

# Paulina's Pottery Barn

TI Calculator & Linear Equations

## Paulina and Her Pottery Barn

Paulina is the owner and operator of *Paulina's Pottery Barn*. She sells a small amount of pottery to customers that visit her shop, but she sells most of her pottery to shopkeepers downtown where the tourist business is. Shopkeepers order what they need through Email on Monday through Tuesday, and on Thursday Paulina makes the needed items, and they are delivered on Friday morning.

Paulina has two types of expenses for her business. Her *overhead* consists of bills she must pay each week regardless of how much pottery is ordered from the downtown shopkeepers. The second type of expense depends on how many items are ordered by her downtown customers. Although there are lots of little expenses associated with each pot that has to be made, the overwhelming factor is the energy required to run her electric kiln. Paulina has tracked this expense for a long time and knows that it costs her about \$0.50 per item to run her kiln.

### Paulina's Overhead Expenses

Expense	Amount
Rent	\$200
Utilities	\$50
<b>Total</b>	<b>\$250</b>

*Question #1:* How much does it cost for Paulina to just run her kiln during a week with 320 items ordered?

*Question #2:* What are Paulina's total expenses for the same week?

*Question #3:* How large an order does it take for Paulina to spend as much on overhead expenses as the energy for her electric kiln?

## Paulina's Predicament

Paulina typically has order sizes between 800–1000 items, so most of Paulina's expenses are on her kiln. Unfortunately, Paulina cannot raise her price because the downtown stores will simply order their pots from her crosstown competitor, *Tom's Talently Thrown Clay Containers*.

<b>Solar Energy</b> \$100/month loan payment for 5 years \$0.35 per item kiln cost
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<b>Wind Power</b> \$200/month loan payment for 5 years \$0.15 per item kiln cost
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But Paulina has investigated all her options and she is considering two ways to decrease the expense of running the kiln. Both solar power and wind energy options require a bank loan to buy alternative energy technology, the bank

loan will increase her *overhead* expense. However, both options will decrease the cost of running her kiln per item ordered.

Is there an option, solar or wind, that you think is the best? What type of calculations might help you decide which option is better?

## Finding the Expense Equations

We will use TI calculators to gain more insight into this problem. But first, we must determine the three mathematical equations that describe Paulina’s Predicament. Copy and complete the following table on a separate piece of paper. The table shows Paulina’s current expenses, her expenses using solar energy, and her expenses using wind energy.

Items	Current			Solar			Wind		
	Overhead	Kiln Cost	Total	Overhead	Kiln Cost	Total	Overhead	Kiln Cost	Total
0	250	0	250	$250 + 100$	0	350	$250 + 200$	0	450
100	250	$100 \times 0.50 = 50$		350	$100 \times 0.35 = 35$		450	$100 \times 0.15 = 15$	
200									
400									
800									
1000									

The data in the table for Paulina’s current expenses, expenses with solar energy, and expenses with wind energy all follow a common form:

$$\text{Expense} = \text{Overhead} + ?? \times \text{Items}$$

Question #4: What is the equation for Paulina’s current expenses?

Question #5: What is the equation for Paulina’s expenses using Solar Energy?

Question #6: What is the equation for Paulina’s expenses using Wind Energy?

## Initializing your TI Calculator

### Steps to Reset Calculator

1. Turn the calculator **ON**
2. Go to the memory menu: **2nd** **MEM** **+**
3. Choose option 7, “Reset...”: **7**
4. Choose option 1, “All RAM...”: **1**
5. Confirm the reset with **2**
6. The display now says “All cleared”, hit **CLEAR**

Our first step in using the calculators for this problem is to *reset* the calculator so that its current settings don’t cause confusion. Follow the steps listed at the left to reset your calculator.

## Setting Up the Plot Window

Next, we want to setup the plotting window so that we only see the portions of graphs that interest us. Select the **WINDOW** button directly underneath the LCD display.

Use the cursor keys **▲**, **▼**, **◀**, **▶**, **CLEAR**, and the **ENTER** key to change the values to match those shown at the right.

Once all the values are correct, use **2nd** **QUIT** (right beside the **2nd** key) to exit the window screen. The display may be blank, with a flashing cursor in the upper-left hand corner, this is O.K.

### WINDOW Parameters

```
WINDOW
Xmin=0
Xmax=1000
Xscl=100
Ymin=200
Ymax=800
Yscl=100
Xres=1
```

## Enter Paulina's Current Expense Equation

Now we can finally use the graphing features of the calculators. The first thing we will do is to plot Paulina's current expenses equation. This is the answer in *Question 4*. The calculator doesn't know about Paulina, her kiln, or her expenses; the calculator simply knows about the Y-axis and the X-axis. The calculator uses the variable *X* instead of the *Items* ordered from Paulina.

### Paulina's Current Expense Equation

```
Plot1 Plot2 Plot3
Y1=250+0.50*X
Y2=
Y3=
Y4=
Y5=
Y6=
Y7=
```

Hit the **Y=** key (below the LCD screen), and use the cursor keys **▲**, **▼**, **◀**, **▶**, **CLEAR**, and the **ENTER** key to enter in an equation for *Y1*.

