

Formulas and Functions - Excel 2004

Formulas

A formula is a mathematical expression that a spreadsheet program solves. It includes values which can be numbers or cells containing numbers and operators (see list below). To write a formula, you select a cell in which you want to display the results of the calculations, type an equal sign, enter the formula, then press the RETURN key.

Excel performs calculations in the following order (from left to right): exponentiation, multiplication and division, then addition and subtraction, You can change the order with the use of parentheses. Excel will calculate the expressions inside parentheses first.

In *Excel*, you begin a formula by typing an equal sign (=). Use cell references instead of actual numbers wherever possible. If the data changes, *Excel* will automatically redo the calculations.

Excel's mathematical operators listed in order of operator precedence:

Operator	Use
()	Groups sections of a formula
^	Exponentiation
*	Multiplication
/	Division
+	Addition
-	Subtraction

Excel's comparison operators

Operator	Meaning
=	Equal to
>	Greater than
>=	Greater than or equal to
<	Less than
<=	Less than or equal to
<>	Not equal to

Practice entering a formula

- Open the Excel file named *Function Example.xls*. This small table represents a quarter record of sales of a fictitious group of salespersons. This information will be used to illustrate the use of some formulas and functions. You may have occasion to have a long column of data that refers to more than one person or entity, and you may want to know how to easily add or sum only those data that refer to one of the persons or entities. This will be first accomplished with the use of a simple formula, then later with the use of an *Excel* built-in function.

- Click in cell B17. This cell will contain salesperson Anderson's commission for the year. You will enter a formula here to sum the values in cells F3, F6, F8, and F11.

- With your cursor in cell B17, type an equal sign.

	A	B	C	D	E	F
1	Salesperson	Total Sales	Number of Sales	Quarter	Average per sale	Quarter Commission
2	Cooley	25,587.50	135	1	189.54	5,117.50
3	Anderson	24,967.45	134	1	186.32	4,993.49
4	Cooley	23,987.50	129	2	185.95	4,797.50
5	Burke	25,246.75	130	1	194.21	5,049.35
6	Anderson	25,967.00	129	2	201.29	5,193.40
7	Burke	24,985.75	128	2	195.20	4,997.15
8	Anderson	29,587.75	140	3	211.34	5,917.55
9	Burke	26,597.45	132	3	201.50	5,319.49
10	Cooley	26,976.00	136	3	198.35	5,395.20
11	Anderson	26,957.00	138	4	195.34	5,391.40
12	Cooley	25,478.50	134	4	190.14	5,095.70
13	Burke	26,005.50	132	4	197.01	5,201.10
14						

Click in cell F3, type a plus sign (+), click in cell F6, type a plus sign, click in cell F8, type a plus sign, and finally click in cell F11 then press the RETURN key. This sums the commission earned by salesperson Anderson. This is a simple formula. There is an easier method to use, the SUMIF function. First, learn a little about *Excel* functions.

Formula Errors

Following are some basic categories of error messages for formulas. Each begins with a pound sign. Some of the more common errors are as follows:

#NAME? This is a common error which occurs when *Excel* doesn't recognize text in a formula. If you see this message, try the following steps:

- Make sure you have typed the name in the formula correctly.
- Check the spelling of any functions used within the formula.
- Make sure you have actually created and saved the range name you are trying to use and that it has not been deleted.
- Check that the name is not enclosed in quotation marks.
- Check the ranges, making sure you did not omit a colon.

#DIV/0! This error indicates that the formula is trying to divide by zero. Check the formula references to make sure no blank cells or cells containing zero are used.

#NUM! This error indicates that *Excel* is having trouble evaluating a number in the formula. Check any evaluation the formula does of numbers and make sure they are within an acceptable input range. Look closely at any functions used, making sure the numeric results you expect are actually possible.

#REF! This error code means *Excel* is having problems interpreting some cell reference within the formula. Check cell references, range names, worksheet names, and workbook names, as well as column and row indicators.

#VALUE! There are two common reasons for this error code:

1. A function is used incorrectly.
2. The data expected by the function is not in the proper format.

ERROR This error occurs when the cell contains a number, date, or time that is wider than the cell or when the cell contains a date and/or time formula that produces a negative result.

#NULL ERROR occurs when you specify an intersection of two areas that do not intersect or use an incorrect range operator.

