Chapter 5

The Next Wave: MORE MODELING AND TRIGONOMETRY

NW-1. TI-82, 4 points; Casio, 6 points

a) An infinite number of them. b) $\frac{17}{6}, -\frac{7}{6}$

c) Add 2 n to $\frac{}{6}, \frac{5}{6}$ d) $\frac{25}{6}, \frac{29}{6}$ e) $-\frac{31}{6}, -\frac{35}{6}$

NW-2. a) The y-coordinates of the points are .

NW-3. a) • b) 2: 0, c) 0 + 2 n, + 2 n

NW-4. a) $\frac{}{3}, \frac{2}{3}$ b) $\frac{}{3} + 2$ n, $\frac{2}{3} + 2$ n

NW-5. a) The x and y are interchanged.
b) Reflection about the line y = x. c) no

NW-7. a) $\frac{3}{2} + 2$ n b) $\frac{}{3}, \frac{5}{3}$ c) $\frac{}{3}, \frac{3}{2}, \frac{5}{3}$
d) $\frac{}{3} + 2$ n, $\frac{5}{3} + 2$ n, $\frac{3}{2} + 2$ n

NW-8. (a) and (b) are the graphs whose inverses are also functions.

NW-9. -1 cos 1

NW-10. a) $\frac{4}{3}, \frac{5}{3}$ b) $\frac{4}{3} + 2$ n, $\frac{5}{3} + 2$ n

NW-11. a) $7 + \frac{13}{2} + 5$ b) $\sum_{k=1}^{3} \frac{1}{2}(k \quad 1)^2 + 7$

NW-12. a) b = 5 b) y = 0.5 c) sin z = 1, $\frac{}{2} + 2$ n

NW-13. $x = \frac{a + 2b}{5}$, $y = \frac{3b \quad a}{5}$ NW-14. 25.6 feet

NW-15. a) $\frac{5}{6}, \frac{7}{6}$ b) $\frac{5}{6} + 2$ n, $\frac{7}{6} + 2$ n

NW-16. Domain = (-5, 7) and Range = [-2, 4]

NW-17. b) Because inverses are symmetric about the line y = x.
c) No, because the vertical line test for functions fails.

NW-18. a) $[-\frac{}{2}, \frac{}{2}]$ b) $[\frac{}{2}, \frac{3}{2}]$ c) Domain is [-1, 1] and Range is $[-\frac{}{2}, \frac{}{2}]$

NW-19. a) 1.047

b) It is not in the range of $y = \sin^{-1}(x)$. $\sin^{-1}$ selects only one of the infinitely many solutions to the equation.

c) $x = \frac{}{3} + 2 \quad n$ or $\frac{2}{3} + 2 \quad n$

d) You have to use the unit circle or a wave.

NW-20. a) No, it does not pass the vertical line test

b) [0,] and [, 2] c) [0,]

d) Domain = -1 x 1, Range = 0 x

NW-21. $y = \sin^{-1}x$: D: [-1, 1], R: $[-\frac{}{2}, \frac{}{2}]$; $y = \cos^{-1}x$: D: [-1, 1], R: [0,]

NW-22. a) It is not in the range of $y = \cos^{-1}(x)$. $\cos^{-1}$ selects only one of the infinitely many solutions to the equation.

b) $x = \frac{}{3} + 2 \quad n, \frac{5}{3} + 2 \quad n$ c) You have to draw and think.

NW-23 0, , 2

NW-24. a) The equation $\cos x = -0.3$ will have multiple solutions.

b) Sylvie needs to include all the solutions, which she can get using a graph or unit circle. She needs to add multiples of 2 , and include the negative values. $x = \pm 1.875 + 2 \quad n$, where n is an integer.

NW-25. a) $\frac{}{3}$ b) $\frac{}{4}$ c) $\frac{3}{4}$ d) $\frac{}{6}$

NW-26. $-\frac{\sqrt{5}}{3}$ NW-27. $x = \frac{3 \pm i\sqrt{66}}{5}$

NW-28. a) $\frac{2x(x \ 1)}{3y}$ b) 2x + h

NW-29. a) 7.071 feet b) 6.403 feet

NW-30. $\sin^{-1}(1) = \frac{}{2}$ 1.571. $\frac{1}{\sin 1}$ = 1.188. It is confusing because $\sin^2(x) = (\sin x)^2$, but $\sin^{-1}(x) \ \pi \ (\sin x)^{-1}$.

NW-31. a) -6 b) 1 c) 1

d) 6 e) impossible f) $\frac{2}{3}$

NW-32. at x = 0, -2, 3 NW-33. Answers vary.

