

Building Basic Formulas

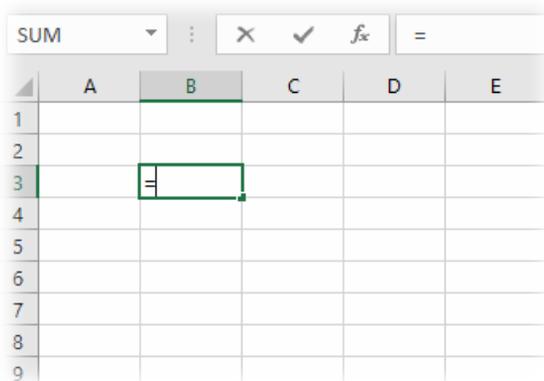
“To get an answer, you must first ask a question.”

Writing an Excel formula is shockingly easy. The trick is to translate the question you have into the language that Excel understands. For example, if you’re wondering “How much tax will I pay for a new coffee table?” you need to tell Excel something like this: `=B3*0.04` (Weird, right?)

In this chapter, you’ll learn to speak Excel’s formula language. You’ll start by asking Excel to add, subtract, and divide simple numbers. Along the way, you’ll take a short detour back to grade school to revisit the rules for *order of operations* and check out the right way to use brackets.

Starting a Formula

Every Excel formula starts in exactly the same way. You move to a blank cell and announce your intentions by typing the equal sign (=).



Take a moment to find the equal sign on your keyboard, if you haven't spotted it already. On most keyboards, you'll find the equal sign on the number row, just to the right of all the numbers.

Once you type the equal sign, Excel knows that you are about to type in a formula. A formula can be as simple and short as you want, or it can be a complex beast of a calculation.

The simplest possible formula isn't really a formula at all, but just an equal sign and a single number like this:

=42

In Excel language, this formula says "equals forty-two." The answer to this formula is, unsurprisingly, the number 42.

A slightly more sophisticated formula combines two numbers in addition, subtraction, multiplication, or division. Here's an example:

=1+1

To see a formula in action, find a blank cell in your worksheet, type it in, and then press the **Enter** key to finish up. On your worksheet, you'll see the *solution* to your formula. So if you asked Excel to add `=1+8` the number 9 will show up on your worksheet.

	TYPE THIS:	SEE THIS:
	=1+8	9

Remember, every formula must start with the equal sign. This is right:

=12+36

But this is wrong:

12+36

If you forget the equal sign, Excel assumes you're typing in some text, and doesn't perform any calculations. Instead of seeing the formula result on your worksheet, you'll see exactly what you typed (in this case, that's the text "12+36" instead of the answer, 48).

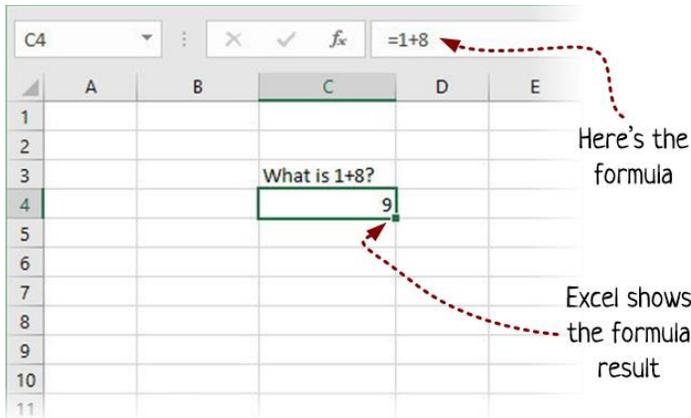
Can I use the equal sign without starting a formula?

It's not very often that you'll want to start a cell with an equal sign but *not* write a formula. But if the need arises, you'll be glad to know that Excel has you covered. The trick is to type an apostrophe (') before you type the equal sign. The apostrophe tells Excel to treat the cell as ordinary text, no matter what it contains. So if you type ' =1+1 rather than just =1+1 Excel assumes that you don't really want a formula. Instead of performing a calculation, Excel shows exactly what you typed (not including the apostrophe).

Editing a Formula

On your worksheet, Excel shows the result of your formula. So if you type a formula that adds two numbers, you'll see the total on your worksheet. However, your original formula still exists—it's just tucked away in the background.

To see your formula, make sure you're in the right cell. (You can move there using the keyboard, or just by clicking the cell with the mouse.) You'll see your original formula in the *formula bar*, which is the editing box that sits at the top of your worksheet, just under the ribbon.



To change your formula, click anywhere in the formula bar. Make your changes, and then press **Enter** to complete them. Once you do, Excel recalculates the formula and shows the new answer in the worksheet.

If you start making a formula change and then decide not to go through with it, press the **Esc** key to cancel your changes.

Pro tip: Keyboard lovers don't need to click in the formula bar to start editing. You can just press the **F2** key to start editing the cell that you're currently on.

Formula Practice

Before you try any fancy formula work, you need to get comfortable with building basic formulas. The best way to do that is to exercise your math skills with the *arithmetic operators*. Those are the symbols that tell Excel to add, subtract, multiply, and divide numbers. Here's your basic toolkit:

- ▶ Use + to add (so `=2+2` is 4)
- ▶ Use - to subtract (so `=6-2` is 4)
- ▶ Use * to multiply (so `=5*6` is 30)
- ▶ Use / to divide (so `=8/2` is 4)
- ▶ Use ^ to add an exponent (so `=3^2` means 3 squared, which is 9)
- ▶ Use . for decimal values (so `=2.5+2.5` is 5)

Let's get one more thing out of the way: spaces are yours to use at your pleasure. So if you want to replace this:

=10+8+2

with this:

=10 + 8 + 2

It's all good. Excel doesn't care, and it'll keep your spaces just the way you typed them in. You won't care either, unless you find that adding the spaces makes a complicated formula slightly easier to read. (If so, go crazy with them.)

