

# Spreadsheet Software

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## 9 Logic

We have seen how to use the functions Average, Date and Days360. Now we see how to use If, CountIf and SumIf. But first we look at the relational operators.

### 9.1 Relational Operators

The relational operators include:

description	symbol	example	explanation
less than	<	2 < 3	2 is less than 3
more than	>	3 > 2	3 is more than 2
equal to	=	2 = 2	2 is equal to 2
less than or equal to	<=	2 <= 3 2 <= 2	2 is less than <b>or</b> equal to 3 2 is less than <b>or</b> equal to 2
more than or equal to	>=	3 >= 2 2 >= 2	3 is more than <b>or</b> equal to 2 2 is more than <b>or</b> equal to 2
not equal to	<>	2 <> 3	2 is not equal to 3

Notice that **Less** than has its point on the **Left**, and **moRe** than has its point on the **Right**. Notice the order: <=. The < symbol comes before the = symbol. And there is no space between the two symbols.

In picture of a number line:



### 9.2 The If Function

The design for our next spreadsheet is:

*Structured English*

*input a person's age*

*if age < 18 then*

*display "Too young"*

*else*

*display "Age OK"*

*endif*

← done if the age is less than 18

← done if the age is NOT less than 18

In Excel, if cell B3 contains a person's age you might write the following formula in C3:

=If (B3 < 18, "Too Young", "Age OK")

