

## Breakeven Analysis

Breakeven analysis is concerned with the relationship between the cost and revenue of an enterprise. Implicit in such an analysis is an examination of the relationship between fixed and variable costs, profits, and pricing policy and the volume of output (quantity produced).

Such an analysis of prices, costs, and profits is good for the short term (usually twelve months). The analysis is only as good as the model that is built; the more flexible the pricing policy, the more difficult the model.

### Objectives:

- Determine the quantity of a product that must be sold to break even.

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The following quantities are important in the breakeven analysis:

- F Fixed Cost
- V Variable cost per unit
- P Unit Price
- X Number of units
- T Pre-tax profit

Revenue  $R(X)$  and costs  $C(X)$  are both functions of  $X$ , the number of units.

$$\text{Revenue} = R(X) = P * X$$

$$\text{Cost} = C(X) = F + V * X$$

$$\text{Profit} = T(X) = R(X) - C(X) = P * X - (F + V * X)$$

If  $R(X)$  and  $C(X)$  are each linear relationships, with  $R(X) = P * X$  and  $C(X) = F + V * X$ , then

$$\text{Profit} = P * X - F - V * X \text{ or } \text{Profit} = (P - V)X - F.$$

The above model is linear based on the quantity  $X$ . Breakeven analysis determines the quantity  $X$  for which the pre-tax profit is zero. Hence, the problem becomes

$$\text{Pre-tax profit} = (P - V)X - F = 0$$

where we must solve for  $X$ , given values for  $P$  (price per unit),  $V$  (variable cost per unit), and  $F$  (fixed cost).

On the TI-84 Plus CE Calculator, the breakeven problem can be solved for the number of units  $X$  in several ways:

- numerically with the Numeric Solver
- graphically
- numerically with tables and inspection



### Example:

Rugged Can Company sells trash cans for \$20 each. Each unit has a variable cost of \$15 and the fixed costs are \$4,000. How many cans must be sold to break even?

### Method 1: Numeric Solver

Use  $(P - V)X - F = 0$  with  $P = 20$ ,  $V = 15$  and  $F = 4000$ .

- From the home screen, press the **math** key, and choose Numeric Solver.  
If necessary, clear E1 or E2 by pressing the **clear** key in either row.

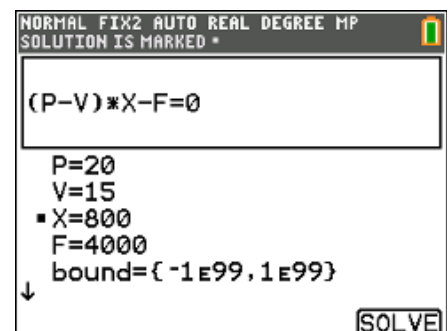
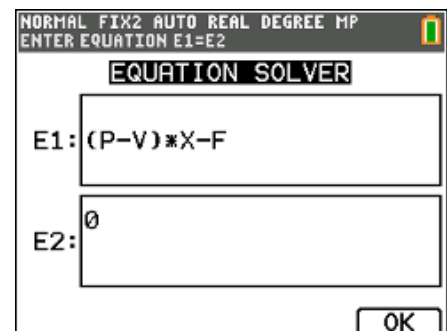
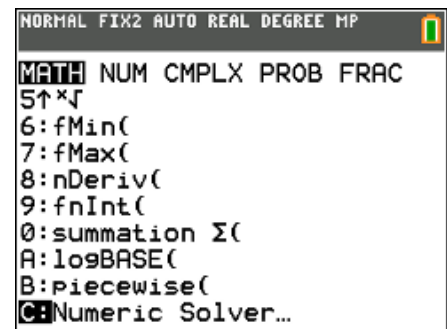
**Note:** The mode DECIMAL SETTING was changed to **FIX2** to round computations to two decimal places.

- Enter  $(P - V) * X - F$  in E1 and **0** in E2.

- Press the “soft key” **graph** to select **OK**. Notice that the variables may contain values from a previous calculation.

- Enter the values for this problem. With the cursor in the **X** row, press the “soft key” **graph** to select **SOLVE**.

Breakeven occurs if 800 units are produced and sold.



Method 2: Graphing

1. Press the  $\boxed{y=}$  key.
2. Use the  $\boxed{\text{clear}}$  key to remove any functions left from another problem.
3. Input the Revenue function in Y1 and the Cost function in Y2, either by using the actual numbers ( $Y_1 = 20 \cdot X$  and  $Y_2 = 15 \cdot X + 4000$ ) or, in general,  $Y_1 = P \cdot X$  and  $Y_2 = V \cdot X + F$ .