Try it out: Excel arithmetic

Before you go any further, it's worth firing up your own copy of Excel so you can enter a few simple formulas of your own. Here's how to practice:

1. Move down a column of cells, one at a time. In each cell, type a new, simple formula, like the ones that are shown in the previous list. Press **Enter** each time you finish a formula, and watch the answer appear in your cell.
2. Now move back up the column, one cell at a time. Make sure to look at each formula in the formula bar.
3. Finally, try editing one of your formulas. When you're in the right cell, click inside the formula bar. Then, make your changes, and press **Enter** to save them.

Easy, right? Just wait—it gets better.

The order of operations

There's no reason to limit your formulas to working with one operator. In fact, you can string together a formula that's as long as you want. Here's an example of a complicated formula that does many different mathematical operations:

=12+43*3-2^2+60/3

When you mix-and-match operators, you need to be aware that Excel won't just calculate the formula from left to right. Instead, it follows the mathematical rules called *order of operations*. Here's the order it uses:

1. Calculate stuff in parentheses (brackets)
2. Calculate exponents
3. Perform multiplication and division (from left to right)
4. Perform addition and subtraction (from left to right)

In the previous example, there aren't any brackets, but there are exponents, multiplication, division, addition, and subtraction. Here's an expanded look at how Excel calculates the formula, one step at a time:

```
=12 + 43 * 3 - 2^2 + 60 / 3
=12 + 43 * 3 - 4 + 60 / 3
=12 + 43*3 - 4 + 60 / 3
=12 + 129 - 4 + 20
=157
```

Controlling the order with brackets

If you have a complicated or long formula, you might lose track of the order of operations. If you're in doubt, or if you just want to make your formula clearer, you can add brackets (also known as *parentheses*). Putting stuff inside brackets is a little like getting into a priority line at Disney World. When Excel evaluates a formula that has brackets, it does the stuff inside the brackets first.

Imagine you timed your morning commute on five different days during the week. Your commute took you 44, 50, 45, 44, and 38 minutes. Now you want to figure out the *average* commuting time. You might try to get the answer from Excel with a formula like this:

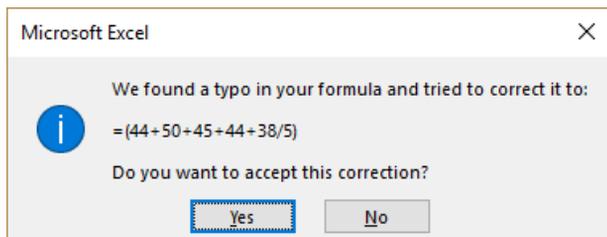
```
=44+50+45+44+38/5
```

But there's a problem. Because of order of operations, Excel will divide 38 by 5, and then add that to your other commuting times, which isn't what you want. Fortunately, one set of brackets can put things right:

```
=(44+50+45+44+38)/5
```

Now Excel adds all your commute times and divides the total by 5. (The answer, should you try this for yourself, is 44.2 minutes, which is a long time to spend on the road. We hope you have audiobooks.)

Excel is notoriously picky about brackets. If you open a pair of brackets then you better be sure to close it later in your formula. If you don't Excel will catch the problem and insist you fix it before allowing you to move on to another cell.



Advanced formula writers can put one set of brackets inside another (and another, and another), but be careful. Usually it's a better idea to break really long formulas

into several smaller formulas, and connect them together with cell references. You'll learn to use this technique in the next chapter.

Exercise #1: Pocket calculator Excel

If your eyes are starting to glaze over from staring at other people's formulas, it's time to write a few of your own.

Head to the tutorial site, <http://lab.halfwit2hero.com/excelformulas> and check out the "Pocket calculator" workbook. It describes several mathematical calculations and asks you to write each one in Excel's formula language. When you see the right result appear on your worksheet, you'll know that Excel did your calculation correctly.

Formula Mistakes

It's easy to make a minor mistake that sidelines a formula.

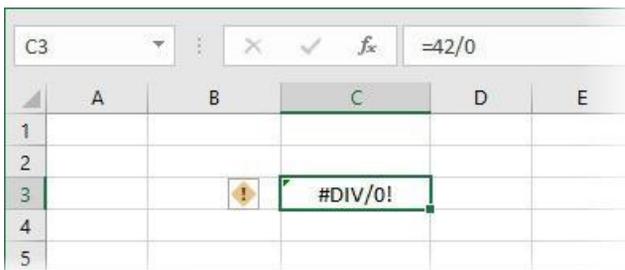
For example, you might add an extra brackets, or accidentally type something that makes no gosh darn sense, like `=5+*2` (5 plus times 2?) or `=4^` (4 to the power of nothing in particular?)

These mistakes are called *syntax problems*, and Excel catches them immediately. Excel won't let you leave a broken formula in your worksheet. Instead, it asks you to fix the problem and even provides a possible correction you can use.

