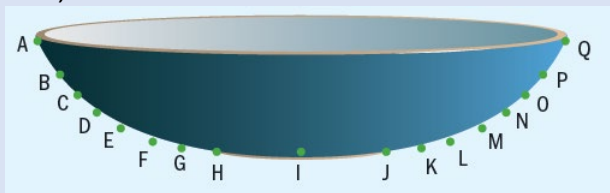


Chapter 6 / **Example 11****Modelling with power functions**

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.

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

Type 'x' in the first cell and enter the x-coordinates in the first column.

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

**Note:** 'x' is a label that will be used to calculate the regression equation. You can use any letter or name to label the list.

	A	B	C	D
1	-16.5			
2	-15.1			
3	-14			
4	-12.8			
5	-11.3			

## Chapter 6 / Example 11

# Modelling with power functions

Type 'y' in the cell to the right of 'x'.

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

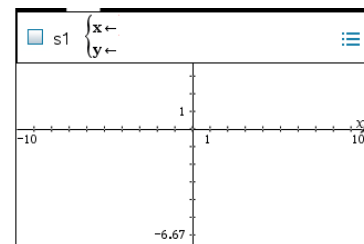
Use the  $\blacktriangle \blacktriangledown \blacktriangleright \blacktriangleleft$  keys on the touchpad to navigate the spreadsheet.

	A	B	C	D
=				
1		-16.5	7	
2		-15.1	4.9	
3		-14	3.62	
4		-12.8	2.53	
5		-11.3	1.54	
6				

Add a new Graphs page to your document by pressing  $\text{ctrl}$   $\text{doc}$   $\text{v}$  ( $\text{+page}$ ) 2:Add Graphs.

Press  $\text{menu}$  3:Graph Entry/Edit | 6:Scatter Plot.

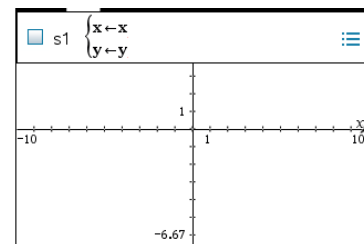
The entry line is shown at the top of the work area.



Type the names of the two variables you created in the spreadsheet: 'x' and 'y'.

You can also select these from the dropdown list by pressing  $\text{var}$ .

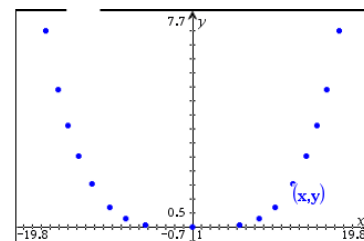
Press  $\text{enter}$ .



To view the data with suitable axes, press  $\text{menu}$  4:Window/Zoom | 9:Zoom – Data.

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

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



Return to the Lists & Spreadsheet page by pressing  $\text{ctrl}$   $\text{del}$ .

To calculate the equation of quadratic regression

Press  $\text{menu}$  4:Statistics | 1:Stat Calculations | 6:Quadratic Regression...

Open the drop-down lists with  $\blacktriangleright$  and select using  $\blacktriangledown$  and  $\text{enter}$   $\text{del}$ .

Choose 'x' for X List, 'y' for Y List, 'f1' for Save RegEqn to and leave the remaining fields unchanged.

Click the touchpad on OK or press  $\text{enter}$ .

Quadratic Regression

X List:  $x$

Y List:  $y$

Save RegEqn to:  $f1$

Frequency List: 1

Category List:

Include Categories:

OK Cancel

Chapter 6 / **Example 11****Modelling with power functions**

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

A	x	B	y	C	D
=					=QuadRe
1	-16.5		7	Title	Quadrat...
2	-15.1		4.9	RegEqn	a*x^2+b...
3	-14		3.62	a	0.026267
4	-12.8		2.53	b	0.
5	-11.3		1.54	c	-1.14981
D1="Quadratic Regression"					

Scroll down using ▼.

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

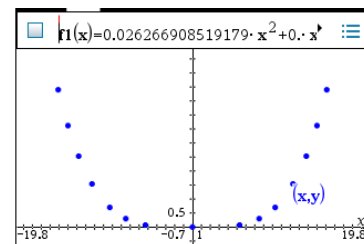
A	x	B	y	C	D
=					=QuadRe
2	-15.1		4.9	RegEqn	a*x^2+b...
3	-14		3.62	a	0.026267
4	-12.8		2.53	b	0.
5	-11.3		1.54	c	-1.14981
6	-9.3		0.7	R <sup>2</sup>	0.932679
D6=0.93267862097483					

Return to the Graph page by pressing **ctrl** **del**

Press **tab** to display the entry line again.

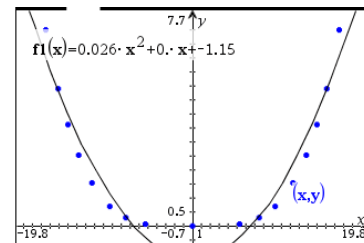
Press **menu** 3:Graph Entry/Edit | 1:Function.

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



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.



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

To calculate the equation of quartic regression

Press **menu** 4:Statistics | 1:Stat Calculations | 8:Quartic Regression...

Open the drop-down lists with ► and select using ▼ and **enter** **del**

Choose 'x' for X List, 'y' for Y List, 'f1' for Save RegEqn to and leave the remaining fields unchanged.

*You will need to type f1 as it will not be in the drop-down list.*

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

Quartic Regression	
X List:	x
Y List:	y
Save RegEqn to:	f1
Frequency List:	1
Category List:	
Include Categories:	
OK Cancel	

Chapter 6 / **Example 11**

# Modelling with power functions

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

	D	E	F
=	=QuadRe		=QuartReg('y
3	0.02626...	a	0.0000946
4	0.	b	0.
5	-1.1498...	c	-0.0000649
6	0.93267...	d	0.
7	sid {0.99864...	e	0.0002138
F8	=QuartReg('x,y,1): CopyVar Stat.Reg		

Scroll down using ▼.

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

	D	E	F
=	=QuadRe		=QuartReg('x
4	0.	b	0.
5	-1.1498...	c	-0.0000649
6	0.93267...	d	0.
7	sid {0.99864...	e	0.0002138
8		R <sup>2</sup>	0.9999977
F8	=0.99999770006149		

Return to the Graph page by pressing **ctrl** **del**

The GDC displays the scatter diagram and the quartic function.

