Microsoft®

Excel 2013
Core Certification Guide

Lesson 3: Using Formulas

Lesson Objectives

In this lesson, you will learn about formulas—what they are, how they work, how to insert simple formulas and use built-in functions to create some formulas. Upon successful completion of this lesson, you will be familiar with:

☐ what formulas are

☐ how to create and edit simple formulas

☐ how to use math operators and understand the precedent order of calculations

☐ how to reference other worksheets

☐ how to use common functions

☐ how to use the SUBTOTAL function

☐ how to use a conditional function

☐ how to use conditional summary functions

☐ how to use text functions

☐ how to use absolute and relative cell references

☐ how to use mixed absolute and relative cell addresses

☐ how to display and print formulas

☐ how to use data validation

Using Formulas
Creating and Editing Formulas

In Excel, every worksheet cell is capable of using a formula. A formula is simply a calculation involving values, cell references, and/or built-in functions.

Worksheets typically contain formulas that refer to other worksheet cells. It is to your advantage to use cell references in your formulas whenever possible rather than the actual values. When these values or amounts change, the dependent cells (the cells containing the formulas) are automatically recalculated.

A formula can be up to 8,192 characters long. Enter your formula in the cell where you want the results to appear. Formulas are easy to recognize – all of them begin with the equal sign (=).

Suppose you have a worksheet with some formulas:

The formulas used in this worksheet are as follows:

Cell	Formula/Value	Description
A1	10	A constant value – numeric in this case. Every workbook with formulas will usually have at least one constant value.
B1	=A1	References the current value in cell A1. No changes or calculations are done to cell B1. If the value in cell A1 is changed, cell B1 will automatically display the new value.
C1	=A1*8	References the value in cell A1 and multiply it by eight.
D1	=C1/5	References the value in cell C1 and divide it by five. Digits to the right of the decimal point will also be displayed if necessary. Note that if the value in cell A1 changes, then the value in cell C1 will change, which will cause the value in this cell to change in a cascading effect.
E1	=SUM(A1:D1)	References a built-in function called SUM to calculate the sum total of all cells in the range from A1 to D1. Note that if the value in cell A1 changes, then the values in cells B1, C1, and D1 will also change at the same time, which will cause the value in this cell to change as well.

Let's change the value in cell A1. All of the formulas are automatically recalculated and the worksheet will now appear as follows:


This example demonstrates that by using formulas, you can have the computer do all of the work of performing the calculations for you quickly, which is a significant time savings for you. You changed the value in only one cell. Excel knows which sequence to perform all of the calculations, so that all of the results will be correct.

Excel does not display the formula you type into a cell in the worksheet, only the result of the formula. To view the formula, select the cell and you will see the formula and cell references in the formula bar. You can also change a setting to display all formulas in a worksheet. This topic is covered later in this lesson.

You can also copy formulas to other cells. Excel will make a copy of the formula and the format while automatically adjusting cell references for the offset distance and direction. This may appear illogical at first, but it is actually a desirable feature in worksheets because the copied formulas are usually supposed to refer to different sets of input values.

When you are entering formulas in a worksheet, Excel helpfully prompts you when it detects an error or inconsistency in your formula, with a suggestion for how to correct it.

Excel displays a ⊤ symbol for easy identification whenever a formula has changed from a trend in the worksheet. This can be very handy if you have to review the worksheet for differences or discrepancies.
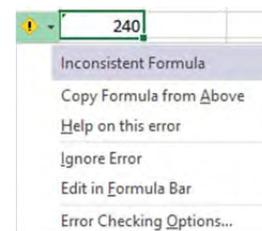
Cell References

Objective 4.1

After pressing the '=' key to start the formula, there are two ways to enter a cell reference:

- type the cell reference (or cell address) directly, or
- click on the cells being referenced.

The majority of formulas have one or more cell references. For example, you may set up a cell with a formula to use the value from another cell, and perform a calculation on it. Cells B1, C1 and D1 in the example worksheet above demonstrate this.

You can also set up another cell with a formula to perform a calculation with two or more cells, such as =A1+B1, or =A1*B1+C4.

A third alternative is to create a formula that uses a function to operate on a range of cells. This is demonstrated in cell E1 in the example worksheet above. A cell range is any rectangular block of cells, written in this format:

<starting cell address>:<ending cell address>

An example of a cell range is C11:E18. Note the use of the ":" to separate the two cell addresses. These cell addresses mark the two opposite corners of the rectangular group of cells. All cells inside this rectangle are used together in the formula.

F19	▾	⁝	✕	✓	*fx*	=SUM(C11:E18)	
	A	B	C	D	E	**F**	
4			Oct	Nov	Dec	Total	
5	Revenues:						
6		Sales	6500	6500	6500		
7		Other Revenues	35	35	35		
8		Total:	6535	6535	6535		
9							
10	Expenses:						
11		Rent	5000	5000	5000		
12		Telephone	150	150	150		
13		Internet	125	125	125		
14		Photocopier	80	80	80		
15		Supplies	250	250	250		
16		Courier	65	65	65		
17		Advertising	250	250	250		
18		Utilities	325	325	325		
19		Total:				18735	

Cell ranges can only be used in functions or arrays, for example =SUM(C11:E18). You can't use a cell range on its own in a formula. The formula =F9+C11:E18 will result in an error in Excel.

The cell range can also be flat with all cells in the same row or column.

You can enter the cell range address in any sequence, as long as you use the cell addresses from the two opposite corners. The follow cell range addresses are equivalent for the same range of cells: C11:E18, E11:C18, C18:E11, E18:C11. Excel will accept every one of these range addresses and will change them to C11:E18, marking the top left and bottom right corner cells.

Cell range addresses can also include entire rows or columns. For example, the formula =SUM(B:C) will calculate the sum total of all values in columns B and C in the worksheet. Similarly, the formula =SUM(3:3) will calculate the sum total of all values in row 3 in the worksheet.

Mathematical Operators

Objective 4.1

The following show the symbols used in Excel to represent the standard mathematical operators:

- **^**   Exponentiation and roots
- *****   Multiplication
- **/**   Division
- **+**   Addition
- –   Subtraction

You generally use formulas to perform calculations, such as ordinary arithmetic. Excel calculates formulas using the standard precedence rule used in mathematics, as follows:

1. Brackets or parentheses
2. Negation (for example -2)
3. Exponents and roots
4. Multiplication and division
5. Addition and subtraction

Multiplication and division operators have the same level of precedence, so Excel performs them in the sequence they appear starting from the left to the right. In the same manner, the addition and subtraction operators are performed as they appear from left to the right.

You can alter this standard order of operation by placing components of the formula within parentheses. Excel will then calculate the portion of the formula in parentheses before defaulting to calculations in the order listed above. Thus, you can control the order of calculations in your formulas with careful use of parentheses.

Learn the Skill

This exercise demonstrates some of Excel's formula capabilities.

1. Open the *Quarterly Income Statement* workbook and save it as `Quarterly Income Statement - Student`. Be sure that the *Quarter 1* worksheet is selected.

2. Select cell **C8** and type: `=c6+c7` (but do not press ⏎ Enter yet).

Excel now shows which cell(s) you selected as part of the formula. You can use this visual tool to see what is happening on the screen when you set up a formula.

4		Jan
5	Revenues:	
6	Sales	6500
7	Other Revenues	35
8	Total:	=c6+c7

3. Press ⏎ Enter to complete the formula.

4. Select cell **C8** again.

In cell **C8**, Excel displays the number *6535*, which is the sum of the numbers in cells C6 and C7. Note the formula displayed in the Formula Bar.

Formula displayed in the
Formula Bar

5   In cell **C7**, type: 125 and press ⎡Enter⎤.

Excel has automatically recalculated the displayed value in cell **C8** because it contains a formula that refers to the values in cells **C6** and **C7**, and a change in either (or both) cells will cause Excel to update the total in cell **C8**. This demonstrates the advantage of using formulas in a worksheet and using a cell reference rather than the cell contents.

6   In cell **D6**, type: 6000 and press ⎡Enter⎤.

This time, the displayed value in cell **C8** does not change when you change the value in cell **D6**. Remember that the formula in cell **C8** has the cell reference to cell **C6**, not **D6**.

Once you enter a formula into the worksheet, you can copy the formula to another location, if the formula operation for the new location is the same. For instance, you can use the same formula to calculate the total revenues for each of the next two months, except that you must use the respective cells for each of those two months. Rather than entering the formula in each of the two cells twice, you can simply copy the formula.

7   Select cell **C8** and, on the Home tab, in the Clipboard group, click **Copy**.

8   Select cells **D8** to **E8** and, on the Home tab, in the Clipboard group, click **Paste**.

If you change a value in a referenced cell, all cells that depend on that value will also change.

9   Select each of the cells in the range **C8** to **E8**.

Notice that Excel has adjusted the formula in each of these cells. This is called *relative addressing*.

Now enter a similar formula, this time adding across three columns.

10   Select cell **F4** and enter: Total.

11   Select cell **F6** and enter: =C6+D6+E6.

12   Select cell **F6** again and copy this formula down to cells **F7** to **F8**.

If a value is changed in one cell, Excel will recalculate all formulas that directly or indirectly reference this cell automatically.

