians/min; $\frac{33\pi}{200}$ or 0.52 m/s
   c) 39π or 122.5 m
   d) approximately 3706 km/h

8. Angles in first rotation:

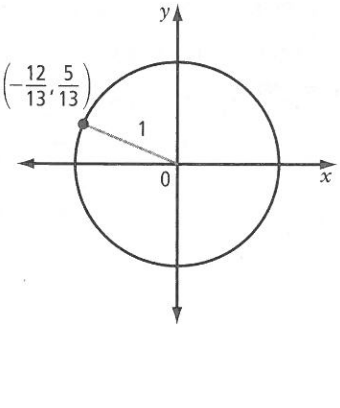
   0°, 0 radians; 30°, $\frac{\pi}{6}$ radians; 45°, $\frac{\pi}{4}$ radians; 60°, $\frac{\pi}{3}$ radians; 90°, $\frac{\pi}{2}$ radians; 120°, $\frac{2\pi}{3}$ radians; 135°, $\frac{3\pi}{4}$ radians; 150°, $\frac{5\pi}{6}$ radians; 180°, π radians; 210°, $\frac{7\pi}{6}$ radians; 225°, $\frac{5\pi}{4}$ radians; 240°, $\frac{4\pi}{3}$ radians; 270°, $\frac{3\pi}{2}$ radians; 300°, $\frac{5\pi}{3}$ radians; 315°, $\frac{7\pi}{4}$ radians; 330°, $\frac{11\pi}{6}$ radians

   Angles in second rotation:

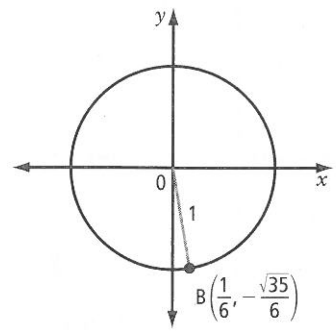
   360°, 2π radians; 390°, $\frac{13\pi}{6}$ radians; 405°, $\frac{9\pi}{4}$ radians; 420°, $\frac{7\pi}{3}$ radians; 450°, $\frac{5\pi}{2}$ radians; 480°, $\frac{8\pi}{3}$ radians; 495°, $\frac{11\pi}{4}$ radians; 510°, $\frac{17\pi}{6}$ radians; 540°, 3π radians; 570°, $\frac{19\pi}{6}$ radians; 585°, $\frac{13\pi}{4}$ radians; 600°, $\frac{10\pi}{3}$ radians; 630°, $\frac{7\pi}{2}$ radians; 660°, $\frac{11\pi}{3}$ radians; 675°, $\frac{15\pi}{4}$ radians; 690°, $\frac{23\pi}{6}$ radians

4.2 The Unit Circle, pages 120–128

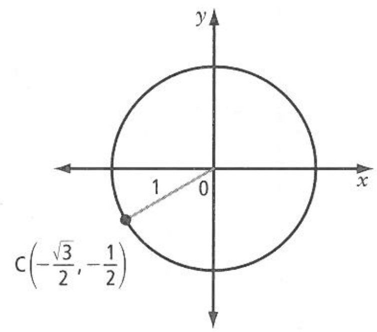
1. **a)** $x^2 + y^2 = 625$ **b)** $x^2 + y^2 = 1.21$
2. **a)** Yes **b)** Yes **c)** No
3. **a)** $-\frac{12}{13}$



   b) $-\frac{\sqrt{35}}{6}$



   c) $-\frac{\sqrt{3}}{2}$



4. **a)** (0, 1) **b)** (1, 0)
   c) $\left(-\frac{1}{2}, \frac{\sqrt{3}}{2}\right)$ **d)** $\left(-\frac{1}{\sqrt{2}}, -\frac{1}{\sqrt{2}}\right)$
   e) $\left(\frac{1}{\sqrt{2}}, -\frac{1}{\sqrt{2}}\right)$ **f)** $\left(\frac{\sqrt{3}}{2}, -\frac{1}{2}\right)$
5. **a)** π **b)** $\frac{\pi}{6}$
   c) $\frac{3\pi}{4}$ **d)** $\frac{4\pi}{3}$
6. **a)** $\frac{\pi}{2}$ **b)** $\frac{5\pi}{6}$
7. **a)** $x^2 + y^2 = 2.25 \times 10^{16}$
   b) $x^2 + y^2 = 1$
   c) Mars has a larger circle with radius 1.38.
   d) 2.76π or 8.67 radians; 503.7 days

