Microsoft

MOS Study Guide

Paul McFedries

EXAM MO-201

Microsoft Excel Expert

Microsoft

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Paul McFedries

Microsoft Office Specialist
Exam MO-201

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Introduction

The Microsoft Office Specialist (MOS) certification program has been designed to validate your knowledge of and ability to use programs in the Microsoft Office 365 and Office 2019 suite of programs. This book has been designed to guide you in studying the types of tasks you are likely to be required to demonstrate in Exam MO-201, Microsoft Excel Expert.

Exam Strategy For information about the tasks you are likely to be required to demonstrate in the core Excel exam, Exam MO-200, Microsoft Excel 2019, see *MOS Study Guide for Microsoft Excel Exam MO-200* by Joan Lambert (Microsoft Press, 2020).

Who this book is for

MOS Study Guide for Microsoft Excel Expert Exam MO-201 is designed for experienced computer users seeking Microsoft Office Specialist Expert certification in Excel and Excel 2019.

MOS exams for individual programs are practical rather than theoretical. You must demonstrate that you can complete certain tasks or projects rather than simply answer questions about program features. The successful MOS certification candidate will have at least six months of experience using all aspects of the program on a regular basis; for example, protecting a worksheet, applying conditional formatting rules, filling a series, and building a PivotTable.

As a certification candidate, you probably have a lot of experience with the program you want to become certified in. Many of the procedures described in this book will be familiar to you; others might not be. Read through each study section and ensure that you are familiar with the procedures, concepts, and tools discussed. In some cases, images depict the tools you will use to perform procedures related to the skill set. Study the images and ensure that you are familiar with the options available for each tool.

How this book is organized

The exam coverage is divided into chapters representing broad skill sets that correlate to the functional groups covered by the exam. Each chapter is divided into sections addressing groups of related skills that correlate to the exam objectives. Each section includes review information, generic procedures, and practice tasks you can complete on your own while studying. You can use the provided practice files to work through the practice tasks, and the result files to check your work. You can practice the generic procedures in this book by using the practice files supplied or by using your own files.

Throughout this book, you will find Exam Strategy tips that present information about the scope of study that is necessary to ensure that you achieve mastery of a skill set and are successful in your certification effort.

IMPORTANT The Excel 2019 program is not available from this website. You should purchase and install that program before using this book.

You will save the completed versions of practice files that you modify while working through the practice tasks in this book. If you later want to repeat the practice tasks, you can download the original practice files again.

The following table lists the practice files provided for this book.

Folder and objective group	Practice files	Result files
MOSExcelExpert2019\Objective1 Manage workbook options and settings	Excel_1-1a.xlsx Excel_1-1b.xlsm Excel_1-2a.xlsx Excel_1-2b.xlsx Excel_1-2c.xlsx Excel_1-2d.xlsx Excel_1-3a.xlsx	Excel_1-1a_results.xlsx Excel_1-2a_results.xlsx Excel_1-2b_results.xlsx Excel_1-2c_results.xlsx
MOSExcelExpert2019\Objective2 Manage and format data	Excel_2-1.xlsx Excel_2-2.xlsx Excel_2-3a.xlsx Excel_2-3b.xlsx Excel_2-3c.xlsx	Excel_2-2_results.xlsx Excel_2-3a_results.xlsx Excel_2-3b_results.xlsx Excel_2-3c_results.xlsx
MOSExcelExpert2019\Objective3 Create advanced formulas and macros	Excel_3-1.xlsx Excel_3-2.xlsx Excel_3-3.xlsx Excel_3-4.xlsx Excel_3-4a.xlsx Excel_3-4b.xlsx Excel_3-4c.xlsx Excel_3-4d.xlsx Excel_3-4e.xlsx Excel_3-4f.xlsx Excel_3-5.xlsx Excel_3-6.xlsm	Excel_3-1_results.xlsx Excel_3-2_results.xlsx Excel_3-3_results.xlsx Excel_3-4_results.xlsx Excel_3-5_results.xlsx Excel_3-6_results.xlsm
MOSExcelExpert2019\Objective4 Manage advanced charts and tables	Excel_4-1.xlsx Excel_4-2.xlsx Excel_4-3.xlsx	Excel_4-1_results.xlsx Excel_4-2_results.xlsx Excel_4-3_results.xlsx

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Microsoft Office Specialist

Exam MO-201

Excel 2019 Expert

This book covers the skills you need to have for certification as a Microsoft Office Specialist Expert in Excel 2019. Specifically, you need to be able to complete tasks that demonstrate the following skill sets:

1. Manage workbook options and settings
2. Manage and format data
3. Create advanced formulas and macros
4. Create advanced charts and tables

With these skills, you can manage, format, populate, and enhance the types of workbooks most commonly used in a business environment.

Prerequisites

We assume that you have been working with Excel 2019 for at least six months and that you know how to carry out fundamental tasks that are not specifically mentioned in the objectives for this Microsoft Office Specialist exam. This level of proficiency includes familiarity with features and tasks such as the following:

- Creating workbooks
- Adding worksheets to existing workbooks
- Copying and moving worksheets
- Inserting and deleting cells, columns, and rows
- Customizing the Quick Access Toolbar and the ribbon
- Freezing panes and splitting the window
- Setting a print area and adding headers and footers
- Changing fonts and cell styles
- Wrapping text within cells
- Creating and editing tables
- Using relative, mixed, and absolute cell references
- Using functions
- Creating and editing charts, and adding data series
- Inserting text boxes, SmartArt, and other images
- Applying styles and effects to objects
- Positioning objects

Exam Strategy For information about the prerequisite tasks, see *MOS Study Guide for Microsoft Excel Exam MO-200* by Joan Lambert (Microsoft Press, 2020).

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Objective group 2

Manage and format data

The skills tested in this section of the Microsoft Office Specialist Expert exam for Microsoft Excel 2019 relate to filling cells with data, creating custom number formats, performing data validation, grouping data, inserting subtotals, removing duplicate records, and applying and managing conditional formatting rules. Specifically, the following objectives are associated with this set of skills:

- **2.1** Fill cells based on existing data
- **2.2** Format and validate data
- **2.3** Apply advanced conditional formatting and filtering

Many worksheets are drab, lifeless conglomerations of numbers, formulas, and text. If you'll be sharing your worksheets with other people, your numbers will have much more impact and will be more easily understood if they're pleasingly formatted and presented in a way that aids comprehension.

This chapter guides you in studying methods for using Flash Fill and advanced Fill Series options; creating custom number formats; configuring data validation; grouping and ungrouping data; inserting totals and subtotals; removing duplicate records from a table; and creating and managing conditional formatting rules.

To complete the practice tasks in this chapter, you need the practice files contained in the **MOSExcelExpert2019\Objective2** practice file folder. For more information, see "Download the practice files" in this book's introduction.

Objective 2.1: Fill cells based on existing data

Fill cells by using Flash Fill

If you have inherited workbooks from someone else or if you have imported data from external data sources, you have probably come across data that was either structured or formatted (or both) in such a way that it was either difficult to read or difficult to work with. It could be mainframe data that arrives as all-uppercase letters, dates that appear in non-date formats, phone numbers that don't have dashes or parentheses, or fields that combine multiple pieces of data (such as first names and last names).

One way to tackle such data is to reenter it by hand in the structure or format you prefer or require. That works for a few records, but it gets tedious and time-consuming for dozens of records, and it becomes unworkable for hundreds or thousands of records.

Fortunately, creating your preferred data from existing data can often be done with only minimal work thanks to an Excel feature called Flash Fill. Given a column of original data, if you use the first cell in the next column to enter the corrected data (which could be data extracted from the original cell or the same data formatted in a different way), select the second cell, then run the Flash Fill command, Excel "recognizes" what you're doing and *automatically* fills in the rest of the column with the corrected data.

Let's look at a few examples:

- Column A contains a list of all-uppercase company names. In column B, I use cell B2 to type the title-case version of the text in cell A2 and then select cell B3. After I run the Flash Fill command, Excel recognizes the pattern and fills in the rest of the column with title-case versions of all the other cells in column A.

	A	B	A	B
1	Company (Upper)	Company	Company (Upper)	Company
2	B'S BEVERAGES	B's Beverages	B'S BEVERAGES	B's Beverages
3	ISLAND TRADING		ISLAND TRADING	Island Trading
4	SPLIT RAIL BEER & ALE		SPLIT RAIL BEER & ALE	Split Rail Beer & Ale
5	CONSOLIDATED HOLDINGS		CONSOLIDATED HOLDINGS	Consolidated Holdings
6	EASTERN CONNECTION		EASTERN CONNECTION	Eastern Connection
7	AROUND THE HORN		AROUND THE HORN	Around The Horn
8	WHITE CLOVER MARKETS		WHITE CLOVER MARKETS	White Clover Markets
9	QUICK-STOP		QUICK-STOP	Quick-Stop
10	SEVEN SEAS IMPORTS		SEVEN SEAS IMPORTS	Seven Seas Imports
11	HUNGRY COYOTE IMPORT STORE		HUNGRY COYOTE IMPORT STORE	Hungry Coyote Import Store
12	BOTTOM-DOLLAR MARKETS		BOTTOM-DOLLAR MARKETS	Bottom-Dollar Markets
13	HUNGRY OWL ALL-NIGHT GROCERS		HUNGRY OWL ALL-NIGHT GROCERS	Hungry Owl All-Night Grocers
14	TRAIL'S HEAD GOURMET PROVISIONERS		TRAIL'S HEAD GOURMET PROVISIONERS	Trail's Head Gourmet Provisioners
15	THE BIG CHEESE		THE BIG CHEESE	The Big Cheese
16	SAVE-A-LOT MARKETS		SAVE-A-LOT MARKETS	Save-A-Lot Markets
17	OLD WORLD DELICATESSEN		OLD WORLD DELICATESSEN	Old World Delicatessen
18	GREAT LAKES FOOD MARKET		GREAT LAKES FOOD MARKET	Great Lakes Food Market
19	LAZY K KOUNTRY STORE		LAZY K KOUNTRY STORE	Lazy K Kountry Store
20	LAUGHING BACCHUS WINE CELLARS		LAUGHING BACCHUS WINE CELLARS	Laughing Bacchus Wine Cellars
21	CHOP-SUEY CHINESE		CHOP-SUEY CHINESE	Chop-Suey Chinese
22	LONESOME PINE RESTAURANT		LONESOME PINE RESTAURANT	Lonesome Pine Restaurant
23	RATTLESNAKE CANYON GROCERY		RATTLESNAKE CANYON GROCERY	Rattlesnake Canyon Grocery
24	THE CRACKER BOX		THE CRACKER BOX	The Cracker Box

You can use Flash Fill to convert all-uppercase text (far left) to title case (far right).

- Column A contains a list of full names, where each cell contains the first name, middle initial, and last name. In cells B2, C2, and D2, I typed the first name, middle initial, and last name, respectively, from cell A2. When I select cell B3 and run Flash Fill, Excel recognizes the pattern and fills in the rest of the first names; similarly, selecting C3 and running Flash Fill adds the middle initials, and selecting D3 and running Flash Fill adds the last names.

	A	B	C	D	A	B	C	D
1	Full Name	First Name	Initial	Last Name	Full Name	First Name	Initial	Last Name
2	Maria Z. Anders	Maria	Z.	Anders	Maria Z. Anders	Maria	Z.	Anders
3	Victoria T. Ashworth				Victoria T. Ashworth	Victoria	T.	Ashworth
4	Helen K. Bennett				Helen K. Bennett	Helen	K.	Bennett
5	Christina C. Berglund				Christina C. Berglund	Christina	C.	Berglund
6	Marie X. Bertrand				Marie X. Bertrand	Marie	X.	Bertrand
7	Elizabeth G. Brown				Elizabeth G. Brown	Elizabeth	G.	Brown
8	Philip Z. Cramer				Philip Z. Cramer	Philip	Z.	Cramer
9	Simon W. Crowther				Simon W. Crowther	Simon	W.	Crowther
10	Ann G. Devon				Ann G. Devon	Ann	G.	Devon
11	Catherine Q. Dewey				Catherine Q. Dewey	Catherine	Q.	Dewey
12	Peter Y. Franken				Peter Y. Franken	Peter	Y.	Franken
13	Thomas V. Hardy				Thomas V. Hardy	Thomas	V.	Hardy
14	Paul M. Henriot				Paul M. Henriot	Paul	M.	Henriot
15	Michael C. Holz				Michael C. Holz	Michael	C.	Holz
16	Janine S. Labrune				Janine S. Labrune	Janine	S.	Labrune
17	Maria A. Larsson				Maria A. Larsson	Maria	A.	Larsson
18	Yoshi N. Latimer				Yoshi N. Latimer	Yoshi	N.	Latimer
19	Elizabeth J. Lincoln				Elizabeth J. Lincoln	Elizabeth	J.	Lincoln
20	Patricia D. McKenna				Patricia D. McKenna	Patricia	D.	McKenna
21	Roland U. Mendel				Roland U. Mendel	Roland	U.	Mendel
22	Liz W. Nixon				Liz W. Nixon	Liz	W.	Nixon
23	Rene M. Phillips				Rene M. Phillips	Rene	M.	Phillips
24	John V. Steel				John V. Steel	John	V.	Steel

You can use Flash Fill to extract substrings (right) from longer strings (left).

- Column A contains a list of phone numbers without any parentheses or dashes. In cell B2, I typed the phone number from cell A2 and added the parentheses and dash. When I select cell B3 and run Flash Fill, Excel recognizes the pattern and fills the rest of the column with the formatted phone numbers.

	A	B	A	B
1	**Phone 1**	**Phone 2**	**Phone 1**	**Phone 2**
2	3175557605	(317) 555-7605	3175557605	(317) 555-7605
3	3175559281		3175559281	(317) 555-9281
4	3175551452		3175551452	(317) 555-1452
5	3175555016		3175555016	(317) 555-5016
6	3175556433		3175556433	(317) 555-6433
7	3175559709		3175559709	(317) 555-9709
8	3175551890		3175551890	(317) 555-1890
9	3175559392		3175559392	(317) 555-9392
10	3175555877		3175555877	(317) 555-5877
11	3175554733		3175554733	(317) 555-4733
12	3175555123		3175555123	(317) 555-5123
13	3175551166		3175551166	(317) 555-1166
14	3175559826		3175559826	(317) 555-9826
15	3175555420		3175555420	(317) 555-5420
16	3175552765		3175552765	(317) 555-2765
17	3175557767		3175557767	(317) 555-7767
18	3175553038		3175553038	(317) 555-3038
19	3175555745		3175555745	(317) 555-5745
20	3175554453		3175554453	(317) 555-4453
21	3175558220		3175558220	(317) 555-8220
22	3175551191		3175551191	(317) 555-1191
23	3175559642		3175559642	(317) 555-9642
24	3175559113		3175559113	(317) 555-9113

You can use Flash Fill to add characters (right) to plain phone numbers (left).

To fill cells by using Flash Fill

➜ Type the first value you want in the first cell of the new column, select the second cell in the new column, and then on the **Data** tab, in the **Data Tools** group, click **Flash Fill**. Alternatively, on the **Home** tab, in the **Editing** group, click **Fill**, then click **Flash Fill**.

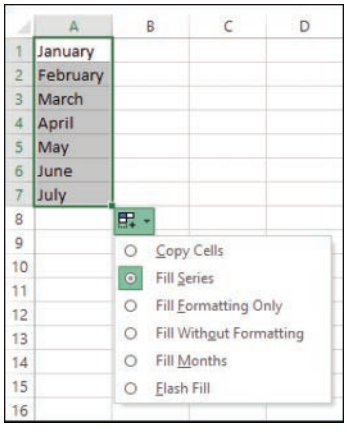
Tip You can also run the Flash Fill command by pressing Ctrl+E.

