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:

$$\frac{dV}{dt} = -8.2\sin\left(\frac{\pi}{12}t + \frac{15\pi}{12}\right) - 5$$

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

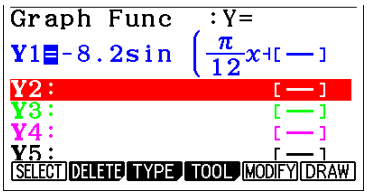
a Sketch the curve for $\frac{dV}{dt}$ against time for a 24-hour period.

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 MENU 5 GRAPH to display the equation entry screen.

Type $-8.2\sin\left(\frac{\pi}{12}x + \frac{15\pi}{12}\right) - 5$ and press EXE to enter the equation as Y1.



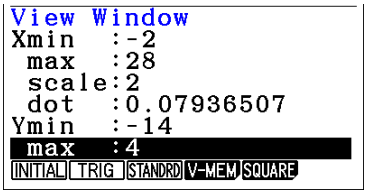
Choose appropriate axes to show the graph.

Press SHIFT F3 V-WIN.

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.

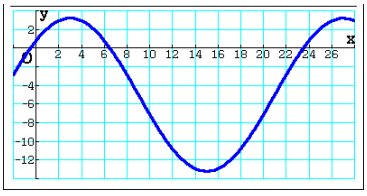
Press EXIT when you have finished.



Press F6 DRAW to display the graph screen.

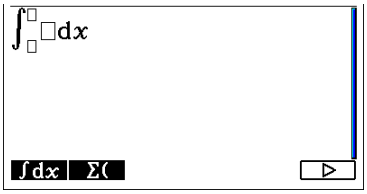
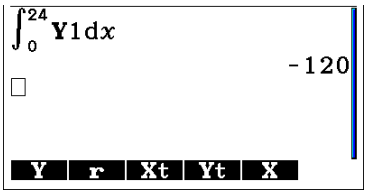
The GDC now displays the quadratic function

$$Y1 = -8.2\sin\left(\frac{\pi}{12}x + \frac{15\pi}{12}\right) - 5.$$



Chapter 11 / **Example 21**

Area under a velocity–time graph

Press MENU 1 RUN·MAT to display the Run-Matrix screen for arithmetical calculations. Press F4 MATH F6 ▷ F1 ∫dx You will see an integral template. There are three fields to complete in the template: one for each of the limits and one for the function you are integrating.	
Press VARS F4 GRAPH F1 Y and type 1. Enter the lower limit 0 and the upper limit 24. Press EXE. The net change in volume is $-120 m^3$.	
Press EXIT twice. Press F4 MATH F6 ▷ F1 ∫dx Enter the modulus function by pressing F6 ▷ F3 Abs Press VARS F4 GRAPH F1 Y and type 1. Enter the lower limit 0 and the upper limit 24. Press EXE. The total amount of water is 149 m^3.