

Science Objectives

- Students will interpret a graph.
- Students will linearize data to find the mathematical relationship between two variables.

Vocabulary

- data
- directly proportional
- inverse
- inversely proportional
- linear
- quadratic

About the Lesson

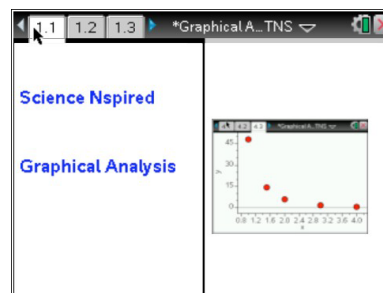
- The student will graph different data sets to determine the mathematical relationship.
- As a result, students will:
 - Learn to recognize whether a relationship is linear or non-linear.
 - Learn to linearize data in order to determine the mathematical relationship.

TI-Nspire™ Navigator™

- Send out the *Graphical_Analysis.tns* file.
- Monitor student progress using Screen Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- *Graphical_Analysis.tns* document
- TI-Nspire™ Technology
- Student problem set



TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Use *Lists and Spreadsheet*
- Use *Data and Statistics*
- Determine regression line

Tech Tips:

Make sure that students understand how to:

- Enter data in *List and Spreadsheets*
- How to graph data in *Data and Statistics*
- How to determine the regression equation.

Lesson Materials:

Student Activity

- Graphical_Analysis_Student.doc
- Graphical_Analysis_Student.pdf

TI-Nspire document

- Graphical_Analysis.tns



TI-Nspire Navigator Opportunities

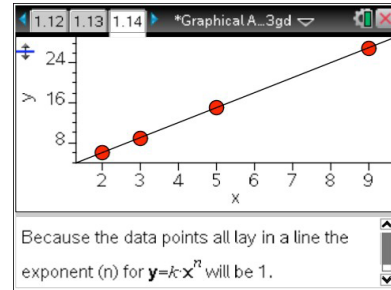
TI-Navigator can be used to make screen shots to follow student progress. A visual check can be made to see which students are successful and which are struggling.

Move to pages 1.2–1.6.

1. Students should read the introduction on pages 1.2–1.6. This lesson directs students through examples of data and the accompanying graphs to determine the relationship between x and y .

Students learn to recognize when data are not linear, and learn how to linearize data to determine the relationship.

Students then obtain three problem sets from the teacher to analyze.



Teacher Tip: If you want students to have a paper copy of this activity, you might consider deleting the direction pages in the *Graphical_Analysis.tns* file before sending out to the students. Alternatively, the .tns file can stand alone because it contains all the directions for completing the activity. You would only have to provide each group or individual with three problem sets for Questions 5, 6, and 7.

Discussion Points and Possible Answers

Move to pages 1.7–1.9.

Have students answer the questions on either the handheld, on the activity sheet, or both.

- Q1. The expression x^{-1} is equal to _____.

Answer: A. $1/x$

- Q2. How do quadratic and linear equations differ? (List all that apply).

Answer: B. and C. are correct. B. The exponent value of X is different. C. One curves and the other doesn't.

- Q3. What does it mean to linearize data?

Answer: Linearizing is this process of modifying an equation to produce new variables which can be plotted to produce a straight-line graph.



Move to pages 1.10–1.14.

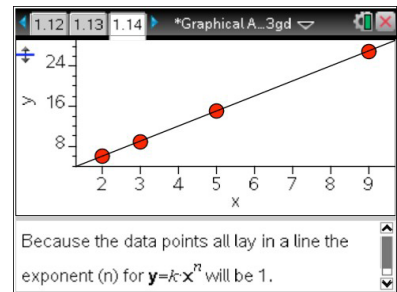
Example 1

2. In this first example, four ordered pairs of data are given on the *List and Spreadsheets* table on page 1.13 like the one shown to the right.

	A	B
1	2.	6.
2	3.	9.
3	5.	15.
4	9.	27.

3. Students' data should look like the *Data and Statistics* graph shown on page 1.14 like the one shown to the right.

Because the data points all lie in a line, the exponent n for $y = k \cdot x^n$ will be 1. The graph is therefore linear. The slope of the line is 3 and the y -intercept is zero.



