Technical Institute of Administration

Business Administration

4. Microsoft Excel - Formulas and Functions

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4. Formulas and Functions

4.1. Intro to 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.

4.1.1. 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.

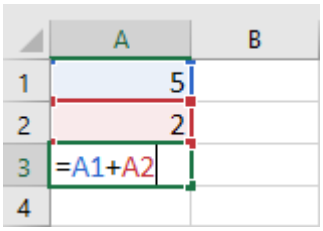
Addition	+
Subtraction	-
Multiplication	*
Division	/
Exponents	^

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.

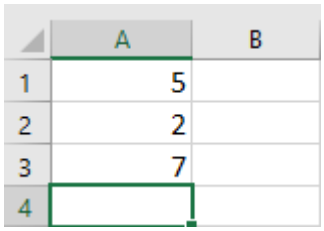
4.1.2. Understanding cell references

While you can create simple formulas in Excel using numbers (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.

In the formula below, cell A3 adds the values of cells A1 and A2 by making cell references:

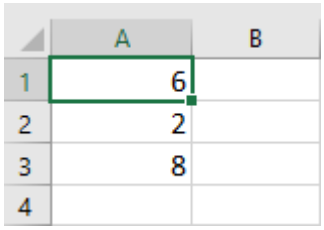


When you press Enter, the formula calculates and displays the answer in cell A3:



	A	B
1	5	
2	2	
3	7	
4		

If the values in the referenced cells change, the formula automatically recalculates:



	A	B
1	6	
2	2	
3	8	
4		

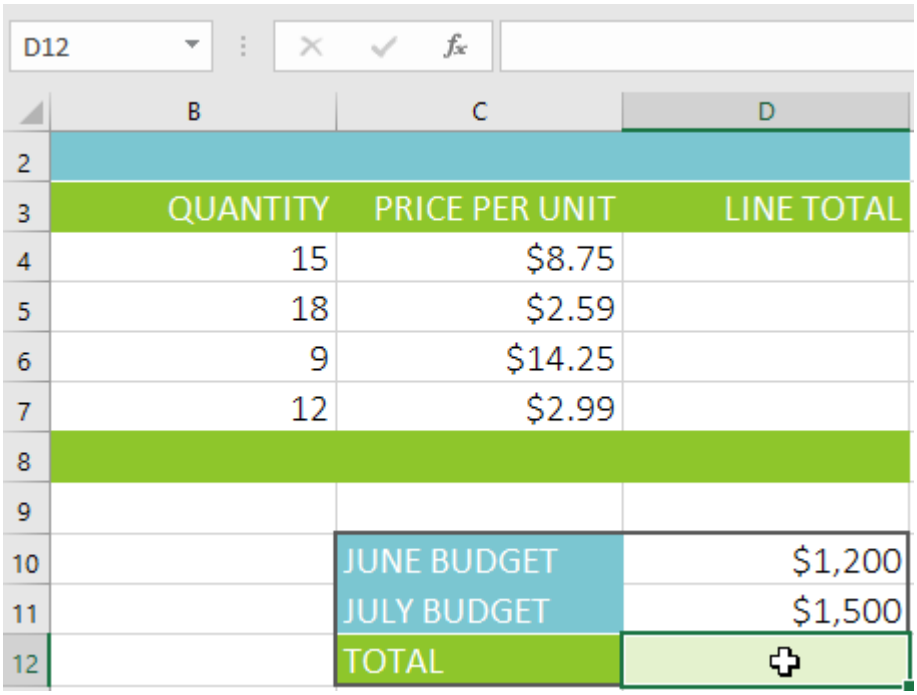
By combining a mathematical operator with cell references, you can create a variety of simple formulas in Excel. Formulas can also include a combination of cell references and numbers, as in the examples below:

=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

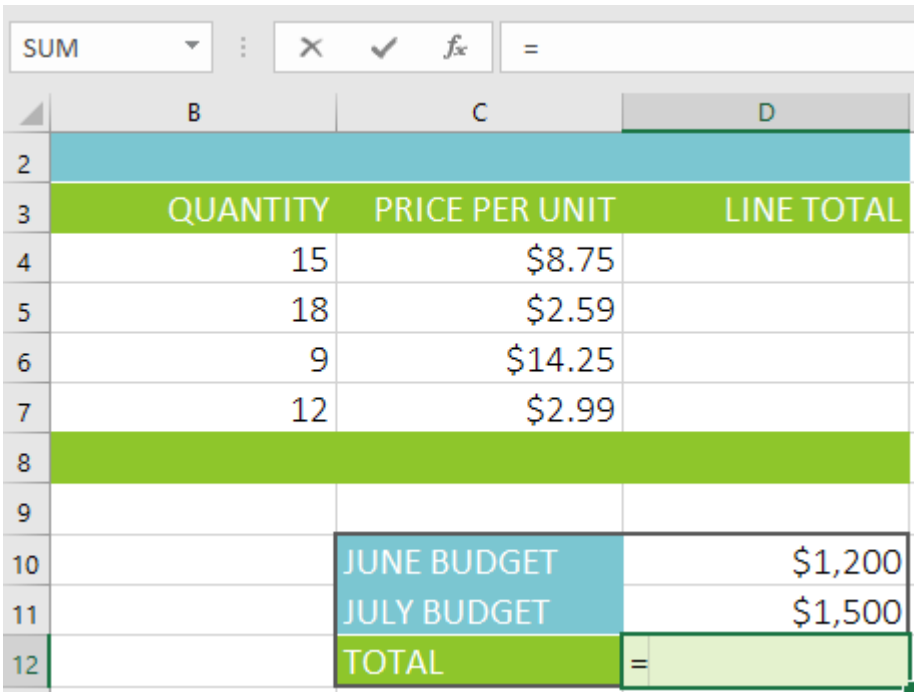
4.1.3. To create a formula:

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

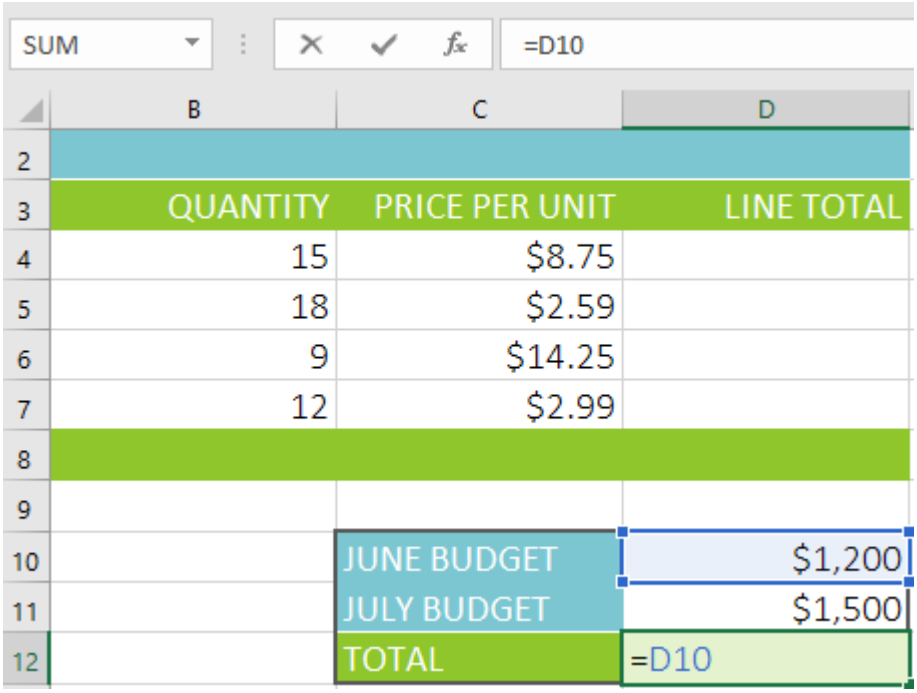
1. Select the **cell** that will contain the formula. In our example, we'll select cell **D12**.



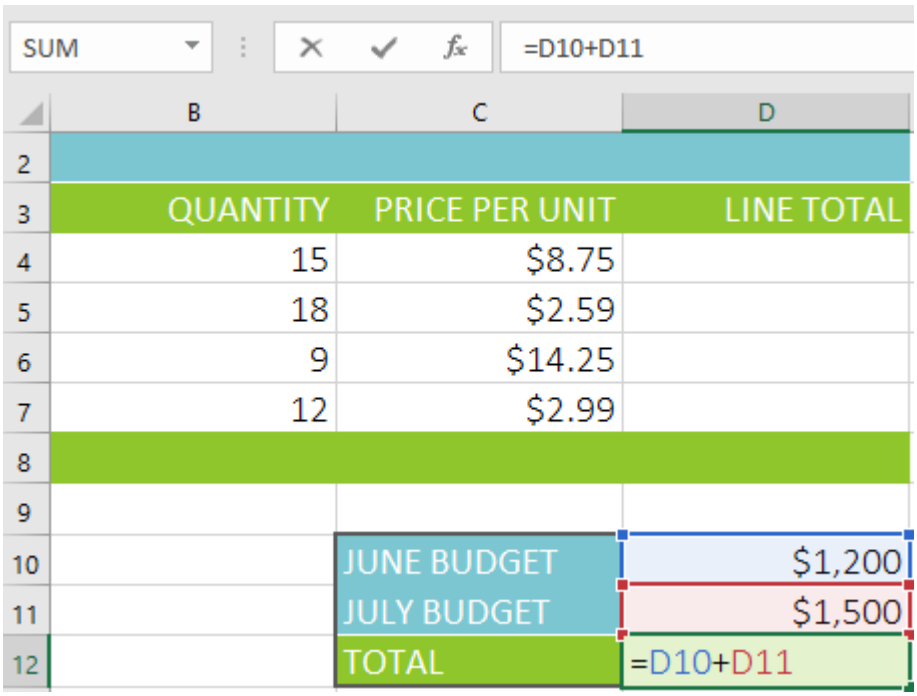
2. Type the **equals sign (=)**. Notice how it appears in both the **cell** and the **formula bar**.



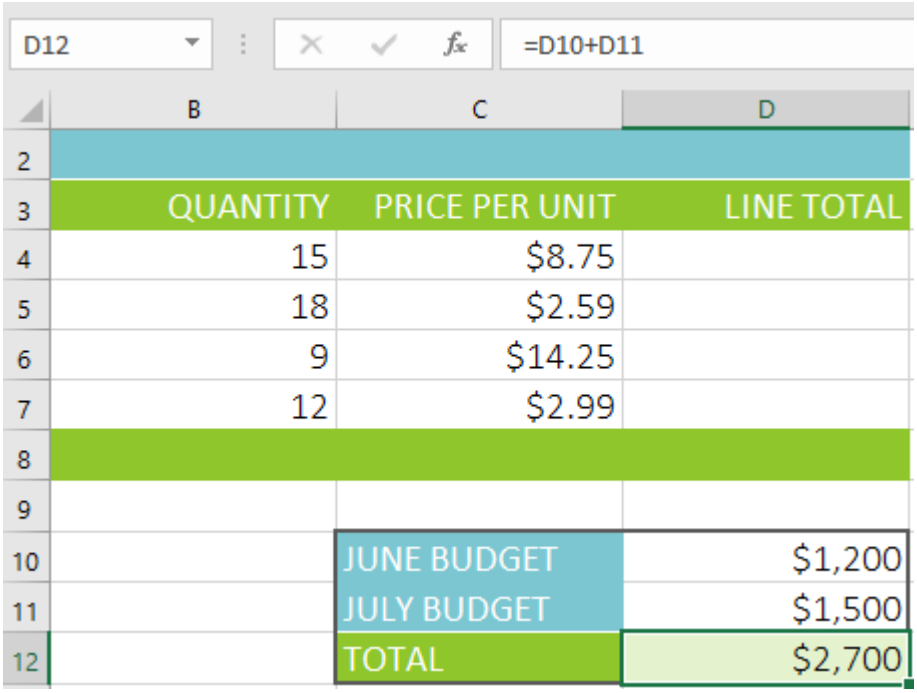
3. Type the **cell address** of the cell you want to reference first in the formula: cell **D10** in our example. A **blue border** will appear around the referenced cell.



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 **D11** in our example. A **red border** will appear around the referenced cell.



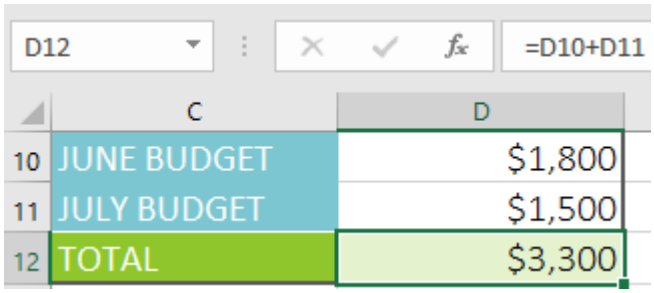
6. Press **Enter** on your keyboard. The formula will be **calculated**, and the **value** will be displayed in the cell. If you select the cell again, notice that the cell displays the result, while the formula bar displays the formula.



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.

4.1.4. 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 D10 from $1,200 to $1,800. The formula in D12 will automatically recalculate and display the new value in cell D12.

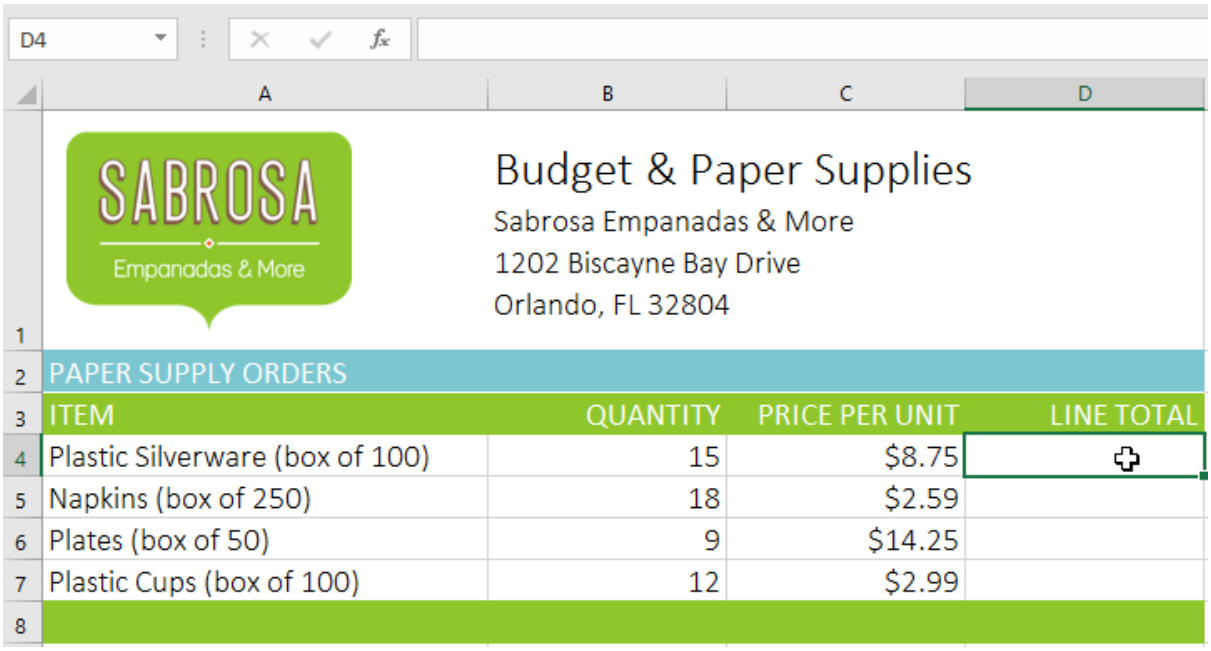


Excel **will not always tell you** if your formula contains an error, so it's up to you to check all of your formulas. To learn how to do this.