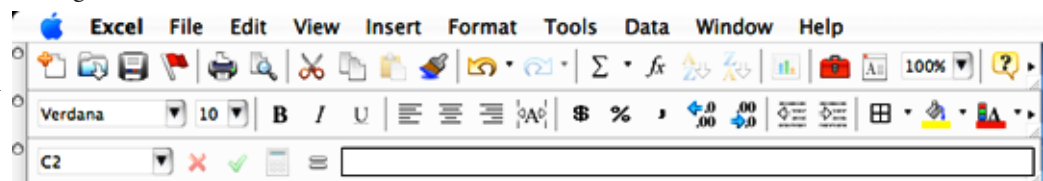
Functions

Functions are a set of standard formulas used to simplify complex calculations. Functions consist of these parts: The function name, the arguments (the values, cell ranges, or text strings to be acted on), the commas that separate any multiple arguments, and the parentheses around the arguments.

The Function Wizard

The FUNCTION button is at the right of the AutoSum function on the Standard toolbar. It looks like a large *F* with a small *x* at its right. It is useful in assisting the user to enter functions correctly. See a screen picture here of the top of an Excel 2004 worksheet with the toolbars showing. The Formula toolbar is at the bottom of these toolbars, and is helpful as you are building a formula.

When you click the FUNCTION button, you will see a PASTE FUNCTION dialog box. You enter function arguments by



using the FUNCTION ARGUMENTS dialog box, and you get information from function tips as you type function arguments directly into a worksheet.

Look at Sheet1 setup.

This spreadsheet contains a small table containing three salespersons' names, the value of their total sales listed by each quarter, the number of sales for each quarter, and the calculated commission for each salesperson, which amounts to two percent of their sales.

This sheet also contains an area that will show each salesperson's total commission for the year, which is the sum of each person's quarter commission. The bonus for the year will be a shared bonus for the three salespersons based on their combined total sales. The individual year-end bonuses will be calculated based on the level of each person's total sales for the year. To do these calculations, you will use the following functions: a SUMIF function, a nested IF function, and the VLOOKUP function.

A function formula's syntax must meet these rules:

- Must have a leading = (equal) sign, and there must be no space between the leading = sign and the function name.
- Required arguments must be enclosed in parentheses (any function not requiring arguments doesn't need parentheses).

The screenshot shows an Excel spreadsheet with the following data:

	A	B	C	D	E	F	G
1	Salesperson	Total Sales	Number of Sales	Quarter	Average per sale	Quarter Commission	
2	Cooley	25,587.50	135	1	189.54	5,117.50	
3	Anderson	24,967.45	134	1	186.32	4,993.49	
4	Cooley	23,987.50	129	2	185.95	4,797.50	
5	Burke	25,246.75	130	1	194.21	5,049.35	
6	Anderson	25,967.00	129	2	201.29	5,193.40	
7	Burke	24,985.75	128	2	195.20	4,997.15	
8	Anderson	29,587.75	140	3	211.34	5,917.55	
9	Burke	26,597.45	132	3	201.50	5,319.49	
10	Cooley	26,976.00	136	3	198.35	5,395.20	
11	Anderson	26,957.00	138	4	195.34	5,391.40	
12	Cooley	25,478.50	134	4	190.14	5,095.70	
13	Burke	26,005.50	132	4	197.01	5,201.10	
14							
15							
16	Commissions for Year						
17	Anderson						
18	Burke						
19	Cooley						
20							
21							
22							
23	Bonus for Year						
24							
25	Individual year-end bonuses						
26	Anderson						
27	Burke						
28	Cooley						
29							
30							
31							

- Multiple arguments must be entered in the specified order for that function.
- If you specify an optional argument, you must specify all preceding optional arguments.

Following are examples of common functions:

- One of the most common functions is the **SUM** function. In the following example of a **SUM** function, the values of cells in the range of B2:B13 are added: **=SUM(B2:B13)**. You can simplify this using a range name: **=SUM(sales)**; however, range names are absolute addresses, and if you plan to copy a formula and you want the cell references to adjust, then do not use a range name. Suppose you had a cell range of 25, 50 or 100 cells that you wanted to add. You can easily see the advantage of using the **SUM** function with a range reference.
- To average a set of cell values: **=AVERAGE(B2:B13)**
- To count the number of values in a cell range: **=COUNT(B2:B13)**
- To find the largest value in the cell range: **=MAX(B2:B13)**
- To find the smallest value in the cell range: **=MIN(B2:B13)**
- To round a specific number value in cell B2 to a specified number of decimals (in this case, 2): **=ROUND(B2,2)**

The SUMIF Function

The syntax of the **SUMIF** function is as follows: **=SUMIF(range, criteria, sum_range)**. The arguments that are bolded represent arguments that are required. Those not bolded may not be required. You will use this function to add those values that match a certain criteria. You will add or sum the quarter commissions for the salesperson, **Burke**.

