$1 = \frac{2\pi}{b}$   $b = 2\pi$

**2.16 Sinusoidal Modeling Day 2**    Date Key

1. A certain person's blood pressure oscillates between 140 and 80. If the heart beats once every second, write a sine function that models the person's blood pressure.

period $= 1$   $a = 30$ 140, 80   $d = 110$   $a = 30$

period $= \frac{2\pi}{b}$

$a = 30$
$b = 2\pi$
$c = 0$
$d = 110$

$y = 30\sin(2\pi x) + 110$

2. A rodeo performer spins a lasso in a circle perpendicular to the ground. The height of the knot from the ground is modeled by $h = -3\cos\left(\frac{5\pi}{3}t\right) + 3.5$, where $t$ is the time measured in seconds. $a = 3$  $d = 3.5$

 a. What is the highest point reached by the knot? 6.5 feet

 b. What is the lowest point reached by the knot? 0.5 feet

$a = 3$, $a = 3$, 6.5, $d = 3.5$, 0.5

 c. What is the period of the model?

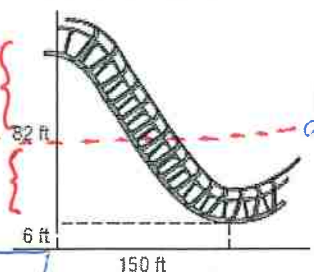
$\text{period} = \frac{2\pi}{5\pi/3} \rightarrow 2\pi \cdot \frac{3}{5\pi} = \frac{6}{5} = 1.2 \text{ seconds}$

 d. According to the model, find the height of the knot after 25 seconds.

$h(25) = -3\cos\left(\frac{5\pi}{3} \cdot 25\right) + 3.5 = \boxed{2 \text{ feet}}$

3. Part of a roller coaster track is a sinusoidal function. The high and low points are separated by 150 feet horizontally and 82 feet vertically as shown. The low point is 6 feet above the ground.

 a. Write a sinusoidal function that models the distance the roller coaster track is above the ground at a given horizontal distance $x$.




$a = 41$, 41, $d = 47$

150 feet is half the period (half the cycle)

period $= 300$
period $= \frac{2\pi}{b}$
$300 = \frac{2\pi}{b}$
$300b = 2\pi$

$b = \frac{2\pi}{300} = \frac{\pi}{150}$
$a = 41$  $c = 0$
$d = 47$

$\boxed{y = 41\cos\left(\frac{\pi}{150}x\right) + 47}$

 b. Point A is 40 feet to the right of the *y-axis*. How far above the ground is the track at point A?

$y(40) = 41\cos\left(\frac{\pi}{150} \cdot 40\right) + 47 \approx \boxed{74.434 \text{ feet}}$

4. A buoy, bobbing up and down in the water as waves pass it, moves from its highest point to its lowest point and back to its highest point every 10 seconds. The distance between its highest and lowest points is 3 feet.

$a = 1.5$   3 feet

 a. Determine the amplitude and period of a sinusoidal function that models the bobbing buoy.

$a = 1.5$ | period $= 10$ | period $= \frac{2\pi}{b}$ | $10 = \frac{2\pi}{b}$ | $10b = 2\pi$, $b = \frac{2\pi}{10} \rightarrow b = \frac{\pi}{5}$

 b. Write an equation of a sinusoidal function that models the bobbing buoy, using x = 0 as its highest point.

*use cosine

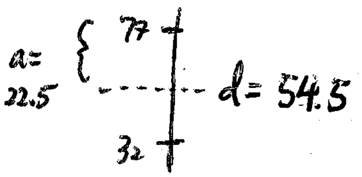
$\boxed{y = 1.5\cos\left(\frac{\pi}{5}x\right)}$

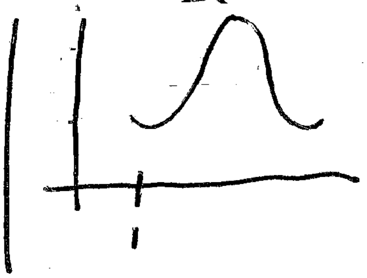
$a = 1.5$
$b = \pi/5$
$c = 0$
$d = 0$

5. The average monthly temperatures for Baltimore, Maryland, are shown below.

a. Determine the amplitude, period, phase shift, and vertical shift of a sinusoidal function that models the monthly temperatures using x = 1 to represent January.

| Month | Temperature (°F) | Month | Temperature (°F) |
|---|---|---|---|
| Jan | 32 | July | 77 |
| Feb | 35 | Aug | 76 |
| Mar | 44 | Sept | 69 |
| Apr | 53 | Oct | 57 |
| May | 63 | Nov | 47 |
| June | 73 | Dec | 37 |




phase shift: $c = 1$

$p = 12$

$p = \frac{2\pi}{b}$

$12 = \frac{2\pi}{b}$

$12b = 2\pi$

$b = \frac{2\pi}{12} = \frac{\pi}{6}$

b. Write an equation of a sinusoidal function that models the monthly temperatures.

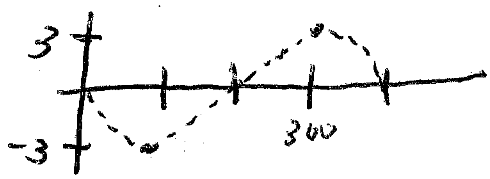
$$y = -22.5 \cos\left[\frac{\pi}{6}(x-1)\right] + 54.5$$

c. According to your model, what is Baltimore's average temperature in July? In December?

$y(7) \approx 77°$  $y(12) \approx 35°$

6. One day all 322 million people in the United States climb up on tables. We all jump off and land on the floor/ground at $t = 0$. The resulting shock as we hit Earth's surface will start the entire earth vibrating in such a way that its surface first moves down from its normal position. At $t = 300$ milliseconds, it has moved up an equal distance above its normal position. The total difference in Earth's vertical position is 6 mm. For an extremely brief amount of time, the vertical position of the surface closely resembles a sinusoidal function.

a. Sketch a graph of Earth's vertical movement over time for this scenario.




b. At what time will the first minimum occur? 100 millisecond

c. What is the period of this function? 400 millisecond

d. What is the amplitude of this function? $a = 3$

e. Write an equation of a sinusoidal function that models Earth's vertical position.

$$d(t) = -3\sin\left[\frac{\pi}{200}(t)\right]$$

$\text{period} = \frac{2\pi}{b}$

$400 = \frac{2\pi}{b}$

$400b = 2\pi$

$b = \frac{2\pi}{400}$

$b = \frac{\pi}{200}$

f. If the wave were to continue, predict the vertical position of Earth 3.25 seconds after our jump.

$t = 3250$ milliseconds

$d(3250) \approx -2.121$

$= 2.121$ mm below normal