Or,

➜ Type the first value you want in the first cell of the new column. Starting in the second cell of the new column, drag the Fill handle through all the cells in the new column that you want to fill, click **Auto Fill Options**, and then click **Flash Fill**.

Fill cells by using advanced Fill Series options

Worksheets often use text series (such as *January, February, March*; or *Sunday, Monday, Tuesday*) and numeric series (such as *1, 3, 5*; or *2021, 2020, 2019*). Instead of entering these series manually, you can create them automatically by using the Auto Fill feature. That is, you enter and select the first couple of values in the series, drag the fill handle over the range you want to fill, and then click Fill Series in the AutoFill Options list.



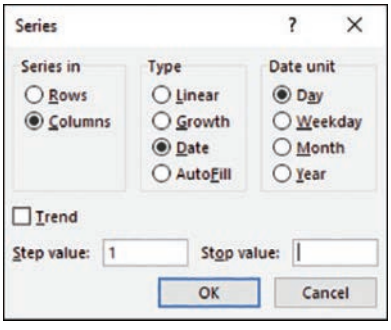
You can use the fill handle and the Fill Series option to extend an existing series.

Instead of using the fill handle to create a series, you can use the Series command to gain more control over the process. By using the Series command, you can specify a direction for the fill (rows or columns); a step value (the value by which each item in the series is changed to produce the next item); a stop value (the value at which Excel should terminate the series); whether you want the series to extend the trend of the initial values; the date units (such as day or month) for a date series; and the series type, which can be one of the following four values:

- **Linear** This option finds the next series value by adding the step value to (or subtracting the step value from) the preceding value in the series.
- **Growth** This option finds the next series value by multiplying the preceding value by the step value.
- **Date** This option creates a series of dates based on the option you select in the Date Unit group (Day, Weekday, Month, or Year).
- **AutoFill** This option works much like the fill handle. You can use it to extend a numeric pattern or a text series (for example, Qtr1, Qtr2, Qtr3).

To fill cells by using the Fill Series command

1. Enter the starting value in the first cell you want to use for the series. If you want to create a series out of a particular pattern (such as 2, 4, 6, and so on), fill in enough cells to define the pattern.
2. Select the entire range you want to fill.
3. On the **Home** tab, in the **Editing** group, click **Fill**, then click **Series** to open the **Series** dialog box.



In the Series dialog box, specify the type of series you want to use to fill the cells.

4. Do either of the following to create the series, starting from the active cell:
   - Click **Rows** to create the series in rows.
   - Click **Columns** to create the series in columns.
5. In the **Type** group, click the type of series you want.
6. Do any of the following:
   - If you selected the Date type, click an option in the **Date unit** group.
   - If you selected the Linear or Growth type and want to extend a series trend, select the **Trend** check box.
   - If you selected a Linear, Growth, or Date series type, enter a number in the **Step value** box. This number is what Excel uses to generate the next value in the series.
   - To place a limit on the series, enter a number in the **Stop value** box.
7. Click **OK** to fill in the series and return to the worksheet.

Objective 2.1 practice tasks

The practice file for these tasks is located in the **MOSExcelExpert2019\Objective2** practice file folder. The folder also contains a result file that you can use to check your work.

➤ Open the **ExcelExpert_2-1** workbook, display the **Flash Fill** worksheet, and do the following:

- ❑ In cell B2, type the company name from cell A2 using title case, select cell B3, and then run the Flash Fill command from the Home tab.
- ❑ In cell D2, type the first name from the full name shown in cell C2, select cell D3, and then run the Flash Fill command from the Data tab.
- ❑ In cell E2, type the initial from the full name shown in cell C2, select cell E3, and then run the Flash Fill command from the Data tab.
- ❑ In cell F2, type the last name from the full name shown in cell C2, select cell F3, and then run the Flash Fill command from the Data tab.
- ❑ In cell H2, type the phone number shown in cell G2, but include parentheses around the area code, a space after the closing parenthesis, and a dash between the sixth and seventh digits. Drag the Fill handle from cell H2 down to cell H24, click Auto Fill Options, and then click Flash Fill.

➤ Display the **Fill Series** worksheet and do the following:

- ❑ In column A, below the *Linear* label, create a linear series that begins at ***0***, has a step value of ***5***, and has a stop value of ***50***.
- ❑ In column B, below the *Growth* label, create a growth series that begins at ***1***, has a step value of ***2***, and has a stop value of ***250***.
- ❑ Fill the range C2:C11 with a Date series that uses a day unit and a step value of ***2***.

- ❑ Fill the range D2:D11 with a Date series that uses a weekday unit and a step value of ***1***.
- ❑ Fill the range E2:E11 with a Date series that uses a month unit and a step value of ***6***.
- ❑ Save the workbook.
- ❑ Open the **ExcelExpert_2-1_results** workbook. Compare the two workbooks to check your work. Then close the open workbooks.

Objective 2.2: Format and validate data

Create custom number formats

One of the best ways to improve the readability of your worksheets is to display your data in a format that is logical, consistent, and straightforward. Formatting currency amounts with leading dollar signs, percentages with trailing percent signs, and large numbers with commas are a few of the ways you can improve your spreadsheet style. However, you can use Excel to go beyond these built-in formats to create custom number and date formats with which you can display your worksheet values exactly as you want them to be seen.

Excel's built-in numeric formats give you a great deal of control over how your numbers are displayed, but they have their limitations. For example, there is no built-in format you can use to display a different currency symbol, such as the Euro symbol (€), or to display temperatures using, say, the degree symbol (°).

To overcome these limitations, you need to create your own custom numeric formats. You can do this either by editing an existing format or by entering your own format from scratch. The formatting syntax and symbols are explained in detail later in this section.

Every Excel numeric format, whether built-in or customized, has the following syntax:

positive format;negative format;zero format;text format

The four parts, separated by semicolons, determine how various numbers are presented. The first part defines how a positive number is displayed, the second part defines how a negative number is displayed, the third part defines how zero is displayed, and the fourth part defines how text is displayed. If you leave out one or more of these parts, numbers are controlled as shown in the following table.

Number of parts used	Format syntax
Three	*positive format;negative format;zero format*
Two	*positive and zero format;negative format*
One	*positive, negative, and zero format*

The following table lists the special symbols you use to define each of these parts.

Symbol	Description
#	Holds a place for a digit and displays the digit exactly as typed. Displays nothing if no number is entered. For example, if a cell's custom format is ### and you enter *25* in the cell, Excel displays *25*.
0	Holds a place for a digit and displays the digit exactly as typed. Displays zero if no number is entered. For example, if a cell's custom format is *000* and you enter *25* in the cell, Excel displays *025*.
?	Holds a place for a digit and displays the digit exactly as typed. Displays a space if no number is entered. For example, if a cell's custom format is 0*???* and you enter *25* in the cell, Excel displays *0 25*.
. (period)	Sets the location of the decimal point. For example, if a cell's custom format is *#.#0* and you enter *34.5* in the cell, Excel displays *34.50*.
, (comma)	Sets the location of the thousands separator. Marks only the location of the first thousand. For example, if a cell's custom format is *#,###* and you enter *12345* in the cell, Excel displays *12,345*.
%	Multiplies the number by 100 (for display only) and adds the percent (%) character. For example, if a cell's custom format is *#%* and you enter *.75* in the cell, Excel displays *75%*.
E+ e+ E- e-	Displays the number in scientific format. E- and e- place a minus sign in the exponent; E+ and e+ place a plus sign in the exponent. For example, if a cell's custom format is *0.00E+00* and you enter *123456789* in the cell, Excel displays *1.23E+08*. Similarly, if a cell's custom format is *0.0E-00* and you enter *0.0000012* in the cell, Excel displays *1.2E-06*.
/ (slash)	Sets the location of the fraction separator. For example, if a cell's custom format is *0/0* and you enter *.75* in the cell, Excel displays *3/4*.
$ ( ) : - + <space>	Displays the character. For example, if a cell's custom format *is $##0.00* and you enter *123.5* in the cell, Excel displays *$123.50*.

Symbol	Description
*	Repeats whatever character immediately follows the asterisk until the cell is full. Doesn't replace other symbols or numbers. For example, you can create a dot trailer in a cell by adding *. to the format. So if the custom format is *#*.* and you enter *123* in the cell, Excel displays *123*..... (where the dots continue until the cell is filled).
_ (underscore)	Inserts a blank space the width of whatever character follows the underscore, which can often help you to align your numbers. For example, the custom format *_(#.00* inserts a blank space the width of the opening parenthesis at the beginning of the displayed value.
\ (backslash)	Inserts the character that follows the backslash. See the next item for an example. In general, you need to use the backslash only for reserved characters (such as # or @) or for the following letters: B, D, E, G, H, M, N, S, and Y. (For all other letters, if you just enter a single character by itself, Excel will display that character.) For example, if a cell's custom format is *#.##\M* and you enter *1.23* in the cell, Excel displays *1.23M*.
"text"	Inserts the text that appears within the quotation marks. For example, if a cell's custom format is *"Part "\#00-0000* and you enter *123456* in the cell, Excel displays *Part #12-3456*.
@	Displays the cell's text. For example, if a cell's custom format is *@" entry"* and you enter *credit* in the cell, Excel displays *credit entry*.
[color]	Displays the cell contents in the specified color. For example, if the cell's custom format is *[green]0.00; [red]0.00*, Excel displays positive cell values in green and negative cell values in red. The predefined color values you can use are *black*, *white*, *red*, *green*, *blue*, *yellow*, *magenta*, and *cyan*, and the color codes *color1* through *color565*.

Although the built-in date and time formats of Excel are fine for most purposes, you might need to create your own custom formats. For example, you might want to display the day of the week (for example, "Friday"). Custom date and time formats generally are simpler to create than custom numeric formats. There are fewer formatting symbols, and you usually don't need to specify different formats for different conditions. The following table lists the date and time formatting symbols.

Symbol	Description
Date Formats	
d	Day number without a leading zero (*1* to *31*)
dd	Day number with a leading zero (*01* to *31*)
ddd	Three-letter day abbreviation (*Mon*, for example)
dddd	Full day name (*Monday*, for example)
m	Month number without a leading zero (*1* to *12*)
mm	Month number with a leading zero (*01* to *12*)
mmm	Three-letter month abbreviation (*Aug*, for example)
mmmm	Full month name (*August*, for example)
yy	Two-digit year (*00* to *99*)
yyyy	Full year (*1900* to *2078*)
h	Hour without a leading zero (*0* to *24*)
hh	Hour with a leading zero (*00* to *24*)
m	Minute without a leading zero (*0* to *59*)
mm	Minute with a leading zero (*00* to *59*)
s	Second without a leading zero (*0* to *59*)
ss	Second with a leading zero (*00* to *59*)
AM/PM, am/pm, A/P	Displays the time using a 12-hour clock
/ : . —	Symbols used to separate parts of dates or times
[color]	Displays the date or time in the color specified

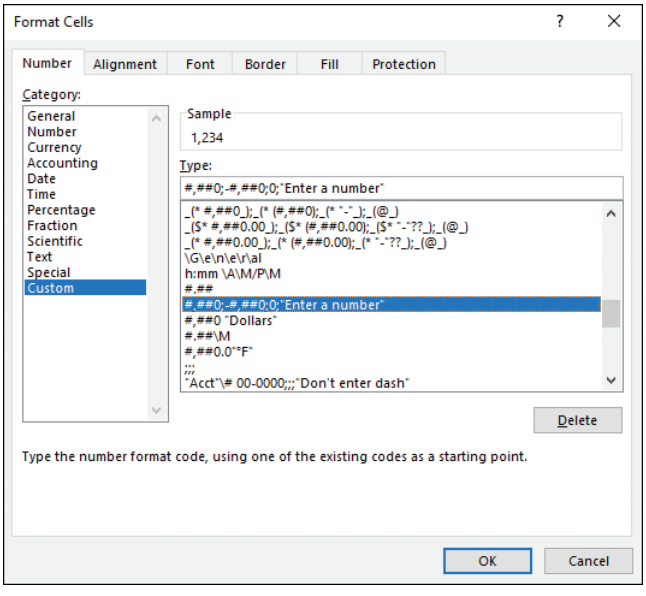
The best way to become familiar with custom formats is to try your own experiments. Excel stores each format that you try. If you find that your list of custom formats is getting a bit unwieldy or that it's cluttered with unused formats, you can delete those formats.

To open the Format Cells dialog box, do one of the following:

- ➜ On the **Home** tab, in the **Cells** group, click **Format**, then click **Format Cells**.
- ➜ Right-click the cell or range, then click **Format Cells**.
- ➜ Press **Ctrl+1**.

To create and apply a custom number format

1. Select the cell or range of cells you want the new format to apply to.
2. Open the **Format Cells** dialog box.
3. On the **Number** tab, in the **Category** list, click **Custom**.
4. To base the custom number format on an existing format, click the base format in the **Type** list.
5. Edit or enter the symbols that define the number format.



Define custom number formats in the Type box.

6. When you are done, click **OK** to return to the worksheet.

To delete custom number formats

1. Display the **Number** tab of the **Format Cells** dialog box.
2. In the **Category** list, click **Custom**.
3. In the **Type** list, click the format you want to remove.

> **Tip** You can delete only custom formats; you can't delete built-in formats.

4. Click **Delete** to remove the format from the list.
5. Click **OK** to close the **Format Cells** dialog box and return to the worksheet.

Configure data validation

Formulas are only as good as the data they're given. For basic data entry errors (for example, entering the wrong date or transposing a number's digits), there's not much you can do other than exhort yourself or the people who use your worksheets to enter data carefully. Fortunately, you have a bit more control when it comes to preventing the entry of improper data such as data that is the wrong type (for example, entering text in a cell that requires a number) or data that falls outside of an allowable range (for example, entering 200 in a cell that requires a number between 1 and 100).

You can prevent these kinds of improper entries, to a certain extent, by adding comments that describe what is allowable inside a particular cell. However, this requires other people to both read and act on the comment text. You can also use custom numeric formatting to "format" a cell with an error message if the wrong type of data is entered. This is useful, but it works only for certain kinds of input errors.

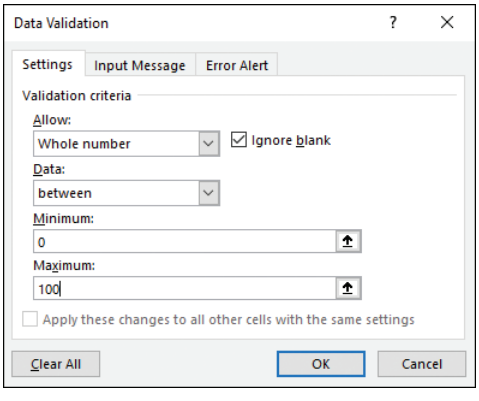
Exam Strategy The Excel Expert exam emphasizes collaboration between users, so be sure to also study the information related to setting up workbooks for other people to view and edit in "Objective 1.2: Prepare workbooks for collaboration."

The best solution for preventing data entry errors is to use the data-validation feature of Excel. With data validation, you create rules that specify exactly what kind of data can be entered and in what range that data can fall. You can also specify pop-up input messages that appear when a cell is selected and error messages that appear when data is entered improperly.

You configure data-validation rules on the Settings tab of the Data Validation dialog box. The following validation types are available:

- **Any Value** Allows any value in the range (that is, it removes any previously applied validation rule). If you're removing an existing rule, be sure to also clear the input message, if any.
- **Whole Number** Allows only whole numbers (integers). You use the Data list to select a comparison operator (such as Between, Equal To, or Less Than) and then enter the specific criteria. For example, if you click the Between option, you must enter Minimum and Maximum values.