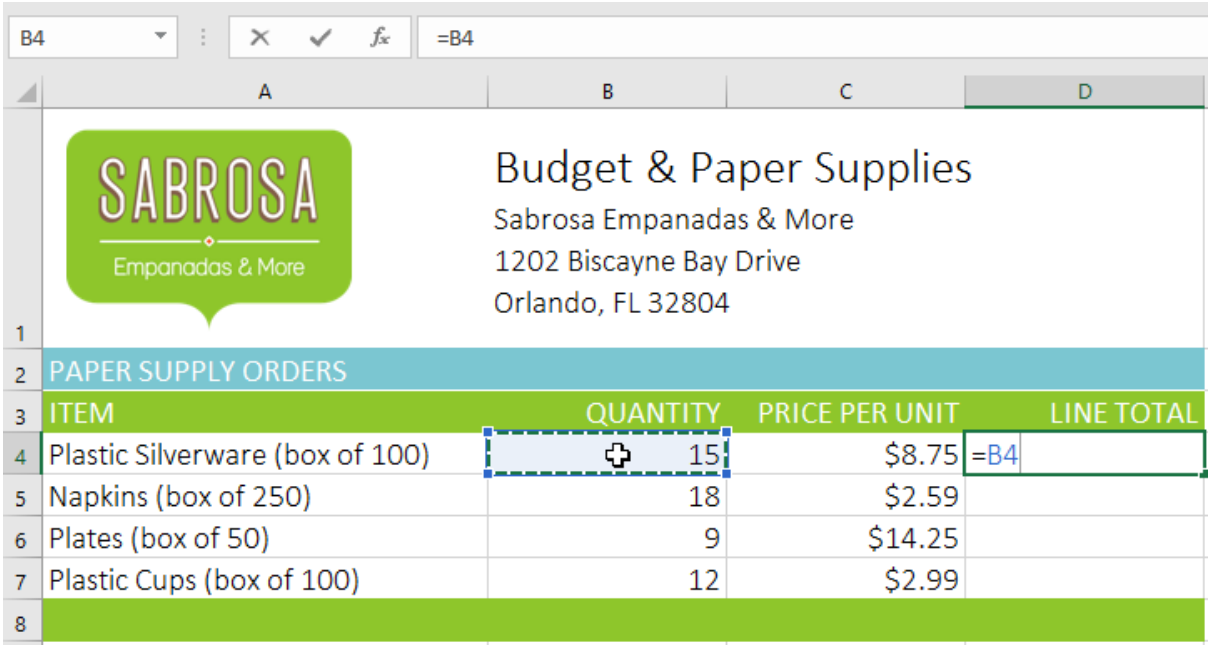
4.1.5. To create a formula using the point-and-click method:

Instead of typing cell addresses manually, you can **point and click** 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.

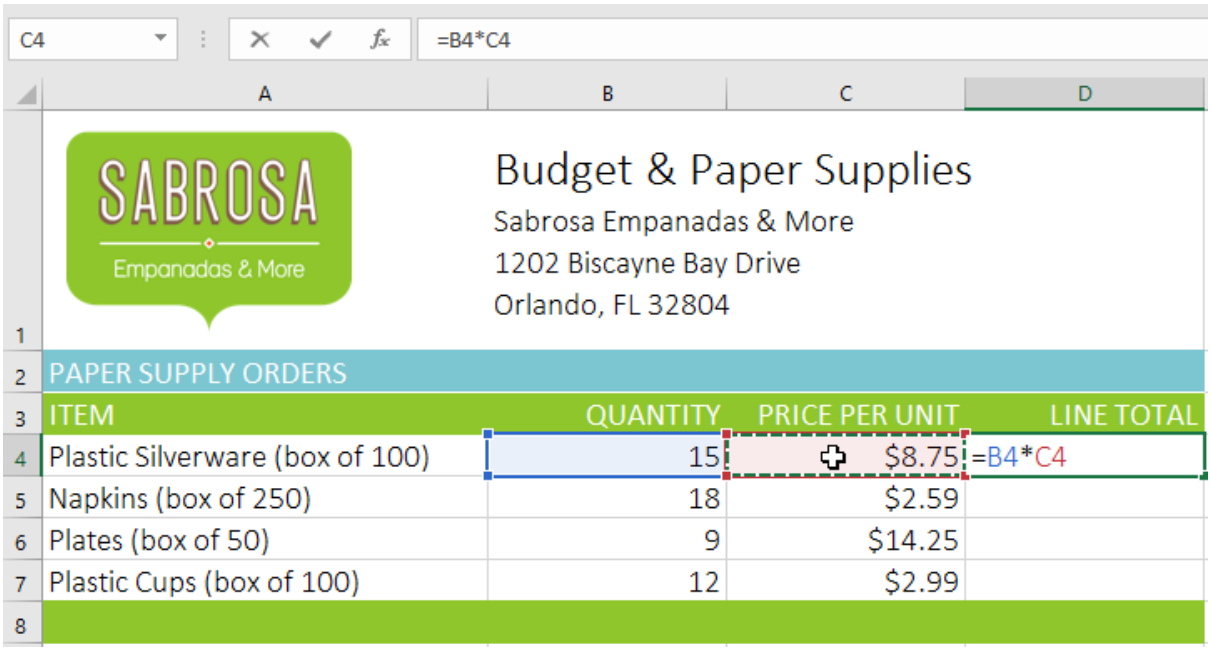
1. Select the **cell** that will contain the formula. In our example, we'll select cell **D4**.



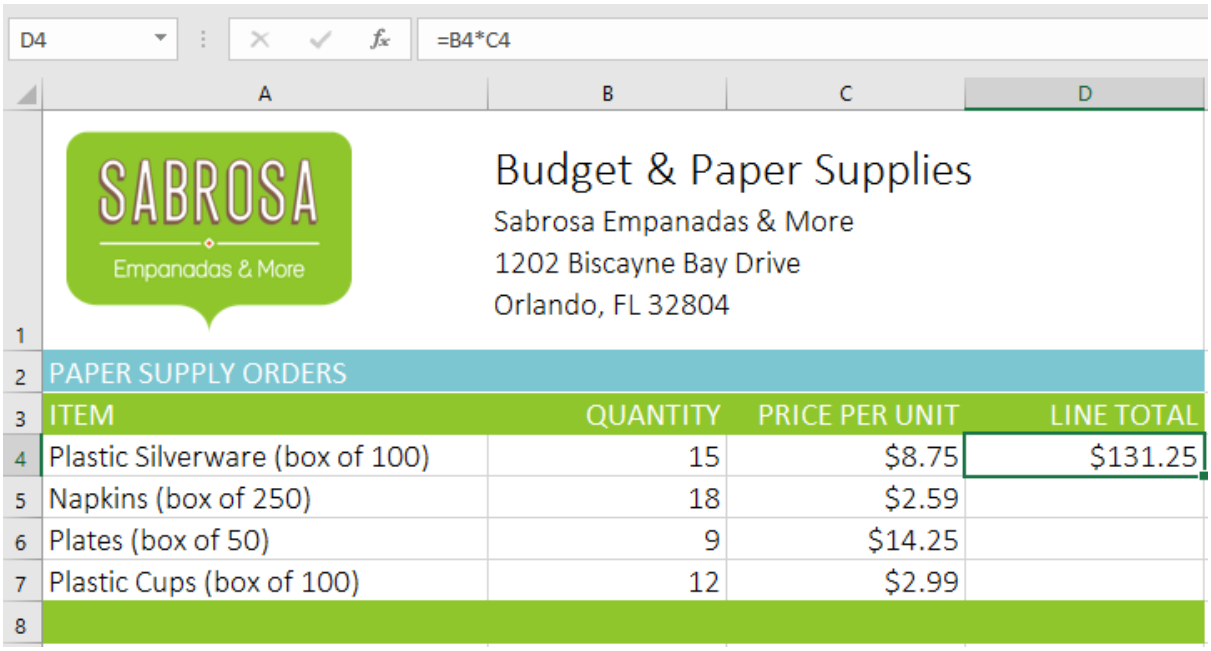
2. Type the **equals sign (=)**.
3. Select the **cell** you want to reference first in the formula: cell **B4** in our example. The **cell address** will appear in the formula.



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 **C4** in our example. The **cell address** will appear in the formula.



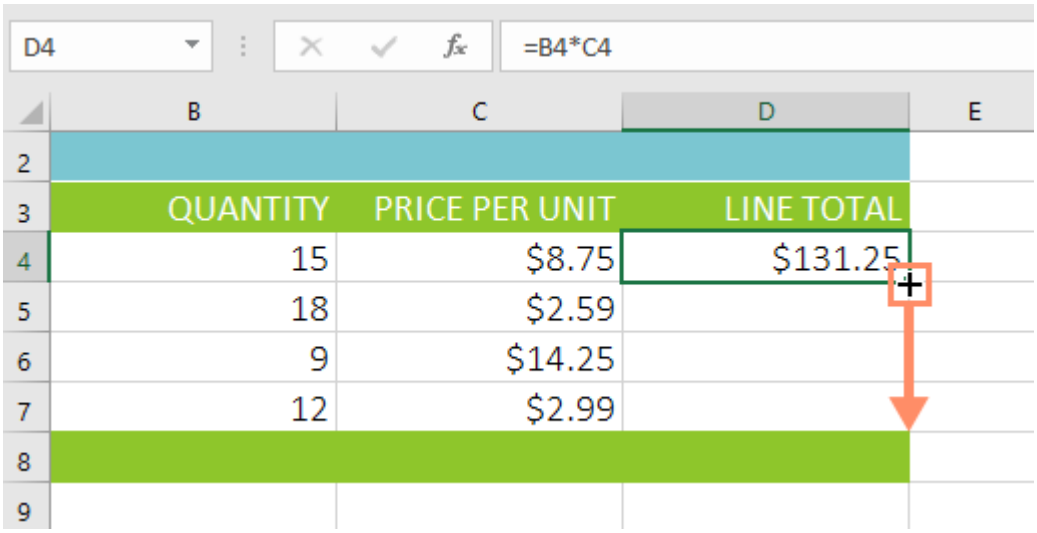
6. Press **Enter** on your keyboard. The formula will be **calculated**, and the **value** will be displayed in the cell.



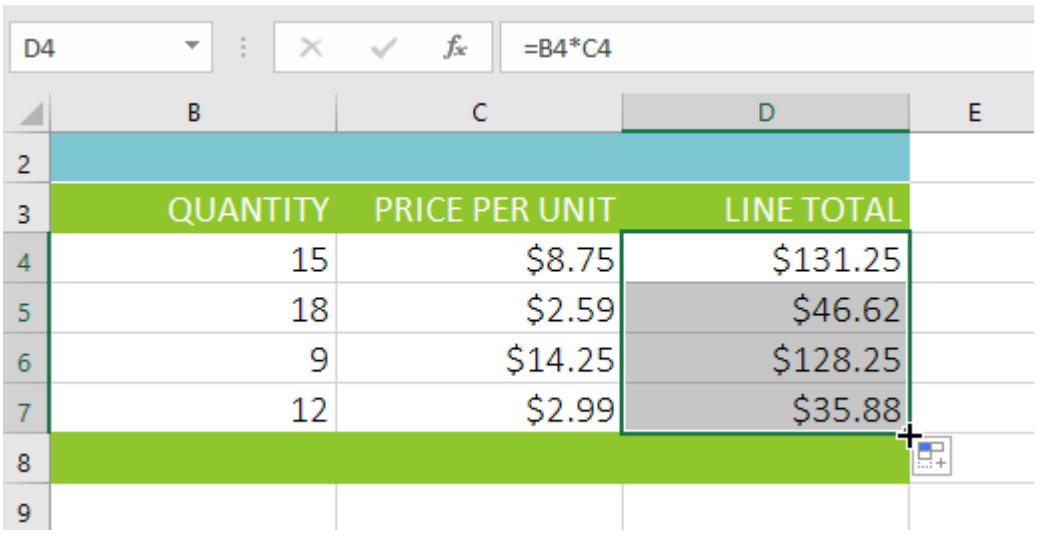
4.1.6. Copying formulas with the fill handle

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. The **fill handle** is the small square at the bottom-right corner of the selected cell(s).

1. Select the cell containing the formula you want to copy. Click and drag the **fill handle** over the cells you want to fill.



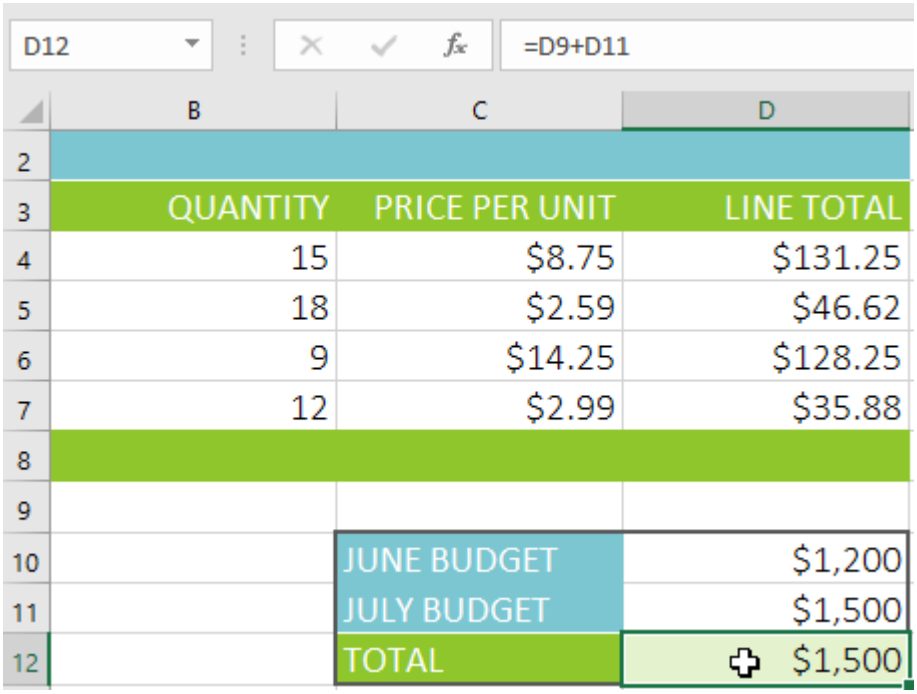
2. After you release the mouse, the formula will be copied to the selected cells.



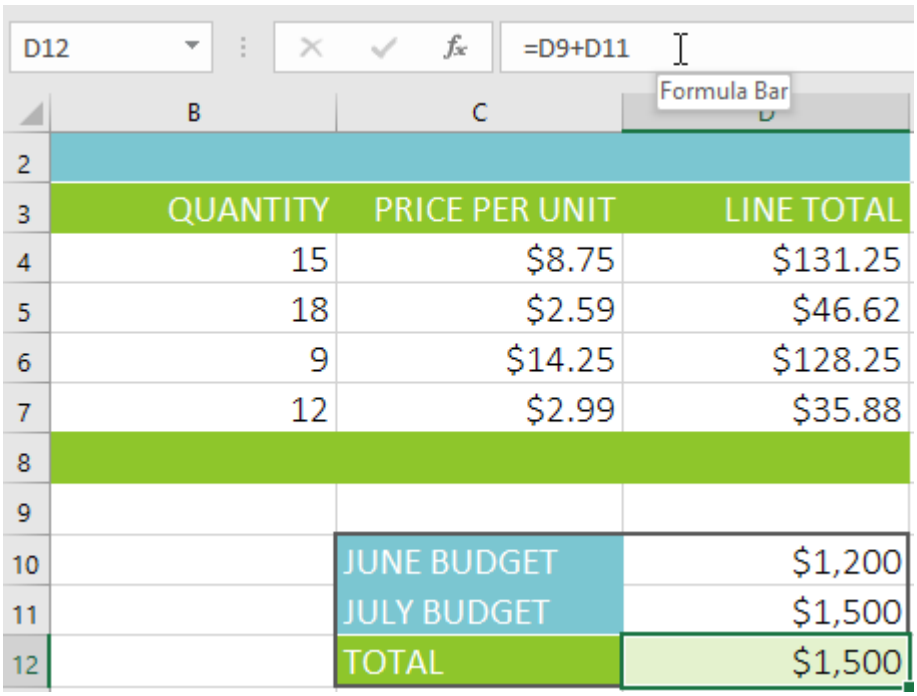
4.1.7. To edit a formula:

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.

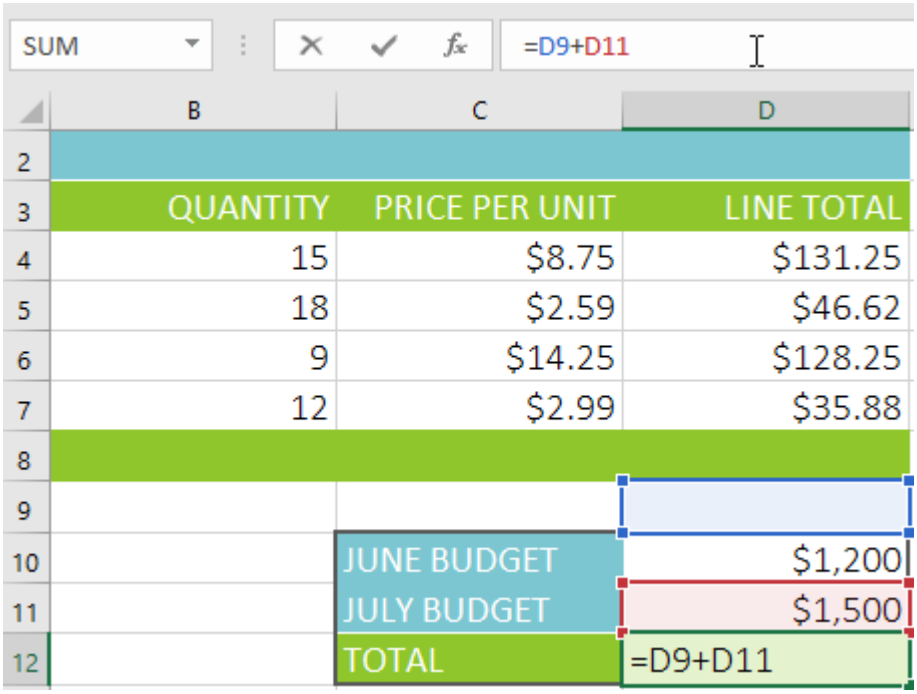
1. Select the **cell** containing the formula you want to edit. In our example, we'll select cell **D12**.



