

# Formulas and Functions - Excel 2003

## Formulas

A formula is an equation 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 ENTER 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 members 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 then
<=	Less than or equal to
<>	Not equal to

	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

## Practice entering a formula

1. Open the Excel file named *Function Example.xls*.
2. See a screen picture of a sales table on Sheet1 pictured above.
3. Click in cell B17. You will enter a formula here to sum the values in cells F3, F6, F8, and F11.
4. Type an equal sign. 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 ENTER key. This sums the commission earned by salesperson Anderson. This is a simple formula.

## Formula Errors

Excel has seven 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. 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:

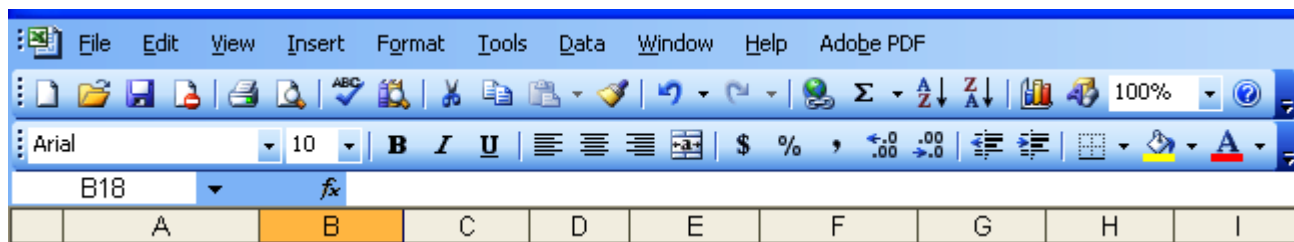
1. A function is used incorrectly.
2. The data expected by the function is not in the proper format.

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

**#NULL ERROR** This 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 Insert Function Wizard

The INSERT FUNCTION button (*fx*) is found at the left of the formula bar at the top of the worksheet. It is useful in assisting the user to enter functions correctly. See a screen picture here of the top of an Excel 2003 worksheet.

The INSERT FUNCTION wizard assists you to search for, find, and use a function by means of the INSERT 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.

Sheet1 contains a small table containing three salesperson's names, the values of their total sales listed by quarter, the number of sales for each quarter, and the calculated commission for each salesperson, which amounts to two percent of their sales.

Sheet1 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. These will be explained as you use them.

	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
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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	<b>Commissions for Year</b>					
17	Anderson					
18	Burke					
19	Cooley					
20						
21						
22						
23	<b>Bonus for Year</b>					
24						
25	<b>Individual year-end bonuses</b>					
26	Anderson					
27	Burke					
28	Cooley					

### 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).
- 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 B2:B13 are added: **=SUM(B2:B13)**. You can simplify this using a range name: **=SUM(sales)**. It is easy to see the value of this function. If you had summed these cell values using a formula, you would have done it this way: **=B2+B3+B4+B5+B6+B7+B8+B9+B10+B11+B12+B13**. 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 or a range name.
- 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

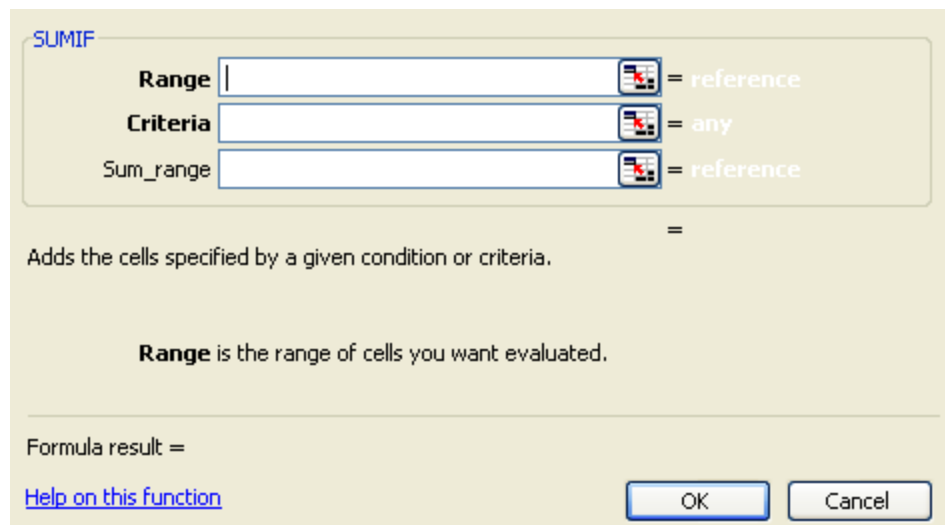
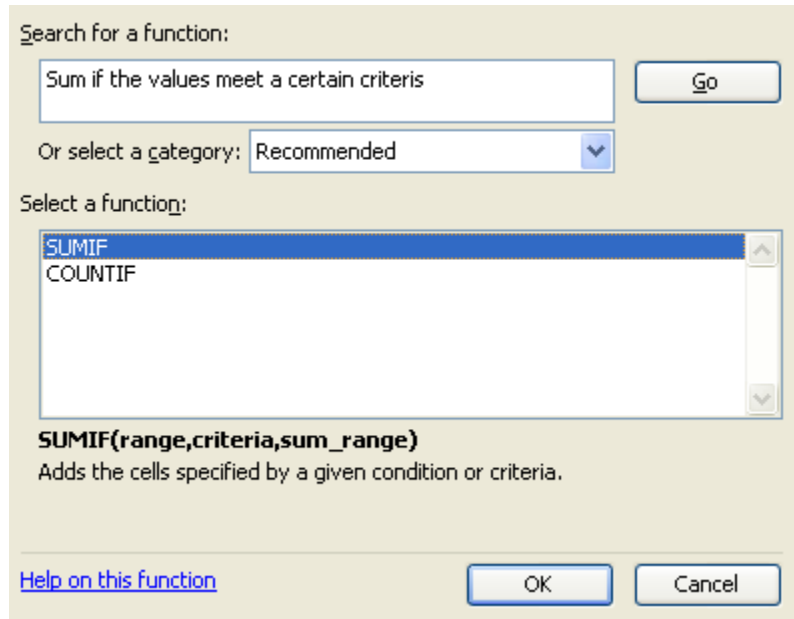
The syntax of the SUMIF function is as follows: **=SUMIF(range,criteria,sum\_range)**. The arguments that are bolded represent arguments that are required. Those not bolded may not be required. You will use this function to add those values that match a certain criteria. You will add or sum the quarter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