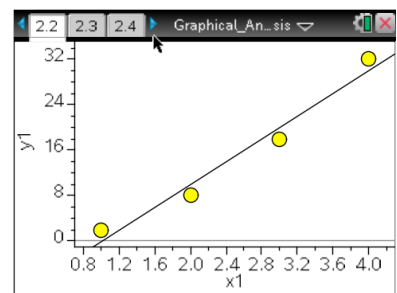
Move to pages 2.1–2.3.

Example 2

4. In this second example, four ordered pairs of data are given on the *List and Spreadsheets* table on page 2.3 like the one shown to the right.

	A	B	C	D	E
	x1	y1	sqx1	invx	
			=x1^2	=1/x1	
1	1.	2.	1.	1.	
2	2.	8.	4.	0.5	
3	3.	18.	9.	0.333333	
4	4.	32.	16.	0.25	

5. The data are graphed on the *Data and Statistics* graph on page 2.3 like the one shown to the right. The data are not randomly distributed about the line. The graph curves upward so the relationship is **not** linear.



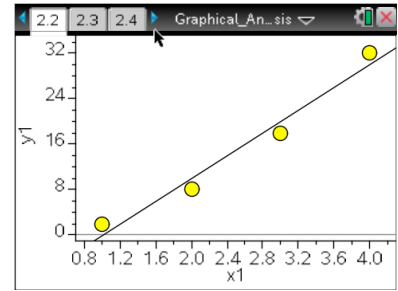
Move to pages 2.4 and 2.5.

6. Read the introduction on page 2.4 and move to page 2.5. One possibility is to graph y vs. the square of x , x^2 , to see if the data is quadratic. Students should see the *Lists and Spreadsheet* table on page 2.3 like the one shown to the right.

	A	B	C	D	E
	x1	y1	sqx1	invx	
			=x1^2	=1/x1	
1	1.	2.	1.	1.	
2	2.	8.	4.	0.5	
3	3.	18.	9.	0.333333	
4	4.	32.	16.	0.25	



- To see the graph of y vs. x^2 , students should move the cursor to the x -axis label on the *Data and Statistics* graph on page 2.3 and choose **sqx**. The graph is now linear indicating that the relationship is linear for y vs. x^2 .

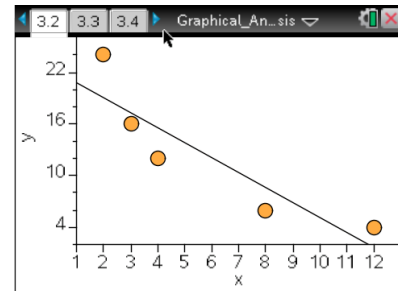


Move to pages 3.1–3.4.

Example 3

- Students should read the information and analyze the graph on pages 3.1–3.4.
There are five ordered pairs of data on the *List and Spreadsheets* table on page 3.4. The data is graphed on the *Data and Statistics* graph on page 3.2. The graph curves downward. The decrease is rapid at first, then begins to level off.
- The relationship may be an inverse proportion. To check whether it is, students should click on the x -axis label on the *Data and Statistics* graph, and choose **invx**.
The graph should now appear linear, indicating that y vs. $1/x$ is linear. **Therefore, the exponent n of x is -1 .**

	x	y	invx =1/x	sqx =x^2
1	2.	24.	0.5	4.
2	3.	16.	0.333333	9.
3	4.	12.	0.25	16.
4	8.	6.	0.125	64.
5	12.	4.	0.083333	144.
A7	=2			

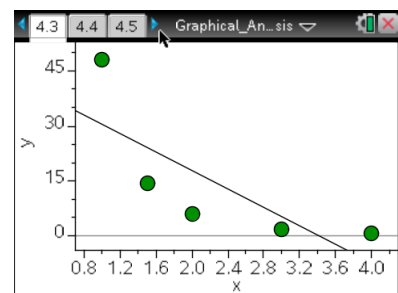


Move to pages 4.1–4.7.

