

IM2 Book 3 Selected Answers

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1. $10\sqrt{2}$
2. (a) $A = \left(\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right)$, $B = \left(\frac{\sqrt{3}}{2}, \frac{1}{2}\right)$
(b) $\cos()$
(c) $\sin()$
3. (a) $\cos(40^\circ)$
(b) $\sin(40^\circ)$
4. (a) $m_{OA} = 1$, $m_{OB} = \frac{\sqrt{3}}{3}$
(b) $\tan()$
5. 470 ft
6. $\frac{3}{5}$
7. Length of line: 3.42 ft
Distance to bobber: 9.40 ft
8. 23.82 ft
9. (a) π ; $(-1, 0)$
(b) $\frac{\pi}{2}$; $(0, 1)$
10. –
11. –
12. –
13. $\cos A = \frac{\sqrt{21}}{5}$, $\tan A = \frac{2}{\sqrt{21}}$, $\sin^2 A + \cos^2 A = 1$
14. (a) 79 ft
(b) $7,873 \text{ ft}^2$
(c) 135 ft
15. 67°

16. 21.6°
17. No
18. 54.8 ft
19. $\frac{2\pi}{3}$
20. $\frac{6\pi}{5}, \frac{9\pi}{5}$
21. $\sin^2 \theta + \cos^2 \theta = 1$
22. length = 5.22; Area = 12.68
23. $\frac{ab \sin C}{2}$
24. 9.9 in^2
25. $(-1, 0), (-1, 0)$
26. -
27. $\pi - \alpha$
28. (a) $(0, 1)$
 (b) $\left(\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right)$
 (c) $\left(\frac{-1}{2}, \frac{\sqrt{3}}{2}\right)$
 (d) $\left(\frac{-\sqrt{3}}{2}, \frac{-1}{2}\right)$
29. (a) $\left(\frac{1}{2}, \frac{\sqrt{3}}{2}\right)$; $\cos \theta$ gives the x-coordinate; $\sin \theta$ gives the y-coordinate
 (b) $\cos \frac{3\pi}{4} = \frac{-\sqrt{2}}{2}, \sin \frac{3\pi}{4} = \frac{\sqrt{2}}{2}$
30. (a) $AD = b - x, BD = \sqrt{a^2 - x^2}$
 (b) $c^2 = a^2 + b^2 - 2bx$
 (c) $c^2 = a^2 + b^2 - 2ab \cos C$
31. 5.01 in.
32. (a) $\left(\frac{1}{2}, \frac{\sqrt{3}}{2}\right), m = \sqrt{3}$
 (b) $\tan \theta$
33. 205°
34. (a) $\sin \frac{2\pi}{3} = \frac{\sqrt{3}}{2}, \cos \frac{2\pi}{3} = \frac{-1}{2}, \tan \frac{2\pi}{3} = -\sqrt{3}$
 (b) $\sin \frac{4\pi}{3} = \frac{-\sqrt{3}}{2}, \cos \frac{4\pi}{3} = \frac{-1}{2}, \tan \frac{4\pi}{3} = \sqrt{3}$
35. (a) $\sin 135^\circ = \frac{\sqrt{2}}{2}, \cos 135^\circ = \frac{-\sqrt{2}}{2}, \tan 135^\circ = -1$