Note that you should use the **X, T, θ, n** key for *X* variable, *not* the **×** key!

When this screen is correct, hit the **GRAPH** button. This will take you to the graphical plot of the equation

$$Y = 250 + 0.50 \times X$$

The calculator screen looks a little different than the plot shown here: this plot is larger, in color, has a key in the upper left-hand corner, has a distinct X-axis, and has the axis tic-marks labeled. These differences won't affect our ability to solve this problem with the calculator.

### Paulina's Current Expenses Plotted

**Y=** **1000000** Current **—**

## Roaming Around the Graph

### The Roaming Cursor in the Plot Window



Now press the  $\Delta$  button 5 times in a row.

The cross-hair above the plot can be moved with the  $\Delta$ ,  $\nabla$ ,  $\leftarrow$ , and  $\rightarrow$  keys. The current location of the cross-hair is shown at the bottom of the screen; your screen probably shows  $X=500$ ,  $Y=548.3871$ .

## Examining the Current Expenses Plot

**Question #7:** Move the cursor along the line shown in the display, do these ordered pairs correspond to values you calculated for Paulina's current expenses in the previous table?

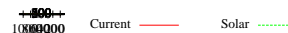
## The Solar Energy Collector Equation

Now, plot the expenses equation for using the Solar Energy. We'll plot this as a *2nd line* in the same graphing window by entering the equation for Y2. Use  $\boxed{Y=}$  to return to the plotting screen and enter the solar equation, then use  $\boxed{\text{GRAPH}}$  to view the new graph.

### Solar Energy Equation

```
Plot1 Plot2 Plot3
Y1=250+0.50*X
Y2=350+0.35*X
Y3=
Y4=
Y5=
Y6=
Y7=
```

### Current and Solar Energy Expenses



**Question #8:** Move the cursor along the *new* line shown in the display, do these ordered pairs correspond to values you calculated for Solar Energy in the previous table?

Let's review quickly, the graph currently shows two lines which show Paulina's expenses. The first line shows her current expenses, with an overhead cost of \$250 and \$0.50 kiln cost per item ordered. The second line shows her expenses *if* she invested in solar technology to help power her kiln. The second line represents an overhead cost of \$350 and a per item kiln cost of \$0.35.

**Question #9:** Where on the graph are *overhead* costs shown? Explain why the overhead cost is not found at the middle or far right of the graphs.

There is an important feature of these lines. They *intersect*. Use the cursor to find the approximate location where the two lines intersect.

**Question #10:** What is the X and Y value where the lines intersect? What does the X value represent to Paulina? What does the Y value represent to Paulina?

**Question #11:** If Paulina expects to have about 400 items ordered per week, should she invest in solar energy? Why or why not? What about 800 items? 650 items?

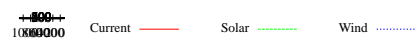
### The Wind Power Equation

Finally, let's add the expense line for wind power so we can help Paulina make a final decision concerning her energy investment. Use the **Y=** and enter the wind energy equation for Y3. Then view the new plot with **GRAPH**.

#### Wind Energy Equation

```
Plot1 Plot2 Plot3
Y1=250+0.50*X
Y2=350+0.35*X
Y3=450+0.15*X
Y4=
Y5=
Y6=
Y7=
```

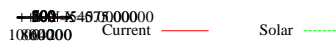
#### Current, Solar, and Wind Energy Expenses



Wow, three lines without color plotting begins to look confusing! Fortunately, we won't have to add a 4th line. Also, the calculator still has some capabilities we haven't used.

### Zooming Plots

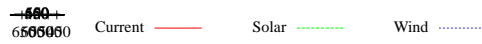
#### Prepared to Zoom



Navigate the cursor to the graph location where all three lines appear to intersect. Now hit the **ZOOM** key (again, directly underneath the LCD screen). Then choose Zoom In with **2**. This returns you to the graphing screen, and the graphing screen does not appear any different than before. Now hit the **ENTER** once, the graph will be redrawn, this time zoomed in on the cursor location.

You can reposition the cursor with **△**, **▽**, **◀**, and **▶**, and hit **ENTER** again if required. Once you have zoomed into the graph area where the three lines intersect, you can use the cursor to determine the location where the line representing the wind expenses intersects the line representing Paulina's current expenses.

#### Zoomed into the Line Intersections



**Question #12:** What is the X and Y value where the wind expense line and Paulina's current expense line intersect? What do the X and Y values represent to Paulina?

*Question #13:* If Paulina expects to have about 400 items ordered per week, should she invest in wind energy? Why or why not? What about 800 items? 650 items?

## **Analysis Conclusions**

Now let's summarize this analysis for Paulina:

*Question #14:* How many items must be ordered per week in order for solar energy to save Paulina money compared to her current expenses?

*Question #15:* How many items must be ordered per week in order for wind energy to save Paulina money compared to her current expenses?

*Question #16:* Given Paulina's three options: not investing her money in an alternative energy source, investing in solar energy, or investing in wind power, which do you recommend she pursue? Why?