- **Decimal** Allows decimal numbers or whole numbers. You use the Data list to select a comparison operator and then enter the specific numeric criteria.
- **List** Allows only values specified in a list. You specify the allowable values in the Source box on the Settings tab of the Data Validation dialog box, either by specifying a range on the same sheet or a range name on any sheet that contains the list of allowable values (preceding the range or range name with an equal sign) or by entering the allowable values directly into the Source box (separated by commas). You have the option of allowing the user to select from the allowable values by using a list.
- **Date** Allows only dates. (If the user includes a time value, the entry is invalid.) You use the Data list to select a comparison operator and then enter the specific date criteria (such as a Start date and an End date).
- **Time** Allows only times. (If the user includes a date value, the entry is invalid.) You use the Data list to select a comparison operator and then enter the specific time criteria (such as a Start time and an End time).
- **Text Length** Allows only alphanumeric strings of a specified length. You use the Data list to select a comparison operator and then enter the specific length criteria (such as Minimum and Maximum lengths).
- **Custom** You can use this option to enter a formula that specifies the validation criteria. You can either enter the formula directly in the Formula box on the Settings tab of the Data Validation dialog box (again preceding the formula with an equal sign) or enter a reference to a cell that contains the formula. For example, if you're restricting cell A2 and you want to be sure the entered value is not the same as what's in cell A1, you would enter the formula **=A2<>A1.**



On the Settings tab of the Data Validation dialog box, set up the criteria for your validation rule.

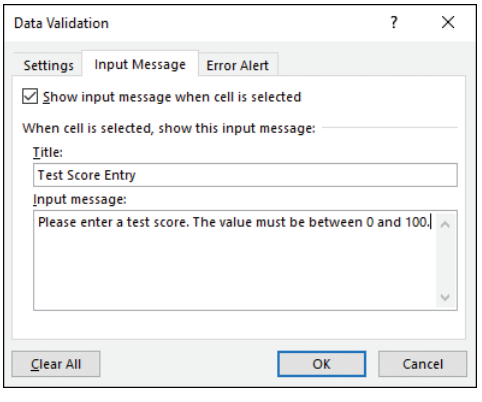
To configure data validation for a cell or range

1. Select the cell or range to which you want to apply the data-validation rule.
2. On the **Data** tab, in the **Data Tools** group, click **Data Validation** to open the **Data Validation** dialog box.
3. On the **Settings** tab, in the **Allow** list, click one of the validation types.
4. Enter the validation criteria you require.
5. To allow blank entries, either in the cell itself or in other cells specified as part of the validation settings, leave the **Ignore blank** check box selected. If you clear this check box, Excel treats blank entries as zero and applies the validation rule accordingly.
6. If the range had an existing validation rule that also applied to other cells, you can apply the new rule to those other cells by selecting the **Apply these changes to all other cells with the same settings** check box.
7. If you want a message to appear when the user selects the restricted cell or any cell within the restricted range, on the **Input Message** tab, do the following:

   Verify that the **Show input message when cell is selected** check box is selected.

   In the **Title** box, enter a title for the message.

   In the **Input message** box, enter the message that you want Excel to display. For example, you could use the message to give the user information about the type and range of allowable values.



You can configure an input message to appear when a workbook user selects the cell.

8. If you want a dialog box to appear when the user enters invalid data, click the **Error Alert** tab, then do the following:

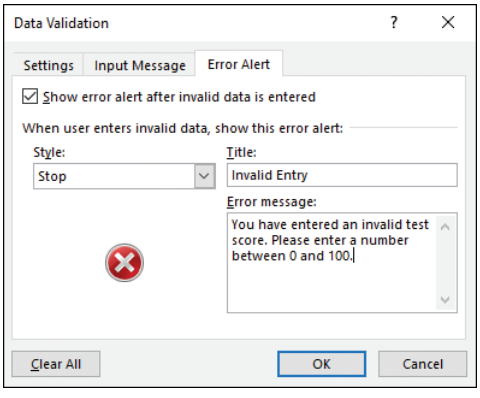
   Select the **Show error alert after invalid data is entered** check box.

   In the **Style** list, click the error style you want: **Stop, Warning, or Information**.

   In the **Title** box, enter a title for the message.

   In the **Error message** box, enter the message that you want Excel to display.

IMPORTANT Only the Stop style prevents users from entering invalid data.



You can configure an error alert to appear when a workbook user enters an invalid entry.

9. Click **OK** to apply the data-validation rule.

Group and ungroup data

You can control a worksheet range display by grouping the data based on the worksheet formulas and data. Grouping the data creates a worksheet outline, which you can use to "collapse" sections of the sheet to display only summary cells, or to "expand" hidden sections to show the underlying detail.

Not all worksheets can be grouped, so you need to make sure your worksheet is a candidate for outlining. First, the worksheet must contain formulas that reference cells or ranges directly adjacent to the formula cell. Worksheets with SUM functions that subtotal cells above or to the left are particularly good candidates for outlining.

Second, there must be a consistent pattern to the direction of the formula references. For example, a worksheet with formulas that always reference cells above or to the

left can be outlined. Excel will not outline a worksheet with, say, SUM functions that reference ranges above and below a formula cell.

If your worksheet meets these criteria, then you can use Excel's Auto Outline command to automatically group the worksheet data. Otherwise, you can group data manually.

When Excel creates an outline, it divides your worksheet into a hierarchy of levels. These levels range from the worksheet detail (the lowest level) to the grand totals (the highest level). Excel outlines can handle up to eight levels of data. In the Budget worksheet shown below, for example, Excel created three levels for both the column and the row data:

- In the columns, the monthly figures are the details, so they're the lowest level (level 3). The quarterly totals are the first summary data, so they're the next level (level 2). Finally, the grand totals (not shown) are the highest level (level 1).
- In the rows, the individual sales and expense items are the details (level 3). The sales and expenses subtotals are the next level (level 2). The Gross Profit row is the highest level (level 1).

	A	B	C	D	E	F	G	H	I	J	K
1		Jan	Feb	Mar	1st Quarter	Apr	May	Jun	2nd Quarter	Jul	Aug
2	*Sales*										
3	Division I	23,500	23,000	24,000	70,500	25,100	25,000	25,400	75,500	26,000	24,000
4	Division II	28,750	27,800	29,500	86,050	31,000	30,500	30,000	91,500	31,000	29,500
5	Division III	24,400	24,000	25,250	73,650	26,600	27,000	26,750	80,350	27,000	25,250
6	SALES TOTAL	76,650	74,800	78,750	230,200	82,700	82,500	82,150	247,350	84,000	78,750
7	*Expenses*										
8	Cost of Goods	6,132	5,984	6,300	18,416	6,616	6,600	6,572	19,788	6,720	6,300
9	Advertising	4,600	4,200	5,200	14,000	5,000	5,500	5,250	15,750	5,500	5,200
10	Rent	2,100	2,100	2,100	6,300	2,100	2,100	2,100	6,300	2,100	2,100
11	Supplies	1,300	1,200	1,400	3,900	1,300	1,250	1,400	3,950	1,300	1,400
12	Salaries	16,000	16,000	16,500	48,500	16,500	16,500	17,000	50,000	17,000	17,000
13	Shipping	14,250	13,750	14,500	42,500	15,000	14,500	14,750	44,250	15,000	14,500
14	Utilities	500	600	600	1,700	550	600	650	1,800	650	600
15	EXPENSES TOTAL	44,882	43,834	46,600	135,316	47,066	47,050	47,722	141,838	48,270	47,100
16	GROSS PROFIT	31,768	30,966	32,150	94,884	35,634	35,450	34,428	105,512	35,730	31,650

When you create an outline, Excel adds outline tools to the worksheet.

To help you work with your outlines, Excel adds the following tools to your worksheet:

- **Level bars**—These bars indicate the data included in the current level. Click a bar to hide the rows or columns marked by a bar.
- **Collapse symbol**—Click this symbol to hide (or collapse) the rows or columns marked by the attached level bar.

- **Expand symbol**—When you collapse a level, the collapse symbol changes to an expand symbol (+). Click this symbol to display (or expand) the hidden rows or columns.
- **Level symbols**—These symbols tell you which level each level bar is on. Click a level symbol to display all the detail data for that level.

Tip To toggle the outline symbols on and off, press Ctrl+8.

To group a worksheet using Auto Outline

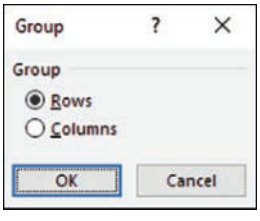
➜ On the **Data** tab, in the **Outline** group, click **Group**, then click **Auto Outline**.

To group data manually

➜ Select the rows or columns you want to group, then on the **Data** tab, in the **Outline** group, click **Group**, then click **Group**.

Or,

1. Select a cell in each row or column you want to group.
2. On the **Data** tab, in the **Outline** group, click **Group**, then click **Group**. Excel asks whether you want to group rows or columns.
3. Select either **Rows** or **Columns**, as appropriate for your data, then click **OK**.



When you group data manually, Excel needs to know whether you're grouping rows or columns.

To remove an outline from a worksheet

➜ On the **Data** tab, in the **Outline** group, click **Ungroup**, then click **Clear Outline**.

To ungroup data

➜ Select the rows or columns you want to ungroup, then on the **Data** tab, in the **Outline** group, click **Ungroup**, then click **Ungroup**.

Or,

1. Select a cell in each row or column you want to ungroup.
2. On the **Data** tab, in the **Outline** group, click **Ungroup**, then click **Ungroup**. Excel asks whether you want to ungroup rows or columns.
3. Select either **Rows** or **Columns**, as appropriate for your data, then click **OK**.

Calculate data by inserting subtotals and totals

Although you can use formulas and worksheet functions to summarize your data in various ways—including sums, averages, counts, maximums, and minimums—if you're in a hurry, or if you just need a quick summary of your data, you can get Excel to do the work for you. The secret here is a feature called *automatic subtotals,* which are formulas that Excel adds to a worksheet automatically.

Excel sets up automatic subtotals based on data groupings in a selected field. For example, if you ask for subtotals based on the Customer field, Excel runs down the Customer column and creates a new subtotal each time the name changes. To get useful summaries, you should sort the range on the field containing the data groupings you're interested in.

	A	B	C	E	F	G	H
1	**Customer**	**Country**	**Region**	**Unit Price**	**Quantity**	**Discount**	**Total**
2	Cactus Comidas para llevar	Argentina		$ 46.00	7	0%	$ 322.00
3	Cactus Comidas para llevar	Argentina		$ 7.75	20	0%	$ 155.00
4	Cactus Comidas para llevar	Argentina		$ 15.00	10	0%	$ 150.00
5	Cactus Comidas para llevar	Argentina		$ 45.60	8	0%	$ 364.80
6	Cactus Comidas para llevar	Argentina		$ 14.00	20	0%	$ 280.00
7	**Cactus Comidas para llevar Total**						$ 1,271.80
8	Océano Atlántico Ltda.	Argentina		$ 6.00	5	0%	$ 30.00
9	Océano Atlántico Ltda.	Argentina		$ 21.35	20	0%	$ 427.00
10	Océano Atlántico Ltda.	Argentina		$ 30.00	6	0%	$ 180.00
11	Océano Atlántico Ltda.	Argentina		$ 34.80	5	0%	$ 174.00
12	Océano Atlántico Ltda.	Argentina		$ 21.00	30	0%	$ 630.00
13	Océano Atlántico Ltda.	Argentina		$ 81.00	15	0%	$ 1,215.00
14	Océano Atlántico Ltda.	Argentina		$ 18.00	10	0%	$ 180.00
15	Océano Atlántico Ltda.	Argentina		$ 13.00	15	0%	$ 195.00
16	**Océano Atlántico Ltda. Total**						$ 3,031.00
17	Rancho grande	Argentina		$ 81.00	5	0%	$ 405.00
18	Rancho grande	Argentina		$ 263.50	2	0%	$ 527.00
19	Rancho grande	Argentina		$ 17.45	6	0%	$ 104.70
20	Rancho grande	Argentina		$ 32.00	6	0%	$ 192.00
21	Rancho grande	Argentina		$ 19.50	20	0%	$ 390.00
22	**Rancho grande Total**						$ 1,618.70

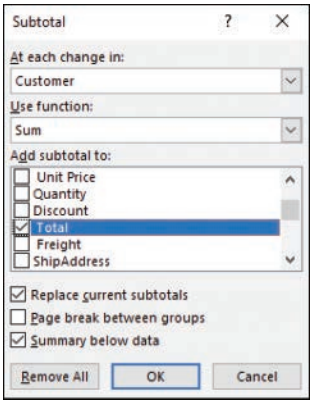
Invoice data showing subtotals for each customer based on the values in the Total column.

See Also For more information on the outline tools that Excel adds to the worksheet when you insert subtotals, see "Group and ungroup data," earlier in this topic.

Note that in the phrase *automatic subtotals,* the word *subtotals* is misleading because it implies that you can only summarize your data with totals. However, you can also count the values (all the values or just the numeric values), calculate the average of the values, determine the maximum or minimum value, and calculate the product of the values. For statistical analysis, you can also calculate the standard deviation and variance, both of a sample and of a population.

To insert subtotals and totals

1. Select a cell within the range you want to subtotal.
2. On the **Data** tab, in the **Outline** group, click **Subtotal** to open the **Subtotal** dialog box.
3. Use the **At each change in** list to select the column you want to use to group the subtotals.
4. In the **Use function** list, select **Sum**.
5. In the **Add subtotal to** list, select the check box for the column you want to summarize.



Use the Subtotal dialog box to apply subtotals to a range.

6. Click **OK**. Excel calculates the subtotals and adds them to the range and also adds a **Grand Total** row to the bottom of the range. Excel also adds outline symbols to the range.

To change the summary calculation

➜ In step 4 from the previous section, in the **Use function** list, select the function you want to use, such as **Count**, **Average**, **Max**, or **Min**.

Remove duplicate records

You can make your Excel data more accurate for analysis by removing duplicate records. Duplicate records throw off calculations by including the same data two or more times. To prevent this, you should delete duplicate records. Rather than looking for duplicates manually, you can use the Remove Duplicates command, which quickly finds and removes duplicates in even the largest ranges or tables.

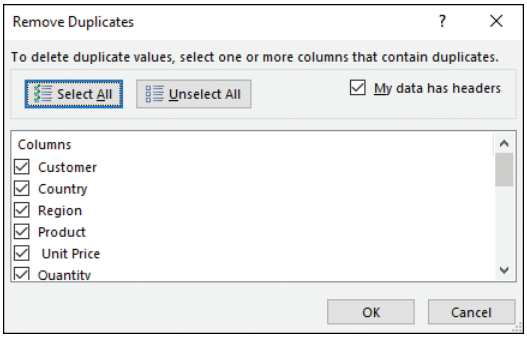
Before you use the Remove Duplicates command, you must decide what defines a duplicate record in your data. You have two choices:

- Two records are duplicates if, for every column in the range or table, the records contain identical values.
- Two records are duplicates if, for only certain columns in the range or table, the records contain identical values.

To remove duplicate records

1. Click a cell inside the range or table.
2. On the **Data** tab, in the **Data Tools** group, click **Remove Duplicates** to open the **Remove Duplicates** dialog box.
3. If your range doesn't have column headers, clear the **My data has headers** check box.
4. Select the check box beside each field that you want Excel to check for duplicate values.