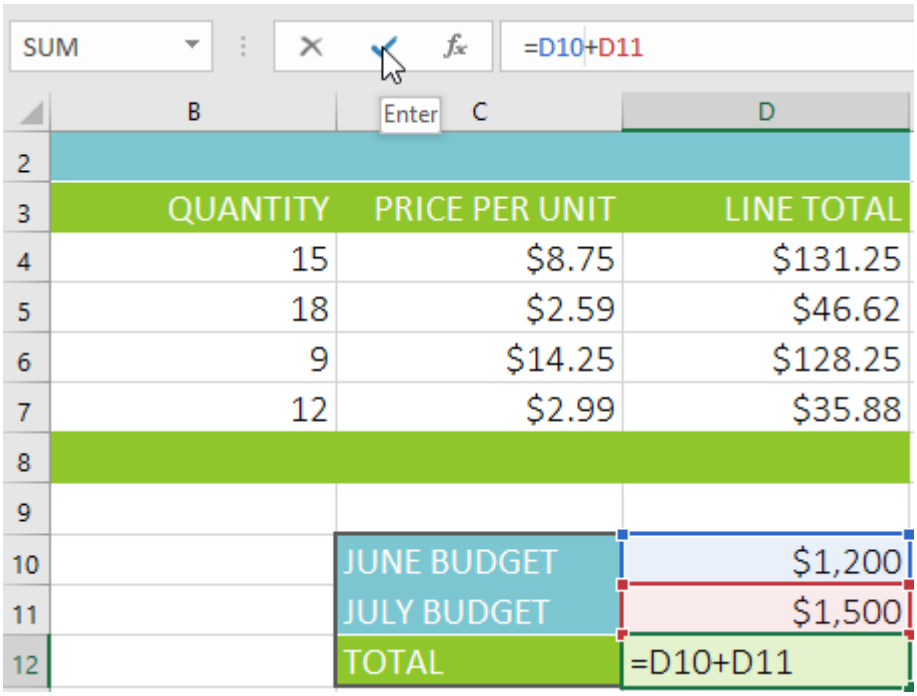
2. Click the **formula bar** to edit the formula. You can also **double-click** the cell to view and edit the formula directly within the cell.



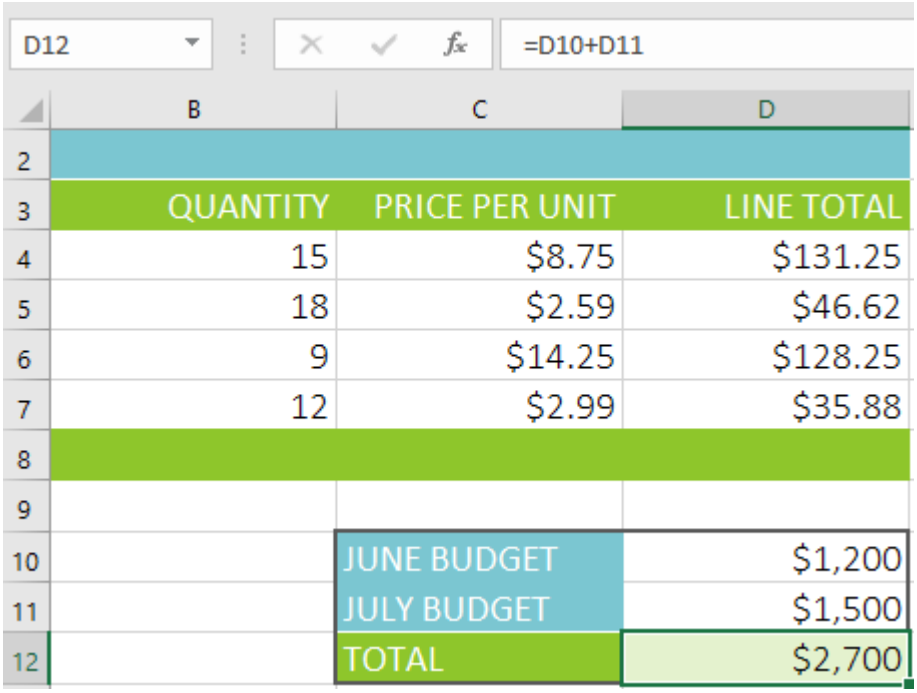
3. A **border** will appear around any referenced cells. In our example, we'll change the first part of the formula to reference cell **D10** instead of cell **D9**.



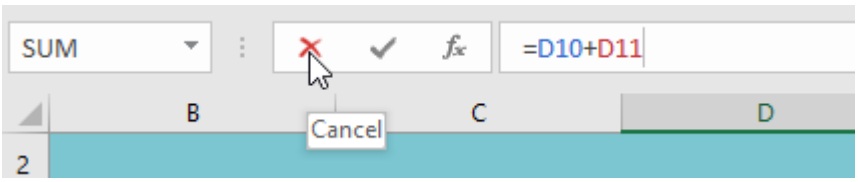
4. When you're finished, press **Enter** on your keyboard or select the **Enter** command in the formula bar.



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



If you change your mind, you can press the **Esc** key on your keyboard or click the **Cancel** command in the formula bar 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.

4.2.Creating More Complex Formulas

You may have experience working with formulas that contain only one operator, such as **7+9**. More complex formulas can contain **several mathematical operators**, such as **5+2*8**. When there's more than one operation in a formula, the **order of operations** tells Excel which operation to calculate first. To write formulas that will give you the correct answer, you'll need to understand the order of operations.

4.2.1. 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

A mnemonic that can help you remember the order is **PEMDAS**, or **P**lease **E**xcuse **M**y **D**ear **A**unt **S**ally.

Click the arrows in the slideshow below to learn how the order of operations is used to calculate formulas in Excel.

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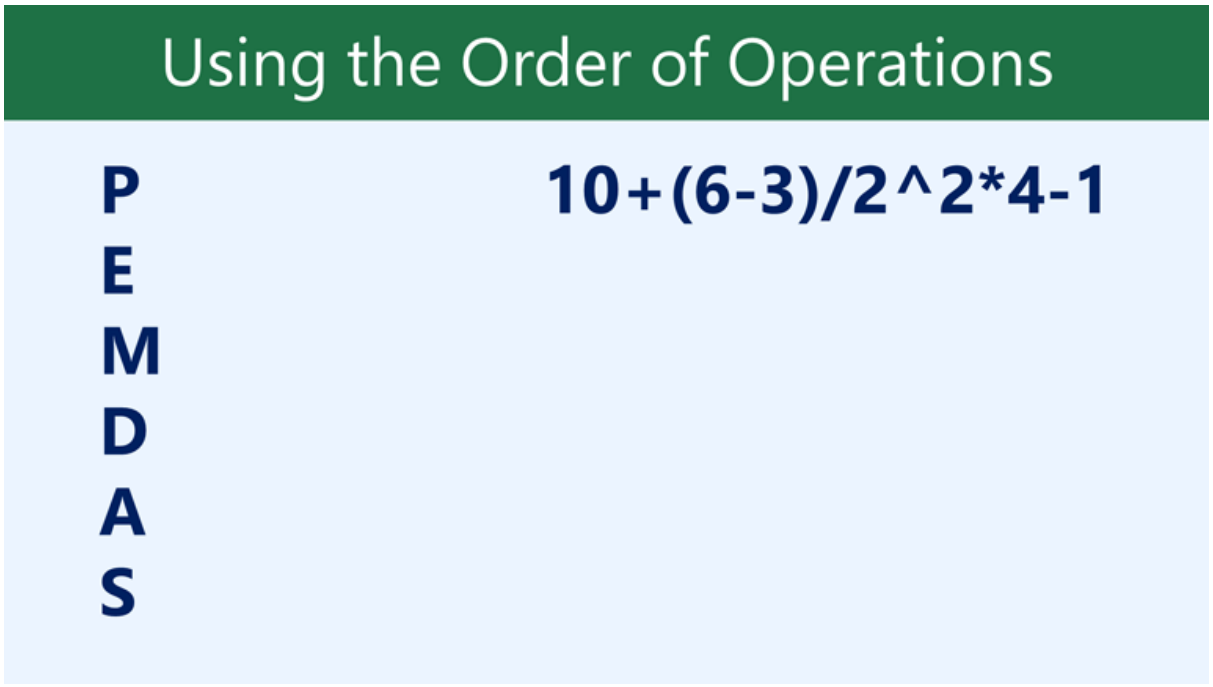
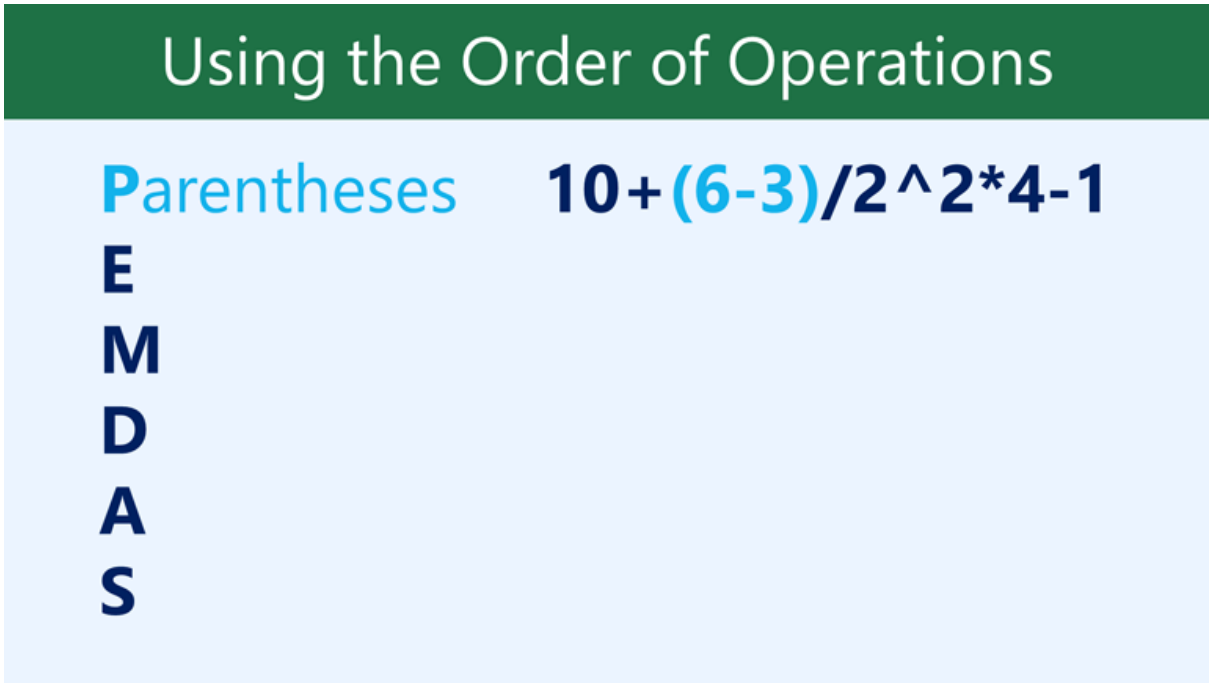
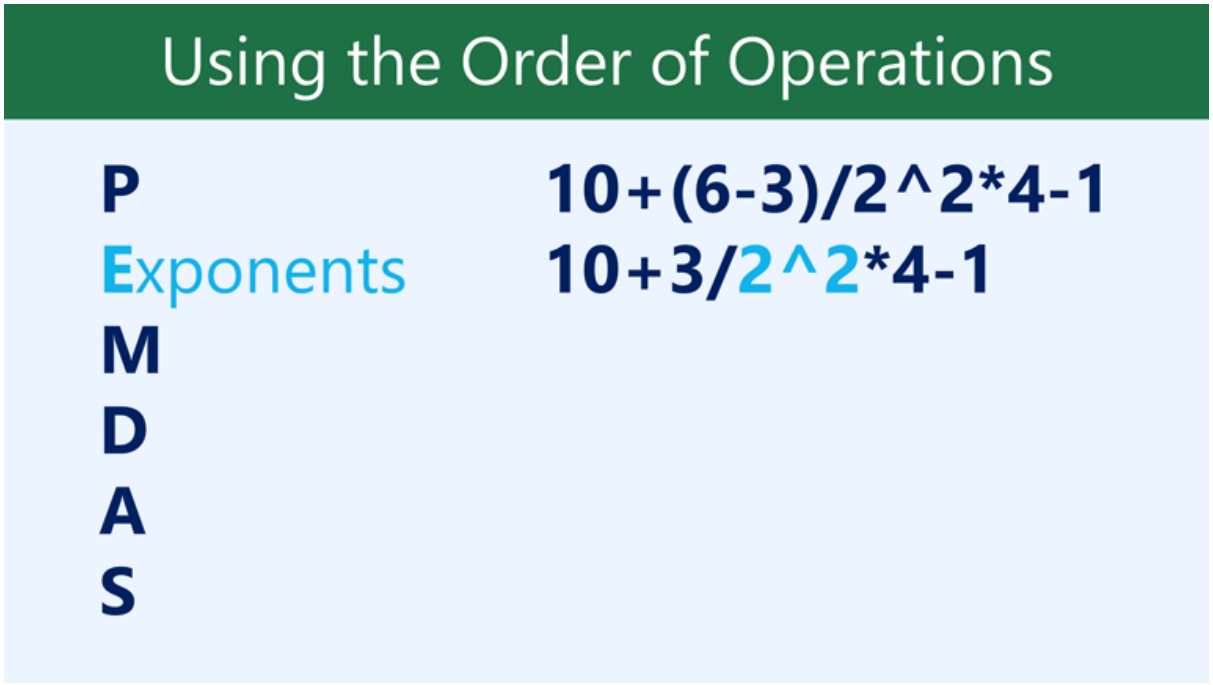


While this formula may look complicated, we can use the order of operations step by step to find the right answer.

- 

First, we'll start by calculating anything inside parentheses. In this case, there's only one thing we need to calculate: 6-3=3.

- 

As you can see, the formula already looks simpler. Next, we'll look to see if there are any exponents. There is one: 2^2=4.

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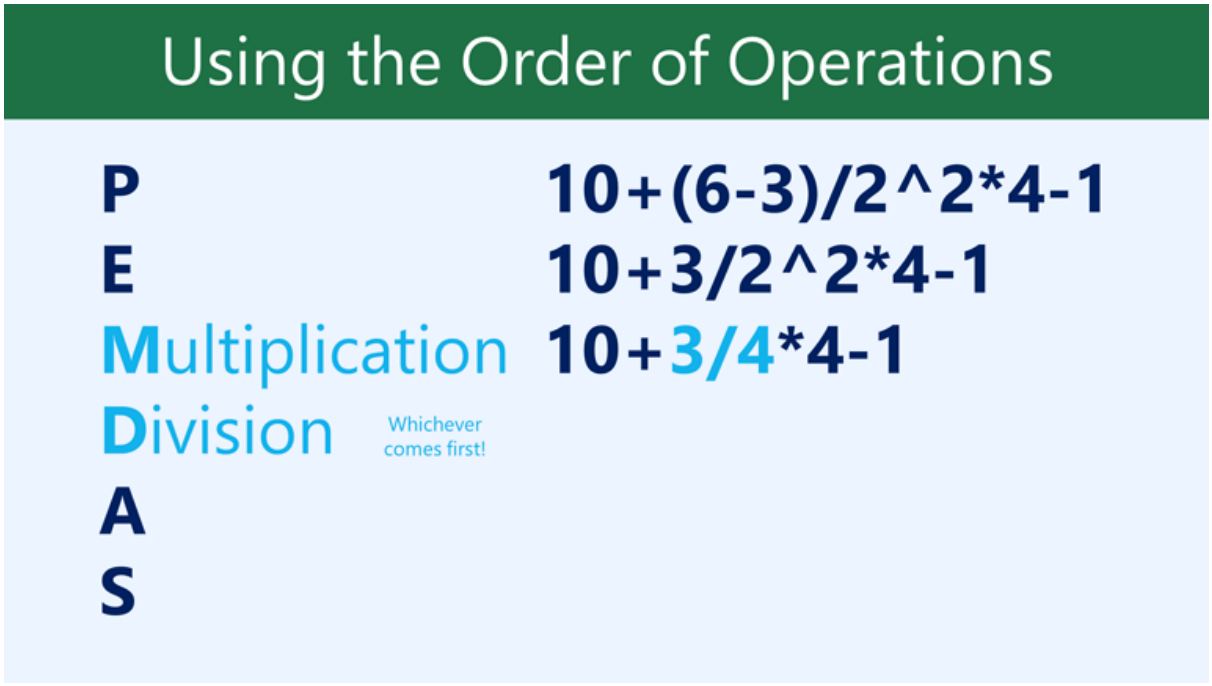

Next, we'll solve any multiplication and division, working from left to right. Because the division operation comes before the multiplication, it's calculated first: 3/4=0.75.