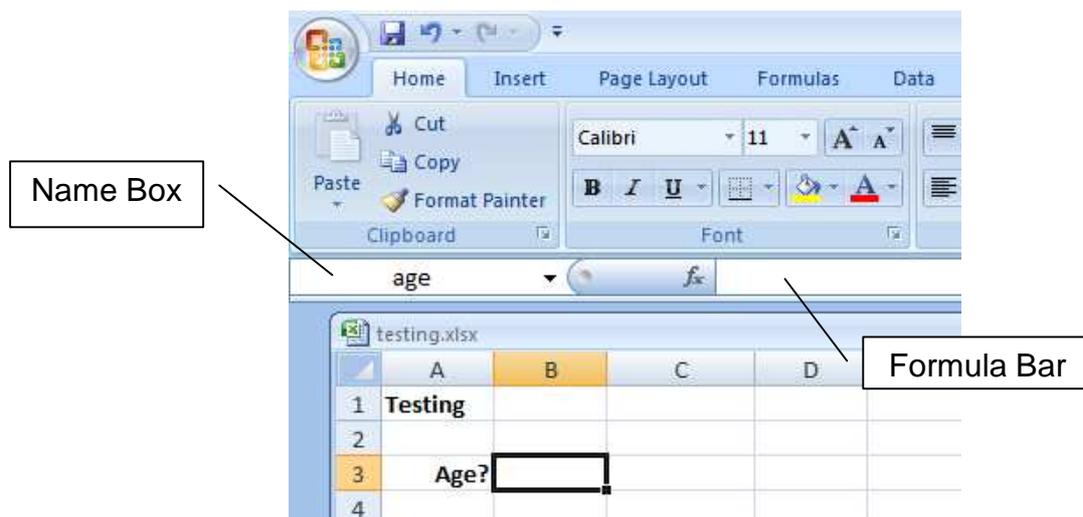


But wouldn't it be easier if we could write

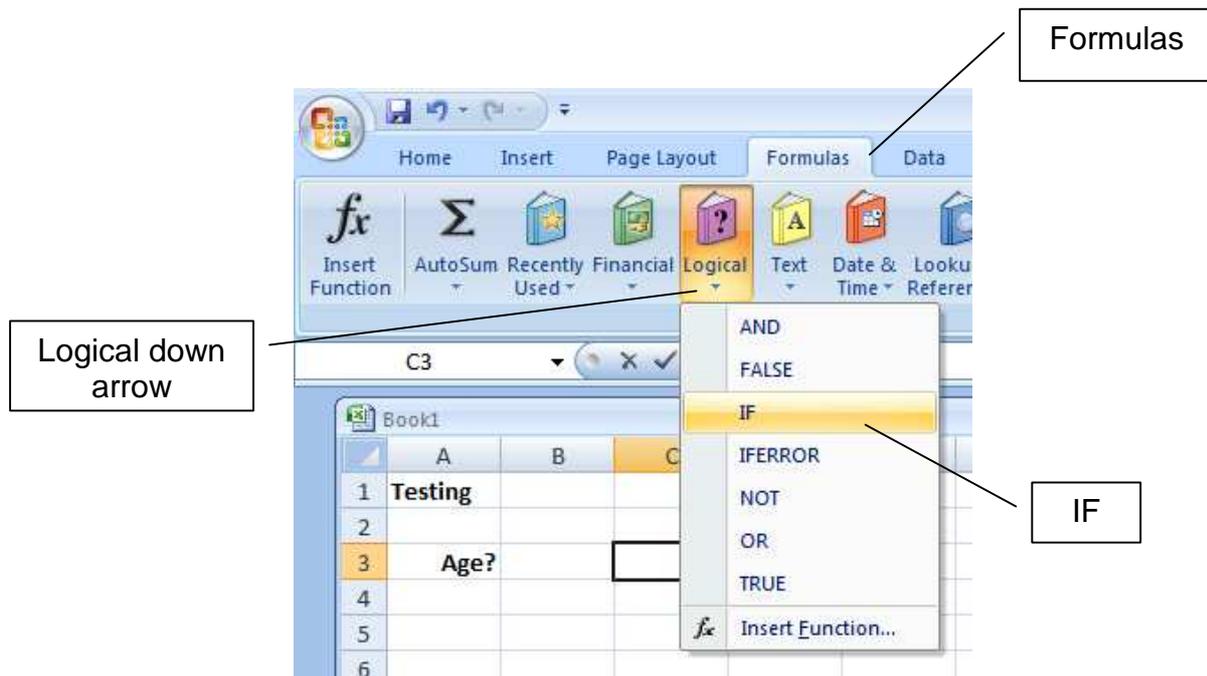
=If (age < 18, "Too Young", "Age OK")

Well, we can.

1. start a new spreadsheet
2. insert the heading *Testing* in A1
3. make cell B3 active
4. name the cell *age* by typing age in the Name Box of the Formula Bar

