

# Chapter 10

## Business Rules

Once data is transformed into information, decisions can be made. Decisions can be based on rules that have simple yes or no outcomes or they can be based on relative comparisons. In this chapter, you examine how logical rules are written in Excel to evaluate business requirements and analyze data. This includes AND and OR functions as well as the logical IF function.

### Why Do I Need to Know This?

As a college student you learn new things in each class. When you understand the new concepts well enough that you internalize the knowledge and are able to apply it to other situations it becomes part of your knowledge set—part of what you understand. In the working world, you might be given a job that must be done repeatedly such as preparing a monthly report or evaluating people or projects every year. You might be assigned a task that requires the same steps be used hundreds of times. In both of these situations, the value you add to the process is your knowledge about how to improve the process—how to do repetitive tasks faster and more accurately. For repetitive work, it can be worth your time to design a worksheet that applies rules to a situation to make the process faster and less prone to error. Your value to your employer goes up when you get your work done accurately and quickly.

## 1 Rules Based on Logic

### Learning Objectives

1. Describe the relationship between binary numbers and TRUE and FALSE [10.1.1]
2. Identify comparison operators and syntax used to determine if a statement is TRUE or FALSE.  
[10.1.2]
3. Identify functions used to recall and compare dates and their syntax [10.1.3]
4. Describe the characteristics of a business rule that is easily translated into a formula. [10.1.4]

5. Identify methods of combining logical functions to match business rules [10.1.5]
6. Identify uses for conditional formatting. [10.1.6]
7. Identify design methods that allow for hiding interim logical steps. [10.1.7]

Most computers use digital logic that is based on the binary numbering system that uses zeros and ones. This type of logic is based on the assumption that a problem can be reduced to simple statements that are either true or false. Computers can represent a true statement with a 1 and a false statement with a 0 or with the words TRUE and FALSE.

### Comparing numbers

For example, a business rule may be that a person must be 18 years old to work on an installation crew. In Excel, we can setup this problem by placing the person's age in one cell and the required age in another., as shown in Figure 10.1.

	A	B
1	Age	Requirement
2	17	18

**Figure 10.1.** Comparison of applicant's age to the required age.

The **syntax**—rules governing how functions are written— for a comparison is:

=CellReference, Operator, CellReference

In this example we use the equals sign at the beginning to indicate a formula or function and then we use it as an operator. In a nearby cell the comparison is written, =A2=B2, as shown in Figure 10.2.

FREQUENCY <span>▼</span> <span>✖</span> <span>✓</span> <span>fx</span> =A2=B2		
	A	B
1	Age	Requirement
2	17	18
3		
4		
5	Comparison Operators	
6	Equals	=A2=B2

**Figure 10.2.** Syntax for writing a comparison using two equals signs.

In this example, the operator is the equals sign. When the formula is entered, the comparison is evaluated as either True or False and one of these words displays in the cell, as shown in Figure 10.3.

	A	B
1	<b>Age</b>	<b>Requirement</b>
2	17	18
3		
4		
5	<b>Comparison Operators</b>	
6	Equals	FALSE

**Figure 10.3.** Because the value in A2 does not equal the value in B2 the result is FALSE.

If the value in cell A2 is changed from 17 to 18, the comparison is evaluated again and this time it is TRUE, as shown in Figure 10.4.

	A	B
1	<b>Age</b>	<b>Requirement</b>
2	18	18
3		
4		
5	<b>Comparison Operators</b>	
6	Equals	TRUE

**Figure 10.4.** Comparison is TRUE.

If the value for age in cell A2 is changed to 19, the comparison will be FALSE because 19 is not equal to 18. This result does not match the intent of the business rule. This is an example of the difference between the way we use our language and the simplicity of a computer that uses logic based on zeros and ones. When we speak to each other, we assume a certain amount of experience, which is known as **world knowledge**. We all know from experience that an age requirement normally includes the people who are older but not those who are younger. A computer doesn't know this; therefore, you must be very careful when you write your business rules. The operators used in previous chapters for comparing numbers can be used to write business rules. Examples of those comparison operators in logic statements involving cells A2 and B2 are shown in the table in Figure 10.5.

Comparison	Operator	Example
Equal	=	=A2=B2
Less than	<	=A2<B2
Less than or equal to	<=	=A2<=B2
Greater than	>	=A2>B2
Greater than or equal to	>=	=A2>=B2
Not equal	<>	=A2<>B2

**Figure 10.5.** Comparison operators used in logic statements.

If each of the comparison operators shown in the table in Figure 10.5 is entered into the worksheet, they are evaluated as shown in Figure 10.6.

