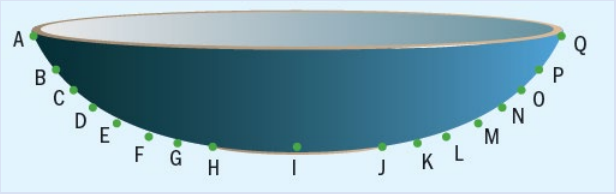
Chapter 6 / **Example 11**

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.

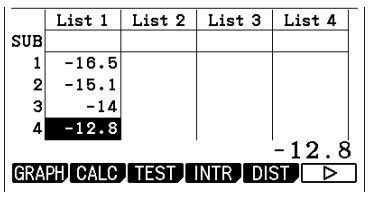
h Assess the choice of model by determining the coefficient of determination, comparing it to the previous model.

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 MENU 2 STAT to display the List Editor screen.

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

Press EXE after each number to move to the next cell.



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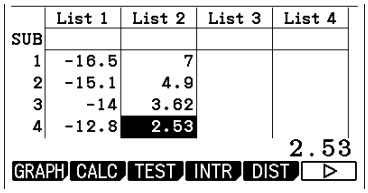
Press ▶ to move to the next column.

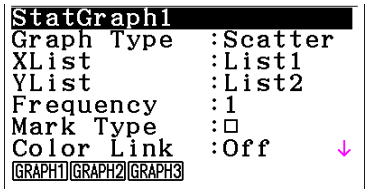
Enter the *y*-coordinates in the second column.



Press F1 GRAPH.

Press F6 SET.

Choose Graph Type: F1 Scatter, XList: List1 and YList: List2.

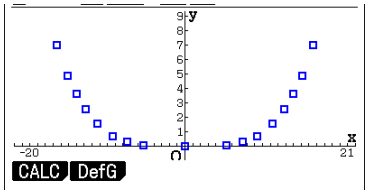


Press EXIT.

Press F1 GRAPH1.

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

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

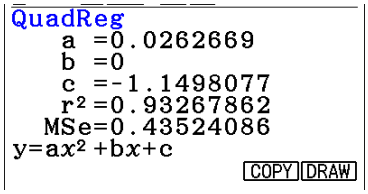


To calculate the equation of the regression line

Press F1 CALC and press F4 X^2.

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

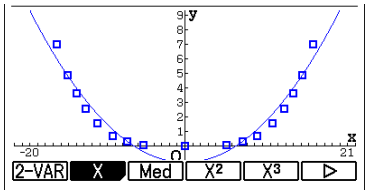
The coefficient of determination is $R^2 = 0.933$, which shows strong association.



Press F6 DRAW.

The GDC displays the scatter diagram and the quadratic function.

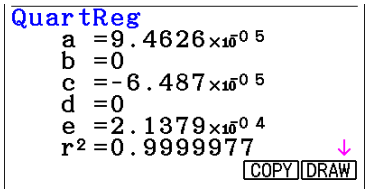
Although the model function goes through (or close to) most points, it still misses the bottom point by a significant amount.



Press EXIT twice then press F1 GRAPH1.

Press F1 CALC and press F6 ▷ F1 X^4 to calculate quartic regression.

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



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Modelling with power functions

Press F6 DRAW.

The GDC displays the scatter diagram and the quartic function.

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