1.

Steamboat Problem Mark Twain sat on the deck of a river steamboat. As the paddlewheel turned, a point on the paddle blade moved in such a way that its distance, d, from the water's surface was a sinusoidal function of time. When his stopwatch read 4 s, the point was at its highest, 16 ft above the water's surface. The wheel's diameter was 18 ft, and it completed a revolution every 10 s.

a. Sketch a graph of the sinusoid.

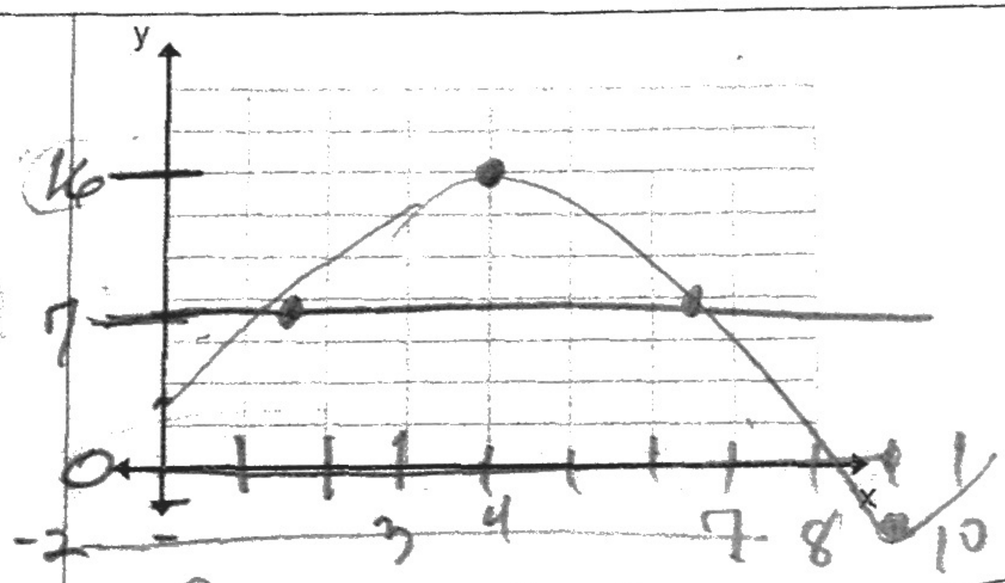
b. Write the equation of the sinusoid.

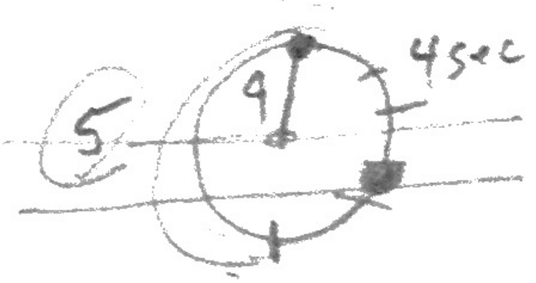
c. How far above the surface was the point when Mark's stopwatch read:

i. 5 s 14.3

ii. 17 s 4.2

d. What is the first positive value of time at which the point was at the water's surface? At that time, was it going into or coming out of the water? Explain.





A: 9
VS: 7
PS: R 4
Period: 10s
b: π/5
Flip: NO

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

$10 = \frac{2\pi}{b}$

$\frac{10b}{10} = \frac{2\pi}{10}$

$b = \pi/5$

$y = 9\cos\frac{\pi}{5}(x-4) + 7$

2.