	A	B
1	<b>Age</b>	<b>Requirement</b>
2	19	18
3		
4		
5	<b>Comparison Operators</b>	
6	Equals	FALSE
7	Less Than	FALSE
8	Less Than or Equal	FALSE
9	Greater Than	TRUE
10	Greater Than or Equal	TRUE
11	Not equal to	TRUE

**Figure 10.6.** Evaluation of six comparison operators.

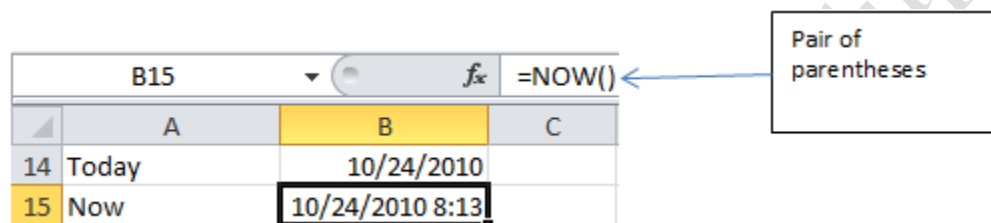
It is extraordinarily difficult to teach a computer enough world knowledge so that it can interpret what people really mean by most statements. Therefore, when writing a business rule, it is best to use words and phrases that can be easily translated into a simple computer statement. The easiest rules to translate correctly are those that parallel the structure of the comparison. For example, here are five ways that someone might state the rule regarding the age requirement. The person must be:

- 18
- 18 or older
- at least 18
- cannot be under 18
- the minimum legal age

Example b is the best choice because it is most like the comparison *greater than or equal to*, >=.

### Comparing Dates

Recall that dates are stored in the computer as sequential numbers that grow larger by 1 with the passage of each day. Therefore, more recent dates are larger than dates from farther back in the past. Personal computers have an internal clock that is set using the operating system's control panel. The current date and time from the computer's clock can be used in Excel using the TODAY or NOW functions. These two functions do not need arguments but the syntax of functions requires the use of parentheses so these functions use a pair of parentheses with nothing between them, as shown in Figure 10.7.



B15		f <sub>x</sub>	=NOW()
	A	B	C
14	Today	10/24/2010	
15	Now	10/24/2010 8:13	

**Figure 10.7.** NOW function displays current date and time.

To find the difference in days between two dates, simply subtract one cell reference from the other. Determining the number of whole months or years between two dates is more difficult. To find the number of months or years between two dates, the DATEDIF function can be used. The DATEDIF function has three arguments, =DATEDIF(EarlyDate,RecentDate, period) where the values for the period can be “d”, “m”, or “y” to indicate day, month or year. The quotation marks are required, as shown in Figure 10.8.

B19		$f_x$	=DATEDIF(B17,B18,"y")	
	A	B	C	D
14	Today	10/24/2010		
15	Now	10/24/2010 8:34		
16				
17	Birthdate	11/15/1992		
18	Today's Date	10/24/2010		
19	Difference in years	17		

"d" for days  
"m" for months  
"y" for years

**Figure 10.8.** The "y" argument is used to find the number of years between two dates.

Observe that this person is almost 18 but the DATEDIF function does not round up so it is useful for

rules that have minimum time requirements.

### Comparing Words

Recall that each character is assigned a number according to the ASCII or UTF standard. The letters of the English alphabet are numbered in sequence to make it easier to sort and alphabetize words. If you compare two words, the computer first compares the value of the first letter in each word and then proceeds to compare the letters in pairs sequentially. Consequently, words compare in the same manner you would use to alphabetize them in a dictionary. For example, any word that starts with the letter A is considered less than any word that starts with B regardless of the length of the word; e.g. Daylight is less than Night.

Computers assign different numbers to the upper and lower case versions of the same letter. The capital A has a different number assigned to it than the lower case a. In some computer programs, this is an important difference and words will sort or compare differently based on whether they have upper or lower case letters. Excel is programmed to compare words as if the capitalization doesn't matter, as shown in Figure 10.9.

	A	B	C	D	E
21	First Word	Second Word	Greater Than	Equal	Less Than
22	Daylight	Night	FALSE	FALSE	TRUE
23	daylight	Daylight	FALSE	TRUE	FALSE

**Figure 10.9.** Comparison of words depends on letter at left.

A word can be used in a comparison formula if it is enclosed in quotation marks, as shown in Figure 10.10.

Words enclosed in quotes. Capitalization difference ignored.			
B26		fx =A26="daylight"	
	A	B	C
25	Word	Comparison	
26	Daylight	TRUE	

**Figure 10.10.** Words may be used within comparison formulas.

If the quotation marks are omitted, the Excel program will assume that the term is the name for a range of cells. If no such name has been defined, the #NAME error displays.

