Chapter 10 / **Example 19**

Exploring the concavity of a function

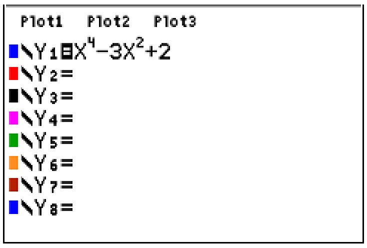
For the function $f(x)=x^4-3x^2+2$

a find the local maximum and minimum points, justifying the nature of each

b find the interval in which the curve is concave down.

Press [F1] $\boxed{\text{Y=}}$ to display the equation entry screen.

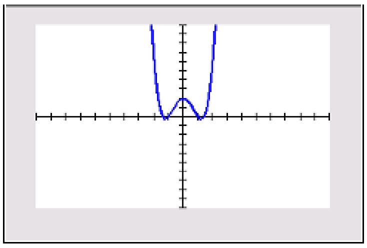
Type $x^4 - 3x^2 + 2$ and press $\boxed{\text{ENTER}}$ to enter the equation as Y_1.



Press [F5] $\boxed{\text{GRAPH}}$ when you have finished.

The GDC displays the graph Y_1.

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

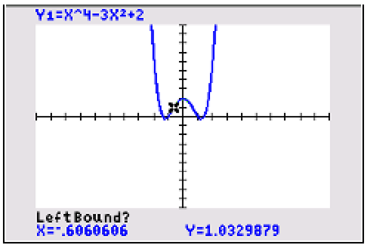


To find the maximum press $\boxed{\text{2nd}}$ a [CALC] 4:maximum

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.

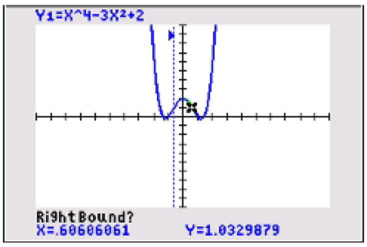
Press $\boxed{\text{ENTER}}$.



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

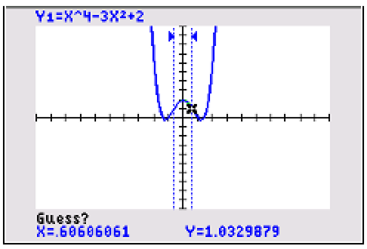
Move the point using ~ | and choose a position to the right of the turning point.

When the region contains the turning point, Press $\boxed{\text{ENTER}}$.



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

Press $\boxed{\text{ENTER}}$.



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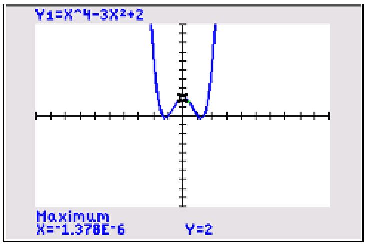
Chapter 10 / **Example 19**

Exploring the concavity of a function

The GDC displays the local maximum point at $(0,2)$.

Take care to interpret what the GDC displays. $X = 1.378\text{E}-6$ *means* $1.378\times 10^{-6} = 0.000001378$ *which is very close to zero. The small difference is due to the numerical way that the GDC calculates the value.*

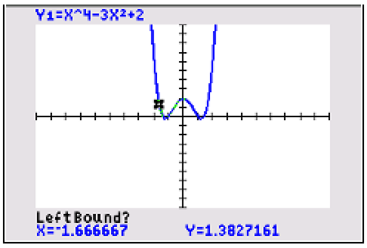


To find the minimum press [2nd] a [CALC] 3:minimum

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.

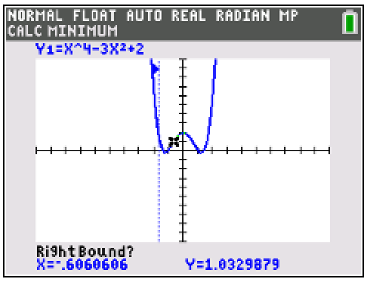
Press [ENTER].



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

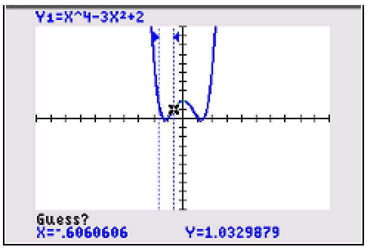
Move the point using ~ | and choose a position to the right of the turning point.

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

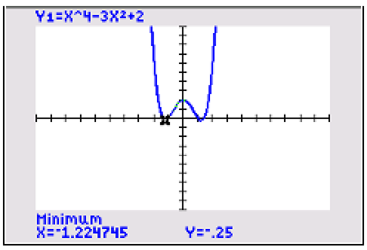


The GDC requires an initial guess for the position of the turning point. Choose the default position.

Press [ENTER].



The first minimum point is at $(-1.22, -0.25)$.



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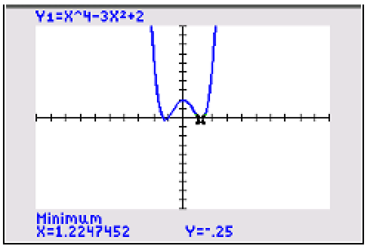
Chapter 10 / **Example 19**

Exploring the concavity of a function

Repeat for the second minimum.

The GDC displays a minimum at $(1.22, -0.25)$.



To find the point at which the concavity changes directly from a GDC you need to find where the second derivative is zero. A faster method is to find the stationary points of the first derivative.

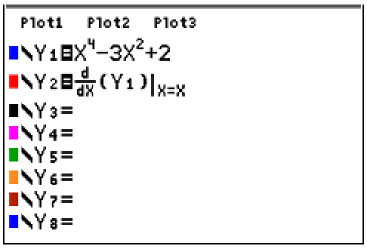
Press [F1] [Y=] to display the equation entry screen.

Press [ALPHA] [F2] 3:nDeriv

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

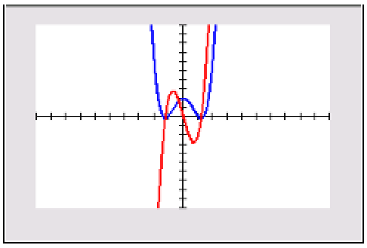
Enter X in the denominator and the function Y_1 using [ALPHA] [F4] 1:Y_1

Type X and press [ENTER].



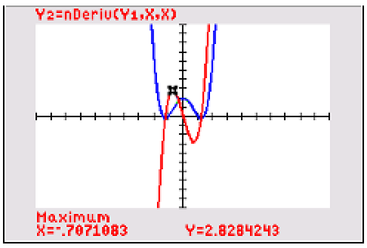
Press [F5] [GRAPH] to display the graph screen.

The GDC displays the graphs Y_1 and its first derivative.



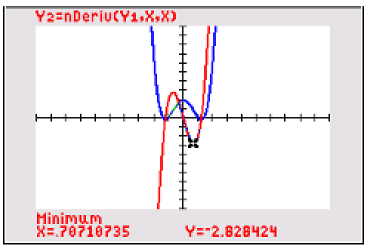
Find the maximum and minimum points of the first derivative as before.

The maximum point is at $(-0.707, 2.83)$.



The minimum point is at $(0.707, -2.83)$.

The curve is concave down for $-0.707 < x < 0.707$.



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