Simple Formulas

One of the most powerful features in Excel is the ability to **calculate** numerical information using **formulas**. Just like a calculator, Excel can add, subtract, multiply, and divide. In this lesson, we'll show you how to use **cell references** to create simple formulas.

Practice document: Excel2013_SimpleFormulas_Practice.xlsx

Mathematical operators

Excel uses standard operators for formulas, such as a **plus sign** for addition (**+**), a **minus sign** for subtraction (**-**), an **asterisk** for multiplication (*****), a **forward slash** for division (**/**), and a **caret** (**^**) for exponents.

Addition	+
Subtraction	-
Multiplication	*
Division	/
Exponents	^

All formulas in Excel must begin with an **equals sign** (**=**). This is because the cell contains, or is equal to, the formula and the value it calculates.

Understanding cell references

While you can create simple formulas in Excel manually (for example, **=2+2** or **=5*5**), most of the time you will use **cell addresses** to create a formula. This is known as making a **cell reference**. Using cell references will ensure that your formulas are always accurate because you can change the value of referenced cells without having to rewrite the formula.

The formula in cell A3 refers to the value in cell A1 plus the value in cell A2

The formula calculates and displays the answer to the equation A1 plus A2

The formula automatically recalculates when the value of a referenced cell is changed

By combining a mathematical operator with cell references, you can create a variety of simple formulas in Excel. Formulas can also include a combination of cell references and numbers, as in the examples below:

=A1+A2	Adds cells A1 and A2
=C4-3	Subtracts 3 from cell C4
=E7/J4	Divides cell E7 by J4
=N10*1.05	Multiplies cell N10 by 1.05
=R5^2	Finds the square of cell R5

To create a formula:

In our example below, we'll use a simple formula and cell references to calculate a budget.

1. Select the **cell** that will contain the formula. In our example, we'll select cell **B3**.

2. Type the **equals sign (=)**. Notice how it appears in both the **cell** and the **formula bar**.

Formula will appear in both the cell and the formula bar

3. Type the **cell address** of the cell you want to reference first in the formula: cell **B1** in our example. A **blue border** will appear around the referenced cell.

4. Type the **mathematical operator** you want to use. In our example, we'll type the **addition sign (+)**.

5. Type the **cell address** of the cell you want to reference second in the formula: cell **B2** in our example. A **red border** will appear around the referenced cell.

6. Press **Enter** on your keyboard. The formula will be **calculated**, and the **value** will be displayed in the cell.

If the result of a formula is too large to be displayed in a cell, it may appear as **pound signs** (#######) instead of a value. This means the column is not wide enough to display the cell content. Simply **increase the column width** to show the cell content.

Modifying values with cell references

The true advantage of cell references is that they allow you to **update data** in your worksheet without having to rewrite formulas. In the example below, we've modified the value of cell B1 from $1,200 to $1,800. The formula in B3 will automatically recalculate and display the new value in cell B3.

To create a formula using the point-and-click method:

Rather than typing cell addresses manually, you can **point and click** on the cells you want to include in your formula. This method can save a lot of time and effort when creating formulas. In our example below, we'll create a formula to calculate the cost of ordering several boxes of plastic silverware.

1. Select the **cell** that will contain the formula. In our example, we'll select cell **D3**.

	A	B	C	D	E
	D3 ▼ : ✕ ✓ *fx*				
1	**Paper Supply Inventory Orders**				
2	Item	Quantity	Price Per Unit	Total Cost	
3	Plastic Silverware (box of 100)	9	$8.75	⊕	
4	Napkins (box of 250)	12	$2.59		
5	Plates (box of 50)	6	$14.25		
6	Cups (box of 75)	10	$11.99		
7	Total				
8					

2. Type the **equals sign (=)**.

3. Select the **cell** you want to reference first in the formula: cell **B3** in our example. The **cell address** will appear in the formula, and a **dashed blue line** will appear around the referenced cell.

	A	B	C	D	E
	B3 ▼ : ✕ ✓ *fx* =B3				
1	**Paper Supply Inventory Orders**				
2	Item	Quantity	Price Per Unit	Total Cost	
3	Plastic Silverware (box of 100)	⊕ 9	$8.75	=B3	
4	Napkins (box of 250)	12	$2.59		
5	Plates (box of 50)	6	$14.25		
6	Cups (box of 75)	10	$11.99		
7	Total				
8					

4. Type the **mathematical operator** you want to use. In our example, we'll type the **multiplication sign (*)**.

5. Select the **cell** you want to reference second in the formula: cell **C3** in our example. The **cell address** will appear in the formula, and a **dashed red line** will appear around the referenced cell.

	A	B	C	D	E
	C3 ▼ : ✕ ✓ *fx* =B3*C3				
1	**Paper Supply Inventory Orders**				
2	Item	Quantity	Price Per Unit	Total Cost	
3	Plastic Silverware (box of 100)	9	⊕ $8.75	=B3*C3	
4	Napkins (box of 250)	12	$2.59		
5	Plates (box of 50)	6	$14.25		
6	Cups (box of 75)	10	$11.99		
7	Total				
8					

6. Press **Enter** on your keyboard. The formula will be **calculated**, and the **value** will be displayed in the cell.

Formulas can also be **copied** to adjacent cells with the **fill handle**, which can save a lot of time and effort if you need to perform the **same calculation** multiple times in a worksheet. Review our lesson on **Relative and Absolute Cell References** to learn more.

Click, hold and drag the Fill handle to copy the function to adjacent cells

To edit a formula:

Sometimes you may want to modify an existing formula. In the example below, we've entered an incorrect cell address in our formula, so we'll need to correct it.

1. Select the **cell** containing the formula you want to edit. In our example, we'll select cell **B3**.

B3	⋮	✕	✓	fx	=B1-C2

	A	B	C
1	Budget Total	$1,050.00	
2	Inventory Cost	$315.23	
3	Total Remaining	$1,050.00	
4			
5			

2. Click the **formula bar** to edit the formula. You can also **double-click** the cell to view and edit the formula directly within the cell.

B3	⋮	✕	✓	fx	=B1-C2

	A	B	C	D	E	F
1	Budget Total	$1,050.00				
2	Inventory Cost	$315.23				
3	Total Remaining	$1,050.00				
4						
5						
6						

Formula Bar

To edit a formula, double-click the selected cell or click the formula bar

3. A **border** will appear around any referenced cells. In our example, we'll change the second part of the formula to reference cell **B2** instead of cell **C2**.

SUM	⋮	✕	✓	fx	=B1-C2

	A	B	C	D
1	Budget Total	$1,050.00		
2	Inventory Cost	$315.23		
3	Total Remaining	=B1-C2		
4				
5				

4. When you're finished, press **Enter** on your keyboard or click the **checkmark** in the formula bar.

SUM	⋮	✕	✓	fx	=B1-B2

	A	B	C
1	Budget Total	$1,050.00	
2	Inventory Cost	$315.23	
3	Total Remaining	=B1-B2	
4			
5			

Enter

5. The formula will be **updated**, and the **new value** will be displayed in the cell.

B3	⋮	✕	✓	fx	=B1-B2

	A	B	C
1	Budget Total	$1,050.00	
2	Inventory Cost	$315.23	
3	Total Remaining	$734.77	
4			
5			

If you change your mind, you can press the **Esc** key on your keyboard to avoid accidentally making changes to your formula.

To show all of the formulas in a spreadsheet, you can hold the **Ctrl** key and press ` (grave accent). The grave accent key is usually located in the top-left corner of the keyboard. You can press **Ctrl+`** again to switch back to the normal view.

Complex formulas

A simple formula is a mathematical expression with one operator, such as **7+9**. A **complex formula** has more than one mathematical operator, such as **5+2*8**. When there is more than one operation in a formula, the **order of operations** tells Excel which operation to calculate first. In order to use Excel to calculate complex formulas, you will need to understand the order of operations

Practice document: Excel2013_ComplexFormulas_Practice.xlsx

The order of operations

Excel calculates formulas based on the following **order of operations**:

1. Operations enclosed in **parentheses**

2. **Exponential** calculations (3^2, for example)

3. **Multiplication** and **division**, whichever comes first

4. **Addition** and **subtraction**, whichever comes first

Creating complex formulas

In the example below, we will demonstrate how Excel solves a complex formula using the order of operations. Here, we want to calculate the cost of **sales tax** for a catering invoice. To do this, we'll write our formula as **=(D2+D3)*0.075** in cell **D4**. This formula will add the prices of our items together and then multiply that value by the 7.5% tax rate (which is written as 0.075) to calculate the cost of sales tax.

		f_x	=(D2+D3)*0.075		
	A	B	C	D	E
1	**Menu Item**	**Price**	**Quantity**	**Total**	
2	Empanadas: Beef Picadillo	$2.99	15	$44.85	
3	Empanadas: Chipotle Shrimp	$3.99	10	$39.90	
4				Tax =(D2+D3)*0.075	
5				Total	
6					

Excel follows the order of operations and first adds the values inside the parentheses: **(44.85+39.90) = $84.75**. It then multiplies that value by the tax rate: **$84.75*0.075**. The result will show that the sales tax is **$6.36**.