### Comparing Logical Statements

Excel reserves the words TRUE and FALSE for use as the result of a logical comparison or function. If the word *True* is typed into a cell, it is automatically converted to TRUE and False is automatically converted to FALSE. Consequently, you don't enclose the words TRUE or FALSE in quotation marks if you want to use them in a logic statement. If you try to use either word inside of quotation marks to make a comparison, the result is FALSE because they do not match.

Some business rules require that something is not true or not false. For example, you might ask if a person has ever had their drivers license suspended. The syntax of the NOT function is;

=NOT(CellReference) where the cell reference contains a TRUE or FALSE value, as shown in Figure 10.11.

B27		fx =NOT(B26)	
	A	B	C
25	Word	Comparison	
26	Daylight	TRUE	
27		FALSE	

NOT function changes TRUE to FALSE or FALSE to TRUE

**Figure 10.11.** NOT function reverses TRUE and FALSE.

The NOT function returns the opposite of its argument. For example, =NOT(TRUE) is FALSE and =NOT(FALSE) is TRUE.

## AND and OR Functions

The AND and OR functions use the same logic in Excel as they do in database queries. The AND function is TRUE if all of its argument statements are TRUE and the OR function is true if any of its arguments are TRUE. The syntax of the two functions are:

=AND(argument1, argument2, argument3,...)

=OR(argument1, argument2, argument3,...)

Observe that the arguments come after the function instead of on either side of it the way they would be arranged in a sentence. The list of arguments can be a range of cells that contain TRUE or FALSE statements. For example, consider a set of business rules that apply to hiring a member of an installation crew that will install solar panels. The applicant must meet each of these conditions:

- a) 18 years old
- b) Valid driver's license
- c) No record of driving under the influence of drugs including alcohol
- d) Five years of experience or a degree plus two years of experience

Each rule needs to be stated using language that is conveniently translated into TRUE statements for a qualified person, as shown in Figure 10.12.

	A	B	C	D	E	F	G	H	I	J
1	<b>Requirements for New Crew Members</b>									
2	<b>Conditions</b>						<b>Business Rules</b>			
3	Age	18					Age greater than or equal to 18			
4	Valid Driver's License	YES					Has a valid driver's license			
5	Record of DUI	NO					Has no record of driving under the influence of drugs including alcohol			
6	Minimum Experience without a degree	5					Experience greater or equal to 5 without degree OR experience greater or equal to 2 with a degree.			
7	Associates Degree or higher in a Related Field	Desired								
8	Minimum Experience with a degree	2								

**Figure 10.12.** Write business rules that will be true for a qualified candidate.

The applicant information can be entered into a row followed by the logical formulas. The columns



containing the formulas can be hidden later, as shown in Figure 10.13.

	A	B	C	D	E	F	G	H	I	J	K
1	<b>Requirements for New Crew Members</b>										
2	<b>Conditions</b>						<b>Business Rules</b>				
3	Age	18					Age greater than or equal to 18				
4	Valid Driver's License	YES					Has a valid driver's license				
5	Record of DUI	NO					Has no record of driving under the influence of drugs including alcohol				
6	Minimum Experience without a degree	5					Experience greater or equal to 5 without degree OR experience greater or equal to 2 with a degree.				
7	Associates Degree or higher in a Related Field	Desired									
8	Minimum Experience with a degree	2									
9											
10	Applicant's Initials	Date of Birth (dd-mm-yy)	License	DUI	Experience (years)	College Degree	Age	License	DUI	Experience / Degree	Qualified
11	JD										

**Figure 10.13.** Design of worksheet so evaluations can be hidden.

Questions that are designed to be true or false are often answered yes or no instead. Both options can be valid if the formulas are designed for it. A validation list can be used to restrict the inputs to TRUE, FALSE, YES, or NO as shown in Figure 10.14.

	A	B	C
10	Applicant's Initials	Date of Birth (dd-mm-yy)	License
11	JD		
12	LT		
13			
14			

**Figure 10.14.** Validation lists limit answers.

To determine if the applicant is at least eighteen years old, the DATEDIF function can be used as an argument, as shown in Figure 10.15. Observe that the absolute reference to cell B3 is used so this formula can be copied for use with other candidates and that the TODAY() function is used as an argument of the DATEDIF function.

