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

a Create a scatter plot of the given data.

b What type of function would model this set of data points and why?

c Use your GDC to determine the model function for this set of data.

d Assess the choice of model by determining the coefficient of determination.

e Sketch the model function over the scatter plot and comment on the closeness of fit to the original data.

f Using the model function, determine the time at which the medication is at its maximum effect.

g Using the model function, determine the time at which the medication will have been fully absorbed by the patient.

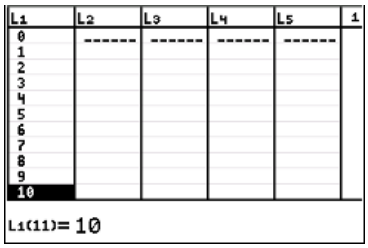
h Can we use the model to determine the concentration of the medication after 24 hours?

Press [STAT] 1:Edit and press [ENTER]

Enter the values of t in the first column.

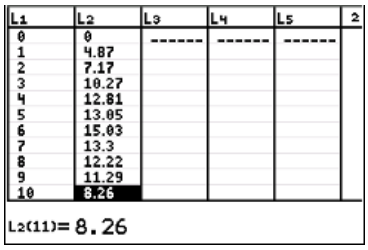
Press [ENTER] or [▼] after each number to move to the next cell.

Note: *If the list contains other numbers, you can clear it by pressing* [STAT] 4:ClrList *and press* [ENTER]. *The home screen displays* ClrList. *Press* [2nd] [1] [L1] *and press* [ENTER]. *Press* [STAT] 1:Edit *and press* [ENTER] *to return to the table*.



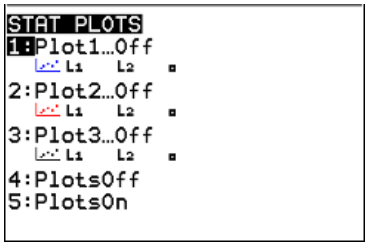
Press [▶] to move to the next column.

Enter values of $C(t)$ in the second column.



Press [2nd] [F1] [STAT PLOT].

Press [ENTER].



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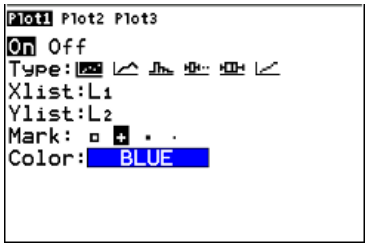
Navigate through the list using ▶ ◀ ▲ ▼ keys.

Select Type ⋰, Xlist L_1 and Ylist L_2 and Mark +. Choose any color.

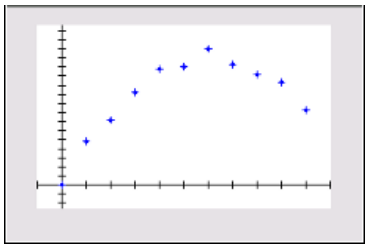
Press ENTER after each choice.



Press F3 ZOOM 9:ZoomStat

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

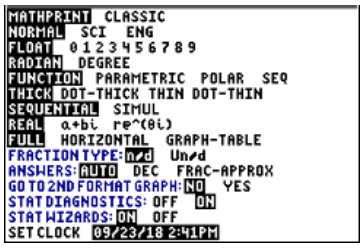
Because the data is approximately quadratic, quadratic regression is appropriate.



Before calculating the equation of quadratic regression, switch the option of calculating the coefficient of determination.

Press MODE

Using ▼ and ▼, navigate down to STAT DIAGNOSTICS and select 'ON' by pressing ENTER.



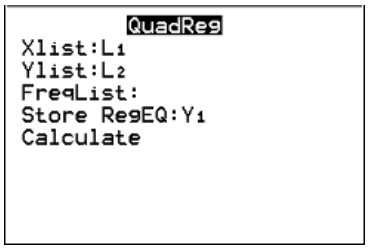
To calculate the equation of quadratic regression press STAT and ▶ to access the CALC menu.

Select 5:QuadReg and press ENTER.

Leave the X List as L_1 and the Y List as L_2.

Enter Y_1 in Store RegEQ by pressing ALPHA F4 1:Y_1

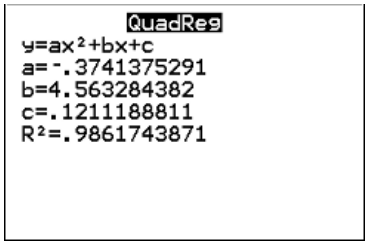
Navigate down to Calculate and press ENTER.



