# Using Logical Functions in Modeling

**Exercise 1. Using Excel's AND, OR, and NOT Functions**
File: LogicPractice.xls, Worksheet: "AND OR NOT"

|   | A |
|---|---|
| 1 | **The Data** |
| 2 | 15 |
| 3 | 9 |
| 4 | 8 |

A. Write an AND formula to determine if A2>A3 and A2<A4 is a true or false statement.

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B. Write an OR formula to determine if A2>A3 or A2<A4 is a true or false statement.

_____

C. Write a formula that expresses that A2+A3=24 is a false statement.

# Logic Practice on Paper – Using Logical Functions in Modeling

**Exercise 2. Using Excel's IF Function**
File: LogicPractice.xls, Worksheet: "IF"

|   | A |
|---|---|
| 1 | **The Data** |
| 2 | 50 |

A. Write an IF statement so that if the number in Cell A2 is less than 100 the formula displays the text "Within budget", otherwise the formula displays the text "Over budget".

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B. Write an IF statement so that if the number in Cell A2 is 100 then the formula sums the range B5:B15. Otherwise, the formula returns a blank (empty text).

_____

# Logic Practice on Paper – Using Logical Functions in Modeling

**Exercise 3. More Practice with IF Functions**
File: LogicPractice.xls, Worksheet: "IF Scores"

| | A |
|---|---|
| **1** | **Scores** |
| **2** | 45 |
| **3** | 90 |
| **4** | 78 |

| If Score is | Then return |
|---|---|
| Greater than 89 | A |
| From 80 to 89 | B |
| From 70 to 79 | C |
| From 60 to 69 | D |
| Less than 60 | F |

A. Write an IF statement to assign a letter grade to the score in Cell A2.

_____

B. Write an IF statement to assign a letter grade to the score in Cell A3.

_____

C. Write an IF statement to assign a letter grade to the score in Cell A4.

_____

# Logic Practice on Paper – Using Logical Functions in Modeling

**Exercise 4. IF Function Practice (from the Proficiency Exercises)**
File: LogicPractice.xls, Worksheet: "Olive Oil Logic -1"

Olive oil can be purchased according to this price schedule:

|  | A | B |
|---|---|---|
| 1 | Cost/gallon for the first 500 gallons | $23 |
| 2 | Cost/gallon for gallons above 500 | $20 |
| 3 | Number of gallons: | |
| 4 | 10 | |
| 5 | 483 | |
| 6 | 500 | |
| 7 | 1,600 | |

Write IF statements to calculate the cost of the quantities of olive oil listed in Cells A5, A6, and A7 above. (See a sample formula to calculate the cost of 10 gallons (A4) below.)

The syntax of Excel's IF function is:
=IF(condition-to-test, value-if-condition-true, value-if-condition-false)

For example, a formula to find the cost for 10 gallons of olive oil is:

=IF(A4<=500,B1* A4, 500*B1+(A4-500)*B2)          See the footnote on this page.*

A. Write a formula to find the cost of 483 gallons.

B. Write a formula to find the cost of 500 gallons.

C. Write a formula to find the cost of 1,600 gallons.

**Note:** It's always a good idea to use cell references instead of constant values in formulas. For the examples here, however, I've used some constants to make the formulas easier to read and understand.

# Logic Practice on Paper – Using Logical Functions in Modeling

### Exercise 5. Building & Using a Nested IF Statement
File: LogicPractice.xls, Worksheet: "Olive Oil Logic -2"

We've modified the olive oil price schedule to give an additional price break for quantities over 1,000 gallons. The new pricing schedule is:

| | A | B |
|---|---|---|
| 1 | Cost/gallon for the first 500 gallons | $23 |
| 2 | Cost/gallon for next 500 gallons | $20 |
| 3 | Cost/gallon for gallons > 1,000 | $15 |
| 4 | | |
| 5 | 1600 | |
| 6 | 483 | |
| 7 | 2001 | |

Write two formulas using nested IF statements to calculate the cost of the quantities of olive oil listed in Cell A6 (483 gallons) and Cell A7 (2,001 gallons) above.

An Excel nested IF function can be written with this syntax:
=IF(condition-to-test, IF(condition-to-test, value-if-condition-true, value-if-condition-false), value-if-condition-true, value-if-condition-false)

For example, one formula to find the cost for 1,600 gallons is:

=IF(A5<=500,A5*$B$1,IF(A5<=1000,(500*$B$1)+(A5-500)*$B$2,(500*$B$1)+(500*$B$2)+(A5-1000)*$B$3))

A. Write a formula to find the cost of 483 gallons.

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B. Write a formula to find the cost of 2,001 gallons.