D4		f_x	=(D2+D3)*0.075		
	A	B	C	D	E
1	**Menu Item**	**Price**	**Quantity**	**Total**	
2	Empanadas: Beef Picadillo	$2.99	15	$44.85	
3	Empanadas: Chipotle Shrimp	$3.99	10	$39.90	
4				Tax	$6.36
5				Total	
6					

It is especially important to enter complex formulas with the correct order of operations. Otherwise, Excel will not calculate the results accurately. In our example, if the **parentheses** are not included, the multiplication is calculated first and the result is incorrect. Parentheses are the best way to define which calculations will be performed first in Excel.

		f_x	=(D2+D3)*0.075		
	A	B		
1	**Menu Item**	**Price**		
2	Empanadas: Beef Picadillo	$2.99		
3	Empanadas: Chipotle Shrimp	$3.99	10	$39.90
4			Tax = D2+D3 *0.075	
5			Total	
6				

Without parentheses, multiplication is performed before addition, leading to an incorrect result

Tax	$47.84
Total	

To create a complex formula using the order of operations:

In our example below, we will use **cell references** along with **numerical values** to create a complex formula that will calculate the **total cost** for a catering invoice. The formula will calculate the cost for each menu item and then add those values together.

1. Select the **cell** that will contain the formula. In our example, we'll select cell **C4**.

2. Enter your **formula**. In our example, we'll type **=B2*C2+B3*C3**. This formula will follow the order of operations, first performing the multiplication: **2.29*20 = 45.80** and **3.49*35 = 122.15**. It then will add those values together to calculate the total: **45.80+122.15**.

3. Double-check your formula for accuracy, then press **Enter** on your keyboard. The formula will **calculate** and display the **result**. In our example, the result shows that the total cost for the order is **$167.95**.

You can add **parentheses** to any equation to make it easier to read. While it won't change the result of the formula in this example, we could enclose the multiplication operations within parentheses to clarify that they will be calculated before the addition.

Challenge!

1. Open the practice document Excel2013_ComplexFormulas_Practice.xlsx.

2. Create a complex formula that will perform addition before multiplication. Create a formula in cell **D6** that first **adds** the values of cells **D3, D4,** and **D5** and then **multiplies** their total by **0.075**. Hint: **You'll need to think about the order of operations for this to work correctly.**

Relative and Absolute Cell References

There are two types of cell references: **relative** and **absolute**. Relative and absolute references behave differently when copied and filled to other cells. Relative references **change** when a formula is copied to another cell. Absolute references, on the other hand, remain **constant**, no matter where they are copied.

Practice document: Excel2013_References_Practice.xlsx

Relative references

By default, all cell references are **relative references**. When copied across multiple cells, they change based on the relative position of rows and columns. For example, if you copy the formula **=A1+B1** from row 1 to row 2, the formula will become **=A2+B2.** Relative references are especially convenient whenever you need to **repeat** the same calculation across multiple rows or columns.

To create and copy a formula using relative references:

In the following example, we want to create a formula that will multiply each item's **price** by the **quantity**. Instead of creating a new formula for each row, we can create a single formula in cell **D2** and then copy it to the other rows. We'll use relative references so the formula correctly calculates the total for each item.

1. Select the **cell** that will contain the formula. In our example, we'll select cell **D2**.

	A	B	C	D	E
1	**Menu Item**	**Price**	**Quantity**	**Total**	
2	Empanadas: Beef Picadillo	$2.99	15		
3	Empanadas: Chipotle Shrimp	$3.99	10		
4	Empanadas: Black Bean & Plantain	$2.49	20		
5	Tamales: Chicken Tinga	$2.29	20		
6	Tamales: Vegetable	$2.29	30		
7	Arepas: Carnitas	$2.89	10		
8	Arepas: Queso Blanco	$2.49	20		
9	Empanadas: Apple Cinnamon	$3.19	40		
10	Beverages: Horchata	$1.89	25		
11	Beverages: Lemonade	$1.89	35		
12	Beverages: Tamarindo	$1.89	10		
13			**Total**		
14					

2. Enter the **formula** to calculate the desired value. In our example, we'll type **=B2*C2**.

C2	▾	:	✕	✓	fx	=B2*C2		

	A	B	C	D	E
1	**Menu Item**	**Price**	**Quantity**	**Total**	
2	Empanadas: Beef Picadillo	$2.99	15	=B2*C2	
3	Empanadas: Chipotle Shrimp	$3.99	10		
4	Empanadas: Black Bean & Plantain	$2.49	20		
5	Tamales: Chicken Tinga	$2.29	20		
6	Tamales: Vegetable	$2.29	30		
7	Arepas: Carnitas	$2.89	10		
8	Arepas: Queso Blanco	$2.49	20		
9	Empanadas: Apple Cinnamon	$3.19	40		
10	Beverages: Horchata	$1.89	25		
11	Beverages: Lemonade	$1.89	35		
12	Beverages: Tamarindo	$1.89	10		
13				**Total**	
14					

3. Press **Enter** on your keyboard. The formula will be **calculated**, and the result will be displayed in the cell.

4. Locate the **fill handle** in the bottom-right corner of the desired cell. In our example, we'll locate the fill handle for cell **D2**.

D2	▾	:	✕	✓	fx	=B2*C2		

	A	B	C	D	E
1	**Menu Item**	**Price**	**Quantity**	**Total**	
2	Empanadas: Beef Picadillo	$2.99	15	$44.85	
3	Empanadas: Chipotle Shrimp	$3.99	10		
4	Empanadas: Black Bean & Plantain	$2.49	20		
5	Tamales: Chicken Tinga	$2.29	20		
6	Tamales: Vegetable	$2.29	30		
7	Arepas: Carnitas	$2.89	10	The fill handle	
8	Arepas: Queso Blanco	$2.49	20		
9	Empanadas: Apple Cinnamon	$3.19	40		
10	Beverages: Horchata	$1.89	25		
11	Beverages: Lemonade	$1.89	35		
12	Beverages: Tamarindo	$1.89	10		
13				**Total**	
14					

5. Click, hold, and drag the **fill handle** over the cells you want to fill. In our example, we'll select cells **D3:D12**.

| D2 | ▼ : ✕ ✓ fx | =B2*C2 |

Click, hold and drag the fill handle to copy the formula to adjacent cells

	A	Price	Quantity	Total
1	**Menu Item**	**Price**	**Quantity**	**Total**
2	Empanadas: Beef Picadillo	$2.99	15	$44.85
3	Empanadas: Chipotle Shrimp	$3.99	10	
4	Empanadas: Black Bean & Plantain	$2.49	20	
5	Tamales: Chicken Tinga	$2.29	20	
6	Tamales: Vegetable	$2.29	30	
7	Arepas: Carnitas	$2.89	10	
8	Arepas: Queso Blanco	$2.49	20	
9	Empanadas: Apple Cinnamon	$3.19	40	
10	Beverages: Horchata	$1.89	25	
11	Beverages: Lemonade	$1.89	35	
12	Beverages: Tamarindo	$1.89	10	
13				**Total**
14				

6. Release the mouse. The formula will be **copied** to the selected cells with **relative references**, and the values will be calculated in each cell.

| D2 | ▼ : ✕ ✓ fx | =B2*C2 |

	A	B	C	D	E
1	**Menu Item**	**Price**	**Quantity**	**Total**	
2	Empanadas: Beef Picadillo	$2.99	15	$44.85	
3	Empanadas: Chipotle Shrimp	$3.99	10	$39.90	
4	Empanadas: Black Bean & Plantain	$2.49	20	$49.80	
5	Tamales: Chicken Tinga	$2.29	20	$45.80	
6	Tamales: Vegetable	$2.29	30	$68.70	
7	Arepas: Carnitas	$2.89	10	$28.90	
8	Arepas: Queso Blanco	$2.49	20	$49.80	
9	Empanadas: Apple Cinnamon	$3.19	40	$127.60	
10	Beverages: Horchata	$1.89	25	$47.25	
11	Beverages: Lemonade	$1.89	35	$66.15	
12	Beverages: Tamarindo	$1.89	10	$18.90	
13				**Total**	
14					

You can double-click the **filled cells** to check their formulas for accuracy. The relative cell references should be different for each cell, depending on their rows.

	A	B	C	D	E
1	**Menu Item**	**Price**	**Quantity**	**Total**	
2	Empanadas: Beef Picadillo	$2.99	15	$44.85	
3	Empanadas: Chipotle Shrimp	$3.99	10	$39.90	
4	Empanadas: Black Bean & Plantain	$2.49		30	
5	Tamales: Chicken Tinga	$2.29		30	
6	Tamales: Vegetable	$2.29		70	
7	Arepas: Carnitas	$2.89	10	$28.90	
8	Arepas: Queso Blanco	$2.49	20	=B8*C8	
9	Empanadas: Apple Cinnamon	$3.19	40	$127.60	
10	Beverages: Horchata	$1.89	25	$47.25	
11	Beverages: Lemonade	$1.89	35	$66.15	
12	Beverages: Tamarindo	$1.89	10	$18.90	
13				**Total**	
14					

SUM — fx =B8*C8

Cell references in row 8 are relative to row 8

Absolute references

There may be times when you do not want a cell reference to change when filling cells. Unlike relative references, **absolute references** do not change when copied or filled. You can use an absolute reference to keep a row and/or column **constant**.

An absolute reference is designated in a formula by the addition of a **dollar sign ($)**. It can precede the column reference, the row reference, or both.

A2	The column and the row do not change when copied
A$2	The row does not change when copied
$A2	The column does not change when copied

You will generally use the **A2** format when creating formulas that contain absolute references. The other two formats are used much less frequently.

When writing a formula, you can press the **F4** key on your keyboard to switch between relative and absolute cell references, as shown in the video below. This is an easy way to quickly insert an absolute reference.

