

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.

- Sketch the curve for $\frac{dV}{dt}$ against time for a 24-hour period.
- By calculating an appropriate definite integral, find the net change in the volume of water in the reservoir over a 24-hour period.
- By calculating an appropriate definite integral, find the total amount of water that has passed through the pipe in a 24-hour period.

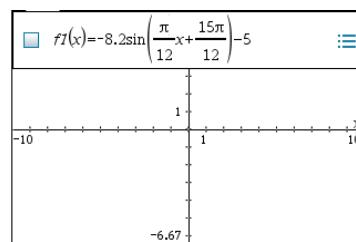
Open a new document and add a Graphs page.

The entry line is displayed at the top of the work area.

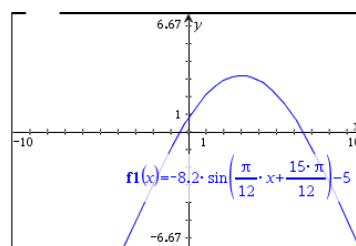
The default graph type is function, so ' $f1(x)=$ ' is displayed.

The default axes are $-10 \leq x \leq 10$ and $-6.67 \leq y \leq 6.67$.

Type $-8.2 \sin\left(\frac{\pi}{12}x + \frac{15\pi}{12}\right) - 5$ and press **enter**.



The GDC displays the graph $f1(x) = -8.2 \sin\left(\frac{\pi}{12}x + \frac{15\pi}{12}\right) - 5$ with the default axes.



Press **menu** 4:Window/Zoom | 1:Window Settings...

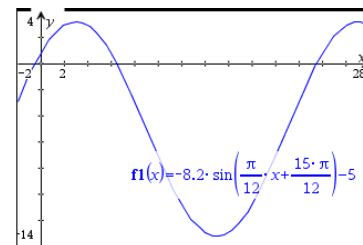
Set the axes to show $-2 \leq x \leq 28$ and $-14 \leq y \leq 4$ with the scales set to 2.

Press **enter** when you have finished.

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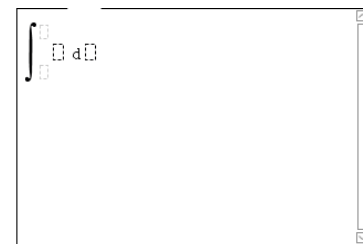
The GDC displays the graph $f1(x) = -8.2 \sin\left(\frac{\pi}{12}x + \frac{15\pi}{12}\right) - 5$.



Press **ctrl** **doc** **(+page)** and add a new Calculator page.

Press **|<|>** and select **|<|>** with the trackpad.

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

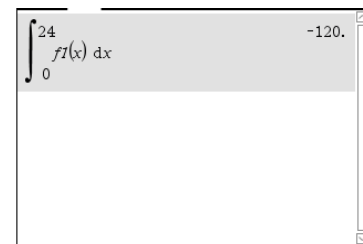


Enter the lower limit 0 and the upper limit 24.

Type f1(x)

Type the variable x and press **enter**.

The net change in volume is -120m^3 .



Press **|<|>** and select **|<|>** with the trackpad.

Enter the lower limit 0 and the upper limit 24.

Enter the modulus function by pressing **|<|>** and selecting **|<|>** with the trackpad.

Type f1(x)

Type the variable x and press **enter**.

The total amount of water is 149 m^3 .