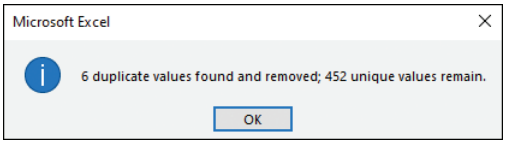
> **Tip** If your range or table has many fields, you may want Excel to use only one or two of those fields to look for duplicate records. Rather than clearing all the other check boxes manually, first click Unselect All in the Remove Duplicates dialog box to clear all the check boxes. You can then click to select just the check boxes you want Excel to use.



Use the Remove Duplicates dialog box to specify which columns must contain identical data for the records to be considered duplicates.

IMPORTANT Excel does not give you a chance to confirm the deletion of the duplicate records, so be sure you want to do this before proceeding.

5. Click **OK**. Excel deletes any duplicate records that it finds and then displays a dialog box telling you the number of duplicate records that it deleted.



Excel tells you how many duplicate records it deleted and how many unique records remain in the range or table.

6. Click **OK**.

Objective 2.2 practice tasks

The practice file for these tasks is located in the **MOSExcelExpert2019\Objective2** practice file folder. The folder also contains a result file that you can use to check your work.

➤ Open the **ExcelExpert_2-2** workbook, display the **Custom Data Formatting** worksheet, and do the following:

- ❑ Select cells A1:A4. Create and apply a custom number format that displays the thousands separator, always displays at least one number, displays a leading minus sign and red text if a negative number is entered, displays 0 if 0 is entered, and displays the message ***Enter a number*** if a non-numeric value is entered.
- ❑ Select cell B1. Create and apply a custom number format that displays the thousands separator and the decimal point, always displays at least one digit before and after the decimal point, and displays ***°C*** (the degree symbol and the letter C, for *degrees Celsius*) at the end.
- ❑ Select cells C1:C2. Create and apply a custom number format that displays a six-digit entry with a dash after the first two digits, the text ***Acct #*** before the digits, and the text ***Enter numbers only*** if the user includes any non-numeric characters in the entry.
- ❑ Select cell D1. Create and apply a custom date format that displays the two-digit month, day, and year, separated by periods.
- ❑ Select cell E1. Create and apply a custom time format that displays the two-digit hour and minute with nothing in between them, followed by a space and the text *hours*.

➤ Display the **Data Validation** worksheet and do the following:

- ❑ Select cell B2. Create and apply a data-validation rule that restricts data entry to values between 0 and 1 (that is, between 0% and 100%).
- ❑ Include an input message titled ***Interest Rate*** with the following text: **Please enter a value between 0 and 1.**

- ❑ Then enter a stop-style error message titled ***Invalid Interest Rate*** with the following text: **The interest rate value you entered is invalid. Please enter a value between 0 and 1.**
- ❑ Select cell B3. Create and apply a data-validation rule that restricts data entry to positive values with a minimum of 1 and a maximum of 30.
- ❑ Include an input message titled ***Loan Period*** with the following text: **Please enter a value between 1 and 30 years.**
- ❑ Then enter a stop-style error message titled ***Invalid Loan Period*** with the following text: **The loan period value you entered is invalid. Please enter a value between 1 and 30 years.**
- ❑ Select cell B4. Create and apply a data-validation rule that restricts data entry to positive values.
- ❑ Include an input message titled ***Loan Principal*** with the following text: **Please enter a value greater than 0.**
- ❑ Enter a stop-style error message titled ***Invalid Loan Principal*** with the following text: **The loan principal value you entered is invalid. Please enter a value greater than 0.**

➤ Display the **Grouping** worksheet and do the following:

- ❑ Run the Auto Outline command to group the worksheet data.
- ❑ Create a manual grouping of the Advertising, Rent, and Supplies expense items.

➤ Display the **Subtotals** worksheet and create Sum subtotals for each customer based on the values in the Total field.

➤ Display the **Remove Duplicates** worksheet and remove the six duplicate records in the range.

➤ Save the workbook.

➤ Open the **ExcelExpert_2-2_results** workbook. Compare the two workbooks to check your work. Then close the open workbooks.

Objective 2.3: Apply advanced conditional formatting and filtering

Create custom conditional formatting rules

Many Excel worksheets contain hundreds of data values. You can make sense of large sets of data by creating formulas, applying functions, and performing data analysis. However, there are times when you don't want to analyze a worksheet per se. Instead, all you want are answers to simple questions such as the following:

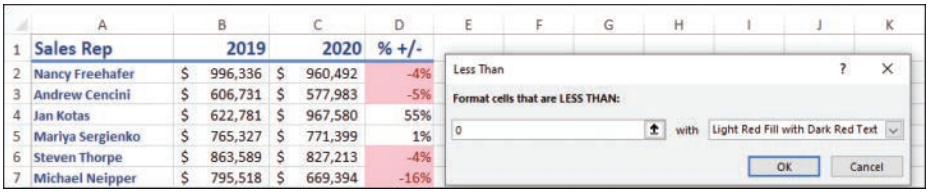
- Which cell values are less than 0?
- What are the top 10 values?
- Which cell values are above average, and which are below average?

Exam Strategy Data analysis is a crucial component of the Excel Expert exam. This means that besides studying the conditional formatting techniques in this topic, be sure to also study the data analysis material in "Objective 3.4: Perform data analysis" and the PivotTable material in "Objective 4.2: Create and modify PivotTables."

These simple questions aren't easy to answer just by glancing at the worksheet, and the more numbers you're dealing with, the harder it gets. To help you "eyeball" your worksheets and answer these and similar questions, Excel lets you apply *conditional formatting* to the cells. This is a special format that Excel applies only to cells that satisfy some condition, which Excel calls a *rule*. For example, you could apply formatting to show all the negative values in a red font, or you could apply formatting to highlight the top 10 values.

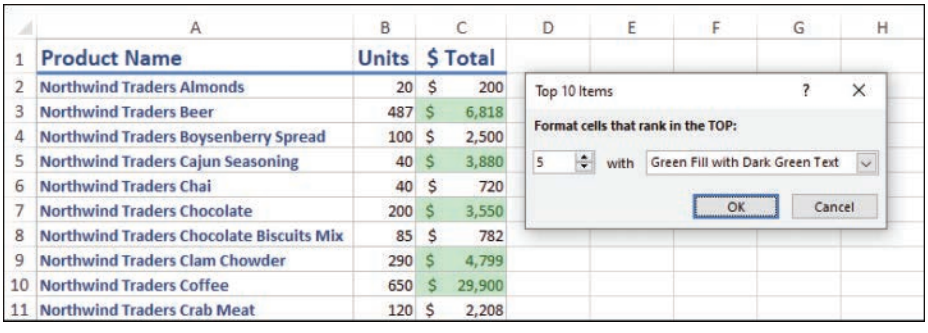
You can apply five types of conditional formatting rules:

- **Highlight cells rules** A *highlight cell* rule applies a format to cells that meet specified criteria. You have seven choices: Greater Than, Less Than, Between, Equal To, Text That Contains, A Date Occurring, and Duplicate Values. In each case, you use a dialog box to specify the condition and the formatting that you want applied to cells that match the condition.



For a Less Than conditional formatting rule, the specified formatting is applied to all cells that have a value that is less than the value specified in the dialog box.

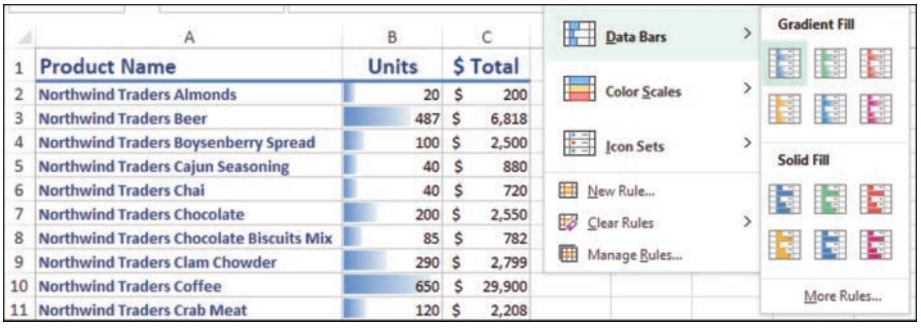
- **Top/bottom rules** A top/bottom rule applies a format to cells that rank in the top or bottom (for numerical items, the highest or lowest) values in a range. You can select the top or bottom either as an absolute value (for example, the top 10 items) or as a percentage (for example, the bottom 25%). You can also format cells that are above or below the average. In each case, you use a dialog box to set up the specifics of the rule. For the Top 10 Items, Top 10%, Bottom 10 Items, and Bottom 10% rules, you use the dialog box to specify the condition and the formatting you want applied to cells that match the condition. For the Above Average and Below Average rules, you use the dialog box to specify the formatting only.



An example of a Top 10 conditional formatting rule.

- **Data bars** If you're interested in the *relationship* between similar values in a worksheet, you need some way to visualize the relative values in a range, and that's where data bars are useful. *Data bars* are colored, horizontal bars that appear "behind" the values in a range. (They're like a bar chart.) Their key feature is that the length of the data bar that appears in each cell is related to the value in that cell: the larger the value, the longer the data bar. The cell with the highest value has the longest data bar, and the data bars that appear in the other cells have lengths that reflect their values. Excel configures its default data

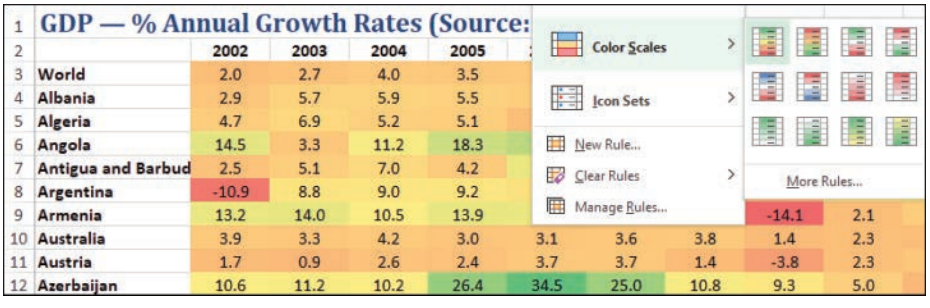
bars with the longest data bar based on the highest value in the range and the shortest data bar based on the lowest value in the range. You can also set up data bars based on a specific range of values (for example, the values *0* and *100* for test scores) or as a percentage of the largest value.



	A	B	C
1	Product Name	Units	$ Total
2	Northwind Traders Almonds	20	$ 200
3	Northwind Traders Beer	487	$ 6,818
4	Northwind Traders Boysenberry Spread	100	$ 2,500
5	Northwind Traders Cajun Seasoning	40	$ 880
6	Northwind Traders Chai	40	$ 720
7	Northwind Traders Chocolate	200	$ 2,550
8	Northwind Traders Chocolate Biscuits Mix	85	$ 782
9	Northwind Traders Clam Chowder	290	$ 2,799
10	Northwind Traders Coffee	650	$ 29,900
11	Northwind Traders Crab Meat	120	$ 2,208

You can apply data bars by using either a gradient fill or a solid fill.

- **Color scales** The color scales in Excel are useful if you want to get a "big picture" view of your data that shows, for example, the overall distribution of the values and whether there are any *outliers* (values that are much higher or lower than all or most of the other values). The color scales are also helpful if you want to make value judgments about your data. For example, high sales and low numbers of product defects are "good," whereas low margins and high employee turnover rates are "bad." A *color scale* is similar to a data bar in that it compares the relative values of cells in a range. Instead of bars in each cell, though, you see cell shading, where the shading color reflects the cell's value. For example, the lowest values might be shaded red; higher values might be shaded light red, then orange, yellow, and lime green; and finally the highest values could be shaded deep green.

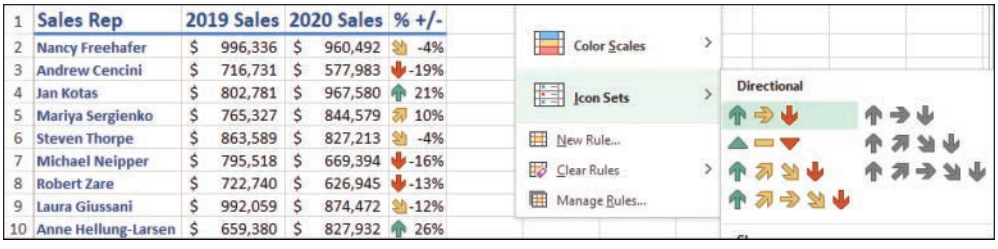


	GDP — % Annual Growth Rates (Source:								
		2002	2003	2004	2005				
3	World	2.0	2.7	4.0	3.5				
4	Albania	2.9	5.7	5.9	5.5				
5	Algeria	4.7	6.9	5.2	5.1				
6	Angola	14.5	3.3	11.2	18.3				
7	Antigua and Barbud	2.5	5.1	7.0	4.2				
8	Argentina	-10.9	8.8	9.0	9.2				
9	Armenia	13.2	14.0	10.5	13.9			-14.1	2.1
10	Australia	3.9	3.3	4.2	3.0	3.1	3.6	3.8	1.4	2.3
11	Austria	1.7	0.9	2.6	2.4	3.7	3.7	1.4	-3.8	2.3
12	Azerbaijan	10.6	11.2	10.2	26.4	34.5	25.0	10.8	9.3	5.0

A Green - Yellow - Red color scale shows the lowest values in the deepest shade of red and the highest values in the deepest shade of green.

- **Icon sets** You use *icon sets* to visualize the relative values of cells in a range. Excel adds an icon to each cell in the range, and that icon tells you something about the cell's value relative to the rest of the range. For example, the highest values might get an up arrow, the lowest values a down arrow, and the values in between a horizontal arrow. Icon sets take advantage of symbols that people have strong associations with.

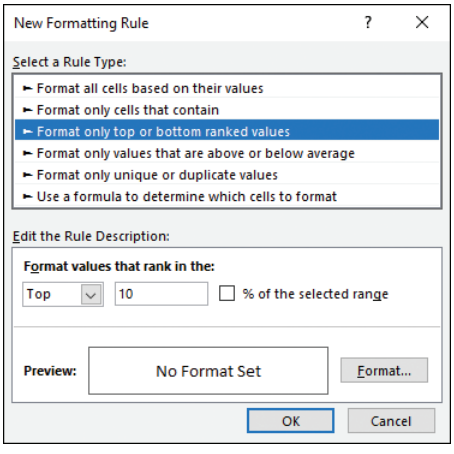
  For example, a check mark means something is good or finished or acceptable, whereas an X means something is bad or unfinished or unacceptable. A green circle is positive, whereas a red circle is negative (similar to traffic lights).



A 3 Arrows icon set indicates low, middle, and high values in a data set by using arrows of different colors and directions.

To create a custom conditional formatting rule

1. Select the range to which you want the custom conditional formatting applied.
2. On the **Conditional Formatting** menu, click **New Rule** to open the **New Formatting Rule** dialog box.
3. In the **Select a Rule Type** group, click the type of rule you want to apply.



The controls in the Edit The Rule Description area vary depending on the rule type you select.

4. Select the rule type's conditions and formatting.
5. Click **OK** to close the dialog box and return to the workbook.

Create conditional formatting rules that use formulas

Excel comes with another conditional formatting component that makes this feature even more powerful: you can apply conditional formatting based on the results of a formula. In particular, you can set up a logical formula as the conditional formatting criterion. If that formula returns TRUE, Excel applies the formatting to the cells; if the formula returns FALSE, instead, Excel doesn't apply the formatting.