Use the Paste Function Feature

Click in cell B18. This is the cell in which the sum of data related to Burke is placed. With the cell selected in which you want the results of the function to appear, click on the *R_x* icon.

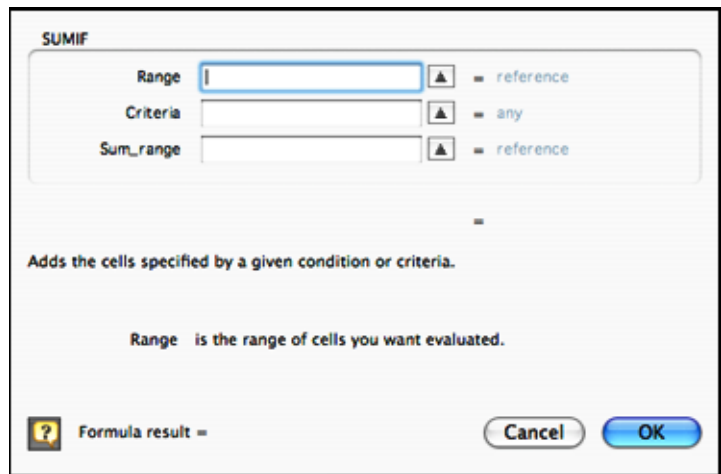


THE PASTE FUNCTION dialog box appears. The window at the left allows you to select a category. You want to find the **SUMIF** function. That function would be organized in the **MATH AND TRIG** category. If you have used it recently on your computer, it may be organized under the **MOST RECENTLY USED** category.

When you locate the **SUMIF** function, click the **OPEN** button to open the function dialog.

Enter this function as follows:

1. See the **SUMIF** arguments dialog, pictured at right.
2. If necessary, drag the **SUMIF** dialog so you can see your spreadsheet.
3. In the **RANGE** box you will enter the range of cells to evaluate. Rather than typing in the range, click on the upper left corner of the data table, cell A2, then hold down the **SHIFT** key and click on cell F13. This will enter this cell range (A2:F13) into the **RANGE** box. Not all the columns in this range are needed, but the two that are needed are separated by three columns. In this case, you must select all the columns that include these two.
4. Click in the **CRITERIA** box, and click on a cell that contains the name **Burke**. You want to sum all the quarterly commissions earned by Burke.
5. Click in the **SUM_RANGE** box. This argument in this function is optional if the selected range is the one you want to sum. In this case it is not, and so you will enter the range to sum by clicking on cell F2, then holding down the **SHIFT** key while you click on cell F13. (You could alternately have dragged over these cells.)



Repeat this process for salesperson **Cooley**. For Cooley, click in cell B19. The process is exactly the same as in the previous steps, with the exception of the criteria. For Cooley, you would click on a cell containing his name for the criteria.

Nesting functions within functions

Suppose you want to use the result of one function as an argument of another function. The **=IF** function is often used this way.

Use the IF Function

The syntax of the **=IF** function (a logical function) follows: **=IF(Cond, TrueExpr, FalseExpr)**. *Cond* is where you enter an expression that returns either a true or false value. *TrueExpr* is where you enter a value or action if the condition is true, and *FalseExpr* is where you enter a value or action if the condition returns a false value.

Suppose the condition makes use of another function such as **AVERAGE(F2:F13)**. This cell range would be tested to calculate the average of these values. Then suppose that average is greater than a value, say 5250. The condition would be written: **AVERAGE(F2:F13) > 5250**. If the value this function returns is greater than 5250, then the result is true. If not, then the result would be false. In the part of the **=IF** function that holds the *TrueExpr*, you would place the action or value that would be returned if the *Cond* is true. In the part of the **=IF** function *FalseExpr*, you would place the action or value that would be returned if the *Cond* is false. In the *Cond* argument, the value returned must either be TRUE or FALSE. If it is not, then Excel returns a **#VALUE!** error value.

If you wrote this function in this way: **=IF(AVERAGE(F2:F13)>5250,SUM(B2:B13)*0.02,SUM(B2:B13)*0.01**, this would mean that if the average of the cell range F2:F13 value s was greater than 5250, then the function would go on to add the cells B2:B13 using the **SUM** function, In addition, it would multiply the result of the **SUM** function with 0.02 to calculate the bonus. If the average of the cell range F2:F13 values was less than or equal to 5250, then the function would multiply the sum by 0.01.

In this case, the **AVERAGE** function and the **SUM** function are both nested and considered second-level functions because they are arguments of the **IF** function. If, for example, you nested a function within the **AVERAGE** function, this would be a third-level function.