To create and copy a formula using absolute references:

In our example, we'll use the 7.5% sales tax rate in cell **E1** to calculate the sales tax for all items in **column D**. We'll need to use the absolute cell reference **E1** in our formula. Because each formula is using the same tax

rate, we want that reference to remain constant when the formula is copied and filled to other cells in column D.

1. Select the **cell** that will contain the formula. In our example, we'll select cell **D3**.

	A	B	C	D	E
1			Sales Tax		7.5%
2	Menu Item	Price	Quantity	Sales Tax	Total
3	Empanadas: Beef Picadillo	$2.99	15		
4	Empanadas: Chipotle Shrimp	$3.99	10		
5	Empanadas: Black Bean & Plantain	$2.49	20		
6	Tamales: Chicken Tinga	$2.29	20		
7	Tamales: Vegetable	$2.29	30		
8	Arepas: Carnitas	$2.89	10		
9	Arepas: Queso Blanco	$2.49	20		
10	Empanadas: Apple Cinnamon	$3.19	40		
11	Beverages: Horchata	$1.89	25		
12	Beverages: Lemonade	$1.89	35		
13	Beverages: Tamarindo	$1.89	10		
14				Total	
15					

2. Enter the **formula** to calculate the desired value. In our example, we'll type =**(B3*C3)*E1**.

SUM   =(B3*C3)*E1

	A	B	C	D	E
1			Sales Tax		7.5%
2	Menu Item	Price	Quantity	Sales Tax	Total
3	Empanadas: Beef Picadillo	$2.99	=(B3*C3)*E1		
4	Empanadas: Chipotle Shrimp	$3.99	10		
5	Empanadas: Black Bean & Plantain	$2.49	20		
6	Tamales: Chicken Tinga	$2.29	20		
7	Tamales: Vegetable	$2.29	30		
8	Arepas: Carnitas	$2.89	10		
9	Arepas: Queso Blanco	$2.49	20		
10	Empanadas: Apple Cinnamon	$3.19	40		
11	Beverages: Horchata	$1.89	25		
12	Beverages: Lemonade	$1.89	35		
13	Beverages: Tamarindo	$1.89	10		
14				Total	
15					

3. Press **Enter** on your keyboard. The formula will calculate, and the result will display in the cell.

4. Locate the **fill handle** in the bottom-right corner of the desired cell. In our example, we'll locate the fill handle for cell **D3**.

| D3 | | f_x | =(B3*C3)*E1 | | |

	A	B	C	D	E
1			**Sales Tax**		**7.5%**
2	**Menu Item**	**Price**	**Quantity**	**Sales Tax**	**Total**
3	Empanadas: Beef Picadillo	$2.99	15	$3.36	
4	Empanadas: Chipotle Shrimp	$3.99	10		
5	Empanadas: Black Bean & Plantain	$2.49	20		
6	Tamales: Chicken Tinga	$2.29	20		
7	Tamales: Vegetable	$2.29	30		
8	Arepas: Carnitas	$2.89	1		
9	Arepas: Queso Blanco	$2.49	20		
10	Empanadas: Apple Cinnamon	$3.19	40		
11	Beverages: Horchata	$1.89	25		
12	Beverages: Lemonade	$1.89	35		
13	Beverages: Tamarindo	$1.89	10		
14				**Total**	
15					

The fill handle

5. Click, hold, and drag the **fill handle** over the cells you want to fill: cells **D4:D13** in our example.

| D3 | | f_x | =(B3*C3)*E1 | | |

Click, hold and drag the fill handle to copy the formula to adjacent cells

	A		Price	Quantity	Sales Tax	Total
1						%
2	**Menu Item**		**Price**	**Quantity**	**Sales Tax**	**Total**
3	Empanadas: Beef Picadillo		$2.99	15	$3.36	
4	Empanadas: Chipotle Shrimp		$3.99	10		
5	Empanadas: Black Bean & Plantain		$2.49	20		
6	Tamales: Chicken Tinga		$2.29	20		
7	Tamales: Vegetable		$2.29	30		
8	Arepas: Carnitas		$2.89	10		
9	Arepas: Queso Blanco		$2.49	20		
10	Empanadas: Apple Cinnamon		$3.19	40		
11	Beverages: Horchata		$1.89	25		
12	Beverages: Lemonade		$1.89	35		
13	Beverages: Tamarindo		$1.89	10		
14					**Total**	
15						

6. Release the mouse. The formula will be **copied** to the selected cells with an **absolute reference**, and the values will be calculated in each cell.

You can double-click the **filled cells** to check their formulas for accuracy. The absolute reference should be the same for each cell, while the other references are relative to the cell's row.

Be sure to include the **dollar sign ($)** whenever you're making an absolute reference across multiple cells. The dollar signs were omitted in the example below. This caused Excel to interpret it as a relative reference, producing an incorrect result when copied to other cells.

The spreadsheet shows a formula bar with `=(B10*C10)*E8` and a data table:

	A	B	C	D	E
1			Sales Tax		7.5%
2	Menu Item	Price	Quantity	Sales Tax	Total
3	Empanadas: Beef Picadillo	$2.99	15	$3.36	$48.21
4	Empanadas: Chipotle Shrimp	$3.99	10	#VALUE!	$42.89
5	Empanada			$2,401.04	$53.54
6	Tamales: C			#VALUE!	$49.24
7	Tamales: V			$168,373.03	$73.85
8	Arepas: Ca			#VALUE!	$31.07
9	Arepas: Qu			$8,388,398.37	$53.54
10	Empanadas: Apple Cinnamon	$3.19	40	=(B10*C10)*E10	$127.60
11	Beverages: Horchata	$1.89	25	$396,354,176.00	$50.79
12	Beverages: Lemonade	$1.89	35	#VALUE!	$71.11
13	Beverages: Tamarindo	$1.89	10	$7,491,094,819.49	$20.32
14				Total	

Callout: **Without the dollar sign ($), the reference to cell E1 was interpreted as a relative reference, leading to incorrect results**

Using cell references with multiple worksheets

Excel allows you to refer to any cell on any **worksheet**, which can be especially helpful if you want to reference a specific value from one worksheet to another. To do this, you'll simply need to begin the cell reference with the **worksheet name** followed by an **exclamation point (!)**. For example, if you wanted to reference cell **A1** on **Sheet1**, its cell reference would be **Sheet1!A1**.

Note that if a worksheet name contains a **space**, you will need to include **single quotation marks (' ')** around the name. For example, if you wanted to reference cell **A1** on a worksheet named **July Budget**, its cell reference would be **'July Budget'!A1**.

To reference cells across worksheets:

In our example below, we'll refer to a cell with a calculated value between two worksheets. This will allow us to use the **exact same value** on two different worksheets without rewriting the formula or copying data between worksheets.

1. Locate the cell you want to reference, and note its worksheet. In our example, we want to reference cell **E14** on the **Menu Order worksheet**.

	A	B	C	D	E
5	Empanadas: Black Bean & Plantain	$2.49	20	$3.74	$53.54
6	Tamales: Chicken Tinga	$2.29	20	$3.44	$49.24
7	Tamales: Vegetable	$2.29	30	$5.15	$73.85
8	Arepas: Carnitas	$2.89	10	$2.17	$31.07
9	Arepas: Queso Blanco	$2.49	20	$3.74	$53.54
10	Empanadas: Apple Cinnamon	$3.19	40	$9.57	$137.17
11	Beverages: Horchata	$1.89	25	$3.54	$50.79
12	Beverages: Lemonade	$1.89	35	$4.96	$71.11
13	Beverages: Tamarindo	$1.89	10	$1.42	$20.32
14				Total	$587.65
15					
16					

Menu Order   Catering Invoice   (+)

2. Navigate to the desired **worksheet**. In our example, we'll select the **Catering Invoice** worksheet.

12	Beverages: Lemonade	$1.89	35	$4.96	$71.11
13	Beverages: Tamarindo	$1.89	10	$1.42	$20.32
14				Total	$587.65
15					
16					

Menu Order   **Catering Invoice**   (+)

3. The **selected worksheet** will appear.

4. Locate and select the **cell** where you want the value to appear. In our example, we'll select cell **B2**.

B2   ⋮   ✕   ✓   *fx*

	A	B	C
1	Total Cost for Requested Services		
2	Menu Items		
3	Paper Items (Plates, silverware, cups)	$110.87	
4	Rental Equipment (Tables, Chairs, Linens)	$249.95	
5	Service Fee (18% of menu items ordered)	$0.00	
6	Total Cost	$360.82	
7			

Menu Order   **Catering Invoice**   (+)

5. Type the **equals sign (=)**, the **sheet name** followed by an **exclamation point (!)**, and the **cell address**. In our example, we'll type **='Menu Order'!E14**.

6. Press **Enter** on your keyboard. The **value** of the referenced cell will appear. If the **value** of cell E14 changes on the Menu Order worksheet, it will be **updated** automatically on the Catering Invoice worksheet.

If you **rename** your worksheet at a later point, the cell reference will be updated automatically to reflect the new worksheet name.

