

## CHAPTER 3

# LOGICAL FUNCTIONS

**INFocus**

Logical functions are used in spreadsheets to test whether a situation is true or false. Depending on the result of that test, you can then elect to do one thing or another.

These decisions can be used to display information, perform different calculations, or to perform further tests.

**In this session you will:**

- ✓ gain an understanding of logical functions
- ✓ learn how to display text using the **IF** function
- ✓ learn how to use **IF** to calculate values
- ✓ learn how to nest **IF** functions
- ✓ learn how to use **IFERROR**
- ✓ learn how to use **TRUE** and **FALSE**
- ✓ learn how to use the **AND** function
- ✓ learn how to use the **OR** function
- ✓ learn how to use the **NOT** function.

# UNDERSTANDING LOGICAL FUNCTIONS

**Logical functions** provide decision-making tools for information in a spreadsheet. They allow you to look at the contents of a cell, or to perform a calculation, and then test that result against a

required figure or value. You can then use the IF logical function to determine which calculation to perform or action to take depending on the outcome of the test. Here are some examples.

## 1 The IF Function

The **IF** function is the key logical function used for decision making. It takes the format:

**=IF(condition, true, false)**

For example, you could use the following formula:

=IF(B2 > 400, "High", "Low") where,

B2 > 400 is the **condition** being tested  
(this could be translated as "Is the value in cell B2 greater than 400?")

"High" is the text to display if B2 is greater than 400 (the result of the test is **yes** or **TRUE**)

"Low" is the text to display if B2 is less than or equal to 400 (the result of the test is **no** or **FALSE**)

## 2 The AND Function

The **AND** function is used to compare more than one condition. It returns TRUE only if all of the conditions are met, and takes the format:

**=AND(condition1, condition2,...)**

For example, you could use the following formula:

=AND(B2 > 400, C2 < 300) where,

B2 > 400 is the first condition being tested

C2 < 300 is the second condition being tested

This will only return the result **TRUE** if the value in cell B2 is greater than 400 **and** the value in cell C2 is less than 300. In all other situations, the result will be **FALSE**.

## 3 The OR Function

The **OR** function is also used to compare more than one condition. It returns TRUE if any of the conditions are met, and takes the format:

**=OR(condition1, condition2,...)**

For example, you could use the following formula:

=OR(B2 > 400, C2 < 300) where,

B2 > 400 is the first condition being tested

C2 < 300 is the second condition being tested

This will return the result **TRUE** if either the value in cell B2 is greater than 400 **or** the value in cell C2 is less than 300. The result will be **FALSE** only if neither of the conditions is met.

# USING IF TO DISPLAY TEXT

The **IF** function can be used to display different information depending on the outcome of the condition test. The resulting text will appear in the cell where the formula containing the **IF** function

resides. In this example, the **IF** function is used to indicate where figures in a neighbouring column meet or exceed a specified target. This makes identifying successful sales people far easier.

## Try This Yourself:

Open File

Before starting this exercise you **MUST** open the file *E819 Logical Functions\_1.xlsx...*

**1** Click on the **IF Function** worksheet tab, then click on **D7** to select the cell

**2** Type  
`=IF(C7>E$2,"Exceeded Target","Below Target")`

**3** Press  to complete the formula

**4** Click on **D7** then double-click on the fill handle to copy the formula down the column

*Notice that the result for Jerry Hancock is Below Target even though she achieved 34,000? Let's modify the formula...*

**5** Click on **D7**, then click in the **Formula bar** immediately to the right of >

**6** Type = then press

**7** Repeat step **4** to copy the formula down the column

**2**

	Target	34,000
	Commission	5%
	Monthly Sales	Status
	45,000	=IF(C7>E\$2,"Exceeded Target","Below Target")
	25,000	
	27,800	
	34,000	