13   In cell **E7**, type: 80 and press ⎡Enter⎤.

14   On the Quick Access Toolbar, click **Undo** to see that the displayed values in cells **E7**, **E8**, **F7** and **F8** change back to their previous values.

15   On the Quick Access Toolbar, click **Redo** to re-apply the change in cell **E7**.

	A	B	C	D	E	F
1	Tolano Adventures					
2	Department Budget					
3						
4			Jan	Feb	Mar	Total
5	Revenues:					
6		Sales	6500	6000	6500	19000
7		Other Revenues	125	35	80	240
8		Total:	6625	6035	6580	19240
9						
10	Expenses:					
11		Rent	5000	5000	5000	
12		Telephone	150	150	150	
13		Internet	125	125	125	
14		Photocopier	80	80	80	
15		Supplies	250	250	250	
16		Courier	65	65	65	
17		Advertising	250	250	250	
18		Utilities	325	325	325	
19		Total:				
20						

Company   **Quarter 1**   Quarter 2   Quarter 3

Repeat these same formulas in the other quarterly worksheets.

16 Select cell **C8** and, on the Home tab, in the Clipboard group, click **Copy.**

17 Select the *Quarter 2* worksheet, then select cells **C8** to **E8** and, on the Home tab, in the Clipboard group, click **Paste**.

18 Select the *Quarter 1* worksheet, then select cells **F4** to **F8** and, on the Home tab, in the Clipboard group, click **Copy.**

19 Select the *Quarter 2* worksheet, then select cell **F4** and, on the Home tab, in the Clipboard group, click **Paste**.

20 Repeat steps 16 to 19 for the two remaining quarterly worksheets: *Quarter 3* and *Quarter 4*.

The series of steps from 16 to 20 demonstrates one way of copying formulas from one worksheet to others. The same end result can be achieved using fewer mouse clicks by doing step 16 first, then repeating step 17 for all three quarterly worksheets. Then do step 18, and repeat step 19 for the same three worksheets. You can then do step 20. This may be faster because all you have to do is copy once and paste three times (once for each worksheet). With more experience in copying and pasting, you will find your own shortcuts to make tasks easier.

21 Save and close the workbook.

What If Analysis

Spreadsheets can easily perform calculations such as simple arithmetic (such as add and multiply) on a large volume of numbers. You don't need an expensive computer to do this type of task. It can be done easily even with a basic calculator because the problem only needs to be solved once and then the task is completed.

Spreadsheets become invaluable when you need to perform what-if analysis, which involves repeating the calculation of a set of formulas many times using different numbers. The trial-and-error method of doing calculations is commonly used when there are multiple competing demands, and users try to find the best compromise between the many choices to make. The name "what-if" describes the thinking process that users face: "what if I change this number, then what will the result look like".

A spreadsheet created to perform what-if analysis often uses simple formulas, although there will usually be a large number of formulas.

Learn the Skill

This exercise demonstrates Excel's formula capabilities in helping with what-if analysis.

Imagine that you are a prospective first-time home-buyer. This worksheet will help you determine how large a mortgage you can assume given your current income level and spending priorities. Many financial institutions rely on two calculations when deciding whether to approve a mortgage application: the gross debt service and the total debt service. The gross debt service is the percentage of gross income required to cover the basic costs of a house, including mortgage payments (principal and interest), property taxes, heating, and condo fees. The total of this cannot exceed 32% of the buyer's gross income. The total debt service is the percentage of gross income required to cover the house and all other debts, such as credit card payments and car loans. This percentage cannot exceed 40% of the buyer's gross income.

1 Open the *Personal Budget* workbook and save it as `Personal Budget - Student`.

First, calculate your monthly take home pay by reducing the monthly gross salary by 25%. This calculation assumes that income taxes and other payroll deductions add up to 25% of your gross pay. You need both your gross pay and take home pay amounts for these calculations.

2 Select cell **B4**, type: `=b3*0.75` and press `Enter`.

Now calculate the excess of your take home pay over your expenses, which you accumulate as savings in a bank account.

3 Select cell **B22**, type: `=b4-b20` and press `Enter`.

At first glance, you appear to be ready to apply for a mortgage to buy your very first home! It seems very reasonable that your current rent payments will become the new monthly mortgage payment, and you can afford a home in that price range.

4 Select cell **A7**, type: `Mortgage payments` and press `Enter`.

After looking at some homes, you can now estimate your property taxes and monthly condominium fees.

5 Select cell **B8**, type: 125 and press `Enter`.

6 Select cell **B9**, type: 100 and press `Enter`.

Your income can no longer cover all of your expenses. You will have to cut back some of your expenses.

7 Select cell **B17**, type: 100 and press `Enter`.

8 Select cell **B14**, type: 100 and press `Enter`.

Your cost cutting will have to include getting a smaller mortgage.

9 Select cell **B7**, type: 1285 and press `Enter`.

With your monthly expenses now under control, calculate the mortgage qualification ratios.

10 Select cell **D3**, type: `=A7` and press `Enter`.

Notice that you can make a cell reference to a cell containing a text value, as demonstrated here.

11 Select cell **E3**, type: `=B7` and press `Enter`.

Alternatively, you can copy the formula from cell **D3** to cell **E3**. Excel will automatically adjust the formula to reference the next cell to the right.

12 Enter the following formulas in the specified cells:

D4	=A8
D5	=A9
D6	=A15
D7	Total housing costs
D8	Ratio (max 32%)

Steps 10 to 12 demonstrate using formulas to copy values from one cell to another. In this group of cells, selected numbers are taken from the personal budget and used for another calculation in a formula entered in step 15 below. If the numbers in the personal budget are changed, these calculations are updated at the same time.

13 Select cells **D4** to **D6** and, on the Home tab, in the Clipboard group, click **Copy**.

14 Select cell **E4** and, on the Home tab, in the Clipboard group, click **Paste**.

15 Enter the following formulas in the specified cells:

E7	=E3+E4+E5+E6
E8	=E7/B3

You calculate the gross debt service as 39% (0.39), which is higher than the maximum allowable 32%. Now calculate the total debt service ratio.

16 Enter the following formulas in the specified cells:

D12	=D7
D14	=A11
D15	=A18
D16	=A19
D17	Total debt costs
D18	Ratio (max 40%)

17 Copy the contents of cell **D12** to cell **E12**.

18 Select cells **D14** to **D16**, then click the AutoFill handle (✚) in the bottom right corner of this block and drag it across to column **E**.

19 Enter the following formulas in the specified cells:

E17	=E12+E14+E15+E16
E18	=E17/B3

You have calculated the total debt ratio as 55.25% (0.5525)—much higher than the maximum allowable 40%. You have too many debt (and other mandatory) payments to make every month to qualify for this mortgage. You will need to make more adjustments in your lifestyle to qualify for a mortgage, such as reducing or paying off your credit card debt, student loans, and car payments. You should also consider looking for ways to increase your monthly income, such as changing to another job with higher pay.

This is an unexpected surprise: your personal budget indicates that you can afford the mortgage payments, but your financial institution requires two additional calculations to determine your eligibility. These calculations seem unreasonable, but are in fact designed to prevent prospective home buyers from accumulating more debt than they can handle, which may result in serious financial problems in the future and possibly even personal bankruptcy or mortgage foreclosure.

Let's assume that you delay buying your new home for several months and concentrate on paying off debts. You were also able to improve your income by another $100 a month. Lastly, you reluctantly lowered your expectations for a home, settling for a less expensive one.

20 Enter the following values in the specified cells:

B19	100
B18	0
B7	1000
B3	4100

This income level is still not enough. Your Gross Debt Service Ratio (cell E8) is 31%, which is below the maximum allowable rate of 32%. However, your Total Debt Service Ratio (cell E18) is 40.8%, which is higher than the maximum allowable rate of 40%.

Let's assume that you are able to increase your income by another $100 a month.

21 Change the contents of cell **B3** again to: 4200.

This demonstrates how you can use cell references very effectively in what-if analyses. The spreadsheet contains many formulas, but they are calculated very quickly so that you can see the results when adjustments are made. With these changes, you will be able to apply for a mortgage and be confident that your application will be successful.

The completed worksheet should look similar to the following:

	A	B	C	D	E
1	Personal Budget				
2				Gross Debt Service:	
3	Monthly Gross Salary	4200		Mortgage payments	1000
4	Monthly Take Home Pay	3150		Property taxes	125
5				Condo monthly fee	100
6	Expenses:			Heat & electricty	50
7	Mortgage payments	1000		Total housing costs	1275
8	Property taxes	125		Ratio (max 32%)	0.303571
9	Condo monthly fee	100			
10	Food	250			
11	Car payments	300		Total Debt Service:	
12	Car insurance	150		Total housing costs	1275
13	Parking	130		Other debts:	
14	Clothing	100		Car payments	300
15	Heat & electricty	50		Student loan payments	0
16	Phone	60		Credit card payments	100
17	Entertainment	100		Total debt costs	1675
18	Student loan payments	0		Ratio (max 40%)	0.39881
19	Credit card payments	100			
20	Total Expenses	2465			
21					
22	Savings/Withdrawals	685			

22 Save and close the workbook.

Referencing Other Worksheets

Objective 4.1

In addition to referencing other cells within the same worksheet, formulas can reference cells in other worksheets within the same workbook. The general format of this kind of reference is:

'<worksheet name>'!<cell reference>

Excel uses the ! symbol to indicate that this cell is located in a different worksheet. The single quotes are required if the worksheet name has blank spaces in it.

