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6.4 Modelling Data with a Curve of Best Fit

YOU WILL NEED
- graphing technology

Keep In Mind

- If a scatter plot seems to follow a curved trend, then
  - There may be a quadratic or cubic relationship between the independent variable and the dependent variable.
  - Graphing technology can be used to determine and graph the equation of the curve of best fit.
- Technology uses polynomial regression to determine the curve of best fit. Polynomial regression results in an equation of a curve that balances the points on both sides of the curve.
- A curve of best fit can be used to predict values that are not recorded or plotted. To do so, read values from the curve of best fit on a scatter plot, or use the equation of the curve of best fit.

Example

A pebble falls from a cliffside into the river 30 m below. This table gives the height of the pebble as it falls.

Time (s)	0	0.5	1.0	1.2	1.5	2.0
Height (m)	30.00	28.77	25.11	22.97	18.98	10.42

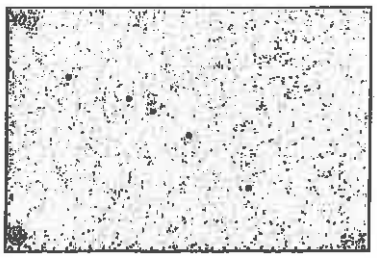
a) Use technology to create a scatter plot, and use quadratic regression to determine the equation of the curve of best fit.

b) Use your equation to determine the height of the pebble after 1.25 s.

c) When does the pebble hit the river, to the nearest hundredth of a second?

Solution

Step 1. I entered the data into my graphing calculator and created a scatter plot.



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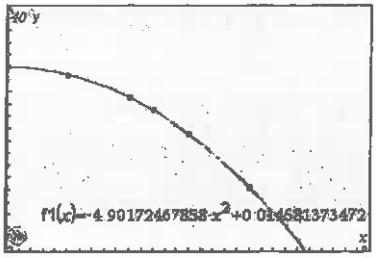
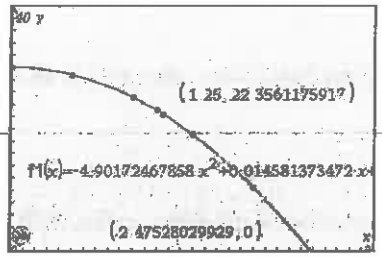
Step 2. I ran the quadratic regression on my calculator, which gave me the curve of best fit and its equation.



a) The equation of the quadratic regression function that models the data is $h = -4.901\ldots t^2 + 0.014\ldots t + 29.996\ldots$.



Step 3. I used my calculator to determine the height of the pebble after 1.25 s.

b) The height of the pebble after 1.25 s is about 22.36 m.

Step 4. I used the Zero application to determine when the pebble had a height of 0 m.

c) The pebble hits the river after about 2.48 s.

Practice

1. The following table shows Canada's population growth from 1871 to 2001.

Year	1871	1881	1891	1901	1911	1921	1931
Population (1000s)	3689	4325	4833	5371	7207	8788	10 377
Year	1941	1951	1961	1971	1981	1991	2001
Population (1000s)	11 507	13 648	18 238	21 568	24 820	28 031	31 021

Source: Statistics Canada.

a) Describe the trend in the data.

b) Use quadratic regression to determine the equation of the curve of best fit for the data.

c) Use quadratic regression to estimate the population of Canada in 2006, to the nearest thousand.

d) If the population of Canada continues to grow according to this trend, what will the population be in 2020, to the nearest thousand?

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2. Arnold hit a golf ball from the top of a hill. The height of the ball above the green is given in the table.

Time (s)	0.5	1	1.5	2.5	3.5	4
Height (m)	30.890	45.025	54.397	58.858	44.279	29.848

a) Describe the trend in the data.

b) Use quadratic regression to determine the equation of the curve of best fit for the data.

c) Use the equation to determine the height of the ball after 2.0 s.

d) When did the ball hit the ground, to the nearest tenth of a second?

3. A biochemist is studying the growth of recently discovered bacteria. She collects the data shown.

Day	1	2	3	4	5	6	7	8
Mass (g)	3.2	4.6	5.4	4.2	5.5	7.1	8	9.2

a) Describe the trend.

b) Use cubic regression to determine the equation of the curve of best fit for the data.

c) Estimate the mass of the bacteria on Day 11.

4. A pebble drops from a cliffside into a river 25 m below. This table gives the height of the pebble as it falls.

Time (s)	0	0.3	0.5	0.7	0.9	1.0
Height (m)	25.00	23.84	22.68	21.21	19.43	18.42

a) Plot the data on a scatter plot. Use quadratic regression to determine the equation of the curve of best fit for the data.

b) Determine the height of the pebble after 1.2 s.

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5. A spherical balloon is being inflated. The table shows the volume of the balloon at different times.

Time (s)	0	1	2	3	3.5	4
Volume (cm^3)	0	43.5	123.1	278.1	540.0	914.8

a) Use technology to plot the data as a scatter plot. Describe the trend that you see.

b) Use cubic regression to create a curve of best fit.

c) Determine the volume of the balloon after 2.5 s, to the nearest tenth of a cubic centimetre.

NUMERICAL RESPONSE

6. Cierra, an architect, is designing a suspension bridge. There will be a suspension cable on each side of the bridge, with support wire hanging down from the cable at different distances, as shown.

Distance from Centre of Bridge (m)	10	20	30	40	50	60
Length of Support Wire (m)	5.56	7.12	9.68	13.24	17.80	23.36

a) A quadratic regression function that models the data is

$f(x) =$ _____$x^2 +$ _____$x +$ _____.

b) The support wire that is 60 m from the centre of the bridge should be _____ m long, to the nearest centimetre.

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WRITTEN RESPONSE

7. Bob likes to solve jigsaw puzzles on the Internet. He recorded the times he took to solve puzzles with different numbers of pieces.

Number of Pieces in Puzzle	0	12	20	54	72	120
Time to Solve (s)	0	53	100	442	817	2293

a) Plot the data as a scatter plot. Describe the trend.

b) Use quadratic regression to determine the equation of the curve of best fit for the data.

c) How long would Bob take to solve a puzzle with 100 pieces, to the nearest second?

8. Jen likes to solve chess puzzles on the Internet. She recorded the times she took to solve different puzzles.

Difficulty of Puzzle	1 star	2 stars	3 stars	4 stars	5 stars	6 stars
Time to Solve (min)	11.5	17.0	26.5	40.0	57.5	79.0

a) Plot the data as a scatter plot. Describe the trend.

b) Use quadratic regression to determine the equation of the curve of best fit for the data.

c) How long would Jen take to solve a 3.5-star chess puzzle, to the nearest tenth of a minute?