**4**

	Target	34,000
	Commission	5%
	Monthly Sales	Status
	45,000	Exceeded Target
	25,000	Below Target
	27,800	Below Target
	34,000	Below Target
	18,350	Below Target
	12,500	Below Target
	75,880	Exceeded Target
	43,778	Exceeded Target
	23,400	Below Target

**5**

fx =IF(C7>E\$2,"Exceeded Target","Below Target")		
IF(logical_test, [value_if_true], [value_if_false])		
Interprises		
	Target	34,000
	Commission	5%
	Monthly Sales	Status
	45,000	=IF(C7>E\$2,"Exceeded Target","Below Target")
	25,000	Below Target
	27,800	Below Target

## For Your Reference...

**IF(logical\_test, value\_if\_true, value\_if\_false)**

This function performs the **test**, then if the result is true, uses the entry in the position **true**. If the result is not true, the entry for **false** is used.

## Handy to Know...

- If you only want text to appear if the result is true, you can enter "" (two double quotes) in the position for **false**. For example, `=IF(C7>=E$2, "Exceeded Target", "")` will only display text if the target was met or exceeded.

# USING IF TO CALCULATE VALUES

One of the most common uses of the **IF function** is to perform numerical computations based on the outcome of the condition test. This is achieved by putting formulas that would normally

be used to **calculate values** in place of the **true** and **false** components in the function. You can also use this structure to show a specific value according to the result of the condition test.

## Try This Yourself:

Same File

Continue using the previous file with this exercise, or open the file *E819 Logical Functions\_2.xlsx...*

- 1 Click on cell **E7**
- 2 Type **=IF(C7>=\$E\$2,(C7-\$E\$2)\*\$E\$3,0)**
- 3 Press  to complete the formula
- 4 Click on **E7** and double-click on the fill handle to copy the formula down

Due to the formatting of the Commission column, instead of a 0, the dash symbol appears where no commission is to be paid

	B	C	D	E	F	G
<b>Global Enterprises</b>						
missions			Target	34,000		
			Commission	5%		
			Monthly Sales	Status	Commission	
Costas		45,000	Exceeded Target	=IF(C7>=\$E\$2,(C7-\$E\$2)*\$E\$3,0)		
Daniels		25,000	Below Target			
Grayson		27,800	Below Target			
Hancock		34,000	Exceeded Target			
Houson		18,350	Below Target			
Kai		12,500	Below Target			
Maunga		75,880	Exceeded Target			
Nguyen		43,778	Exceeded Target			
Rualowy		23,400	Below Target			

2

	B	C	D	E	F	G
<b>Global Enterprises</b>						
missions			Target	34,000		
			Commission	5%		
			Monthly Sales	Status	Commission	
Costas		45,000	Exceeded Target	550		
Daniels		25,000	Below Target	-		
Grayson		27,800	Below Target	-		
Hancock		34,000	Exceeded Target	-		
Houson		18,350	Below Target	-		
Kai		12,500	Below Target	-		
Maunga		75,880	Exceeded Target	2,094		
Nguyen		43,778	Exceeded Target	489		
Rualowy		23,400	Below Target	-		

4

## For Your Reference...

**IF(test, true-calculation, false-calculation)**

This function performs the **test**, then if the result is true, performs the calculation in the position **true**. If the result is not true, the entry for **false** is used.

## Handy to Know...

- When you work with values, rather than text, it is better to use **0** (zero) than to use "" where there is no calculation to perform. This means that all of the results will be values, rather than a mixture of text and values, and the cell formatting can be used to control the way the values are displayed.

# NESTING IF FUNCTIONS

If you need to make more than one decision before calculating an answer, you can nest or embed an **IF** function inside an **IF** function. For example, you can use an **IF** function in place of

the **true** component of the **IF** function. If the result of the first condition test is true, the second condition will be tested. This structure provides for three alternative outcomes instead of two.

## Try This Yourself:

Same File

Continue using the previous file with this exercise, or open the file *E819 Logical Functions\_3.xlsx*...

