

### Maximization and Minimization

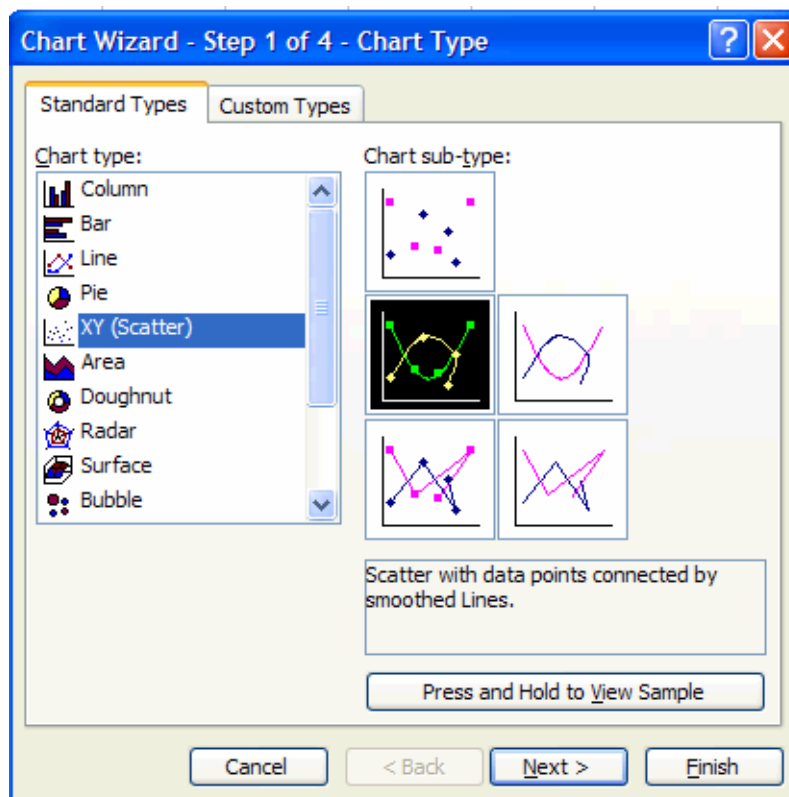
You can find the maximum or the minimum of a function using the Solver option in Excel.

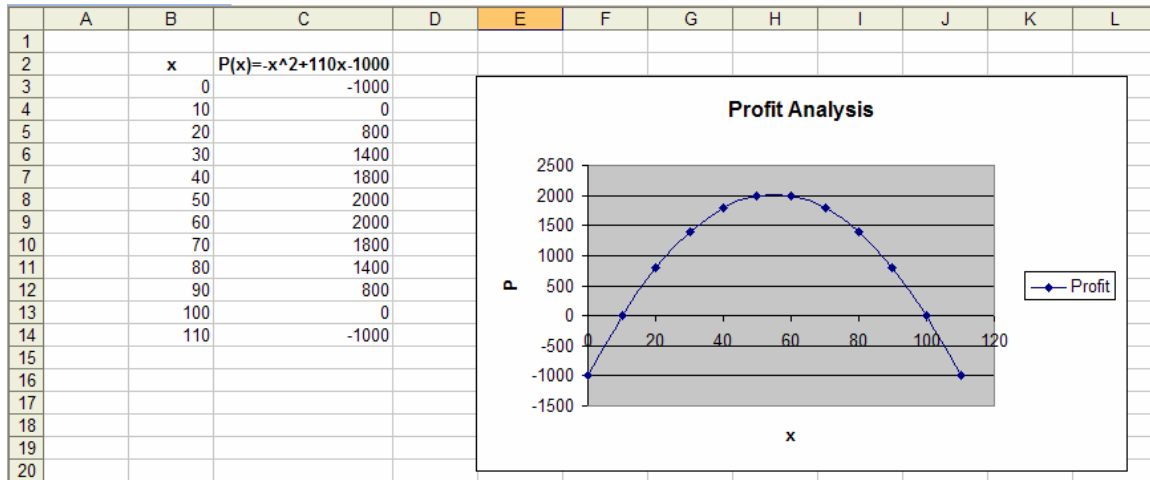
EXAMPLE: Maximize profit if  $P(x) = -x^2 + 110x - 1000$ .