If you enter a worksheet name incorrectly, the **#REF!** error will appear in the cell. In our example below, we've mistyped the name of the worksheet. Click the **Error** button and select the desired option from the drop-down menu to **edit** or **ignore** the error.
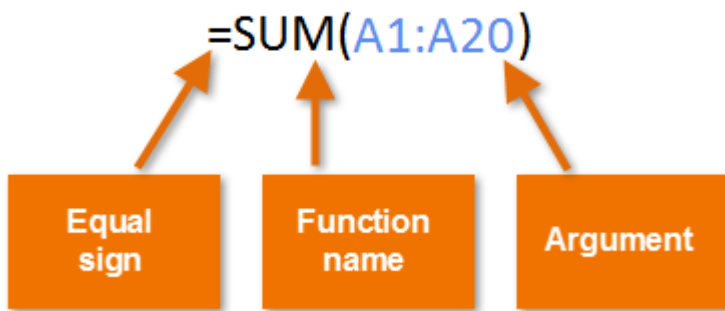
Functions

A **function** is a **predefined formula** that performs calculations using specific values in a particular order. Excel includes many common functions that can be useful for quickly finding the **sum**, **average**, **count**, **maximum value**, and **minimum value** for a range of cells. In order to use functions correctly, you'll need to understand the different **parts of a function** and how to create **arguments** to calculate values and cell references

Practice document: Excel2013_Functions_Practice.xlsx

The parts of a function

In order to work correctly, a function must be written a specific way, which is called the **syntax**. The basic syntax for a function is the **equals sign (=)**, the **function name** (SUM, for example), and one or more **arguments**. Arguments contain the information you want to calculate. The function in the example below would add the values of the cell range A1:A20.

Working with arguments

Arguments can refer to both **individual cells** and **cell ranges** and must be enclosed within **parentheses**. You can include one argument or multiple arguments, depending on the syntax required for the function.

For example, the function **=AVERAGE(B1:B9)** would calculate the **average** of the values in the cell range B1:B9. This function contains only one argument.

Multiple arguments must be separated by a **comma**. For example, the function **=SUM(A1:A3, C1:C2, E1)** will **add** the values of all the cells in the three arguments.

	A	B	C	D	E	F
1	7		5		15	
2	4		12			
3	23					
4						
5	=SUM(A1:A3,C1:C2,E1)					
6						

Formula bar: =SUM(A1:A3,C1:C2,E1)

Creating a function

Excel has a variety of functions available. Here are some of the most common functions you'll use:

- **SUM**: This function **adds** all of the values of the cells in the argument.

- **AVERAGE**: This function determines the **average** of the values included in the argument. It calculates the sum of the cells and then divides that value by the number of cells in the argument.

- **COUNT**: This function **counts** the number of cells with numerical data in the argument. This function is useful for quickly counting items in a cell range.

- **MAX**: This function determines the **highest cell value** included in the argument.

- **MIN**: This function determines the **lowest cell value** included in the argument.

To create a basic function:

In our example below, we'll create a basic function to calculate the **average price per unit** for a list of recently ordered items using the AVERAGE function.

1. Select the **cell** that will contain the function. In our example, we'll select cell **C11**.

C11

	A	B	C	D	E
1	Food Supply Inventory Orders (Non-Perishable Items)				
2	Item	Quantity	Price Per Unit	Total Cost	Date Ordered
3	Tomatoes (case of 12)	3	$17.44	$52.32	
4	Black Beans (case of 10)	5	$20.14	$100.70	
5	All Purpose Flour (50 lb.)	5	$14.05	$70.25	
6	Corn Meal/Maza (25 lb.)	5	$18.69	$93.45	
7	Brown Rice (25 lb.)	5	$10.99	$54.95	
8	Salsa, Medium (1 gallon)	12	$8.47	$101.64	
9	Olive Oil (2.5 gallon)	4	$28.69	$114.76	
10	Vegetable Wash (1 gallon)	2	$8.99	$17.98	
11	Average Price Per Unit				
12	Total Cost				
13					

2. Type the **equals sign (=)** and enter the desired **function name**. You can also select the desired function from the list of **suggested functions** that will appear below the cell as you type. In our example, we'll type **=AVERAGE**.

COUNTA	▼	⋮	✕	✓	*fx*		=AVERAGE		

	A	B	C	D	E
1	Food Supply Inventory Orders (Non-Perishable Items)				
2	Item	Quantity	Price Per Unit	Total Cost	Date Ordered
3	Tomatoes (case of 12)	3	$17.44	$52.32	
4	Black Beans (case of 10)	5	$20.14	$100.70	
5	All Purpose Flour (50 lb.)	5	$14.05	$70.25	
6	Corn Meal/Maza (25 lb.)	5	$18.69	$93.45	
7	Brown Rice (25 lb.)	5	$10.99	$54.95	
8	Salsa, Medium (1 gallon)	12	$8.47	$101.64	
9	Olive Oil (2.5 gallon)	4	$28.69	$114.76	
10	Vegetable Wash (1 gallon)	2	$8.99	$17.98	
11	e Per Unit	=AVERAGE Ⅰ			
12		*fx* AVERAGE	Returns the average (arithmetic mean)		
13		*fx* AVERAGEA			
		fx AVERAGEIF			
14		*fx* AVERAGEIFS			

Type the function name or select it from the list of suggested functions

3. Enter the **cell range** for the **argument** inside **parentheses**. In our example, we'll type **(C3:C10)**. This formula will add the values of cells C3:C10 and then divide that value by the total number of cells in the range to determine the average.

COUNTA	▼	⋮	✕	✓	*fx*		=AVERAGE(C3:C10)		

	A	B	C	D	E
1	Food Supply Inventory Orders (Non-Perishable Items)				
2	Item	Quantity	Price Per Unit	Total Cost	Date Ordered
3	Tomatoes (case of 12)	3	$17.44	$52.32	
4	Black Beans (case of 10)	5	$20.14	$100.70	
5	All Purpose Flour (50 lb.)	5	$14.05	$70.25	
6	Corn Meal/Maza (25 lb.)	5	$18.69	$93.45	
7	Brown Rice (25 lb.)	5	$10.99	$54.95	
8	Salsa, Medium (1 gallon)	12	$8.47	$101.64	
9	Olive Oil (2.5 gallon)	4	$28.69	$114.76	
10	Vegetable Wash (1 gallon)	2	$8.99	$17.98	
11	Average Price Per Unit		=AVERAGE(C3:C10) Ⅰ		
12	Total Cost				
13					

4. Press **Enter** on your keyboard. The function will be **calculated**, and the **result** will appear in the cell. In our example, the average price per unit of items ordered was **$15.93**.

C11	▼	⋮	✕	✓	*fx*	=AVERAGE(C3:C10)

|	A	B	C	D	E
1	**Food Supply Inventory Orders (Non-Perishable Items)**				
2	**Item**	**Quantity**	**Price Per Unit**	**Total Cost**	**Date Ordered**
3	Tomatoes (case of 12)	3	$17.44	$52.32	
4	Black Beans (case of 10)	5	$20.14	$100.70	
5	All Purpose Flour (50 lb.)	5	$14.05	$70.25	
6	Corn Meal/Maza (25 lb.)	5	$18.69	$93.45	
7	Brown Rice (25 lb.)	5	$10.99	$54.95	
8	Salsa, Medium (1 gallon)	12	$8.47	$101.64	
9	Olive Oil (2.5 gallon)	4	$28.69	$114.76	
10	Vegetable Wash (1 gallon)	2	$8.99	$17.98	
11	**Average Price Per Unit**		$15.93		
12				**Total Cost**	
13					

To create a function using the AutoSum command:

The **AutoSum** command allows you to automatically insert the most common functions into your formula, including SUM, AVERAGE, COUNT, MIN, and MAX. In our example below, we'll create a function to calculate the **total cost** for a list of recently ordered items using the SUM function.

1. Select the **cell** that will contain the function. In our example, we'll select cell **D12**.

D12	▼	⋮	✕	✓	*fx*	

	A	B	C	D	E
1	**Food Supply Inventory Orders (Non-Perishable Items)**				
2	**Item**	**Quantity**	**Price Per Unit**	**Total Cost**	**Date Ordered**
3	Tomatoes (case of 12)	3	$17.44	$52.32	
4	Black Beans (case of 10)	5	$20.14	$100.70	
5	All Purpose Flour (50 lb.)	5	$14.05	$70.25	
6	Corn Meal/Maza (25 lb.)	5	$18.69	$93.45	
7	Brown Rice (25 lb.)	5	$10.99	$54.95	
8	Salsa, Medium (1 gallon)	12	$8.47	$101.64	
9	Olive Oil (2.5 gallon)	4	$28.69	$114.76	
10	Vegetable Wash (1 gallon)	2	$8.99	$17.98	
11	**Average Price Per Unit**		$15.93		
12				**Total Cost**	⊹
13					

2. In the **Editing** group on the **Home** tab, locate and select the **arrow** next to the **AutoSum** command and then choose the **desired function** from the drop-down menu. In our example, we'll select **Sum**.
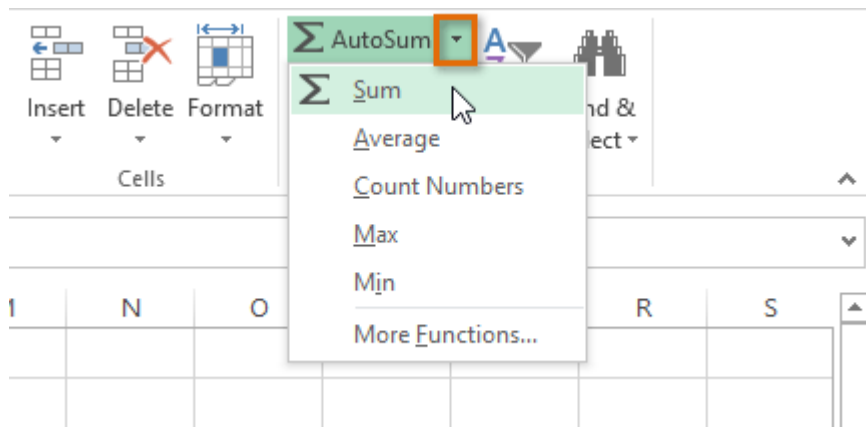
3. The selected **function** will appear in the cell. If logically placed, the AutoSum command will **automatically** select a cell range for the argument. In our example, cells **D3:D11** were selected automatically and their values will be **added** together to calculate the total cost. You can also manually enter the desired cell range into the argument.


