Chapter 8 / **Example 7**

Kinematics

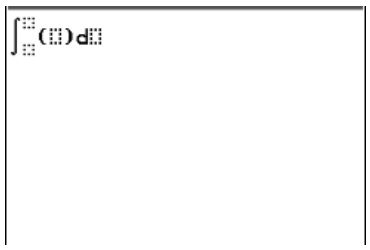
A particle moves in a straight line such that its velocity at any time t can be modelled by $v(t) = t - t^3$ ms^{-1}. Find

a the displacement of the particle in the first two seconds, and interpret your answer.

b the total distance travelled by the particle in the first two seconds.

To enter the integral template press [MATH] [f2] 4:fnInt(.

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



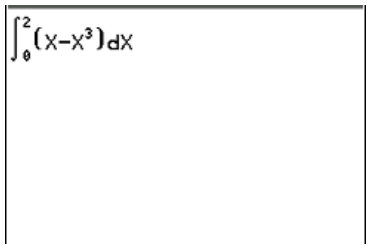
Enter the lower limit 0 and the upper limit 2.

Enter the function $x - x^3$.

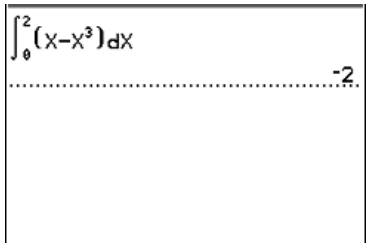
Use [◄] [►] [▲] [▼] to navigate around the template.

Type X.

Press [enter].



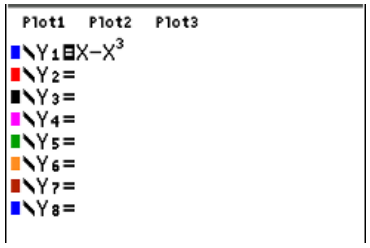
The solution shows that the displacement is −2, which is 2 m to the left of the starting position.



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

Press [f1] [y=] to display the equation entry screen.

Type $x - x^3$ and press [enter] to enter the equation as Y_1.



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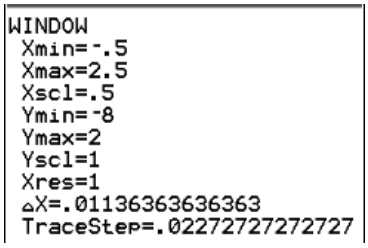
Choose suitable window settings to display the graph.

Press [f2] [window] [format]

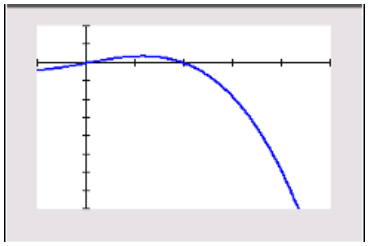
Set the axes to show $-0.5 \leq x \leq 2.5$ with a scale of 0.5 and $-8 \leq y \leq 2$ with a scale of 1.

You can leave the other items as they are.

Press [f5] [graph] when you have finished.



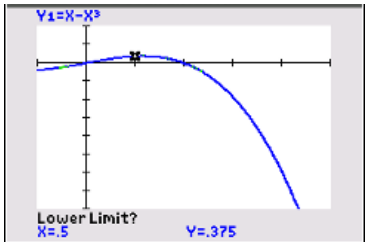
The GDC displays the curve $Y_1 = x - x^3$ in a suitable window.



To find the integral press [2nd] [f4] [calc] 7:∫f(x)dx.

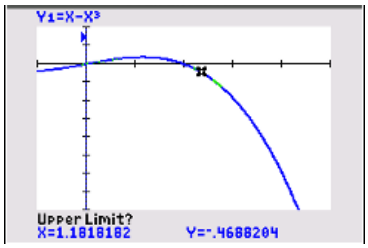
To find the area you need to give the lower and upper limits of the region that includes the intersection.

The GDC asks you to set the lower limit.



Type 0 and press [enter].

The GDC asks you to set the upper limit.

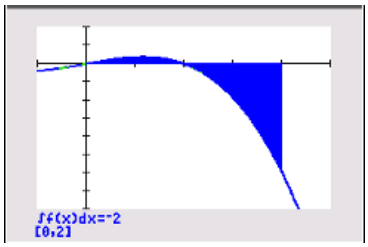


Type 2, the upper limit, and press [enter].

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

$\int_0^2 \left(x - x^3\right) \mathrm{d}x = -2$.

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



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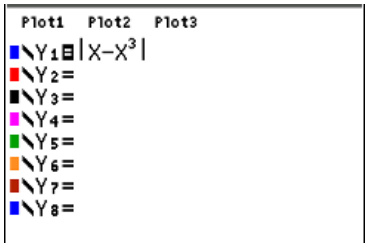
To find the total distance travelled the two portions of the area could be calculated separately. Alternatively, the function $Y_1 = |x - x^3|$ could be used.

Press [f1] [y=] to display the equation entry screen.

Delete Y_1 and press [CLEAR] [f2] [calc] 1:abs(.

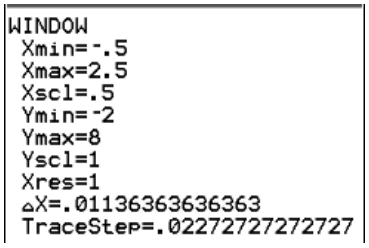
Type $x - x^3$ and press [enter].



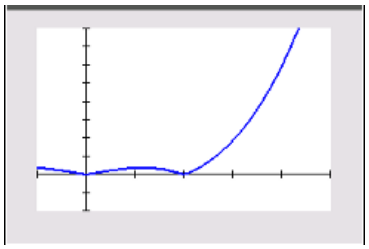
Press [f2] [window] [format]

Change the y-axis to $-2 \leq y \leq 8$ and leave the other items as they are.

Press [f5] [graph] when you have finished.



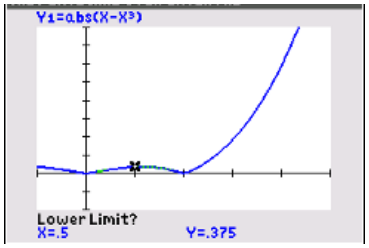
The GDC displays the curve $Y_1 = |x - x^3|$ in a suitable window.



To find the integral press [2nd] [f4] [calc] 7:∫f(x)dx.

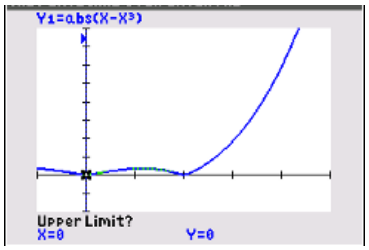
To find the area you need to give the lower and upper limits of the region that includes the intersection.

The GDC asks you to set the lower limit.



Type 0 and press [enter].

The GDC asks you to set the upper limit.



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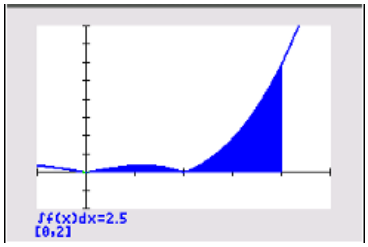
Type 2, the upper limit, and press [enter].

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.



Press [2nd] [quit] to enter the home screen.

Enter the integral template by pressing [MATH] [f2] 4:fnInt(.

Enter the lower limit 0 and the upper limit 2.

Enter the function $|x - x^3|$ pressing [MATH] [f2] [calc] 1:abs(to enter the modulus function.

Use [◀] [▶] [▲] [▼] to navigate around the template.

Type X and press [enter].

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