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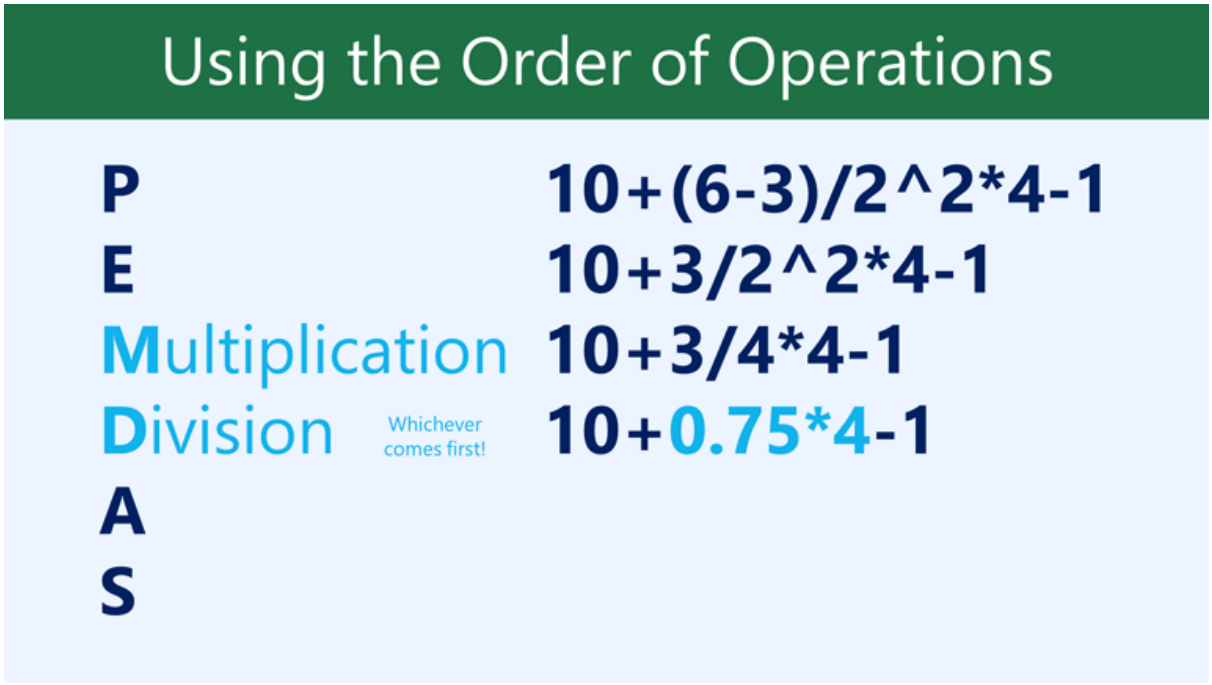

Now, we'll solve our remaining multiplication operation: 0.75*4=3.

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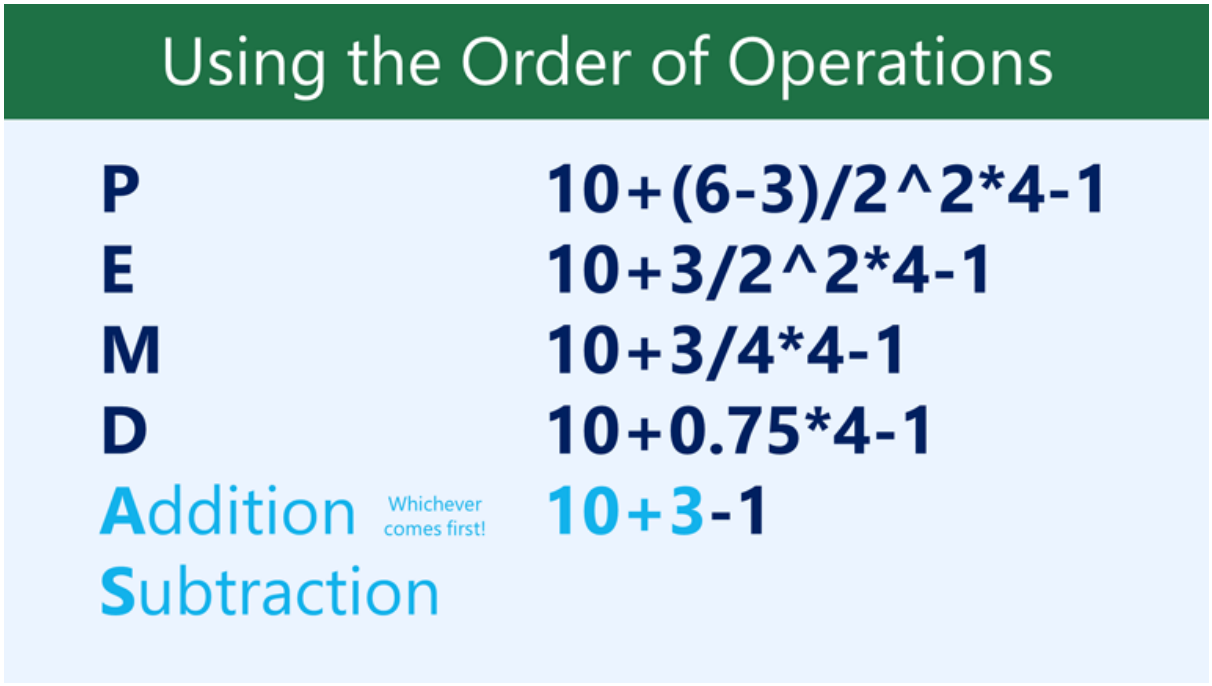

Next, we'll calculate any addition or subtraction, again working from left to right. Addition comes first: 10+3=13.

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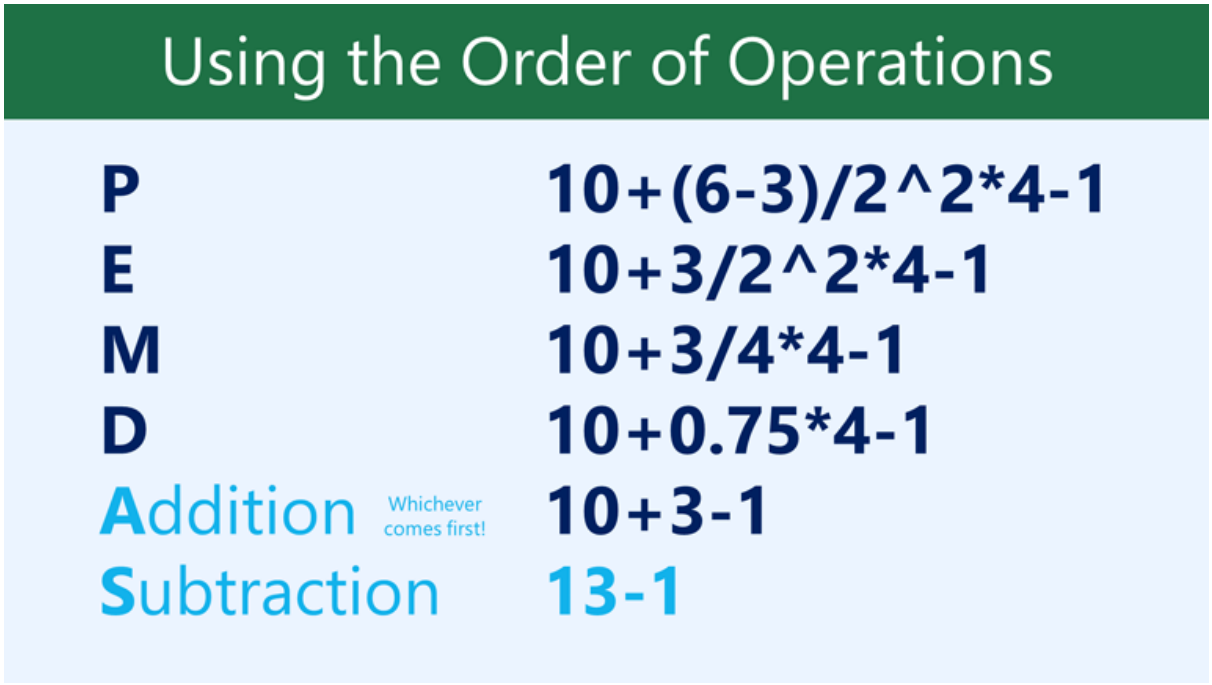

Finally, we have one remaining subtraction operation: 13-1=12.

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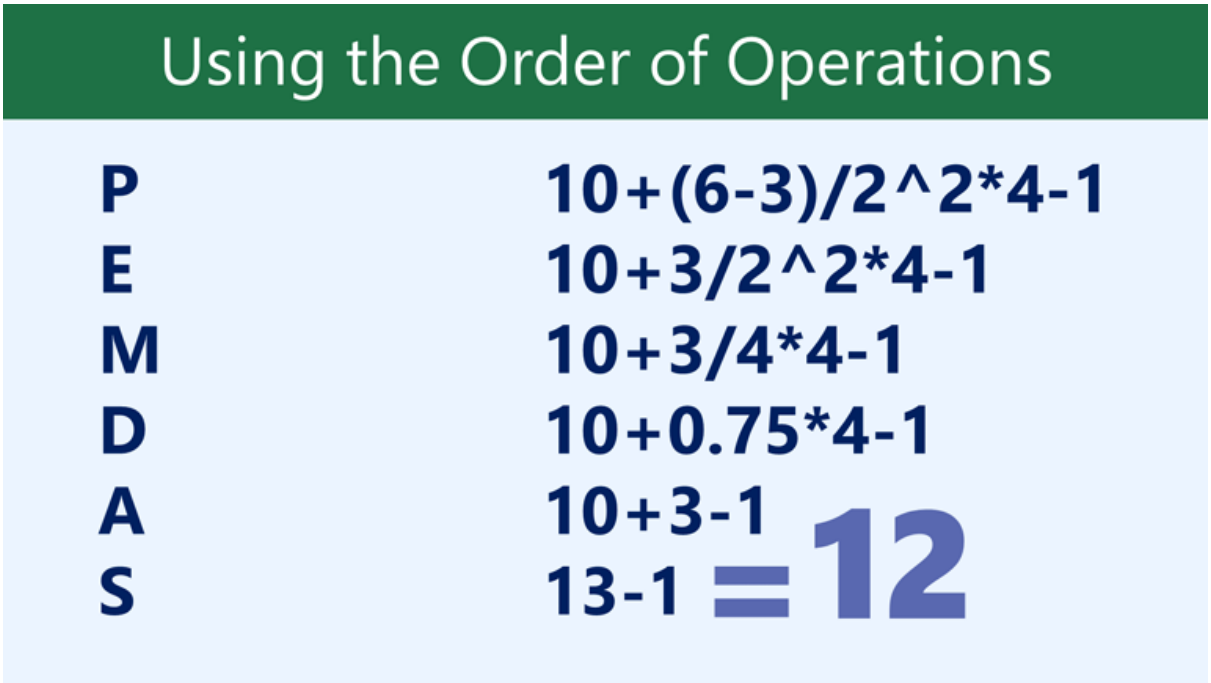

Now we have our answer: 12. And this is the exact same result you would get if you entered the formula into Excel.

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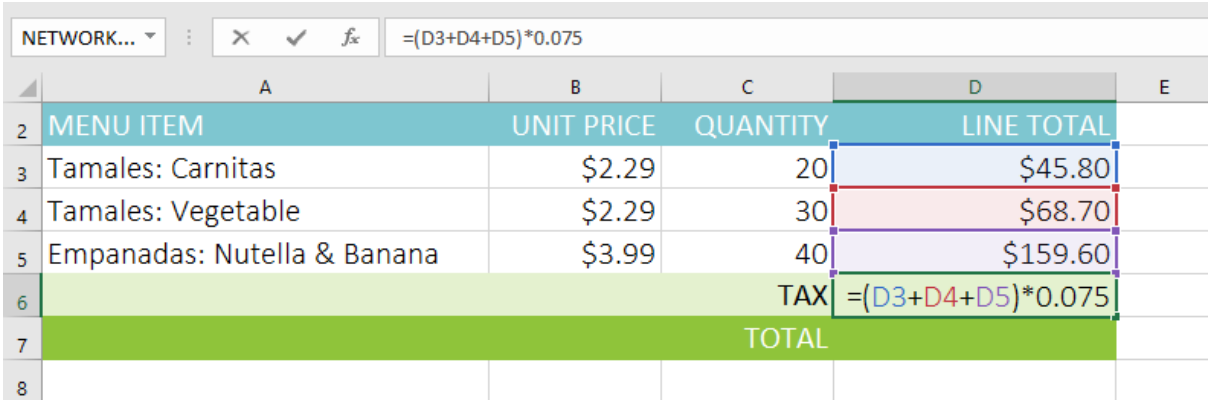
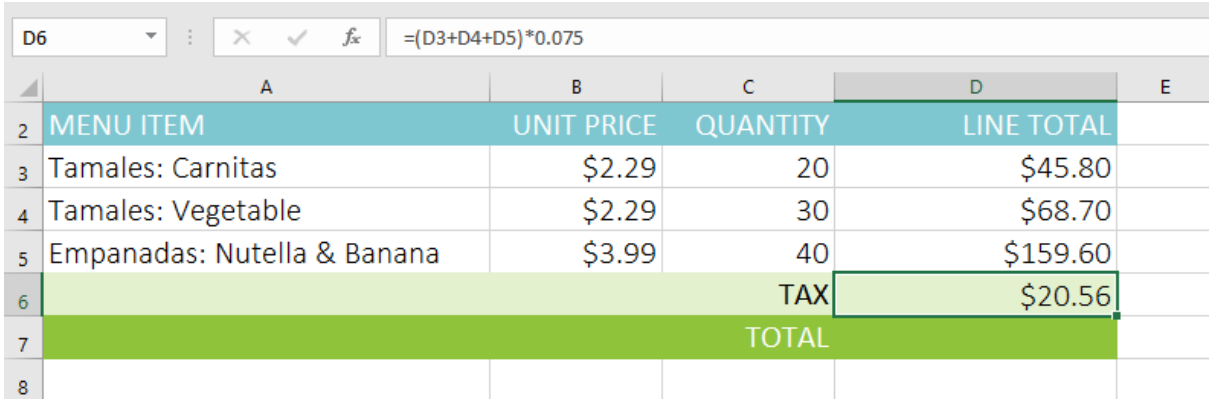
4.2.2. Creating complex formulas

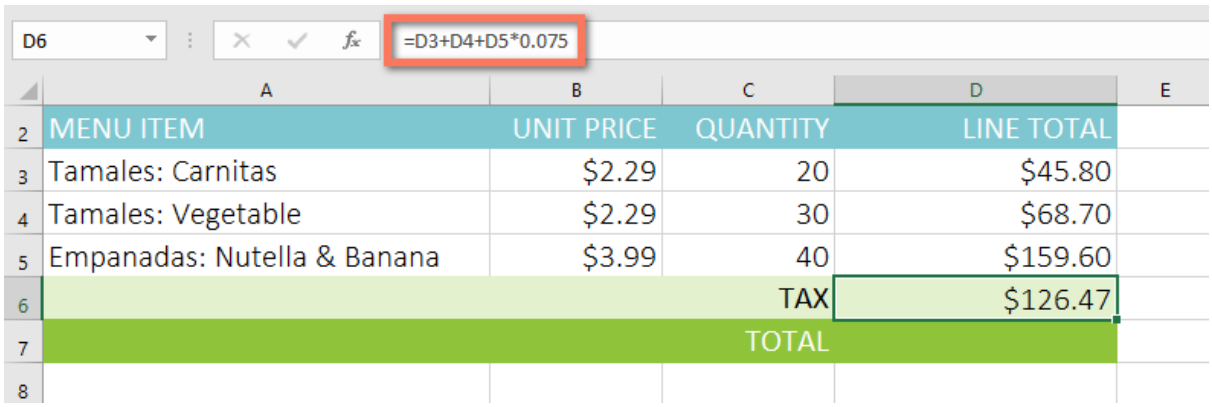
In the example below, we'll demonstrate how Excel uses the order of operations to solve a more complex formula. Here, we want to calculate the cost of **sales tax** for a catering invoice. To do this, we'll write our formula as **=(D3+D4+D5)*0.075** in cell **D6**. This formula will add the prices of our items, then multiply that value by the 7.5% tax rate (which is written as 0.075) to calculate the answer.



Excel follows the order of operations and first adds the values inside the parentheses: **(45.80+68.70+159.60) = 274.10**. It then multiplies that value by the tax rate: **274.10*0.075**. The result will show that the sales tax is **$20.56**.



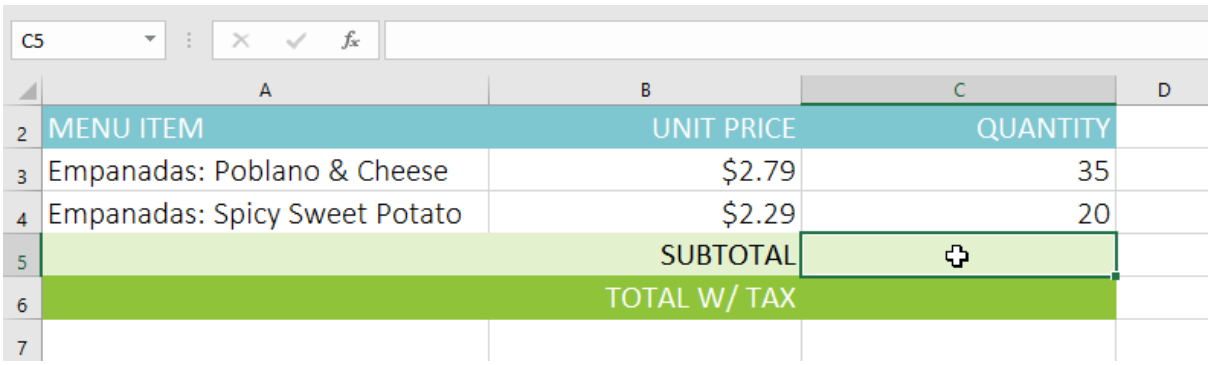
It's especially important to follow the order of operations when creating a formula. Otherwise, Excel won't calculate the results accurately. In our example, if the **parentheses** are not included, the multiplication is calculated first and the result is incorrect. Parentheses are often the best way to define which calculations will be performed first in Excel.