- (b) $\sin 225^\circ = -\frac{\sqrt{2}}{2}$, $\cos 225^\circ = -\frac{\sqrt{2}}{2}$, $\tan 225^\circ = 1$
36. (a) $\left(\frac{\sqrt{3}}{2}, -\frac{1}{2}\right)$, $m = -\frac{\sqrt{3}}{3}$
 (b) $\sin\left(-\frac{\pi}{6}\right) = -\frac{1}{2}$, $\cos\left(-\frac{\pi}{6}\right) = \frac{\sqrt{3}}{2}$, $\tan\left(-\frac{\pi}{6}\right) = -\frac{\sqrt{3}}{3}$
37. $\sin\left(-\frac{2\pi}{3}\right) = -\frac{\sqrt{3}}{2}$, $\cos\left(\frac{5\pi}{2}\right) = 0$, $\tan\left(\frac{2\pi}{3}\right) = -\sqrt{3}$
38. $\cos A = -\frac{\sqrt{91}}{10}$, $\tan A = -\frac{3}{\sqrt{91}}$
39. 2.52 km
40. side length = 16.8 cm, Area = 91.3 cm²
41. 78.5°, 57.1°, 44.4°
42. (a) $c = p + q$
 (b) $c = |p - q|$
 (c) $c = \sqrt{p^2 + q^2}$
43. (a) $\sin 60^\circ = \sin 120^\circ = \frac{\sqrt{3}}{2}$
 (b) $\sin 30^\circ = \sin 150^\circ = \frac{1}{2}$
 (c) -
44. $\sin \theta = \sin(\pi - \theta)$
45. $\cos \theta = -\cos(\pi - \theta)$
46. $\tan \theta = \tan(\theta + \pi)$
47. $\cos x = -\frac{\sqrt{4-a^2}}{2}$, $\tan x = -\frac{a}{\sqrt{4-a^2}}$
48. (a) $\frac{\pi}{6}, \frac{5\pi}{6}$
 (b) $\sin(x) = \frac{1}{2}$
49. $\frac{\pi}{3}, \pi - \frac{\pi}{3}$
50. $\cos 280^\circ \approx 0.174$, $\cos 100^\circ = \cos 260^\circ \approx -0.174$, $\sin 190^\circ \approx -0.174$
51. (a) $\cos 310^\circ < \cos 311^\circ$
 (b) $\sin 76^\circ > \sin 106^\circ$
 (c) $\sin 81^\circ = \sin 99^\circ$
 (d) $\tan 89^\circ > \tan 71^\circ$
52. $BC = 4.01$
53. (a) 1
 (b) 1

- (c) $\frac{\sqrt{3}}{2}$
- (d) $\frac{\sqrt{2}}{2}$
- 54. (a) $\frac{\sqrt{3}}{2}$
- (b) $\frac{\sqrt{3}}{2}$
- (c) $-\sqrt{3}$
- (d) $\frac{\sqrt{2}}{2}$
- 55. (a) $\theta = \frac{5\pi}{6}, \frac{7\pi}{6}$
- (b) $\theta = 0, \pi$
- (c) $\theta = \frac{3\pi}{2}$
- 56. (a) $\theta = 0^\circ, 180^\circ$
- (b) $\theta = 135^\circ, 225^\circ$
- (c) $\theta = 45^\circ, 225^\circ$
- 57. –
- 58. (a) $\cos B = \frac{106-x^2}{90}$
- (b) $\cos D = \frac{58-x^2}{42}$
- (c) $\cos B = -\cos D$
- (d) $x = 8.56$
- 59. (a) $\sin(-\alpha) = -\sin(\alpha)$
- (b) $\sin(180 - \alpha) = \sin(\alpha)$
- (c) $\sin(360 + \alpha) = \sin(\alpha)$
- (d) $\cos(-\alpha) = \cos(\alpha)$
- (e) $\cos(180 - \alpha) = -\cos(\alpha)$
- (f) $\cos(90 - \alpha) = \sin(\alpha)$
- 60. (a) $A = 109^\circ$
- (b) $A = 230^\circ, 310^\circ$
- (c) No solutions
- (d) $A = 110^\circ, 250^\circ$
- 61. (a) $\frac{\sqrt{2}}{2}$
- (b) 0
- (c) $\frac{-\sqrt{3}}{2}$
- (d) -1
- (e) $\frac{-\sqrt{3}}{2}$

