

Chapter 6 / Example 6

Quadratic regression

A patient takes a specific drug in the form of a pill. Data is collected for the amount of the drug found in the blood stream of the patient as soon as he has taken the medication. Time (t) is measured in hours and the concentration of the medication (C) is measured in milligrams of the medication found per litre of blood.

t	0	1	2	3	4	5	6	7	8	9	10
$C(t)$	0	4.87	7.17	10.27	12.81	13.05	15.03	13.3	12.22	11.29	8.26

- Create a scatter plot of the given data.
- What type of function would model this set of data points and why?
- Use your GDC to determine the model function for this set of data.
- Assess the choice of model by determining the coefficient of determination.
- Sketch the model function over the scatter plot and comment on the closeness of fit to the original data.
- Using the model function, determine the time at which the medication is at its maximum effect.
- Using the model function, determine the time at which the medication will have been fully absorbed by the patient.
- Can we use the model to determine the concentration of the medication after 24 hours?

Open a new document and add a Lists & Spreadsheet page.

Type ' t ' in the first cell.

Enter the values of t in the first column.

Press **enter** or **▼** after each number to move to the next cell.

Note: ' t ' is a label that will be used to calculate the regression equation. You can use any letter or name to label the list.

A	t	B	C	D
1	0			
2	1			
3	2			
4	3			
5	4			

Type ' C ' in the cell to the right of ' t '.

Enter the concentration of the medication in the second column.

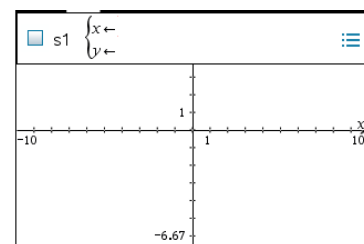
Use the **▲ ▼ ► ◀** keys on the touchpad to navigate the spreadsheet.

A	t	B	C	D
1	0	0		
2	1	4.87		
3	2	7.17		
4	3	10.27		
5	4	12.81		

Add a new Graphs page to your document by pressing **ctrl** **doc** (**⌕** **page**) 2: Add Graphs.

Press **menu** 3: Graph Entry/Edit | 6: Scatter Plot.

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

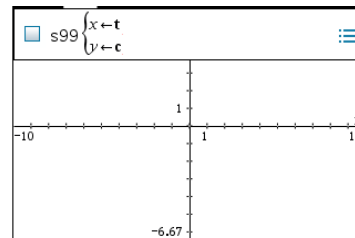


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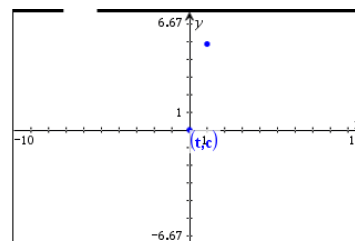
Type the names of the two variables you created in the spreadsheet: 't' and 'c'.

You can also select these from the dropdown list by pressing **var**.

Press **enter**.



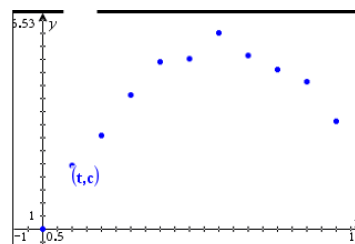
The GDC displays some of the data with the default axes.



To view the data with suitable axes, press **menu** 4:Window/Zoom | 9:Zoom – Data.

The GDC displays a scatter diagram of t against $C(t)$.

Because the data is approximately quadratic, quadratic regression is appropriate.



Return to the Lists & Spreadsheet page by pressing **ctrl** **del**.

To calculate the equation of quadratic regression

Press **menu** 4:Statistics | 1:Stat Calculations | 6:Quadratic Regression...

Open the drop down lists with **▶** and select using **▼** and **enter** **del**.

Choose 't' for X List, 'c' for Y List, f1 for Save RegEqn to and leave the remaining fields unchanged.

Click the touchpad on OK or press **enter**.

The parabola is given by the equation

$$C(t) = -0.374t^2 + 4.56t + 0.121.$$

A	t	B	c	C	D
=					=QuadRe
1	0	0	Title	Quadrat...	
2	1	4.87	RegEqn	a*x^2+b...	
3	2	7.17	a	-0.3741...	
4	3	10.27	b	4.56328	
5	4	12.81	c	0.121119	
D1	="Quadratic Regression"				

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Scroll down using \blacktriangledown .

The coefficient of determination is $R^2 = 0.986$, which shows very strong quadratic association.