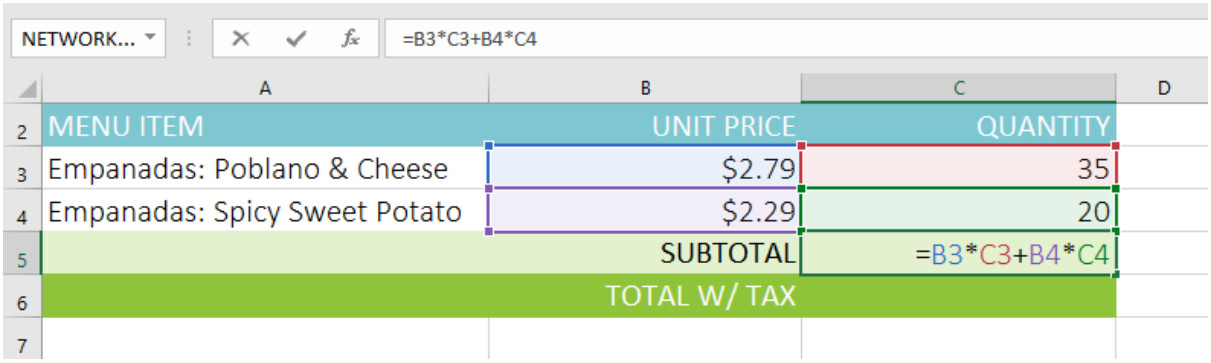
4.2.3. To create a complex formula using the order of operations:

In the example below, we'll use **cell references** along with **numerical values** to create a complex formula that will calculate the **subtotal** for a catering invoice. The formula will calculate the cost of each menu item first, then add these values.

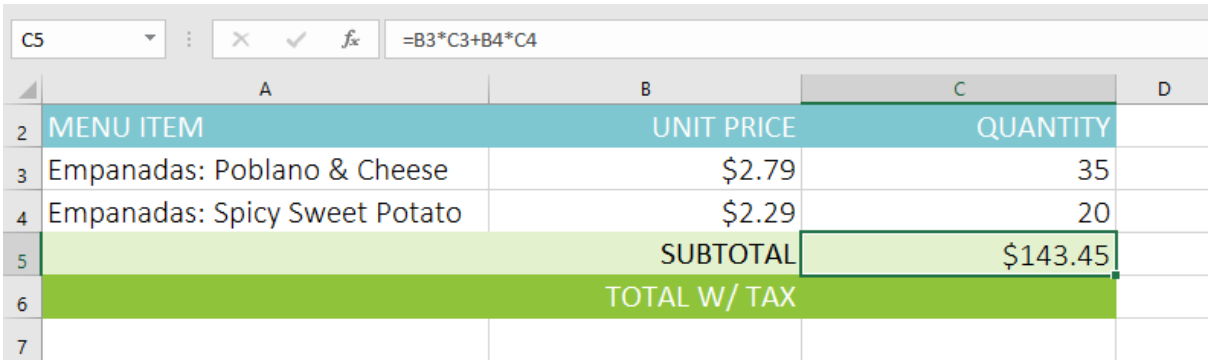
1. Select the **cell** that will contain the formula. In our example, we'll select cell **C5**.



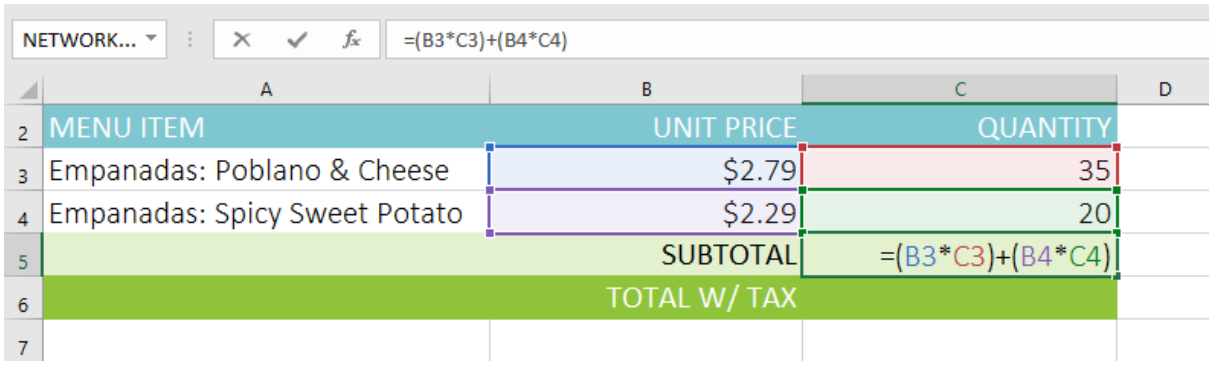
2. Enter your **formula**. In our example, we'll type **=B3*C3+B4*C4**. This formula will follow the order of operations, first performing the multiplication: **2.79*35 = 97.65** and **2.29*20 = 45.80**. It then will add these values to calculate the total: **97.65+45.80**.



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 subtotal for the order is **$143.45**.



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.



Excel **will not always tell you** if your formula contains an error, so it's up to you to check all of your formulas. To learn how to do this.

4.3.Relative and Absolute Cell References

4.3.1. Introduction

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.

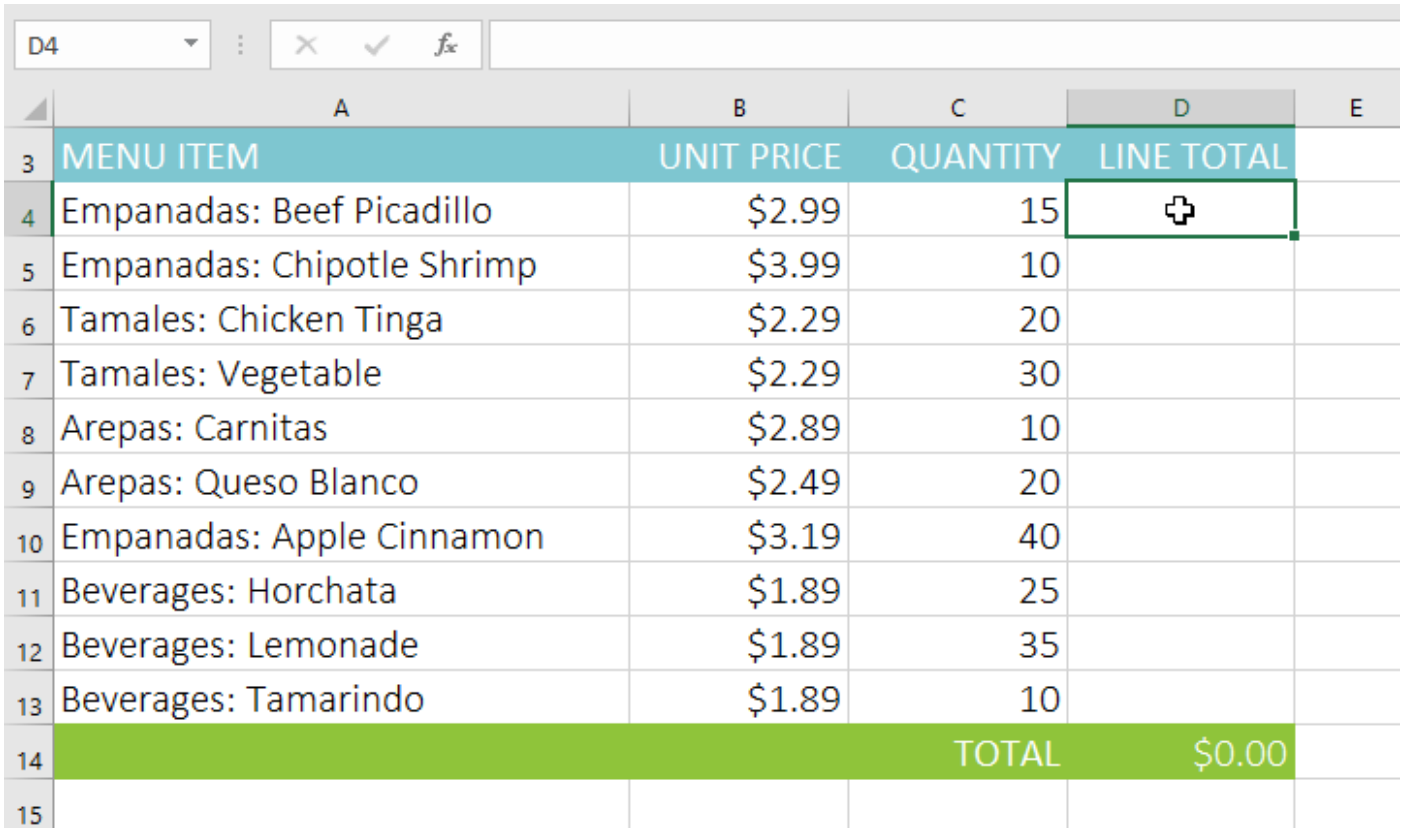
4.3.2. Relative references

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.

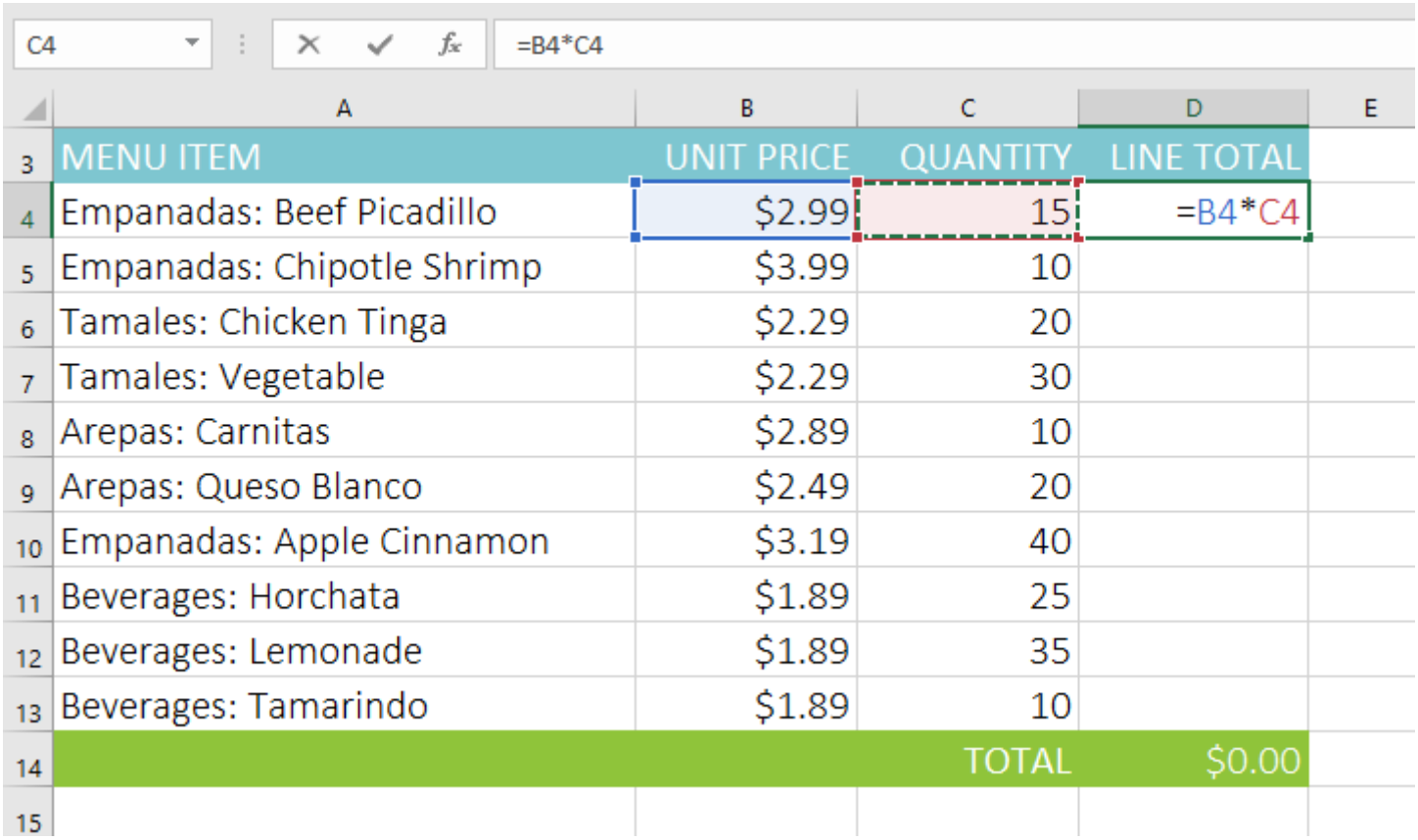
4.3.3. To create and copy a formula using relative references:

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 **D4** and then copy it to the other rows. We'll use relative references so the formula calculates the total for each item correctly.