- (f) 0
62. $\theta = 60^\circ, 300^\circ$
63. (a) $h = b \sin A, h = a \sin B$
 (b) $\frac{\sin A}{a} = \frac{\sin B}{b}$
 (c) $\frac{b}{\sin B} = \frac{a}{\sin A}$
64. $NC = 8.08 \text{ in.}, CY = 3.19 \text{ in.}$
65. (a) $3.42 \text{ ft} < l < 10 \text{ ft}$
 (b) $l = 3.42 \text{ ft}$ or $l \geq 10 \text{ ft}$
 (c) $0 \text{ ft} \leq l < 3.42 \text{ ft}$
66. (a) $\theta = 140^\circ$
 (b) $\theta = 300^\circ$
 (c) $\theta = 50^\circ, 310^\circ$
67. (a) $\tan \theta = \frac{\sqrt{b^2 - a^2}}{a}$
 (b) $\cos(\pi + \theta) = \frac{-a}{b}$
 (c) $\sin(\pi + \theta) = \frac{-\sqrt{b^2 - a^2}}{b}$
 (d) $\cos(\pi - \theta) = \frac{-a}{b}$
68. (a) $\frac{\pi}{6} < t < \frac{11\pi}{6}$
 (b) $\frac{7\pi}{6} < w < \frac{11\pi}{6}$
69. (a) $\frac{\pi}{2}, y = 1$
 (b) π
 (c) $\frac{3\pi}{2}, y = -1$
 (d) 2π
 (e) $-$
70. (a) $\frac{\pi}{2}$
 (b) π
 (c) $\frac{3\pi}{2}$
 (d) 2π
 (e) $-$
71. (a) $-$
 (b) $-$
 (c) $-$
 (d) Domain: $(-\infty, \infty)$, Range: $[-1, 1]$

72. –
73. 232.1
74. Triangle 1: $B = 34.8^\circ, C = 125.2^\circ, AB = 14.3$
 Triangle 2: $B = 145.2^\circ, C = 14.8^\circ, AB = 4.5$
75. (a) $BC = 3.42$
 (b) –
76. 63.1 miles
77. $\frac{\pi}{4} < \theta < \frac{\pi}{2} \cup \frac{5\pi}{4} < \theta < \frac{3\pi}{2}$
78. (a) $x = \frac{\pi}{6}, \frac{5\pi}{6}$
 (b) $x = \frac{7\pi}{6}, \frac{11\pi}{6}$
 (c) $x = 0.927, 5.356$ (radians)
79. (a) 2π seconds, 10π seconds
 (b) –
 (c) 2π
80. (a) $x = \pi$
 (b) $x = -3\pi, -\pi, \pi, 3\pi$
 (c) $x = \pi + 2\pi n$, where n is an integer
81. (a) $x = \frac{\pi}{6}, \frac{5\pi}{6}$
 (b) $x = \dots, -3\pi, -\pi, \pi, 3\pi, \dots$
 (c) $x = \pi + 2\pi n$, where n is an integer
82. $x = \frac{5\pi}{6}, \frac{7\pi}{6}$
 $x = \frac{5\pi}{6} + 2\pi n, \frac{7\pi}{6} + 2\pi n$, where n is an integer
83. 22.2 ft
84. Smallest angle = 0.48996, $D = 21.25$ in.
85. Triangle 1: $P = 53.1^\circ, R = 120.5^\circ, Q = 6.4^\circ, p = 13, r = 14, q = 1.8$
 Triangle 2: $P = 53.1^\circ, R = 59.5^\circ, Q = 67.4^\circ, p = 13, r = 14, q = 15$
86. (a) $x = 30^\circ, 150^\circ$
 (b) $B = 30^\circ, 150^\circ$; No
87. B has no solutions
88. There are a bunch of typos here. The second sentence should say "The ride starts at (1, 2) with a starting height of 2 feet."

