

## Chapter 8 / Example 7

# Kinematics

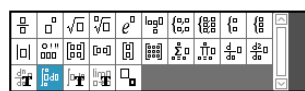
A particle moves in a straight line such that its velocity at any time  $t$  can be modelled by  $v(t) = t - t^3 \text{ ms}^{-1}$ . Find

- the displacement of the particle in the first two seconds, and interpret your answer.
- the total distance travelled by the particle in the first two seconds.

Open a new document and add a 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.




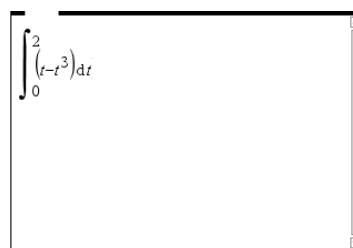
Enter the lower limit 0 and the upper limit 2.

Enter the function  $t - t^3$ .

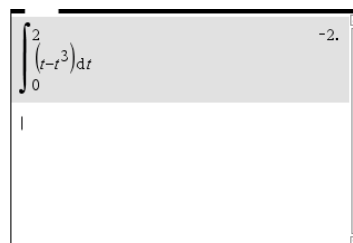
Use     or  to navigate around the template.

Type  $t$ .




Press .



The solution shows that the displacement is  $-2$ , which is 2 m to the left of the starting position.




To understand this, you will look at the graph of the function.

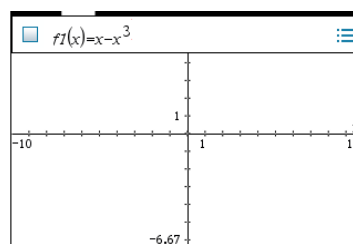
Add a new Graph page by pressing   ().

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  $-6.67 \leq y \leq 6.67$ .

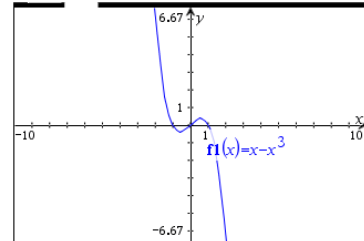
Type  $x - x^3$  and press .



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The GDC displays the curve  $f_1(x) = x - x^3$  in the default window.

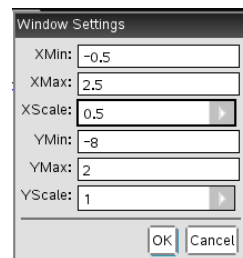


To view the curves in a suitable window Press

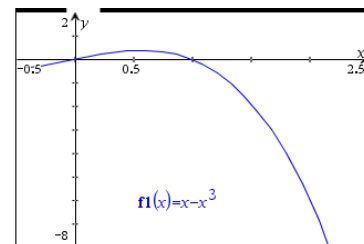
**menu** 4:Window/Zoom | 1:Window Settings...

Set the axes to show  $-0.5 \leq x \leq 2.5$  with a scale of 0.5 and  $-8 \leq y \leq 2$  with a scale of 1.

Press **enter** when you have finished.



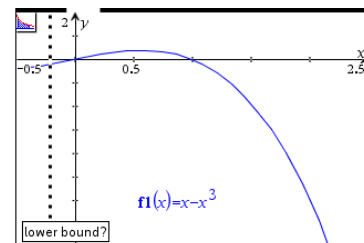
The GDC displays the curve  $f_1(x) = x - x^3$  in a suitable window.



To find the integral press **menu** 6:Analyze Graph | 6:Integral.

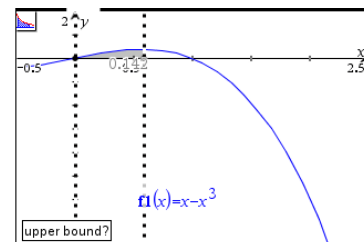
To find the intersection you need to give the lower and upper bounds of the region that includes the intersection.

The GDC shows a line and asks you to set the lower bound.



Do not use the line to set the lower bound as you need to enter an exact value.

Type  $-2$  and press **enter**.



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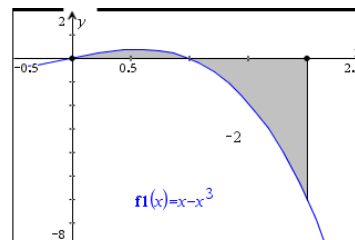
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Type 2, the upper bound, and press **enter**.

The GDC shows the area defined by the integral and its value.

$$\int_0^2 (x - x^3) dx = -2.$$

As you can see part of the area shaded is above and part below the x-axis.



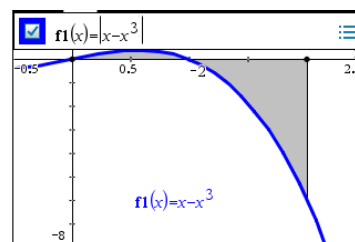
To find the total distance travelled the two portions of the area could be calculated separately. Alternatively, the function

$$f1(x) = |x - x^3| \text{ could be used.}$$

Click the trackpad twice on the label f1(x) to display the entry line. Select  $x - x^3$  with the trackpad, press **abs** and select **|** with the trackpad.



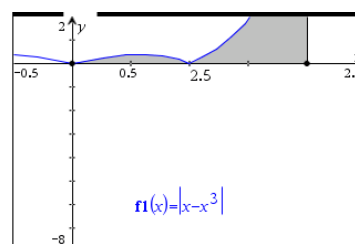
When the function has been edited press **enter**.



The GDC displays the edited function  $f1(x) = |x - x^3|$  with the integral area still shaded.

Click and hold the touchpad somewhere on the white area of the screen. You should see the cursor change to . Drag the axes. This is called panning.

When you have a better view of the curve, click the touchpad again (or press **esc**).

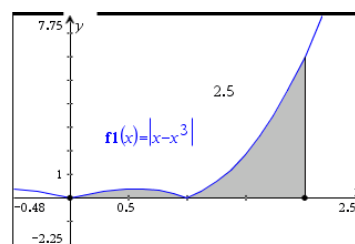


The GDC shows the area defined by the integral and its value.

$$\int_0^2 |x - x^3| dx = 2.5.$$

As you can the whole of the shaded area is above the x-axis.

The total distance travelled is 2.5 m.



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Return to the Calculator page by pressing **ctrl** **◀ del**

Press **∫** and select **∫** with the trackpad.

Enter the lower limit 0 and the upper limit 2.

Enter the function  $|t - t^3|$  by pressing **|** and selecting **t** with the trackpad to enter the modulus function.

Use **◀ ▶ ▲ ▼** or **tab** to navigate around the template.

Type  $t$  and press **enter**.

The solution shows that the total distance travelled is 2.5 m.

The image shows a TI-Nspire CX calculator screen. The top part of the screen displays the definite integral  $\int_0^2 (t - t^3) dt$  with a result of -2. The bottom part of the screen displays the definite integral  $\int_0^2 |t - t^3| dt$  with a result of 2.5. The calculator interface includes a trackpad and various function keys.