	A	B	C	D	E
1	Food Supply Inventory Orders (Non-Perishable Items)				
2	Item	Quantity	Price Per Unit	Total Cost	Date Ordered
3	Tomatoes (case of 12)	3	$17.44	$52.32	
4	Black Bea...	5	$20.14	$100.70	
5	All Purpo	$14.05	$70.25		
6	Corn Mea	$18.69	$93.45		
7	Brown Ri	$10.99	$54.95		
8	Salsa, Medium (1 gallon)	12	$8.47	$101.64	
9	Olive Oil (2.5 gallon)	4	$28.69	$114.76	
10	Vegetable Wash (1 gallon)	2	$8.99	$17.98	
11	Average Price Per Unit		$15.93		
12			Total Cost	=SUM(D3:D11)	
13				SUM(**number1**, [number2], ...)	
14					

The cell range is selected automatically based on the location of the function

4. Press **Enter** on your keyboard. The function will be **calculated**, and the **result** will appear in the cell. In our example, the sum of D3:D11 is **$606.05**.

D12 — =SUM(D3:D11)

|	A	B	C	D	E
1	Food Supply Inventory Orders (Non-Perishable Items)				
2	Item	Quantity	Price Per Unit	Total Cost	Date Ordered
3	Tomatoes (case of 12)	3	$17.44	$52.32	
4	Black Beans (case of 10)	5	$20.14	$100.70	
5	All Purpose Flour (50 lb.)	5	$14.05	$70.25	
6	Corn Meal/Maza (25 lb.)	5	$18.69	$93.45	
7	Brown Rice (25 lb.)	5	$10.99	$54.95	
8	Salsa, Medium (1 gallon)	12	$8.47	$101.64	
9	Olive Oil (2.5 gallon)	4	$28.69	$114.76	
10	Vegetable Wash (1 gallon)	2	$8.99	$17.98	
11	Average Price Per Unit		$15.93		
12			Total Cost	$606.05	
13					

The **AutoSum** command can also be accessed from the **Formulas** tab on the **Ribbon**.
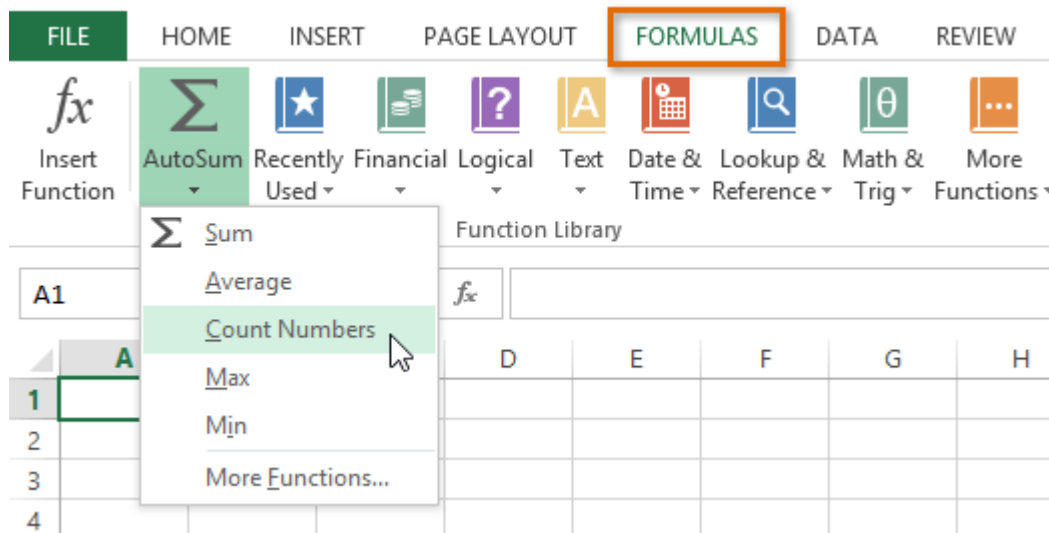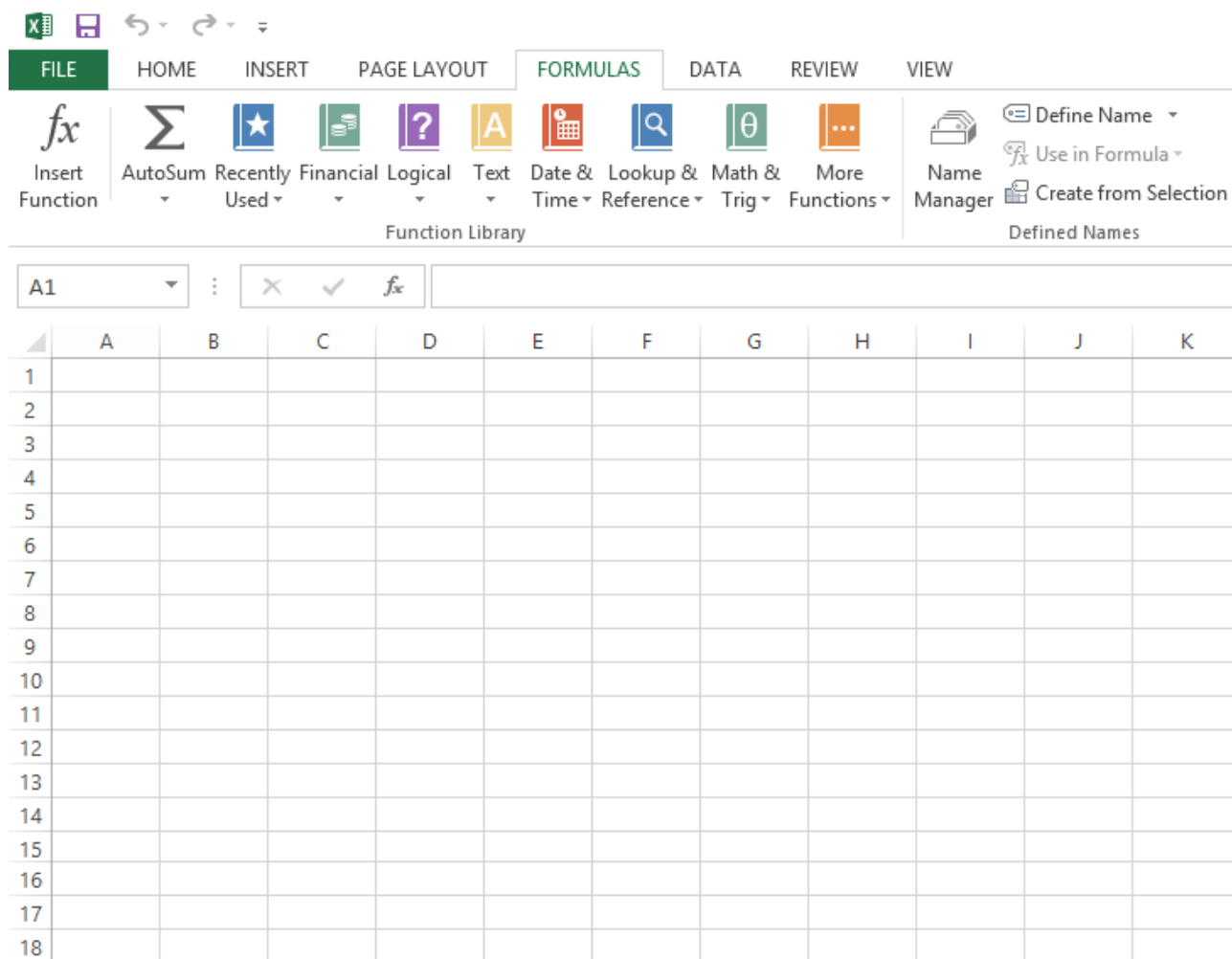

The Function Library

While there are hundreds of functions in Excel, the ones you use most frequently will depend on the **type of data** your workbooks contains. There is no need to learn every single function, but exploring some of the different **types of functions** will be helpful as you create new projects. You can search for functions **by category**, such as **Financial**, **Logical**, **Text**, **Date & Time**, and more from the **Function Library** on the **Formulas** tab.