1. Select the **cell** that will contain the formula. In our example, we'll select cell **D4**.

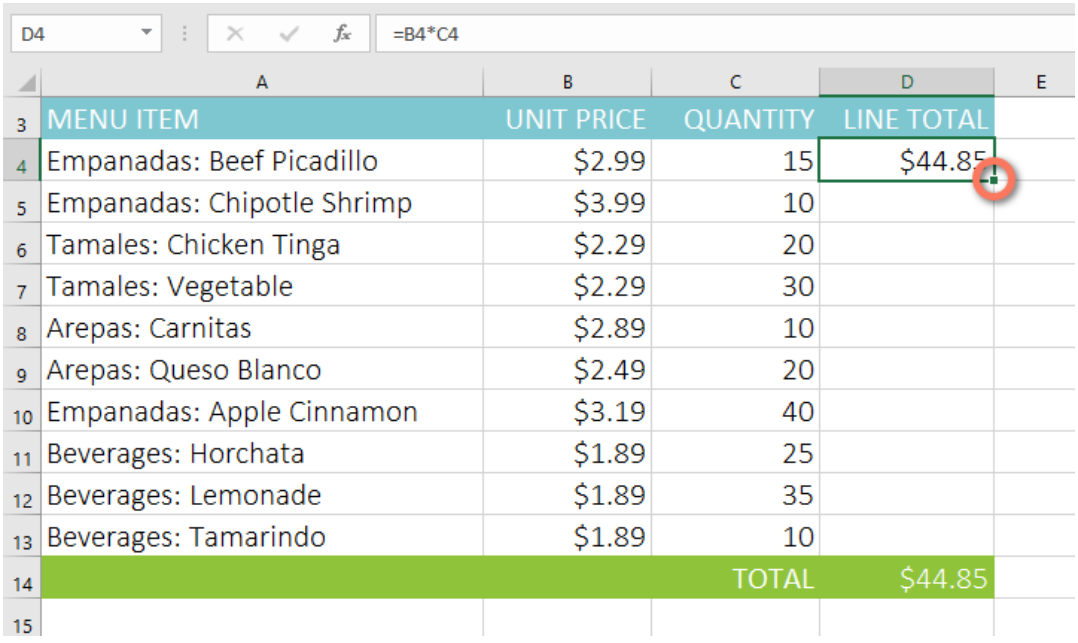


2. Enter the **formula** to calculate the desired value. In our example, we'll type **=B4*C4**.



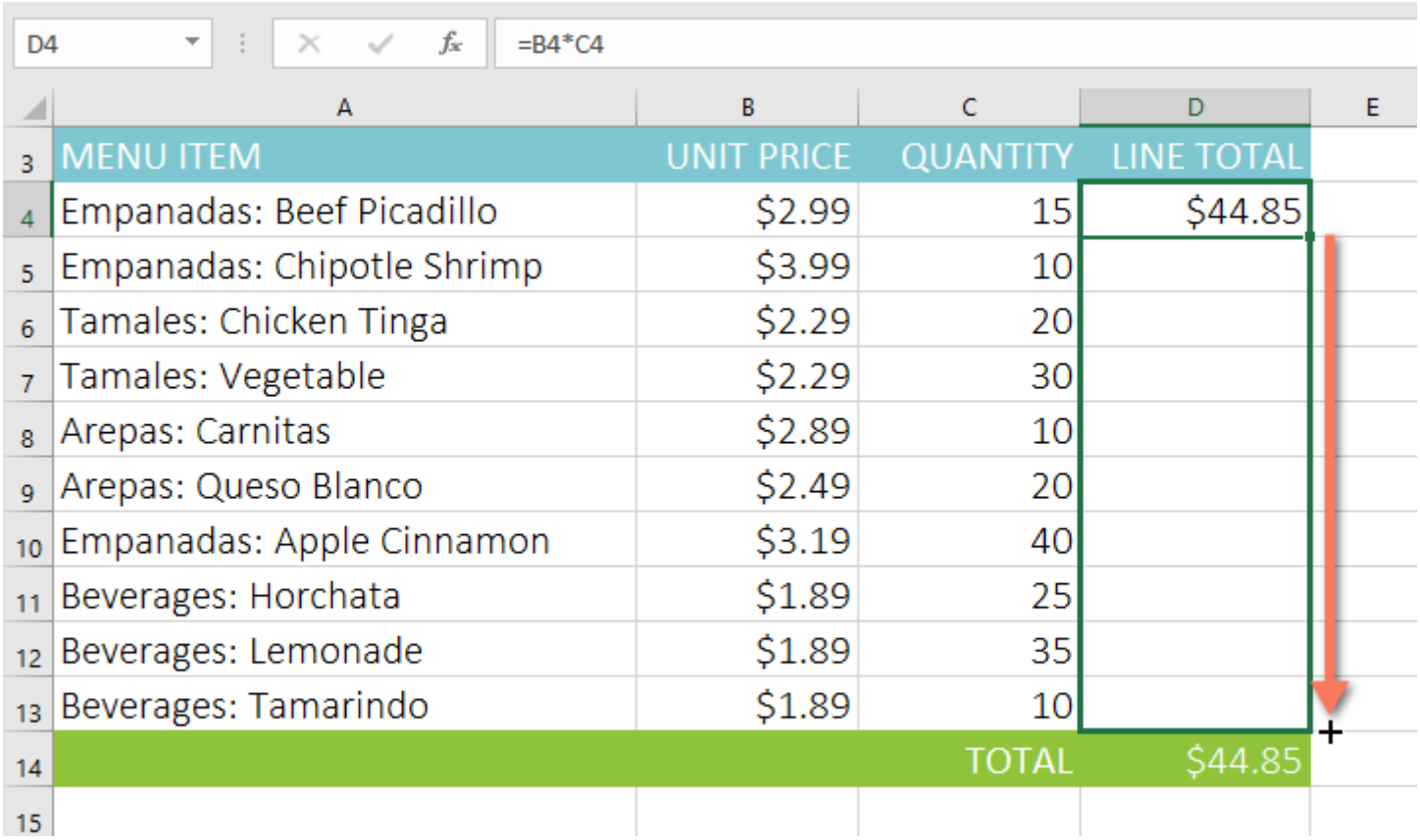
	A	B	C	D	E
3	MENU ITEM	UNIT PRICE	QUANTITY	LINE TOTAL	
4	Empanadas: Beef Picadillo	$2.99	15	=B4*C4	
5	Empanadas: Chipotle Shrimp	$3.99	10		
6	Tamales: Chicken Tinga	$2.29	20		
7	Tamales: Vegetable	$2.29	30		
8	Arepas: Carnitas	$2.89	10		
9	Arepas: Queso Blanco	$2.49	20		
10	Empanadas: Apple Cinnamon	$3.19	40		
11	Beverages: Horchata	$1.89	25		
12	Beverages: Lemonade	$1.89	35		
13	Beverages: Tamarindo	$1.89	10		
14			TOTAL	$0.00	
15					

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 **D4**.



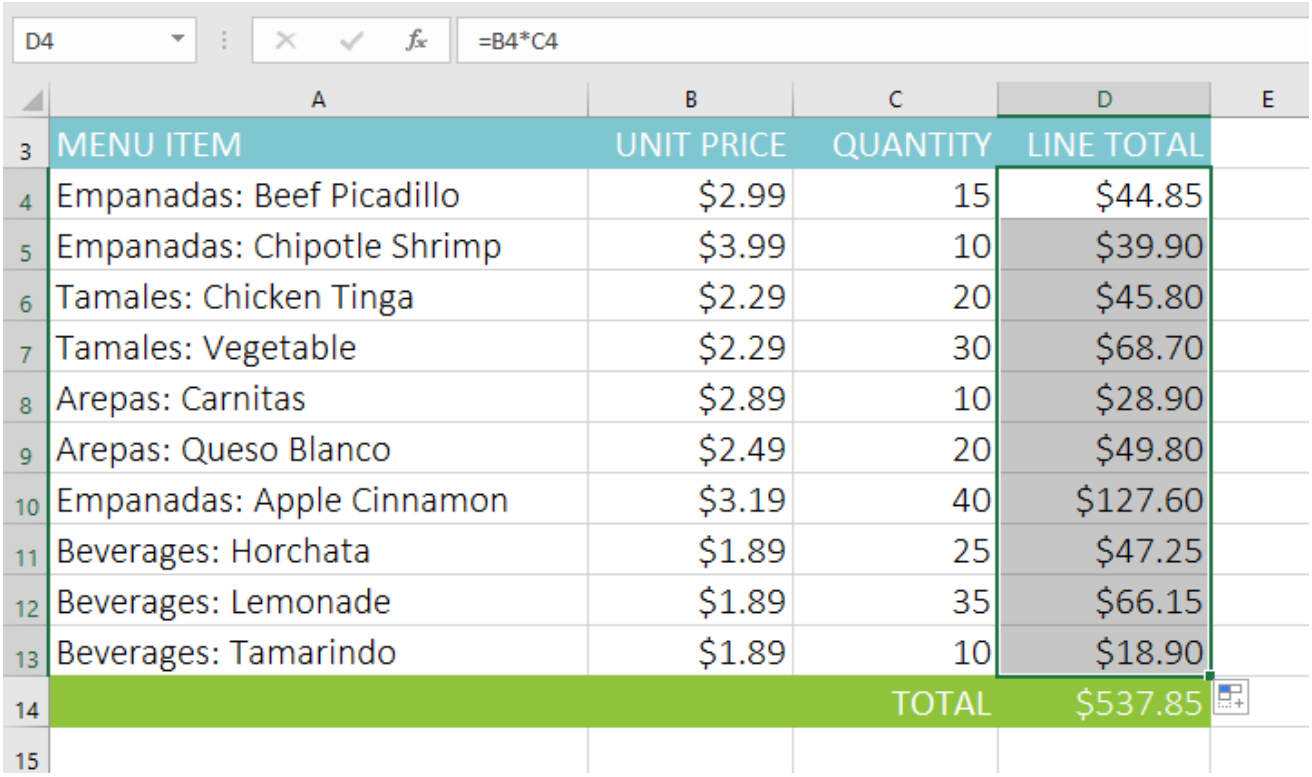
	A	B	C	D	E
3	MENU ITEM	UNIT PRICE	QUANTITY	LINE TOTAL	
4	Empanadas: Beef Picadillo	$2.99	15	$44.85	
5	Empanadas: Chipotle Shrimp	$3.99	10		
6	Tamales: Chicken Tinga	$2.29	20		
7	Tamales: Vegetable	$2.29	30		
8	Arepas: Carnitas	$2.89	10		
9	Arepas: Queso Blanco	$2.49	20		
10	Empanadas: Apple Cinnamon	$3.19	40		
11	Beverages: Horchata	$1.89	25		
12	Beverages: Lemonade	$1.89	35		
13	Beverages: Tamarindo	$1.89	10		
14			TOTAL	$44.85	
15					

5. Click and drag the **fill handle** over the cells you want to fill. In our example, we'll select cells **D5:D13**.



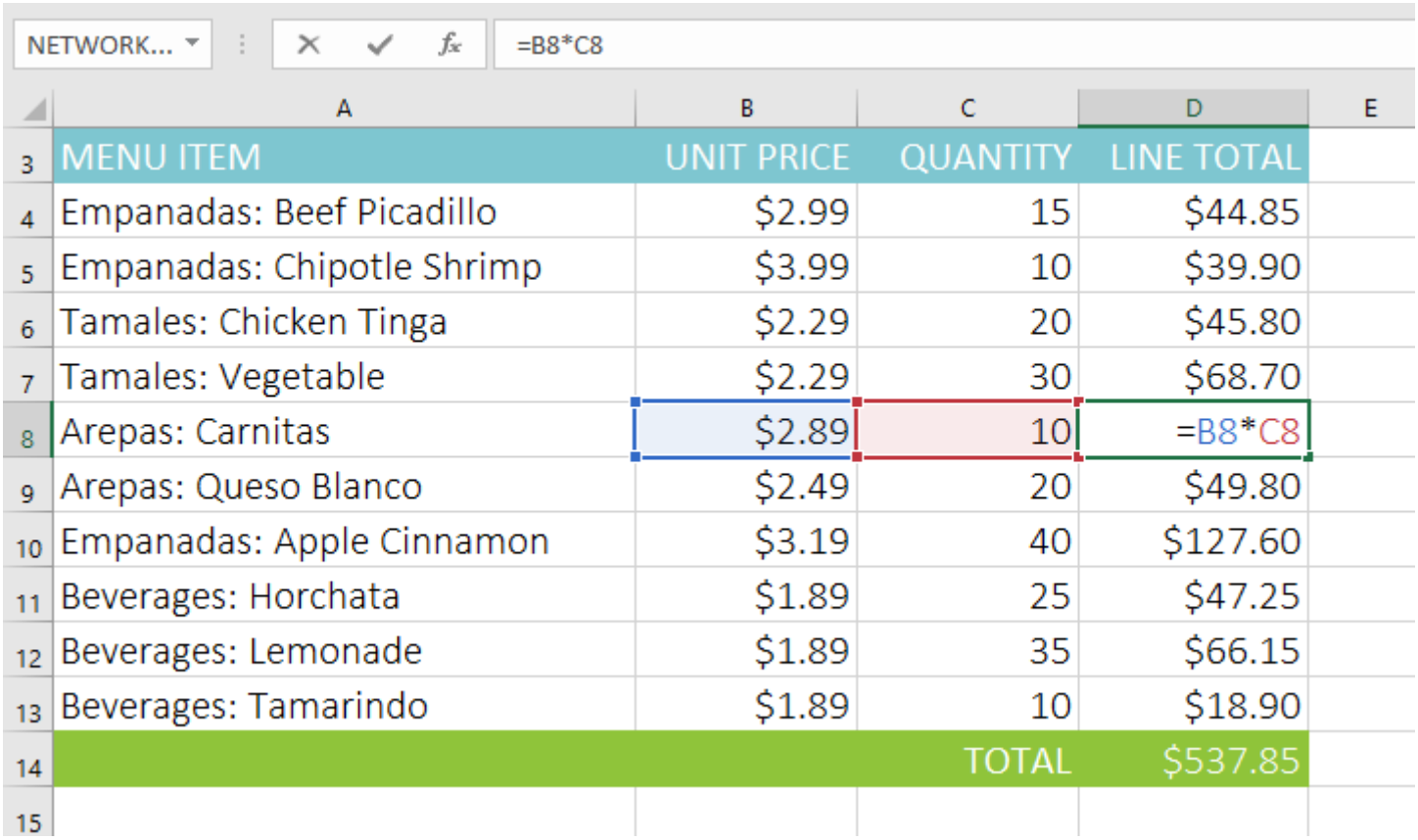
	A	B	C	D	E
3	MENU ITEM	UNIT PRICE	QUANTITY	LINE TOTAL	
4	Empanadas: Beef Picadillo	$2.99	15	$44.85	
5	Empanadas: Chipotle Shrimp	$3.99	10		
6	Tamales: Chicken Tinga	$2.29	20		
7	Tamales: Vegetable	$2.29	30		
8	Arepas: Carnitas	$2.89	10		
9	Arepas: Queso Blanco	$2.49	20		
10	Empanadas: Apple Cinnamon	$3.19	40		
11	Beverages: Horchata	$1.89	25		
12	Beverages: Lemonade	$1.89	35		
13	Beverages: Tamarindo	$1.89	10		
14			TOTAL	$44.85	
15					

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



	A	B	C	D	E
3	MENU ITEM	UNIT PRICE	QUANTITY	LINE TOTAL	
4	Empanadas: Beef Picadillo	$2.99	15	$44.85	
5	Empanadas: Chipotle Shrimp	$3.99	10	$39.90	
6	Tamales: Chicken Tinga	$2.29	20	$45.80	
7	Tamales: Vegetable	$2.29	30	$68.70	
8	Arepas: Carnitas	$2.89	10	$28.90	
9	Arepas: Queso Blanco	$2.49	20	$49.80	
10	Empanadas: Apple Cinnamon	$3.19	40	$127.60	
11	Beverages: Horchata	$1.89	25	$47.25	
12	Beverages: Lemonade	$1.89	35	$66.15	
13	Beverages: Tamarindo	$1.89	10	$18.90	
14			TOTAL	$537.85	
15					

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
3	MENU ITEM	UNIT PRICE	QUANTITY	LINE TOTAL	
4	Empanadas: Beef Picadillo	$2.99	15	$44.85	
5	Empanadas: Chipotle Shrimp	$3.99	10	$39.90	
6	Tamales: Chicken Tinga	$2.29	20	$45.80	
7	Tamales: Vegetable	$2.29	30	$68.70	
8	Arepas: Carnitas	$2.89	10	=B8*C8	
9	Arepas: Queso Blanco	$2.49	20	$49.80	
10	Empanadas: Apple Cinnamon	$3.19	40	$127.60	
11	Beverages: Horchata	$1.89	25	$47.25	
12	Beverages: Lemonade	$1.89	35	$66.15	
13	Beverages: Tamarindo	$1.89	10	$18.90	
14			TOTAL	$537.85	
15					

4.3.4. 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 ($)** before the column and row. If it precedes the column or row (but not both), it's known as a **mixed reference**.

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

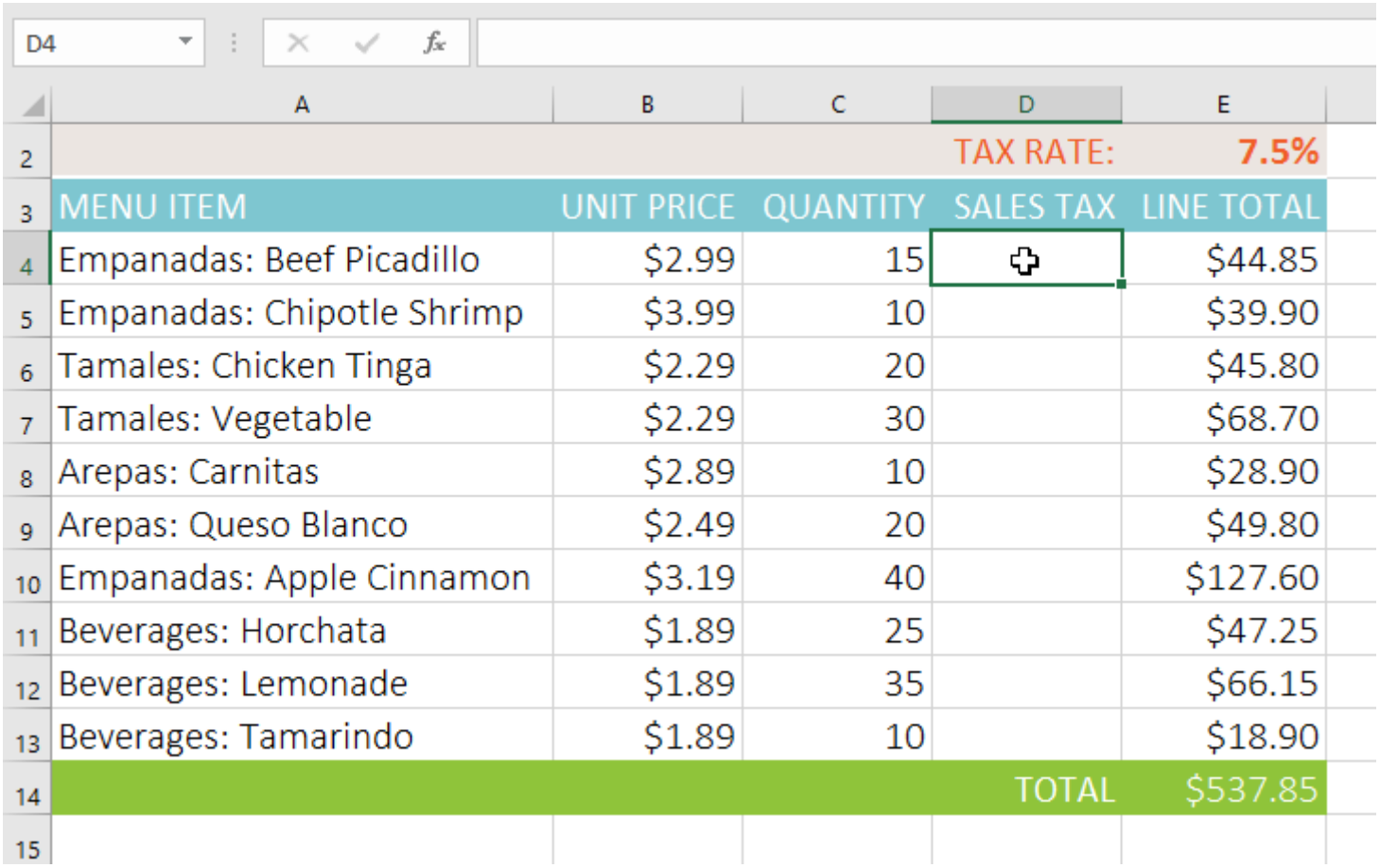
You will use the relative (**A2**) and absolute (**A2**) formats in most formulas. Mixed references are used less frequently.