Furthermore, you can also use cell references for cells located in a different workbook. This topic will be covered in the Expert level courseware.

Learn the Skill

This exercise demonstrates how to create formulas that reference cells located in other worksheets.

1 Open the *Quarterly Income Statement - Student* workbook.

2 Click the *Company* worksheet tab to make it the active worksheet.

3 In cell **C4**, type: Qtr 1 and press [Enter].

4 In cell **C6**, type: = (but do not press [Enter] yet).

5 Click the *Quarter 1* worksheet and select cell **F6**.

   Notice that a marquee now appears around cell **F6** and the formula bar shows ='*Quarter 1'!F6* with single quotes around the worksheet name.

6 Press [Enter].

7 Copy the contents of cell **C6** (in the *Company* worksheet) to cells **C7** to **C8** using your preferred method.

   Notice that Excel automatically adjusts only the cell reference part, while keeping the worksheet reference component unchanged.

8 Select cell **C4**. Then click the AutoFill handle (✚) in the bottom right corner and drag it across the worksheet to column **F**.

9 Repeat steps 4 to 7 for the other three quarters in columns **D** to **F**.

	A	B	C	D	E	F
1	Tolano Adventures					
2	Quarterly Income Statement					
3						
4			Qtr 1	Qtr 2	Qtr 3	Qtr 4
5	Revenues:					
6		Sales	19000	19500	19500	19500
7		Other Revenues	240	105	105	105
8		Total:	19240	19605	19605	19605
9						
10	Expenses:					
11		Rent				
12		Telephone				
13		Internet				

10 Save the workbook.

Using Functions
Common Excel Functions

Objective 4.2

Typing cell addresses and plus signs is a good method when you are adding the contents of a small number of cells. However, if you need to sum up a column of 50 numbers, this method is time-consuming and will soon exceed the maximum limits on cell contents. It would be very inefficient to enter something like "=B1+B2+B3+B4+...B50" for each cell you want to include.

Excel provides a large library of built-in functions to facilitate this and other types of mathematical and data operations. These functions enable the calculation of long or complex formulas to be simplified by using a specialized function. In this courseware, you will learn the most commonly used functions as well as some more complex ones.

An Excel function follows this general format:

=FUNCTION(arguments)

At first, it may appear that the number and variety of Excel functions is intimidating. The most commonly used ones are similar to each other, and very easy to use. The functions you will learn in this lesson are:

=SUM	Sum the range of specified cells.
=AVERAGE	Average the specified cells (total the range and divide the total by the number of entries).
=MIN	Display the minimum value of specified cells.
=MAX	Display the maximum value of specified cells.
=COUNT	Count the number of cells in the specified range that contain numeric values.

The Excel Expert courseware examines many of the other functions available.

There are some general rules to understand regarding the arguments used in the functions:

• Functions accept values (numeric, text or date, depending on the type of function) and cell references as arguments within parentheses. Each function has specifications for its arguments but the most common type of argument is a cell range. The format of the cell range is as follows:

<first cell address>:<last cell address>
Examples:
A10:B15
D25:B5
C5:C25

• Many functions allow you to enter a variable number of arguments. For example:

=SUM(C6:C18) – calculates the sum of the numbers in all cells from C6 to C18

=SUM(C6:C18,D6:D18,F6:F18) – calculates the sum of the numbers in all cells from C6 to C18, and D6 to D18, and F6 to F18

=SUM(C6:C18,C20) – calculates the sum of the numbers in all cells from C6 to C18, and cell C20

You can enter a cell range either by typing the cell reference(s) directly, or by using the pointing method. To use the pointing method, simply use the mouse to click on the first cell and drag to the last cell to select the cell range. The latter method has the advantage of visually identifying the cell range, which reduces the possibility of entering incorrect cell references.

An alternative to entering the SUM function into a cell is to use the AutoSum button in the Ribbon. Because the SUM function is so commonly used, Excel provides three ways of activating it:

• On the Formulas tab, in the Function Library group, click **AutoSum** ($\sum$ AutoSum), or

• on the Home tab, in the Editing group, click **AutoSum** ($\sum$ AutoSum).

• You can also click **Insert Function** on the left of the formula bar.

Note: If the Excel window is in Maximize view, this command appears as AutoSum. If the window is in Restore view, this may appear as just an icon because the window is not wide enough to display the whole button.

When using AutoSum, be sure to verify that you have selected the correct cell range. Excel will automatically select the range of cells immediately above or to the left of the selected cell, and display it for you to accept or change.

Notice that there is an arrow next to AutoSum. When you click the arrow, it will display other summary functions that you can use in your formulas.
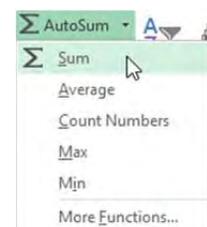
Learn the Skill

This exercise demonstrates how to calculate the sum total of a row or column of numbers.

1   Ensure the *Quarterly Income Statement - Student* workbook is open.

2   Click the *Quarter 1* worksheet tab and select cell **C19**.

3   On the Home tab, in the Editing group, click **AutoSum**.

Notice that the cell now shows *=SUM(C11:C18)*, with the cell range **C11:C18** highlighted, and a marquee around that cell range. Excel also reminds you of other ways to enter this formula using individual data values.

	A	B	C	D	E	F
1	Tolano Adventures					
2	Department Budget					
3						
4			Jan	Feb	Mar	Total
5	Revenues:					
6		Sales	6500	6000	6500	19000
7		Other Revenues	125	35	80	240
8		Total:	6625	6035	6580	19240
9						
10	Expenses:					
11		Rent	5000	5000	5000	
12		Telephone	150	150	150	
13		Internet	125	125	125	
14		Photocopier	80	80	80	
15		Supplies	250	250	250	
16		Courier	65	65	65	
17		Advertising	250	250	250	
18		Utilities	325	325	325	
19		Total:	=SUM(C11:C18)			
20			SUM(number1, [number2], ...)			
21						

4   Press (Enter) to accept the formula as displayed.

Excel always includes the cell immediately above the active cell, even if it is blank, and extends up the current column until it finds a blank cell. There are still numbers in the cells above the selected range, but they are not automatically included because there is at least one blank cell between them. You can manually extend the range to include additional cells.

5   Select cell **C19** again and copy it to cells **D19** to **E19**.

6   Select cell **F11** and type: =SUM(but do not press (Enter) yet.

Note: You may enter cell references and the function name in lower or upper case characters. Excel will convert them all to upper case.

7   Use the mouse to select the cell range **C11** to **E11.** Then press (Enter).

In this case, Excel permits you to omit entering the last parenthesis for this function. However, Excel does not always permit this, and it is poor practice.

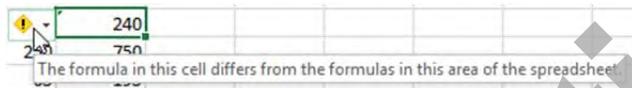**8**   Select cell **F11** again and copy it to cells **F12** to **F19**.

Other arithmetic operations can be performed in a formula such as multiplication. If a cell contains a formula that is different from the cells around it (if any), Excel displays a marker symbol.

9   Select cell **F14**.

**10**   Type: =C14+D14+E14 and press (Enter).

The worksheet should look similar to the following example:

	A	B	C	D	E	F
1	Tolano Adventures					
2	Department Budget					
3						
4			Jan	Feb	Mar	Total
5	Revenues:					
6		Sales	6500	6000	6500	19000
7		Other Revenues	125	35	80	240
8		Total:	6625	6035	6580	19240
9						
10	Expenses:					
11		Rent	5000	5000	5000	15000
12		Telephone	150	150	150	450
13		Internet	125	125	125	375
14		Photocopier	80	80	80	240
15		Supplies	250	250	250	750
16		Courier	65	65	65	195
17		Advertising	250	250	250	750
18		Utilities	325	325	325	975
19		Total:	6245	6245	6245	18735

Note the ⊢ symbol in cell **F14**. This marker is a reminder that this cell contains a formula that is different from the cells around it. It is not an error symbol because the different formula may be intentional. To remove the symbol, click on the smart tag.

11 Select cell **F14** again, position the mouse over the smart tag, click the arrow and select **Ignore Error**.
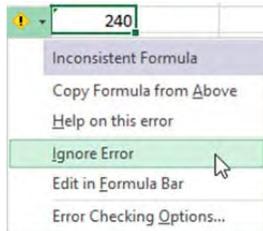
12 Select cell **C19** again and copy it to cells **C19** to **E19** in worksheets *Quarter 2*, *Quarter 3*, and *Quarter 4*.

13 Select cell **F11** in the *Quarter 1* worksheet again and copy it to cells **F11** to **F19** in worksheets *Quarter 2*, *Quarter 3* and *Quarter 4*.