- To access the **Function Library**, select the **Formulas** tab on the **Ribbon**.
  The **Function Library** will appear.
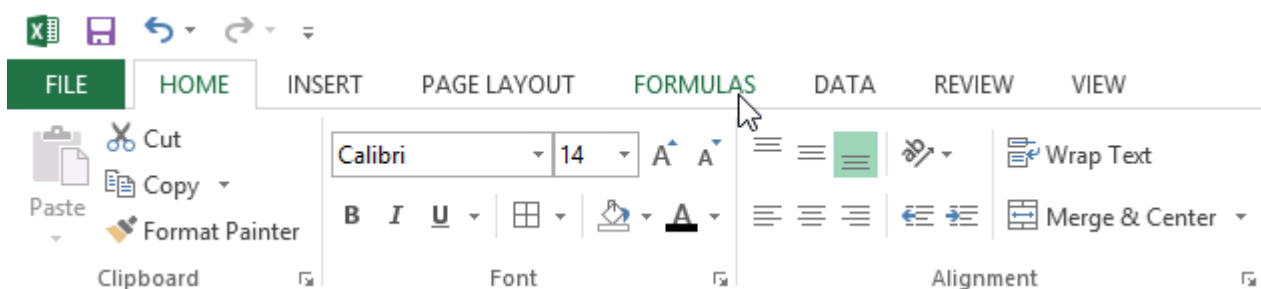
Click the buttons in the interactive below to learn more about the different types of functions in Excel.

## To insert a function from the Function Library:

In our example below, we'll use a function to calculate the **number of business days** it took to receive items after they were ordered. In our example, we'll use the dates in columns **B** and **C** to calculate the delivery time in column **D**.

1. Select the **cell** that will contain the function. In our example, we'll select cell **D3**.


2. Click the **Formulas** tab on the **Ribbon** to access the **Function Library**.
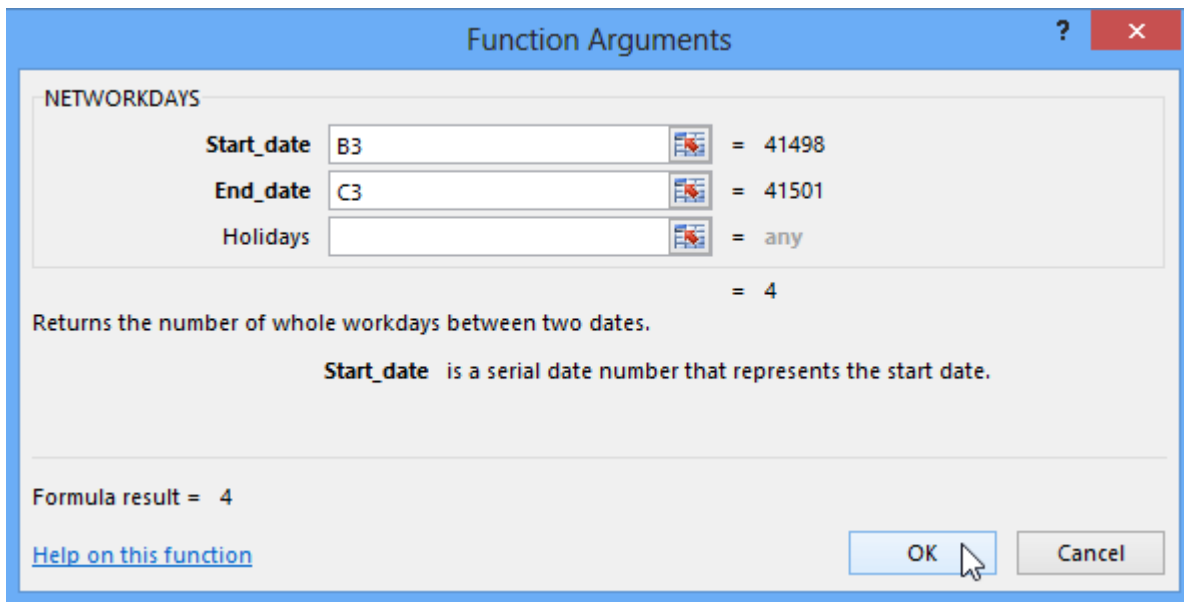
3. From the **Function Library** group, select the desired **function category**. In our example, we'll choose **Date & Time**.
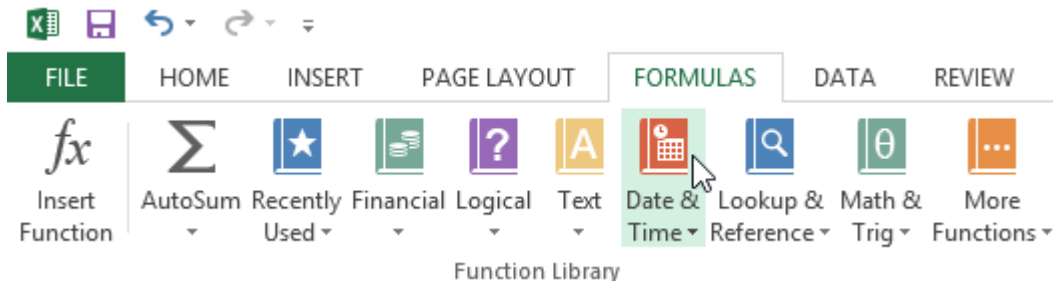
4. Select the **desired function** from the drop-down menu. In our example, we'll select the **NETWORKDAYS** function to count the number of business days between the ordered date and received date.
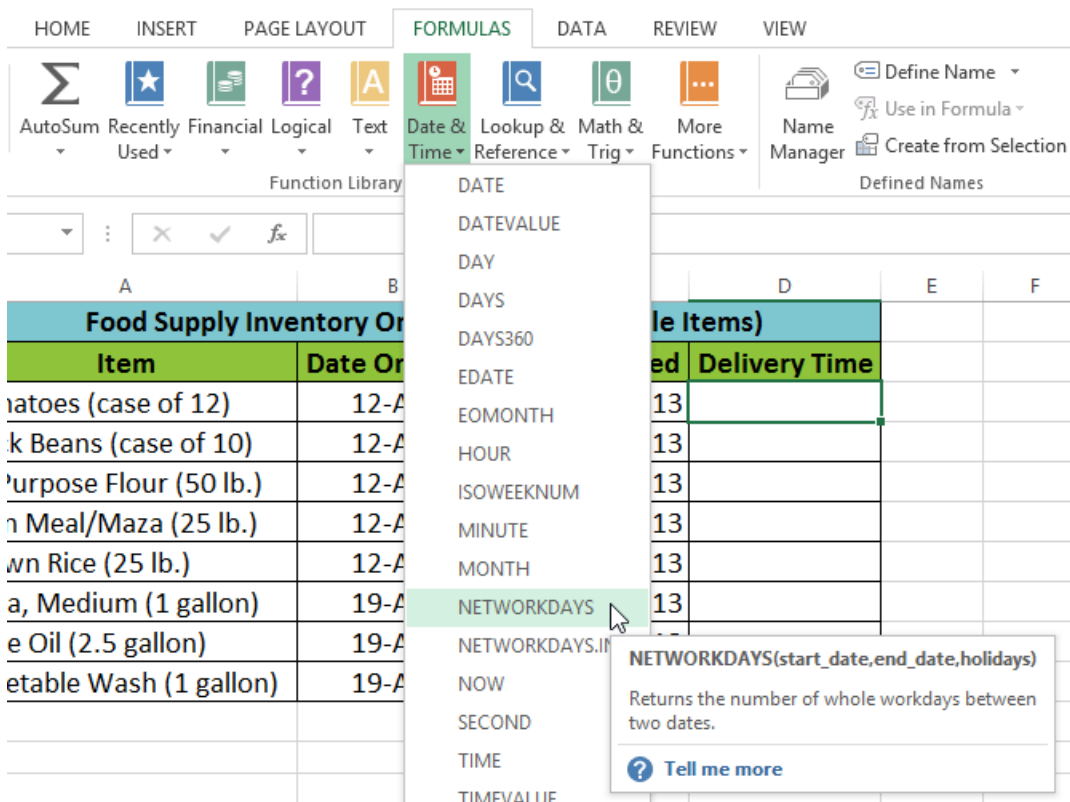
5. The **Function Arguments** dialog box will appear. From here, you'll be able to enter or select the cells that will make up the arguments in the function. In our example, we'll enter **B3** in the **Start_date:** field and **C3** in the **End_date:** field.

6. When you're satisfied with the arguments, click **OK**.

Function Arguments

NETWORKDAYS

Start_date	B3	=	41498
End_date	C3	=	41501
Holidays		=	any

= 4

Returns the number of whole workdays between two dates.

Start_date   is a serial date number that represents the start date.

Formula result =   4

Help on this function   OK   Cancel

7. The function will be **calculated,** and the **result** will appear in the cell. In our example, the result shows that it took **four business days** to receive the order.