8. $P(0) = (1, 0)$; $P\left(\frac{\pi}{6}\right) = \left(\frac{\sqrt{3}}{2}, \frac{1}{2}\right)$; $P\left(\frac{\pi}{4}\right) = \left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)$;
$P\left(\frac{\pi}{3}\right) = \left(\frac{1}{2}, \frac{\sqrt{3}}{2}\right)$; $P\left(\frac{\pi}{2}\right) = (0, 1)$;
$P\left(\frac{2\pi}{3}\right) = \left(-\frac{1}{2}, \frac{\sqrt{3}}{2}\right)$; $P\left(\frac{3\pi}{4}\right) = \left(-\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)$;
$P\left(\frac{5\pi}{6}\right) = \left(-\frac{\sqrt{3}}{2}, \frac{1}{2}\right)$; $P(\pi) = (-1, 0)$;
$P\left(\frac{7\pi}{6}\right) = \left(-\frac{\sqrt{3}}{2}, -\frac{1}{2}\right)$; $P\left(\frac{5\pi}{4}\right) = \left(-\frac{1}{\sqrt{2}}, -\frac{1}{\sqrt{2}}\right)$;
$P\left(\frac{4\pi}{3}\right) = \left(-\frac{1}{2}, -\frac{\sqrt{3}}{2}\right)$; $P\left(\frac{3\pi}{2}\right) = (0, -1)$;
$P\left(\frac{5\pi}{3}\right) = \left(\frac{1}{2}, -\frac{\sqrt{3}}{2}\right)$; $P\left(\frac{7\pi}{4}\right) = \left(\frac{1}{\sqrt{2}}, -\frac{1}{\sqrt{2}}\right)$;
$P\left(\frac{11\pi}{6}\right) = \left(\frac{\sqrt{3}}{2}, -\frac{1}{2}\right)$; $P(2\pi) = (1, 0)$

4.3 Trigonometric Ratios, pages 129–137

1. $\sin \theta = -\frac{24}{25}$, $\cos \theta = \frac{7}{25}$, $\tan \theta = -\frac{24}{7}$,
$\csc \theta = -\frac{25}{24}$, $\sec \theta = \frac{25}{7}$, $\cot \theta = -\frac{7}{24}$

2. **a)** − **b)** +
c) + **d)** −

3. **a)** I, III **b)** III
c) I, II **d)** II

4. **a)** $\frac{1}{2}$ **b)** $\frac{1}{\sqrt{2}}$ **c)** 0
d) $\frac{1}{\sqrt{3}}$ **e)** $-\frac{2}{\sqrt{3}}$ **f)** $-\sqrt{2}$

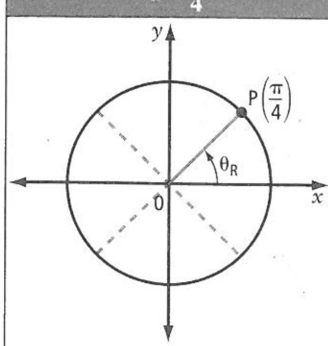
5. **a)** 3.628 **b)** −0.249
c) 2.985 **d)** −1.701

6. **a)** 108°, 288°, 468°, 648°
b) −197°, −163°, 163°, 197°

7. **a)** $\frac{4\pi}{3}, \frac{5\pi}{3}, \frac{10\pi}{3}, \frac{11\pi}{3}$
b) $-\frac{11\pi}{6}, -\frac{7\pi}{6}, \frac{\pi}{6}, \frac{5\pi}{6}$

8. $\sin \theta = \frac{3}{5}$, $\cos \theta = -\frac{4}{5}$, $\tan \theta = -\frac{3}{4}$,
$\sec \theta = -\frac{5}{4}$, $\cot \theta = -\frac{4}{3}$

9. Example:

$\theta_R = \frac{\pi}{4}$	Quadrant I	Quadrant II	Quadrant III	Quadrant IV
	$\sin \frac{\pi}{4} = \frac{1}{\sqrt{2}}$ $\csc \frac{\pi}{4} = \sqrt{2}$	$\sin \frac{3\pi}{4} = \frac{1}{\sqrt{2}}$ $\csc \frac{3\pi}{4} = \sqrt{2}$	$\sin \frac{5\pi}{4} = -\frac{1}{\sqrt{2}}$ $\csc \frac{5\pi}{4} = -\sqrt{2}$	$\sin \frac{7\pi}{4} = -\frac{1}{\sqrt{2}}$ $\csc \frac{7\pi}{4} = -\sqrt{2}$
	$\cos \frac{\pi}{4} = \frac{1}{\sqrt{2}}$ $\sec \frac{\pi}{4} = \sqrt{2}$	$\cos \frac{3\pi}{4} = -\frac{1}{\sqrt{2}}$ $\sec \frac{3\pi}{4} = -\sqrt{2}$	$\cos \frac{5\pi}{4} = -\frac{1}{\sqrt{2}}$ $\sec \frac{5\pi}{4} = -\sqrt{2}$	$\cos \frac{7\pi}{4} = \frac{1}{\sqrt{2}}$ $\sec \frac{7\pi}{4} = \sqrt{2}$
	$\tan \frac{\pi}{4} = 1$ $\cot \frac{\pi}{4} = 1$	$\tan \frac{3\pi}{4} = -1$ $\cot \frac{3\pi}{4} = -1$	$\tan \frac{5\pi}{4} = 1$ $\cot \frac{5\pi}{4} = 1$	$\tan \frac{7\pi}{4} = -1$ $\cot \frac{7\pi}{4} = -1$

4.4 Introduction to Trigonometric Equations, pages 138–144

1. **a)** 30°, 150° **b)** $\frac{3\pi}{4}, \frac{7\pi}{4}, \frac{11\pi}{4}, \frac{15\pi}{4}$