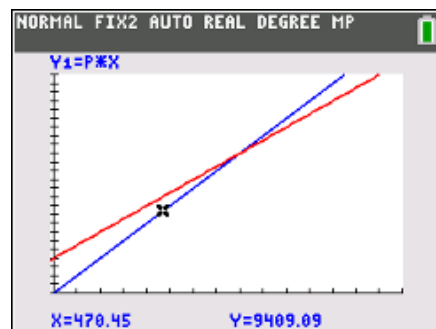
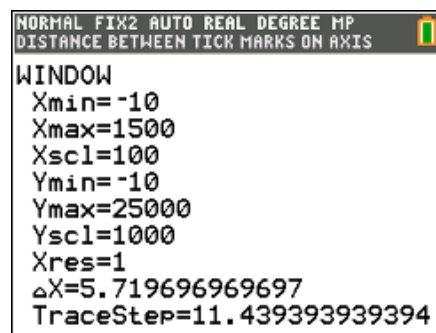
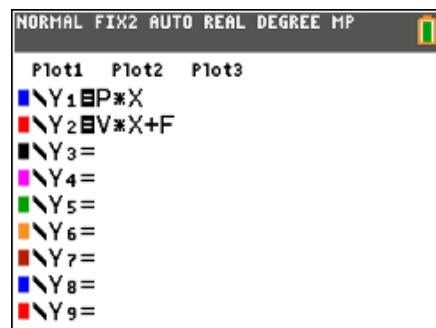
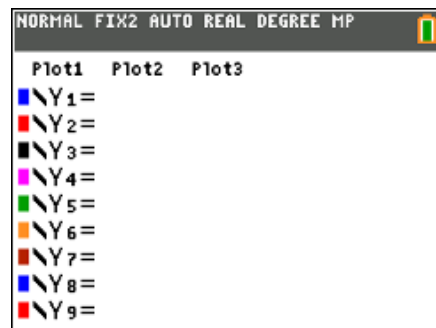
**Note:** Either approach will work in this case since the values have already been entered for P, F, and V. Otherwise, the values for P, F, and V must be entered on the home screen using the  $\boxed{\text{sto} \rightarrow}$  key, e.g.,  $20 \boxed{\text{sto} \rightarrow} \boxed{\alpha} \boxed{P} \boxed{\text{enter}}$ .

4. Choose an appropriate viewing window for these values.

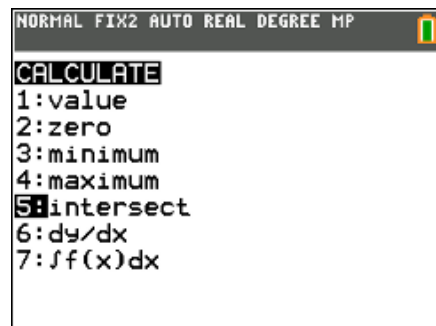
Press the  $\boxed{\text{window}}$  key. Enter Xmin = -10, Xmax = 1500, Xscl = 100, Ymin = -10, Ymax = 25000, and Yscl = 1000.

5. Press  $\boxed{\text{graph}}$  to plot the equations.
6. Press the  $\boxed{\text{trace}}$  key to see the values of X and the function evaluated at X. The left and right arrow keys move the "spider-like" cursor along the functions. The up and down arrow keys cycle through the functions. Notice that the function is listed at the top of the screen on the left.

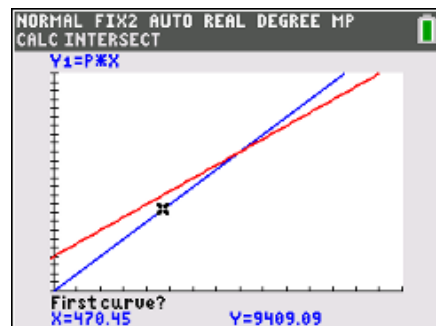
**Note:** To show the function value at a particular value of X, type the X value, and press  $\boxed{\text{enter}}$ .



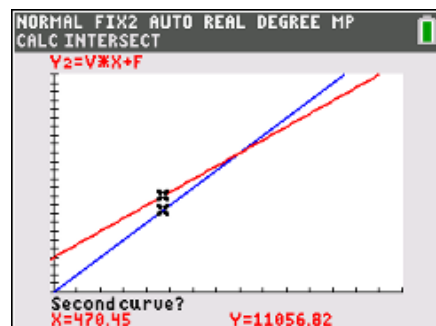
7. To find the point of intersection, press **2nd** **[calc]**. From the CALCULATE menu, choose **intersect**.



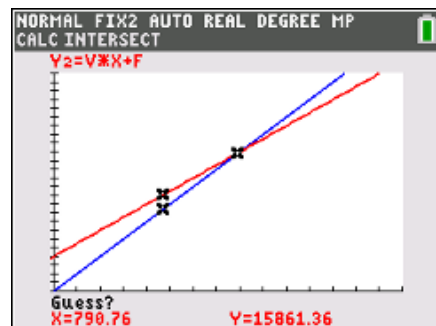
8. For the question "First curve?," move the cursor to Y1 and press **enter**.