NW-34. a) vertical asymptotes: x = $\frac{3}{2}$, $\frac{}{2}, \frac{}{2}, \frac{3}{2}$ b) roots: -2 , - , 0, , 2

NW-35. a) x π $\frac{n}{2}$, where n is any odd integer b) all real numbers
c) y = 0, x = ± n, n is any integer
d) x = $\frac{n}{2}$, where n is any odd integer e) increasing; odd

NW-36. a) Restrict the domain b) (-$\frac{}{2}$, $\frac{}{2}$)
c) Domain: all real numbers, Range: (-$\frac{}{2}$, $\frac{}{2}$)

NW-37. a) sin $^{1}\left(\frac{4}{5}\right) = 0.927$ b) x = 0.927 and 2.214
c) 0.9273 + 2 n, 2.2143 + 2 n, n is an integer.

NW-38. a) 1.128, 5.155 b) no solution
c) 3.871 + 2 n, 5.553 + 2 n d) 1.823 + 2 n, 4.460 + 2 n

NW-39. tan = $\frac{y}{x}$ NW-40. $\frac{8}{22.5}$, = 19.573∞ NW-41. 2.572

NW-42. a) $\frac{}{6}, \frac{5}{6}$ b) + 2 n, n is an integer.
c) $\frac{}{4} + 2$ n, $\frac{3}{4} + 2$ n d) no solutions

NW-43. Yes, the first is the inverse function, the second the reciprocal function of y = cos x

NW-44. It is false. For example, take = $\frac{}{6}$, = $\frac{}{3}$

NW-45. a = 8, b = 2 NW-46. -11 + 2i NW-47. A = 2, B = -2

NW48. Amplitude = 3, Horizontal shift = 2 to the right, Vertical shift = 1 up, Period = 4

NW-49. -$\sqrt{3}$

NW-50. Laurel is. Hardy's equation only shifts the graph $\frac{}{6}$ to the right.

NW-51. y = 2 sin (3 (x –)) + 4

NW-52. a) 2, $\frac{}{2}$ to the right, 3 down, p = b) $y = 2 \sin 2(x - \frac{}{2}) - 3$

NW-55. a) (0.4, 46) and (2.2, 26)
b) period = 3.6, amplitude = 10, horizontal shift = .4 or -1.4, vertical shift = 36
c) One possible answer is $h = 10 \cos ((\frac{5}{9})(t - 0.4)) + 36$.

NW-56. a) $\frac{5}{8}$ b) $-\frac{\sqrt{39}}{8}$ c) $-\frac{5}{\sqrt{39}} = -\frac{5\sqrt{39}}{39}$

NW-57. a) The range of sine and cosine is -1 y 1.
b) A fraction can equal $\frac{3}{7}$ without the numerator being 3 and the denominator being 7. For example, $\frac{0.3}{0.7} = \frac{3}{7}$.
c) 0.405 or 3.546

NW-58. $x = \pm\sqrt{\frac{ab}{ae\ 1}}$ NW-59 a) 7, -3 b) 3, -2 c) -2, $\frac{5}{3}$ d) $\frac{5}{3}$, $-\frac{5}{2}$

NW-60 1 NW-61. $y - 912 = \pm 0.532(x - 285)$ NW-62. a) 52.5° b) $\frac{2\ ^2}{45}$

NW-66. a) $\frac{\sqrt{6}\ \sqrt{2}}{4}, 0.259$ b) $\frac{\sqrt{6}+\sqrt{2}}{4}, 0.966$ c) $\frac{\sqrt{6}+\sqrt{2}}{4}, 0.966$ d) $\frac{\sqrt{6}\ \sqrt{2}}{4}, 0.259$

NW-67. 0.738 NW-68. a) sin b) cos

NW-69. a) $-\frac{3}{5}$ b) $-\frac{\sqrt{7}}{4}$ c) $\frac{12\ \ 3\sqrt{7}}{20}$ d) $\frac{9+4\sqrt{7}}{20}$

NW-70. cos (–) = -cos NW-71. sin (–) = sin

NW-72. a) $\frac{}{2}, \frac{3}{2}$ b) $\frac{5}{4}, \frac{7}{4}$ c) $\frac{}{2}, \frac{3}{2}, \frac{5}{4}, \frac{7}{4}$ d) $\frac{}{2} +$ n, $\frac{5}{4} + 2$ n, $\frac{7}{4} + 2$ n