14 Save and close the workbook.

There is no need to be concerned about the look of your worksheet. At this point, it is important to make sure the data is accurate. Enhancing the look of the worksheet can take place later. We will look at formatting in the next lesson.

Using the Subtotal Function

Objective 2.3

The SUM function calculates an arithmetical total of the selected cell range. In most situations, it is the appropriate function for automatically adding together the value in multiple cells.

In some worksheets, you may already have SUM functions included in the data to calculate the subtotals for subgroups of data. In these situations, it may be more appropriate to use the SUBTOTAL function.

The SUBTOTAL function does more than calculate a sum total for a range of cells. It actually performs a variety of statistical operations, depending on which function number is used. The general format of the SUBTOTAL function is:

=SUBTOTAL(Function #, Cell Range)

The most commonly used function numbers are:

Function #	Function
1	AVERAGE—mean average of the cell range
2	COUNT—number of cells containing numeric values
3	COUNTA—number of non-blank cells
4	MAX—highest value in the cell range
5	MIN—lowest value in the cell range
9	SUM—sum total of the cell range

Other function numbers that are also available for SUBTOTAL are:

Function #	Function
6	PRODUCT (all numbers multiplied together)
7	STDEV.S (standard deviation based on a sample)
8	STDEV.P (standard deviation based on entire population)
10	VAR.S (variance based on a sample)
11	VAR.P (variance based on entire population)

The primary advantage of SUBTOTAL over SUM is that it will not include any other SUBTOTAL calculations within its range. As a result, you can insert subtotal, total, and grand total calculations into a table—without any risk of accidentally double-counting a subtotal—by simply including the entire range of cells.

To insert the SUBTOTAL function, use one of the following methods:

- Click **Insert Function** and then, in the Or select a category field, click **Math & Trig**, or
- on the Formulas tab, in the Function Library group, click **Math & Trig**, or
- type the formula directly into the cell.

Learn the Skill

This exercise demonstrates the use of the SUBTOTAL function.

1 Open the *Weekly Expense Report* workbook and save it as Weekly Expense Report – Student.

First, use the traditional SUM function to calculate the subtotal values in column **C**.

2 Select cell **C6** and then, on the Home tab, in the Editing group, click **AutoSum**. Verify that only cell **C5** is selected as the argument for the SUM function and press Enter.

3 Select cell **C9** and then, on the Home tab, in the Editing group, click **AutoSum**. Verify that only cell **C8** is selected as the argument for the SUM function and press Enter.

4 Select cell **C13** and then, on the Home tab, in the Editing group, click **AutoSum**. Verify that both expense values in the cells above are selected and press Enter.

5 Repeat either step 3 or 4 (depending on whether there is one or two values to add together) for each of the remaining subtotal cells in cells **C17**, **C21**, **C24**, **E6**, **E9**, **E13**, **E17**, **E21**, and **E24**.

	A	B	C	D	E	F	G
1	Tolano Adventures						
2	Weekly Expense Report						
3			SUM		SUM +		SUBTOTAL
4	Office	Travel Director	Expenses		Expenses		Expenses
5	Cape Town	Jamie Gibson	122.05		122.05		122.05
6	Subtotal for Cape Town		122.05		122.05		
7							
8	London	Andrew McSweeney	234.62		234.62		234.62
9	Subtotal for London		234.62		234.62		
10							
11	New York	Madison Cowell	178.92		178.92		178.92
12	New York	Nick Klassen	199.25		199.25		199.25
13	Subtotal for New York		378.17		378.17		
14							
15	Sydney	Curtis Gorski	82.54		82.54		82.54
16	Sydney	Lawrence Jang	101.76		101.76		101.76
17	Subtotal for Sydney		184.30		184.30		
18							
19	Tokyo	Christie Akira	287.92		287.92		287.92
20	Tokyo	Kanda Yamoto	274.10		274.10		274.10
21	Subtotal for Tokyo		562.02		562.02		
22							
23	Toronto	Toby Belanger	164.29		164.29		164.29
24	Subtotal for Toronto		164.29		164.29		
25	Grand Total - All Offices						
26	Average						
27	Count						
28	Highest						
29	Lowest						

Up to this point, both columns C and D have been identical. The subtotal values have been calculated for each travel office. You will now try to calculate the grand total for all offices.

To do this, you will deliberately create an incorrect grand total for column C, which you will use for comparative purposes.

6 Select cell **C25** and then, on the Home tab, in the Editing group, click **AutoSum**. Select cells **C5:C24** and press ⎡Enter⎤.

7 Enter the following formulas:

Cell	Formula
C26	=AVERAGE(C5:C24)
C27	=COUNT(C5:C24)
C28	=MAX(C5:C24)
C29	=MIN(C5:C24)

Now enter the correct formulas for column E. The grand total of =SUM(E6,E9,E13,E17,E21,E24) calculates based only on the subtotal values.

8 Select cell **E25** and then, on the Home tab, in the Editing group, click **AutoSum**.

To select individual cells instead of the full range as you did in step 6, you must use the ⎡Ctrl⎤ key.

9 Select cell **E6**, hold down the ⎡Ctrl⎤ key, and then click on each of cells **E9**, **E13**, **E17**, **E21**, and **E24**. Release the ⎡Ctrl⎤ key and press ⎡Enter⎤.

Notice that the grand total in column E is half of the grand total in column C. This demonstrates that the latter value is double-counting everything in column C.

Now calculate the average weekly expense for all employees

10 Select cell **E26** and enter the following formula:

Cell	Formula
E26	=AVERAGE(E5,E8,E11,E12,E15,E16,E19,E20,E23)

Note that the cells in this AVERAGE function are not the same as for the SUM function above. The average is calculated using each individual person's expense amount, not the subtotal for the office.

11 Enter the rest of the summary formulas:

Cell	Formula
E27	=COUNT(E5,E8,E11,E12,E15,E16,E19,E20,E23)
E28	=MAX(E5,E8,E11,E12,E15,E16,E19,E20,E23)
E29	=MIN(E5,E8,E11,E12,E15,E16,E19,E20,E23)

As you can see, steps 10 and 11 were painful—they were tedious and error-prone.

Alternatively, you can repeat steps 8 and 9 to use the **AutoSum** button in the Ribbon to make it easier: click the arrow for **AutoSum**, select the desired summary function, then use the Ctrl key to select each of these cells.

Note: For step 11, you can also copy the AVERAGE formula from cell E26 to these cells, and change the function name. You will need to change the cell references to absolute cell references before copying it. Absolute cell references are covered later in this lesson.

	A	B	C	D	E	F	G
1	Tolano Adventures						
2	Weekly Expense Report						
3			SUM		SUM +		SUBTOTAL
4	Office	Travel Director	Expenses		Expenses		Expenses
5	Cape Town	Jamie Gibson	122.05		122.05		122.05
6	Subtotal for Cape Town		122.05		122.05		
7							
8	London	Andrew McSweeney	234.62		234.62		234.62
9	Subtotal for London		234.62		234.62		
10							
11	New York	Madison Cowell	178.92		178.92		178.92
12	New York	Nick Klassen	199.25		199.25		199.25
13	Subtotal for New York		378.17		378.17		
14							
15	Sydney	Curtis Gorski	82.54		82.54		82.54
16	Sydney	Lawrence Jang	101.76		101.76		101.76
17	Subtotal for Sydney		184.30		184.30		
18							
19	Tokyo	Christie Akira	287.92		287.92		287.92
20	Tokyo	Kanda Yamoto	274.10		274.10		274.10
21	Subtotal for Tokyo		562.02		562.02		
22							
23	Toronto	Toby Belanger	164.29		164.29		164.29
24	Subtotal for Toronto		164.29		164.29		
25	Grand Total - All Offices		3290.90		1645.45		
26	Average		219.39		182.83		
27	Count		15		9		
28	Highest		562.02		287.92		
29	Lowest		82.54		82.54		

Now use the SUBTOTAL function and see how it works.

12 Select cell **G6** and enter: =SUBTOTAL(9,G5).

13 Now enter the remaining subtotal formulas:

Cell	Formula
G9	=SUBTOTAL(9,G8)
G13	=SUBTOTAL(9,G11:G12)
G17	=SUBTOTAL(9,G15:G16)
G21	=SUBTOTAL(9,G19:G20)
G24	=SUBTOTAL(9,G23)

Note that you can select the cell or cell range instead of typing the cell reference addresses into the function, if that is easier for you.

14 Select cell **G25** and enter: =SUBTOTAL(9,G5:G24).

Enter the remaining statistical functions using SUBTOTAL.

15 Enter the following formulas:

Cell	Formula
G26	=SUBTOTAL(1,G5:G24)
G27	=SUBTOTAL(2,G5:G24)
G28	=SUBTOTAL(4,G5:G24)
G29	=SUBTOTAL(5,G5:G24)

Step 15 was much easier to do than step 10 because you simply selected the entire cell range in the column (including the grand total). The SUBTOTAL function simply ignored the presence of any other SUBTOTAL function within that cell range. As a result, column G shows the same results as column E. It was just as easy in column C to enter those formulas, but the results were incorrect.