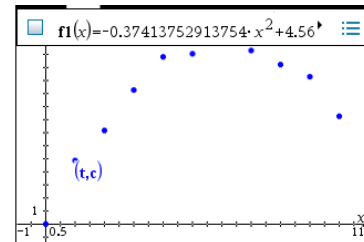
A	t	B	c	C	D
=					=QuadRe
2	1	4.87	RegEqn	a*x^2+b...	
3	2	7.17	a	-0.3741...	
4	3	10.27	b	4.56328	
5	4	12.81	c	0.121119	
6	5	13.05	R ²	0.986174	
D6 = 0.9861743870841					

Return to the Graph page by pressing ctrl \blacktriangleright del

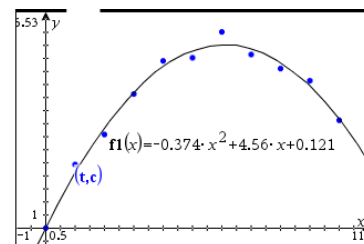
Press tab to display the entry line again.

Press menu 3:Graph Entry/Edit | 1:Function.

This time 'f2(x)= ' is displayed. Press \blacktriangle to display 'f1(x)' and press enter to select it.



The GDC displays the scatter diagram and the regression line.

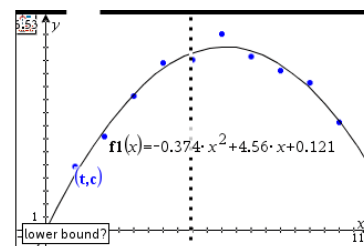


To find the vertex press menu 6:Analyse Graph | 3:Maximum.

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

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 vertex.

Click the touchpad.

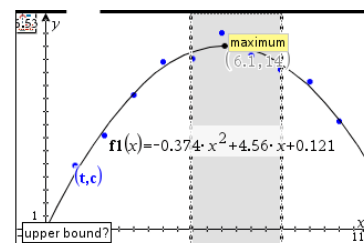


The GDC shows another line and asks you to set the upper bound.

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

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

Click the touchpad.



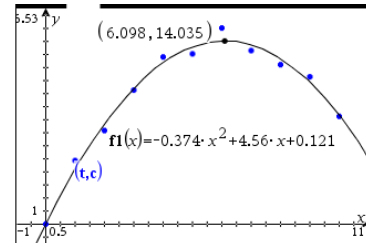
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The GDC displays the vertex.

The vertex of the quadratic function is at (6.10,14.0).

The maximum amount of medication occurs around 6.1 hours after it was taken by the patient.



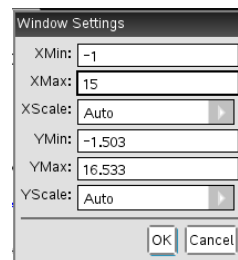
To find the x-intercept you must first modify the window to show this point.

Press **menu** 4:Window/Zoom | 1:Window Settings...

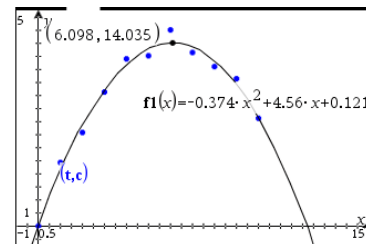
Change the value of Xmax to 15.

You can leave the other items as they are.

Press **enter** when you have finished.



The GDC displays the quadratic function in a suitable window that includes the x-intercept.

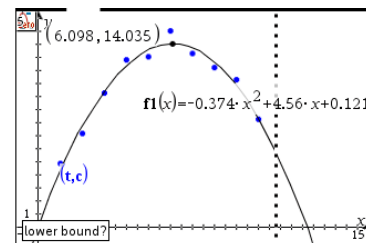


To find the zero press **menu** 6:Analyse Graph | 1:Zero.

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

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 zero.

Click the touchpad.

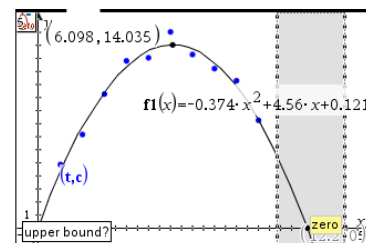


The GDC shows another line and asks you to set the upper bound.

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

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

Click the touchpad.

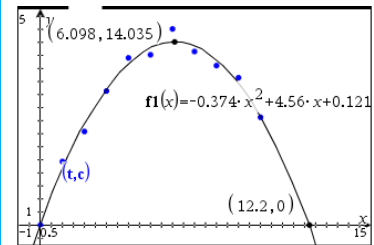


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The GDC displays a zero at $(12.2, 0)$.

It will take about 12.2 hours for the whole of the medication to be fully absorbed.



Add a new Calculator page to your document by pressing

ctrl **doc** **(+page)** 1:Add Calculator.

Type $f1(24)$ and press **enter**.

Since $C(24) = -106$, the negative value means that the model cannot be used.

