Chapter 4 / **Example 30**

Finding turning points and points of inflexion

Find any turning points and points of inflexion of $y=(x+1)(x-3)^3$ and justify your answers. Confirm your answers graphically.

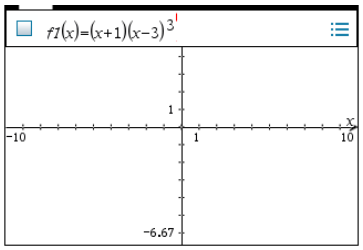
Open a new document and add a Graphs page.

The entry line is displayed at the top of the work area.

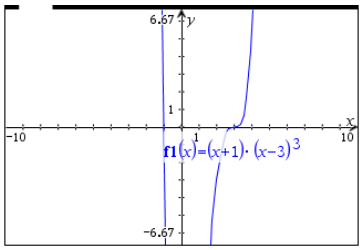
The default graph type is function, so '$f1(x)=$' is displayed.

The default axes are $-10 \le x \le 10$ and $-6.67 \le y \le 6.67$.

Type $(x+1)(x-3)^3$ and press enter.



The GDC displays the graph $f1(x)=(x+1)(x-3)^3$ with the default axes.

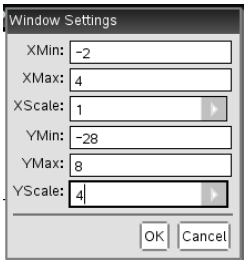


Change the window settings for a better view.

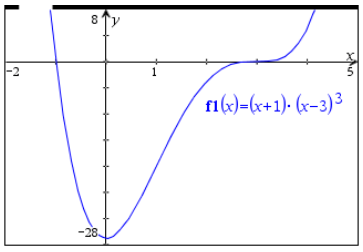
Press menu 4:Window/Zoom | 1:Window Settings…

Set the axes to show $-2 \le x \le 4$ with a scale of 1 and $-28 \le y \le 8$ with a scale of 4.

Press enter when you have finished.



The GDC displays the graph in a suitable window.



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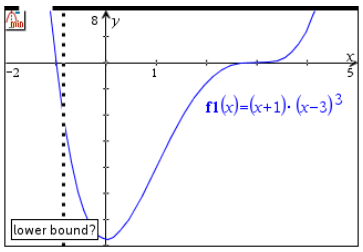
To find the minimum press menu 6:Analyse Graph | 2: Minimum.

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

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 minimum.

Click the touchpad.

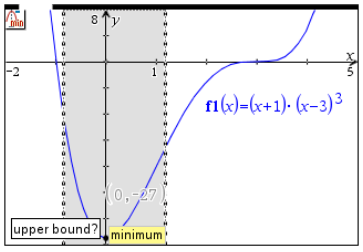


The GDC shows another line and asks you to set the upper bound.

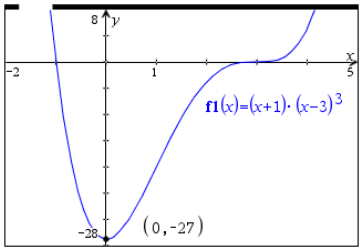
Use the touchpad to move the line so that the region between the lower and upper bounds contains the minimum.

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

Click the touchpad.



The GDC displays the minimum at $(0,-27)$.



Consider the nature of the function in the region around the point $(3,0)$.

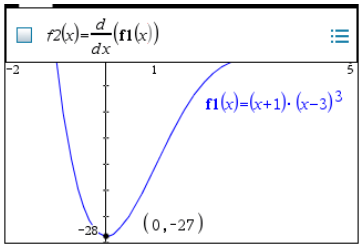
Plot the first derivative function.

Press tab to display the entry line again. This time '*f2*(*x*)=' is displayed.

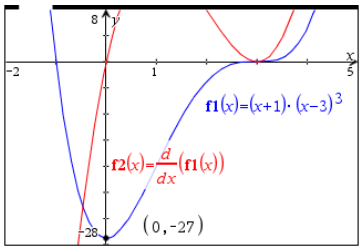
Press menu and select $\frac{d}{d\square}$.

Type X in the denominator and the function *f*1(x)

Press enter.



The GDC now displays the derivative function.



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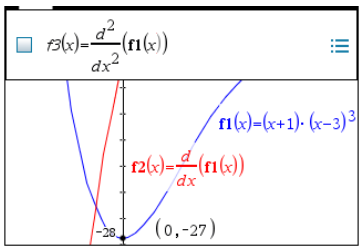
Plot the second derivative function.

Press tab to display the entry line again. This time '*f3*(*x*)=' is displayed.

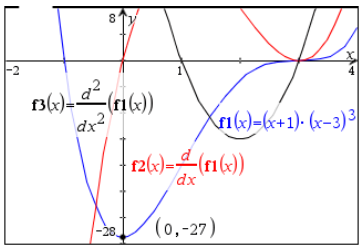
Press ctrl and select $\frac{d^2}{dx^2}$

Type X in the denominator and the function *f*1(x)

Press enter.



The GDC now displays the function and its first and second derivatives.



Click and hold the touchpad somewhere on the white area of the screen. You should see the cursor change to ✋. Drag the axes. This is called panning.

When you have a better view of the region around the point $(3,0)$, click the touchpad again (or press esc).

At $(3,0)$ we see that $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}$ changes from negative to positive.

This means that $\frac{\mathrm{d}y}{\mathrm{d}x}$ (the gradient of the curve) changes from decreasing to increasing (there is a minimum point), which means in turn that the concavity of the function changes from concave down to concave up.

The point is therefore a horizontal inflexion.