	A	B	C	D	E	F	G
1	Tolano Adventures						
2	Weekly Expense Report						
3			SUM		SUM +		SUBTOTAL
4	Office	Travel Director	Expenses		Expenses		Expenses
5	Cape Town	Jamie Gibson	122.05		122.05		122.05
6	Subtotal for Cape Town		122.05		122.05		122.05
7							
8	London	Andrew McSweeney	234.62		234.62		234.62
9	Subtotal for London		234.62		234.62		234.62
10							
11	New York	Madison Cowell	178.92		178.92		178.92
12	New York	Nick Klassen	199.25		199.25		199.25
13	Subtotal for New York		378.17		378.17		378.17
14							
15	Sydney	Curtis Gorski	82.54		82.54		82.54
16	Sydney	Lawrence Jang	101.76		101.76		101.76
17	Subtotal for Sydney		184.30		184.30		184.30
18							
19	Tokyo	Christie Akira	287.92		287.92		287.92
20	Tokyo	Kanda Yamoto	274.10		274.10		274.10
21	Subtotal for Tokyo		562.02		562.02		562.02
22							
23	Toronto	Toby Belanger	164.29		164.29		164.29
24	Subtotal for Toronto		164.29		164.29		164.29
25	Grand Total - All Offices		3290.90		1645.45		1645.45
26	Average		219.39		182.83		182.83
27	Count		15		9		9
28	Highest		562.02		287.92		287.92
29	Lowest		82.54		82.54		82.54

16 Save and close the workbook.

Conditional Functions

The ability to perform different calculations based on changing values is one of the most powerful and useful features of spreadsheets. The primary function used for this is the IF function. This function makes an evaluation or logical test and performs one of two different calculations based on the result. This automatic evaluation provides "on the fly" conditional worksheet calculations.

The format of the IF function is as follows:

=IF(logical test,value if true,value if false)

Logical Test	Specify what the IF statement will evaluate.
Value if True	If the Logical Test is found to be true, then the result of the IF function will be whatever is in this section of the formula.
Value if False	If the Logical Test is found to be false, then the result of the IF function will be whatever is in this section of the formula.

The Logical Test section of the function often uses comparison operators that will help you obtain the desired result. Qualifiers are punctuation marks used to identify or define different types of data. For example, text used in a formula requires double quotes as qualifiers.

Some of the comparison operators you can use are:

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

The Value if True/False sections can contain a text string, values or even other functions. In fact, you can nest or embed up to 64 IF functions within one IF function. An example of a nested IF function would appear as follows:

=IF(A1=10, "text A",IF(A1=20, "text B", "text C"))

In this example, Excel will display the following values when the conditions are met:

If A1 contains	Then this will display
10	text A
20	text B
Any other value	text C

Learn the Skill

This exercise demonstrates how to use the IF function

You will use a worksheet that will calculate the number of travel points given to customers based on the amount they spend. For every dollar a customer spends, the program awards 100 AirKm points. In addition, the program awards customers an additional 20 points for every dollar if the total amount is over $500.

1 Open the *AirKm Awards* workbook and save it as *AirKm Awards - Student*.

First, calculate the number of points per dollar.

2 Select cell **D5**, type: =C5*100 and press `Enter`.

3 Select cell **D5** again and copy it down to cells **D6** to **D20**.

Now calculate the bonus points per dollar, but only do this where the amount is greater than 500.

4 Select cell **E5**, and click **Insert Function**.

5 In the Or select a category list, click **Logical**.

6 In the **Select a function** list, click **IF** and click **OK**.

Excel displays the Function Arguments dialog box to help you enter the correct arguments for this function. You will base the conditional on the cost of travel, which is in cell C5, and must be over 500.

7 In the Logical_test field, type: C5>500.

The next section is the Value_if_true section. If the result of the conditional test (C5 > 500 in this case) is true, Excel will return the value in this box to the worksheet cell. In this case, the value has to be calculated.

8 In the Value_if_true field, type: C5*20.

The last part of the function is the Value_if_false section. If the result of the conditional test is false, Excel will return this value. In this case, the value would be zero.

9   In the Value_if_false field, type: 0.

10 Click **OK**.

Note that the resulting formula is =IF(C5>500,C5*20,0).

Since the calculated value could result in a decimal value, you can use an additional rounding function to round the value up or down to the nearest whole number. You can accomplish this by embedding the IF function inside the ROUND function.

11 In cell **E5**, press F2.

12 Move the cursor inside the cell to the left, to a position between the = and IF, and type: ROUND(

13 Press the End key, type: ,0) and press Enter.

=ROUND(IF(C5>500,C5*20,0),0)

14 Copy the formula from cell **E5** to cells **E6:E20**.

Bonus points are now calculated only if the amount in column B is greater than $500.

15 Save the workbook.

You can modify your IF function if you want a more presentable worksheet. For example, if you want the IF formula to show a blank cell instead of zeros or dashes when the amount is $500 or less, modify the formula to appear as follows:

=ROUND(IF(C5>500,C5*20,""),0)

The set of double quotes will cause Excel to insert a blank in any cell that proves FALSE based on the argument in the Logical_test.

To have either example work properly, remember to copy the changed formula to the other cells on the worksheet.

When using the Insert Function, Excel will insert the quotes for you when entering text in the Value if True/False fields. When you want either of these fields to be blank, you must type both quotation marks or the word True or False will appear in the cell.

Using Conditional Summary Functions

Objective 4.3

The summary functions AVERAGE, COUNT, and SUM will simply perform the calculations on a range of cells. The conditional function IF allows you to perform one of two different calculations, depending on the results of a logical test. These two can be combined together into what are known as conditional summary functions: AVERAGEIF, COUNTIF, and SUMIF.

AVERAGEIF	Calculate the average value of all cells in a range which meet the logical test. The format of this function is as follows: AVERAGEIF(criteria_range, logical_test, average_range) The average range is optional. If it is not specified, it is assumed to be the same as the criteria range.
COUNTIF	Count the number of cells in a range that contain a non-blank value and meet the logical test. COUNTIF(criteria_range, logical_test)
SUMIF	Calculate the sum total of all cells in a range which meet the logical test. SUMIF(criteria_range, logical_test, sum_range) The sum range is optional. If it is not specified, it is assumed to be the same as the criteria range.

An example of a conditional summary function is:

=SUMIF(D4:D207,"Visa",F4:F207)

In this function, the criteria range is D4 to D207, the sum range is F4 to F207, and the logical test is "Visa". Therefore, Excel will examine each of the cells in the range D4 to D207. If the cell contains the value "Visa," the corresponding numeric value in the cell range F4 to F207 will be included in the sum total.

These functions are different from the IF function in that a more flexible logical test is used. With an IF function, you can only specify one logical test which must result in a TRUE or FALSE value, and this generally requires the use of a comparison operator.

A conditional summary function will apply the logical test to <u>each</u> and <u>every</u> cell in the range you specify (D4 to D207 in the example above). And if you do not specify a comparison operator, Excel will assume you want to use the "=" operator, for example, =SUMIF(D4:D207,"=Visa",F4:F207) is the same as =SUMIF(D4:D207,"Visa",F4:F207).

The logical test may be a fixed value or a cell reference. The SUMIF formula above is an example of a fixed value test by comparing each cell in the range D4 to D207 to determine if it is equal to the value of "Visa". An example of a cell reference is =SUMIF(E4:E207,">"&B2). Notice that only the comparison operator is inside double-quotes, and the cell reference must be preceded by the & symbol.

The average_range and sum_range are optional. For the AVERAGEIF and SUMIF functions, you can perform the logical test on one cell range, and perform the AVERAGE or SUM calculation on a different cell range. This option makes these functions more flexible to use.

Learn the Skill

This exercise demonstrates the use of conditional summary functions.

1   Select the *AirKm Awards – Student* workbook.

Enter text into cells to help identify the function of the first set of conditional formulas.

2   Enter the following text into cells:

Cell	Text
G5	Sales Over $500
G6	Total Sales Over $500
G7	Avg Sales Over $500

Now enter the conditional summary formulas.

3   Enter the following formulas into cells:

Cell	Text
H5	=COUNTIF(C2:C20,">500")
H6	=SUMIF(C2:C20,">500")
H7	=AVERAGEIF(C2:C20,">500")

If you want to enable an advanced feature of these conditional summary functions, you can enter the logical test into worksheet cells instead of into each of the formulas. For example, suppose cell **H5** has the formula =COUNTIF(C2:C20,G15), and cell **G15** contained the text string >500. Referencing a cell that contains the test criteria makes it easier to change the logical test and avoid forgetting to change a function that contains the test criteria.

Notice that the SUMIF and AVERAGEIF conditional formulas used here perform their calculations on the same column in which the test criteria are applied. In other words, these formulas select only those cells that meet the stated criteria and then perform the COUNT, SUM, and AVERAGE on only those cells. The significance of this will become clearer as you examine the next set of conditional formulas.

Now enter conditional summary formulas that pertain only to rows where the sales type is "Corporate."