DATEDIF determines the whole number of years between today's date and the date of birth

Years since birth compared to requirement

G11      fx      =DATEDIF(B11,TODAY(),"Y")>=\$B\$3									
	A	B	C	D	E	F	G	H	I
1	<b>Requirements for New Crew Members</b>								
2	<i>Conditions</i>						<i>Buisness Rules</i>		
3	Age	18					Age greater than or equal to 18		
4	Valid Driver's License	YES					Has a valid driver's license		
5	Record of DUI	NO					Has no record of driving under th of drugs including alcohol		
6	Minimum Experience without a degree	5					Experience greater or equal to 5 degree OR experience greater or with a degree.		
7	Associates Degree or higher in a Related Field	Desired							
8	Minimum Experience with a degree	2							
9									
10	Applicant's Initials	Date of Birth (dd-mm-yy)	License	DUI	Experience (years)	College Degree	Age	License	DUI
11	JD	21-May-90					TRUE		

**Figure 10.15.** Formula in cell G11 confirms minimum age.

Because an acceptable answer for the driver's license question can be TRUE or YES, the OR function is used, as shown in Figure 10.16. In the Formula, observe that YES is in quote marks, but TRUE is not because it is a logical operator.

H11      fx      =OR(C11=TRUE,C11="YES")								
	A	B	C	D	E	F	G	H
10	Applicant's Initials	Date of Birth (dd-mm-yy)	License	DUI	Experience (years)	College Degree	Age	License
11	JD	21-May-90	YES				TRUE	TRUE

**Figure 10.16.** OR function used to check for TRUE or YES.

The question about a record of driving under the influence of drugs or alcohol is worded so that a candidate will answer YES or TRUE if they have a DUI. The logic statement in column I is written to evaluate the DUI answer and return a TRUE response for a qualified candidate. To qualify, the candidate's response should be NO or FALSE (they do not have a DUI record) and the logical statement in column I converts this answer to TRUE to indicate the candidate is qualified as shown in Figure 10.17.

I11		fx =OR(D11=FALSE,D11="NO")							
	A	B	C	D	E	F	G	H	I
10	Applicant's Initials	Date of Birth (dd-mm-yy)	License	DUI	Experience (years)	College Degree	Age	License	DUI
11	JD	21-May-90	YES	NO			TRUE	TRUE	TRUE

**Figure 10.17.** FALSE or NO answer is TRUE.

The rule about experience and education is more complex. There are two ways to meet the requirement so the OR function is used: five years experience or a combination of education and experience. Each requirement is an argument of the OR function. One of the conditions has two parts that are both required so the AND function is used: 2 years of experience and a degree. The answer to the question of a degree could be YES or TRUE as shown in Figure 10.18.

5 yrs Experience

2 yrs Experience

Has a degree

J11

fx =OR(E11>=\$B\$6,AND(E11>=\$B\$8,OR(F11=TRUE,F11="YES")))

	A	B	C	D	E	F	G	H	I	J
1	Requirements for New Crew Members									
2	Conditions		Business Rules							
3	Age	18	Age greater than or equal to 18							
4	Valid Driver's License	YES	Has a valid driver's license							
5	Record of DUI	NO	Has no record of driving under the influence of drugs including alcohol							
6	Minimum Experience without a degree	5	Experience greater or equal to 5 without degree OR experience greater or equal to 2 with a degree.							
7	Associates Degree or higher in a Related Field	Desired								
8	Minimum Experience with a degree	2								
9										
10	Applicant's Initials	Date of Birth (dd-mm-yy)	License	DUI	Experience (years)	College Degree	Age	License	DUI	Experience / Degree
11	JD	21-May-90	YES	NO	3	YES	TRUE	TRUE	TRUE	TRUE

**Figure 10.18.** Nesting multiple criteria for experience and education.

The first part of the argument evaluates if the person has five years of experience, the second part, beginning with AND, evaluates if they have two or more years of experience and a college degree, which could be answered YES or TRUE.


If all four conditions listed in cells G3:B8 are TRUE then the candidate is qualified. The AND function is true if the other functions are all TRUE, as shown in Figure 10.19.

K11		=AND(G11,J11,H11,I11)									
	A	B	C	D	E	F	G	H	I	J	K
10	Applicant's Initials	Date of Birth (dd-mm-yy)	License	DUI	Experience (years)	College Degree	Age	License	DUI	Experience / Degree	Qualified
11	JD	21-May-90	YES	NO	3	YES	TRUE	TRUE	TRUE	TRUE	TRUE

**Figure 10.19.** AND function is true if the candidate meets all four requirements.

The formula could also be written =AND(G11:J11). The formulas can be filled downward to use with as many candidates as necessary, because the formulas were designed with absolute references where needed. The columns with the logic can be hidden to simplify the form, as shown in Figure 10.20.