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

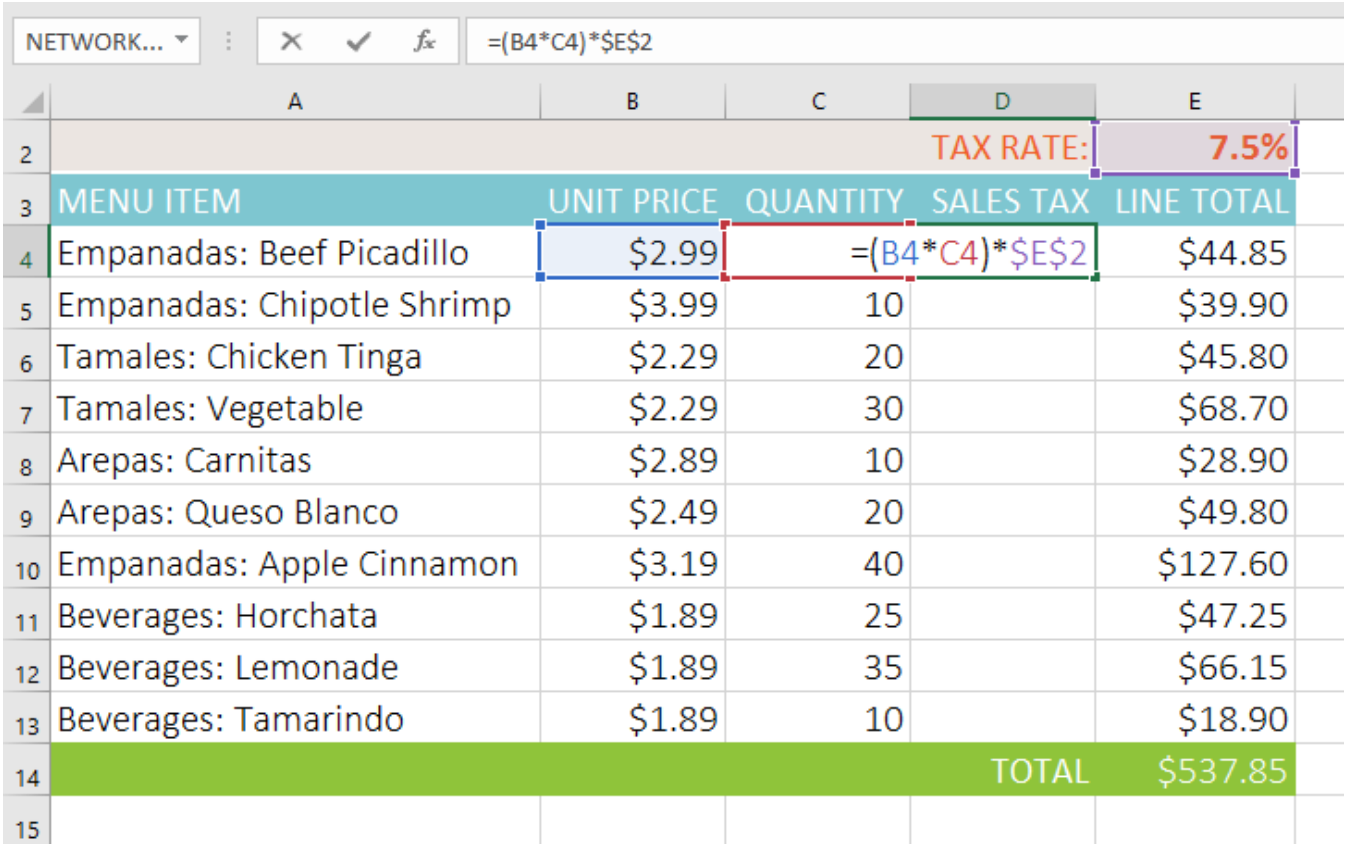
4.3.5. To create and copy a formula using absolute references:

In the example below, we're going to use cell **E2** (which contains the tax rate at 7.5%) to calculate the sales tax for each item in **column D**. To make sure the reference to the tax rate stays constant—even when the formula is copied and filled to other cells—we'll need to make cell **E2** an absolute reference.

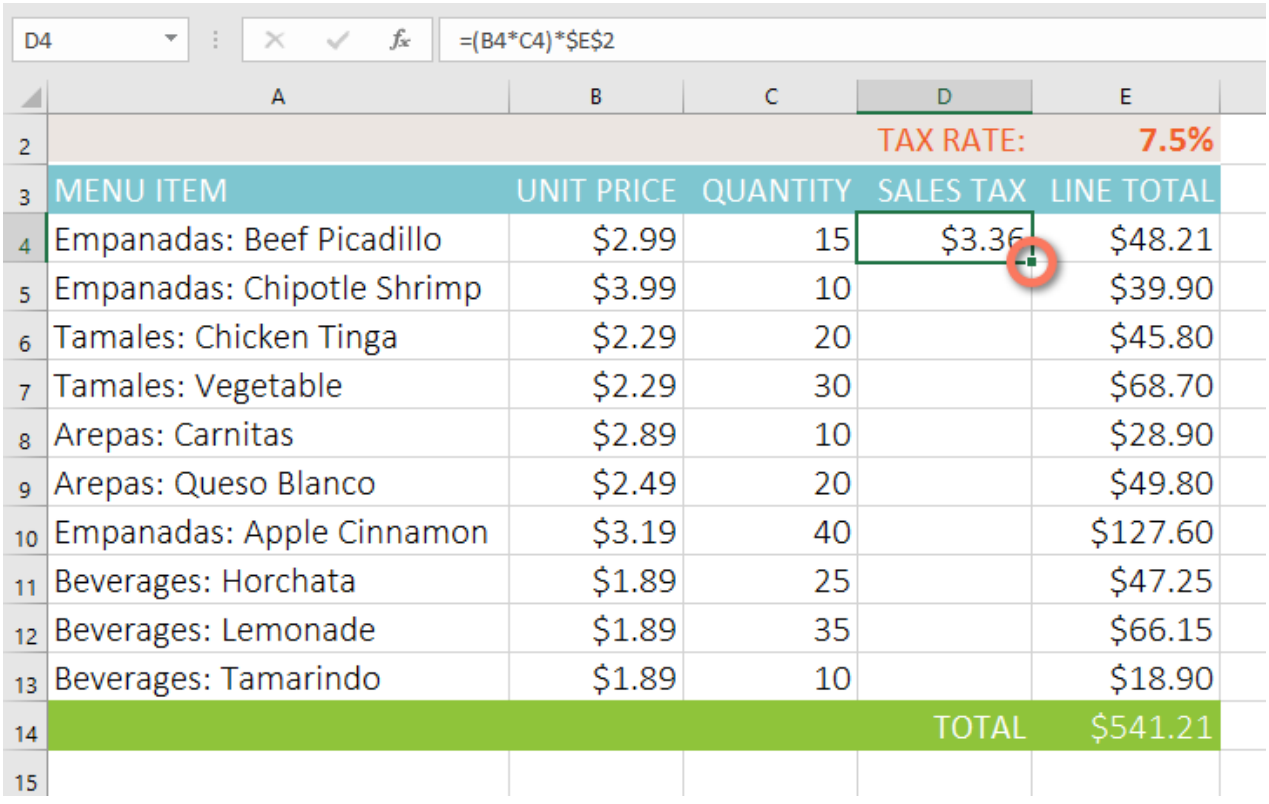
1. Select the **cell** that will contain the formula. In our example, we'll select cell **D4**.



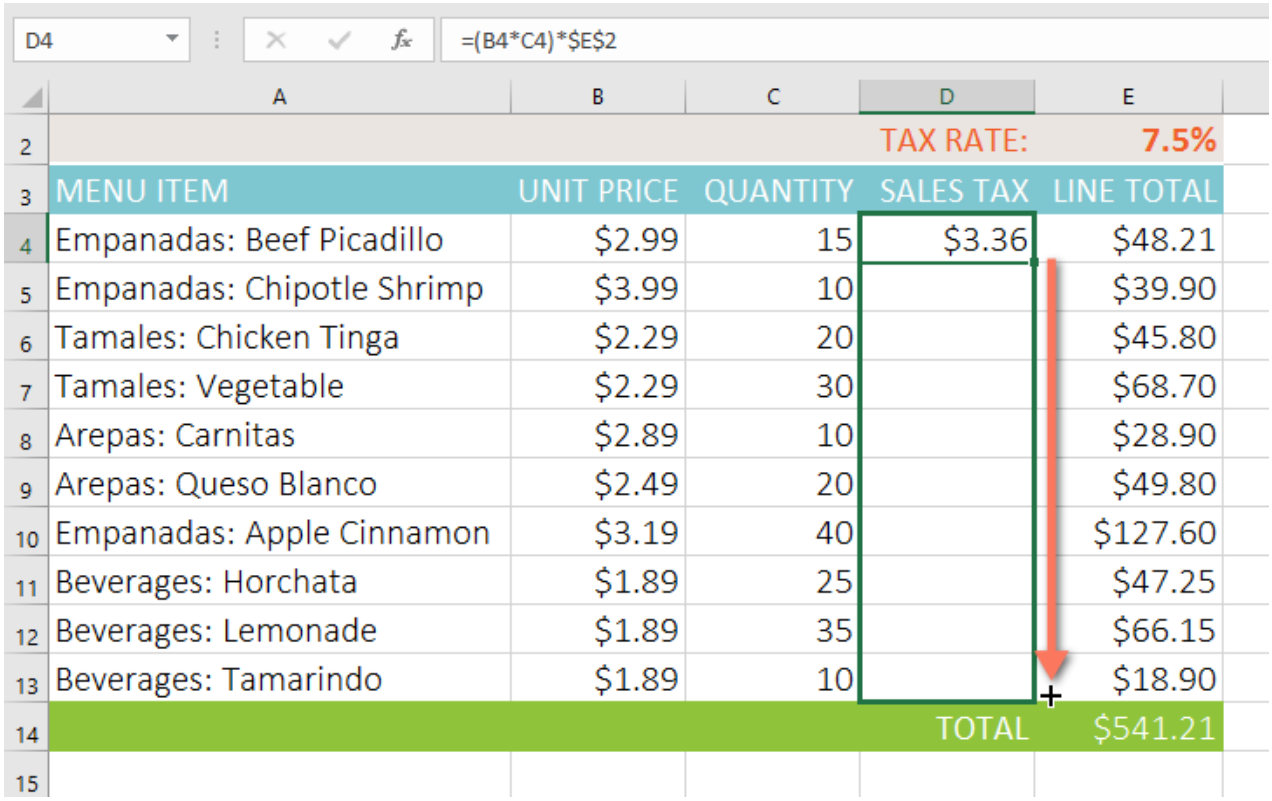
2. Enter the **formula** to calculate the desired value. In our example, we'll type =**(B4*C4)*E2**, making **E2** an absolute reference.



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 **D4**.

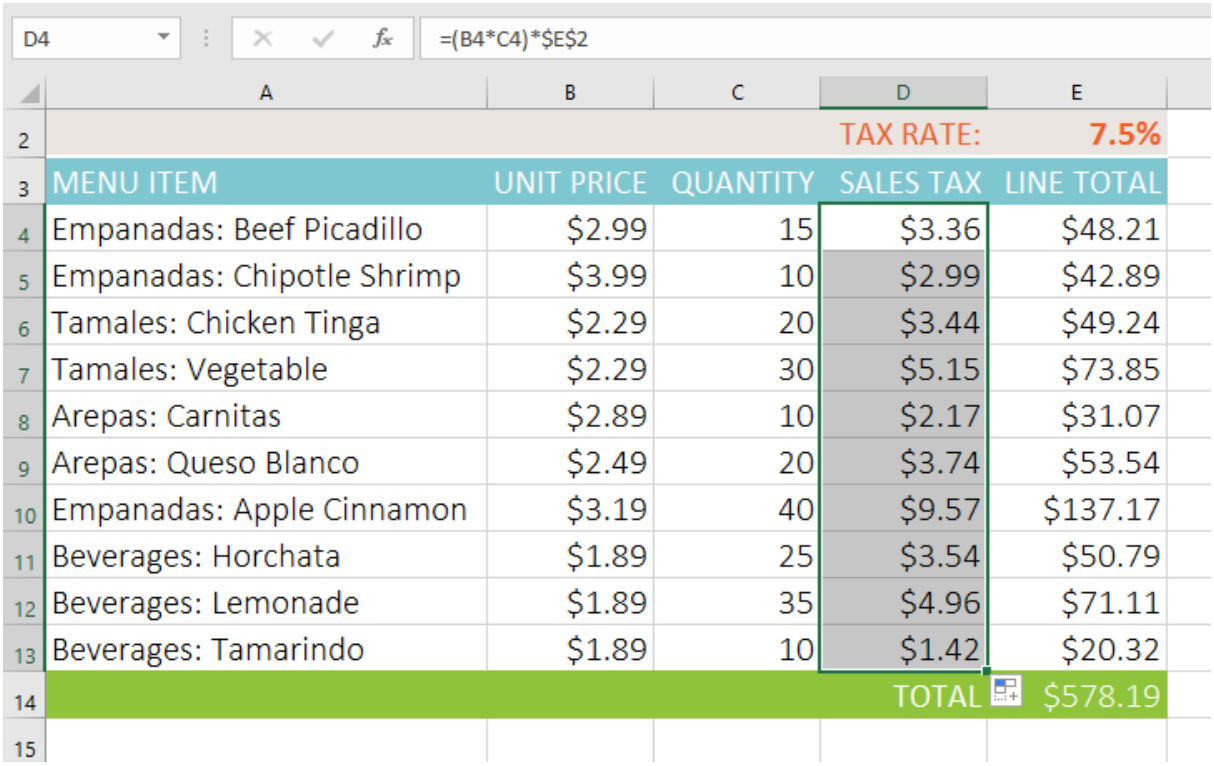


5. Click and drag the **fill handle** over the cells you want to fill (cells **D5:D13** in our example).



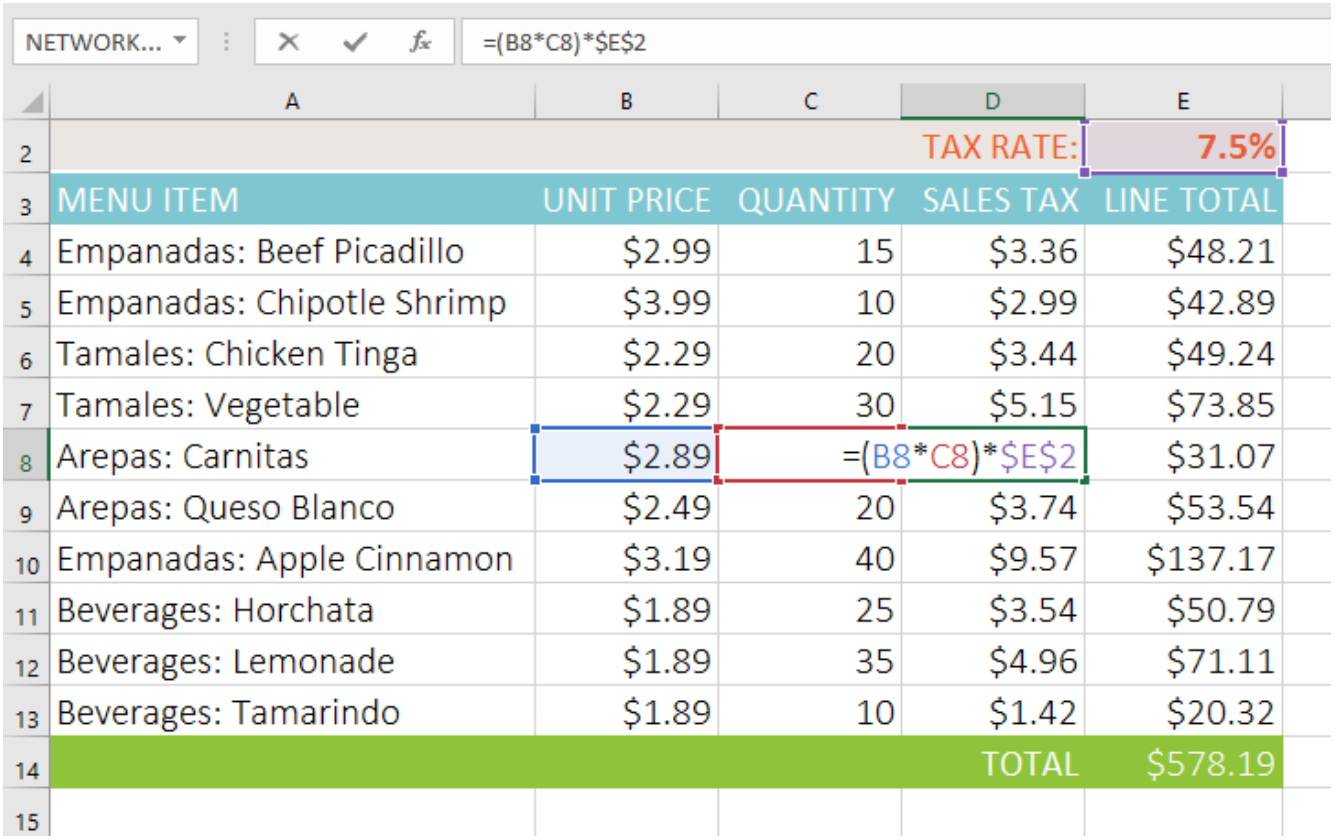
D4	=(B4*C4)*E2			
	A	B	C	D	E
2				TAX RATE:	7.5%
3	MENU ITEM	UNIT PRICE	QUANTITY	SALES TAX	LINE TOTAL
4	Empanadas: Beef Picadillo	$2.99	15	$3.36	$48.21
5	Empanadas: Chipotle Shrimp	$3.99	10		$39.90
6	Tamales: Chicken Tinga	$2.29	20		$45.80
7	Tamales: Vegetable	$2.29	30		$68.70
8	Arepas: Carnitas	$2.89	10		$28.90
9	Arepas: Queso Blanco	$2.49	20		$49.80
10	Empanadas: Apple Cinnamon	$3.19	40		$127.60
11	Beverages: Horchata	$1.89	25		$47.25
12	Beverages: Lemonade	$1.89	35		$66.15
13	Beverages: Tamarindo	$1.89	10		$18.90
14				TOTAL	$541.21
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.



