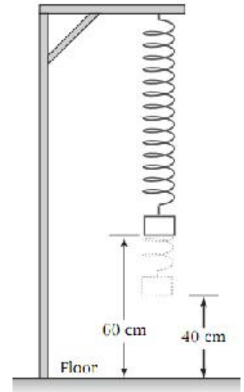
Chapter 5.5: Application of Sinusoids

Now that we've learned how to sketch and write equations of sinusoids, we will learn to now apply them to various applications. It is because we have been graphing our unitless sine and cosine ratios against our unitless radians that we are able to prescribe any units we want to our axes to model any number of situations exhibiting sinusoidal behavior or **simple harmonic motion**.

Example 1:
The Ferris Wheel at the Comal County Fair is a three minute ride that takes its riders on a thrilling ride up to a maximum height of 105 feet and a low point of 5 feet. Assuming that the Ferris Wheel rotates at 6 revolutions per minute and a rider starts his stopwatch immediately as his ride starts at its low point,

(a) Sketch the graph of the rider's height above ground h in feet as a function of time t in seconds since the rider started the stopwatch.
(b) Assuming that h is a sinusoidal function of time t, write a particular equation. Confirm your results by graphing your equation in your graphing calculator in the window in which you sketched it.
(c) How high above the ground is the rider at time 48.5 seconds? At this time, is the rider going up or down?
(d) At what positive time is the rider 88 feet above ground coming down for the third time?
(e) During the 3-minte ride, for how many seconds was the rider above 100 feet? Show the work that leads to your answer.
(f) What is the linear velocity of the rider, in miles per hour, as the Ferris Wheel rotates?

Example 2:
If the rider from Example 1 started his stopwatch when he was 12 feet in the air going up, what would the new equation of his height above ground as a function of time be?



Example 3:
The rider from Example 1 and Example 2 leaves the Fair, goes home, and constructs a perpetual motion machine (shown at right). It is a weight attached to the end of a long spring that is bouncing up and down. As it bounces, its distance from the floor varies sinusoidally with time. The rider sets the spring in motion by compressing it to a high point of 60 centimeters above the floor at which time he starts his stopwatch. 1.8 seconds later, it gets its closest to the floor, 40 centimeters above it.

(a) Sketch the graph of this sinusoidal function.

(b) Find a particular equation for the distance from the floor, in centimeters, as a function of time.

(c) What is the distance from the floor when the stopwatch reads 10.5 seconds. At this time, is the weight moving towards or away from the floor?

(d) What is the first positive value of time when the weight is 47 cm above the floor?

(e) During the first 9 seconds, for how long is the weight at least 53 cm above the floor?

(e) If the rider's little sister starting the machine when the rider was at the Yogurt shop, and the rider came home and happened upon the machine, already in motion, and started his stopwatch when the weight was 51 cm above the floor and moving away from it, what would our new equation be?

Example 4:

The Bay of Fundy in Nova Scotia is known for having the highest tidal range in the world. Approximately every 6 hours 14 minutes, the high tide and low tide switch, with a difference of 55.8 feet in between! If we assume that on a particular day, we observed the low tide at 8:45 A.M.,

(a) Sketch the graph of the tides (in feet) for that entire 24-hour day (in minutes after midnight). Assume the sinusoidal axis is at $y = 0$.

(b) Write an equation that models the motion of the tides.

(c) At midnight the morning of, what was the water level in the Bay of Fundy? At this time, was the tide coming in or going out?

(d) At 7:30 that evening, what was the water level in the Bay of Fundy? At this time, was the tide coming in or going out?

(e) At what times during the day was the water level 25 feet above normal with the tide going out?