Chapter 12 / **Example 7**

Maximum and minimum points and optimisation

Consider the curve $s = 3t^3 + 2t^2 - 4t + 2$.

a Find $\frac{ds}{dt}$.

b On the same axes, sketch $s = 3t^3 + 2t^2 - 4t + 2$ and its derivative.

c Solve the equation $\frac{ds}{dt} = 0$.

d What feature of $s = 3t^3 + 2t^2 - 4t + 2$ is indicated by these points.

e If the domain of the function is restricted to, $-2 \le t \le 2$ find the actual maximum and minimum values of the function.

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

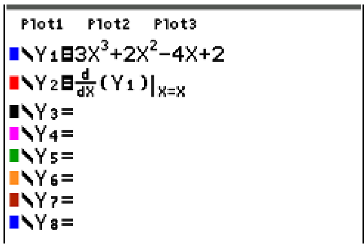
Type $3x^3 + 2x^2 - 4x + 2$ and press [enter] to enter the equation as Y_1.

Press [alpha] [f2] 3:nDeriv

The template has spaces for the variable, x, the function and the value that it is evaluated at.

Type X for the variable, press [alpha] [f4] 1:Y_1 for the function and X for the value that it is evaluated at.

Press [enter] when you have finished.

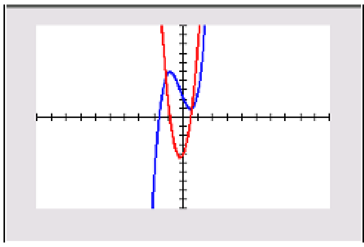


Press [f5] [graph] to display the graph screen.

The GDC now displays the quadratic function:

$Y_1 = 3x^3 + 2x^2 - 4x + 2$ and its derivative.

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

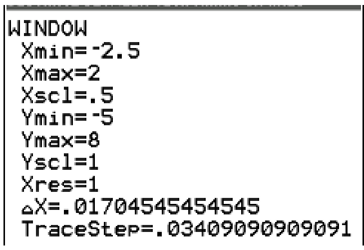


Press [f2] [window][format]

Set the axes to show $-2.5 \le x \le 2$ with a scale of 0.5 and $-5 \le y \le 8$ with a scale of 1.

You can leave the last three items as they are.

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



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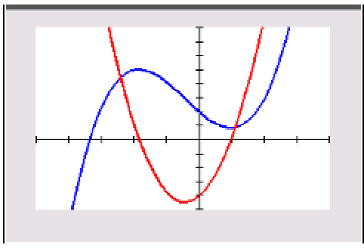
The GDC now displays the function and its derivative in a suitable window.



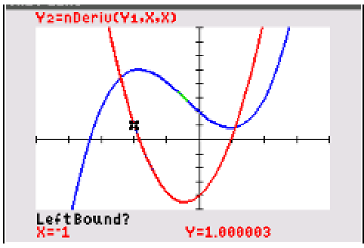
To find the zeros press [2nd] [f4] [calc] 2:zero

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

Select Y_2 using [▲] [▼].

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.

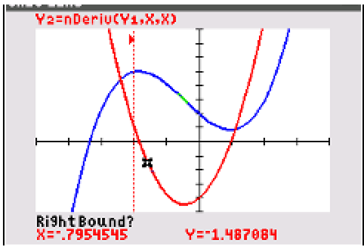
Press [enter].



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

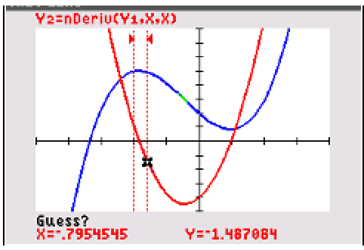
Move the point using [▶] [◀] and choose a position to the right of the zero.

When the region contains the zero, Press [enter].

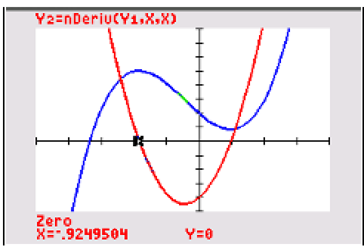


The GDC requires an initial guess for the position of the zero. Choose the default position.

Press [enter].



The GDC displays a zero at $(-0.925, 0)$.



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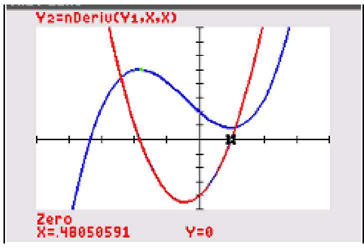
Maximum and minimum points and optimisation

Repeat for the second zero.