- 1 Double-click on **E7** to open the formula for editing
- 2 Click after the first equal sign and type **IF(C7>=(2\*\$E\$2),** then press **Alt** + **Enter** to create a new line
- 3 Type **(C7-\$E\$2)\*(2\*\$E\$3),** then press **Alt** + **Enter** to create a new line
- 4 Click immediately after the first comma on this line and press **Alt** + **Enter**
- 5 Click immediately after the first comma on this line and press **Alt** + **Enter**  
*Your formula is now divided into components. Let's complete the formula...*
- 6 Press **End** to move to the end of the formula, and type **)**
- 7 Press **Enter**, click on **E7** then double-click on the fill handle to copy the formula down the column

2

Monthly Sales	Status	Commission
45,000	Exceeded Target	=IF(C7>=(2*\$E\$2),
25,000	Below Target	F(C7>=\$E\$2,(C7-\$E\$2)*\$E\$3,0)
27,800	Below Target	IF(logical_test, [value_if_true], [value_if_false])
34,000	Exceeded Target	-
18,350	Below Target	-

6

Monthly Sales	Status	Commission
45,000	Exceeded Target	=IF(C7>=(2*\$E\$2),
25,000	Below Target	(C7-\$E\$2)*(2*\$E\$3),
27,800	Below Target	IF(C7>=\$E\$2,
34,000	Exceeded Target	(C7-\$E\$2)*\$E\$3,
18,350	Below Target	0))
12,500	Below Target	-
75,880	Exceeded Target	2,094

7

C	D	E	F	G	H
<b>erprises</b>					
	Target	34,000			
	Commission	5%			
Monthly Sales	Status	Commission			
45,000	Exceeded Target	550			
25,000	Below Target	-			
27,800	Below Target	-			
34,000	Exceeded Target	-			
18,350	Below Target	-			
12,500	Below Target	-			
75,880	Exceeded Target	4,188			
43,778	Exceeded Target	489			
23,400	Below Target	-			

## For Your Reference...

### IF(test, true-calculation, false-calculation)

This function performs the **test**, then if the result is true, performs the calculation in the position **true**. If the result is not true, the entry for **false** is used. You can substitute an entire **IF** function for the **true** and/or the **false** calculations.

## Handy to Know...

- When you create nested formulas, Excel will colour-code the paired brackets to make it easier to see what you are doing. The outside brackets are coloured black.
- You can nest any function within another function, but plan carefully.

# USING IFERROR

**IFERROR** is used to trap errors that may occur as the result of a calculation and then display alternative text or values. For example, if you divide a number by zero, Excel will normally

return the message **#DIV/0!** which can be a bit alarming for novice users. **IFERROR** tests a calculation to see if it works and, if so, performs the calculation. If not, it displays an alternative.

## Try This Yourself:

Same File

Continue using the previous file with this exercise, or open the file *E819 Logical Functions\_4.xlsx*...

- 1 Click on the **IFERROR Function** worksheet tab and click on **E7**
- 2 Type the following  
**=IFERROR(C7/D7, "First Year")**
- 3 Press
- 4 Click on **E7** and double-click on the fill handle to copy the formula down the column

*Instead of giving an error where the divisor is zero, Excel displays the text "First Year" in the cell*

2

	B	C	D	E	F	G
	<b>Global Enterprises</b>					
	Annual Sales					
		<b>Total Sales</b>	<b>Years as Agent</b>	<b>Average Annual Sales</b>		
Costas		2,578,015	2	=IFERROR(C7/D7, "First Year")		
Daniels		4,875,485	4			
Grayson		2,978,450	3			
Hancock		7,586,204	6			
Houson		1,083,650	0			
Kai		1,284,500	0			
Maunga		7,658,900	8			
Nguyen		4,357,859	5			
Rualowy		2,487,652	3			

4

		<b>Total Sales</b>	<b>Years as Agent</b>	<b>Average Annual Sales</b>
Costas		2,578,015	2	1,289,008
Daniels		4,875,485	4	1,218,871
Grayson		2,978,450	3	992,817
Hancock		7,586,204	6	1,264,367
Houson		1,083,650	0	First Year
Kai		1,284,500	0	First Year
Maunga		7,658,900	8	957,363
Nguyen		4,357,859	5	871,572
Rualowy		2,487,652	3	829,217

## For Your Reference...

**IFERROR(calculation, error\_value)**

This function performs the **calculation** and if there are no errors, displays the result of the calculation. If an error does occur, it displays the **error\_value**.

