

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 **MENU** 5 **GRAPH** to display the equation entry screen.

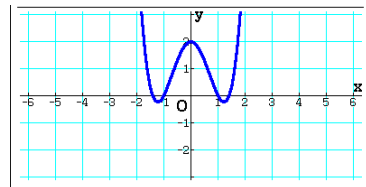
Type  $x^4 - 3x^2 + 2$  to enter the equation as Y1.

Graph Func : Y=  
Y1:  $x^4 - 3x^2 + 2$  [—]  
Y2: [—]  
Y3: [—]  
Y4: [—]  
Y5: [—]  
Y6: [—]  
[SELECT] [DELETE] [TYPE] [TOOL] [MODIFY] [DRAW]

Press **F6** DRAW to display the graph screen

The GDC displays the graph Y1.

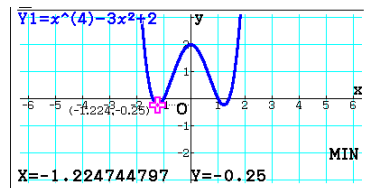
The default axes are  $-6.3 \leq x \leq 6.3$  and  $-3.1 \leq y \leq 3.1$ .



To find the minimum points press **F5** G-Solv **F3** MIN.

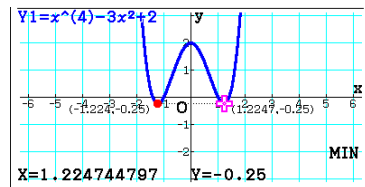
Press **EXE** to display the coordinates.

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



Press **▶** to move to the next minimum and press **EXE** to display its coordinates.

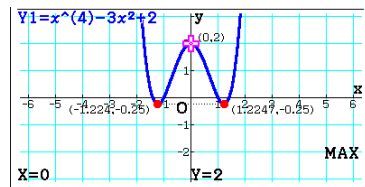
The GDC displays a minimum at  $1.22, -0.25$ .



To find the maximum press **F5** G-Solv **F2** MAX.

Press **EXE** to display the coordinates.

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



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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.

To display the derivative, press **EXIT** then press **OPTN**, **F2** CALC, **F1** d/dx

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

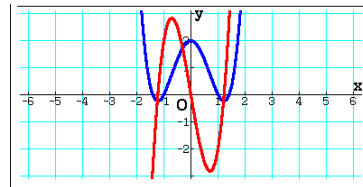
Enter the function Y1 by pressing **F1** Y and typing 1

Type x and press **EXE**.

Graph Func : Y=  
 Y1  $x^4 - 3x^2 + 2$  [—]  
 Y2  $\frac{d}{dx}(Y1)|_{x=x}$  [—]  
 Y3 : [—]  
 Y4 : [—]  
 Y5 : [—]  
 [SELECT] [DELETE] [TYPE] [TOOL] [MODIFY] [DRAW]

Press **F6** DRAW to display the graph screen

The GDC displays the graphs Y1 and its first derivative.



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

The points are  $-0.707, 2.83$  and  $0.707, -2.83$ .

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

