

## Section 5.5 Make Connections With Sine Functions

- The height,  $H$ , of the tide in metres in the Gulf of Maine near Yarmouth, NS on a particular day can be approximated by the equation  $H(t) = 2.2 \sin(29.0t - 82.8) + 2.4$ , where  $t$  is the time in hours, and  $0 \leq t \leq 24$ .
  - Use a graphing calculator to graph the function.
  - Determine the maximum height of the tide, and when it occurs.
  - Determine the minimum height of the tide, and when it occurs.
  - Determine the height of the horizontal axis of the wave.
- The population,  $P$ , of hares living in a 30 ha forest can be approximated by the equation  $P(t) = 195 \sin(37.5t + 122.5) + 345$ , where  $t$  is the time, in years since 2008.
  - Use a graphing calculator to graph the function for 20 years.
  - Explain why a sine function was used to model the population of hares.
  - What was the initial population of hares?
  - What is the period of the function?
  - The population,  $P$ , of red foxes living in the same forest can be approximated by the equation  $P(t) = 3 \sin(37.5t + 32.5) + 6$ . Use a graphing calculator to graph the function for 20 years and explain how the populations of hares and foxes are related.
- A steel pedestrian bridge may sway slightly if a large number of people walk on it. During a peak use period, the displacement of the centre of a particular bridge, in millimetres, relative to the normal position, is modelled by  $f(t) = 6 \sin(240t)$ , where  $t$  is the time, in seconds.
  - Sketch a graph of the function for 3 s.
  - What is the displacement after 2 s?
  - How wide is the sway?
  - What is the period of the sway?
- A piston is a cylindrical piece of metal that moves up and down inside a larger, hollow cylinder in an engine. The height of a piston in a small engine, in centimetres, relative to the bottom of the cylinder it is moving in, is modelled by  $H(t) = 6 \sin(3.6t) + 16$ , where  $t$  is the time, in milliseconds.
  - Sketch a graph of this function for 300 ms.
  - Determine the period and amplitude of the function.
  - The stroke length is the total distance the piston travels in half of its period. Determine this piston's stroke length.
  - How would the graph and equation change if the piston moved faster?
- An LFO is an electronic signal frequently used in electronic music and sound design to create interesting effects. The value,  $v$ , in percent, of an LFO is given by the equation  $v = 20 \sin(\frac{4}{5}t + 45)$ , where  $t$  is the time, in milliseconds.
  - Sketch a graph of the function for 1000 ms.
  - What is the amplitude and period of the LFO?
- The distance above or below the centre of a clock,  $D$ , in centimetres, of the tip of a minute hand relative to time can be determined using the formula  $D(t) = A \sin(\omega t + p)$ , where  $t$  is the time in minutes. Substitute values for  $A$ ,  $\omega$ , and  $p$  to model the distance of a minute hand that is 10 cm in length and starts out pointing at 9 on the clock face.
- Without the use of technology, sketch a graph of each function for one period.
  - $f(x) = 3 \sin x + 2$
  - $f(x) = -\sin(x + 90^\circ)$