

Thickest Piece of Paper in the World

Exponents
Exponential Growth
Problem Solving
Decimals
Scatter Plots



Standards: Problem Solving, Communication, Reasoning, Algebra, Functions, Statistics,

Materials: CFX-9850G or CFX-9850Ga and 1 piece of notebook paper

Calculator Menus: RUN and STAT

A piece of notebook paper is about 0.0032 inches thick. Fold a piece of notebook paper in half. Repeat this procedure 4 times. How thick is the **stack**? How would you calculate the thickness?

Fill in the table below for 6 such folds.

| Number of folds | Thickness of stack (in inches) |
|-----------------|--------------------------------|
| 0 | 0.0032 |
| 1 | A. _____ |
| 2 | B. _____ |
| 3 | C. _____ |
| 4 | D. _____ |
| 5 | E. _____ |
| 6 | F. _____ |

? represents a high level question

Interest made on invested money is an example of exponential growth. Where else have you heard exponential growth mentioned?

? How fast is the stack's thickness increasing? **G.** _____

Does color of the paper have anything to do with the paper's thickness? **H.** _____

Is all paper the same thickness? **I.** _____ Why or why not? **J.** _____

Reusing Previous Expressions from the RUN Menu

Enter 0.0032(2)^10
 Press EXE

To reuse use this expression substituting 15 for 10:
 Press left arrow key
 move cursor to 0
 Press 5
 EXE

This type of increase is called Exponential Growth. The general formula is

$$Y = a(C)^x$$

where **a** is the initial amount you start with, **C** is the change factor, and **x** is the number of times the change occurs.

The **initial amount** is the thickness of the piece of paper before it is folded. The **change factor** is what is happening to the stack's thickness each time it is folded.

For the paper folding experiment, what is:

the initial amount (**a**)? **K.** _____ the change factor (**C**)? **L.** _____

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Altering Settings of Data Graphs

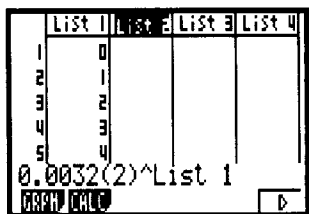
In the STAT Menu,
 Press F1 (GRPH)
 F6 (SET)
 Highlight Graph Type
 F1 (Scat)
 Highlight XList and YList and
 select the appropriate list for
 you data graph.
 EXIT
 Use the arrow keys to high-
 light any mode to change.

Drawing a Scatter Plot

Enter the STAT menu
 Enter desired values in
 LIST 1 and LIST 2.
 Press F1 (GRPH)
 F1 (GPH1)

Using an Expression to Fill a List.

Highlight the top of LIST 2



With data in List 1,
 Highlight "List 2",
 Enter: 0.0032
 (
 2
)
 ^
 OPTN
 F1 (LIST)
 F1 (List)
 1
 EXE.

Write a formula by substituting your values for **a** and **C** into the general formula $Y = a(C)^x$. **M.** _____

Find the thickness of your stack after ten folds by substituting 10 for **x** in the right side of the formula and solving for **Y**. **N.** _____

What is the thickness after 15 folds? **O.** _____

Convert the 15 fold thickness to feet. **P.** _____

Graphing Exponential Data

In the STAT MENU, enter the number of folds in List 1. You want to fill List 2 with the paper thickness after each fold. Highlight the top of List 2 and enter $0.0032(2)^{\text{List 1}}$. The results are shown in Figure 1. Graph a scatter plot. An example of a similar scatter plot is shown in Figure 2.

| List 1 | List 2 | List 3 | List 4 |
|--------|--------|--------|--------|
| 0 | 3.2E-3 | | |
| 1 | 6.4E-3 | | |
| 2 | 0.0128 | | |
| 3 | 0.0256 | | |
| 4 | 0.0512 | | |

Figure 1

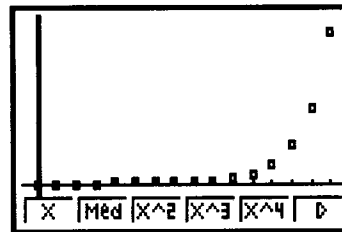


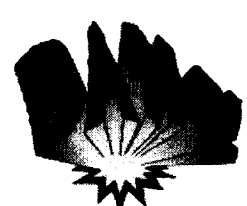
Figure 2

Looking at your scatter plot, would the equation for the data be linear? **Q.** _____
 Explain your response. **R.**

With your scatter plot on the screen, press F1 (X). What is **r**? **S.** _____
 Is this an acceptable correlation coefficient? Why or why not? **T.**

Press F6 (DRAW) to draw your best fit line for the data. Is this an acceptable best fit line for the data? Why or why not? **U.**

Press F6 (▷), then F2 (EXP). What is the value of **r**? **V.**
 What does this value say about the data? **W.**

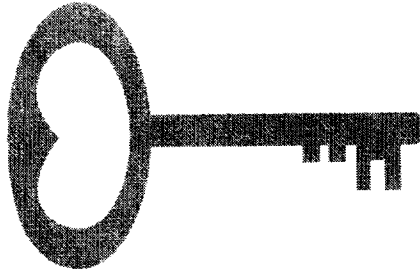


How thick would your stack be after 25 folds? **X.** _____

What unit of measure is best used to express this thickness? Why? **Y.**

? How many folds would it take for the stack to reach or exceed the distance from the earth to the sun? **Z.** _____

Solution Key



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- A.** 0.0064 **B.** 0.0128 **C.** 0.0256 **D.** 0.0512 **E.** 0.1024
F. 0.2048 **G.** By a factor of 2. It is doubling or multiplied by 2.
H. No. **I.** No.
J. Bonded paper and stock paper are thicker than notebook paper
K. 0.0032 **L.** 2 **M.** $y = 0.0032(2)^x$ **N.** 3.2768 inches
O. 104.8576 inches **P.** 8.73813 feet **Q.** No.
R. Linear data models a straight line. This data models a curve.
S. $r = 0.55377493$
T. No. The value of r should be close to -1 or 1. The closer to -1 or 1, the better a linear model fits the data. Depending on the data, a value of 0.8 or greater is usually an acceptable value for r for linear regression.
U. No. A linear model represents data that takes the shape of a straight line. An exponential model represents data that takes the shape of a curve.
V. $r = 1$
W. An exponential model is a perfect fit for this data.
X. 107,374.1824 inches
Y. Miles. Easier to understand. Most people do not realize how large 100,000 inches are.
Z. The mean distance of the earth to the sun is 92,000,000 miles. 50 folds yields approximately 56,863,631 miles and 51 folds yields approximately 113,727,263 miles. Therefore, you would need at least 51 folds.
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