Example 4

- Students should read the information and follow the directions on these pages. In this example, students view five ordered pairs of data on the *List and Spreadsheets* table on page 4.3. This data is then graphed on the *Data and Statistics* graph on page 4.7. The graph curves downward. The relationship is not linear. It may be inverse, quadratic or a combination.
- It appears to be an inverse proportion. To confirm this, students should click on the x -axis label on the *Data and Statistics* graph and choose **invx**. The graph is still curved. **Therefore, the exponent n of x is not -1 .**
- Students should click on the x -axis label of the *Data and Statistics* graph and choose **invxsq**. The graph is still not linear since the regression line does not pass through each of the points. **Therefore, the exponent n of x is not -2 .**

	x	y	invx =1/x	invxsq =1/x^2	invxcub =1/x^3
1	1.	48.	1.	1.	1.
2	1.5	14.2	0.6666...	0.4444...	0.296296
3	2.	6.	0.5	0.25	0.125
4	3.	1.78	0.3333...	0.1111...	0.037037
5	4.	0.75	0.25	0.0625	0.015625
A7	=1				





13. Next, students should click on the x -axis label of the *Data and Statistics* graph and choose **invxcub**.

The graph is now linear. **Therefore, the exponent n of x is -3 .**

Move to page 4.8.

Have students answer the question on either the handheld, on the activity sheet, or both.

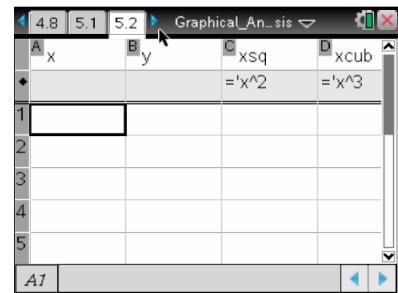
Q4. As the graph was changed from x to the inverse of x to the inverse of x^2 , and finally to the inverse of x^3 , how did the alignment of the data points change in relation to the regression line?

Answer: The points became more linear and moved to align with the regression line.

Move to pages 5.1–5.3.

14. After the students finish the examples in Questions 1–4, assign three data sets to solve in Questions 5, 6, and 7. Assign one data set per row to vary the type of relationship.

15. Students should graph their data on the *Data and Statistics* graph on page 5.3, and determine the value of the exponent n for each data set. The *List and Spreadsheet* and *Data and Statistics* pages are already inserted for use.



Model for your students how to isolate the constant k , solve for k twice using two different data pairs, and how to substitute the value of k into the original equation.

Move to page 5.4.

Have students answer the question on either the handheld, on the activity sheet, or both.

Q5. The value of the exponent (n) for the first data set is _____.

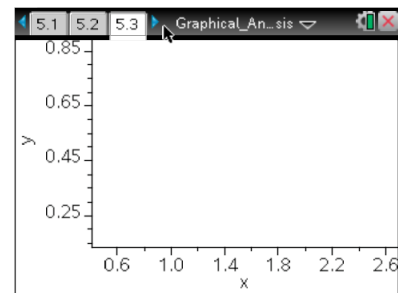
Answer: Answer varies according to assigned data set. See problem solutions at the end of the Teacher Guide.

Move to pages 5.5 and 5.6.

16. The equations from this exercise fit the equation $y = k \cdot x^n$.

Students should write their equation for Question 6 in this form substituting in the value of n that they determined for the data set.

17. Students should then isolate k from this equation. Page 5.6 is a calculator page. They should choose an ordered pair (x, y) and solve for k . Students should repeat for a second ordered pair. The two values of k **MUST** be equal (or very close).



Move to page 5.7.

Have students answer the question on either the handheld, on the activity sheet, or both.



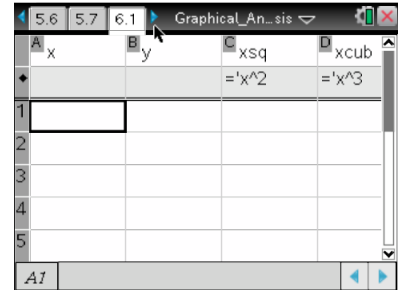
Q6. What is true of the value of k that was calculated for the two ordered pairs?

Answer: The value was constant.

Move to pages 6.1 and 6.2.

18. In the space below students should:

- show the equation solved for k
 $k = \underline{\hspace{2cm}}$
- give the two values of k that you solved
 $k = \underline{\hspace{1cm}} \ \& \ \underline{\hspace{1cm}}$
- write the original equation with the value of k substituted into the equation
 $y = \underline{\hspace{2cm}}$



19. They should then repeat the steps from Question 6 for your second data set.

Move to page 6.3.

Have students answer the question on either the handheld, on the activity sheet, or both.

Q7. The value of the exponent (n) for the second data set is _____.