## Handy to Know...

- In this example we've used text as the entry to be displayed if an error is located, but you could just as easily display nothing using "" (two double quotes) or perform an alternative calculation.

# USING TRUE AND FALSE

**TRUE** and **FALSE** are logical values. The result of a logical test is either true or false and Excel allows you to enter these values in cells or test for them in functions. TRUE and FALSE can be

entered as **values**, which are TRUE and FALSE, or as **formulas** with no parameters, which are =TRUE() and =FALSE(). The value TRUE and the formula =TRUE() are treated as identical by Excel.

## Try This Yourself:

Same File

Continue using the previous file with this exercise, or open the file *E819 Logical Functions\_5.xlsx*...

- 1 Click on the **AND Function** worksheet tab and click on cell **D7**
- 2 Type the **TRUE** and **FALSE** entries in the column as shown
- 3 Click on **E7** and type **=IF(C7>=\$E\$2, IF(D7=TRUE, (C7-\$E\$2)\*\$E\$3,0),0)**
- 4 Press
- 5 Click on **D7** and double-click on the fill handle to copy the formula down the column

2

2	Agency Commissions		Target	34,000
3			Commission	5%
4				
5	Agent	Monthly Sales	On Staff	Commission
6				
7	Janet	Costas	45,000	TRUE
8	Mark	Daniels	25,000	TRUE
9	Maureen	Grayson	27,800	FALSE
10	Jerry	Hancock	34,000	FALSE
11	Brian	Houson	18,350	FALSE
12	Helen	Kai	12,500	TRUE
13	Norris	Maunga	75,880	TRUE
14	Alex	Nguyen	43,778	FALSE
15	Kate	Rualowy	23,400	FALSE
16				
17				

3

	Target	34,000	
	Commission	5%	
	Monthly Sales	On Staff	Commission
	45,000	TRUE	=IF(C7>=\$E\$2,IF(D7=TRUE,(C7-\$E\$2)*\$E\$3,0),0)
	25,000	TRUE	
	27,800	FALSE	
	34,000	FALSE	

5

	Target	34,000	
	Commission	5%	
	Monthly Sales	On Staff	Commission
	45,000	TRUE	550
	25,000	TRUE	-
	27,800	FALSE	-
	34,000	FALSE	-
	18,350	FALSE	-
	12,500	TRUE	-
	75,880	TRUE	2,094
	43,778	FALSE	-
	23,400	FALSE	-

### For Your Reference...

**TRUE**

The logical value TRUE

**FALSE**

The logical value FALSE

### Handy to Know...

- TRUE** is used really just to make formulas more readable. You could also write the above formula as **=IF(C7>=\$E\$2,IF(D7,(C7-\$E\$2)\*\$E\$3,0),0)**. Here the **=TRUE** in the second **IF** statement is left out because Excel automatically reads the IF expression as "if D7 is true, then..."

# USING AND

The **AND** function is used to compare the results of more than one condition test. It ensures that a calculation will not be performed unless all of the specified conditions are met. In other words, the

first and second and third (and so on) conditions must all be true before **AND** returns the value **true**. This is ideal to use with the IF function to test for a collection of conditions.

## Try This Yourself:

Same File

Continue using the previous file with this exercise, or open the file *E819 Logical Functions\_6.xlsx*...

