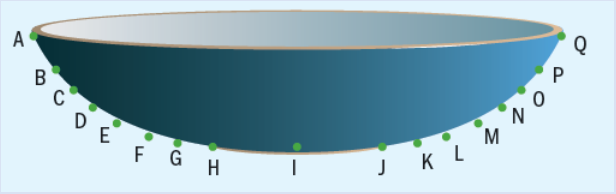
Chapter 6 / **Example 11**

Modelling with power functions

A designer wants to create a model function for a bowl that she sketched by hand in order to be able to process it digitally. To do so, she put the sketch over a grid and marked some data points, with the centre of the bottom of the bowl being the origin.



The data points are the following:

Point	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
x	–16.5	–15.1	–14	–12.8	–11.3	–9.3	–7.5	–5.3	0
y	7	4.9	3.62	2.53	1.54	0.7	0.3	0.07	0

Point	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**
x	5.3	7.5	9.3	11.3	12.8	14	15.1	16.5
y	0.07	0.3	0.7	1.54	2.53	3.62	4.9	7

a Plot the given data on your GDC or other technology.

She first thought of using a quadratic function to model the shape.

b Explain with your reasoning why a quadratic function could be suitable to model this shape.

c Use your GDC to determine the quadratic 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.

Not being satisfied with the model function she created, she decided to determine a new quartic model function.

f Explain why the designer might have not been satisfied with the model function she created and why a quartic function could be a suitable alternative model.

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

h Assess the choice of model by determining the coefficient of determination, comparing it to the previous model.

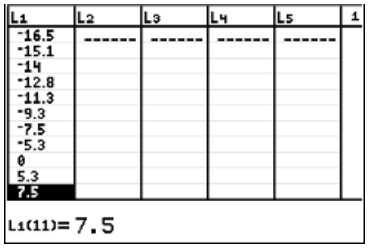
i Sketch the model function over the scatter plot and comment on the closeness of fit to the original data and compare it to the previous model.

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

Enter the *x*-coordinates in the first column.

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

Note: *You can clear the list 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.*



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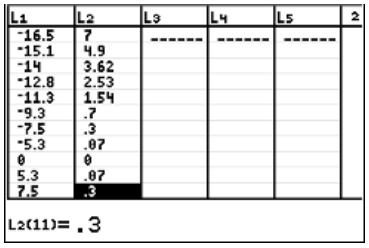
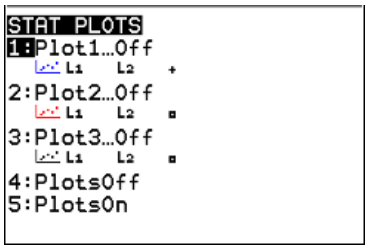
Press ▶ to move to the next column.

Enter the *y*-coordinates in the second column.



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

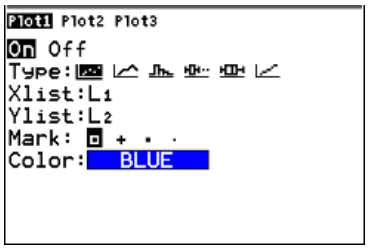
Press [ENTER].



Navigate through the list using ▶ ◀ ▲ ▼ keys.

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

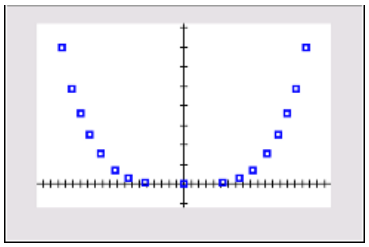
Press [ENTER] after each choice.



Press [F3] [ZOOM] 9:ZoomStat

The GDC displays a scatter diagram of *x* against *y*.

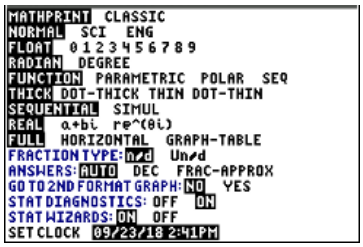
Because the data is approximately quadratic, quadratic regression is appropriate.



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].



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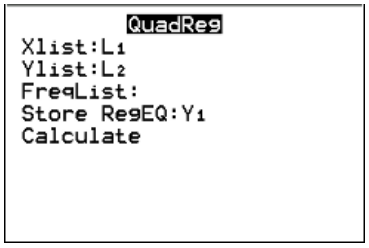
To calculate the equation of quadratic regression press STAT and ▶ to access the CALC menu.

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] $1:Y_1$

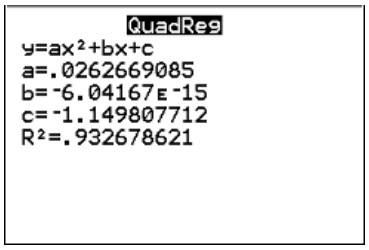
Navigate down to Calculate and press ENTER.



The quadratic curve is given by the equation $y = 0.0263x^2 - 1.15$

The coefficient of determination is $R^2 = 0.933$, which shows strong association.

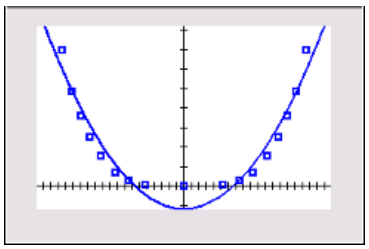
Ignore the value of b as it is very close to zero.



Press [F5] GRAPH.

The GDC displays the scatter diagram and the quadratic function.

Although the model function goes through (or close to) most points, it still misses the bottom point by a significant amount.



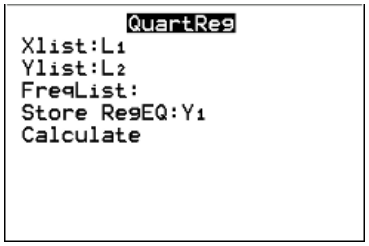
To calculate the equation of quartic regression press STAT and ▶ to access the CALC menu.

Select 7:QuartReg and press ENTER.

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

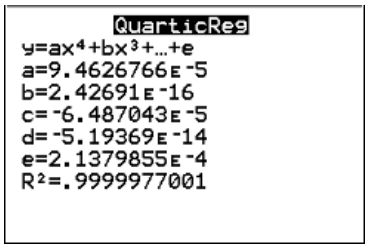
Enter Y_1 in Store RegEQ by pressing ALPHA [F4] $1:Y_1$

Navigate down to Calculate and press ENTER.



The quartic function is $0.0000946x^4 - 0.0000649x^2 + 0.000214$

Ignore the values of b and d as they are very close to zero.



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Press [F5] [GRAPH].

The GDC displays the scatter diagram and the quadratic function.

The coefficient of determination is $R^2 = 0.999\ldots$, which shows an almost exact fit.