The GDC displays a zero at $(0.481, 0)$.



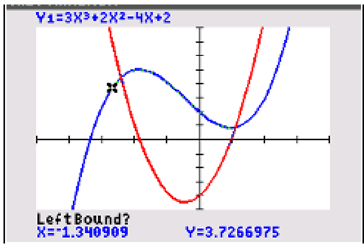
To find the maximum press [2nd] [f4] [calc] 4:maximum

Select Y_1 using [▲] [▼].

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

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 turning point.

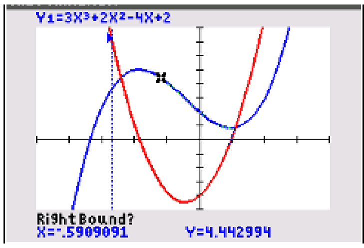
Press [enter].



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

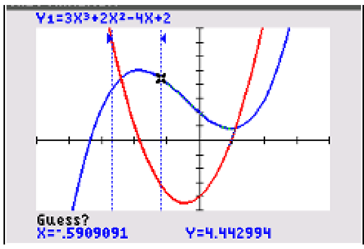
Move the point using [▶] [◀] and choose a position to the right of the turning point.

When the region contains the turning point, Press [enter].



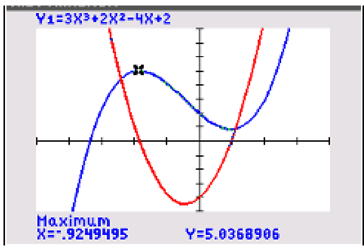
The GDC requires an initial guess for the position of the turning point. Choose the default position.

Press [enter].



The GDC displays the local maximum point at $(-0.925, 5.04)$.

This corresponds to the first zero of Y_2.



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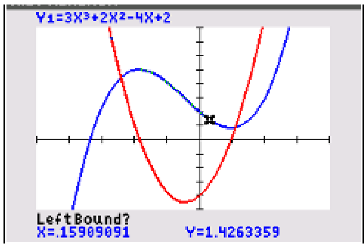
To find the minimum press [2nd] [f4] [calc] 3:minimum

Select Y_1 using [▲] [▼].

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

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 turning point.

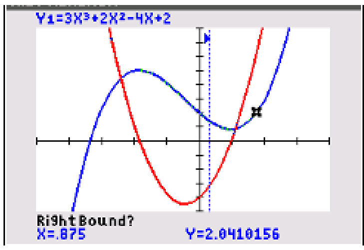
Press [enter].



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

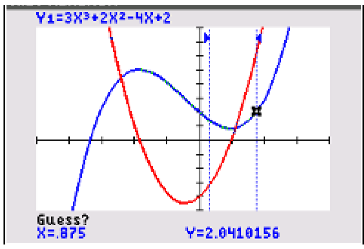
Move the point using [▶] [◀] and choose a position to the right of the turning point.

When the region contains the turning point, Press [enter].



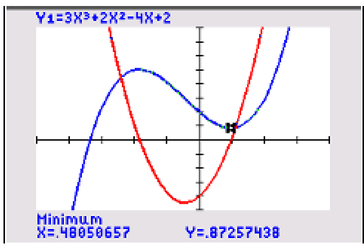
The GDC requires an initial guess for the position of the turning point. Choose the default position.

Press [enter].



The GDC displays the local maximum point at $(0.481, 0.873)$.

This corresponds to the second zero of Y_2.



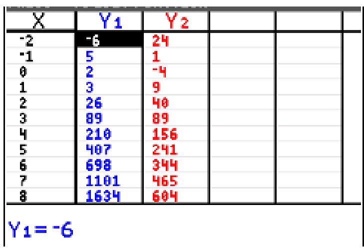
The global maximum and minimum values are at the end points of the curve. These can be viewed in a table.

Press [2nd] [f5] [table].

A table of values is displayed.

You can scroll through the table using [▲] [▼].

The global minimum value of Y1 is −6.



X	Y1	Y2
-2	-6	24
-1	5	1
0	2	-4
1	3	9
2	26	40
3	89	89
4	210	156
5	407	241
6	698	344
7	1101	465
8	1634	604

Y1=-6

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The global maximum value of Y1 is 26.

X	Y_1	Y_2
-2	-6	24
-1	5	1
0	2	-4
1	3	9
2	26	40
3	89	89
4	210	156
5	407	241
6	698	344
7	1101	465
8	1634	604

$Y_1=26$