1 Click on the **AND Function** worksheet, then click on **E7** and type:  
**=AND(C7>=\$E\$2,D7=TRUE)**

2 Press **Enter**

The result will be **TRUE**, because both conditions are satisfied. Now to add the **IF** function...

3 Double-click on **E7** then click after the first equal sign and type **IF(**

4 Press **End** to move to the end of the formula and type **,** then press **Alt** + **Enter** to create a new line

5 Type **(C7-\$E\$2)\*\$E\$3,0)**

6 Press **Enter**

7 Click on **E7** then double-click on the fill handle to copy the formula down the column

The result is the same, it's just a different way of testing the values

1

Global Enterprises			
missions		Target	34,000
		Commission	5%
	Monthly Sales	On Staff	Commission
Costas	45,000	TRUE	=AND(C7>=\$E\$2,D7=TRUE)
Daniels	25,000	TRUE	-
Grayson	27,800	FALSE	-
Hancock	34,000	FALSE	-
Houson	18,350	FALSE	-

5

Global Enterprises			
		Target	34,000
		Commission	5%
	Monthly Sales	On Staff	Commission
	45,000	TRUE	=IF(AND(C7>=\$E\$2,D7=TRUE), (C7-\$E\$2)*\$E\$3,0)
	25,000	TRUE	-
	27,800	FALSE	-
	34,000	FALSE	-
	18,350	FALSE	-

7

Global Enterprises			
missions		Target	34,000
		Commission	5%
	Monthly Sales	On Staff	Commission
Costas	45,000	TRUE	550
Daniels	25,000	TRUE	-
Grayson	27,800	FALSE	-
Hancock	34,000	FALSE	-
Houson	18,350	FALSE	-
Kai	12,500	TRUE	-
Maunga	75,880	TRUE	2,094
Nguyen	43,778	FALSE	-
Rualowy	23,400	FALSE	-

## For Your Reference...

### AND(logical1, logical2,...)

This function tests the logical value of each entry e.g. **logical1**. If they are all true, it will return the value **TRUE**. If any one of them is false, the function will return **FALSE**.

## Handy to Know...

- A condition in an **AND** function can simply be a reference to a cell holding a logical value (that is, **TRUE** or **FALSE**). For example, **=AND(B2,C2)** will return the value **FALSE** if B2 and/or C2 contain the text **FALSE**.



# USING OR

The **OR** function is used to compare the results of more than one condition test. It will return the value **TRUE** if any of the condition tests return the value **TRUE**. It will only return the value

**FALSE** if all of the condition tests return **FALSE**. The **OR** function is often used in conjunction with the **IF** function to test a collection of conditions, and is easier to work with than nested **IF** functions.

## Try This Yourself:

Same File

Continue using the previous file with this exercise, or open the file *E819 Logical Functions\_7.xlsx*...

- 1 Click on the **OR Function** worksheet tab and click on **E7**
- 2 Type `=OR(D7="Gold",D7="Silver")`
- 3 Press
- The result will be **TRUE**, because both conditions are satisfied. Now to add the **IF** function...
- 4 Double-click on cell **E7** then click after the first equal sign and type **IF**
- 5 Press  to move to the end of the formula and type `,`, then press  +  to create a new line
- 6 Type `(C7-$E$2)*$E$3,0)`
- 7 Press
- 8 Click on **E7**, then double-click on the fill handle to copy the formula down the column

2

	Monthly Sales	Agent Classification	Commission
Costas	45,000	Gold	<code>=OR(D7="Gold",D7="Silver")</code>
Daniels	25,000	Bronze	
Grayson	27,800	Bronze	
Hancock	34,000	Silver	

3

	Monthly Sales	Agent Classification	Commission
Costas	45,000	Gold	TRUE
Daniels	25,000	Bronze	
Grayson	27,800	Bronze	
Hancock	34,000	Silver	

6

	Monthly Sales	Agent Classification	Commission
	45,000	Gold	<code>=IF(OR(D7="Gold",D7="Silver"),(C7-\$E\$2)*\$E\$3,0)</code>
	25,000	Bronze	
	27,800	Bronze	
	34,000	Silver	