Hidden columns



	A	B	C	D	E	F	K
1	<b>Requirements for New Crew Members</b>						
2	<b>Conditions</b>						
3	Age	18					
4	Valid Driver's License	YES					
5	Record of DUI	NO					
6	Minimum Experience without a degree	5					
7	Associates Degree or higher in a Related Field	Desired					
8	Minimum Experience with a degree	2					
9							
10	Applicant's Initials	Date of Birth (dd-mm-yy)	License	DUI	Experience (years)	College Degree	Qualified
11	JD	21-May-90	YES	NO	3	YES	TRUE
12	LT	15-Jun-94	TRUE	FALSE	7	NO	FALSE
13	MR	14-Aug-87	FALSE	NO	10	FALSE	FALSE
14	RM	22-Dec-88	YES	NO	1	YES	FALSE

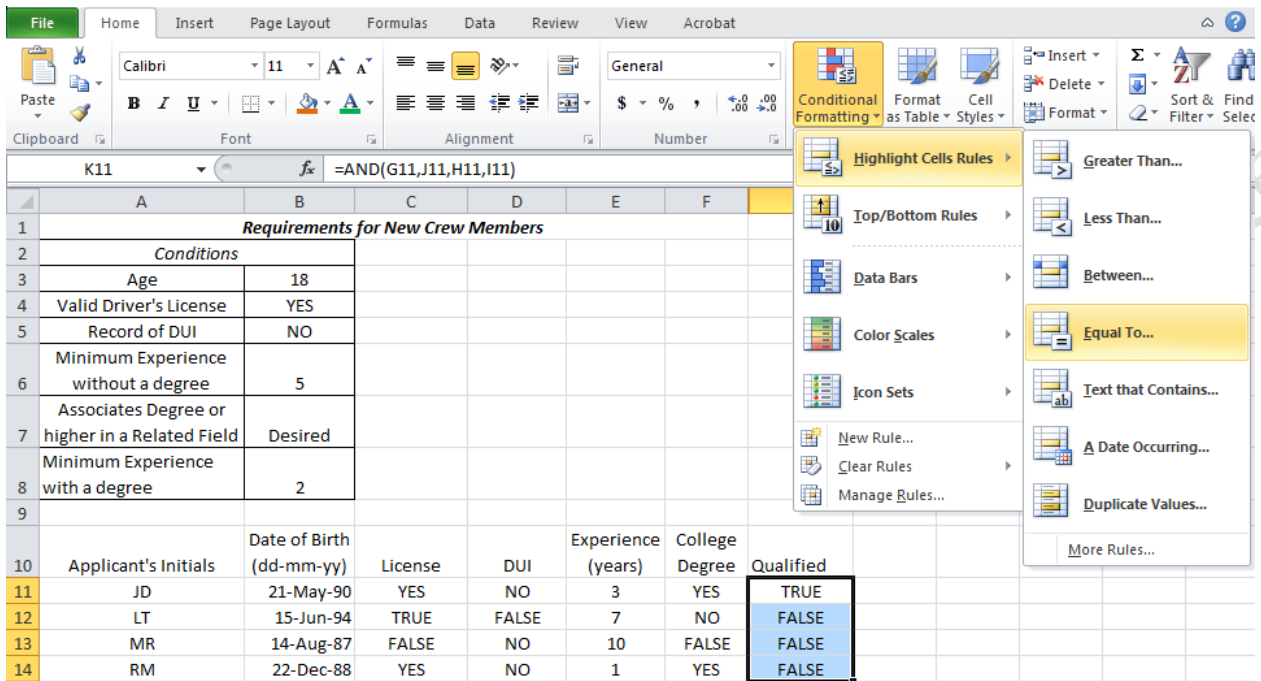
**Figure 10.20.** Business rules applied to several candidates and columns hidden.

### Conditional Formatting

When there are many rows of similar numbers or words, it can be difficult to visually separate the significant values from the rest. Different colors or fonts can be applied to cells that contain values that meet certain criteria. In this example, if we had fifty candidates, one of the qualified people might be overlooked.

Formatting cells based on whether their content meets criteria is called **conditional formatting**. There are

several options on the Conditional Formatting menu as shown in Figure 10.21.



**Figure 10.21.** Conditional formatting options.

In this case, a rule can be created that changes the fill color and font to shades of red if the content of the cell is TRUE. The result makes it much easier to identify the qualifying candidates, as shown in Figure 10.22.