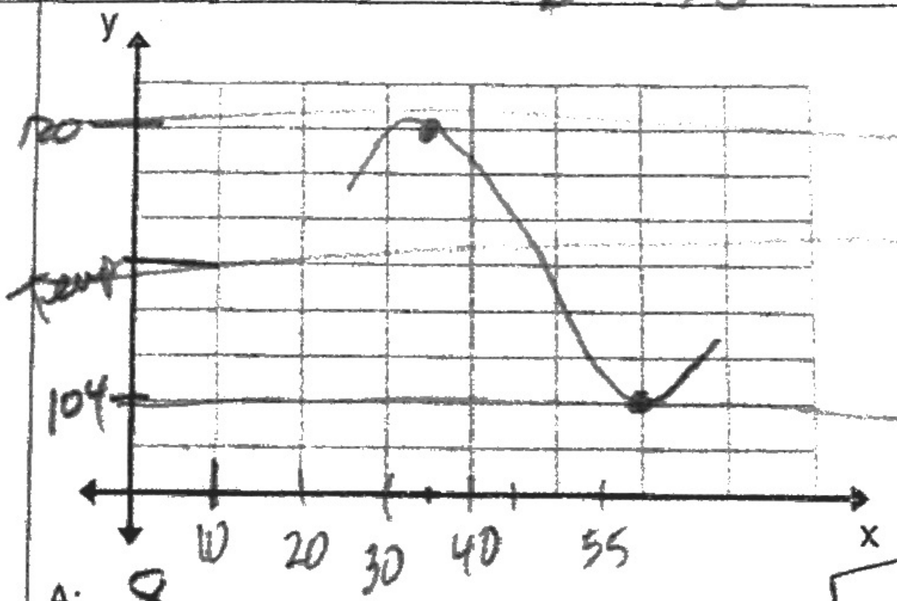
Extraterrestrial Being Problem Researchers find a creature from an alien planet. Its body temperature is varying sinusoidally with time. 35 min after they start timing, it reaches a high of 120°F. 20 min after that it reaches its next low, 104°F.

a. Sketch a graph of this sinusoid.

b. Write an equation expressing temperature in terms of minutes since they started timing.

c. What was its temperature when they first started timing? 117.66

d. Find the first three times after they started timing at which the temperature was 114°F.



A: 8
VS: 112
PS: 35
Period: 40
b: π/20
Flip: NO

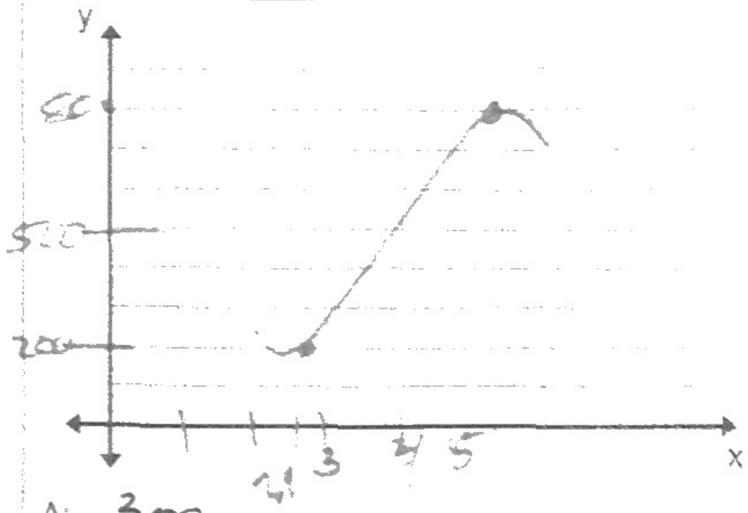
$40 = \frac{2\pi}{b}$

$b = \frac{\pi}{20}$

$y = 8\cos\frac{\pi}{20}(x-35) + 1$

3. *Fox Population Problem* Naturalists find that the populations of some kinds of predatory animals vary periodically. Assume that the population of foxes in a certain forest varies sinusoidally with time. Records started being kept when time $t = 0$ years. A minimum number, 200 foxes, occurred when $t = 2.9$ years. The next maximum, 800 foxes, occurred at $t = 5.1$ years.

a. Sketch a graph of this sinusoid.
b. Write an equation expressing the number of foxes as a function of time, t.
c. Predict the population when $t = 7$.
d. Foxes are declared to be an endangered species when their population drops below 300. Between what two nonnegative values of t were foxes first endangered?
e. Show on your graph that your answers to part (d) are correct.