Recall that we can create a table of values, and use the table to generate a graph of the function. Remember to enter the function in each cell to calculate the profit. Use ^ (above the 6 key on your keyboard) for exponents. For this profit function you would enter

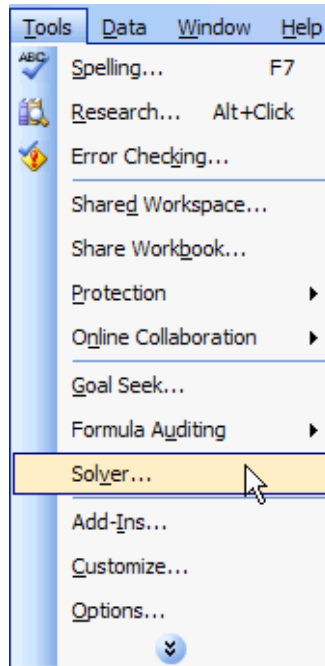
$$= -(B3)^2 + 110*B3 - 1000$$

(assuming the  $x$  value is in the cell A3). Note that you must put the  $(B3)^2$  in another parentheses before we use the  $-$  to change the sign on that term. Enter in the values 0, 10, 20, 30, . . . , 110 for  $x$ . Highlight the two columns of values and select the Chart Wizard. Because the graph of this function is a curve, rather than a straight line, select the option in the second row first column of XY( Scatter).

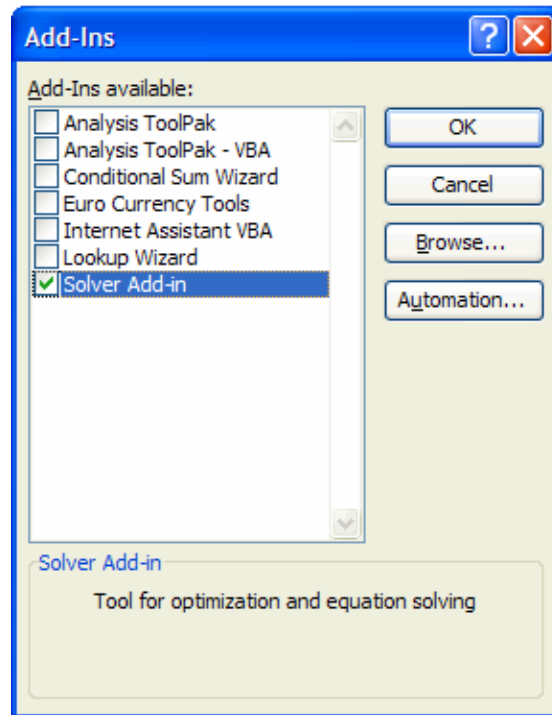




To find the maximum or minimum value of a function we must use the Solver. First, go to Tools, and check to see if the Solver is one of the available options.



If the Solver is not one of the options, we must tell Excel to include it as an option in the Tools. Go to Tools and select Add-Ins..., in the menu box, scroll down until you find the Solver Add-in. Check the box beside Solver Add-in by clicking on the box, then select OK. The Solver is now an option in Tools.

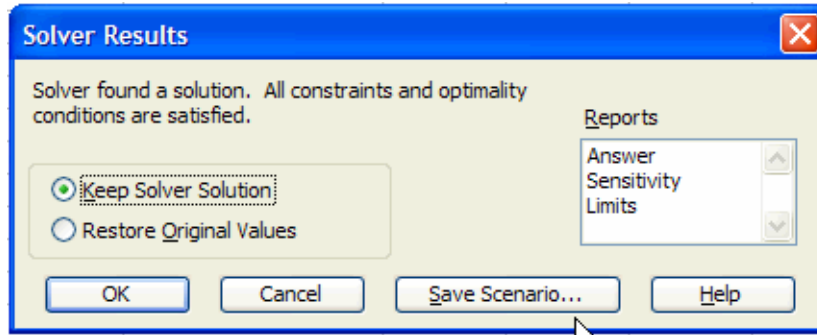


To find the maximum profit, copy and paste the formula for the profit into an empty cell in the profit column. Click to highlight the cell, then go to Tools and select Solver. The first entry, Set Target Cell should have the location of the profit cell we have highlighted. To find the maximum, click on the button to the left of Max. Enter the location of the cell of the  $x$ -coordinate of the maximum that we are trying to find.