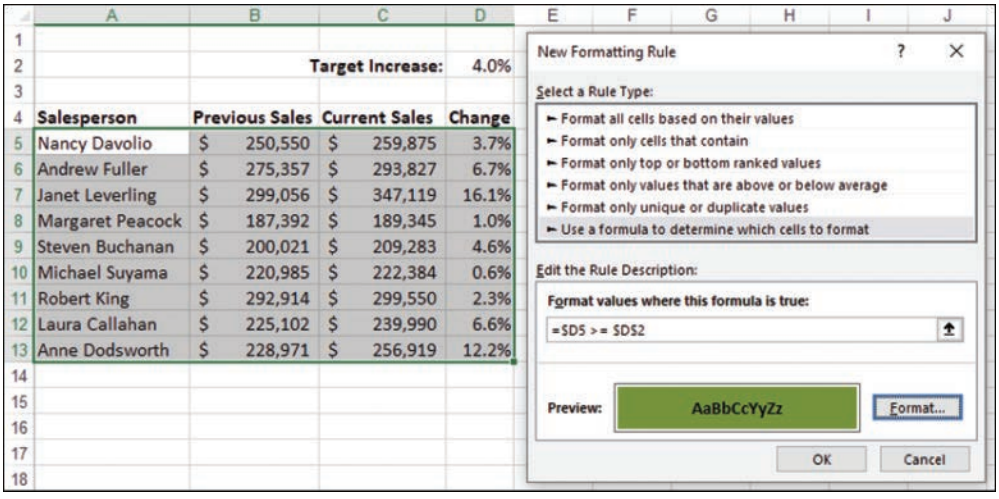
When comparing worksheet values in a conditional formatting rule's logical formula, you generally set up the expression to compare the value you seek with a specific value from the range, and then use a mixed-reference format for that specific value so that Excel can compare all the values in the range to the target value. For example, suppose you have a list of percentage increases in the range D5:D13 and a "target" percentage in cell D2. You want to apply a format only on those entries where the percentage increase is greater than or equal to the target value. Here's the logical formula to use:

=$D5 >= D2

The mixed-reference format $D5 tells Excel to keep the column (D) fixed while varying the row number (in this example, 5 through 13), and in each case compare the resulting cell value with the value in D2.

To create a custom conditional formatting rule based on a formula

1. Select the range to which you want the custom conditional formatting applied.
2. In the **New Formatting Rule** dialog box, in the **Select a Rule Type** list, click **Use a formula to determine which cells to format**.
3. In the **Format values where this formula is true** box, enter your logical formula.



You can create custom conditional formatting rules based on logical formulas.

4. Click **Format** to open the **Format Cells** dialog box.
5. On the **Number**, **Font**, **Border**, and **Fill** tabs, specify the formatting you want Excel to apply when the formula evaluates to TRUE, then click **OK**.
6. In the **New Formatting Rule** dialog box, click **OK**.

Manage conditional formatting rules

Conditional formatting rules are extremely useful and powerful tools, so you might find that you use them frequently. As you use them, however, your need to manage those rules will increase. For example, you'll often need to edit existing rules to update the conditions or change the formatting. Similarly, if you've applied two or more rules to the same range, you should know how to change the order that Excel uses to apply those rules. Finally, you also need to know how to delete existing rules that you no longer require.

To edit a conditional formatting rule

1. Click any cell in the range that has the conditional formatting applied.
2. On the **Conditional Formatting** menu, click **Manage Rules** to open the **Conditional Formatting Rules Manager** dialog box.
3. Click the rule you want to modify, then click **Edit Rule** to open the **Edit Formatting Rule** dialog box.

4. Make your changes to the rule type, rule conditions, or rule formatting, then click **OK**.
5. In the **Edit Formatting Rule** dialog box, click **OK**.
6. In the **Conditional Formatting Rules Manager** dialog box, click **OK**.

To change the order in which conditional formatting rules are applied

1. Click any cell in the range that has the conditional formatting applied.
2. Open the **Conditional Formatting Rules Manager** dialog box.
3. Click a rule, then click either the up arrow or the down arrow until the rule is in the position you prefer.
4. Repeat for the other rules you want to move, then click **OK**.

To delete a conditional formatting rule

1. Click any cell in the range that has the conditional formatting applied.
2. Open the **Conditional Formatting Rules Manager** dialog box.
3. Click the rule you want to remove, then click **Delete Rule**. Excel removes the rule.
4. Click **OK** to close the dialog box and return to the worksheet.

Tip If you want to delete multiple rules, a quicker method is to click any cell in the range that has the rules applied, click the Home tab, click Conditional Formatting in the Styles group, click Clear Rules, and then click Clear Rules From Selected Cells. If you want to delete every rule in the current worksheet, click Clear Rules From Entire Sheet.

Objective 2.3 practice tasks

The practice files for these tasks are located in the **MOSExcelExpert2019\Objective2** practice file folder. The folder also contains result files that you can use to check your work.

➤ Open the **ExcelExpert_2-3a** workbook and do the following:

- ❑ On the **Student Grades** worksheet, for the cells in the Grade column, create and apply a custom conditional formatting rule that applies the 4 Traffic Lights Icon Set formatting based on the cell values. Display the black icon for values less than 50; the red icon for values from 50 to 59; the yellow icon for values from 60 to 79; and the green icon for values of 80 and greater.
- ❑ On the **Projects** worksheet, for the cells in the Percent column, create and apply a custom conditional formatting rule that applies the Data Bar format with a green gradient fill based on the cell values. Set the minimum value to 0 and the maximum value to 1.
- ❑ On the **Product Inventory** worksheet, for the Product Name column, create and apply a custom conditional formatting rule that applies an Orange fill color to cells that contain duplicate product names.
- ❑ Save the workbook.
- ❑ Open the **ExcelExpert_2-3a_results** workbook. Compare the two workbooks to check your work, and then close the open workbooks.

➤ Open the **ExcelExpert_2-3b** workbook and do the following:

- ❑ On the **Customers** worksheet, for the cell range A4:K94, create and apply a formula-based conditional formatting rule that evaluates cell B1 and applies a Yellow fill color to all the cells of each row that has the same country/region in column I. Test the conditional formatting rule by changing the country/region in cell B1.

- ❑ On the **Accounts Receivable Data** worksheet, for the cell range A4:G55, use the MOD function (refer to Excel Help if you are not familiar with this function) to create and apply a formula-based conditional formatting rule that applies a light gray fill color to every other row. Test the conditional formatting rule by deleting a row.
- ❑ On the **Products** worksheet, for the cell range A2:B78, create and apply a formula-based conditional formatting rule that applies a Red fill color and Bold font to the cells in the rows that contain the highest and lowest values in the Change In Units Sold column. Test the conditional formatting rule by entering new high and low values.
- ❑ Save the workbook.
- ❑ Open the **ExcelExpert_2-3b_results** workbook. Compare the two workbooks to check your work, and then close the open workbooks.

➤ Open the **ExcelExpert_2-3c** workbook, display the **Accounts Receivable Data** worksheet, and do the following for the cell range A4:G55:

- ❑ Create and apply a conditional formatting rule that applies a Light Green fill color to the cells in each row that has an Invoice Amount value greater than $2,000.
- ❑ Create and apply a conditional formatting rule that applies an Orange fill color to the cells in each row that has a Days Overdue value greater than or equal to 30.
- ❑ Edit the first rule so that it applies the formatting to rows that have an Invoice Amount value that is greater than $1,500.
- ❑ Change the order of the conditional formatting rules so that Excel applies the Invoice Amount rule before it applies the Days Overdue rule.
- ❑ Save the workbook.
- ❑ Open the **ExcelExpert_2-3c_results** workbook. Compare the two workbooks to check your work, and then close the open workbooks.

Objective group 3

Create advanced formulas and macros

The skills tested in this section of the Microsoft Office Specialist Expert exam for Microsoft Excel 2019 relate to the advanced use of formulas and data analysis. Specifically, the following objectives are associated with this set of skills:

- **3.1** Perform logical operations in formulas
- **3.2** Look up data by using functions
- **3.3** Apply advanced date and time functions
- **3.4** Perform data analysis
- **3.5** Troubleshoot formulas
- **3.6** Create and modify simple macros

Although Excel works well as a simple database, in most of your worksheets you'll want to do more than just store data. You'll also want to summarize your data, apply statistical methods, perform data analysis, automate tasks with macros, and perform other techniques that you can use to interrogate your worksheet data and draw conclusions that are relevant to your business requirements. This level of dynamism requires creating worksheet models that use formulas, functions, and macros.

This chapter guides you in studying methods for performing logical operations by using functions, nesting functions, performing statistical operations with functions, looking up data with functions, applying advanced date and time functions, analyzing and consolidating data, creating financial formulas, troubleshooting formula errors, and recording and editing simple macros.

To complete the practice tasks in this chapter, you need the practice files contained in the **MOSExcelExpert2019\Objective3** practice file folder. For more information, see "Download the practice files" in this book's introduction.

Objective 3.1: Perform logical operations in formulas

Insert functions into a formula

Formulas that combine operators with basic operands such as numeric and string values are the mainstay of any Excel spreadsheet. But to get the most benefit from the spreadsheet model, you need to expand your formula repertoire to include worksheet functions. Excel includes dozens of these functions, and they're essential to making your worksheet easier to work with and more powerful.

To insert a function into a formula

1. Enter your formula up to the point where you want to insert the function.
2. On the **Formulas** tab, in the **Function Library** group, click the category that contains the function you want to use. Then on the category menu, click the function.
3. In the **Function Arguments** dialog box, enter the function arguments, then click **OK**.

Perform logical operations by using the IF, AND, OR, and NOT functions

In the computer world, we *very* loosely define something as *intelligent* if it can perform tests on its environment and act in accordance with the results of those tests. However, a computer is a binary machine, so "acting in accordance with the results of a test" means that it can do only one of two things. Even with this limited range of options, you can still bring a great deal of intelligence to your worksheets. Your

formulas will be able to test the values in cells and ranges and then return results based on those tests. This is all done with the logical functions in Excel, which are designed to create decision-making formulas.

The following table describes the most common logical functions.

Function	Description
IF(*logical_test*, *value_if_true*[, *value_if_false*])	Performs a logical test and returns a value based on the result
AND(*logical1*[, *logical2*,...])	Returns TRUE if all the arguments are true
OR(*logical1*[, *logical2*,...])	Returns TRUE if any argument is true
NOT(*logical*)	Reverses the logical value of the argument

You use the IF function to test some condition and then return a value based on the result of that test. This is the simplest version of the IF function:

IF(logical_test, value_if_true)

The *logical_test* argument is a logical expression—that is, an expression that returns TRUE or FALSE (or their equivalent numeric values: 0 for FALSE and any other number for TRUE); the *value_if_true* argument is the value returned by the function if *logical_test* evaluates to TRUE.

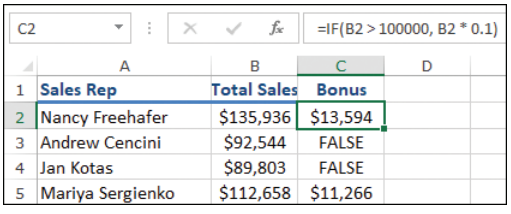
A *logical expression* compares two or more numbers, text strings, cell contents, or function results. If the expression is true, it's given the logical value TRUE (which is equivalent to any nonzero value); if the expression is false, it's given the logical value FALSE (which is equivalent to zero). The following table summarizes the comparison operators you can use in logical expressions.

Operator	Name	Example	Result
=	Equal to	=10=5	FALSE
>	Greater than	=10>5	TRUE
<	Less than	=10<5	FALSE
>=	Greater than or equal to	="a">="b"	FALSE
<=	Less than or equal to	="a"<="b"	TRUE
<>	Not equal to	="a"<>"b"	TRUE

For example, suppose cell B2 contains a sales rep's total sales and you want to give the rep a 10-percent bonus if those sales are greater than $100,000. Here's a formula that does that:

*=IF(B2 > 100000, B2 * 0.1)*

The logical expression B1 > 100000 is used as the test. Assume that you add this formula to cell C2. If the logical expression proves to be true (that is, if the value in cell B2 is greater than 100,000), the function returns the value B2 * 0.1—that is, 10 percent of the number in B2—and that's the value you see in cell C2.



	A	B	C	D
1	**Sales Rep**	**Total Sales**	**Bonus**	
2	Nancy Freehafer	$135,936	$13,594	
3	Andrew Cencini	$92,544	FALSE	
4	Jan Kotas	$89,803	FALSE	
5	Mariya Sergienko	$112,658	$11,266	

A formula that uses the IF function to return a bonus for reps with sales greater than 100,000.

When the IF function test returns FALSE (that is, the value in column B is less than or equal to 100,000), the function returns FALSE as its result. That's not inherently bad, but the worksheet would look tidier (and, hence, be more useful) if the formula returned, for instance, the value 0 instead.

To do this, you need to use the full IF function syntax:

IF(logical_test, value_if_true, value_if_false)

The extra *value_if_false* argument is the value returned by the function if *logical_test* evaluates to FALSE. Here's a modification of the sales rep bonus calculation that takes a FALSE result into account:

*=IF(B2 > 100000, B2 * 0.1, 0)*

It's often necessary to perform an action if and only if two conditions are true. For example, you might want to pay a salesperson a bonus if and only if dollar sales exceed a certain amount *and* unit sales also exceed some minimum value. If the dollar sales, the unit sales, or both fall below the minimum, no bonus is paid. In Boolean logic, this is called an *And* condition because one expression *and* another must be true for a positive result.

In Excel, And conditions are handled by the AND logical function:

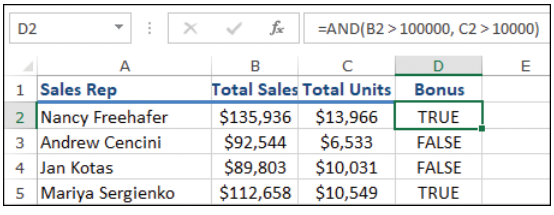
AND(logical1[, logical2,...])

Here, *logical1* and *logical2* arguments are the logical conditions to test. (The ellipsis means that you can enter as many conditions as you need.) The AND result is calculated as follows:

- If *all* the arguments return TRUE (or any nonzero number), AND returns TRUE.
- If one or more of the arguments return FALSE (or 0), AND returns FALSE.

Consider a formula that uses AND to check whether a sales rep's sales total is greater than $100,000 and units total is greater than 10,000. That formula could look like this:

=AND(B2 > 100000, C2 > 10000)



	A	B	C	D	E
1	**Sales Rep**	**Total Sales**	**Total Units**	**Bonus**	
2	Nancy Freehafer	$135,936	$13,966	TRUE	
3	Andrew Cencini	$92,544	$6,533	FALSE	
4	Jan Kotas	$89,803	$10,031	FALSE	
5	Mariya Sergienko	$112,658	$10,549	TRUE	

A formula that uses the AND function to test whether the values in columns B and C exceed a specified minimum.

In many worksheet models, you need to take an action if one thing *or* another is true. For example, you might want to pay a salesperson a bonus if she exceeds the dollar sales budget *or* if she exceeds the unit sales budget. In Boolean logic, this is called an *Or* condition.

In Excel, Or conditions are handled by the OR function:

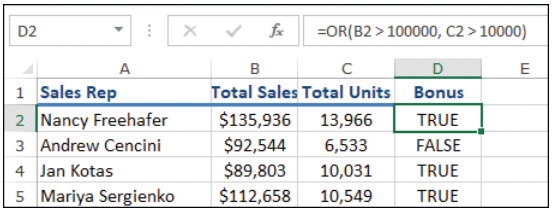
OR(logical1[, logical2,...])

Here, *logical1* and *logical2* arguments are the logical conditions to test. (The ellipsis means that you can enter as many conditions as you need.) The OR result is calculated as follows:

- If one or more of the arguments return TRUE (or any nonzero number), OR returns TRUE.
- If *all* of the arguments return FALSE (or 0), OR returns FALSE.