Answer:

Move to pages 6.4 and 6.5.

Have students answer the question on either the handheld, on the activity sheet, or both.

Q8. What is true of the value of k that was calculated for the two ordered pairs?

Sample Answer:

- $k = y/x$
 - $k = 0.33 \ \& \ 0.33$
 - $y = 0.33x$
20. Repeat the steps from Question 5 for your third data set.

Note: The solutions for Questions 7 and 8 will be similar to the solution to Question 6.

Refer to the solutions at the end of the Teacher Guide.

Move to page 6.6.

Have students answer the question on either the handheld, on the activity sheet, or both.

Q9. What is true of the value of k that was calculated for the two ordered pairs?



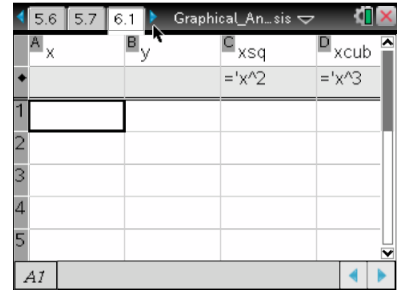
Answer: The value was constant.

- a. $k = y/x$
- b. $k = 0.33$ & 0.33
- c. $y = 0.33x$

Move to pages 7.1 and 7.2.

21. In the space below:

- a. show the equation solved for k
 $k = \underline{\hspace{2cm}}$
- b. give the two values of k that you solved
 $k = \underline{\hspace{1cm}}$ & $\underline{\hspace{1cm}}$
- c. write the original equation with the value of k substituted into the equation
 $y = \underline{\hspace{2cm}}$



22. Repeat the steps from Question 5 for your third data set.

Move to page 7.3.

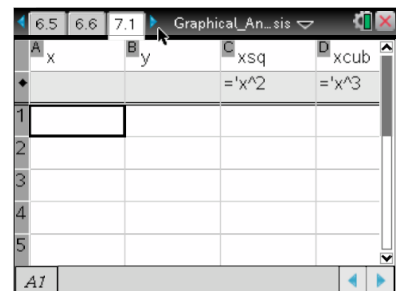
Have students answer the question on either the handheld, on the activity sheet, or both.

Q10. The value of the exponent (n) for the third data set is _____.

Answer:

Move to pages 7.4 and 7.5.

23. Write you equation for Question 5 in this form substituting in the value of n that you determined for the data set. Isolate k from this equation. Use page 7.5 as a calculator page. Choose an ordered pair and solve for k. Repeat for a second ordered pair.



Move to page 7.6. Answer the following question here or in the .tns file.

Q11. What is true of the value of k that was calculated for the two ordered pairs?

Answer:

Move to page 8.1–8.10.

Have students answer the questions on either the handheld, on the activity sheet, or both.

Q12. When the graph of y vs. x is linear, the value of the exponent (n) is _____.



Answer: A. 1

Q13. When the graph of y vs. x curves upward, the value of n must be _____.

Answer: C. > 1

Q14. When the graph of y vs. x decreases rapidly and then levels off, the value of n must be _____.

Answer: B. < 0

Q15. When the value of $n = 2$, the equation for the relationship is _____.

Answer: D. $y = x^2$

Q16. When the value of $n = -1$, the graph is said to be _____.

Answer: B. inverse

Q17. When the value of n is 1, the graph is _____.

Answer: A. linear

Q18. When the value of x is 2 and y is 8, the equation would be $y =$ _____.

Answer: D. x^3

Q19. When the value of x is greater than 1, the graph is said to be _____.

Answer: C. exponential

Q20. If the equation for a relationship between x and y were $y = x^0$, the graph would be _____.

Answer: D. horizontal line

Q21. If a graph curves downward, first try _____ the value of x and regraphing the data to make the graph linear.