Sometimes, you'll write a formula that is syntactically correct but produces an error when Excel tries to evaluate it. This problem is more common when you start pulling information in from other parts of your worksheet and adding fancy functions—techniques you'll learn later. But you can see one example if you defy your high-school math teacher and attempt to divide by zero:

`=42/0`

Math nerds know that this isn't solvable. (Technically, the answer is "undefined.") Excel tries to explain the problem by showing an error code in the cell.



Error codes always start with the # symbol. The code #DIV/0! means “Whoops, you tried to divide by zero!”

A cell that has a formula error also gets a little green triangle in the top-left corner. If your worksheet has a bunch of mistakes, these triangles let you spot them easily.

When you move to a cell that has an error, Excel pops up a handy error icon (an exclamation mark in a diamond). If you click the error icon, Excel shows a more descriptive error name (like “Divide by Zero Error”) and gives you a few more options:

- ▶ **Help on this error** pops up the Excel help window, which tries to explain what this error code means, using the sort of language a robot might use when talking to a calculator. (Don’t expect it to be much help.)
- ▶ **Show Calculation Steps** shows a special window where you can watch Excel solving your formula, one step at a time. This window isn’t useful right now, but if you have a complex formula that draws on information throughout your worksheet, it can help you find out what part of the formula went bad.
- ▶ **Ignore Error** tells Excel to stop showing you the green triangle for this cell, because you don’t care about this problem. The error code that’s in the cell stays put.
- ▶ **Edit in Formula Bar** has the same effect as just clicking in the formula bar, where you can edit the broken formula and make it work again.
- ▶ **Error Checking Options** brings up a page of Excel settings where you can choose to ignore certain types of errors, or just change the color of Excel’s green error triangles. Unless you’re an expert, there’s no reason to tweak these details.

Most of these choices are overkill. If you have a bad formula, you can just click up in the formula bar and fix the problem yourself.

Unmasking Your Formulas

One thing that can cause confusion when you start learning about formulas is the way they lurk behind the scenes. When you look at a worksheet, all you see is a bunch of text and numbers. You can’t tell (at least not at a glance) where your formulas are placed. You can go to each cell and peek in the formula bar, but that takes time, and it forces you to look at each formula separately.

But Excel has a nifty trick that can yank the curtain back and expose *all* your formulas at once. To try it out, open a workbook that has at least one formula (but preferably more). Then, choose **Formulas** ▾ **Formula Auditing** ▾ **Show Formulas**. (Depending on the size of your Excel window, Excel might not show the “Show Formulas” caption on the button. If you don’t see it at first, look for a tiny picture with the “15/fx” symbol.

Hover over that, and you'll see the words "Show Formulas" pop up, confirming you've got the right button.)

When you click **Show Formulas**, Excel does two things. First, it doubles the width of every column on your worksheet, so you have more room to read formulas. Second, it shows every formula *on your worksheet*, right inside each cell.

So if you start with a worksheet like this:

	A	B	C	D	E	F
1						
2		JAN-APR	MAY-AUG	SEP-DEC	Total	
3	Starting Balance	\$1,500.00			Total	
4	Total Income	\$0.00	\$0.00	\$0.00	\$0.00	
5	Total Expenses	\$0.00	\$0.00	\$0.00	\$0.00	
6	Net Difference	\$0.00	\$0.00	\$0.00	\$0.00	
7	End Balance	\$1,500.00	\$1,500.00	\$1,500.00		
8						

When you click **Show Formulas**, you'll get this:

	A	B	C	D	E	F
1						
2		JAN-APR	MAY-AUG	SEP-DEC	Total	
3	Starting Balance	1500			Total	
4	Total Income	=B15	=C15	=D15	=SUM(B4:D4)	
5	Total Expenses	=B32+B43+B53+B59+B116+E	=C32+C43+C53+C59+C116+C:	=D32+D43+D53+D59+D116	=SUM(B5:D5)	
6	Net Difference	=B4-B5	=C4-C5	=D4-D5	=SUM(B6:D6)	
7	End Balance	=B4-B5+B3	=B7+C4-C5	=C7+D4-D5		
8						

In this example there are plenty of formulas to check out. For example, look at cell B7. In normal view it shows the formula result, which is the number \$1,500. In formula view it shows the formula that does the work, which is `=B4-B5+B3`

Formula view doesn't damage your worksheet—it's temporary. To get back to normal, just click **Show Formulas** again. When you do, Excel tucks your formulas back out of sight and shrinks all your columns by half, getting them back to their original sizes.

Itching to try this out for yourself? You can use this trick on the "Pocket calculator" workbook from the exercise earlier in this chapter. Give it a whirl!

Pro tip: If you really want to impress ordinary people, learn the secret **Ctrl+** shortcut. It lets you trigger the **Show Formulas** command without lifting your fingers from the keyboard. The trick is to find the right key. It's not the ordinary apostrophe,

but the mysterious “accent grave” key (also known as the “backtick”). On a standard keyboard, you can find it to the left of the number 1 key, near the top-left corner of your keyboard. It shares space with the equally exotic tilde (~) character. Once you’ve found the right key, hold down **Ctrl** and press this key to show or hide your formulas instantly.

If you want, you can even *print* your worksheet o’ formulas. Just use the standard **File** ▷ **Print** command while you’re in formula view. However, you’ll probably want to resize your columns beforehand. Shrink the columns that don’t have formulas, so you aren’t wasting paper with blank space. Expand any columns that still aren’t wide enough to show your formulas, so your printout has the full calculations. But be warned, if you resize your columns in formula view, you’ll need to resize them again when you switch back to normal.