Consider the following formula, which uses OR to check whether a sales rep's sales total is greater than $100,000 or the units total is greater than 10,000:

=OR(B2 > 100000, C2 > 10000)



	A	B	C	D	E
1	**Sales Rep**	**Total Sales**	**Total Units**	**Bonus**	
2	Nancy Freehafer	$135,936	13,966	TRUE	
3	Andrew Cencini	$92,544	6,533	FALSE	
4	Jan Kotas	$89,803	10,031	TRUE	
5	Mariya Sergienko	$112,658	10,549	TRUE	

A formula that uses the OR function to test whether the values in columns B or C exceed a specified minimum.

You sometimes need to return the opposite of a logical expression. For example, you might want to set up a worksheet that looks for the sales reps who did not make their sales quota and then flag those reps for further training. If you have a worksheet that already returns a TRUE or FALSE value based on whether a sales rep meets his quota, flagging whether the sales rep needs more training is a matter of returning the opposite value: if a sales rep meets her quota (TRUE), she doesn't need training (FALSE); if a sales rep doesn't meet his quota (FALSE), he does need training (TRUE).

In Excel, you return the opposite of a logical expression by using the NOT function:

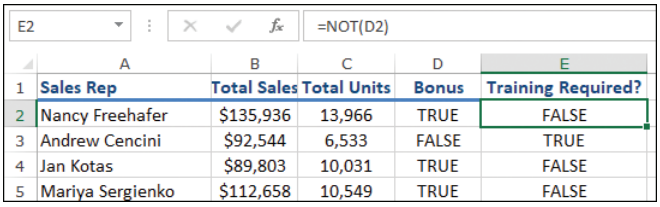
NOT(logical)

Here, the *logical* argument is the logical condition to test. The NOT result is calculated as follows:

- If *logical* is TRUE (or any nonzero number), NOT returns FALSE.
- If *logical* is FALSE (or 0), NOT returns TRUE.

The following formula uses NOT in the Training Required? column (E) to return the opposite of the logical value in the Bonus column (D):

=NOT(D2)



	A	B	C	D	E
1	Sales Rep	Total Sales	Total Units	Bonus	Training Required?
2	Nancy Freehafer	$135,936	13,966	TRUE	FALSE
3	Andrew Cencini	$92,544	6,533	FALSE	TRUE
4	Jan Kotas	$89,803	10,031	TRUE	FALSE
5	Mariya Sergienko	$112,658	10,549	TRUE	FALSE

A formula that uses the NOT function to return the opposite of the logical values in column D.

To insert a logical function into a formula

➜ On the **Formulas** tab, in the **Function Library** group, click **Logical**, click one of the functions in the list (such as IF, AND, OR, or NOT), and then enter the arguments, if any, as described earlier in this topic.

Perform logical operations by using nested functions

You can create sophisticated logical tests by combining one or more logical functions within a single expression. In particular, you can create complex expressions by including one logical function within another. This is called *nesting*, and the inner function is called a *nested function*.

A good time to use nested IF functions arises when you need to calculate a tiered payment or charge. That is, if a certain value is X, you want one result; if the value is Y, you want a second result; and if the value is Z, you want a third result. For example, suppose you want to calculate tiered bonuses for a sales team as follows:

- If the salesperson did not meet the sales target, no bonus is given.
- If the salesperson exceeded the sales target by less than 10 percent, a bonus of $1,000 is awarded.
- If the salesperson exceeded the sales target by 10 percent or more, a bonus of $5,000 is awarded.

Assuming that cell D2 contains the percentage that each salesperson's actual sales were above or below her target sales, here's a formula that handles these rules:

=IF(D2 < 0, "", IF(D2 < 0.1, 1000, 5000))

E2 =IF(D2 < 0, "", IF(D2 < 0.1, 1000, 5000))

	A	B	C	D	E
1	**Sales Rep**	**Total Sales**	**Sales Target**	**Pct of Target**	**Bonus**
2	Nancy Freehafer	$135,936	$119,000	14.2%	$5,000
3	Andrew Cencini	$92,544	$86,000	7.6%	$1,000
4	Jan Kotas	$89,803	$95,000	-5.5%	
5	Mariya Sergienko	$112,658	$113,000	-0.3%	

A formula that uses nested IF functions to calculate a tiered bonus.

To nest logical functions

1. Insert the first logical function into your formula.
2. Enter the function arguments as described earlier in this topic, including the logical function you want to nest as one of the arguments.

Perform multiple logical tests with the IFS function

Nesting one IF function inside another is a handy way to perform a couple of logical tests, but the method quickly becomes unwieldly and difficult to decipher when the nesting goes three or more IF functions deep. If your data analysis requires more than two logical tests, you can make your worksheet model easier to read by turning to the IFS function:

IFS(logical_test1, value_if_true1, [logical_test2, value_if_true2,...])

The IFS function consists of a series of logical tests, each of which has an associated return value. IFS performs each logical test in turn, and when it comes across the first logical test to return TRUE, it returns that logical test's associated value.

For example, here's how you'd use IFS to calculate the tiered bonuses that I introduced in the previous section:

=IFS(D2 < 0, 0, D2 < 0.1, 1000, D2 >= 0.1, 5000)

E2 =IFS(D2 < 0, "", D2 < 0.1, 1000, D2 >= 0.1, 5000)

	A	B	C	D	E	F
1	**Sales Rep**	**Total Sales**	**Sales Target**	**Pct of Target**	**Bonus**	
2	Nancy Freehafer	$135,936	$119,000	14.2%	$5,000	
3	Andrew Cencini	$92,544	$86,000	7.6%	$1,000	
4	Jan Kotas	$89,803	$95,000	-5.5%		
5	Mariya Sergienko	$112,658	$113,000	-0.3%		

A formula that uses the IFS function to calculate a tiered bonus.

Perform logical operations with criteria

You use the SUM, AVERAGE, and COUNT functions in Excel to return the total value, the mean value, and the number of values, respectively, within a specified range. These functions operate over the entire range, but it's often the case that you want the sum, the average, or the count of only those cells that meet some criterion. For example, you might want the total sales for just the customers from the United States. Even more sophisticated calculations are possible when you use multiple criteria. For example, you might want the total sales for those customers who are from the United States and who are based in Oregon.

These seem like they would require complex combinations of the IF, AND, and OR functions nested within the SUM, AVERAGE, or COUNT function. Fortunately, Excel includes three summary functions that you can use to specify multiple criteria without complex nesting: SUMIF, AVERAGEIF, and COUNTIF. In each case, the "IF" part of the function name implies that an IF function is built into each function, without being explicitly invoked.

The SUMIF function is similar to SUM, except that it sums only those cells in a range that meet a specified condition:

SUMIF(range, criteria[, sum_range])

Here, the *range* argument is the range of cells to use for the criteria; the *criteria* argument is the criteria, entered as text, that Excel applies to *range* to determine which cells to sum; *sum_range* is an optional argument that specifies the range from which the sum values are taken. Excel sums only those cells in *sum_range* that correspond to the cells in *range* and meet the *criteria*. If you omit *sum_range*, Excel uses *range* for the sum.

For the *criteria* argument, you generally use the following format:

"*operator value*"

Here, you replace *operator* with a comparison operator such as equal to (=) or greater than (>), and you replace *value* with a comparison value. Many Excel functions also support text-only *criteria* arguments that optionally use one or more wildcard characters: * to match any number of characters and ? to match any single character.

For example, the following formula sums only those values in the range B3:B21 that are greater than 100000:

=SUMIF(B3:B21, "> 100000")

E1 =SUMIF(B3:B21, "> 100000")

	A	B	C	D	E
1					$1,553,835
2	**Sales Rep**	**Total Sales**	**Total Units**	**Return Rate**	**Bonus**
3	Nancy Freehafer	$135,936	13,966	11%	$0
4	Andrew Cencini	$101,234	10,023	9%	$10,123
5	Jan Kotas	$89,803	10,031	8%	$0
6	Mariya Sergienko	$112,658	10,549	7%	$11,266
7	Steven Thorpe	$92,021	8,818	10%	$0
8	Michael Neipper	$99,021	5,545	9%	$0
9	Robert Zare	$121,454	14,685	15%	$0
10	Laura Giussani	$117,387	8,032	8%	$0
11	Anne Hellung-Larsen	$136,349	8,955	11%	$0
12	Maria Anders	$125,386	14,694	9%	$12,539
13	Thomas Hardy	$120,297	12,865	8%	$12,030
14	Hanna Moos	$137,914	7,293	10%	$0
15	Victoria Ashworth	$98,923	10,179	11%	$0
16	Patricio Simpson	$115,869	9,604	10%	$0
17	Elizabeth Brown	$108,428	6,059	14%	$0
18	Ann Devon	$93,914	13,082	15%	$0
19	Paolo Accorti	$102,601	7,846	12%	$0
20	Carlos Hernández	$118,322	7,429	10%	$0
21	Yoshi Latimer	$91,553	5,849	13%	$0

A formula that uses the SUMIF function.

The COUNTIF function counts the number of cells in a range that meet a single condition:

COUNTIF(range, criteria)

Here, replace *range* with the range of cells to use for the count; replace *criteria* with the criteria, entered as text, that Excel applies to *range* to determine which cells to count.

For example, you can use the following formula to count the number of cells in the range D3:D21 that are greater than or equal to 0.1:

=COUNTIF(D3:D21, ">= 0.1")

E1 =COUNTIF(D3:D21, ">= 0.1")

	A	B	C	D	E
1					12
2	**Sales Rep**	**Total Sales**	**Total Units**	**Return Rate**	**Bonus**
3	Nancy Freehafer	$135,936	13,966	11%	$0
4	Andrew Cencini	$101,234	10,023	9%	$10,123
5	Jan Kotas	$89,803	10,031	8%	$0
6	Mariya Sergienko	$112,658	10,549	7%	$11,266
7	Steven Thorpe	$92,021	8,818	10%	$0
8	Michael Neipper	$99,021	5,545	9%	$0
9	Robert Zare	$121,454	14,685	15%	$0
10	Laura Giussani	$117,387	8,032	8%	$0
11	Anne Hellung-Larsen	$136,349	8,955	11%	$0
12	Maria Anders	$125,386	14,694	9%	$12,539
13	Thomas Hardy	$120,297	12,865	8%	$12,030
14	Hanna Moos	$137,914	7,293	10%	$0
15	Victoria Ashworth	$98,923	10,179	11%	$0
16	Patricio Simpson	$115,869	9,604	10%	$0
17	Elizabeth Brown	$108,428	6,059	14%	$0
18	Ann Devon	$93,914	13,082	15%	$0
19	Paolo Accorti	$102,601	7,846	12%	$0
20	Carlos Hernández	$118,322	7,429	10%	$0
21	Yoshi Latimer	$91,553	5,849	13%	$0

A formula that uses the COUNTIF function.

The AVERAGEIF function calculates the average of a range set for those items that meet a specified condition:

AVERAGEIF(range, criteria[, average_range])

Here, the *range* argument is the range of cells to use for the criteria; the *criteria* argument is the criteria, entered as text, that Excel applies to *range* to determine which cells to average; *average_range* is an optional argument that specifies the range from which the average values are taken. Excel averages only those cells in *average_range* that correspond to the cells in *range* and meet the *criteria*. If you omit *average_range*, Excel uses *range* for the average.

For example, the following formula averages only those values in the range D3:D21 that correspond to those values in the range C3:C21 that are greater than or equal to 10,000:

=AVERAGEIF(C2:C21, "> 10000", D3:21)

E1 =AVERAGEIF(C3:C21, ">= 10000", D3:D21)

	A	B	C	D	E
1					10.3%
2	**Sales Rep**	**Total Sales**	**Total Units**	**Return Rate**	**Bonus**
3	Nancy Freehafer	$135,936	13,966	11%	$0
4	Andrew Cencini	$101,234	10,023	9%	$10,123
5	Jan Kotas	$89,803	10,031	8%	$0
6	Mariya Sergienko	$112,658	10,549	7%	$11,266
7	Steven Thorpe	$92,021	8,818	10%	$0
8	Michael Neipper	$99,021	5,545	9%	$0
9	Robert Zare	$121,454	14,685	15%	$0
10	Laura Giussani	$117,387	8,032	8%	$0
11	Anne Hellung-Larsen	$136,349	8,955	11%	$0
12	Maria Anders	$125,386	14,694	9%	$12,539
13	Thomas Hardy	$120,297	12,865	8%	$12,030
14	Hanna Moos	$137,914	7,293	10%	$0
15	Victoria Ashworth	$98,923	10,179	11%	$0
16	Patricio Simpson	$115,869	9,604	10%	$0
17	Elizabeth Brown	$108,428	6,059	14%	$0
18	Ann Devon	$93,914	13,082	15%	$0
19	Paolo Accorti	$102,601	7,846	12%	$0
20	Carlos Hernández	$118,322	7,429	10%	$0
21	Yoshi Latimer	$91,553	5,849	13%	$0

A formula that uses the AVERAGEIF function.

To insert a SUMIF function into a formula

➜ On the **Formulas** tab, in the **Function Library** group, click **Math & Trig**, click **SUMIF**, and then enter the arguments, as described earlier in this topic.

To insert an AVERAGEIF or COUNTIF function into a formula

➜ On the **Formulas** tab, in the **Function Library** group, click **More Functions**, click **Statistical**, click **AVERAGEIF** or **COUNTIF**, and then enter the arguments, as described earlier in this topic.

Perform logical operations with multiple ranges and criteria

The SUMIF, COUNTIF, and AVERAGEIF functions that I describe in the previous section replace simple nested functions with a single condition. However, there are many situations in which your logical formula requires multiple criteria applied to multiple ranges. To handle these situations, Excel includes five summary functions that you can use to specify multiple criteria: SUMIFS, AVERAGEIFS, COUNTIFS, MAXIFS, and MINIFS. In each case, the "IFS" part of the function name implies that multiple IF functions are built into each function, without being explicitly invoked.

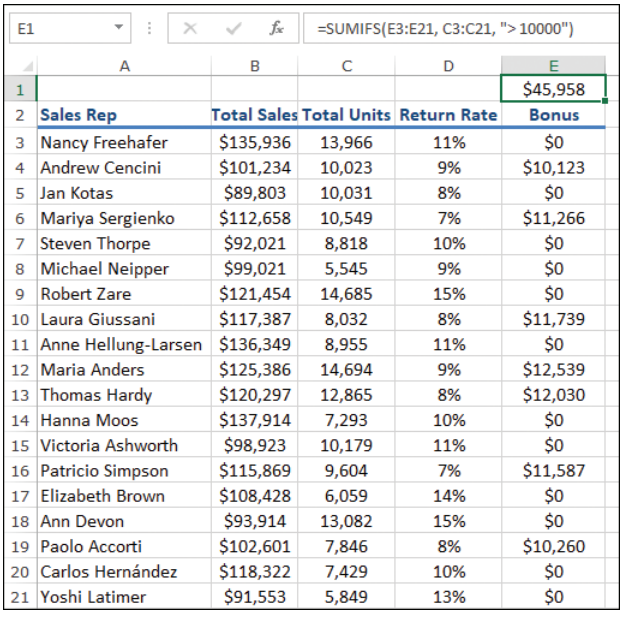
The SUMIFS function sums cells in a range that correspond to those cells in one or more ranges that meet one or more criteria:

SUMIFS(sum_range, range1, criteria1[, range2, criteria2, ...])

The *sum_range* argument is the range from which the sum values are taken. Excel sums only those cells in *sum_range* that correspond to the cells that meet the criteria. The *range1* argument is the first range of cells to use for the sum criteria, and the *criteria1* argument is the first criterion, entered as text, that determines which cells to sum. Excel applies the criterion to *range1*. You can enter up to 127 range/criterion pairs.