4   Enter the following text into cells:

Cell	Text
G9	Corporate Sales
G10	Total Corporate Sales
G11	Average Corporate Sales

5   Enter the following formulas into cells:

Cell	Text
H9	=COUNTIF(B2:B20,"Corporate")
H10	=SUMIF(B2:B20,"Corporate",C2:C20)
H11	=AVERAGEIF(B2:B20,"Corporate",C2:C20)

These are the same conditional formulas as used previously, except that an additional argument has been added to the SUMIF and AVERAGEIF. In this variation, the test criteria are applied to the cells in column B (= "Corporate"), but the SUM and AVERAGE are applied to the corresponding cells in column C, which is where the sales amounts are located. The average value can be verified by dividing the sum value into the count value.

The worksheet should now appear as follows:

	A	B	C	D	E	F	G	H
1	Tolano Adventures							
2	AirKm Points Awarded							
3								
4	Passenger Name	Type	Amount	Points	Bonus Pts			
5	Chan, A	Personal	968.48	96848	19370		Sales Over $500	8
6	Chan, H	Personal	968.48	96848	19370		Total Sales Over $500	5504.03
7	Cox, T	Corporate	315.58	31558	0		Avg Sales Over $500	688.00375
8	Cox, W	Personal	315.58	31558	0			
9	Dali, P	Corporate	548.27	54827	10965		Corporate Sales	5
10	Dali, S	Personal	548.27	54827	10965		Total Corporate Sales	2720.26
11	Koehn, J	Personal	370.82	37082	0		Avg Corporate Sales	544.052
12	Koehn, P	Personal	370.82	37082	0			
13	Moore, M	Personal	366.03	36603	0			
14	Noire, N	Personal	464.78	46478	0			
15	Singh, G	Corporate	835.69	83569	16714			
16	Smith, A	Corporate	528.28	52828	10566			
17	Smith, B	Corporate	492.44	49244	0			
18	Smith, T	Personal	528.28	52828	10566			
19	Williams, M	Personal	441.44	44144	0			
20	Wong, K	Personal	578.28	57828	11566			

8   Save and close the workbook.

Using Text Functions

Objective 4.4

Excel includes several text-oriented functions that are useful for handling text strings. They are often used to manipulate data imported from other sources. Some of the most useful text functions include:

LEFT	Extract the specified number of characters starting from the left side of the text string. The format of this function is: LEFT(text_string, number_of_characters)
	The text_string can be a cell range. If number is greater than the total length of the text string, then the shorter text string is returned and extra blank characters will not be padded on the right.
RIGHT	Extract the specified number of characters starting from the right side of the text string. The format of this function is: RIGHT(text_string, number_of_characters)
	The text_string can be a cell range. If number is greater than the total length of the text string, then the shorter text string is returned and extra blank characters will not be padded on the left or right.
MID	Extract the specified number of characters starting from any position in the text string. The format of this function is: MID(text_string, starting_position, number_of_characters)
	The text_string can be a cell range. If number is greater than the number of characters available, then the shorter text string is returned and extra blank characters will not be padded on the right.
UPPER	Convert all characters in a text string to uppercase. The format of this function is: UPPER(text_string)
LOWER	Convert all characters in a text string to lowercase. The format of this function is: LOWER(text_string)
PROPER	Convert the first letter of the text string and any letter following a non-alphabetic character to uppercase. All other characters are set to lowercase. The format of this function is: PROPER(text_string)

CONCATENATE	Join two or more text strings together to create one text string. Alternatively, the & operator can be used instead of the CONCATENATE function. The format of this function is: CONCATENATE(text_string_1, text_string_2, text_string_3, ...)

When spreadsheets are used for lists or as a database, these often overlooked functions can save many hours of manually entering data.

Learn the Skill

This exercise is designed to demonstrate how text functions can be used to change character strings.

1 Create a new, blank workbook.

2 Enter the following values (be sure to use the upper and lower characters as specified here):

Cell	Value
A1	JaNe
B1	pArkER-smiTh

3 Increase the width of columns **A**, **B**, and **C** to 22.

4 Select cell **C1** and type: =CONCATENATE(A1**,**" ",B1). Be sure to place one blank space between the quotation marks.

The space between the quotation marks is required to separate first and last names.

5 Select cell **A2** and type: =LOWER(A1).

6 Select cell **A3** and type: =UPPER(A1).

7 Select cell **A4** and type: =PROPER(A1).

8 Copy cells **A2:A4** to **B2:C4**.

Notice that Excel inserts capitals in all the proper locations, including after the hyphen.

Now use other text functions to extract parts of text strings or join them together in different ways.

9 In cell **A6**, type: BIRTHDAY

10 In cell **B6**, type: =LEFT(A6,5).

11 In cell **C6**, type: =RIGHT(A6,3).

12 In cell **B7**, type: =CONCATENATE(LEFT(A6,3),MID(A6,6,1)).

You will find the & operator to be easier to use than the CONCATENATE function, and it creates the same result.

13 In cell **C7**, type: =LEFT(A6,3)&MID(A6,6,1).

	A	B	C
1	JaNe	pArkER-smiTh	JaNe pArkER-smiTh
2	jane	parker-smith	jane parker-smith
3	JANE	PARKER-SMITH	JANE PARKER-SMITH
4	Jane	Parker-Smith	Jane Parker-Smith
5			
6	BIRTHDAY	BIRTH	DAY
7		BIRD	BIRD

14 Save the workbook as *Text Functions – Student* and close it.

Using Absolute and Relative Cell References

Using Absolute Cell References

Objective 4.1

Most formulas in an Excel worksheet use relative addressing for cells. If you copy a formula that contains a relative cell address and paste it to another cell, Excel automatically adjusts it for the new location. For example, suppose you have a formula that adds three rows together within one column. You can copy this formula to another column to add the adjusted set of three rows in the new column. The formula is relative to the column in which you place it.

This automatic adjustment feature is advantageous when you are creating sheets, such as budget sheets, which require the same formula to be repeated across many months or line items. However, in some cases you may not want this automatic adjustment feature.

Fortunately, Excel enables you to make cell addresses absolute or fixed. An absolute cell address refers to a fixed (non-moving) location on the worksheet.

To change a relative cell address to an absolute (fixed) cell address in a formula or function, enter a dollar sign before the row number and/or column letter (for example, *$E$5*). This ensures that when you copy a formula, Excel will not adjust the absolute cell addresses for the new location.

Another method to obtain the absolute signs in cell addresses is to press F4 once you have typed the cell address. You can also go back to formulas you have typed previously, edit them, position the insertion point in the cell address you wish to make absolute and press F4.

The number of times you press F4 determines which references become absolute:

- Press once to make both the column and row reference absolute.
- Press twice to make only row references absolute.
- Press three times to make only the column reference absolute.
- Press four times to remove the absolute references on both column and row.

Using Mixed Absolute and Relative Cell References

Objective 4.1

Cell addresses do not have to have both absolute column and row references. You can have mixed cell references. The column reference can be absolute and the row reference relative (for example, $E5). If a formula including this reference is copied to a new location, only the column reference ($E) is constant, and the row reference is adjusted for the new location.

Conversely, if you copy a formula including a cell reference with an absolute row reference and a relative column reference (for example, E$5) to a new location, Excel will adjust only the column reference for the new location. This adds flexibility for creating cell formulas, which will become increasingly important as your worksheets become more complex.

As a general rule of thumb: if you intend to copy the formula to other cells in the same row and keep the column reference locked, place the $ in front of the column letter. If you intend to copy the formula to other cells in the same column and keep the row reference locked, place the $ in front of the row number.

Learn the Skill

This exercise demonstrates the use of absolute cell references.

1 Open the *Quarterly Income Statement - Student* workbook. If necessary, click the *Company* worksheet tab.

First create a new column of totals.

2 Select cell **G4** and type: Total.

3 Select cells **C6** to **G8** and on the Home tab, in the Editing group, click **AutoSum**.

4 In cell **C11**, type: = then click the *Quarter 1* worksheet and select cell **F11** and press Enter.

5 Repeat step 4 for other cells in this row:

Cell	Source
D11	Quarter 2 worksheet cell F11
E11	Quarter 3 worksheet cell F11
F11	Quarter 4 worksheet cell F11

6 Select cells **C11** to **G11** and on the **Home** tab, in the **Editing** group, click **AutoSum**.

7 Copy the contents of the cell range **C11** to **G11** down to cells **C12** to **G19**.

The relative addressing feature in Excel has saved you a lot of time in setting up these formulas.

8 Select cell **A21** and type: Profit.

9 Select cell **C21** and type: =C8-C19.

10 Copy cell **C21** across to cells **D21** to **G21**.

11 Select cell **A22** and type: Quarterly Margin.

12 Select cell **C22** and enter: =C21/G8.

13 Copy cell **C22** across to cells **D22** to **G22**.

At first, it appears as if you can copy the formula into the other cells in row **22**. However, the result is as shown in the following:

	A	B	C	D	E	F	G	H	I
1	Tolano Adventures								
2	Quarterly Income Statement								
3									
4			Qtr 1	Qtr 2	Qtr 3	Qtr 4	Total		
5	Revenues:								
6	Sales		19000	19500	19500	19500	77500		
7	Other Revenues		240	105	105	105	555		
8	Total:		19240	19605	19605	19605	78055		
9									
10	Expenses:								
11	Rent		15000	15000	15000	15000	60000		
12	Telephone		450	450	450	450	1800		
13	Internet		375	375	375	375	1500		
14	Photocopier		240	240	240	240	960		
15	Supplies		750	750	750	750	3000		
16	Courier		195	195	195	195	780		
17	Advertising		750	750	750	750	3000		
18	Utilities		975	975	975	975	3900		
19	Total:		18735	18735	18735	18735	74940		
20									
21	Profit		505	870	870	870	3115		
22	Quarterly Margin		0.00647	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!		