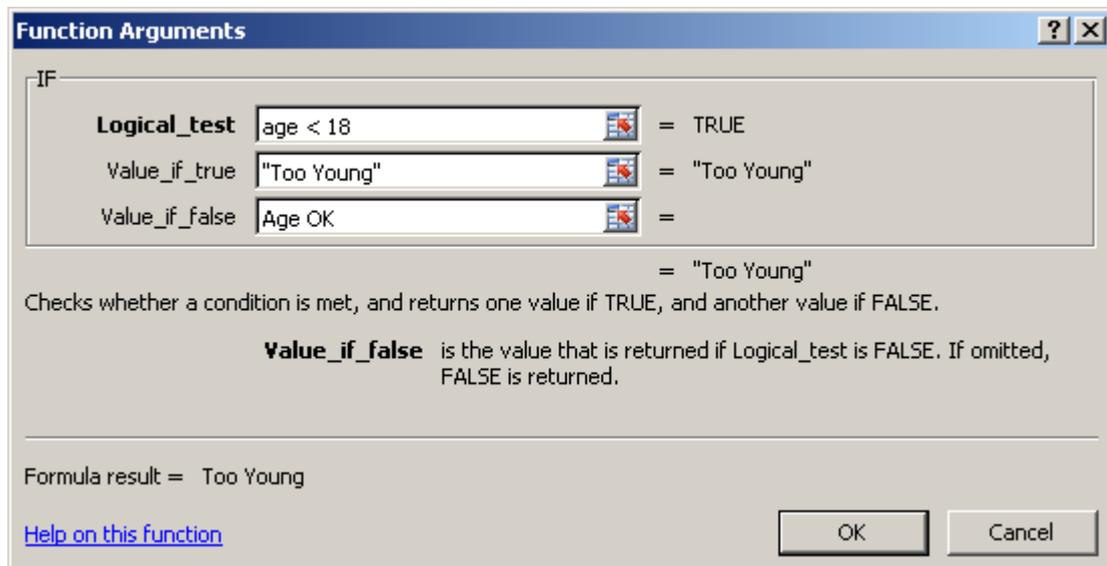


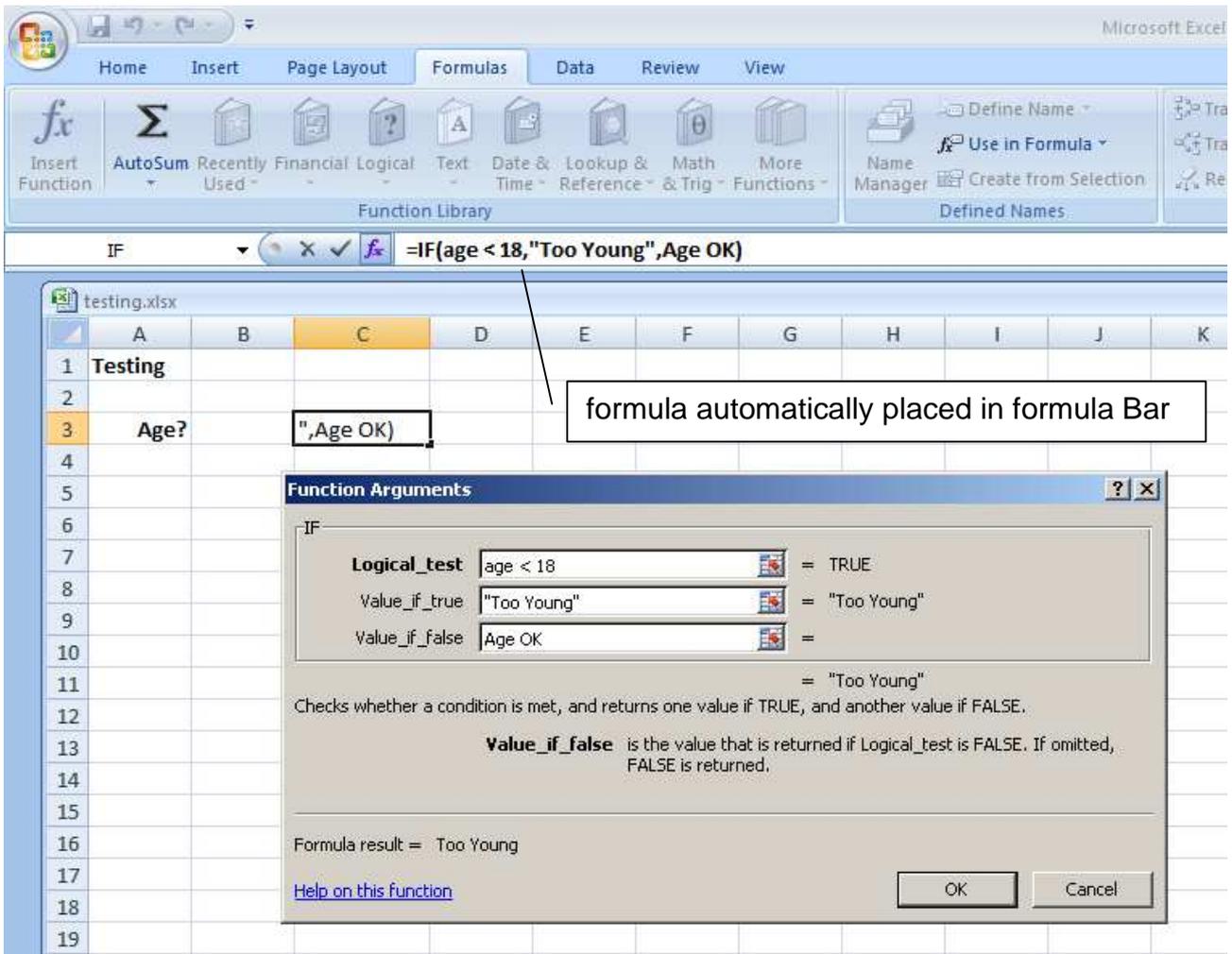
5. make C3 the active cell
6. choose Formulas, Logical down arrow, IF