_____

# Logic Practice on Paper – Using Logical Functions in Modeling

### Exercise 6. The IF Function, the MIN Function and the SUMPRODUCT Function
File: LogicPractice.xls, Worksheet: "Olive Oil Logic -3"

The price schedule for olive oil is the same but the data layout has changed, as illustrated below. In this view, the costs for each of the quantities (Cells G6 through I6) have already been calculated. The answers are in Cells G12:I12.

| | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|
| 6 | | | | | | **1600** | **483** | **2001** |
| 7 | | | | | | gallons | gallons | gallons |
| 8 | Price Schedule: | | | | | gals/price level | gals/price level | gals/price level |
| 9 | first | 500 | gallons at | $  23.00 | | 500 | 483 | 500 |
| 10 | next | 500 | gallons at | $  20.00 | | 500 | 0 | 500 |
| 11 | any additional | | gallons at | $  15.00 | | 600 | 0 | 1001 |
| 12 | | | | | Cost | $  **30,500.00** | $  **11,109.00** | $  **36,515.00** |
| 13 | | | | | | | | |

Write formulas that use the MIN function, the IF function (nested), and the SUMPRODUCT function to calculate the cost of the quantities of olive oil listed in Cells H6 (483 gallons) and I6 (2,001 gallons), above.

The syntax of Excel's MIN function is:  =MIN(number1, number2, …)

One way to write Excel's nested IF function is:  =IF(condition-to-test, IF(condition-to-test, value-if-condition-true, value-if-condition-false), value-if-condition-true, value-if-condition-false)

Excel's SUMPRODUCT function multiplies corresponding components in the given ranges and returns the sum of those products. One way to write Excel's SUMPRODUCT function is:  **=SUMPRODUCT(range1, range2)** where ranges 1 and 2 hold components you want to multiply and then add. (Both ranges must be the same length.)

## Exercise 6, Continued

| | B | C | D | E | F | G |
|---|---|---|---|---|---|---|
| 6 | | | | | | **1600** |
| 7 | | | | | | gallons |
| 8 | Price Schedule: | | | | | gals/price level |
| 9 | first | 500 | gallons at | $ 23.00 | | 500 |
| 10 | next | 500 | gallons at | $ 20.00 | | 500 |
| 11 | any additional | | gallons at | $ 15.00 | | 600 |
| 12 | | | | | Cost | $ 30,500.00 |

For example, formulas to calculate the cost of 1,600 gallons are located below in Cells G9, G10, G11, and G12.

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| 6 | | | | | | | 1600 |
| 7 | | | | | | | gallons |
| 8 | | | | | | | gals/price level |
| 9 | | First | 500 | gallons at | 23 | | =MIN(G$6, $C$9) |
| 10 | | Next | 500 | gallons at | 20 | | =MAX(IF(G$6<$C$9+$C$10, G$6-$C$9, $C$10), 0) |
| 11 | | Any | additional | gallons at | 15 | | =IF(G$6>1000, G$6-1000, 0) |
| 12 | | | | | | Cost: | =SUMPRODUCT($E$9:$E$11, G9:G11) |

A. Write the four formulas to calculate the cost of 483 gallons.

_____

_____

_____

_____

B. Write the four formulas to calculate the cost of 2001 gallons.

_____

_____

_____

_____

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## More Logic Practice on Paper – Writing a Formula to Account for Multiple Conditions

### Exercise 7. Calculate Employee Retirement & Health Plan
File: MoreLogicPractice.xls, Worksheet: "Benefit Calculations"

A company contributes to each eligible employee's retirement plan at the rate of 4% of the employee's annual salary. However, to be eligible for this benefit, an employee must have full-time status with two or more years of employment. A calculation for the retirement contribution requires a test of two conditions: Full- or part-time status and number of years of employment. A graphical view of the conditions to test might look like this illustration:
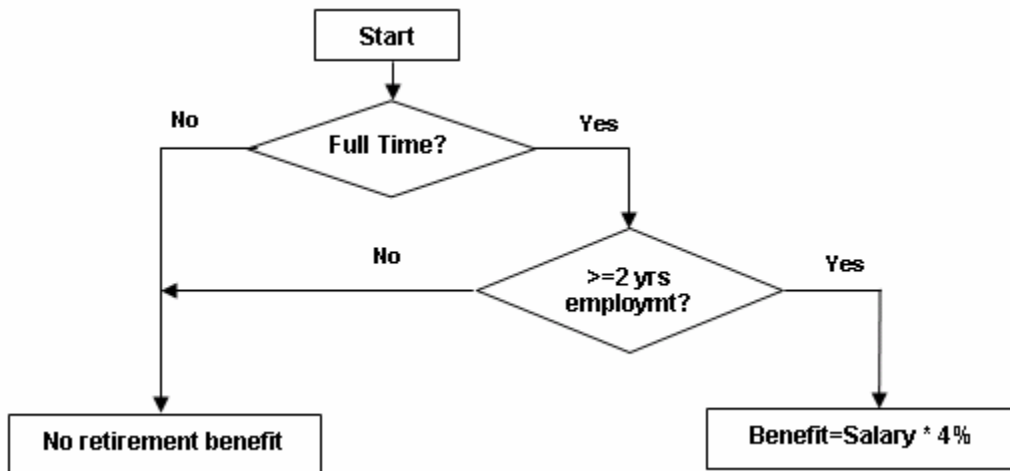
There are three retirement contribution possibilities to account for:

- An employee works full time AND has been employed two or more years. The retirement benefit applies.
- An employee works full time but has NOT been employed two or more years. The retirement benefit does not apply.
- An employee does NOT work full time. The retirement benefit does not apply.