Clearly, the answers provided are incorrect—Excel displays a *#DIV/0!* (division by zero) error message in the other cells. Now examine the formulas you had copied in column **C**.

14 Select cell **D22** and examine the formula bar.

| × | ✓ | *fx* | =D21/H8 |

As you can see, Excel has adjusted the cell address using relative addressing for each cell where you copied the formula. This adjustment process, which was so useful when you were creating and copying other formulas, is now causing a problem: dividing a value in cell **D21** by the value in cell **H8**. The problem is that cell **H8** is blank, which is interpreted as having the value of zero. If you divide any number by zero, you will get a "division by zero" error message.

You can resolve this problem by returning to cell **C22** and editing the formula. The formula must use absolute cell referencing for the **G8** cell reference. Thus, the formula in cell **C22** should be =C21/$G$8 or =C21/$G8.

15 Select cell **C22** and press F2 to activate the editing mode.

16 Press F4 to put the absolute value signs around the nearest cell reference in the formula (G8).

17 Press Enter to accept this formula.

Note that the amount in cell **C22** does not change.

18 Copy the formula from cell **C22** to cells **D22** through to **G22**.

Your worksheet should now look like the following example:

	A	B	C	D	E	F	G
1	Tolano Adventures						
2	Quarterly Income Statement						
3							
4			Qtr 1	Qtr 2	Qtr 3	Qtr 4	Total
5	Revenues:						
6		Sales	19000	19500	19500	19500	77500
7		Other Revenues	240	105	105	105	555
8		Total:	19240	19605	19605	19605	78055
9							
10	Expenses:						
11		Rent	15000	15000	15000	15000	60000
12		Telephone	450	450	450	450	1800
13		Internet	375	375	375	375	1500
14		Photocopier	240	240	240	240	960
15		Supplies	750	750	750	750	3000
16		Courier	195	195	195	195	780
17		Advertising	750	750	750	750	3000
18		Utilities	975	975	975	975	3900
19		Total:	18735	18735	18735	18735	74940
20							
21	Profit		505	870	870	870	3115
22	Quarterly Margin		0.00647	0.011146	0.011146	0.011146	0.039908

Check the formulas now entered in column **C**:

C22	contains	=C21/$G$8
D22	contains	=D21/$G$8
E22	contains	=E21/$G$8
F22	contains	=F21/$G$8
G22	contains	=G21/$G$8

When the reference to cell **G8** is absolute, it is anchored to the total revenues cell.

19 Save the workbook.

Displaying and Printing Formulas

Objective 1.4

To see the formula in a cell, you must select that cell and examine the formula displayed in the Formula Bar, or press F2 to see the formula in the cell. In some circumstances, you may want to see all the formulas in all the cells at the same time, especially when you are verifying the accuracy of the spreadsheet. Excel has an option available to display all formulas in a worksheet at the same time. Cells that contain numeric or other values will simply display those data values.

Excel allows you to print the worksheet with the formulas displayed. This is an excellent technique for verifying that you have entered all the formulas correctly.

Learn the Skill

This exercise demonstrates how to display the formulas in worksheet cells, or to display the formula results.

1   If necessary, open the *Quarterly Income Statement - Student* workbook.

2   Click the **File** tab, then click **Options**.

3   Click **Advanced** in the left pane of the Excel Options dialog box.

4   Scroll down to the Display options for this worksheet group of options.

5   Verify that you have set the display options box to **Company**, and then click the **Show formulas in cells instead of their calculated results** check box.

Hint: An alternative way of activating this feature is to use the keyboard shortcut key sequence CTRL+ `(GRAVE ACCENT).
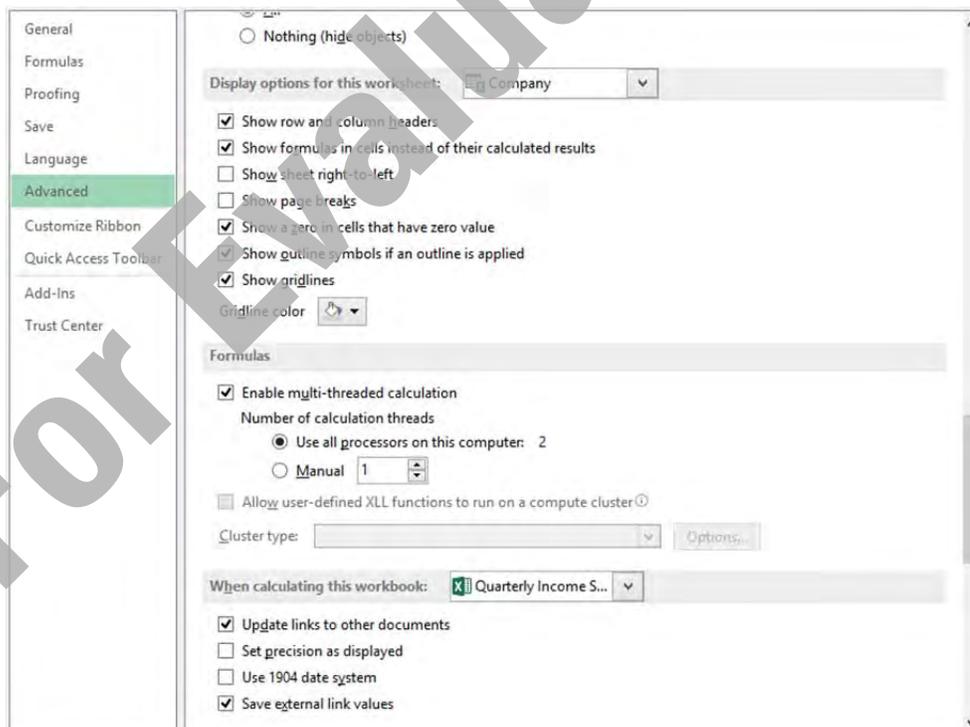
6   Click **OK**.

7   If necessary, increase the size of the workbook window.

	A	B	C	D	E	F	G
1	Tolano Ad						
2	Quarterly						
3							
4			Qtr 1	Qtr 2	Qtr 3	Qtr 4	Total
5	Revenues:						
6		Sales	='Quarter 1'!F6	='Quarter 2'!F6	='Quarter 3'!F6	='Quarter 4'!F6	=SUM(C6:F6)
7		Other Revenues	='Quarter 1'!F7	='Quarter 2'!F7	='Quarter 3'!F7	='Quarter 4'!F7	=SUM(C7:F7)
8		Total:	='Quarter 1'!F8	='Quarter 2'!F8	='Quarter 3'!F8	='Quarter 4'!F8	=SUM(C8:F8)
9							
10	Expenses:						
11		Rent	='Quarter 1'!F11	='Quarter 2'!F11	='Quarter 3'!F11	='Quarter 4'!F11	=SUM(C11:F11)
12		Telephone	='Quarter 1'!F12	='Quarter 2'!F12	='Quarter 3'!F12	='Quarter 4'!F12	=SUM(C12:F12)
13		Internet	='Quarter 1'!F13	='Quarter 2'!F13	='Quarter 3'!F13	='Quarter 4'!F13	=SUM(C13:F13)
14		Photocopier	='Quarter 1'!F14	='Quarter 2'!F14	='Quarter 3'!F14	='Quarter 4'!F14	=SUM(C14:F14)
15		Supplies	='Quarter 1'!F15	='Quarter 2'!F15	='Quarter 3'!F15	='Quarter 4'!F15	=SUM(C15:F15)
16		Courier	='Quarter 1'!F16	='Quarter 2'!F16	='Quarter 3'!F16	='Quarter 4'!F16	=SUM(C16:F16)
17		Advertising	='Quarter 1'!F17	='Quarter 2'!F17	='Quarter 3'!F17	='Quarter 4'!F17	=SUM(C17:F17)
18		Utilities	='Quarter 1'!F18	='Quarter 2'!F18	='Quarter 3'!F18	='Quarter 4'!F18	=SUM(C18:F18)
19		Total:	='Quarter 1'!F19	='Quarter 2'!F19	='Quarter 3'!F19	='Quarter 4'!F19	=SUM(C19:F19)
20							
21	Profit		=C8-C19	=D8-D19	=E8-E19	=F8-F19	=G8-G19
22	Quarterly		=C21/$G$8	=D21/$G$8	=E21/$G$8	=F21/$G$8	=G21/$G$8

To turn off the display of the formulas, repeat the same steps but clear the check box.

8 Click the **File** tab, then click **Options**.

9 Click **Advanced** in the left pane of the Excel Options dialog box.

10 Scroll down to the Display options for this worksheet group of options and clear the **Show formulas in cells instead of their calculated results** check box. Click **OK**.

