Chapter 11 / **Example 21**

Area under a velocity–time graph

A hydro-electric power station generates electricity from water flowing through a pipe. During periods of low demand, water is pumped back up the pipe to the reservoir above. Let the volume of water in the reservoir be V and assume that the only water that enters or leaves the lake during this period is through the pipe. The rate at which water flows through the pipe during a 24-hour period is given by the following equation:

$$\frac{\mathrm{d}V}{\mathrm{d}t} = -8.2\sin\left(\frac{\pi}{12}t + \frac{15\pi}{12}\right) - 5$$

where t is measured in hours after midnight and V is measured in millions of litres.

a Sketch the curve for $\frac{\mathrm{d}V}{\mathrm{d}t}$ against time for a 24-hour period.

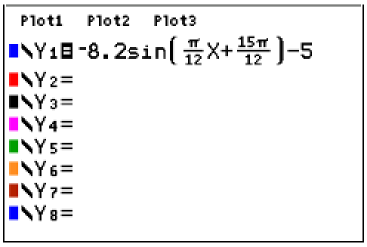
b By calculating an appropriate definite integral, find the net change in the volume of water in the reservoir over a 24-hour period.

c By calculating an appropriate definite integral, find the total amount of water that has passed through the pipe in a 24-hour period.

Press [F1] [Y=] to display the equation entry screen.

Type $-8.2\sin\left(\frac{\pi}{12}x + \frac{15\pi}{12}\right) - 5$ and press [ENTER] to enter the equation as Y_1.

Use the fraction template: [ALPHA] [F1] 1:n/d.

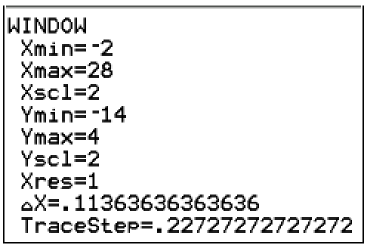


Press [F2] [WINDOW]

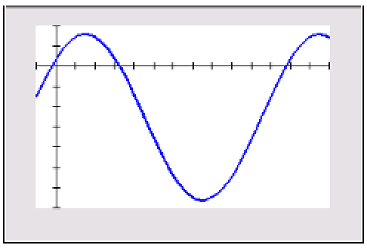
Set the axes to show $-2 \le x \le 28$ and $-14 \le y \le 4$ with the scales set to 2.

You can leave the other items as they are.

Press [F5] [GRAPH] when you have finished.



The GDC displays the graph $Y_1 = -8.2\sin\left(\frac{\pi}{12}x + \frac{15\pi}{12}\right) - 5$.



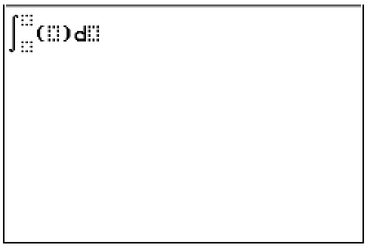
Chapter 11 / **Example 21**

Area under a velocity–time graph

Press 2nd [QUIT].

To enter the integral template press ALPHA [F2] 4:fnInt(.

The template shows places for the limits, the function and the variable that you are integrating with respect to.

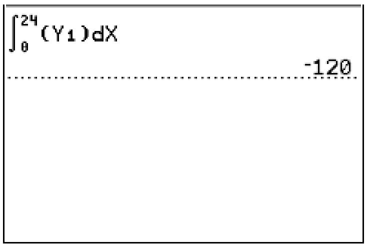


Enter the lower limit 0 and the upper limit 24.

Press ALPHA [F4] 1:Y_1

Type the variable X and press ENTER.

The net change in volume is −120m^3.



Press ALPHA [F2] 4:fnInt(.

Enter the lower limit 0 and the upper limit 24.

Enter the modulus function by pressing ALPHA [F2] 1:abs(

Press ALPHA [F4] 1:Y_1

Type the variable X and press ENTER.

The total amount of water is 149 m^3.