

## Chapter 5 / Example 9

# Tangents and normals

The GDC can be used to find the equations of tangents and normals as an alternative to using differentiation or to check results.

$$f(x) = 3x^2 - 2$$

Find:

- a the derivative of the curve at  $x = 1$
- b the equation of the tangent to the curve at  $x = 1$
- c the equation of the normal to the curve at  $x = 1$

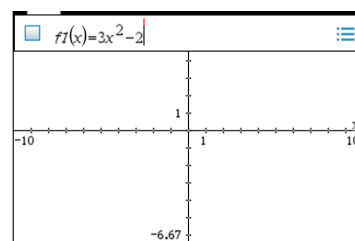
Open a new document and add a Graphs page.

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

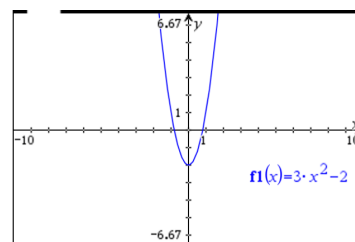
The default graph type is function, so 'f1(x)= ' is displayed.

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

Type  $3x^2 - 2$  and press **enter**.



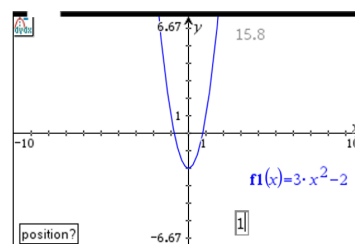
The GDC displays the graph  $f1(x) = 3x^2 - 2$  with the default axes.



To find the gradient at  $x = 1$  press

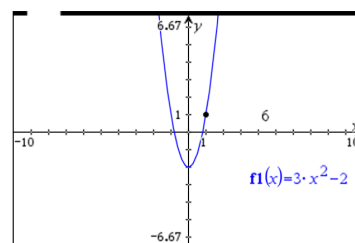
**menu** 6:Analyse Graph | 6:dy/dx

Type 1, the value of the x-coordinate, and press **enter**



The GDC displays a point on  $f(x) = 3x^2 - 2$  and the gradient of the curve at that point.

$$f'(1) = 6.$$



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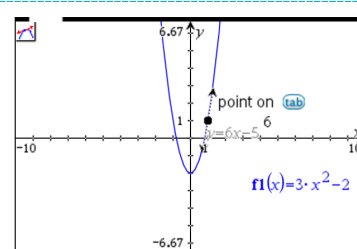
# Tangents and normals

To draw the tangent at  $x = 1$  press

**menu** 8:Geometry | 1:Points & Lines | 7:Tangent

Use the touchpad to position the cursor on the point at  $x = 1$ .  
The GDC will display 'point on' when you are close enough.

Click the touchpad.

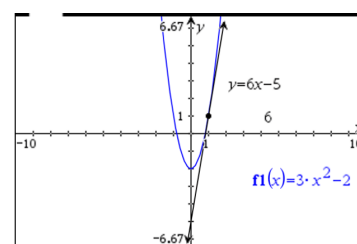


The GDC displays the function and the tangent at  $x = 1$

You can extend the line by pulling on the two arrows at its ends.

The equation of the tangent is displayed too.

$$y = 6x - 5$$



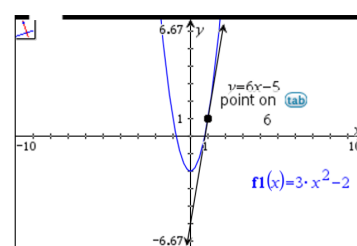
The TINspire CX will not find the normal to the curve directly.  
However the following steps can be used.

Press **menu** 8:Geometry | 4:Construction | 1:Perpendicular

Use the touchpad to move the cursor to the point at  $x = 1$

The GDC will display the words 'point on' when you are close enough.

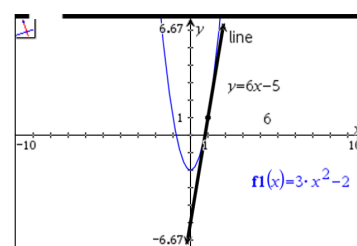
Click the touchpad.



Use the touchpad to move the cursor to the tangent line.

The GDC will display the word 'line'.

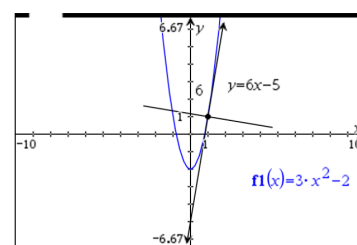
Click on the touchpad.



The GDC displays the normal at the point  $x = 1$

Press **esc** to exit perpendicular line drawing mode.


*Note that the default axes have the same x and y scales. This means that the tangent and normal appear to be at perpendicular. Changing the x-axis scale, for example, would distort the graph and alter the angle between the lines.*



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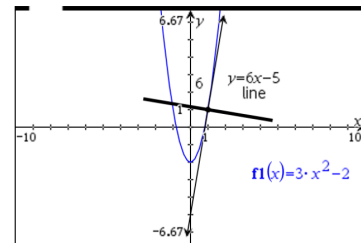
# Tangents and normals

To find the equation of the normal line you have drawn press

 1:Actions | 8:Coordinates and Equations.

Use the trackpad to move the cursor to the line. When you are close enough the word 'line' is displayed.

Click the touchpad.



The GDC displays the equation of the normal at  $x = 1$

The equation of the normal is  $y = 0.17x + 1.17$