- (a) $\frac{\pi}{2}, 3$
 - (b) π
 - (c) $\frac{3\pi}{2}, 1$
 - (d) 2π
 - (e) $-$
 - (f) $-$
 - (g) $y = \sin x + 2$
89. (a) $-$
- (b) $-$
- (c) $y = -3$
90. Midline: $y = 4$. Maximum value: 5. Minimum value: 3.
91. (a) $x = \frac{2\pi}{3} + 2\pi n, \frac{4\pi}{3} + 2\pi n$, where n is an integer
- (b) $x = \frac{\pi}{4} + 2\pi n, \frac{3\pi}{4} + 2\pi n$, where n is an integer
- (c) $x = \pi n$, where n is an integer
92. (a) $x = 45^\circ + 360^\circ \cdot n, 135^\circ + 360^\circ \cdot n$, where n is an integer
- (b) $180^\circ + 360^\circ \cdot n$, where n is an integer
- (c) $30^\circ + 360^\circ \cdot n, 330^\circ + 360^\circ \cdot n$, where n is an integer
93. $d = 21.28$
94. $A = 84 \text{ in.}^2$
95. 30.8 km
96. 289 ft^2 or 111 ft^2
97. $-$
98. $-$
99. (a) Translate up 3
- (b) Translate up 2
100. $P = (-42^\circ, 0.7431), R = (318^\circ, 0.7431), S = (402^\circ, 0.7431)$
101. 15.71
102. The Law of Sines!
103. (a) $\frac{\pi}{2}, 3$
- (b) π
- (c) $\frac{3\pi}{2}, -3$

(d) 2π

(e) $-$

(f) $y = 3 \sin x$

	x	$\cos x$	$4 \cos x$
	0	1	4
104. (a)	$\frac{\pi}{2}$	0	0
	π	-1	-4
	$\frac{3\pi}{2}$	0	0
	2π	1	4

(b) $-$

(c) 4

105. Midline: x-axis

Amplitude: 2

Max value: 2

Min value: -2

Period: 2π

106. (a) Midline: $y = -3$

Amplitude: 2

Max value: -1

Min value: -5

Period: 2π

(b) Center: $(0, -3)$

Radius: $r = 2$

107. $(67^\circ, 0.39073)$, $(293^\circ, 0.39073)$, $(427^\circ, 0.39073)$

108. $-$

109. $Q = (\pi - \theta, k)$, $R = (\theta + 2\pi, k)$, $S = (3\pi - \theta, k)$

110. $-$

111. $-$

112. $\tan 75^\circ = 2 + \sqrt{3}$

113. $-$

114. $-$

115. $M = 40.5^\circ$, $L = 19.5^\circ$

116. $-$

117. (a)	x	$\sin x$	$-\sin x$
	0	0	0
	$\frac{\pi}{2}$	1	-1
	π	0	0
	$\frac{3\pi}{2}$	-1	1
	2π	0	0

(b) –

(c) Reflection over the x-axis

118. –

119. (a) Midline: $y = 0$
 Amplitude: 2
 Period: 2π
 Formula: $y = -2 \cos x$

(b) Midline: $y = 1$
 Amplitude: 2
 Period: 2π
 Formula: $y = 2 \sin x + 1$

120. (a) $5 \sin \theta, 5 \cos \theta$
 (b) $(\text{hypotenuse}) \cdot \sin(\text{angle}), (\text{hypotenuse}) \cdot \cos(\text{angle})$
 (c) $x^2 \sin \alpha, x^2 \cos \alpha$
 (d) $\cos \alpha \sin \beta, \cos \alpha \cos \beta$

121. –

122. (a) Starting from (1,0) and rotating clockwise:
 $0, 1, \text{undefined}, -1, 0, 1, \text{undefined}, -1$
 (b) Starting from (1,0) and rotating clockwise:
 $0, \frac{\sqrt{3}}{3}, 1, \sqrt{3}, \text{undefined}, -\sqrt{3}, -1, -\frac{\sqrt{3}}{3}, 0, \frac{\sqrt{3}}{3}, 1, \sqrt{3}, \text{undefined}, -\sqrt{3}, -1, -\frac{\sqrt{3}}{3}$

123. (a) 0
 (b) Positive, increasing
 (c) $\frac{\pi}{4}, \frac{5\pi}{4}$
 (d) It increases towards positive infinity.
 (e) –

124. (a) –
 (b) The graph approaches $\pm\infty$ at those lines.
 (c) Domain: All real numbers except $\frac{\pi}{2} + \pi n$ where n is an integer
 Range: $(-\infty, \infty)$

125. –

126. –

127. –

128. $x = -1.23 + 2\pi n, 1.23 + 2\pi n$ where n is an integer

129. $x = \frac{7\pi}{6} + 2\pi n, \frac{11\pi}{6} + 2\pi n$ where n is an integer

130. (a) $w = h \cos(B)$
 $y = h \cos(B) \sin(A)$
 $x = h \cos(B) \cos(A)$

(b) $z = h \cos^3(B)$

131. 10.31 in

132. $2\sqrt{37}$ in.