The Last Word

You’ve now taken one step into the world of Excel formulas. You wrote a few formulas that use basic math, saw their results, and learned how to edit them. You then got a bit fancy by learning to spot formula mistakes and expose an entire worksheet of formulas at once.

Right now, your formulas don’t have much pizzazz. But in the next chapter you’ll take a big leap forward. You’ll learn to pull information out of the cells in your worksheet and weave it into your formulas. Read on to learn how.

Using Cell References

“The answer is in your worksheet. But first you must tell Excel where to find it.”

So now you know what an Excel formula is, and how to write one. The problem is that the formulas you’ve used so far aren’t terribly useful.

That’s about to change. In this chapter you’ll take the next big step—you’ll learn to pull numbers out of other cells in your worksheet and use *them* in your formulas. This sounds like a small detail, but it changes everything. It means that instead of using Excel like a glorified pocket calculator, you can use it to analyze your own information. Even better, when you edit your worksheet, your formulas will adjust themselves to use the new numbers. It’s like magic! Read on to see how it works.

Referring to Another Cell

It's easy to grab a value from another cell. Just type the equal sign (=) to start a formula, and then type the *cell address*. Here's an example:

=B1

This formula tells Excel "look for cell B1 and copy its value into my formula." If cell B1 has the number 26 in it, the result of this formula is, unsurprisingly, 26.

Now consider this formula:

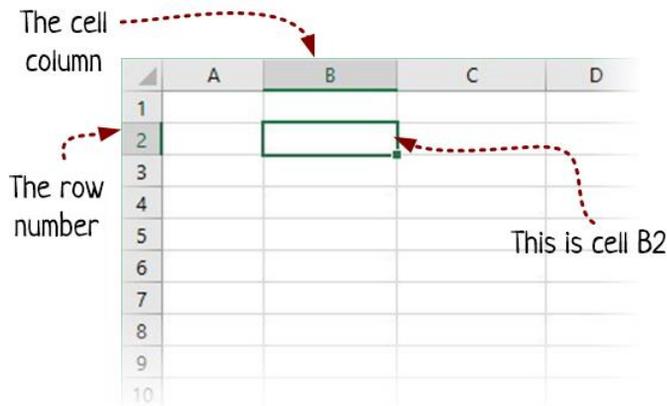
=B1+B2

When Excel evaluates this formula, it gets the numbers in cell B1 and cell B2, adds them together, and shows the result. Where does the result appear? Wherever you've put the formula, of course.

A quick refresher on cell addresses

To be comfortable with Excel, you need to get comfortable with cell references.

Each cell address is a label that points to a single cell in Excel's grid. The first part of the cell address is a letter that identifies the column (like B) and the second part is a number that identifies the row (like 2).



For example:

- ▶ The cell address B2 points to the cell in column B, row 2.
- ▶ The cell address F2 points to a cell in the same row 2, but farther to the right, in column F.

- ▶ The cell address B100 points to the one hundredth cell in the B column.

If you aren't sure which cell you're in, Excel can help you out. Look in the small white box that appears at the top-left corner above the worksheet grid. The address of the current cell appears there. (And if you want some extra practice using cell addresses, check out the "Find the cell" practice exercise from Chapter 1, which is on the tutorial website.)

The #VALUE! error

Excel expects numbers in your formula. If you try to use a cell that has some text in it, your formula won't work. For example, there's no way to add 432 and "Pajama party."

You'll know that one of your cell references has text in it if your formula shows the error code #VALUE! instead of a proper result.

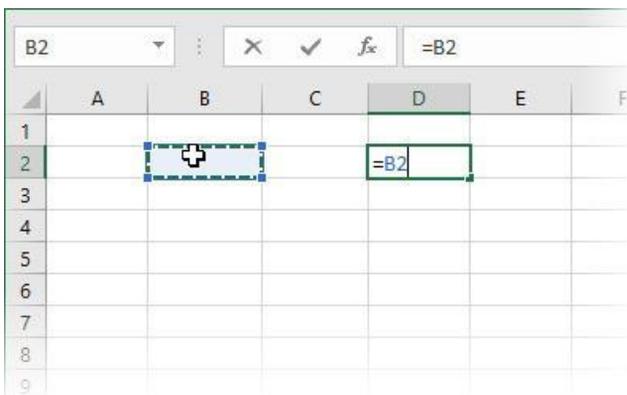
Interestingly, there's no rule against using blank cells. In a formula, Excel treats a blank cell as though it has the number 0 in it.

Try it out: Point-and-click formulas

The straightforward way to add a cell reference is to type it in. But if you're having trouble remembering the exact cell address, there's another way. You can simply *click* the cell you want to use while you're building your formula.