D3   ⋮   ✕ ✓ *fx*   =NETWORKDAYS(B3,C3)

	A	B	C	D	E
1	**Food Supply Inventory Orders (Non-Perishable Items)**				
2	**Item**	**Date Ordered**	**Date Received**	**Delivery Time**	
3	Tomatoes (case of 12)	12-Aug-13	15-Aug-13	4	
4	Black Beans (case of 10)	12-Aug-13	17-Aug-13		
5	All Purpose Flour (50 lb.)	12-Aug-13	14-Aug-13		
6	Corn Meal/Maza (25 lb.)	12-Aug-13	15-Aug-13		
7	Brown Rice (25 lb.)	12-Aug-13	15-Aug-13		
8	Salsa, Medium (1 gallon)	19-Aug-13	23-Aug-13		
9	Olive Oil (2.5 gallon)	19-Aug-13	24-Aug-13		
10	Vegetable Wash (1 gallon)	19-Aug-13	21-Aug-13		
11					

Like formulas, functions can be copied to adjacent cells. Hover the mouse over the **cell** that contains the function, then click, hold, and drag the **fill handle** over the cells you want to fill. The function will be copied, and values for those cells will be calculated relative to their rows or columns.

	ntory Orders (Non-Perishable Items)	
Date Ordered	Date Received	Delivery Time
12-Aug-13	15-Aug-13	
12-Aug-13	17-Aug-13	
12-Aug-13	14-Aug-13	
12-Aug-13	15-Aug-13	
12-Aug-13	15-Aug-13	
19-Aug-13	23-Aug-13	
19-Aug-13	24-Aug-13	
19-Aug-13	21-Aug-13	

Click, hold and drag the fill handle to copy the function to adjacent cells

=NETWORKDAYS(B10,C10)

	B	C	D	E	F	G
	ntory Orders (Non-Perishable Items)					
	Date Ordered	Date Received	Delivery Time			
	12-Aug-13	15-Aug-13	4			
	12-Aug-13	17-Aug-13	5			
	12-Aug-13	14-Aug-13	3			
	12-Aug-13	15-Aug-13	4			
	12-Aug-13	15-Aug-13	4			
	19-Aug-13	23-Aug-13	5			
	19-Aug-13	24-Aug-13	5			
	19-Aug-13	21-Aug-13	=NETWORKDAYS(B10,C10)			

NETWORKDAYS(start_date, end_date, [holidays])

The Insert Function command

If you're having trouble finding the right function, the **Insert Function** command allows you to search for functions using **keywords**. While it can be useful, this command is sometimes difficult to use. If you don't have much experience with functions, you may have more success browsing the **Function Library** instead. For more **advanced users**, however, the Insert Function command can be a powerful way to find a function quickly.
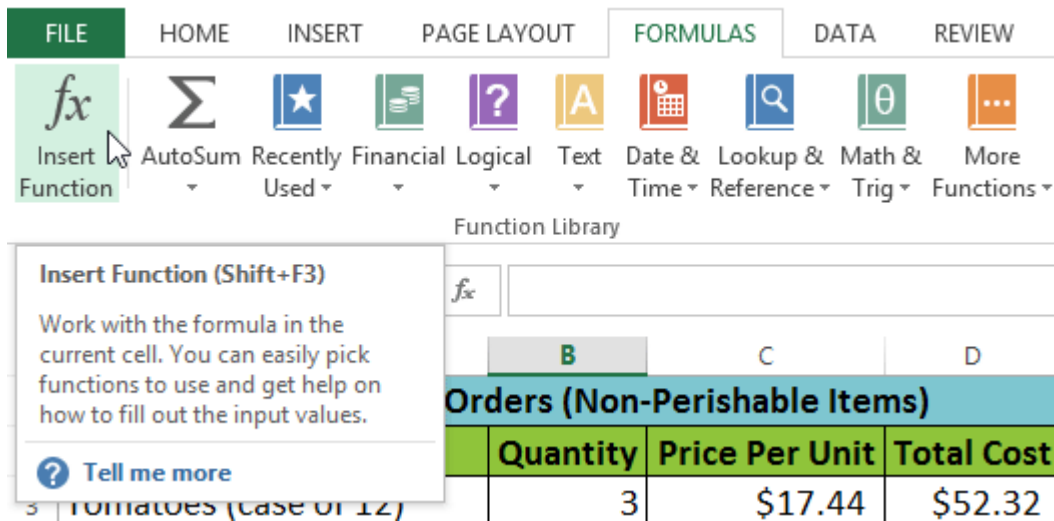
To use the Insert Function command:

In our example below, we want to find a function that will count the total number of **items** ordered. We want to count the cells in the **Item** column, which uses text. We cannot use the basic COUNT function because it will only count cells with numerical information. Instead, we will need to find a function that counts the **total number of cells** within a cell range.

1. Select the **cell** that will contain the function. In our example, we'll select cell **B16**.

	A	B	C	D	E	F
1	Food Supply Inventory Orders (Non-Perishable Items)					
2	Item	Quantity	Price Per Unit	Total Cost	Date Ordered	
3	Tomatoes (case of 12)	3	$17.44	$52.32		
4	Black Beans (case of 10)	5	$20.14	$100.70		
5	All Purpose Flour (50 lb.)	5	$14.05	$70.25		
6	Corn Meal/Maza (25 lb.)	5	$18.69	$93.45		
7	Brown Rice (25 lb.)	5	$10.99	$54.95		
8	Salsa, Medium (1 gallon)	12	$8.47	$101.64		
9	Olive Oil (2.5 gallon)	4	$28.69	$114.76		
10	Vegetable Wash (1 gallon)	2	$8.99	$17.98		
11	Average Price Per Unit		$15.93			
12			Total Cost	$606.05		
13						
14						
15	Inventory Order Summary					
16	Total Items Ordered	✛				
17	Most Expensive Item					
18	Average Shipping Time					
19						

2. Click the **Formulas** tab on the **Ribbon**, then select the **Insert Function** command.

FILE	HOME	INSERT	PAGE LAYOUT	FORMULAS	DATA	REVIEW

fx Σ ★ 💰 ? A 📅 🔍 θ ⋯

Insert Function | AutoSum | Recently Used | Financial | Logical | Text | Date & Time | Lookup & Reference | Math & Trig | More Functions

Function Library

Insert Function (Shift+F3)

Work with the formula in the current cell. You can easily pick functions to use and get help on how to fill out the input values.

❓ **Tell me more**

fx

|	B	C	D
	Orders (Non-Perishable Items)		
	Quantity	Price Per Unit	Total Cost
3	Tomatoes (case of 12)	3	$17.44	$52.32

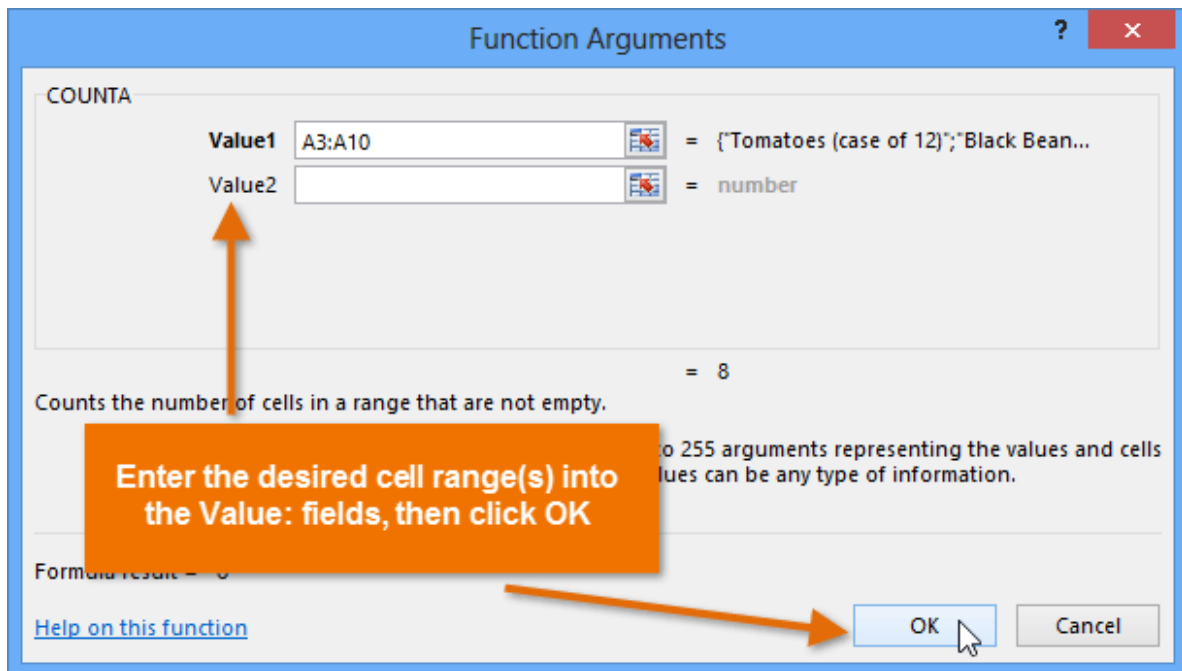3. The **Insert Function** dialog box will appear.