You can also print the worksheet with the formulas displayed.

**11** Close the workbook and discard any changes.

Data Validation

Objective 1.3

Electronic spreadsheets first appeared as very crude blank sheets. You could enter any type of value in any cell and the spreadsheet would attempt to cope with it. For example, even if it seemed like there should be a numeric value in a cell, Excel would accept a text string in it. If that cell were subsequently used in a calculation, Excel treated that cell as if it contained the value 0 (zero). This flexibility (or, described another way, the willingness of the spreadsheet to accept anything anywhere without many complaints) made spreadsheets very popular with novice computer users.

However, this flexibility often resulted in undesirable side effects when wrong values were entered into certain cells. For example, the upper case letter "O" can be mistakenly entered instead of the number "0" and the lower case "l" can be mistaken for the number "1" in some character fonts.

Excel can prevent this with the Data Validation feature which displays a helpful message whenever the user selects a particular cell or an error message if an incorrect value is entered.
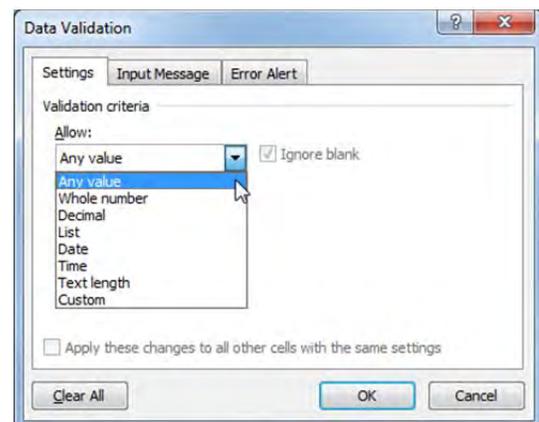
You can choose from different data types as validation checks:

|	
Any value	Deactivate any data validation. This is the default setting for all cells. However, you can also use it to display an input message without validating any data entry.
Whole number	Allow only numeric values without any decimal digits.
Decimal	Allow any numeric value.
List	Allow selections from a defined list of values in a cell range. This is also known as a pick list.
Date	Allow only date values. The lowest date value is January 1, 1900.
Time	Allow only valid time values.
Text length	Allow only the specified number of text characters. This validation does not permit any numbers, dates, or time values to be entered.
Custom	Enter a formula to validate the data being entered into the cell. The result of the formula must be a true or false value.

Learn the Skill

This exercise demonstrates how to use the Data Validation feature.

1 Open the *Feedback Form* workbook and save as Feedback Form – Student.

2 Select cell **B10**. On the Data tab, in the Data Tools group, click **Data Validation**. If you clicked the drop-down button below the Data Validation button, click **Data Validation**.

3 Enter or select the following options for the Settings tab and click **OK**:

Criteria	Select
Allow	Whole number
Data	between
Minimum	1
Maximum	5
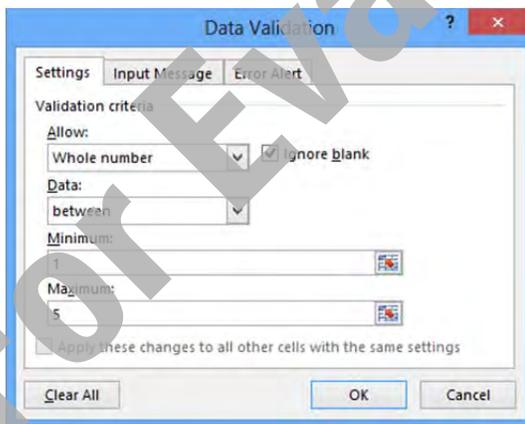
Now try entering an invalid rating value and observe the results.

4 Select cell **B10**. Type: 0 and press (Enter).
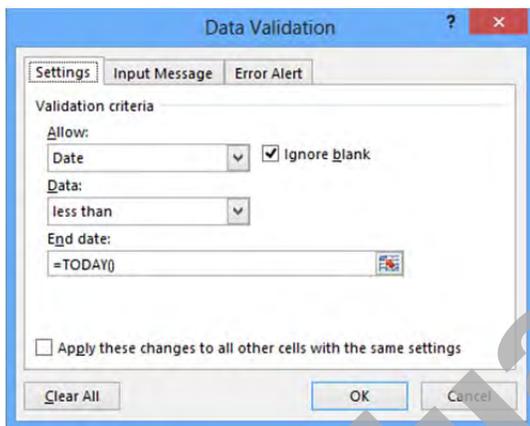
Excel displays the default error message.

5   Click **Cancel**.

You can customize this error message to help users understand what values are valid or invalid.

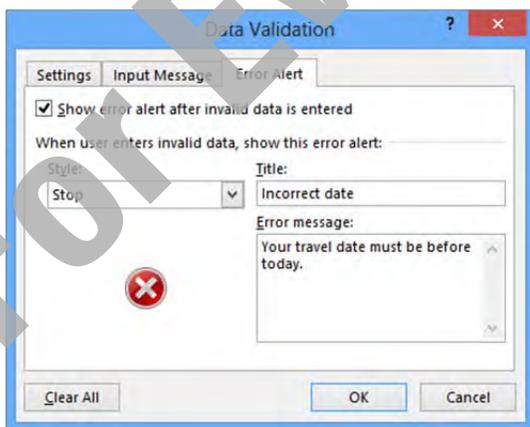**6**   Select cell **B6**. On the **Data** tab, in the **Data Tools** group, click **Data Validation**.

7   Enter or select the following options for the Settings tab:

Criteria	Select
Allow	Date
Data	less than
End date	=TODAY( )

8   Click the **Error Alert** tab, enter the following settings, and click **OK**:

Criteria	Enter
Style	Stop
Title	Incorrect date
Error message	Your travel date must be before today.

9   Select cell **B6** and enter a future date.

Your customized error message is now displayed.
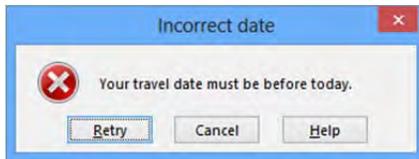
10 Click **Cancel**.

You can also display a helpful message when a cell is selected.

11 Select cell **B13**. On the **Data** tab, in the **Data Tools** group, click **Data Validation**.

12 Click the **Settings** tab and enter or select the following:

Criteria	Select
Allow	Text length
Data	less than
Maximum	150

13 Click the **Input Message** tab, enter the following settings, and click **OK**:

Criteria	Enter
Title	Your comments
Input message	Your comments will be entered into a grand prize draw!
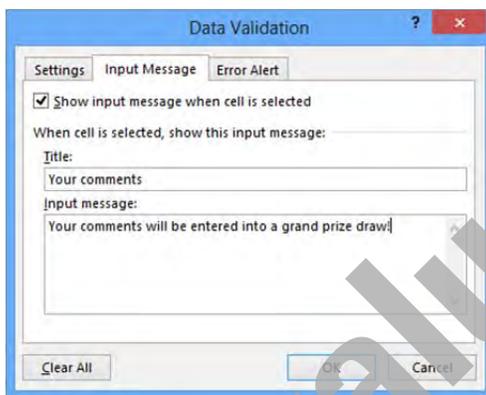
Your customized input message is now displayed.

14 Click on another worksheet cell and then click on cell **B13** again to see the input message display again.

15 Test the worksheet by entering values of your own choosing into the various cells.

16 Save and close the workbook.

Lesson Summary

In this lesson, you learned about formulas—what they are, how they work, how to insert simple formulas and how to use built-in functions to create some formulas. You should now be familiar with:

☑ what formulas are

☑ how to create and edit simple formulas

☑ how to use math operators and understand the precedent order of calculations

☑ how to reference other worksheets

☑ how to use common functions

☑ how to use the SUBTOTAL function

☑ how to use a conditional function

☑ how to use conditional summary functions

☑ how to use text functions

☑ how to use absolute and relative cell references

☑ how to use mixed absolute and relative cell addresses

☑ how to display and print formulas

☑ how to use data validation

Review Questions

MMM
Go online for Additional Review and Activities

1. List which standard math operators Excel uses and what is their order of precedence.

2. Give examples of how using formulas to perform a what-if analysis is beneficial to you.

3. Which of the following are invalid?

    a) =MAX(B5:B15)

    b) =MAX(B5,B6,B7,B8,B9,B10,B11,B12,B13,B14)

    c) =MAX(B5:B7,B8:B10,B11:B15)

    d) =MAX(B1,B5:B8,B9:B15)

    e) All of the above are invalid formulas

    f) None – all are valid formulas

    g) c

    h) b, c, and d

4. Define the different parts of a reference to other worksheets using the reference Tours!B4 as an example.

5. What is the main difference between an IF function and other functions discussed in this lesson such as SUM, AVERAGE, and UPPER?

6. Are the LEFT and MID functions fully interchangeable? In other words, can you always use the LEFT function instead of MID, as well as using MID instead of LEFT?

7. Explain the difference between absolute and relative cell references.

8. Provide examples of when or why it may be beneficial to print the formulas in the worksheet.