TI-*nspire*™

Grade level: 9-12
Subject: mathematics
Statistics
Time required: 45 to 90 minutes

Exploring Planetary Motion

by – Diana Lossner

Activity overview

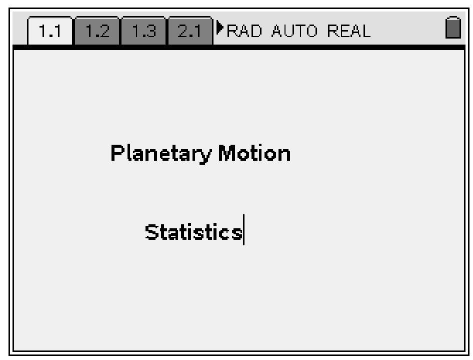
Students will find the best model for the orbits of planets about the sun. Students will practice using the laws of exponents.

Concepts

- *Laws of exponents*
- *Linear regression*
- *Exponential regression*
- *Power regression*

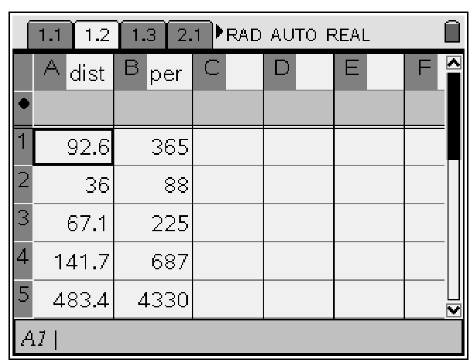
Step-by-step directions

Open PlanetMotion document on Nspire handheld.

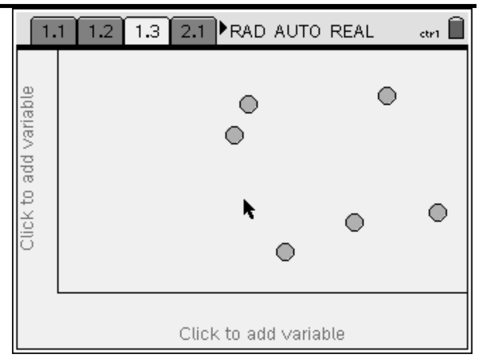


Planets revolve around the sun in elliptical orbits. We want to discover how the distance from the sun affects the planet's period in days compared to the earth's period of 365 days.

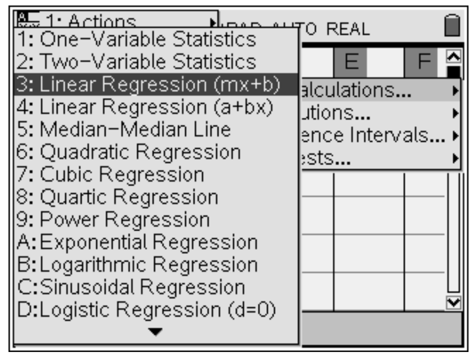
ctrl ▸ to get to page 2 of your document. You see the lists of distance from the sun in "dist" column and period in the "per" column.



(ctrl) ▸ to get to the next page. Click on x-axis and put your independent variable there. Click on the y-axis and put your dependent variable there. Sketch your graph. What type of graph do you think it might be? Let's find out for sure. (Dots on graph will change once you put in x- and y- values.



Go back to the previous page and do regressions to see which is best. (menu) ❹ (Statistics) ❶ (Stat Calculations) ❹ (Linear Regression (a + bx)). Use pull down menus to x List (dist), y List (per); (tab between entries), tab to OK and press enter. Your data will appear in the next columns of your list page. After linear, do exponential and power regression and fill in table below.



Type	Resulting Equation	Correlation Coefficient (r)
Linear	y = ____________________	____________
Exponential	y = ____________________	____________
Power	y = ____________________	____________

By comparing correlation coefficients, which regression equation fits best?

Look at the regressions on the graph, does one fit better than the others? Is it the same one with the best correlation coefficient?

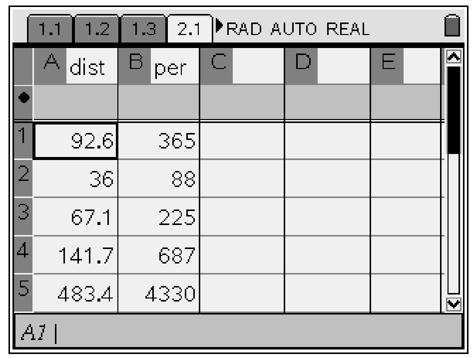
Copy your equation into the template. $y = \_\_\_\_\_\_\_ x^{\_\_\_\_\_\_\_}$

Using algebra and the laws of exponents transform this function into a linear function.

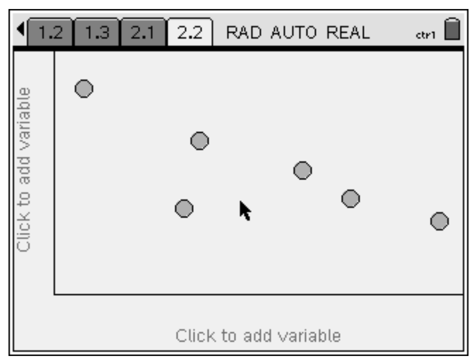
1. Take the ln of both sides. ln y = ln ___________________
2. Rewrite the right side using a property of logs. ln y = ln ____________+ ln _________
3. Rewrite the right side using another property of logs. ln y = ln ______+ ______ln _________
4. Find the ln of the number on the right side. ln y = ________ + _____ ln ________

Notice that we have written ln y as a linear function of ln x.

If the power function is the best fit for the data, we should see a linear relationship from the data if we graph the scatter plot (ln x, ln y). (ctrl) ▸ to get to the next problem. On this spread sheet go to the space next to C and type in "ldist", arrow down, press (enter) , type in ln(dist) and press (enter) . Arrow over to D, type in "lper", arrow down, press (enter) , type in ln(per) and press (enter) .



(ctrl) ▸ to get to the next page. Click on x-axis and put your new independent variable there. Click on the y-axis and put your new dependent variable there. Sketch your graph. Does it appear linear? Let's find the linear regression.



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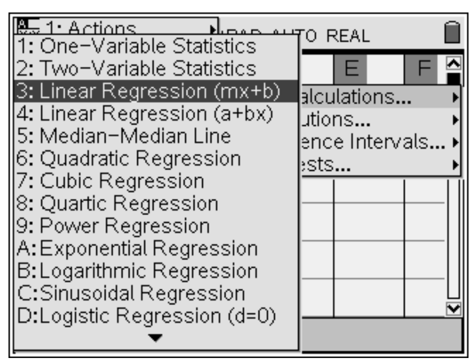

Write your linear regression equation. Have you seen these numbers Slope of line = _________

before? What does that tell you?

y-intercept = __________

equation of line: __________________

Conclusion: If a, x, and y are positive, then the ordered pairs (x, y) are related by th power function if and only if the ordered pairs (ln x, ln y) are related by a linear function. To prove this, let's use algebra:

Using algebra and the laws of exponents transform this function into a linear function.

$y = ax^b$

1. Take the ln of both sides. ln y = ln ___________________
2. Rewrite the right side using a property of logs. ln y = ln ____________+ ln _________
3. Rewrite the right side using another property of logs. ln y = ln ______+ ______ln _________