Consider the following SUMIFS function example. In this model, SUMIFS is used to calculate the total bonuses (range E3:E21) just for those sales reps whose total units (range C3:C21) are greater than 10,000:

=SUMIFS(E3:E21, C3:C21, " > 10000")



	A	B	C	D	E
1					$45,958
2	**Sales Rep**	**Total Sales**	**Total Units**	**Return Rate**	**Bonus**
3	Nancy Freehafer	$135,936	13,966	11%	$0
4	Andrew Cencini	$101,234	10,023	9%	$10,123
5	Jan Kotas	$89,803	10,031	8%	$0
6	Mariya Sergienko	$112,658	10,549	7%	$11,266
7	Steven Thorpe	$92,021	8,818	10%	$0
8	Michael Neipper	$99,021	5,545	9%	$0
9	Robert Zare	$121,454	14,685	15%	$0
10	Laura Giussani	$117,387	8,032	8%	$11,739
11	Anne Hellung-Larsen	$136,349	8,955	11%	$0
12	Maria Anders	$125,386	14,694	9%	$12,539
13	Thomas Hardy	$120,297	12,865	8%	$12,030
14	Hanna Moos	$137,914	7,293	10%	$0
15	Victoria Ashworth	$98,923	10,179	11%	$0
16	Patricio Simpson	$115,869	9,604	7%	$11,587
17	Elizabeth Brown	$108,428	6,059	14%	$0
18	Ann Devon	$93,914	13,082	15%	$0
19	Paolo Accorti	$102,601	7,846	8%	$10,260
20	Carlos Hernández	$118,322	7,429	10%	$0
21	Yoshi Latimer	$91,553	5,849	13%	$0

A formula that uses SUMIFS to apply a criterion to a sum.

The AVERAGEIFS function averages cells in a range that correspond to those cells in one or more ranges that meet one or more criteria:

AVERAGEIFS(average_range, range1, criteria1[, range2, criteria2, ...])

The *average_range* argument is the range from which the average values are taken. Excel averages only those cells in *average_range* that correspond to the cells that meet the criteria. The *range1* argument is the first range of cells to use for the average criteria, and the *criteria1* argument is the first criterion, entered as text, that determines which cells to average. Excel applies the criterion to *range1*. You can enter up to 127 range/criterion pairs.

In the following example, AVERAGEIFS is used to calculate the average sales (range B3:B21) just for those sales reps whose total units (C3:C21) are greater than 10,000 and whose return rate (D3:D21) is less than 10 percent:

=AVERAGEIFS(B3:B21, C3:C21, " > 10000", D3:D21, " < 0.1")

E1 =AVERAGEIFS(B3:B21, C3:C21, ">10000", D3:D21, "<0.1")

	A	B	C	D	E	F
1					$109,876	
2	**Sales Rep**	**Total Sales**	**Total Units**	**Return Rate**	**Bonus**	
3	Nancy Freehafer	$135,936	13,966	11%	$0	
4	Andrew Cencini	$101,234	10,023	9%	$10,123	
5	Jan Kotas	$89,803	10,031	8%	$0	
6	Mariya Sergienko	$112,658	10,549	7%	$11,266	
7	Steven Thorpe	$92,021	8,818	10%	$0	
8	Michael Neipper	$99,021	5,545	9%	$0	
9	Robert Zare	$121,454	14,685	15%	$0	
10	Laura Giussani	$117,387	8,032	8%	$11,739	
11	Anne Hellung-Larsen	$136,349	8,955	11%	$0	
12	Maria Anders	$125,386	14,694	9%	$12,539	
13	Thomas Hardy	$120,297	12,865	8%	$12,030	
14	Hanna Moos	$137,914	7,293	10%	$0	
15	Victoria Ashworth	$98,923	10,179	11%	$0	
16	Patricio Simpson	$115,869	9,604	7%	$11,587	
17	Elizabeth Brown	$108,428	6,059	14%	$0	
18	Ann Devon	$93,914	13,082	15%	$0	
19	Paolo Accorti	$102,601	7,846	8%	$10,260	
20	Carlos Hernández	$118,322	7,429	10%	$0	
21	Yoshi Latimer	$91,553	5,849	13%	$0	

A formula that uses AVERAGEIFS to apply multiple criteria to an average.

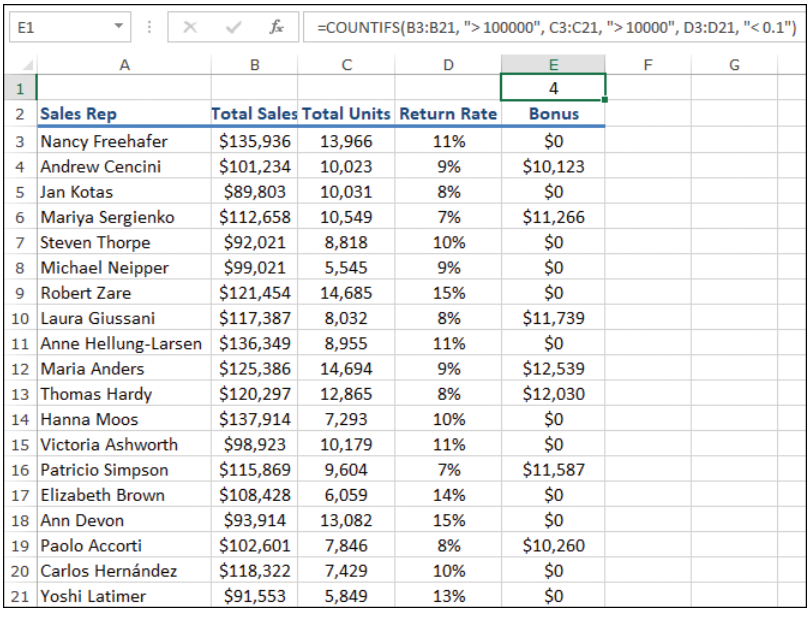
The COUNTIFS function counts the number of cells in one or more ranges that meet one or more criteria:

COUNTIFS(range1, criteria1[, range2, criteria2, ...])

The *range1* argument is the first range of cells to use for the count, and the *criteria1* argument is the first criterion, entered as text, that determines which cells to count. Excel applies the criterion to *range1*. You can enter up to 127 range/criterion pairs.

In the following example, COUNTIFS is used to count the number of sales reps whose dollar sales (range B3:B21) are greater than $100,000, whose unit sales (C3:C21) are greater than 10,000, and whose return rate (D3:D21) is less than 10 percent:

=COUNTIFS(B3:B21, " > 100000", C3:C21, " > 10000", D3:D21, " < 0.1")



E1 =COUNTIFS(B3:B21, ">100000", C3:C21, ">10000", D3:D21, "<0.1")

	A	B	C	D	E	F	G
1					4		
2	**Sales Rep**	**Total Sales**	**Total Units**	**Return Rate**	**Bonus**		
3	Nancy Freehafer	$135,936	13,966	11%	$0		
4	Andrew Cencini	$101,234	10,023	9%	$10,123		
5	Jan Kotas	$89,803	10,031	8%	$0		
6	Mariya Sergienko	$112,658	10,549	7%	$11,266		
7	Steven Thorpe	$92,021	8,818	10%	$0		
8	Michael Neipper	$99,021	5,545	9%	$0		
9	Robert Zare	$121,454	14,685	15%	$0		
10	Laura Giussani	$117,387	8,032	8%	$11,739		
11	Anne Hellung-Larsen	$136,349	8,955	11%	$0		
12	Maria Anders	$125,386	14,694	9%	$12,539		
13	Thomas Hardy	$120,297	12,865	8%	$12,030		
14	Hanna Moos	$137,914	7,293	10%	$0		
15	Victoria Ashworth	$98,923	10,179	11%	$0		
16	Patricio Simpson	$115,869	9,604	7%	$11,587		
17	Elizabeth Brown	$108,428	6,059	14%	$0		
18	Ann Devon	$93,914	13,082	15%	$0		
19	Paolo Accorti	$102,601	7,846	8%	$10,260		
20	Carlos Hernández	$118,322	7,429	10%	$0		
21	Yoshi Latimer	$91,553	5,849	13%	$0		

A formula that uses COUNTIFS to apply multiple criteria to a count.

The MAXIFS function returns the maximum value from a range that corresponds to those cells in one or more ranges that meet one or more criteria:

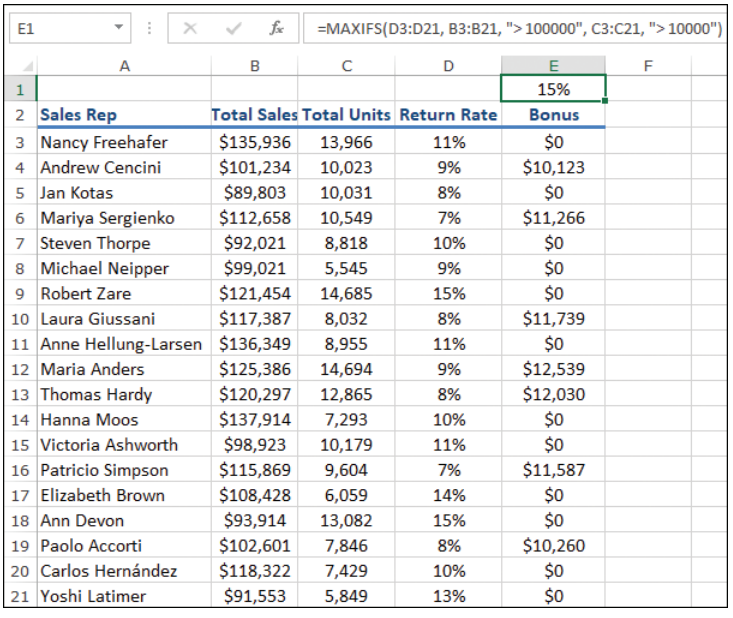
MAXIFS(max_range, range1, criteria1[, range2, criteria2, ...])

The *max_range* argument is the range from which the maximum value is taken. Excel looks for the maximum only in those cells in *max_range* that correspond to the cells that meet the criteria. The *range1* argument is the first range of cells to use for the maximum criteria, and the *criteria1* argument is the first criterion, entered as text, that determines which cells to include. Excel applies the criterion to *range1*. You can enter up to 127 range/criterion pairs.

Consider the following MAXIFS function example. In this model, MAXIFS is used to calculate the maximum return rate (from the range D3:D21) just for those sales reps

whose total sales (range B3:B21) are greater than $100,000 and whose total units (range C3:C21) are greater than 10,000:

=MAXIFS(D3:D21, B3:B21, "> 100000", C3:C21, " > 10000")



E1 =MAXIFS(D3:D21, B3:B21, "> 100000", C3:C21, "> 10000")

	A	B	C	D	E	F
1					15%	
2	**Sales Rep**	**Total Sales**	**Total Units**	**Return Rate**	**Bonus**	
3	Nancy Freehafer	$135,936	13,966	11%	$0	
4	Andrew Cencini	$101,234	10,023	9%	$10,123	
5	Jan Kotas	$89,803	10,031	8%	$0	
6	Mariya Sergienko	$112,658	10,549	7%	$11,266	
7	Steven Thorpe	$92,021	8,818	10%	$0	
8	Michael Neipper	$99,021	5,545	9%	$0	
9	Robert Zare	$121,454	14,685	15%	$0	
10	Laura Giussani	$117,387	8,032	8%	$11,739	
11	Anne Hellung-Larsen	$136,349	8,955	11%	$0	
12	Maria Anders	$125,386	14,694	9%	$12,539	
13	Thomas Hardy	$120,297	12,865	8%	$12,030	
14	Hanna Moos	$137,914	7,293	10%	$0	
15	Victoria Ashworth	$98,923	10,179	11%	$0	
16	Patricio Simpson	$115,869	9,604	7%	$11,587	
17	Elizabeth Brown	$108,428	6,059	14%	$0	
18	Ann Devon	$93,914	13,082	15%	$0	
19	Paolo Accorti	$102,601	7,846	8%	$10,260	
20	Carlos Hernández	$118,322	7,429	10%	$0	
21	Yoshi Latimer	$91,553	5,849	13%	$0	

A formula that uses MAXIFS to apply a criterion to a maximum.

The MINIFS function returns the minimum value from a range that corresponds to those cells in one or more ranges that meet one or more criteria:

MINIFS(min_range, range1, criteria1[, range2, criteria2, ...])

The *min_range* argument is the range from which the minimum value is taken. Excel looks for the minimum only in those cells in *min_range* that correspond to the cells that meet the criteria. The *range1* argument is the first range of cells to use for the minimum criteria, and the *criteria1* argument is the first criterion, entered as text, that determines which cells to include. Excel applies the criterion to *range1*. You can enter up to 127 range/criterion pairs.

Consider the following MINIFS function example. In this model, MINIFS is used to calculate the minimum units (from the range C3:C21) just for those sales reps whose total

sales (range B3:B21) are greater than $100,000 and whose return rate (range D3:D21) are less than 10 percent:

=MINIFS(C3:C21, B3:B21, " > 100000", D3:D21, "< 0.1")

E1 =MINIFS(C3:C21, B3:B21, ">100000", D3:D21, "<0.1")

	A	B	C	D	E	F
1					7,846	
2	**Sales Rep**	**Total Sales**	**Total Units**	**Return Rate**	**Bonus**	
3	Nancy Freehafer	$135,936	13,966	11%	$0	
4	Andrew Cencini	$101,234	10,023	9%	$10,123	
5	Jan Kotas	$89,803	10,031	8%	$0	
6	Mariya Sergienko	$112,658	10,549	7%	$11,266	
7	Steven Thorpe	$92,021	8,818	10%	$0	
8	Michael Neipper	$99,021	5,545	9%	$0	
9	Robert Zare	$121,454	14,685	15%	$0	
10	Laura Giussani	$117,387	8,032	8%	$11,739	
11	Anne Hellung-Larsen	$136,349	8,955	11%	$0	
12	Maria Anders	$125,386	14,694	9%	$12,539	
13	Thomas Hardy	$120,297	12,865	8%	$12,030	
14	Hanna Moos	$137,914	7,293	10%	$0	
15	Victoria Ashworth	$98,923	10,179	11%	$0	
16	Patricio Simpson	$115,869	9,604	7%	$11,587	
17	Elizabeth Brown	$108,428	6,059	14%	$0	
18	Ann Devon	$93,914	13,082	15%	$0	
19	Paolo Accorti	$102,601	7,846	8%	$10,260	
20	Carlos Hernández	$118,322	7,429	10%	$0	
21	Yoshi Latimer	$91,553	5,849	13%	$0	

A formula that uses MINIFS to apply a criterion to a minimum.

To insert a SUMIFS function into a formula

➜ On the **Formulas** tab, in the **Function Library** group, click **Math & Trig**, click **SUMIFS**, and then enter the arguments, as described earlier in this topic.

To insert an AVERAGEIFS, COUNTIFS, MAXIFS, or MINIFS function into a formula

➜ On the **Formulas** tab, in the **Function Library** group, click **More Functions**, click **Statistical**, click the function—**AVERAGEIFS**, **COUNTIFS**, **MAXIFS**, or **MINIFS**,—and then enter the arguments, as described earlier in this topic.

Apply multiple exact-match criteria to a value

The IFS function that I describe earlier in this objective enables you to create sophisticated criteria using comparison operators such as less than (<) and greater than or equal to (>=). However, it's often the case that your comparisons require only

exact matches using the equal operator (=). In such cases, it is often easier to use the SWITCH function rather than IFS.

