

Managing a gas field.

Checkpoints



Activity 1: Viewing the gas flow data.



Parts B and C – Data entry

The input of list names and data should look like for *time*...

	List 1	List 2	List 3	List 4
SUB:	TIME			
1	0			
2				
3				
4				

→

	List 1	List 2	List 3	List 4
SUB:	TIME			
11	11			
12	12			
13	13			
14				

... and like this for *flow*...

	List 1	List 2	List 3	List 4
SUB:	TIME	FLOW		
1	1	0		
2	2			
3	3			
4	4			

→

	List 1	List 2	List 3	List 4
SUB:	TIME	FLOW		
11	11	13.403		
12	12	12.72		
13	13	11.285		
14				



Part D – Drawing a graph.

Pressing **GRPH** (F1) and then pressing **SET** (F6) gives

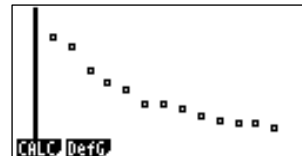
	List 1	List 2	List 3	List 4
SUB:	TIME	FLOW		
1	1	51.717		
2	2	47.724		
3	3	36.717		
4	4	31.755		

→

StatGraph1	
Graph Type	: Scatter
XList	: List1
YList	: List2
Frequency	: 1
Mark Type	: *

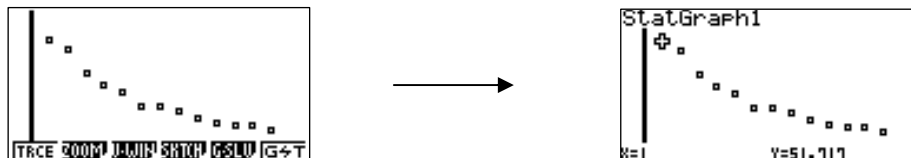
Using the default settings and pressing **GRAPH** (F1)

(when in the main  window) results in



Part E – Tracing through the graph.

Press **SHIFT** then **TRCE** (F1) then press **◀** and **▶**



Answers

1. It falls/decreases in a fairly consistent manner, quickly at first, then more slowly as time passes
2. Yes, it looks like it will keep falling until it falls below 5 MMscf/day. It might 'level off' below it reaches 5 MMscf/day, but in the context of gas extraction this is unlikely.
3. In around 6 months time (i.e. December 1999) is a very rough estimate.

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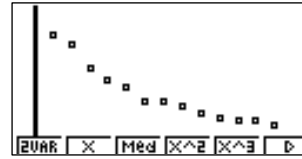
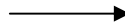
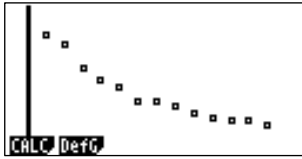
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Activity 2: Developing a model for the gas flow data.



Back at the original graph, press **CALC** **[F1]** to see some options



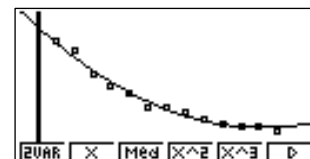
Answers

1. Investigating a *quadratic* model, for example, by pressing **[F4]** results in the following information

```
QuadReg
a =0.31263536
b =-7.611906
c =58.8162377
r²=0.98743509
MSe=2.67266507
y=ax²+bx+c
COPY DRAW
```

Then pressing **DRAW** **[F6]**, we can see that the model, in general, fits well but clearly is about to 'turn' and start increasing towards the end of the time period.

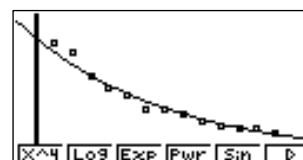
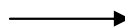
This makes extrapolation to find when the flow falls below 5 MMscf/day impossible, as a quadratic model says that it never will, but the scatter plot and common sense suggest otherwise.



Looking for a model type that decays to a flow of zero, two algebraic model types could be considered, a *simple exponential* model and a *power* model.

Investigating the *simple exponential model* firstly by pressing **[>]** **[F6]** then **[F3]** gives,

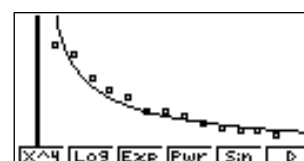
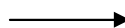
```
ExpReg
a =54.8833597
b =-0.1281985
r =-0.9905712
r²=0.98123144
MSe=5.2012E-03
y=a·e^bx
COPY DRAW
```



Then pressing **DRAW** **[F6]**, we see that an exponential model fits the data well (after the first few points). It fits particularly well as time passes, making it suitable for the extrapolation that we require.