Here's how this trick works:

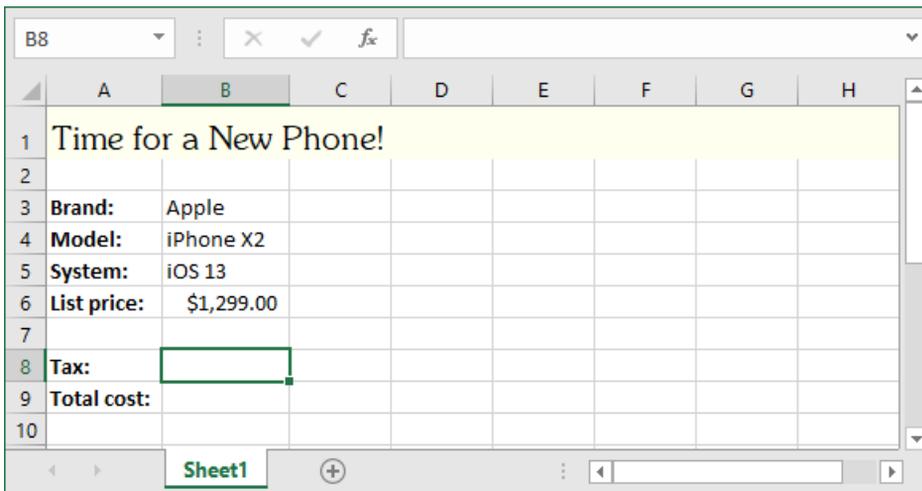
1. Press the equal sign (=) to start your formula.
2. Now click the cell that has what you want. (If you accidentally pick the wrong one, just click again on the right one.) Excel highlights the cell you clicked and adds a reference for it to your formula. Here's what it looks like if you start a formula in cell D2 and then click cell B2:



3. Keep typing in your formula. For example, if you want to add a number from another cell, press the plus sign (+) and click *that* cell. Excel will add the matching reference to your formula.
4. When your formula is perfect, press **Enter** to finish it.

Exercise #1: Calculate the sales tax

To see how useful cell references can be, you need to try a more realistic example. On the tutorial website (<http://lab.halfwit2hero.com/excelformulas>) there's an example that invites you to calculate the total cost of a fancy new smartphone, with tax included.



Here you start with the list price. It's up to you to write a formula that grabs the list price (using a cell reference) and calculates the tax. You'll then build on this with another formula (and another cell reference) to calculate the total cost. Before you go any further, try it out.

Cell references are alive (sort of)

Here's the nifty thing about cell references: they never go out of date. When you change the number in a cell, Excel notices. It instantly recalculates any formulas that use the cell.

It's easy to try this out using the "buy a smartphone" example. Simply edit the cell that has the cost of the phone. When you press the **Enter** key to make your change, Excel updates the result of the tax-calculating and total-calculating formulas to reflect the new price.

This flexibility is what makes cell references so useful. Imagine you create a worksheet that calculates the total cost of something more complicated—for

example, a computer with lots of parts, or a home renovation. Later, you can change any number, and Excel will update *all* the formulas that are affected.

Remember, you can format your answer

When you write a formula that uses cell references, Excel tries to guess what formatting you want for the result. For example, if you're adding two Currency values (numbers that have dollar signs and two decimal places), Excel assumes the answer should use the Currency format as well. But if that's not what you want, you can pick a different format, in the same way that you pick a format for any other cell.

If you've forgotten how to pick the format for your cell, just remember it's all in the ribbon. First, move to the cell. Then, click the **Home** tab and look in the **Number** section. There you'll see a handy list of format choices you can pick from, and extra options for adding or removing decimal places, commas, and currency symbols.

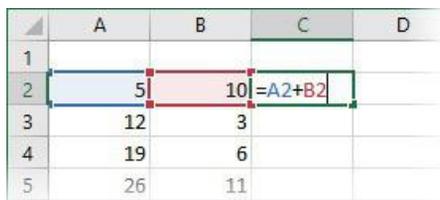
Copying Formulas

A typical Excel worksheet doesn't have just one formula. It doesn't have just two. It could easily have a dozen or more.

Often, many of these formulas are similar to each other. In this situation, Excel has a feature that can save you some serious time. Instead of forcing you to write a dozen versions of the same formula, Excel can take one of your formulas and create copies that are tweaked *just right* so they work with different cells.

Try it out: Copy a formula

To see how Excel's formula copying feature works, start by writing a formula in a workbook. This formula can be as simple as you want, as long as it uses at least one cell reference. Here's an example with a basic formula that adds two cells in a row:



	A	B	C	D
1				
2	5	10	=A2+B2	
3	12	3	15	
4	19	6		
5	26	11		

Now it's time to copy your formula. Follow these steps:

1. Move to the cell that has the formula.
2. Press **Ctrl+C** to copy the formula.
3. Move to a different cell and press **Ctrl+V** to paste your copy.

4. Now, look at the formula in the formula bar. You'll notice that Excel didn't copy the formula exactly. Instead, it *changed* the cell references.

	A	B	C	D
1				
2	5	10	15	
3	12	3	=A3+B3	
4	19	6		
5	26	11		

So what happened? Just as you shifted your formula to a new position, Excel shifted all the cell references to match. Move your formula ten rows down, and Excel shifts all the cell references down ten rows, too. And if you move your formula two columns to the right, your references go with it, two columns to the right.

Exercise #2: Copy a calorie formula

It's easier to understand how Excel's formula copying feature works if you do it yourself. The "Calorie counter" exercise gives you a good place to practice. It starts out with a spreadsheet that totals up the calories in different meals.

Food Item	Portion Size (grams)	Calories Per Portion	Amount Eaten	Calories Eaten
Chocolate pudding	230	300	120	157
Oreo ice cream cake	140	296	80	
Chocolate cheesecake	280	801	124	
Fudge	60	120	72	
Beef gravy	15	32	10	
Apple fritter donut	210	189	420	
Banana sandwich	410	505	410	

At first, the calorie counter has just one formula, in cell E7. This formula calculates how many calories you've eaten of a specific food—in this case, chocolate pudding.