4. Type a few **keywords** describing the calculation you want the function to perform, then click **Go**. In our example, we'll type **Count cells**, but you can also search by selecting a **category** from the drop-down list.
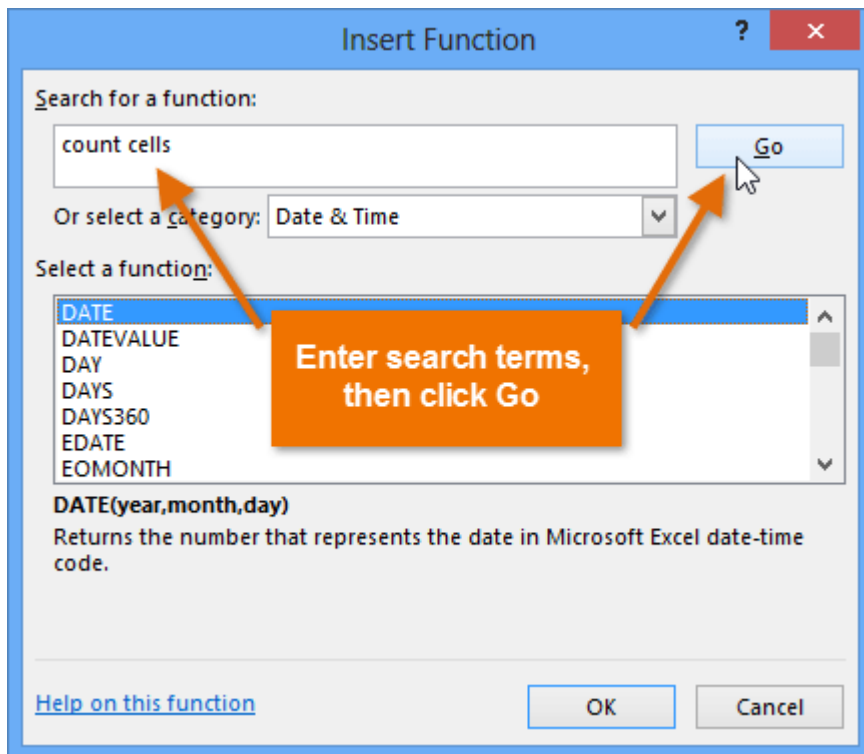
5. Review the **results** to find the desired function, then click **OK**. In our example, we'll choose **COUNTA** because it will count the number of cells in a cell range.
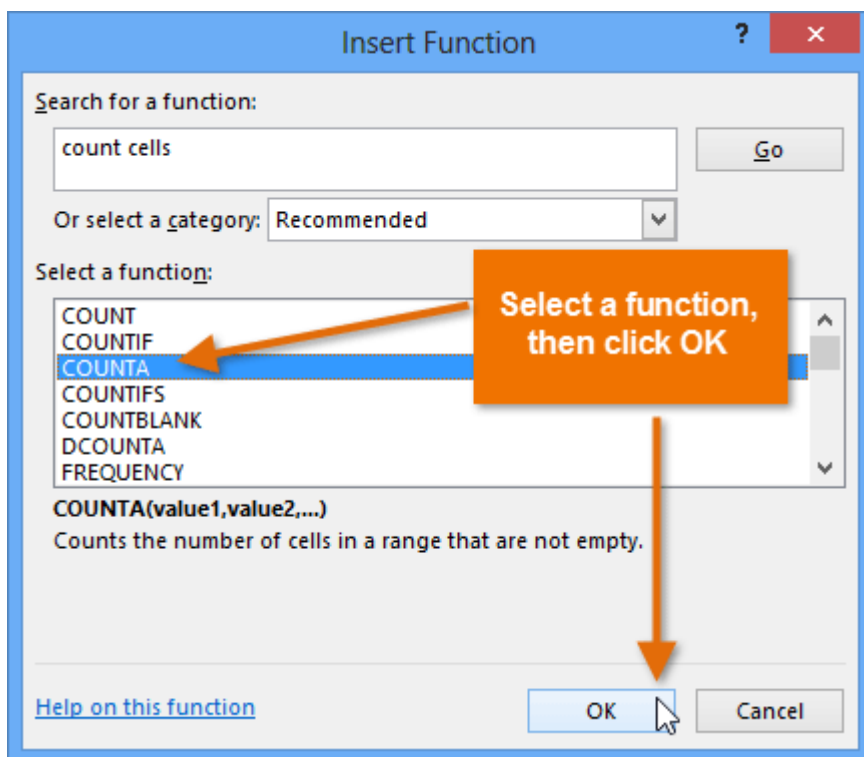
6. The **Function Arguments** dialog box will appear. Select the **Value1:** field, then enter or select the desired cells. In our example, we'll enter the cell range **A3:A10**. You may continue to add arguments in the **Value2**: field, but in this case we only want to count the number of cells in the cell range **A3:A10**.

7. When you're satisfied, click **OK**.

Counts the number of cells in a range that are not empty.

Enter the desired cell range(s) into the Value: fields, then click OK

8. The function will be **calculated**, and the **result** will appear in the cell. In our example, the result shows that a total of **eight items** were ordered.

The inserted function and calculated value

Challenge!

1. Open the practice document Excel2013_Functions_Practice.xlsx.

2. Create a function that contains one **argument**. Use the **SUM** function in cell **B16** to calculate the total quantity of items ordered.

3. Use the **AutoSum** command to insert a function. Insert the **MAX** function in cell **B23** and use the cell range **D3:D15** for the argument to find the most expensive item that was ordered.

Homework

1. Linear Regression

Fill out the following data in a spreadsheet:

	A	B	C	D	E	F	G
1	AGE X	GLUCOSE LEVEL Y	x	y	xy	x^2	y^2
2	43	99					
3	21	65					
4	25	79					
5	42	75					
6	57	87					
7	59	81					
8							

To calculate the linear regression $y = a + bx$ that approximates a set of data points you will need to:

1. Find the average of X's and Y's
   Insert the formula **=AVERAGE(A2:A7)** in cell **A8**.
   Insert the formula **=AVERAGE(B2:B7)** in cell **B8**.

2. Compute the standard deviation about X and Y:
$$x = X - X_{avg}, y = Y - Y_{avg}$$
   Insert the formula =**A2-A8** in cell **C2** and copy the formula down with the **fill handle**.
   Do the same for the y column

3. Compute the squared values of the standard deviations and the scalar product of x and y
   Insert the formula **=C2*D2** in cell **E2** and copy the formula down with the fill handle.
   Insert the formula **=C2*C2** in cell **F2** and copy the formula down with the fill handle.
   Do the same for the y^2 column.

4. Compute the coefficients of the line a and b:
$$b = \frac{\sum xy}{\sum x^2} \text{ and } a = Y_{avg} - bX_{avg}$$
   Add the function **=SUM(E2:E7)** in cell **E8**.
   Do the same for the remaining two columns x^2 and y^2
   Compute in two adjacent cell the two coefficients a and b:

   a = 65.14157 and b = 0.385225

   In the end, the table should have the following values:

AGE X	GLUCOSE LEVEL Y	x	y	xy	x2	y2	Ycomp
43	99	1.833333	18	33	3.361111	324	81.70625
21	65	-20.1667	-16	322.6667	406.6944	256	73.2313
25	79	-16.1667	-2	32.33333	261.3611	4	74.7722
42	75	0.833333	-6	-5	0.694444	36	81.32102
57	87	15.83333	6	95	250.6944	36	87.0994
59	81	17.83333	0	0	318.0278	0	87.86985
41.16667	81			478	1240.833	656	
				b	0.385225		
				a	65.14157		

2. Centroid cross section

To calculate the centroid of a cross section made out of parts with known centroid positions about a central coordinate system, the following formulae can be used:

$$x = \frac{\sum_{i=1}^{n} x_i A_i}{\sum_{i=1}^{n} A_i}, y = \frac{\sum_{i=1}^{n} y_i A_i}{\sum_{i=1}^{n} A_i}$$

where: x_i and y_i are the coordinates of each parts centroid about the global axis and A_i is the area of the part
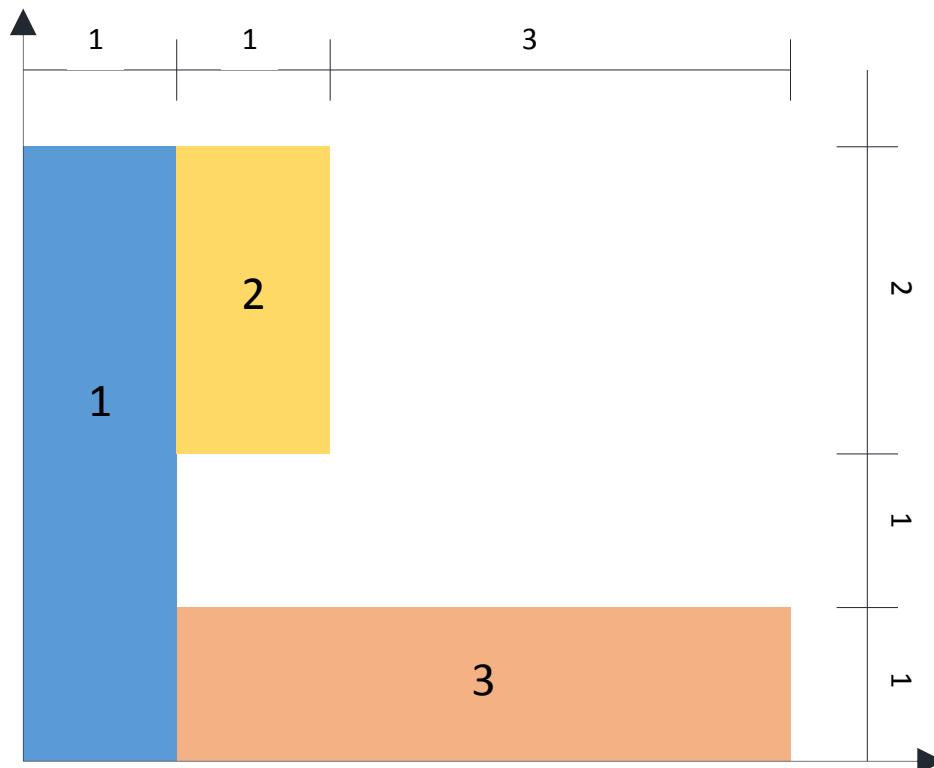
1. Create a new spreadsheet
2. Fill out the header of the table as in the figure below.
3. Fill out each parts area, and centroid position x and y
4. Enter the formulas for calculating the products between each area and their coordinates in columns **E** and **F**.
5. Sum up the values in columns E and F
6. Compute the centroids position with the two formulae given in the beginning

	A	B	C	D	E	F
1	Part	Ai	xi	yi	xiAi	yiAi
2	1	4	0.5	2		
3	2					
4	3					
5				Σ		
6						