You can account for these three possibilities in a single formula. Write your formula using logical functions. There's more than one way to write this formula. For example, you might use both the IF and AND statements or you could express the same thing with a nested IF statement.
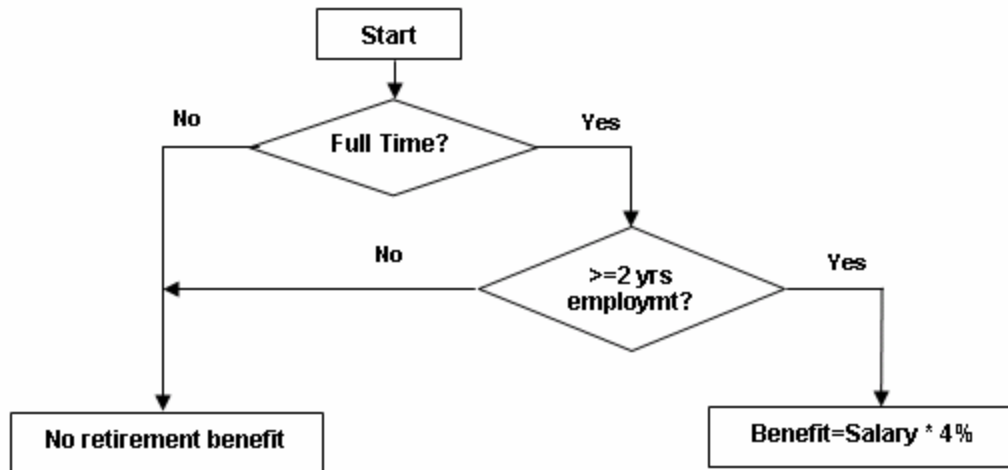
| | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 8 | Name | Employmt. Status | Health Plan | Salary | Hire Date | # Years Employed | Retirement Contribution |
| 9 | Gopnik | part time | family | $45,000 | Jan-98 | 5 | |
| 10 | Mahfouz | full time | family | $120,000 | May-89 | 13 | |
| 11 | Bryson | full time | individual | $145,000 | Mar-01 | 2 | |
| 12 | Peters | full time | individual | $100,000 | Nov-00 | 2 | |
| 13 | deVries | full time | individual | $115,000 | Jul-97 | 5 | |
| 14 | Talento | part time | family | $55,000 | Aug-95 | 7 | |
| 15 | Yang | full time | other plan | $95,000 | Apr-99 | 4 | |
| 16 | Marks | part time | family | $15,000 | May-01 | 1 | |
| 17 | Heller | full time | family | $124,000 | Oct-00 | 2 | |

A. Write the formula to calculate the Retirement Contribution for Gopnik. You should be able to copy this formula down the column to get valid values for employees Mahfouz through Heller.

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The company supplies two health plan options:

- Up to $10K of annual coverage for employees who choose the family plan.
- Up to $8K of annual coverage for employees who choose the individual plan.

These benefits do not apply if the employee or employee-and-family is already covered by some other health plan. A calculation for health insurance requires a test of three conditions: Individual, Family, Already Covered. A graphical view of the conditions to test might look like this illustration that follows.

Start

Full Time? — No / Yes

>=2 yrs employmt? — No / Yes

No retirement benefit

Benefit=Salary * 4%

| | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|
| | | Employmt. | Health | | Hire | # Years | Retirement | |
| 8 | Name | Status | Plan | Salary | Date | Employed | Contribution | Health Plan Cost |
| 9 | Gopnik | part time | family | $45,000 | Jan-98 | 5 | $0 | |
| 10 | Mahfouz | full time | family | $120,000 | May-89 | 13 | $4,800 | |
| 11 | Bryson | full time | individual | $145,000 | Mar-01 | 2 | $5,800 | |
| 12 | Peters | full time | individual | $100,000 | Nov-00 | 2 | $4,000 | |
| 13 | deVries | full time | individual | $115,000 | Jul-97 | 5 | $4,600 | |
| 14 | Talento | part time | family | $55,000 | Aug-95 | 7 | $0 | |
| 15 | Yang | full time | other plan | $95,000 | Apr-99 | 4 | $3,800 | |
| 16 | Marks | part time | family | $15,000 | May-01 | 1 | $0 | |
| 17 | Heller | full time | family | $124,000 | Oct-00 | 2 | $4,960 | |

B. Write the formula to calculate the Health Plan Cost for Gopnik. You should be able to copy this formula down the column to get valid values for employees Mahfouz through Heller.