Create a nested IF function

Using this function you will finish these calculations for these salespersons by calculating whether or not they, as a group, earned a larger or smaller group bonus in addition to their commissions. You want them to work as a team, and so you will average their commissions and base their shared bonus on the average.

If all their commissions average more than a certain amount for the year (in this case 5250), you will give them a larger bonus than they would receive if their average commissions were equal to or less than 5250 .

1. Click in cell B23. This cell will hold the calculations of the nested **IF** function.
2. Click on the **INSERT FUNCTION** button located near the **FORMULA BAR**.
3. Under **FUNCTION CATEGORY**, select **LOGICAL**. Notice that the syntax of the **IF** function is given when you highlight the **IF** function name. Its syntax is as follows:
(logical_test,value_if_true,value_if_false)
4. Under **FUNCTION NAME**, click on **IF** and click the **OK** button.
5. Look at the **IF** dialog box, pictured below. You are now ready to type in the logical test in the **Logical_test** box. Whatever you put in here must return either a **TRUE** or **FALSE**. You will enter the following:
AVERAGE(F2:F13)>5250
6. Click in the **Value_if_true** box. This is where you enter the value that will be returned if the logical test expression returns a true value. You will enter the following: **SUM(B2:B13)*0.02**
7. Click in the **Value_if_False** box and enter **SUM(B2:B13)*0.01**, and click the **OK** button.

The function says is that if the average of the values in the range F2:F13 is greater than 5250, then the formula in the **Value_if_true** argument tells *Excel* to sum the range B2:B13, then multiply that value with 0.02 (2 percent). If the average is equal to or less than 5250, then the value will test false, and in the **Value_if_False** box, you have told *Excel* to enter the sum of the sales and multiply that by 0.01 (one percent).

Even though all functions or formulas begin with an equal sign (=), those that are nested do not need to have the equal sign preceding them because they are second or third level functions and the first level function (the **IF** function) did begin with an equal sign.

Calculate the Individual year-end bonuses

23							
24						BONUS TABLE	
						Bonus	
25	Sales Rep	Total Sales	Bonus Rate		Sales Level	Rate	
26	Anderson				102,000.00	1.0%	
27	Burke				103,000.00	1.5%	
28	Cooley				104,000.00	2.0%	
29					105,000.00	2.5%	
30					106,000.00	3.0%	
31					107,000.00	3.5%	
32							

In calculating the individual year-end bonuses, you will use the SUMIF function and the VLOOKUP function and the table that you see on Sheet 2. This table has been set up in columns; therefore, you will use the VLOOKUP function that scans a column vertically then returns a corresponding value on the same row in a specified column.

Before you can use the VLOOKUP function, you will need to fill in the total sales figures for each salesperson on Sheet2. To do this, you will have to use the SUMIF function, as you did earlier. Except that this time, you will start on Sheet2, and subsequently use data that you will locate on Sheet1 in the SUMIF dialog.

1. Click in the B26 cell on Sheet2. This cell will hold the sum of salesperson Anderson's total sales for the year.
2. Click the PASTE FUNCTION button.
3. Locate the SUMIF function and open that dialog.
4. With the SUMIF function dialog open, do the following steps:
 - a. Click in the Range box of the SUMIF dialog.
 - b. Click Sheet1, then click Cell A2, then Shift-click Cell F13.
 - c. Click in Criteria box.
 - d. Click Anderson
 - e. Click Sum Range box.
 - f. Select Cell range F2F13
 - g. Click the OK button.
5. You are returned to Sheet 2, and the total yearly sales figure for Anderson appears in Cell B26 (Sheet2).
6. Repeat the above instructions, except that you will sum the total sales for Burke in Cell B27 (Sheet2) and the total sales for Cooley in Cell B28 (Sheet2).



Use the VLOOKUP function

Lookup functions are used to search for one value in a list and return another corresponding value from the list. In this exercise, VLOOKUP finds a value in a list and looks up a value in a corresponding column. By default, you must sort the list in ascending order before you can use VLOOKUP.

In this example spreadsheet, the commissions are not large, because these salespersons are on salary. The bonus figured for them as a group is not large—not much of an incentive. The administration wants to give an additional yearly bonus based on each salesperson's sales at the end of the year. The bonus rate for each individual will differ based on his or her sales. You will use a VLOOKUP table to generate the bonus rate for each individual.