**Burke.** The SUMIF means to sum only those that meet a certain criteria.

## The SUMIF Function

Enter this function as follows:

1. Cell B18 is the current cell. This is the cell in which you will place the sum of Burke's commissions.
2. Click the INSERT FUNCTION button.
3. Select the MATH & TRIG function category.
4. Under FUNCTION name, click on the function **SUMIF** and click the OK button.
5. See the **SUMIF** arguments dialog, pictured at right.
6. If necessary, drag the **SUMIF** dialog so you can see your spreadsheet.
7. 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 spreadsheet, cell A2, then hold down the SHIFT key and click on cell F13. This will enter this cell range 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.
8. 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.
9. 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 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 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. 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.

## Calculate the Individual year-end bonuses

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.

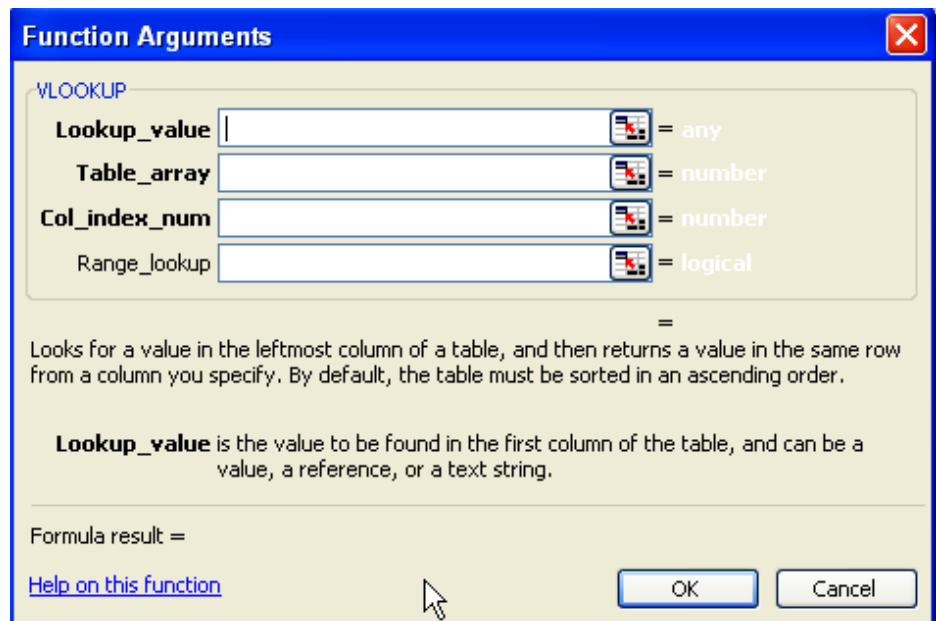
Before you can use the **VLOOKUP** function, you will need to fill in the total sales figures for each salesperson on Sheet2. To do this, you will have to use the **SUMIF** function, as you did earlier. Except that this time, you will start on Sheet2, and subsequently use the data on Sheet1 in the **SUMIF**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

- Click in the B26 cell on Sheet2. This cell will hold the sum of salesperson Anderson's total sales for the year.
- Click the PASTE FUNCTION button.
- Locate the SUMIF function and open that dialog.
- With the SUMIF function dialog open, do the following steps:
  - Click in the Range box of the SUMIF dialog.
  - Click Sheet1, then click Cell A2, then Shift-click Cell F13.
  - Click in Criteria box.
  - Click Anderson
  - Click Sum Range box.
  - Select Cell range F2:F13
  - Click the OK button.
- You are returned to Sheet 2, and the total yearly sales figure for Anderson appears in Cell B26 (Sheet2).
- 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).

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

## Using 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 with row labels and is used when your list has row labels in the leftmost column and you want to look up a value in another column based on the row. 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. That bonus rate will differ based on the sales ranges. 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:

- 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

BONUS TABLE	
Sales Level	Bonus 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%

figure of each salesperson.

- **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 in case the VLOOKUP formula is copied. You want the table array to be an absolute cell address. 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 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 F26:H28.
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 the above steps for the other two salespersons, in cells C27 and C28.

## Calculate the end-of-year 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.
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 ENTER 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.
9. Check to see whether you need to apply any other number formats on Sheet1.

### 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 ENTER key.