Chapter 13 / **Example 14**

Displacement and distance

A particle moves along a straight line such that its displacement s in metres from an origin O is given by $s(t) = t^2 - 4t + 3$, for $0 \le t \le 5$, where t is time in seconds.

a Find the velocity of the particle at time t.

b Find when the particle is moving to the right and when it is moving to the left.

c Draw a motion diagram for the particle.

d Write definite integrals for the particle's displacement on the interval $0 \le t \le 5$ and for the distance travelled on the interval $0 \le t \le 5$. Use a GDC to find the value of the integrals. Use the motion diagram to verify the results.

$v(t) = 2t - 4$.

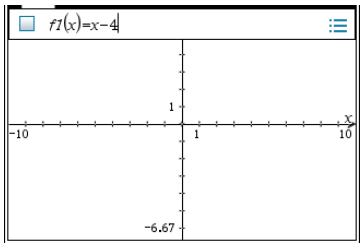
Open a new document and add a Graphs page.

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 $-10 \le x \le 10$ and $-6.67 \le y \le 6.67$.

Type $2x - 4$ and press enter.

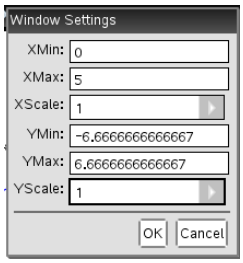


Press menu 4:Window/Zoom | 1:Window Settings…

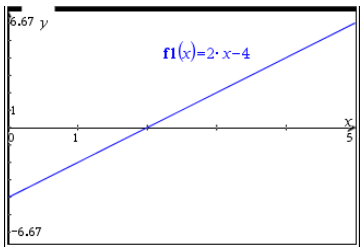
Set the axes to show $0 \le x \le 5$ and change the scales to 1.

You can leave the other settings the same.

Press enter when you have finished.



The GDC displays the velocity time graph for $0 \le x \le 5$.

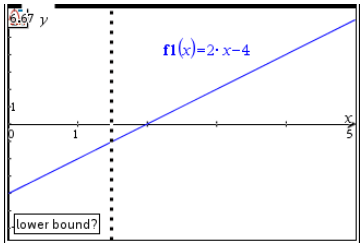


To find the zero press menu 6:Analyse Graph | 1:Zero

You will need to give the lower and upper bounds of the region that includes the zero.

The GDC shows a line and asks you to set the lower bound. Move the line using the touchpad and choose a position to the left of the zero.

Click the touchpad.



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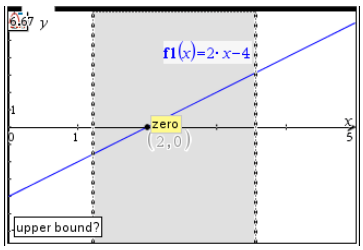
The GDC shows another line and asks you to set the upper bound.

Use the touchpad to move the line so that the region between the lower and upper bounds contains the zero.

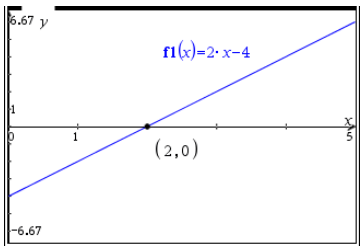
When the region contains the zero, the calculator will display the word 'zero' in a box.

Click the touchpad.



The GDC displays a zero at $(2,0)$.

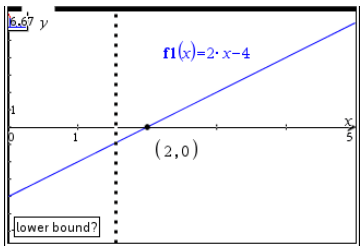
The particle is moving left for $0 < t < 2$ since $v(t) < 0$ on $[0,2]$ and moving right for $2 < t < 5$ since $v(t) > 0$ on $[2,5]$.



To find the displacement between $t = 0$ and $t = 5$ press menu 6:Analyze Graph | 6:Integral

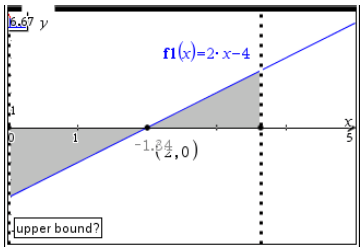
To find the intersection you need to give the lower and upper bounds of the region that includes the intersection.

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 0 and press enter.

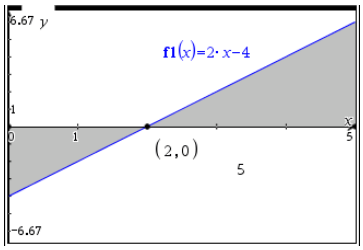


Type 5, the upper bound, and press enter.

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

$\int_0^5 2x - 4\,\mathrm{d}x = 5$

The displacement is 5 m.



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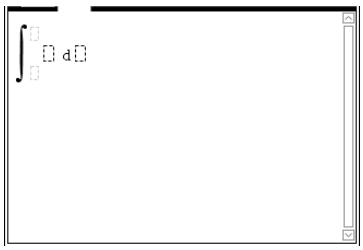
The distance travelled can be calculated using the integral function.

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

Press ▭ and select $\int_{\square}^{\square}\square\,d\square$ with the trackpad.

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



Using the modulus function

Enter the lower limit 0 and using the upper limit 5.

Enter the function $|2x-4|$.

To enter the modulus function press ▭ and select $|\square|$ with the trackpad.

Use | ~ } † to navigate around the template.

Type X.

Press Í.

$$\int_0^5 |2x-4|\,dx = 13$$

The distance travelled is 13 m.