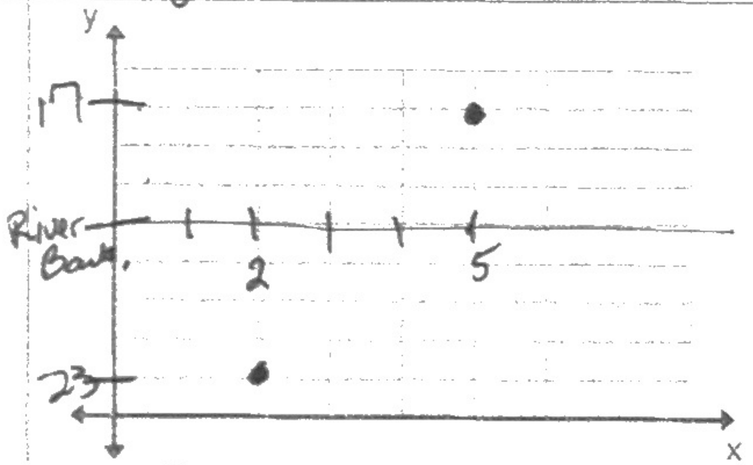
A: 300
VS: 500
PS: 2.9 Rt
Period: 4.4
b: π/2.2
Flip: yes

$y = -300 \cos \frac{\pi}{2}(x - 2.9) + 500$

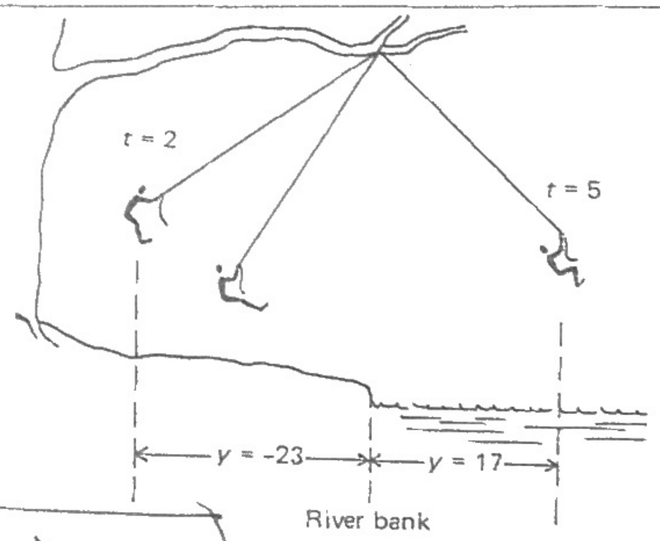
4. *Tarzan Problem* Tarzan is swinging back and forth on his grapevine. As he swings, he goes back and forth across the river bank, going alternately over land and water (Figure 2-12f). Jane decides to model mathematically his motion and starts her stopwatch. Let t be the number of seconds the stopwatch reads and let y be the number of meters Tarzan is from the river bank. Assume that y varies sinusoidally with t, and that y is positive when Tarzan is over water and negative when he is over land.

Jane finds that when $t = 2$, Tarzan is at one end of his swing, where $y = -23$. She finds that when $t = 5$ he reaches the other end of his swing and $y = 17$.

a. Sketch a graph of this sinusoidal function.
b. Write an equation expressing Tarzan's distance from the river bank in terms of t.
c. Predict y when:
   i. $t = 2.8$
   ii. $t = 6.3$
   iii. $t = 15$
d. Where was Tarzan when Jane started the stopwatch?



A: 20
VS: -3
PS: 2
Period: 6
b: π/3
Flip: yes.



$y = -20 \cos \frac{\pi}{3}(x - 2) - 3$