1. (a) horizontal ≈ 0.45   (b) vertical ≈ 0.89   (c) vertical ≈ -0.35   (d) horizontal ≈ -0.49

   (e) horizontal ≈ 0.93   (f) vertical ≈ 0.81   (g) vertical ≈ -0.55

2. (a) When the horizontal displacement is 0.3, arc ≈ 1.27 or 5.01
   (b) When the vertical displacement is 0.7, arc ≈ 0.78 or 2.36
   (c) When the vertical displacement is -0.7, arc ≈ 3.90 or 5.50

5. The point associated with arc $-x$ on the unit circle has the same horizontal displacement as x and the opposite vertical displacement. Therefore:

   (a) not true   (b) true

   (c) true   (d) not true

19.2 Modifying the Graphs of Sine and Cosine

4. (a)
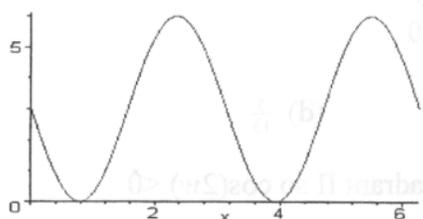
   (b) amp = 3,   period = π

5. (a) Domain = R, Range = [-3,3] (b) Domain = R, Range = [0,2] (c) Domain = R, Range = [-1,1]

   (d) Domain = R, Range = [-3,1] (e) Domain = $\cdots \cup [-2\pi,-\pi] \cup [0,\pi] \cup [2\pi,3\pi] \cup \cdots$, Range = [0,1]

7. (a) B = $\frac{2\pi}{2}$, vertical shift up $\frac{1}{2}$, and double the amplitude is 1, so $y = \frac{1}{2}\cos(\pi x) + \frac{1}{2}$

   (b) B = $\frac{2\pi}{20}$, vertical shift up $\frac{\pi}{2}$ and double amplitude of 3π so $y = \frac{3\pi}{2}\cos(\frac{\pi}{10}x) + \frac{\pi}{2}$

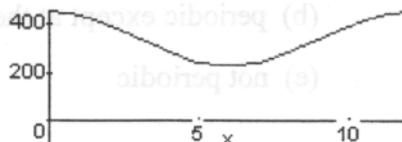14. $B(12) = 2\pi \Rightarrow B = \frac{\pi}{6}$.

   $A = \frac{450-130}{2} = 110$

   baseline value = $\frac{450+230}{2} = 340$ so

   (a) $R(t) = 110\cos(\frac{\pi}{6}t) + 340$

   (b) average = 340 mm

   c) $340(12) = 4080$,

   $\frac{4080-4370}{4080} = -7.1\%$. Prediction is too low.

15. (a) $p = 12 = \frac{2\pi}{\frac{\pi}{6}}$, $a = \frac{23-4}{2} = \frac{19}{2}$, balance value = $\frac{23+4}{2} = \frac{27}{2}$ $\Rightarrow R(t) = -\frac{19}{2}\cos(\frac{\pi}{6}t) + \frac{27}{2}$ or

   $R(t) = \frac{19}{2}\sin(\frac{\pi}{6}(t-3)) + \frac{27}{2}$

   (b) balance value = $\frac{27}{2}$ so average rain days per year = $\frac{27}{2}$ times 12 = 162 rain days per year.

19.3 The function $f(x) = \tan x$

2. We see from the graph that   (a) $-\infty$ (b) ∞ (c) the two sided limit doesn't exist.

4. The period of tan is π and tan is an odd function

   (a) $\tan(\alpha + \pi) = \tan(\alpha) = b$ 6. $\tan x = 0$ whenever vertical component = 0, when $x = k\pi$, $k \in \mathbf{Z}$

   (b) $\tan(-\alpha) = -\tan(\alpha) = -b$ 12. (a) $x = \beta + k\pi$, $k \in \mathbf{Z}$

   (c) $\tan(\pi - \alpha) = \tan(-\alpha) = -b$ (b) $x = -\beta + k\pi$, $k \in \mathbf{Z}$