The syntax for VLOOKUP is:

=VLOOKUP(lookup_value,table_array,col_index_num,range_lookup). Arguments that appear bolded are required; those not in bold are optional. The specific arguments for this function are explained in the order shown:

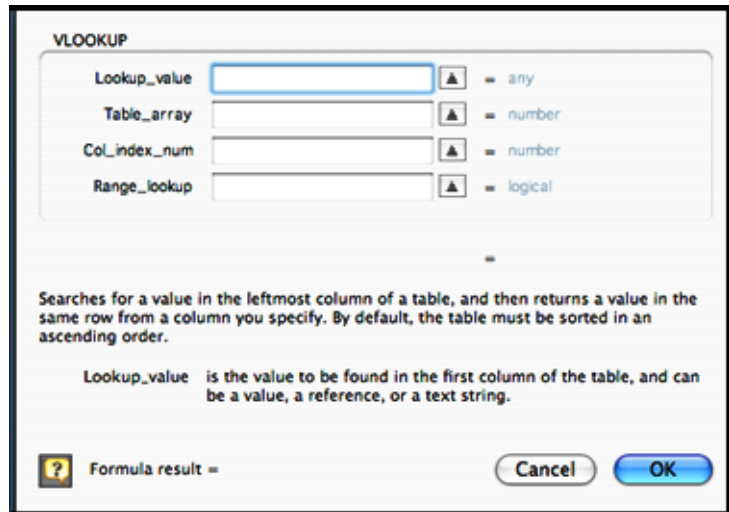
BONUS TABLE	
	Bonus
Sales Level	Rate
102,000.00	1.0%
103,000.00	1.5%
104,000.00	2.0%
105,000.00	2.5%
106,000.00	3.0%
107,000.00	3.5%

- **lookup_value**. The value being searched for. The lookup_value can be a number, a cell reference, or text. In this exercise, the lookup_value is the yearly sales figure of each salesperson which has now been calculated using the SUMIF function.

- **table_array.** The list of information in which data is being looked up, commonly referred to as the table. Use a range name or absolute cell reference for the table. If you would want to copy the formula, you would want the table reference to stay the same. In this example, the table array is the range \$F\$26:\$G\$28 and has been given the range name, **Table**.
- **col_index_num.** The column index number. If the columns in the table array were numbered, from left to right, the column index number is the column number from which the matching value will be returned. In this example, it is 2 (the second column of the table array) which lists the BONUS RATE.
- **range_lookup.** This is a logical value that specifies whether you want VLOOKUP to find an exact match or an approximate match. If TRUE is entered or is omitted, an approximate match is returned. If an exact match is not found, the next largest value that is less than lookup_value is returned. If you enter FALSE, VLOOKUP will find an exact match, and if one is not found, the error value #N/A is returned.

Set up the VLOOKUP function

1. On SHEET 2, click in cell C26. This will hold the bonus rate for Anderson that the lookup function returns.
2. Click on the INSERT FUNCTION button.
3. Click on the LOOKUP & REFERENCE category,
4. In the FUNCTION NAME list, find the VLOOKUP function, highlight it by clicking on it and click on the OK Button.
5. In the LOOKUP_VALUE box, enter B26 (or click on cell B26).
6. In the TABLE_ARRAY box, enter the range name, **Table**. This range name has been given to the range \$F\$26:\$H\$28.
7. In the COL_INDEX_NUM box enter 2. The column containing the BONUS RATE is the second column of the table array.
8. In the RANGE_LOOKUP box, enter TRUE, (you could alternately leave this box empty).
9. Click the OK button.
10. Repeat this process for the other salespersons.



Calculate the yearly bonus for each salesperson

This bonus for each salesperson will be calculated by multiplying the total sales of each salesperson by the bonus rate as calculated by the VLOOKUP function. These figures are on Sheet 2 of the Excel workbook. You will, however, show the bonus on Sheet 1 of the workbook, as follows:

1. On Sheet 1, click in cell B26. This will be Anderson's year-end bonus.
2. Type an equal sign (=) which will start the formula.
3. Click on the Sheet 2 tab and click on cell B26.
4. Type an asterisk (which is a multiplication operator).
5. Click on cell C26 (you are still on Sheet 2) and press the RETURN key.
6. You are back to Sheet 1, and you see the result of this calculation appear in cell B26.
7. Click in cell B26 to make it the current cell, and use the AUTOFILL feature to place the formula just entered into cells B27 and B28.
8. Format cells B26 to B28 in a number format with 2 decimals.
10. Format any other cells containing numbers that need formatting.

Some notes about functions

You don't have to use the INSERT FUNCTION feature to enter a function. If you know the syntax of a function well, you can start the function with an equal sign, type the function name, then type in opening parenthesis in the FORMULA BAR, enter the arguments (separating them with commas if there are more than one), type in the closing parenthesis and press the RETURN key.