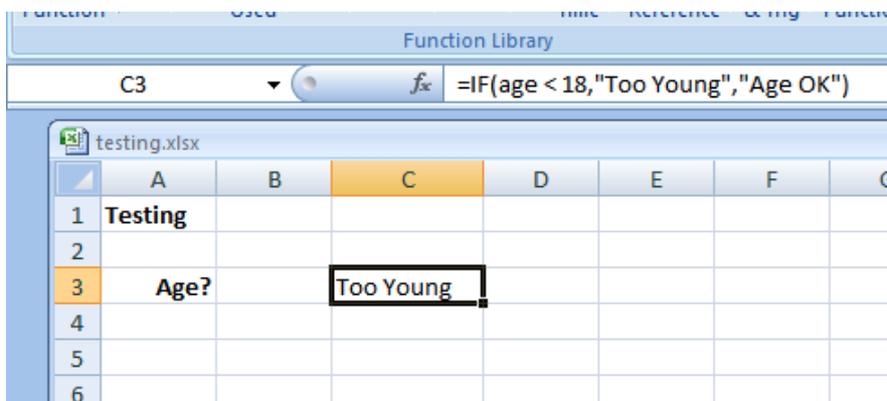
7. in the Function Arguments dialogue box write:

- age < 18* for the Logical\_test
- "Too Young"* for Value\_if\_true
- "Age OK"* for Value\_if\_false



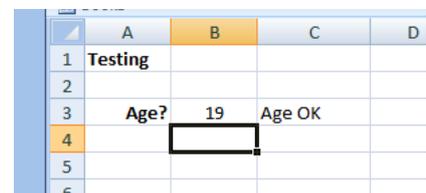
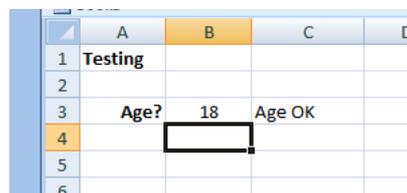
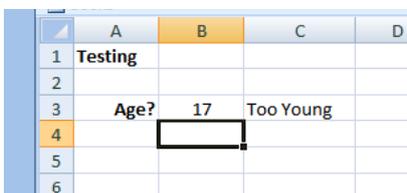


8. OK



9. test your formula three times, with the ages shown below, in B3:

- a. 17
- b. 18
- c. 19



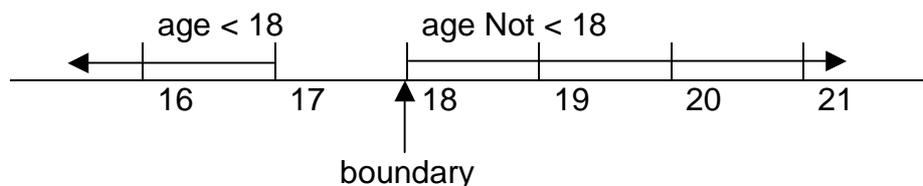
Note: If you name a cell and create a formula that uses that cell, then try and copy the formula down into a range of other cells, the named cell remains fixed, just as if it was an absolute cell reference (see a handout #4 to remind you what absolute referencing is about).

### 9.3 Boundary Testing

Look at

```
If age < 18 Then
  display "Too young"
Else
  display "Age OK"
End If
```

$age < 18$  is an example of a *boundary*. If *age* had the value 17, then *Too young* would be displayed. If *age* had the value 18, then *Age OK* would be displayed. A boundary occurs wherever a small change in value (e.g. from 17 to 18) causes a big change in effect (e.g. from *Too Young* to *Age OK*).



You always test your spreadsheet with the values **closest** to the boundary points because spreadsheet writers (people like you and me) are sometimes human and humans sometimes make mistakes. Errors in logic are often found close to boundary points.

### 9.4 Test Plans

Spreadsheets have errors like dogs have fleas (have I said that before?). The purpose of testing is to find errors. If you had a job as a tester, you would be looking for errors in spreadsheets. No matter how many errors you find, you can never guarantee to have found every error. Check out [www.eusprig.org/hdykysir.pdf](http://www.eusprig.org/hdykysir.pdf) for some horror stories.