NW-73. b) f(x) = x, g(x) = $\frac{1}{x}$

NW-75. a) $2x^2y^2z^3(5x + 6z^2)$ b) $(x-1)^2 y (5y^2 + 8z)$

NW-76 $7 - 3 \sin^2 z$ NW-77. a) z = 2, 3 b) z = 1.5

NW-78. $y = 8 \cos\left(2\left(x + \frac{}{6}\right)\right)$ 4 NW-79. = $\frac{}{3}$

NW-80. $y = 20\cos\frac{}{6}(x \quad 2) + 44$

a) 49.18 inches b) at approximately 9:39 AM

NW-81. 1) $h = 34\cos \quad (t - 1.25) + 34$

a) 49.44 cm b) 0.526 sec and 1.974 sec

2) $h = 4\cos\left(\frac{2}{3}(x \pm 2)\right) + 5$

a) 7.677 feet b) 1.528 sec and 2.472 sec

3) $d = 29\sin\left(\frac{}{3}(t \pm 5.5)\right) + 54$

a) 68.5 cm b) 3.273 seconds

4) $h = 23\cos\left(\frac{8}{3}(x \pm 0.125)\right) + 38$

a) 40.404 cm b) 0.075 seconds

5) $F = 19\sin\left(\frac{}{12}(t \pm 10)\right) + 84$

a) 88.918° b) 1.164 hours after noon or about 1:10 PM

6) $A = 1.1\sin\left(\frac{}{3}(t \pm 3.5)\right) + 1.7$

a) 1.7 liters b) 4.051 seconds

7) $h = 15.5\sin\left(\frac{5}{2}(t \pm 3.4)\right) + 23.5$

a) 23.5 cm b) 0.105 seconds

8) $h = 31\sin(\quad(t - 3.5)) + 71$

a) 102 cm b) 0.710 seconds

9) $h = 6\cos\left(\frac{}{4}(t \pm 5)\right) + 12$

a) 7.757 cm b) 3.929 seconds

NW-82. a) $a = \pm\frac{\sqrt{21}}{3}, \pm\frac{i\sqrt{21}}{3}$ b) $x = \frac{1 \pm i\sqrt{47}}{6}$

c) $y = 7$ d) $x = 9, -1$

NW-83. a) $y = 2 + 4\sin x$; other answers are possible.

b) $y = 2 + 4\cos\left(x - \frac{}{2}\right)$; other answers are possible.

NW-84. a) $\frac{\sqrt{5}}{3}$ b) $\frac{\sqrt{15}}{4}$ c) $\frac{2 \quad 5\sqrt{3}}{12}$

d) $\frac{\sqrt{5} \quad 2\sqrt{15}}{12}$ e) -0.459

NW-85. $\sin = \frac{3}{5}, \tan = \frac{3}{4}, \csc = \frac{5}{3}, \sec = \frac{5}{4}$, and $\cot = \frac{4}{3}$

NW-86. $x = 10$ NW-87. $x = -4.5,\ y = 5$ or $x = 1.5,\ y = -1$

NW-88. $\frac{ab}{b \quad a}$ NW-89. $\frac{13}{19}$

NW-90. a) $\frac{2}{3}$ b) 2 c) 10 d) 10

NW-91. -sin NW-92. $\frac{}{6} +$ n, $\frac{5}{6} +$ n

NW-93. a) sin (+) or sin cos + sin cos

NW-94. a) cos (+) or cos cos – sin sin

NW-96. a) sin 6x b) 1 c) cos 80˚
d) cos (2y – 10) e) sin 70˚ f) cos 4w

NW-97. $= \frac{}{2}$ NW-99. a) sin $= \frac{5}{\sqrt{34}}$, cos $= \frac{3}{\sqrt{34}}$, tan $= \frac{5}{3}$

b) csc $= \frac{\sqrt{34}}{5}$, sec $= \frac{\sqrt{34}}{3}$, cot $= \frac{3}{5}$

c) sin 2 $= \frac{15}{17}$, cos 2 $= \frac{8}{17}$, sin $\frac{}{2} = \frac{\sqrt{578+(51\sqrt{34})}}{34}$

NW-100. a) x = 0, 1, 2, 3 b) x = 995

NW-101. a) $2 + \frac{x}{y} + \frac{y}{x}$ b) xy

NW-102. a) 3 + 2i b) a = -6, b = 13 c) a = -4 + 2i, b = 3 – 2i

NW-103. $\sin 2x = \frac{24}{25}$, $\cos 2x = \frac{7}{25}$, $\sin \frac{x}{2} = \frac{3}{\sqrt{10}}$, $\cos \frac{x}{2} = \frac{1}{\sqrt{10}}$

NW-104. x 6.176 NW-105. a) x π 2, -2 b) x = 2, -2

NW-106. a) sin 10p b) sin $\frac{}{12}$ NW-107. 0.340, 2.802

NW-109. After using the sum and difference rules, find the product. Use the Pythagorean Identity to express a in terms of sine, b in terms of cosine.