The formula works by dividing the amount you ate (D7) by the portion size (B7) to find out the number of portions you ate. It then multiplies that by the calories per portion (C7) to find out the total number of calories you consumed:

$$=D7/B7*C7$$

This formula gets all its information from the cells in the same row. (This is a common arrangement. Formulas often use the numbers beside them in the same row, or the numbers above them in the same column.)

Here's closer look at how this formula gets its information:

	A	B	C	D	E
	Food Item	Portion Size (grams)	Calories Per Portion	Amount Eaten	Calories Eaten
6	Chocolate pudding	230	300	120	=D7/B7*C7
8	Oreo ice cream cake	140	296	88	
9	Chocolate cheesecake	280	301	122	
10	Fudge	60	120	72	
11	Beef gravy	15	32	10	

To calculate the amount of calories in the next item on the list (Oreo ice cream cake), you need a similar formula:

$$=E8/B8*C8$$

This is basically the same formula, but for row 8 instead of row 7.

Now, you *could* type the right formula for each food item. But that takes time, and there's a chance you'll make a typo along the way that will result in a difficult-to-spot calculation error. Copying the formula is much quicker, because it gets Excel to make the adjustments you need. Try this example on the tutorial site at <http://lab.halfwit2hero.com/excelformulas>.

Relative references and fixed references

Technically, the cell references you've seen so far (like A1 and E4) are *relative references*. That means they depend on the position of your formula.

Excel also allows you to create *fixed references*. Relative references and fixed references behave exactly the same, except if you copy your formula. When copying, Excel adjusts the relative references but it doesn't adjust the fixed references.

To use a fixed reference, just add a dollar sign (\$) in front of the column letter and another one in front of the row number.

For example, you could change this relative reference:

=A4

to this fixed reference:

=\$A\$4

Both references point to cell A4 (and both have exactly the same effect in your calculation). The difference is that Excel won't change the fixed reference (\$A\$4) if you copy the formula to another cell.

A formula can have a mix of relative and fixed references. In fact, that's often exactly what you need. The following exercise demonstrates why.

Exercise #3: Copy a calorie formula (again)

When you copy a formula and Excel adjusts the references, it seems a little like magic. But sometimes this adjustment makes a reference point to the wrong cell.

To see this problem in action, consider a different version of the calorie counter worksheet:

The screenshot shows an Excel spreadsheet with the following data:

	A	B	C	D	E	F	G	H	I
1	The Daily Calorie Counter								
2									
3	Calorie goal per day:		2000						
4	Meals per day:		4						
5	Calorie goal per meal:		500						
6									
7	Date	Meal	Calories Eaten	Amount Over					
8	3/7/2018	Breakfast	612	112					
9	3/7/2018	Lunch	580						
10	3/7/2018	Dinner	512						
11	3/7/2018	Snack	500						

As in the previous exercise, the worksheet starts with a single formula. You need to copy this formula (in cell D8) to the cells underneath.

The problem is that the calorie-calculation formula in this example draws on cells that are in different places. The “calories eaten” cell is in the same row as the formula. The “calorie goal” cell sits above the table, in cell C5.

	A	B	C	D	E
3	Calorie goal per day:		2000		
4	Meals per day:		4		
5	Calorie goal per meal:		500		
6					
7	Date	Meal	Calories Eaten	Amount Over	
8	3/7/2018	Breakfast	612	=C8-C5	
9	3/7/2018	Lunch	580		

The calorie goal is the same for every formula, so every copy should use cell C5. But when you paste a copy of the formula, Excel adjusts it to point to a different cell. This messes up your calculation.

You may already see how you can solve this problem with a fixed reference. Head to the tutorial site (<http://lab.halfwit2hero.com/excelformulas>) to work through the solution.

Mixed references

Along with relative references and fixed references, Excel supports another type of reference.

You can make a *mixed* reference by adding just *one* dollar sign (\$). For example, if you use reference \$A4, the column is fixed but the row is not. When you copy the formula, Excel can change the row (for example, to \$A5 or \$A7) but not the column. Similarly, if you use the mixed reference A\$5 in a formula and copy it, Excel can change the column letter but not the row.

Mixed references are less common than relative references and fixed references, but we thought you should know about them. You’ll get to use them when you work through the “Make me a millionaire” exercise in Chapter 6.

Referring to Cells in Other Sheets

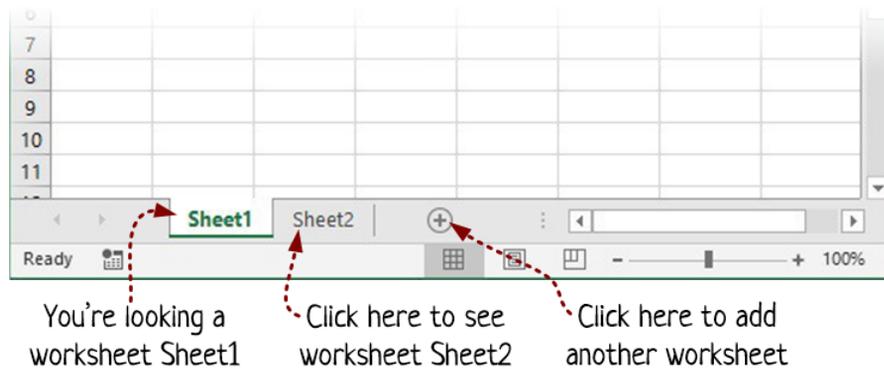
So far, you’ve used references to point to different cells on the same worksheet. This is the most popular type of reference. But Excel lets you reach out even farther, to cells that are in other worksheets.