A test plan always has four columns:

Test #	Test Data	Reason	Expected Result
1	age = 17	boundary between Too young and Age OK	Too young
2	age = 18		Age OK
3	age = 19		Age OK

When you test your spreadsheet you compare your actual results with the ones you were expecting. Sometimes you are surprised. The result you actually get is not the one you expected. A mistake has been made somewhere. What do you do? You **either** fix the error (the error could be in your test plan or in your spreadsheet or ...) **or** you write: *There is an error. I don't know why. I will fix it later.* The best spreadsheet writers are up front

about their errors. Better that you tell me about your errors than it is for me to find them for you. Better you find your errors before your customers do!

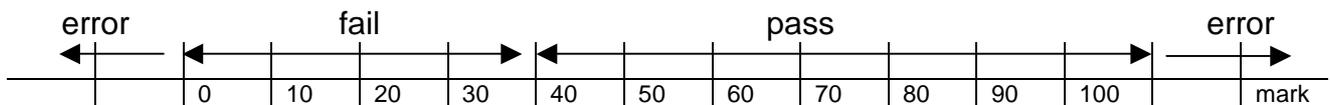
### Exercise 9.1

1. Design, write, comment and test spreadsheets to:
  - a. input a thermometer reading. If the temperature is less than (or equal to) zero write *freezing*, otherwise write *not too cold*.
  - b. read the clinical thermometer. If the temperature is more than 37.4 write *patient has a fever*, otherwise write *patient does not have a fever*.
  - c. read the number of people who have passed through a turnstile. If it is more than 50000 write *stadium full*, otherwise write *seats available*.

## 9.5 Extending the If Function

We look at the exam mark problem. If you get an exam mark of less than 40 then you have failed. But if you get an exam mark of between 40 and 100 inclusive, then you have passed. If you get an exam mark of less than zero then it is an error. If you get an exam mark of more than 100 then you have cheated.

On a number line:



We start with the lowest boundary:

```
if mark < 0 then
  display "Error"
```

Then we add on the next boundary:

```
if mark < 0 then
  display "Error"
else if mark < 40 then
  display "Fail"
```

Then we add on the next boundary:

```
if mark < 0 then
  display "Error"
else if mark < 40 then
  display "Fail"
else if mark <= 100 then
  display "Pass"
```

Finally we add on the trailing else:

```

if mark < 0 then
  display "Error"
else if mark < 40 then
  display "Fail"
else if mark <= 100 then
  display "Pass"
Else
  display "Error"
Endif

```

The last Else means *if none of the above is true*.

The order in which we write the boundaries is important because it is always the first one that is True that is carried out before skipping to the end. Let us put this to the test.

If the exam mark was actually 39, then the first test that is true is *mark < 40*. So we display *Fail* and skip to the end.

If the exam mark was actually 41, then the first test that is true is *mark <= 100*. So we display *Pass* and skip to the end.

If the exam mark was actually 101, then none of the tests (*mark < 0*, *mark < 40*, and *Mark <= 100*) is true. So we display *Error* and skip to the end.