	Domain	Range
133. $y = \sin x$	$(-\infty, \infty)$	$[-1, 1]$
$y = \cos x$	$(-\infty, \infty)$	$[-1, 1]$
$y = \tan x$	All real numbers except $x = \frac{\pi}{2} + \pi n$ where n is an integer	$(-\infty, \infty)$

134. (a) –

(b) One rotation: π seconds
 To reach max: $\frac{\pi}{4}$ seconds
 To reach min: $\frac{3\pi}{4}$ seconds
 Period: π

135. Center: (0,0)
 Radius 3
 Speed: 2 radians/second
 Starting point: (3,0)

136. Period: π

137. (a) $\tan(\pi - \theta) = -\frac{2}{5}$

(b) $\tan(\theta + \frac{\pi}{2}) = -\frac{5}{2}$

(c) $\tan(\theta + \pi) = \frac{2}{5}$

138. $\sin(2\alpha) = 2 \sin \alpha \cos \alpha$
 $\cos(2\alpha) = \cos^2 \alpha - \sin^2 \alpha$

139. $\cos(2\alpha) = 1 - 2 \sin^2 \alpha$
 $\cos(2\alpha) = 2 \cos^2 \alpha - 1$

140. $\cos(2\theta) = \frac{7}{25}$
 $\sin(2\theta) = \pm \frac{24}{25}$

141. Center: $(0, -3)$
 Radius: 2
 Speed: 1 radian/second (the coefficient on x inside sine)
 Starting Point: $(2, -3)$

142. Center $(0, 0)$
 Radius: 1
 Speed: 0.5 radians/second
 Starting point: $(1, 0)$

143. –

144. –

145. –

146. (a) "blob" = $\frac{\pi}{6} + 2\pi n$, $\frac{5\pi}{6} + 2\pi n$ where n is an integer
 (b) $2x = \frac{\pi}{6} + 2\pi n$
 $2x = \frac{5\pi}{6} + 2\pi n$ where n is an integer
 (c) $x = \frac{\pi}{12} + \pi n$
 $x = \frac{5\pi}{12} + \pi n$ where n is an integer

147. –

148. –

	Slope of the Spoke	Angles
	-1	$-\frac{\pi}{4} + \pi n$
149.	0	πn
	1	$\frac{\pi}{4} + \pi n$
	undefined	$\frac{\pi}{2} + \pi n$

150. –

151. –

152. $\cos 15^\circ = \frac{\sqrt{2+\sqrt{3}}}{2}$

$$\sin 15^\circ = \frac{1}{2\sqrt{2+\sqrt{3}}}$$

153. (a) $x = \frac{\pi}{4} + \pi n$, $\frac{3\pi}{4} + \pi n$ where n is an integer
 (b) $x = \frac{\pi}{4} + \pi n$, $\frac{3\pi}{4} + \pi n$ where n is an integer

- | x | $\cos(x - \frac{\pi}{4})$ |
|------------------|---------------------------|
| $\frac{\pi}{4}$ | 1 |
| $\frac{3\pi}{4}$ | 0 |
| $\frac{5\pi}{4}$ | -1 |
| $\frac{7\pi}{4}$ | 0 |
| $\frac{9\pi}{4}$ | 0 |
154. (a)
- (b) –
- (c) Shift right by $\frac{\pi}{4}$
155. (a) Midline: $y = 0$
 Max: 2
 Min: -2
 Period: 2π
 Left/Right Shift: Left by $\frac{\pi}{2}$
- (b) $y = 2 \cos x$
156. –
157. –
158. –
159. –
160. –
161. –
162. –
163. $\sin(2\alpha) = \pm \frac{4\sqrt{2}}{9}$
 $\cos(2\alpha) = \frac{7}{9}$
 $\tan(2\alpha) = \pm \frac{4\sqrt{2}}{7}$