|    | A | B   | C                     | D | E | F | G | H | I | J | K | L |
|----|---|-----|-----------------------|---|---|---|---|---|---|---|---|---|
| 1  |   |     |                       |   |   |   |   |   |   |   |   |   |
| 2  |   | x   | $P(x)=-x^2+110x-1000$ |   |   |   |   |   |   |   |   |   |
| 3  |   | 0   | -1000                 |   |   |   |   |   |   |   |   |   |
| 4  |   | 10  | 0                     |   |   |   |   |   |   |   |   |   |
| 5  |   | 20  | 800                   |   |   |   |   |   |   |   |   |   |
| 6  |   | 30  | 1400                  |   |   |   |   |   |   |   |   |   |
| 7  |   | 40  | 1800                  |   |   |   |   |   |   |   |   |   |
| 8  |   | 50  | 2000                  |   |   |   |   |   |   |   |   |   |
| 9  |   | 60  | 2000                  |   |   |   |   |   |   |   |   |   |
| 10 |   | 70  | 1800                  |   |   |   |   |   |   |   |   |   |
| 11 |   | 80  | 1400                  |   |   |   |   |   |   |   |   |   |
| 12 |   | 90  | 800                   |   |   |   |   |   |   |   |   |   |
| 13 |   | 100 | 0                     |   |   |   |   |   |   |   |   |   |
| 14 |   | 110 | -1000                 |   |   |   |   |   |   |   |   |   |
| 15 |   |     | -1000                 |   |   |   |   |   |   |   |   |   |
| 16 |   |     |                       |   |   |   |   |   |   |   |   |   |
| 17 |   |     |                       |   |   |   |   |   |   |   |   |   |
| 18 |   |     |                       |   |   |   |   |   |   |   |   |   |
| 19 |   |     |                       |   |   |   |   |   |   |   |   |   |
| 20 |   |     |                       |   |   |   |   |   |   |   |   |   |

Then click on Solve, and the solver will find the  $x$ - and  $y$ -coordinates of the maximum.



Click OK on the Solver Results box.

|    | A | B   | C                           | D |
|----|---|-----|-----------------------------|---|
| 1  |   |     |                             |   |
| 2  |   | x   | $P(x) = -x^2 + 110x - 1000$ |   |
| 3  |   | 0   | -1000                       |   |
| 4  |   | 10  | 0                           |   |
| 5  |   | 20  | 800                         |   |
| 6  |   | 30  | 1400                        |   |
| 7  |   | 40  | 1800                        |   |
| 8  |   | 50  | 2000                        |   |
| 9  |   | 60  | 2000                        |   |
| 10 |   | 70  | 1800                        |   |
| 11 |   | 80  | 1400                        |   |
| 12 |   | 90  | 800                         |   |
| 13 |   | 100 | 0                           |   |
| 14 |   | 110 | -1000                       |   |
| 15 |   | 55  | 2025                        |   |
| 16 |   |     |                             |   |

The maximum profit is \$2,025 when  $x$  is 55.

1. The profit function for a firm making widgets is  $P(x) = -x^2 + 88x - 1200$ . Use Excel and create a table of at least 5 values, and use these values to graph the function. Be sure to label your graph. Use the Solver to determine how many widgets should be produced and sold to maximize the profit? What is the maximum profit?
2. Suppose a company has fixed costs of \$28,000 and variable costs of  $\frac{2}{5}x^2 + 222x$  dollars, where  $x$  is the total number of units produced. Suppose further that the selling price is  $1250 - \frac{3}{5}x$  dollars per unit. Find the Cost, Revenue, and Profit functions. Use Excel and create a table of at least 5 values, and use these values to graph the function. Be sure to label your graph. Use the Solver to determine how many widgets should be produced and sold to maximize the profit? What is the maximum profit?