Investigating the power model by pressing **[>]** **[F6]** then **[F4]** gives,

```
PowerReg
a =67.5996513
b =-0.6374188
r =-0.9680409
r²=0.93710328
MSe=0.01743017
y=a·x^b
COPY DRAW
```

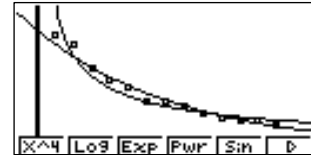


Then pressing **DRAW** **[F6]**, we see that this model fits the shape of the data less well.

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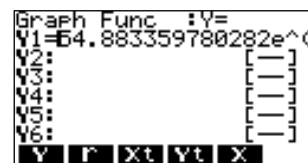
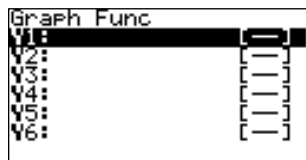
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Note: If more than one model is drawn in succession then both are visible at the same time, for example,



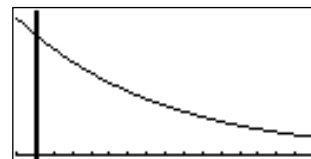
This can be a good way to compare the fit of two possible models, but if this is not desired then you will need to exit out of the graph and redraw it between successive model fittings. This can be done by pressing **EXIT** twice then pressing **GRAPH** **F1**

Once you have the model of your choice (in this case the exponential model is the best of the choices available) the models equation should be stored in **GRAPH** **F1**. Use **COPY** **F5** to put this in your choice of row (e.g. in **Y1**).



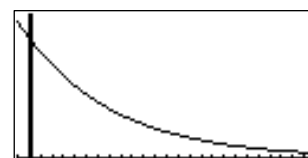
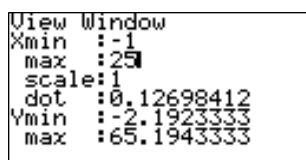
2.

With the chosen model stored, we can work with it in **GRAPH** **F1**. The view window settings from the last graph drawn, the scatter plot drawn in **STAT** mode, are unchanged by changing modes. All we need to do to graph the model is select it by pressing **SEL** **F1** then press **DRAW** **F6**, getting this result

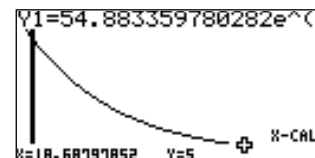
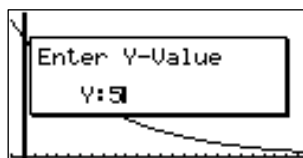
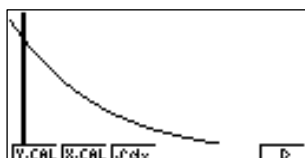


The extrapolation that we wish to do, to find when the model predicts that the gas flow falls below 5 MMscf/day, is equivalent to extending the graph to the right.

By pressing **V-Window** **F3** (pressing **SHIFT** is not strictly required in this case) we can change the X_{max} up to 25 months.



To find when the graph of the flow falls below 5 MMscf/day we can do an x calculation. Press **G-Solve** **F5** then **>** **F6** then **F2**, then enter the value $y=5$. The screen sequence looks like this



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This provides the crucial x value of 18.7, corresponding to a time towards the end of November 1999 when the sixth well will be required.

If the 9860G AU responds with Not Found then the y value given does not occur in the current view window and you may need to widen your view!

Activity 3: Further modelling

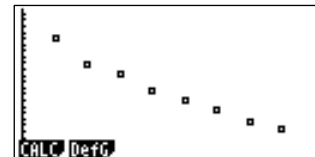


The output fell below 5 MMscf/day in October 1999 and the sixth well seems to have started producing in November 1999. This corresponds quite well with the prediction that was made.

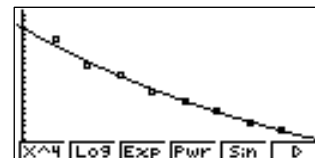
Using the data from April 2000, when the sixth well seems to be in full production, the data we need to model looks like

	List 1	List 2	List 3	List 4
SUB	TIME	FLOW	TIME	FLOW
5	5	28.066	5	18.963
6	6	22.248	6	17.335
7	7	22.199	7	15.61
8	8	19.154	8	14.516

By changing the GRPH **F1** SET **F6** so that the scatter plot is of List 3 against List 4 the following graph can be obtained



Fitting an exponential model to this looks like



And this model allows us, in **GRAPH** mode, to predict the time when the gas production site is no longer viable

```
Graph Func :Y=
Y1=54.8833597802[ ]
Y2=30.8350278720[ ]
Y3: [ ]
Y4: [ ]
Y5: [ ]
Y6: [ ]
[SEL DEL TYPE STYL MEM DRAW]
```

```
View Window
Xmin : 0
max : 20
scale:1
dot : 0.15873015
Ymin : 0
max : 33.6706666
[INIT TRIG STO STO RCL]
```

```
Y2=30.83502787201e^( -
X=18.86095801 Y=5
```

This equates to a prediction of late November, 2001.