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.

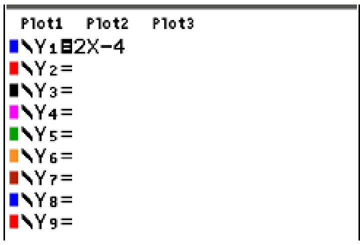
c Draw a motion diagram for the particle.

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.

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

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

Type $2x - 4$ in the template and press [enter] to enter the equation as Y_1.

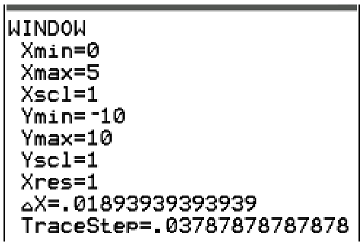


Press [f2] [window]

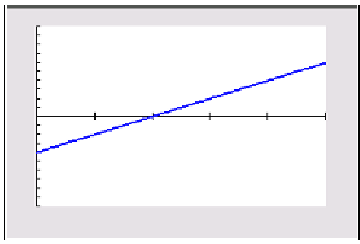
Set the axes to show $0 \le x \le 5$

You can leave the other items as they are.

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



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

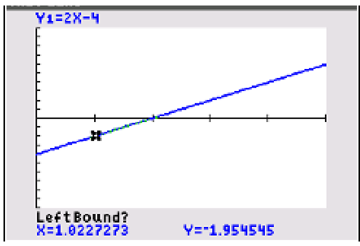


To find the zero press [2nd] [f4] [calc] 2:zero

You will need to give the left and right bounds of the region that includes the zero.

The GDC shows a point on the curve and asks you to set the left bound. Move the point using [▶] [◀] and choose a position to the left of the zero.

Press [enter].



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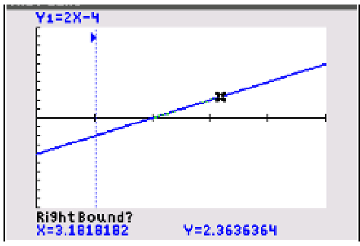
The GDC shows a line where you have set the left bound and a point on the curve.

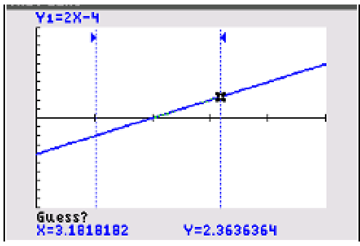
Move the point using ▶ ◀ and choose a position to the right of the zero.

When the region contains the zero, Press enter.



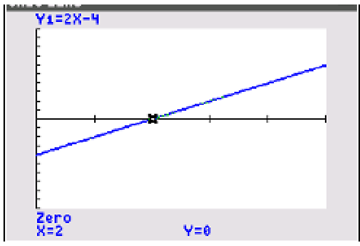
The GDC requires an initial guess for the position of the zero. Choose the default position.

Press enter.



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

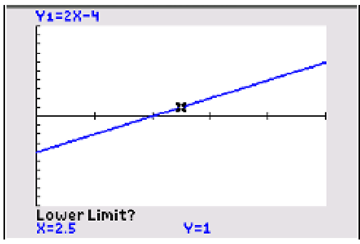
The particle is moving left for $0 < t < 2$ since $v(t) < 0$ on $[0,2]$ and moving right for $2 < t < 5$ since $v(t) > 0$ on $[2,5]$.



To find the displacement between $t = 0$ and $t = 5$ press 2nd [f4] [calc] 7:∫f(x)dx

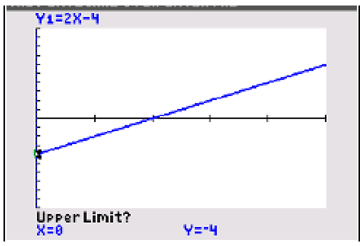
To find the area you need to give the lower and upper limits of the region that includes the intersection.

The GDC asks you to set the lower limit.



Type 0 and press enter.

The GDC asks you to set the upper limit.

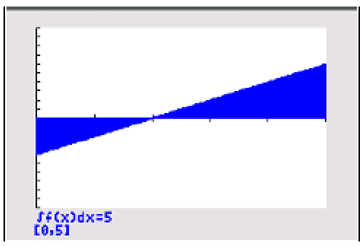


Type 5, the upper limit, and press enter.

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

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

The displacement is 5 m.



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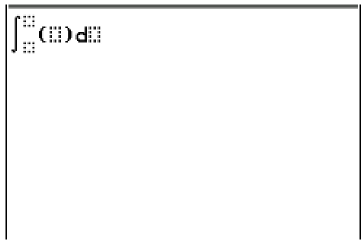
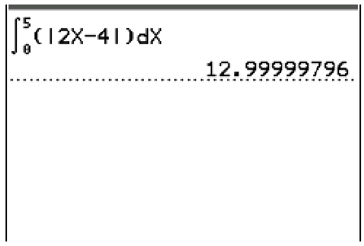
The distance travelled can be calculated using the integral function. Press 2nd [quit]. To enter the integral template press ALPHA [f2] 4:fnInt(. The template shows places for the limits, the function and the variable that you are integrating with respect to.	
Using the modulus function Enter the lower limit 0 and using the upper limit 5. Enter the function $\lvert 2x-4 \rvert$. To enter the modulus function press math ▶ NUM 1:abs(Use ◀ ▶ ▲ ▼ to navigate around the template. Type X. Press enter. $\int_0^5 \lvert 2x-4 \rvert \, dx = 13$ The distance travelled is 13 m.	 *Ignore the rounding error and interpret 12.99999796 to be 13.*