	A	B	C	D	E	F	K
	Applicant's Initials	Date of Birth (dd-mm-yy)	License	DUI	Experience (years)	College Degree	Qualified
10	JD	21-May-90	YES	NO	3	YES	TRUE
12	LT	15-Jun-94	TRUE	FALSE	7	NO	FALSE
13	MR	14-Aug-87	FALSE	NO	10	FALSE	FALSE
14	RM	22-Dec-88	YES	NO	1	YES	FALSE

**Figure 10.22.** Conditional formatting highlights cells that meet criteria.

## Key Takeaways

- Computers store words and numbers using the binary numbering system, which uses only two numerals, zero and one. Logic conditions are similarly binary, where one represents TRUE and zero represents FALSE [10.1.1]

- Content of cells are compared using the syntax =cellref=cellref. Other comparison operators that are used with numbers such as <, <=, >=, >, <> may be used in place of the = sign between the cell references: [10.1.2]
- The TODAY() and NOW() functions recall the date and date plus time from the computer's clock. The DATEDIF function will determine the number of days, months, or years between two dates. The TODAY function can be used as an argument in the DATEDIF function. [10.1.3]
- Business rules should be written so they parallel the construction of a formula using phrases like *greater than or equal to* to match the comparison operators. [10.1.4]
- Use the OR function if any of several conditions are sufficient to be TRUE. Use the AND function if all of the conditions must be TRUE. [10.1.5]
- Conditional formatting is used to draw attention to cells that meet criteria for the purpose of assisting the user to locate important results. [10.1.6]
- Instead of combining all of the logical steps in long nested functions, they can be separated into individual cells. This makes it easier to troubleshoot the steps of the logical rule. Chose the placement of other elements such as titles so that they will not be affected if the rows or columns with interim steps are hidden. [10.1.7]

## 2 Logical Actions

### Learning Objectives

1. Describe the use of an energy audit to focus action. [10.2.1]
2. Identify the arguments and uses of an IF function. [10.2.2]
3. Identify arguments and uses for conditional sum and count functions. [10.2.3]

Logical functions can be used to assist in making choices for action. If the data does not exist, the first step is to gather it. Making a list of energy consuming devices and their characteristics for the purpose of analysis is called an **energy audit**. In general, if data does not exist, the user can create the data by careful and systematic observation and measurement.

For example a homeowner made a list of the types of lighting devices used in his home and listed the

data in a table, as shown in Figure 10.23.

	A	B	C	D	E	F	G
1	<b>Lighting Audit</b>						
2							
3	<b>Room</b>	<b>Type</b>	<b>Description</b>	<b>Number</b>	<b>Wattage</b>	<b>Hours per day</b>	<b>WattHrs</b>
4	Bathroom 1	I	Chandelier	1	40	0	0
5	Bathroom 1	I	Sconce	3	40	0.5	60
6	Bathroom 2	I	Chandelier	3	60	1	180
7	Bathroom 2	I	Chandelier	1	60	1	60
8	Bathroom 2	I	Flood	3	50	0.5	75
9	Bathroom 2	I	Sconce	4	60	1	240
10	Bathroom 3	F	Uplight	1	20	0	0
11	Bathroom 3	I	Sconce	2	40	0	0
12	Dining	CFL	Flood	1	15	6	90

**Figure 10.23.** Energy use by lighting devices.

A formula is used in column G to multiply the wattage in column E by the hours per day in column F to find the energy use in Watt-hours.

The homeowner is advised that incandescent lights are much less efficient than alternatives such as traditional straight fluorescent tubes, spiral compact fluorescent lamps (CFL), or light emitting diodes (LED) and the best return on an investment in more efficient lighting will come from replacing lamps that are used at least four hours a day. CFLs are coiled fluorescent tubes that can replace light bulbs and LEDs are like transistors that emit light.

### **The IF function**

He decides to include a column with an alert that will display a message on each row of the audit if the lamp type is incandescent (I) and the hours of operation are greater or equal to four.

The IF function has three arguments and its syntax is:

=IF(condition, action if TRUE, action if FALSE)

The condition can be any comparison that results in a conclusion of TRUE or FALSE. The actions can be formulas, logical statements, or words within quotation marks. In this example, the homeowner

chooses to display the phrase *Consider CFL or LED* if the condition is TRUE and no statement if the condition is false. As shown in Figure 10.24, the following IF function is written in cell H4 to evaluate the lamp type in column B and the hours per day in column F:

=IF(AND(B4="I",F4>=4),"Consider CFL or LED", "")

	A	B	C	D	E	F	G	H
1	Lighting Audit							
2								
3	Room	Type	Description	Number	Wattage	Hours per day	WattHrs	Alerts
4	Bathroom 1	I	Chandelier	1	40	0	0	

**Figure 10.24.** IF function used to display a phrase or nothing.

In this example, the condition uses a nested AND function that has two arguments. To make the AND statement true, the value in cell B4 must be the letter I. Observe that words or letters must be enclosed in quotation marks so they are not confused with cell references. To print a phrase as the result of an IF statement, the phrase is used as one of the arguments enclosed within quotation marks. To display nothing if the result of the condition is false, two quotation marks are used next to each other with nothing between them as the third argument of the IF function.