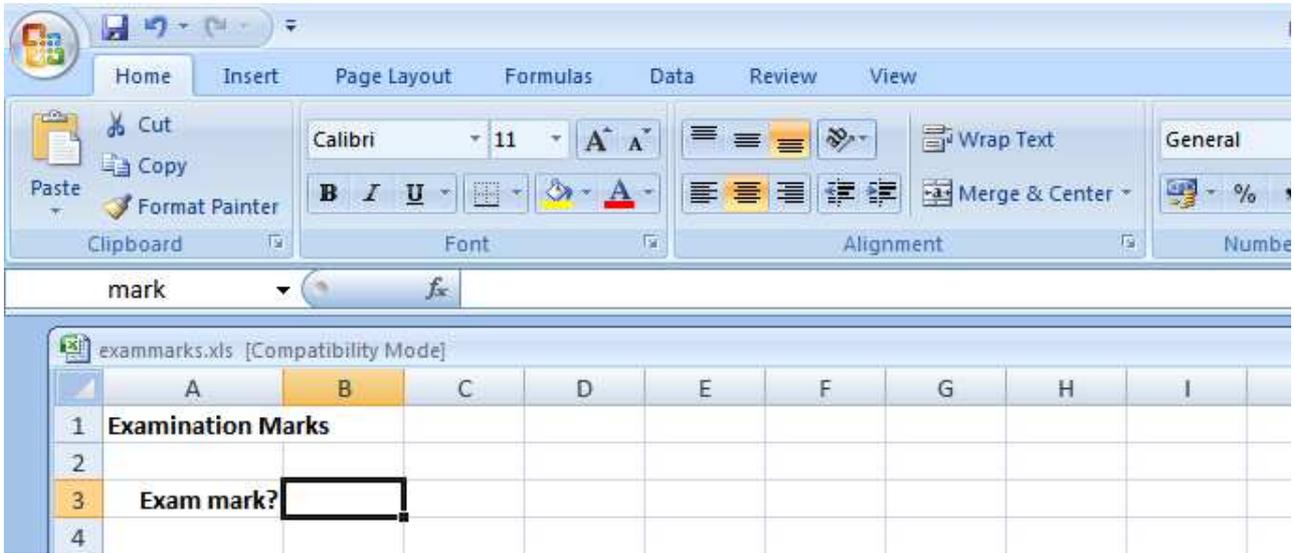
Now we write this in Excel.

English	Excel
if mark < 0 then display Error	if (mark < 0, "Error", ...
but if mark < 40 then display Fail	if (mark < 0, "Error", if (mark < 40, "Fail", ...
but if mark <= 100 then display Pass	if (mark < 0, "Error", if (mark < 40, "Fail", if (mark <= 100, "Pass", ...
but if none of the above is true then display Error	if (mark < 0, "Error", if (mark < 40, "Fail", if (mark <= 100, "Pass", "Error")))

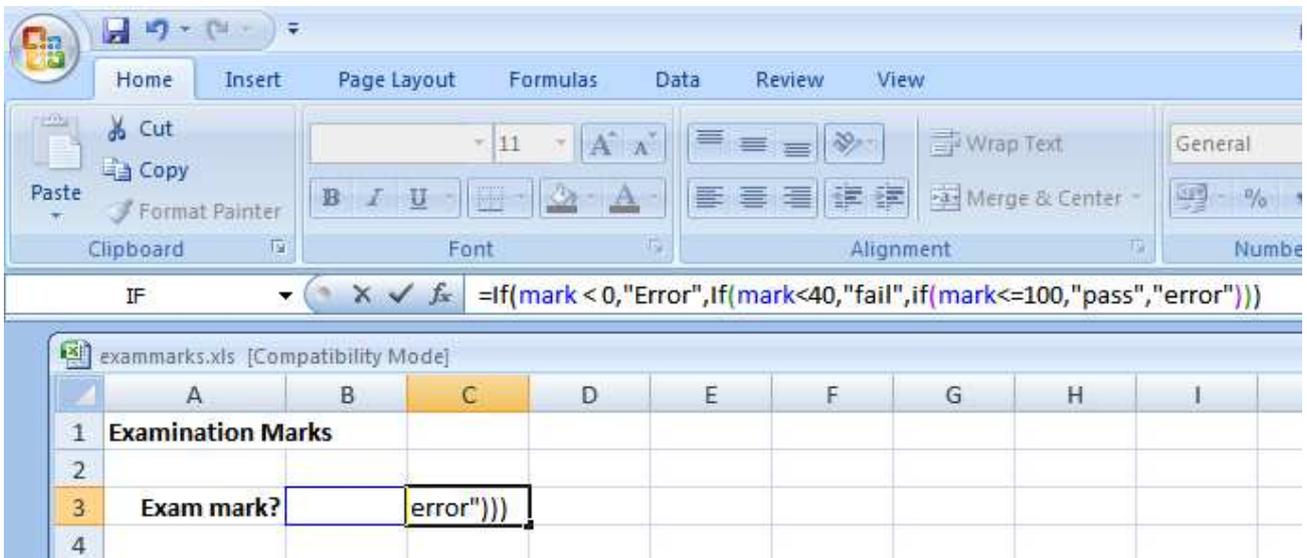
The number of closing ) must match the number of opening (.