2. **a)** 42.8°, 317.2° **b)** 224.9°, 315.1°

3. **a)** $\frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6}$ **b)** 11.54°, 168.46°, 210°, 330°

4. **a)** $\frac{\pi}{6} + 2\pi n, n \in I$ **b)** $\frac{11\pi}{6} + 2\pi n, n \in I$

5. **a)** $\frac{\pi}{4}, \frac{5\pi}{4}, \frac{9\pi}{4}, \frac{13\pi}{4}$ **b)** $\frac{\pi}{4} + \pi n, n \in I$

6. It is not permissible to divide by tan θ since tan θ can equal 0. To solve, it is necessary to factor the expression to obtain (tan θ)(tan θ − 3) = 0. Setting the factor (tan θ) equal to 0 gives two of the solutions. Setting the factor (tan θ − 3) equal to 0 gives the other two solutions.

Correct solution: 0, 1.25, 3.14, 4.39

7. **a)** $0, \frac{\pi}{2}, \frac{3\pi}{2}$
b) $2\pi n, n \in I$; $\frac{\pi}{2} + 2\pi n, n \in I$;
$\frac{3\pi}{2} + 2\pi n, n \in I$; The three expressions cannot be combined in a single expression, because the intervals between solutions in one revolution are not consistent.

8. No. Example: $n = 1$ does not work.

9. If sin θ < 0, the solutions will be in quadrants III and IV. If csc θ < 0, the solutions will be in quadrants III and IV. If sin θ > 0, the solutions will be in quadrants I and II. If csc θ > 0, the solutions will be in quadrants I and II.

If cos θ < 0, the solutions will be in quadrants II and III. If sec θ < 0, the solutions will be in quadrants II and III. If cos θ > 0, the solutions will be in quadrants I and IV. If sec θ > 0, the solutions will be in quadrants I and IV.

If tan θ < 0, the solutions will be in quadrants II and IV. If cot θ < 0, the solutions will be in quadrants II and IV. If tan θ > 0, the solutions will be in quadrants I and III. If cot θ > 0, the solutions will be in quadrants I and III.

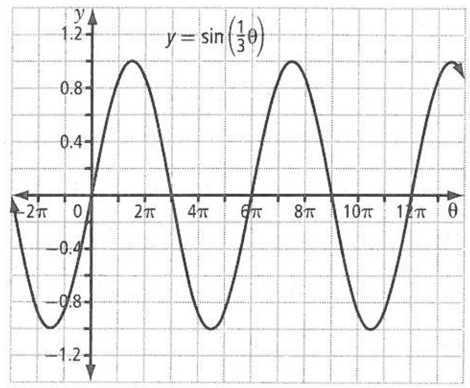
Chapter 4 Review, pages 145–147

1. a) $\frac{3\pi}{2}$ b) 300°
   c) $\frac{5\pi}{3}$ d) $\frac{-720°}{\pi}$
   e) $\frac{11\pi}{4}$ f) 585°
2. Examples:
   a) $\frac{23\pi}{6}, -\frac{\pi}{6}$,
   general form: $\frac{11\pi}{6} \pm 2\pi n, n \in N$
   b) 345°, −735°,
   general form: $-375° \pm (360°)n, n \in N$
3. a) 6.3 b) 28.6°
4. $-\frac{\sqrt{5}}{3}$
5. a) $\frac{\pi}{3}$ b) $\frac{7\pi}{4}$
6. 56°, 304°, 416°, 664°
7. a) $-\sqrt{3}$ b) $-\frac{2}{\sqrt{3}}$
8. $\theta_1 \approx 128.7° + 360°n, n \in I$;
   $\theta_2 \approx 231.3° + 360°n, n \in I$
9. $\frac{\pi}{6}, \frac{5\pi}{6}, \frac{3\pi}{2}$

Chapter 5

5.1 Graphing Sine and Cosine Functions, pages 149–157

1. a) 2 b) $\frac{1}{4}$
   c) 5 d) 3
2. a) 360°, 2π b) 180°, π
   c) 1440°, 8π d) 240°, $\frac{4\pi}{3}$
3. a) $2\pi; \frac{1}{2}$ b) $\frac{2\pi}{3}; 1$
   c) $\frac{\pi}{2}; 2$ d) $6\pi; 1.5$
4. a) For $y = \sin \theta$:
   amplitude: 1; maximum value: 1; minimum value: −1; period: 2π; θ-intercepts: $\pi n, n \in I$; y-intercept: 0
   For $y = \sin\left(\frac{1}{3}\theta\right)$:
   amplitude: 1; maximum value: 1; minimum value: −1; period: 6π; θ-intercepts: $3\pi n$, $n \in I$; y-intercept: 0



   b) For $y = \sin \theta$:
   amplitude: 1; maximum value: 1; minimum value: −1; period: 2π; θ-intercepts: $\pi n, n \in I$; y-intercept: 0
   For $y = 1.5 \sin (2\theta)$:
   amplitude: 1.5; maximum value: 1.5; minimum value: −1.5; period: π; θ-intercepts: $\frac{\pi}{2}n, n \in I$; y-intercept: 0