In row 4, the lamps use incandescent bulbs but they are on less than four hours so the result of the AND function is FALSE. The third argument is chosen and nothing is displayed in cell H4. When this function is filled downward in column H, the rows where the condition is true, display the message in the first argument, as shown in Figure 10.25.



	A	B	C	D	E	F	G	H
1	<b>Lighting Audit</b>							
2								
3	<b>Room</b>	<b>Type</b>	<b>Description</b>	<b>Number</b>	<b>Wattage</b>	<b>Hours per day</b>	<b>WattHrs</b>	<b>Alerts</b>
4	Bathroom 1	I	Chandelier	1	40	0	0	
5	Bathroom 1	I	Sconce	3	40	0.5	60	
6	Bathroom 2	I	Chandelier	3	60	1	180	
7	Bathroom 2	I	Chandelier	1	60	1	60	
8	Bathroom 2	I	Flood	3	50	0.5	75	
9	Bathroom 2	I	Sconce	4	60	1	240	
10	Bathroom 3	F	Uplight	1	20	0	0	
11	Bathroom 3	I	Sconce	2	40	0	0	
12	Dining	CFL	Flood	1	15	6	90	
13	Dining	I	Chandelier	12	40	0.5	240	
14	Dining	I	Flood	1	50	6	300	Consider CFL or LED
15	Dining	I	Spotlight	2	50	6	600	Consider CFL or LED

**Figure 10.25.** IF function used to display a phrase where conditions are met.

#### The COUNTIF and SUMIF functions

Summarizing the values in a table by category is a very useful step in analyzing data. The COUNTIF function can be used to count the number of times a word or phrase occurs in a range of cells. The syntax for the COUNTIF function is:

=COUNTIF(range, word or phrase in quotes)

For example, if the homeowner wanted to count the number of times the word *Chandelier* occurred in column C, a COUNTIF function at the bottom of the column could be used, as shown in Figure 10.26.

C54		fx		=COUNTIF(C4:C53,"Chandelier")			
	A	B	C	D	E	F	G
1	<b>Lighting Audit</b>						
2							
3	<b>Room</b>	<b>Type</b>	<b>Description</b>	<b>Number</b>	<b>Wattage</b>	<b>Hours</b>	
52	TV Room	I	Chandelier	1	60		
53	Upstairs Bedrooms	I	Chandelier	3	60		
54				8			

**Figure 10.26.** COUNTIF function used to count the number of times a word occurs.

The SUMIF function is very useful for creating summary tables. The syntax of the SUMIF function

is:

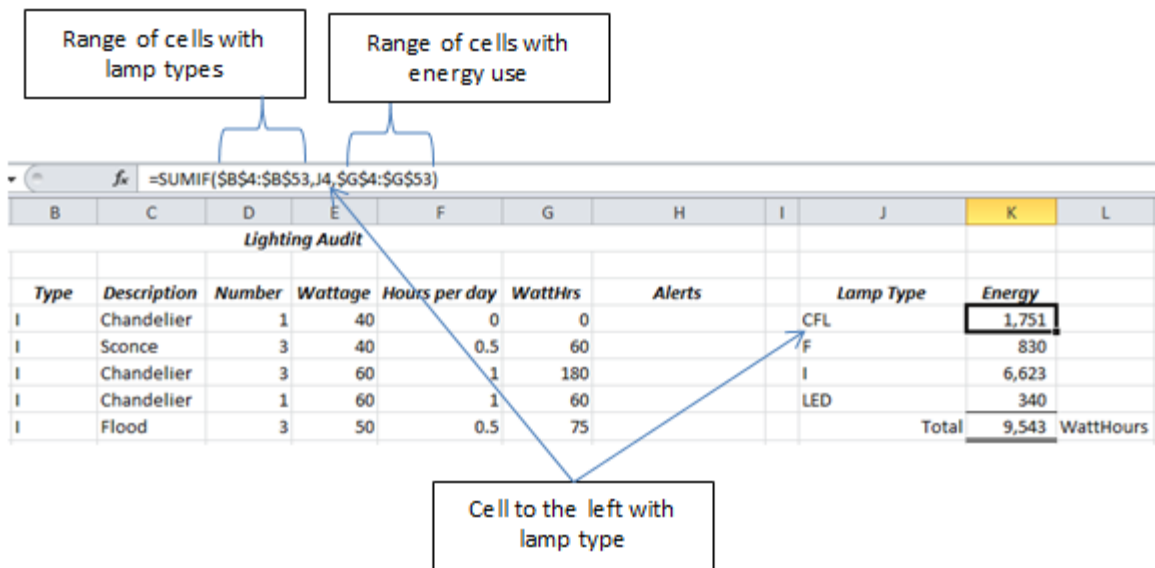
=SUMIF(range,criteria,sumrange)

The first argument refers to the range of cells to be evaluated, the second argument is the logical function that can be TRUE or FALSE, the third argument is the range of cells that contain the numbers to be summed if the condition is true. Using range names in place of cell references make it easier to understand the arguments. The criteria can be a word or phrase in quotes or a logical function. For example, a SUMIF function can be used to find the total watt-hours of energy use for the CFL lamps, as shown in Figure 10.27.