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1. start a new spreadsheet
2. insert the headings shown below
3. give cell B3 the name *mark*



4. make cell B3 active
5. in the formula bar write  
`=If(mark<0,"Error",If(mark<40,"fail",Ifmark<=100,"pass", "error"))`



You have no choice but to write out the formula in full in the formula bar.

6. carefully test each boundary point by inserting, in turn, the values -1, 0, 1, 39, 40, 41, 99, 100 and 101 in B3
7. save and print your work, both spreadsheet values and formula

## Exercise 9.2

1. Design, write, comment and test spreadsheets to:
  - a. input the pollen count. If the pollen count is less than zero, write *error*. If the pollen count is between 0 and 29 inclusive, write *low*. If the pollen count is between 30 and 69 inclusive, write *medium*. If the pollen count is between 70 and 100 inclusive, write *high*. If the pollen count is more than 100, write *very high*.
  - b. input the bill. If the bill is less than zero, write *error*. If the bill is between 0 and 50 inclusive write *no discount*. If the bill is over 50 write *discount is 10%*.
  - c. input the time taken to cover a  $\frac{1}{4}$  mile from a standing start. If the time is less than 4 seconds write *quick*. If the time is between 4 and 8 seconds inclusive, write *average*. If the time is more than 8 seconds write *slow*. If the time is negative write *Error*.
  - d. read the number of steps taken by a marathon runner in one minute. If the number of steps is less than 175 write *speed up*. If the number of steps is more than 225 write *slow down*. If the number of steps is between 175 and 225 inclusive write *write on*. If the number of steps is less than zero or more than 500 write *Error*.
  - e. Normal body temperature is  $35.7 \pm 2.5$  i.e. between 33.2 and 38.2 inclusive. Input body temperature. If it is less than 33.2 write *hypothermic*. If it is more than 38.2 write *hyperthermic*. If it is between 33.2 and 38.2 inclusive, write *normal*.

## 9.6 Countlf and Sumlf

*Countlf* Countlf counts (1, 2, 3, ...) the number of items that meets a given condition, for example, counts the number of people who owe you money.

1. create the spreadsheet shown below

	A	B	C	D
1	<b>Debtors</b>			
2				
3	<b>Customer</b>	<b>Bill</b>	<b>Has Paid</b>	
4	Justin Case	£60.00	TRUE	
5	Barb Dwyer	£67.00	FALSE	
6	Stan Still	£61.50	TRUE	
7	Anna Prentice	£72.50	FALSE	
8	Annette Curtain	£78.00	FALSE	
9				
10	<b>Number People Not Paid:</b>			
11	<b>Total Amount Owed:</b>			
12				

2. make C10 the active cell
3. in the Formula Bar enter =Countlf(
4. click on C4
5. drag bottom right hand corner of C4 to C8
6. in the formula Bar enter ,FALSE)

The screenshot shows the Microsoft Excel interface. The formula bar at the top displays the formula `=COUNTIF(C4:C8, FALSE)`. The spreadsheet below has the following data:

	A	B	C	D	E	F
1	<b>Debtors</b>					
2						
3	<b>Customer</b>	<b>Bill</b>	<b>Has Paid</b>			
4	Justin Case	£60.00	TRUE			
5	Barb Dwyer	£67.00	FALSE			
6	Stan Still	£61.50	TRUE			
7	Anna Prentice	£72.50	FALSE			
8	Annette Curtain	£78.00	FALSE			
9						
10	<b>Number People Not Paid:</b>		<b>,FALSE)</b>			
11	<b>Total Amount Owed:</b>					