A quick refresher on worksheets

Before you go any further, here's a quick recap about worksheets and workbooks. Every *workbook* (that's the official name for an Excel file) starts with a single *worksheet*. But you can add as many worksheets as you want.

There are plenty of reasons to add more worksheets. For example, imagine you're running a catering company. You can create a workbook that has two worksheets. On one, you put the list of all the food and services you offer, and their prices. On the other worksheet you can total up the cost of everything your client wants for their next party. Neat, right? (You'll see how to create this example in Chapter 10.)

At the bottom of the Excel window, there's a tab for each worksheet. A new workbook has one worksheet, named Sheet1.



To add a new worksheet, click the plus (+) button. If you've never done it before, try it out now.

You can add as many worksheets as you want, but once you get more than four or five the list of tabs starts to get crowded. Of course, you can only *see* one worksheet at a time. Click a worksheet tab to switch from one sheet to another.

Here are a few more things you can do with worksheets:

- ▶ **Rename a worksheet.** Names like Sheet1 and Sheet2 don't mean much. To pick something more descriptive (like Sales or Catalog) right-click the worksheet tab, choose **Rename**, and type in a better name.
- ▶ **Change the order.** To rearrange your worksheets, click a worksheet tab and drag it to the left or to the right, while holding down the mouse button.
- ▶ **Delete a worksheet.** If you don't want to a worksheet any longer, right-click the worksheet tab and choose **Delete**. Excel won't let you delete all the worksheets in your workbook, because that wouldn't make sense, would it?

- ▶ **Copy a worksheet.** Sometimes you need several worksheets with the same basic layout. To create a quick worksheet copy, right-click the worksheet tab and choose **Move or Copy**. Then check the **Create a copy** checkbox and click **OK**.
- ▶ **Hide a worksheet.** You can make a worksheet disappear temporarily. Right-click the worksheet tab and choose **Hide**. (When you want it back, right-click any worksheet tab, and choose **Unhide**.) Right now, you probably can't think of any good reason to hide worksheets, but it can be useful if you're sharing a workbook with lots of different people, and you want to tuck some of the details out of the way.

Worksheet references

As you already know, you refer to another cell like this:

```
=A1
```

This formula grabs the value from cell A1 in the current worksheet (the worksheet where you're typing the formula).

But what if you want to grab the value from cell A1 in a *different* worksheet?

It's easy. Just put the workbook name, followed by an exclamation mark (!), followed by the cell address. For example, if your cell is in a worksheet named Sheet2, you would write this:

```
=Sheet2!A1
```

And here's a formula that adds the numbers from cell A1 and cell A2, both of which are on Sheet2:

```
=Sheet2!A1+Sheet2!A2
```

There's one catch. If the worksheet name has a space in it, you need to wrap the whole name in apostrophes ('). So if your worksheet has the name Product Catalog, you would need to refer to it like this:

```
='Product Catalog'!A1
```

If you make a mistake in the sheet name, Excel won't be able to find what you want. Instead of getting a proper result, you'll see the error code #REF! appear on your worksheet.

Try it out: Referring to another worksheet

Now's a good time to try this out for yourself. Here's how:

1. Create a new workbook. Like all workbooks, it will start with a single worksheet, named Sheet1.

2. Add a new worksheet to your workbook by clicking the plus (+) button. Excel names the new worksheet Sheet2.
3. In Sheet2, pick a cell (any cell), and type in a number.
4. Click Sheet1 to switch back to your first worksheet.
5. Type = to start writing a formula in Sheet1. Now you're going to add a reference to your cell in Sheet2.
6. You could type the reference in by hand. But a quicker approach is to use Excel's point-and-click formula feature. While you're editing your formula, click the Sheet2 tab and then click the cell that has your number in it.
7. Click back to Sheet1. You'll see that Excel has added the Sheet2 reference to your formula.
8. Add to the formula if you want, or just press **Enter** to finish up.

Workbook references

Referring to a cell in another worksheet is super-useful. Excel also allows you to referring to a cell in another workbook file, which is less useful and a lot more risky.

The problem is that there's no way to make sure your files stick together. If one workbook file points to another, what happens when you email that workbook to a friend or move it to another folder? (Spoiler alert, the workbook won't be able to find the cell it needs any longer, and you'll be stuck with out-of-date information.)

But if you really must create a workbook reference, there's only one good way to do it—use the trusty point-and-click formula method. Here's how:

1. Open both workbooks at once.
2. Press = to start a formula in one workbook.
3. Switch to your other workbook and click the cell you want to reference.
4. Switch back to the workbook where you're writing the formula and keep going. (Or, just press **Enter** to switch back and finish the formula in one step.)

Here's the sort of reference Excel will create:

```
='[Price list.xlsx]Sheet1'!$B$8
```

When you add a reference to a cell in another workbook, Excel includes the file name in square brackets (Price list.xlsx), the sheet name (Sheet1), and the cell address as a fixed reference (\$B\$8).

This is actually a simplified version of the real reference. As soon as you close the workbook that you're referencing (in this case, that's "Price list.xlsx"), Excel will

update your reference with the full file path. Your formula will change into something like this:

```
= 'C:\Users\joemascapone\My Documents\[Price list.xlsx]Sheet1'!$B$8
```

That's a loooong formula for a single reference. It's a hot mess.