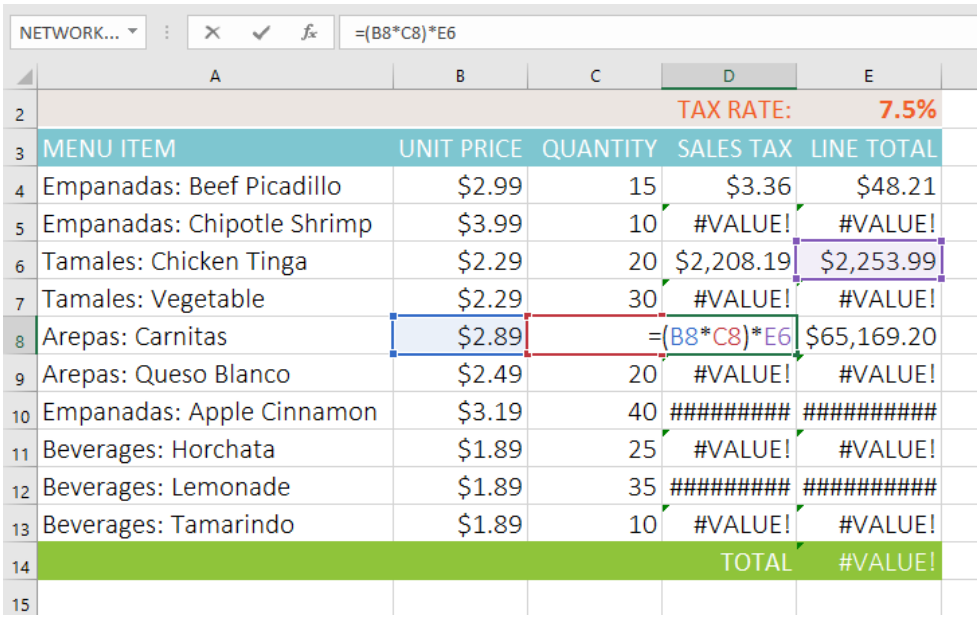
D4	=(B4*C4)*E2			
	A	B	C	D	E
2				TAX RATE:	7.5%
3	MENU ITEM	UNIT PRICE	QUANTITY	SALES TAX	LINE TOTAL
4	Empanadas: Beef Picadillo	$2.99	15	$3.36	$48.21
5	Empanadas: Chipotle Shrimp	$3.99	10	$2.99	$42.89
6	Tamales: Chicken Tinga	$2.29	20	$3.44	$49.24
7	Tamales: Vegetable	$2.29	30	$5.15	$73.85
8	Arepas: 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	$578.19
15					

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.



	A	B	C	D	E
2				TAX RATE:	7.5%
3	MENU ITEM	UNIT PRICE	QUANTITY	SALES TAX	LINE TOTAL
4	Empanadas: Beef Picadillo	$2.99	15	$3.36	$48.21
5	Empanadas: Chipotle Shrimp	$3.99	10	$2.99	$42.89
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	=(B8*C8)*E2		$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	$578.19
15					

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.



	A	B	C	D	E
2				TAX RATE:	7.5%
3	MENU ITEM	UNIT PRICE	QUANTITY	SALES TAX	LINE TOTAL
4	Empanadas: Beef Picadillo	$2.99	15	$3.36	$48.21
5	Empanadas: Chipotle Shrimp	$3.99	10	#VALUE!	#VALUE!
6	Tamales: Chicken Tinga	$2.29	20	$2,208.19	$2,253.99
7	Tamales: Vegetable	$2.29	30	#VALUE!	#VALUE!
8	Arepas: Carnitas	$2.89	=(B8*C8)*E6		$65,169.20
9	Arepas: Queso Blanco	$2.49	20	#VALUE!	#VALUE!
10	Empanadas: Apple Cinnamon	$3.19	40	##########	##########
11	Beverages: Horchata	$1.89	25	#VALUE!	#VALUE!
12	Beverages: Lemonade	$1.89	35	##########	##########
13	Beverages: Tamarindo	$1.89	10	#VALUE!	#VALUE!
14				TOTAL	#VALUE!
15					

4.3.6. Using cell references with multiple worksheets

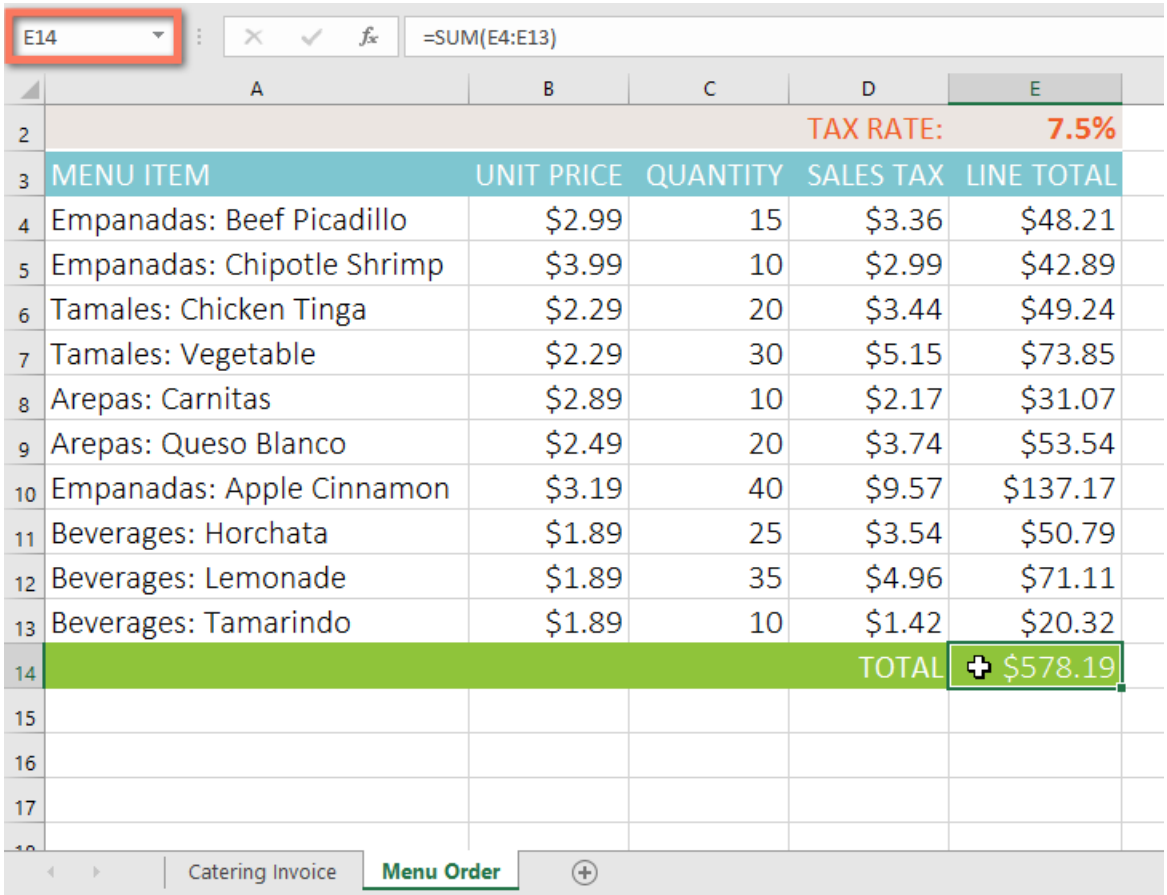
Excel allows you to refer to any cell on any **worksheet**, which can be especially helpful if you want to reference a specific value from one worksheet to another. To do this, you'll simply need to begin the cell reference with the **worksheet name** followed by an **exclamation point (!)**. For example,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

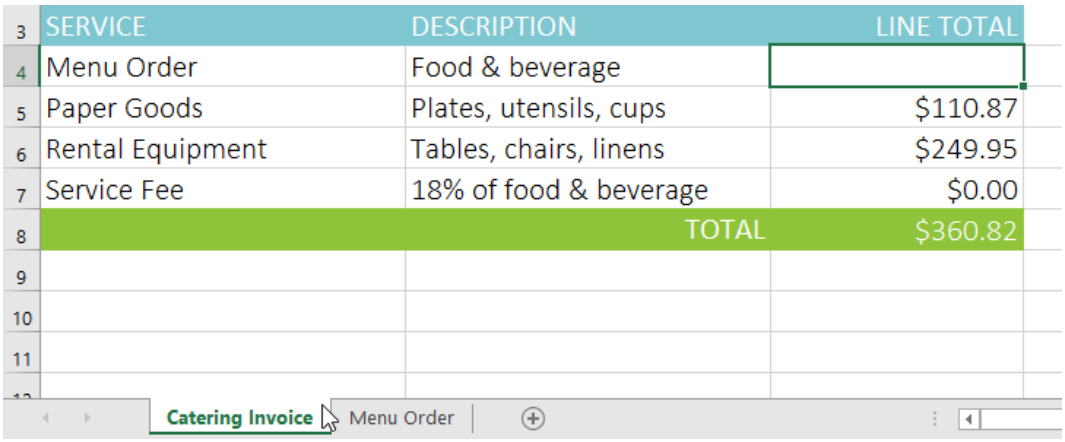
4.3.7. To reference cells across worksheets:

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.

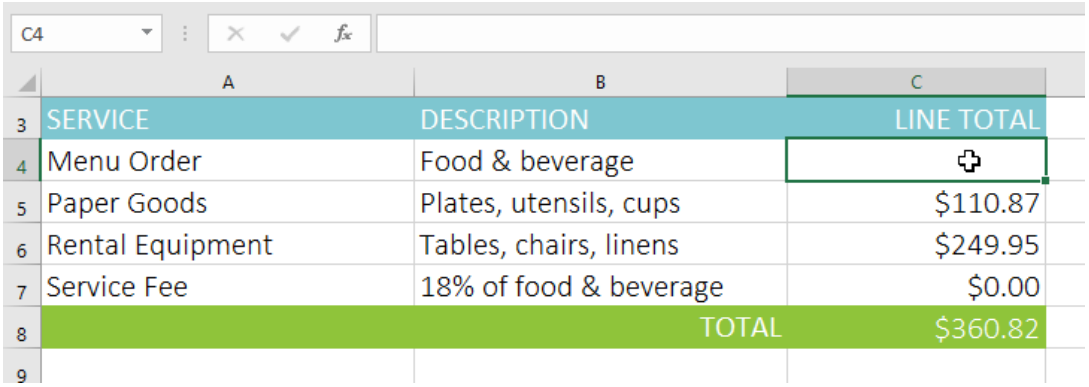
1. Locate the cell you want to reference, and note its worksheet. In our example, we want to reference cell **E14** on the **Menu Order** worksheet.



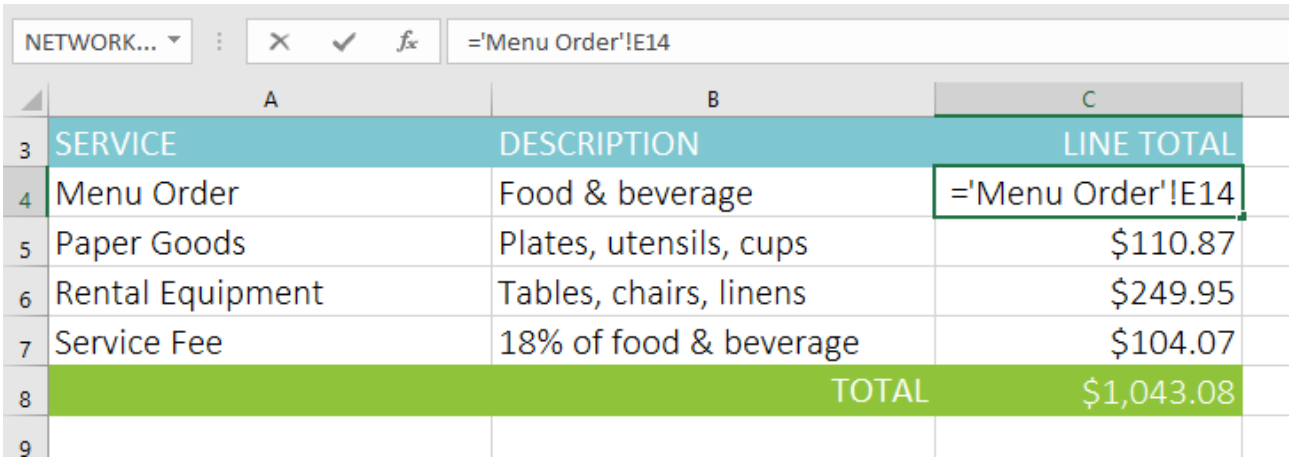
2. Navigate to the desired **worksheet**. In our example, we'll select the **Catering Invoice** worksheet.



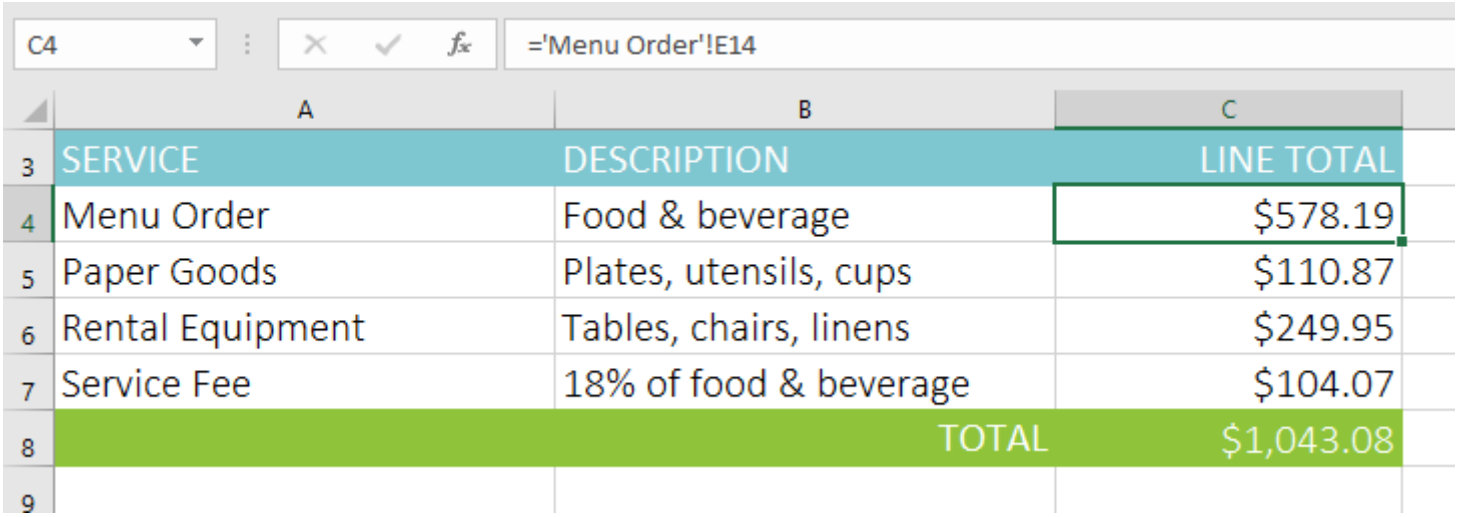
3. Locate and select the **cell** where you want the value to appear. In our example, we'll select cell **C4**.



4. 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**.



5. Press **Enter** on your keyboard. The **value** of the referenced cell will appear. Now, 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. To edit, ignore, or investigate the error, click the **Error** button beside the cell and choose an option from the **menu**.