9. For the question "Second curve?," make sure the cursor is on the other curve and press **enter**.

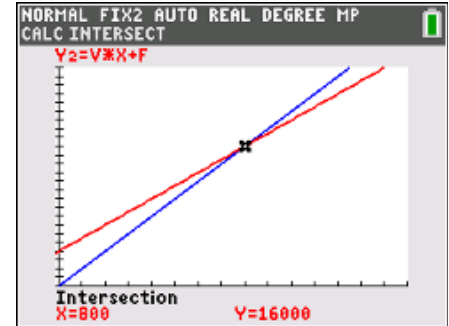


10. At the question "Guess?," move the cursor close to the point of intersection.



11. Press **enter**. The cursor will move to the point of intersection.

The coordinates of the intersection point are shown on the bottom of the screen, indicating a breakeven point of  $X = 800$ .

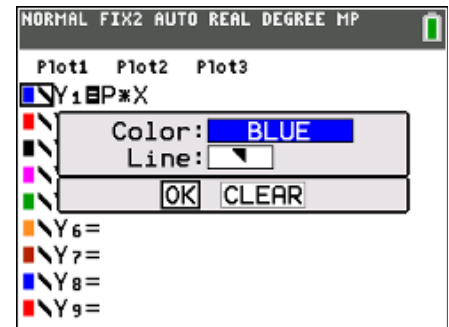


12. To graphically show the loss, press the **y=** key.

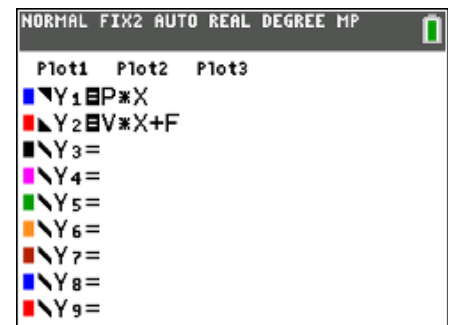
13. Arrow to the left of  $Y_1$ , and press **enter**.



14. Arrow down to **Line:** and press the right arrow key to choose the “shade above” icon for  $Y_1$ . Arrow to OK, and press **enter**.



15. Repeat for  $Y_2$  but choose the “shade below” icon.

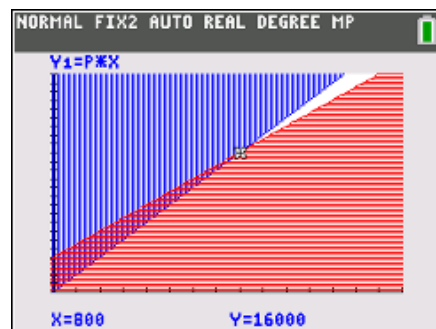
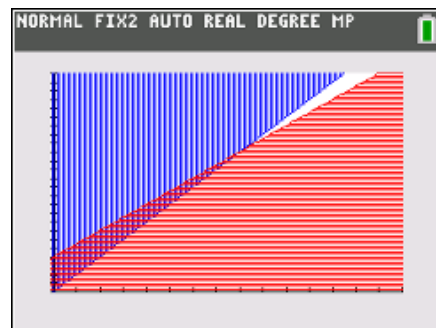


16. Press **[graph]**. Notice that the first function (Revenue) was shaded with vertical lines, while the second function (Cost) was shaded with horizontal lines.

To display the breakeven point, press the **[trace]** key, enter 800, and press **[enter]**.

The area with both types of shading represents the net loss (negative profit). This region, to the lower left of the breakeven point, shows the difference between the Cost line and the Revenue line.

Conversely, the area with no shading to the upper right of the breakeven point represents the net profit. This area, between the two lines, shows the difference between the Revenue line and the Cost line, and represents the profit area.



### Method 3: Tables

Once Y1 and Y2 have been defined as Revenue and Cost, respectively, tables can give a numerical visualization of the problem.

- Press **[2nd]** **[tblset]**.
- Let TblStart be 0 and  $\Delta$ Tbl be 100. X, the number of items, can never be negative. The choice of 100 for the table increment,  $\Delta$ Tbl, is convenient for this problem.
- Press **[2nd]** **[table]**. Notice that at 800, the values in Y1 and Y2 are both 16,000. Breakeven occurs when revenue equals cost.

If either or both of the cost and revenue functions are non-linear, these same methods will apply.

NORMAL FIX2 AUTO REAL DEGREE MP

TABLE SETUP

TblStart=0

$\Delta$ Tbl=100

Indent: **Auto** Ask

Depend: **Auto** Ask

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PRESS  $\Delta$  FOR  $\Delta$ Tbl

X	Y1	Y2			
0.00	0.00	4000.0			
100.00	2000.0	5500.0			
200.00	4000.0	7000.0			
300.00	6000.0	8500.0			
400.00	8000.0	10000			
500.00	10000	11500			
600.00	12000	13000			
700.00	14000	14500			
800.00	16000	16000			
900.00	18000	17500			
1000.0	20000	19000			

X=0