If you ignore our advice and use workbook references, and your references break because you've moved or renamed your files, all is not lost. Excel will notice the problem and ask you to pick the file you're trying to reference. Once you do that, your references will be reconnected. (You can also look at all the linked files your workbook uses—and change them—by choosing **Data** ▷ **Queries & Connections** ▷ **Edit Links**.)

Tracing References with Arrows

You've now learned everything you need to know about cell references. In fact, you're ready to skip on to the next chapter and start tackling the next stage of formula writing. But if you have a spare moment, it's worth taking a quick detour to learn about a nifty Excel trick called *tracing arrows*.

The idea is simple. When you use tracing, Excel temporarily draws arrows on your worksheet to point out important relationships. There are two types of relationships you can see:

- ▶ **Precedents.** These are the cells that a formula uses to make its calculation. If you have the formula `=A1+A2` then A1 and A2 are precedents.
- ▶ **Dependents.** These are the formulas that use your cell. For example, if you're positioned on cell B3, every cell with a formula that uses B3 is a dependent.

The best way to understand this precedent/dependent jargon is to see it for yourself, in action, with Excel's tracing feature.

Try it out: Tracing the calorie counter

The sample exercises in this chapter are a great testing ground for tracing, because they all have formulas that use cell references. Here's how you can get started exploring the calorie counter:

1. Open the "Calorie Counter 2" workbook that you used in the third exercise. If you have your completed copy on hand, use that. If not, you can grab the starting workbook from <http://lab.halfwit2hero.com/excelformulas> (there's a link in the first step of the third exercise) and switch to the Solution tab.
2. Move to cell D8, which has the "Amount Over" calculation for the first row in the table.

- Click **Formulas** > **Formula Auditing** > **Trace Precedents**. The effect is immediate. You'll see two arrows that show the relationships: the formula in cell D8 uses cells C5 and C8:

	A	B	C	D	E
1	The Daily Calorie Counter				
2					
3	Calorie goal per day:		2000		
4	Meals per day:		4		
5	Calorie goal per meal:		500		
6					
7	Date	Meal	Calories Eaten	Amount Over	
8	3/7/2018	Breakfast	612	112	
9	3/7/2018	Lunch	580	80	
10	3/7/2018	Dinner	512	12	
11	3/7/2018	Snack	500	0	
12	3/8/2018	Breakfast	601	101	
13	3/8/2018	Lunch	513	13	
14	3/8/2018	Dinner	554	54	
15	3/8/2018	Snack	400	-100	
16					

- You don't need to stop your investigation just yet. If you click **Trace Precedents** again Excel digs one level deeper. It adds arrows to show you what your dependent cells use:

	A	B	C	D	E
1	The Daily Calorie Counter				
2					
3	Calorie goal per day:		2000		
4	Meals per day:		4		
5	Calorie goal per meal:		500		
6					
7	Date	Meal	Calories Eaten	Amount Over	
8	3/7/2018	Breakfast	612	112	
9	3/7/2018	Lunch	580	80	
10	3/7/2018	Dinner	512	12	
11	3/7/2018	Snack	500	0	
12	3/8/2018	Breakfast	601	101	
13	3/8/2018	Lunch	513	13	
14	3/8/2018	Dinner	554	54	
15	3/8/2018	Snack	400	-100	
16					

In this example, C8 doesn't use anything, so it doesn't get any arrows. But C5 has its own formula that uses cells C3 and C4, so you get two more arrows there.

These arrows are a bit harder to see, because Excel draws them one on top of the other.

5. You could go to another cell (like D9) and find its dependents, too. There's no limit to how many arrows you can draw on your worksheet at a time. When you're finished, click **Formulas** ▸ **Formula Auditing** ▸ **Remove Arrows** to clear the arrows off your worksheet.
6. Now let's try tracing dependents. Move to cell C5.
7. Click **Formulas** ▸ **Formula Auditing** ▸ **Trace Dependents**. Excel finds all the cells that use C5 in a calculation and draws an arrow to each one:

	A	B	C	D	E
1	The Daily Calorie Counter				
2					
3	Calorie goal per day:		2000		
4	Meals per day:		4		
5	Calorie goal per meal:		500		
6					
7	Date	Meal	Calories Eaten	Amount Over	
8	3/7/2018	Breakfast	612	112	
9	3/7/2018	Lunch	580	80	
10	3/7/2018	Dinner	512	12	
11	3/7/2018	Snack	500	0	
12	3/8/2018	Breakfast	601	101	
13	3/8/2018	Lunch	513	13	
14	3/8/2018	Dinner	554	54	
15	3/8/2018	Snack	400	-100	

As you can see, there are eight cells that use C5.

In this example, your tracing didn't uncover anything unexpected. But tracing can become very useful when you need to investigate errors and figure out where a failed formula is getting its bad data.

You might have noticed that tracing arrows are the second formula auditing feature that you've seen. In Chapter 2, you looked at the **Show Formulas** button, which is in the same **Formulas** ▸ **Formula Auditing** section of the ribbon. You'll learn about one more formula auditing feature in Chapter 5—that's the **Evaluate Formula** button that lets you watch Excel crunch the numbers in any one of your formulas.

The Last Word

Cell references are one of the most important ingredients in Excel formulas. They let you write formulas that use the information on your worksheet—*your* information.

In this chapter, you learned to write cell references. You also learned how Excel adjusts relative references when you copy them (and how you can tell Excel to lay off with fixed references). Finally, you created long-armed formulas that reach out to gather their information from other worksheets.