Answer: C. the inverse of



Problem Sets

<p>1. $x y$ 0.6 .198 0.8 .264 1.5 .495 2.0 .660 2.5 .825</p>	<p>7. $x y$ 0.20 .290 0.25 .363 0.30 .435 0.45 .653 0.60 .870</p>	<p>13. $x y$ 1.5 1.13 2.0 1.50 2.5 1.88 3.5 2.63 5.0 3.75</p>	<p>19. $x y$ 45 405 37 333 16 144 4 36 64 576</p>	<p>25. $x y$ 89 8.72 321 31.5 47 4.61 213 20.9 436 42.7</p>
<p>2. $x y$ 32 819 13 135 43 1479 8 51.2 24 461</p>	<p>8. $x y$ 0.7 16.7 1.2 49.0 1.8 110 4.5 689 2.5 213</p>	<p>14. $x y$ 2 8 8 128 6 72 5 50 3 18</p>	<p>20. $x y$ 4 8.0 3 4.5 7 24.5 5 12.5 8 32.0</p>	<p>26. $x y$ 0.1 .002 0.2 .008 0.3 .018 0.5 .050 0.7 .098</p>
<p>3. $x y$ 1 2 2 16 3 54 4 128 5 250</p>	<p>9. $x y$ 0.4 .192 0.6 .648 0.2 .024 0.8 1.54 0.9 2.19</p>	<p>15. $x y$ 0.1 .0005 0.5 .0625 0.3 .0135 0.7 .1715 1.0 .5000</p>	<p>21. $x y$ 7 82.3 12 415 10 240 15 810 3 6.48</p>	<p>27. $x y$ 0.5 2.25 0.8 9.22 1.1 24.0 1.9 123.5 0.2 0.144</p>
<p>4. $x y$ 2.0 1.5 2.5 1.2 1.5 2.0 3.0 1.0 5.0 0.6</p>	<p>10. $x y$ 2.5 10.00 1.5 16.67 12.0 2.083 19.0 1.316 5.0 5.000</p>	<p>16. $x y$ 6 2.50 9 1.67 10 1.50 12 1.25 20 0.75</p>	<p>22. $x y$ 14 5.36 25 3.00 19 3.95 36 2.08 48 1.56</p>	<p>28. $x y$ 5 0.16 2 0.40 8 0.10 15 0.053 0.5 1.60</p>
<p>5. $x y$ 2.0 1.00 3.0 0.444 5.0 0.160 1.5 1.78 8.0 .0625</p>	<p>11. $x y$ 5.0 0.84 2.0 5.25 3.0 2.33 4.8 0.91 7.5 0.373</p>	<p>17. $x y$ 1.5 5.33 2.0 3.00 5.0 0.48 3.8 0.83 6.0 0.333</p>	<p>23. $x y$ 5 5.80 11 1.20 15 0.644 24 0.252 30 0.161</p>	<p>29. $x y$ 0.5 3.00 0.8 1.17 1.3 0.444 2.0 0.188 3.0 .0833</p>



6. $x \cdot y$ 11 0.236 17 .0639 6 1.454 28 .0143 20 .0393	12. $x \cdot y$ 0.85 1.04 1.5 .190 0.5 5.12 2.0 .080 3.0 .0237	18. $x \cdot y$ 0.4 78.1 0.9 6.85 0.7 14.6 1.2 2.89 0.6 23.2	24. $x \cdot y$ 4.5 .154 5 .112 7 .041 3 .591 8 .0273	30. $x \cdot y$ 2 3.00 3 0.889 5 0.192 7 0.070 9 0.033
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Problem Solutions

1. $y = 0.33x$	2. $y = 0.8x^2$	3. $y = 2x^3$
4. $y = 3/x$	5. $y = 4/x^2$	6. $y = 314/x^3$
7. $y = 1.45x$	8. $y = 34x^2$	9. $y = 3x^3$
10. $y = 25/x$	11. $y = 721/x^2$	12. $y = 0.64/x^3$
13. $y = 0.75x$	14. $y = 2x^2$	15. $y = 0.5x^3$
16. $y = 15/x$	17. $y = 12/x^2$	18. $y = 5/x^3$
19. $y = 9x$	20. $y = 0.5x^2$	21. $y = 0.24x^3$
22. $y = 75/x$	23. $y = 145/x^2$	24. $y = 14/x^3$
25. $y = 0.098x$	26. $y = 0.2x^2$	27. $y = 18x^3$
28. $y = 0.8/x$	29. $y = 0.75/x^2$	30. $y = 24/x^3$

Wrap Up

When students are finished with the activity, pull back the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions using Slide Show.

Assessment

- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved by TI-Nspire Navigator™. The TI-Navigator™ Slide Show can be utilized to give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test, inquiry project, performance assessment, or an application/elaborate activity.