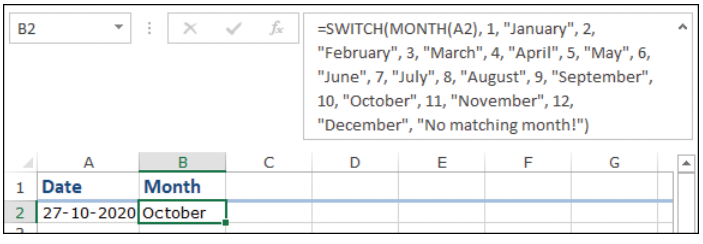
The SWITCH function evaluates an expression, compares the result to a list of values that you supply, and then returns a value that corresponds to the first match that Excel finds:

SWITCH(expression, value_to_match1, value_to_return1[, value_to_match2, value_to_return2, ..., value_if_no_match])

SWITCH first evaluates *expression*. SWITCH then compares that result to each *value_to_match* argument; when SWITCH comes across the first match, it returns the corresponding *value_to_return*; if no match is found, SWITCH returns the *value_if_no_match* argument. You can enter up to 126 match/return value pairs.

For example, given a date, the MONTH function returns a number between 1 (for January) and 12 (for December). For a date in cell A2, you can use the following SWITCH formula to return the date's month name based on the results of the MONTH(A2) expression:

==SWITCH(MONTH(A2), 1, "January", 2, "February", 3, "March", 4, "April", 5, "May", 6, "June", 7, "July", 8, "August", 9, "September", 10, "October", 11, "November", 12, "December", "No matching month!")



A formula that uses SWITCH to apply multiple exact-match criteria to an expression.

To insert a SWITCH function into a formula

➜ On the **Formulas** tab, in the **Function Library** group, click **Logical**, click **SWITCH**, and then enter the arguments, as described earlier in this topic.

Objective 3.1 practice tasks

The practice file for these tasks is located in the **MOSExcelExpert2019 \Objective3** practice file folder. The folder also contains a result file that you can use to check your work.

➤ Open the **ExcelExpert_3-1** workbook and do the following:

- ❑ On the **Gross Margin** worksheet, add formulas to the Gross Margin field (H7:H14) that calculate the gross margin by subtracting Cost from Retail and then dividing by Cost. To avoid #DIV/0! (division by 0) errors, wrap the calculation inside an IF function that returns the gross margin if Cost is not 0, or the message ***Cost is 0!*** otherwise.
- ❑ On the **Inventory** worksheet, populate the Reorder Now? column with formulas that use nested logical functions to determine whether a product should be reordered based on two conditions: The Qty Available is less than or equal to the Reorder Level, and the Qty on Order is 0. Each function should return "Yes" if a reorder is required, and nothing otherwise.
- ❑ On the **Inventory** worksheet, create a formula in cell K1 that uses the SUMIF function to sum the Value range for products with a non-zero Qty Available value.
- ❑ On the **Inventory** worksheet, create a formula in cell K2 that uses the SUMIFS function to sum the Qty On Hand range for products with a Product Name value that includes *Soup* and a Qty On Hold value of zero. (Hint: To match cells that include some text, surround that text with the * wildcard character.)
- ❑ On the **Parts** worksheet, create a formula in cell F16 that uses the AVERAGEIF function to calculate the average of the Gross Margin values for the parts that cost less than $10. Use structured table references in your formula (the table name is *Parts*).

- ❑ On the **Customers** worksheet, create a formula in cell L1 that uses the COUNTIFS function to return the number of customers with the Country value *United States* and the Region value *OR* (the abbreviation for *Oregon*, not the OR function).
- ❑ On the **Orders** worksheet, populate the Weekday column with formulas that use the SWITCH function to return the weekday of each date in the Date column.

➤ Save the workbook.

➤ Open the **ExcelExpert_3-1_results** workbook. Compare the two workbooks to check your work, and then close the open workbooks.

Objective 3.2: Look up data by using functions

The table—more properly referred to as a *lookup table*—is the key to performing lookup operations in Excel. The most straightforward lookup table structure is one that consists of two columns (or two rows):

- **Lookup column** This column contains the values that you look up. For example, if you were constructing a lookup table for a dictionary, this column would contain the words.
- **Data column** This column contains the data associated with each lookup value. In the dictionary example, this column would contain the definitions.

In most lookup operations, you supply a value that the function locates in the designated lookup column. It then retrieves the corresponding value in the data column.

The lookup table theme has many variations. The lookup table can be one of these:

- **A single column or row** In this case, the lookup operation consists of finding the *n*th value in the column.
- **A range with multiple data columns** For instance, in the dictionary example, you might have a second column for each word's part of speech (noun or verb, for example), and perhaps a third column for its pronunciation. In this case, the lookup operation must also specify which of the data columns contains the value required.
- **An array** In this case, the table doesn't exist on a worksheet but is either an array of literal values or the result of a function that returns an array. The lookup operation finds a particular position within the array and returns the data value at that position.

The VLOOKUP function works by looking in the first column of a table for the value you specify. (The *V* in VLOOKUP stands for *vertical*.) It then looks across to the column that you specify and returns whatever value it finds there.

Here's the full syntax for VLOOKUP:

VLOOKUP(lookup_value, table_array, col_index_num[, range_lookup])

The following table describes the VLOOKUP function arguments.

Argument	Description
lookup_value	The value you want to find in the first column of *table_array*. You can enter a number, string, or reference.
table_array	The cell range or named table to use for the lookup.
col_index_num	The column number in *table_array* that contains the data you want the formula to return (the first column—that is, the lookup column—is 1, the second column is 2, and so on).
range_lookup	A Boolean value that determines how Excel searches for *lookup_value* in the first column. If FALSE, VLOOKUP returns the first exact match for *lookup_value*. If TRUE (the default), if no exact match is found, the function returns the largest value that is less than *lookup_value*.

Here are some notes to keep in mind when you work with VLOOKUP:

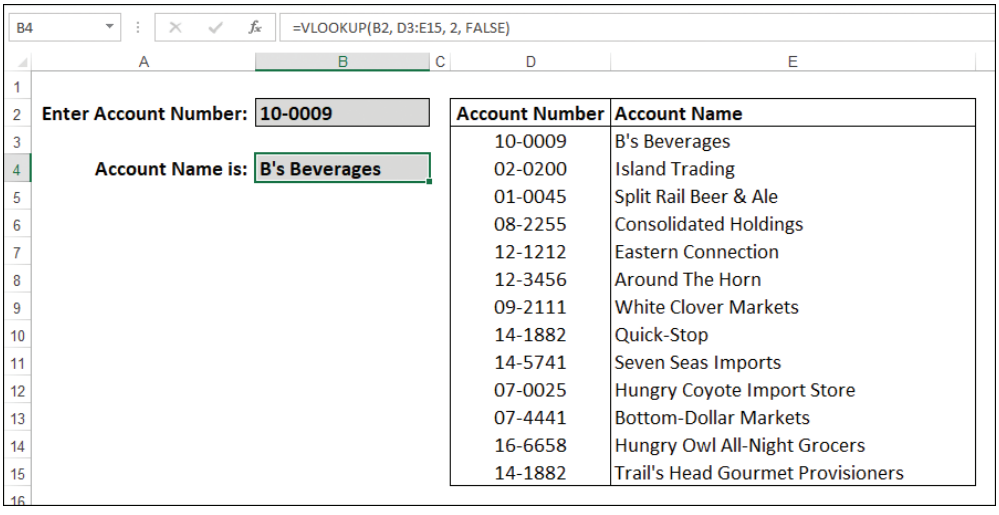
- If *range_lookup* is TRUE or omitted, you must sort the values in the first column in ascending order.
- If the first column of the table is text, you can use the standard wildcard characters in the *lookup_value* argument (use ? to substitute for individual characters; use * to substitute for multiple characters).
- If *lookup_value* is less than any value in the lookup column, VLOOKUP returns the #N/A error value.
- If VLOOKUP doesn't find a match in the lookup column, it returns #N/A.
- If *col_index_num* is less than 1, VLOOKUP returns #VALUE!; if *col_index_num* is greater than the number of columns in *table_array*, VLOOKUP returns #REF!.

As an example, assume that a worksheet uses a VLOOKUP formula in cell B4 to take the account number entered in cell B2, locate the exact match in the first column of the range D3:E15, and return the account name from the second column in that range. The formula would look like this:

=VLOOKUP(B2, D3:E15, 2, FALSE)

The HLOOKUP function is similar to VLOOKUP except that it searches for the lookup value in the first row of a table. (The *H* in HLOOKUP stands for *horizontal*.) If successful, this function then looks down to the specified row and returns the value it finds there. Here's the syntax for HLOOKUP:

HLOOKUP(lookup_value, table_array, row_index_num[, range_lookup])



A formula that uses VLOOKUP to look up an account name given an account number.

The following table describes the HLOOKUP function arguments.

Argument	Description
lookup_value	The value you want to find in the first row of *table_array*. You can enter a number, string, or reference.
table_array	The cell range or named table to use for the lookup.
row_index_num	The row number in the table that contains the data you want the formula to return (the first row—that is, the lookup row—is 1, the second row is 2, and so on).
range_lookup	A Boolean value that determines how Excel searches for *lookup_value* in the first row. If FALSE, HLOOKUP returns the first exact match for *lookup_value*. If TRUE (the default), if no exact match is found, the function returns the largest value that is less than *lookup_value*.

As an example, assume that a worksheet uses an HLOOKUP formula in cell C10 to take the month entered in cell C9, locate the exact match in the first row of the range C1:N7, and return the value from the TOTAL row (the seventh row in that range).

The formula would look like this:

=HLOOKUP(C9, C1:N7, 7, FALSE)

C10 =HLOOKUP(C9, C1:N7, 7, FALSE)

	A	B	C	D	E	F	G	H	I	J	K
1		EXPENSES	January	February	March	April	May	June	July	August	September
2		Advertising	$4,600	$4,200	$5,200	$4,600	$4,200	$5,200	$4,600	$4,200	$5,200
3		Rent	$2,100	$2,100	$2,100	$2,100	$2,100	$2,100	$2,100	$2,100	$2,100
4		Supplies	$1,300	$1,200	$1,400	$1,300	$1,200	$1,400	$1,300	$1,200	$1,400
5		Salaries	$16,000	$16,000	$16,500	$16,000	$16,000	$16,500	$16,000	$16,000	$16,500
6		Utilities	$500	$600	$600	$500	$600	$600	$500	$600	$600
7		TOTAL	$24,500	$24,100	$25,800	$24,500	$24,100	$25,800	$24,500	$24,100	$25,800
8											
9		Month	May								
10		Total	$24,100								
11											

A formula that uses HLOOKUP to look up a monthly expenses total given a month name.

The basic lookup procedure—finding a value in a column or row and then returning an offset value—will satisfy most of your needs. However, a few operations require a more sophisticated approach that makes use of two more lookup functions: MATCH and INDEX.

The MATCH function looks through a row or column of cells for a value. If MATCH finds that value, it returns the relative position of the match in the row or column. Here's the syntax:

MATCH(lookup_value, lookup_array[, match_type])

The following table describes the MATCH function arguments.

Argument	Description
lookup_value	The value you want to find. You can use a number, string, reference, or logical value.
lookup_array	The row or column of cells you want to use for the lookup.
match_type	How you want Excel to match the *lookup_value* with the entries in the *lookup_array*. You have three choices: • 0 finds the first value that exactly matches *lookup_value*. The *lookup_array* can be in any order. • 1 finds the largest value that is less than or equal to *lookup_value* (this is the default value). The *lookup_array* must be in ascending order. • –1 finds the smallest value that is greater than or equal to *lookup_value*. The *lookup_array* must be in descending order.

Tip You can use wildcard characters within the *lookup_value* argument (provided that *match_type* is 0 and *lookup_value* is text). You can use the question mark (?) for single characters and the asterisk (*) for multiple characters.

Normally, you don't use the MATCH function by itself; you combine it with the INDEX function. INDEX returns the value of a cell at the intersection of a row and column inside a reference. Here's the syntax for INDEX:

INDEX(reference, row_num[, column_num][, area_num])

The following table describes the INDEX function arguments.

Argument	Description
reference	A reference to one or more cell ranges.
row_num	The number of the row in *reference* from which to return a value.
column_num	The number of the column in *reference* from which to return a value. You can omit *column_num* if *reference* is a single column.
area_num	If you entered more than one range for *reference*, *area_num* is the range you want to use. The first range you entered is 1 (this is the default), the second is 2, and so on.

The idea is that you use MATCH to get *row_num* and/or *column_num* (depending on how your table is laid out) and then use INDEX to return the value you need.

For example, consider a worksheet that uses a MATCH and INDEX formula in cell B2 to take the part number entered in cell B1, locate the match in the range H6:H13, and return the quantity from the range C6:C13.

The formula would look like this:

=INDEX(C6:C13, MATCH(B1, H6:H13, 0))

B2 =INDEX(C6:C13, MATCH(B1, H6:H13, 0))

	A	B	C	D	E	F	G	H
1	**Part Number**	D-178						
2	**Quantity**	57						
3								
4	**Parts Database**							
5	**Division**	**Description**	**Quantity**	**Cost**	**Total Cost**	**Retail**	**Gross Margin**	**Number**
6	4	Gangley Pliers	57	$10.47	$ 596.79	$17.95	71.4%	D-178
7	3	HCAB Washer	856	$ 0.12	$ 102.72	$ 0.25	108.3%	A-201
8	3	Finley Sprocket	357	$ 1.57	$ 560.49	$ 2.95	87.9%	C-098
9	2	6" Sonotube	86	$15.24	$1,310.64	$19.95	30.9%	B-111
10	4	Langstrom 7" Wrench	75	$18.69	$1,401.75	$27.95	49.5%	D-017
11	3	Thompson Socket	298	$ 3.11	$ 926.78	$ 5.95	91.3%	C-321
12	1	S-Joint	155	$ 6.85	$1,061.75	$ 9.95	45.3%	A-182
13	2	LAMF Valve	482	$ 4.01	$1,932.82	$ 6.95	73.3%	B-047

A formula that uses MATCH and INDEX to look up a quantity given a part number.

To insert a VLOOKUP or an HLOOKUP function into a formula

➜ On the **Formulas** tab, in the **Function Library** group, click **Lookup & Reference**, click **VLOOKUP** or **HLOOKUP**, and then enter the arguments, as described earlier in this topic.

To insert the MATCH and INDEX functions into a formula

1. On the **Formulas** tab, in the **Function Library** group, click **Lookup & Reference**, and then click **INDEX**.
2. In the **Select Arguments** dialog box, click **reference,row_num,column_num,area_num**, then click **OK**.
3. In the **Function Arguments** dialog box, enter the INDEX function arguments, including a MATCH function for the *row_num* and/or *column_num* arguments, and then click **OK**.

Objective 3.2 practice tasks

The practice file for these tasks is located in the **MOSExcelExpert2019 \Objective3** practice file folder. The folder also contains a result file that you can use to check your work.

➤ Open the **ExcelExpert_3-2** workbook and do the following:

- ❑ On the **Tax Rate** worksheet, add a formula to cell B18 that uses the tax table in the range C9:F15 to look up the income entered in cell B17 and return the applicable tax rate.
- ❑ On the **Discount Schedule** worksheet, create formulas in the range D3:D10 that use the discount schedule in the range B13:G14 to look up the units ordered from the range A3:A10 and return the applicable discount percentage.
- ❑ On the **Parts** worksheet, add a formula to cell B3 that uses the range A7:H14 to look up the part number entered in cell B1 and then return the corresponding value from the field entered in cell B2.

➤ Save the workbook.

➤ Open the **ExcelExpert_3-2_results** workbook. Compare the two workbooks to check your work, and then close the open workbooks.

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