NW-110. $d = \frac{3h}{h \ 1.62}$

NW-111. a) $(3a - 2b)^5$
b) $243a^5 – 810a^4b + 1080a^3b^2 – 720a^2b^3 + 240ab^4 – 32b^5$

NW-112. 9 NW-113. a) y = 100 - x b) 200x – 2 x^2

NW-114. The total length is 551.379 cm

Teacher's Solution: Draw a line through B parallel to CD meeting AC at E. Then AE = 60 cm , AB = 100 cm, and ABE is a right triangle. Hence BE = CD = 80. Let be the central BAC. Then cos = 0.6, so 0.927 radians. Thus the wire length around the large log is 80(2 – 2(0.927)) cm. The wire around the small log is 20(2(0.927) cm in length and the wire between the logs is 2(80) cm. Thus, the total length is $160 + 160 \quad 120\cos^{1}(0.6) \quad 551.379$

NW-115. a) 45 b) 2 NW-116. $-\frac{3}{2}\cos\left(\frac{}{2}(x \pm 2)\right) + 3.5$

NW-117. $\cos x = \frac{\sqrt{5}}{3}$, $\tan x = \frac{2}{\sqrt{5}}$, $\csc x = \frac{3}{2}$, $\sec x = \frac{3}{\sqrt{5}}$, $\cot x = \frac{\sqrt{5}}{2}$

NW-118. a) $2\sin^2 x \pm \sin x \quad 3 = 0$ c) $\frac{3}{2}$

NW-119. a) c = 0, $\frac{1}{2}$ b) $\frac{}{2}$ NW-120. a) $\frac{}{2}, \frac{3}{2}, \frac{}{3}, \frac{5}{3}$ NW-121. n

NW-122. c) + 2 n NW-123. a) x = 0, , 2 b) x = $\frac{}{3}$

c) $\frac{}{4}, \frac{}{2}, \frac{5}{4}, \frac{3}{2}$, all + 2 n d) $x = \frac{2}{3}, \frac{5}{3}$

NW-124. a) cosine, secant b) sine, cosecant, tangent, cotangent

NW-125. A = 2, B = -2 NW-126. $x = \frac{1+i}{2}$ NW-129. x = 3, y = 6

NW-130. a) x π 7 b) y goes to • c) y goes to -•
d) It approaches y = 2 e) It approaches y = 2

NW-131. a) = 0, $\frac{}{2}$, , $\frac{3}{2}$, 2 b) = $\frac{}{4}, \frac{3}{4}, \frac{5}{4}, \frac{7}{4}$

NW-134. a) 480 seconds b) $y = 7\sin(\frac{}{2}x)$ c) $y = \frac{2}{}\sin^{1}\left(\frac{x}{7}\right)$

NW-135. a) 3.055 feet b) at 0.2704 and 2.2296 seconds

NW-136. a) 29.6˚ b) in 20 seconds c) $= \tan^{-1}\left(\frac{125}{220\ \ 11t}\right)$

NW-137. a) 0, , 2 , $\frac{}{6}, \frac{5}{6}$ b) 0, , $\frac{}{6}, \frac{5}{6}$, all + 2 n

c) 0, , 2 , $\frac{}{3}, \frac{5}{3}$ d) 0, , $\frac{}{3}, \frac{5}{3}$, all + 2 n

NW-139. $\sin^{-1}$: $[-\frac{}{2}, \frac{}{2}]$, $\cos^{-1}$: $[0, \quad]$, $\tan^{-1}$: $(-\frac{}{2}, \frac{}{2})$

NW-141. a) $\frac{1\pm\sqrt{11}}{2}$ b) 1, 1 c) 4 d) -3, $\frac{5}{2}$

NW-142. 12, 16, 20

NW-144. a) $\frac{}{2}, \frac{3}{2}$, both $+ 2$ n b) $\frac{}{6}, \frac{5}{6}, \frac{7}{6}, \frac{11}{6}$, all $+ 2$ n

NW-145. $y + 5 = -\frac{9}{5}(x \pm 2)$

NW-146. $x^2(a \pm b)(a + b)\left(a^2 + b^2\right)$