8

	Monthly Sales	Agent Classification	Commission
	45,000	Gold	550
	25,000	Bronze	-
	27,800	Bronze	-
	34,000	Silver	-
	18,350	Bronze	-
	12,500	Bronze	-
	75,880	Gold	2,094
	43,778	Gold	489
	23,400	Silver	-

### For Your Reference...

**OR(logical1, logical2,...)**  
 This function tests the specified **logical** conditions or cell references. If any one of the conditions is true, it will return the value **TRUE**. If all of them are false, the function will return **FALSE**.

### Handy to Know...

- If you want to pay commission to Gold and Silver agents *only* if they exceed the target, you can use the following formula:  
`=IF(AND(C7>=$E$2, OR(D7="Gold",D7="Silver")), (C7-$E$2)*$E$3,0)`

# USING NOT

Sometimes the best way to get the result you need is to exclude the values that you don't want, rather than testing for the values that you do. The **NOT** function is perfect for this situation,

returning the logical opposite of the condition test. If the condition test returns the value **TRUE**, the **NOT** function will return the value **FALSE**. This can also be used to great effect with the **IF** function.

## Try This Yourself:

Same File

Continue using the previous file with this exercise, or open the file *E819 Logical Functions\_8.xlsx*...

1 Click on the **OR Function** worksheet, double-click on cell **E7** then click before **OR**

2 Press **Del** to remove the **OR** function until the formula reads **=IF("),(C7-\$E\$2)\*\$E\$3,0)**

3 Add the **NOT** function before the double quotes so that the formula reads **=IF(NOT(D7="Bronze"),(C7-\$E\$2)\*\$E\$3,0)**

*This excludes any of the Bronze sales agents, therefore selecting Silver and Gold...*

4 Press **Enter**

5 Click on **E7**, then double-click on the fill handle to copy the formula down the column

*The results are the same, we've just tested the contents of the cells in a slightly different way*

2

	C	D	E	F	G	H
	<b>Enterprises</b>					
		Target	34,000			
		Commission	5%			
		<b>Agent</b>				
	<b>Monthly Sales</b>	<b>Classification</b>	<b>Commission</b>			
	45,000	Gold	=IF(")			
	25,000	Bronze	(C7-\$E\$2)*\$E\$3,0)			
	27,800	Bronze	IF(logical_test, [value_if_true], [value_if_false])			
	34,000	Silver	-			
	18,350	Bronze	-			

3

	C	D	E	F	G	H
	<b>Enterprises</b>					
		Target	34,000			
		Commission	5%			
		<b>Agent</b>				
	<b>Monthly Sales</b>	<b>Classification</b>	<b>Commission</b>			
	45,000	Gold	=IF(NOT(D7="Bronze"),			
	25,000	Bronze	(C7-\$E\$2)*\$E\$3,0)			
	27,800	Bronze	NOT(logical)			
	34,000	Silver	-			
	18,350	Bronze	-			

5

		<b>Agent</b>	
	<b>Monthly Sales</b>	<b>Classification</b>	<b>Commission</b>
	45,000	Gold	550
	25,000	Bronze	-
	27,800	Bronze	-
	34,000	Silver	-
	18,350	Bronze	-
	12,500	Bronze	-
	75,880	Gold	2,094
	43,778	Gold	489
	23,400	Silver	530

### For Your Reference...

#### **NOT(logical)**

This function tests the specified **logical** condition or contents of a cell. If the condition is true, it will return the value **FALSE**. If the condition is false, the function will return **TRUE**.

### Handy to Know...

- If you want to pay commission to Gold and Silver agents only if they exceed the target (to avoid paying negative commission), you can use:

**=IF(AND(C7>=\$E\$2, NOT(D7="Bronze")), (C7-\$E\$2)\*\$E\$3, 0)**