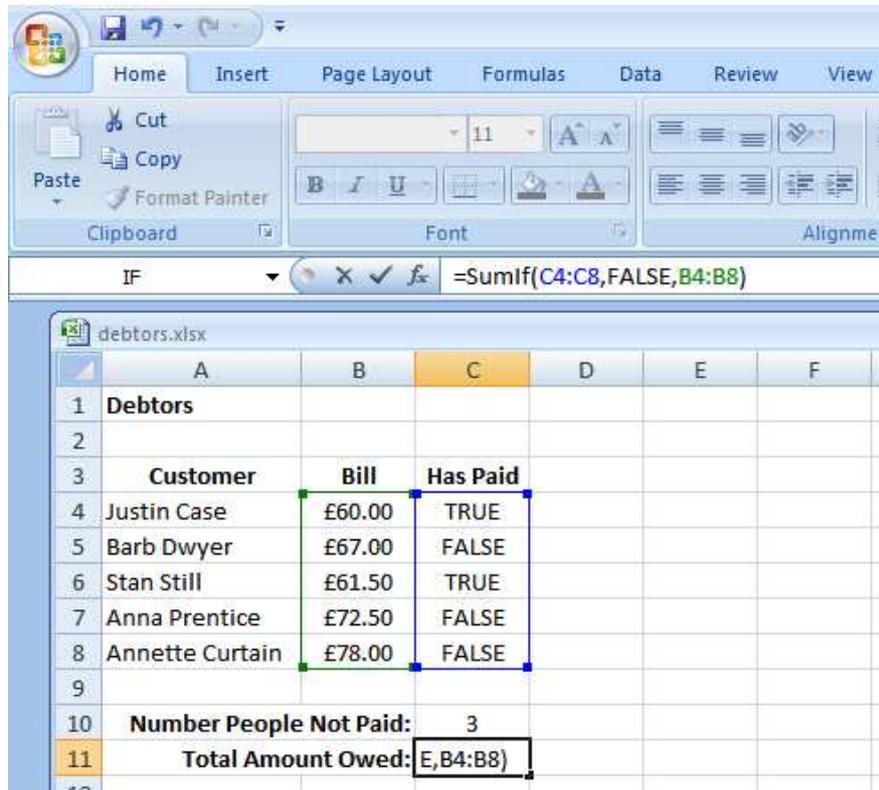
7. check that the number of people who have not paid is correct

	A	B	C	D
1	<b>Debtors</b>			
2				
3	<b>Customer</b>	<b>Bill</b>	<b>Has Paid</b>	
4	Justin Case	£60.00	TRUE	
5	Barb Dwyer	£67.00	FALSE	
6	Stan Still	£61.50	TRUE	
7	Anna Prentice	£72.50	FALSE	
8	Annette Curtain	£78.00	FALSE	
9				
10	<b>Number People Not Paid:</b>		<b>3</b>	
11	<b>Total Amount Owed:</b>			

## SumIf

SumIf counts the values stored in a range of cells if a given condition is true, for example it counts the amount of money owed to you.

1. make C11 active
2. in the Formula Bar enter =SumIf(C4:C8,TRUE,B4:B8)



3. check that the total amount owed is correct

	A	B	C	D
1	<b>Debtors</b>			
2				
3	<b>Customer</b>	<b>Bill</b>	<b>Has Paid</b>	
4	Justin Case	£60.00	TRUE	
5	Barb Dwyer	£67.00	FALSE	
6	Stan Still	£61.50	TRUE	
7	Anna Prentice	£72.50	FALSE	
8	Annette Curtain	£78.00	FALSE	
9				
10	<b>Number People Not Paid:</b>	3		
11	<b>Total Amount Owed:</b>	£217.50		

CountIf has this format:

CountIf(rangeToBeCounted, condition)

SumIf has this format:

SumIf(rangeToBeChecked, condition, rangeToBeSummed)

### **Exercise 9.3**

1. Try out the spreadsheet to count debtors and the money they owe (shown above)
2. Extend the spreadsheet completed in question 1 above by including how many have paid and how much has been paid.

**We have** looked at If, CountIf and SumIf.

**Next** we look at Data Tables.

### **Bibliography**

*www.eusprig.org/hdykysif.pdf* accessed August 2009  
*www.homeandlearn.co.uk* accessed August 2009