Broadband

Data Sheet

Telewest Communications is a leading broadband cable communications operator that provides multi-channel television, telephone and Internet services to millions of UK houses. It also provides voice and data telecommunications services to over 60 000 business customers.

In March 2000 Telewest Communications launched Blueyonder, the UK's first high speed broadband Internet service for home personal computers. Since then the number of broadband connections in the UK has grown rapidly.

The table below shows this growth over a 3 year period from January 2001 to January 2004.

y represents an estimate of the total number of broadband connections in thousands and *x* represents the number of 6 month time intervals since January 2001.

Time (6 mth intervals) *x* = 0 on 1st January 2001	**No. of Connections (thousands)**
x	***y***
0	110
1	200
2	370
3	830
4	1500
5	2370
6	3200

Broadband

Using the CASIO *fx-7400G PLUS* to find a quadratic model

- On the **MENU** select **STAT** (i.e. 2)

- **Enter the values of *x*** given on the Data Sheet (i.e. the time intervals) in **List 1** pressing **EXE** after each value.

- Press ▶ on the REPLAY button to move to **List 2.**
  Enter the values of *y* (i.e. the number of connections in thousands) in **List 2.**

- **Press F1** GRPH then **F1 again** **GPH1**

  The calculator should display a graph of the data.

  If it doesn't then check the set-up for Graph 1.

- **Press F3** **X^2**

  The calculator should give you the coefficients of the best quadratic model of the data:

  $y = 90.7142x^2 - 17.8571x + 100$

  QuadReg
  a = 90.7142
  b = – 17.8571
  c = 100
  $y = ax^2 + bx + c$

- **Press F4** **DRAW**

  The calculator will show the graph of this function with the original data.

Broadband

Using The CASIO *fx-7400G PLUS* to check a quadratic model

(found by algebra or other methods)

- On the **MENU** select **GRAPH** (i.e. 4)

- **To enter the data, use parametric graphs as follows:**

  Use the arrow button ▶ to show more options

  and **press F2** [Parm] to select parametric graphs

  then enter the seven data points as shown:
  (Press **EXE** after each .)

G-Funct : Y =
Xt1 = 0
Yt1 = 110
Xt2 = 1
Yt2 = 200
Xt3 = 2
Yt3 = 370
Xt4 = 3
Yt4 = 830
Xt5 = 4
Yt5 = 1500
Xt6 = 5
Yt6 = 2370
Xt7 = 6
Yt7 = 3200

- **Now set the graph to Y = type**

  To do this use the arrow button ▶ again and

  press F1 [Y =] to select the correct type.

- **Enter the following equation:** (Note this model was found using algebra.)

  (Y8:) $\mathbf{91\frac{2}{3}X^2 - 35X + 110}$ using the $a^b/_c$ button for the fraction

  the X,T button for X

  and the x^2 button for the square.

- **Press F4** [DRAW] and the calculator should plot each point and then draw the graph of the quadratic model. Note how well it fits the data.

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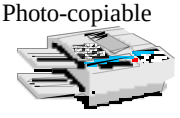


How good is the quadratic model?

The graphic calculator gives the quadratic function $\boldsymbol{y = 90.7142x^2 - 17.8571x + 100}$ to model the data.

You can describe how close a model is to the actual data using percentage errors.

$$\textbf{\% error} = \frac{\textbf{predicted value} - \textbf{actual value}}{\textbf{actual value}} \times \textbf{100}$$

Example

When $x = 2$ (i.e. on 1st January 2002) the model $\boldsymbol{y = 90.7142x^2 - 17.8571x + 100}$ estimates the number of broadband connections to be 427 thousand (to 3sf) wheras the data value was 370 thousand.

$$\% \text{ error} = \frac{427 - 370}{370} \times 100 = 15\% \text{ (nearest \%)}$$

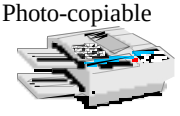
Note the fact that the % error is positive means that the prediction of 427 thousand is 15% too high, whereas a negative % error would mean the prediction was too low.

Some to try:

1. a) Use a calculator to find the % error when the function $y = 90.7142x^2 - 17.8571x + 100$ is used to model the data for each of the other values of x.
   b) Interpret your results from part a).

2. The model can also be used to estimate what the number of broadband connections were before 2001 by using negative values of x.
   a) Use the model to calculate y when $x = -1$,
   b) Explain what information this gives and say whether or not you think it seems realistic.

3. When evaluating a model it is also a good idea to think about how well the function is likely to predict values in the future.
   a) Calculate the number of broadband connections the model predicts for (i) $x = 10$ (ii) $x = 20$
   b) Comment on your answers to part a).



Teacher Notes

Unit Advanced Level, Working with algebraic and graphical techniques

Notes

The data on the Data Sheet shows how the number of broadband connections has grown in recent years. It is the same as that given in Broadband A and C, but whereas A shows how to use Excel to find a quadratic model and C shows how to use algebra, this activity shows how to use the Casio ***fx-7400G PLUS***. Students who have other graphs or data stored in their calculators may need to be advised to remove this before they start.

The activity ends with some questions about how well the models fit the data and their limitations. These can be done by students as an exercise or used as a starting point for class discussion. The answers to these questions are given below.

Answers

1 a)

Time (6 mth intervals) x = 0 on 1st January 2001	**No. of Connections (thousands)**	**Model**	**% Error in Model**
x	y	$y = 90.7142x^2 - 17.8571x + 100$	
0	110	100	**– 9%**
1	200	172.8571	**– 14%**
2	370	427.1426	**15%**
3	830	862.8565	**4%**
4	1500	1479.9988	**– 1%**
5	2370	2278.5695	**– 4%**
6	3200	3258.5686	**2%**

b) The model gives better predictions for the larger values of x than for smaller values of x.

2 a) y = 209 (to 3sf)

b) The model estimates that the number of broadband connections on 1st July 2000 was 209 thousand. This is not realistic as it is higher than the number of connections given by the original data for 1st January 2001.

3 a) (i) 8990 thousand (to 3 sf) (ii) 36 000 thousand (to 3 sf)

b) Part a) suggests that there will be about 9 000 000 broadband connections by January 2006 and 36 000 000 by January 2011. These estimates seem unrealistically high, bearing in mind that there are roughly 60 000 000 people in the UK.