

## 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)  $\pi$ ;  $(-1, 0)$   
(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.  $67^\circ$

16.  $21.6^\circ$
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.  $9.9 \text{ in}^2$
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.  $205^\circ$
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 cm<sup>2</sup>
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)  $\pi$   
 (c)  $\frac{3\pi}{2}, y = -1$   
 (d)  $2\pi$   
 (e)  $-$
70. (a)  $\frac{\pi}{2}$   
 (b)  $\pi$   
 (c)  $\frac{3\pi}{2}$   
 (d)  $2\pi$   
 (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)  $2\pi$  seconds,  $10\pi$  seconds  
 (b) –  
 (c)  $2\pi$
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)  $\pi$
  - (c)  $\frac{3\pi}{2}, 1$
  - (d)  $2\pi$
  - (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.  $289 \text{ ft}^2$  or  $111 \text{ ft}^2$
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)  $\pi$
- (c)  $\frac{3\pi}{2}, -3$

(d)  $2\pi$

(e)  $-$

(f)  $y = 3 \sin x$

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

(b)  $-$

(c) 4

105. Midline: x-axis

Amplitude: 2

Max value: 2

Min value: -2

Period:  $2\pi$

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

Amplitude: 2

Max value: -1

Min value: -5

Period:  $2\pi$

(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
$\pi$	0	0
$\frac{3\pi}{2}$	-1	1
$2\pi$	0	0

(b) –

(c) Reflection over the x-axis

118. –

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

(b) Midline:  $y = 1$   
Amplitude: 2  
Period:  $2\pi$   
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, undefined, -1, 0, 1, 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:  $\pi$  seconds  
 To reach max:  $\frac{\pi}{4}$  seconds  
 To reach min:  $\frac{3\pi}{4}$  seconds  
 Period:  $\pi$

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

136. Period:  $\pi$

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 (we haven't really talked about this yet)  
 Starting Point:  $(2, -3)$

142. –

143. –

144. –

145. –

146. –

147. –

148. –

149.

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