The parabola is given by the equation

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

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



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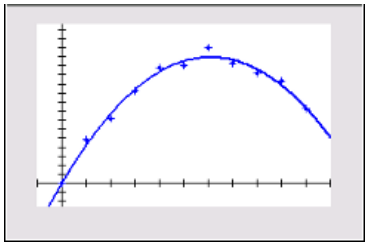
Quadratic regression

Press [F5] [GRAPH].

The GDC displays the scatter diagram and the regression line.

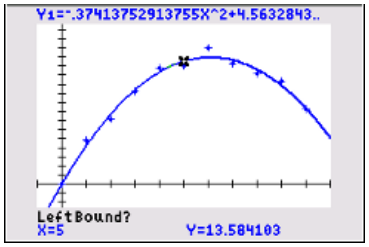


To find the vertex press [2nd] [F4] [CALC] 4:maximum

You will need to give the left and right bounds of the region that includes the vertex.

The GDC shows 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 vertex.

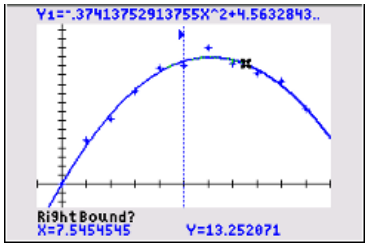
Press [ENTER].



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

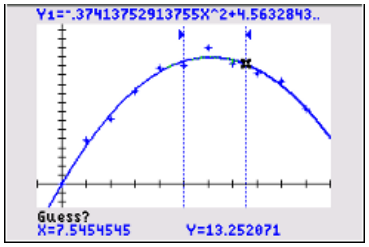
Move the point using [▶] [◀] and choose a position to the right of the vertex.

When the region contains the vertex, press [ENTER].



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

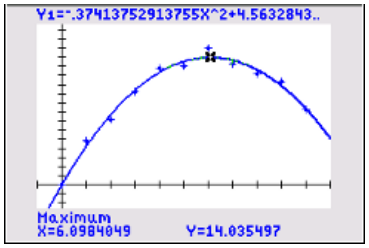
Press [ENTER].



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.



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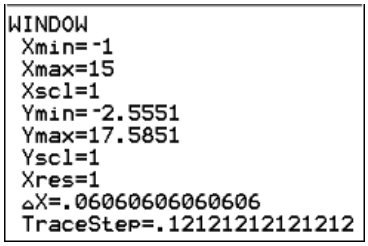
To find the *x*-intercept you must first modify the window to show this point.

Press [F2] [WINDOW]

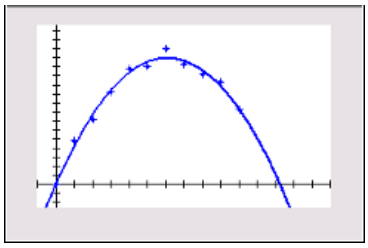
Change the value of Xmax to 15.

You can leave the other items as they are.

Press [F5] [GRAPH] when you have finished.



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

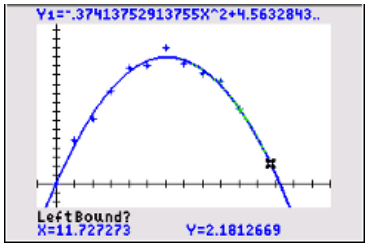


To find the zero press [2nd] [F4] [CALC] 2:zero

You will need to give the left and right bounds of the region that includes the zero.

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 zero.

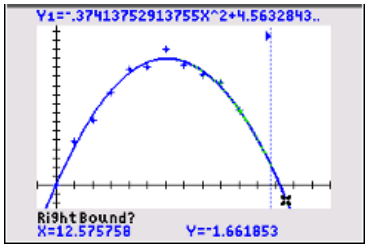
Press [ENTER].



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

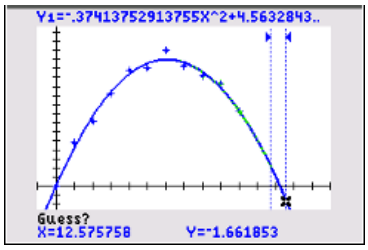
Move the point using [▶] [◀] and choose a position to the right of the zero.

When the region contains the zero, Press [ENTER].



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

Press [ENTER].



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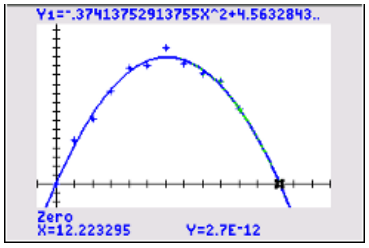
The GDC displays a zero at $(12.2, 0)$. It will take about 12.2 hours for the whole of the medication to be fully absorbed.	
Press 2nd MODE [QUIT]. Press ALPHA [F4] 1:Y_1, type (24) and press ENTER. Since $C(24) = -106$, the negative value means that the model cannot be used.