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3	Room	Type	Description	Number	Wattage	Hours per day	WattHrs	Alerts		Lamp Type	Energy
4	Bathroom 1	I	Chandelier	1	40	0	0			CFL	1,751

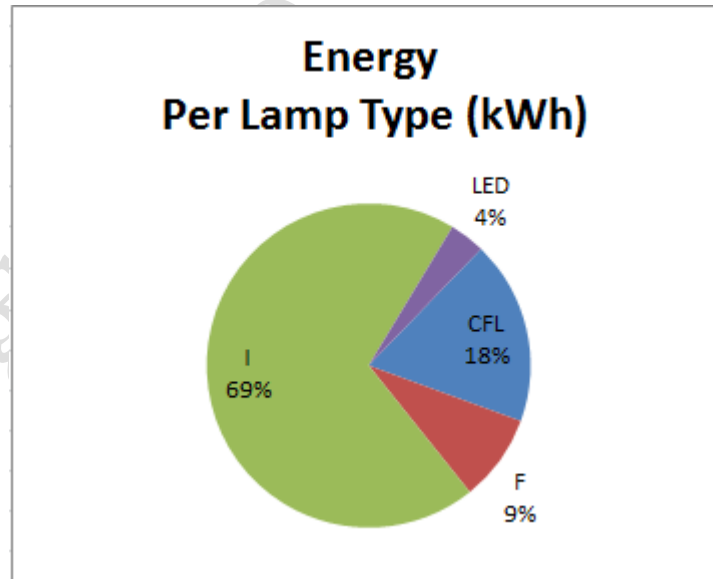
**Figure 10.27.** SUMIF function used to sum the energy use by type of lamp.

The first argument identified the range to be evaluated—named Type, the second argument identified the cells in the Type column that contained the value in cell J4 (CFL), and the third argument then summed the energy in column G where the Type was equal to CFL. The arguments can be edited so the function can be filled downward to create a summary table. The two ranges can be named or absolute references used so they do not change when filled, and the criteria changed to refer to the cell to the left, as shown in Figure 10.28.



**Figure 10.28.** SUMIF function used to create a summary table.

Summary tables can be charted to assist in recognizing patterns and relationships. For example, the summary table showing the energy used per type of lamp could be displayed as a pie chart with percentages, as shown in Figure 10.29.



**Figure 10.29.** Data from energy audit shows that more than two-thirds of the lighting energy is still used in incandescent lamps.

This type of analysis shows where opportunities for improvement exist, and helps the homeowner

make decisions about purchasing lamps or utilizing lighting energy.

## Key Takeaways

- An energy audit is an examination of how energy is used. It usually consists of a list of appliances, lights, or other devices that use energy along with their rate of energy consumption and hours of operation. [10.1.1]
- An IF function has three arguments. The first is a condition that evaluates as either TRUE or FALSE. The next argument is an action that is taken if the condition is TRUE and the third argument is an action to be taken if the condition is FALSE. The action can be another IF statement, formula, or text to be displayed. Text must be enclosed within quotation marks. [10.2.2]
- The COUNTIF function has two arguments. The first is a range of cells to examine and the second is text or a number to use for comparison. The COUNTIF function returns a count of the number of cells that match the content of the second argument. The SUMIF function has three arguments. The first is a range of cells to be evaluated, the second is a number or text used for comparison, and the third is a range of cells that contain numbers to be summed if the condition is met. The SUMIF function only sums the values from the rows where the condition is met. [10.2.3]

## 3 Applying Logic in an Energy Audit

### Learning Objectives

1. Read residential electric and gas meters. [10.3.1]
2. Use conditional formulas and conditional formatting as analysis tools. [10.3.2]
3. Adjust heating comparisons for confounding factors of outdoor temperature using heating degree days using the SUMIF function. [10.3.3]
4. Apply date formats and functions such as DATEDIF to find average energy use per day. [10.3.4]
5. Evaluate complex formulas step-by-step. [10.3.5]

An energy audit is an example of a process that can be done repeatedly where accuracy is important. The skills you apply in this exercise can be transferred to many other situations where rules and formulas are

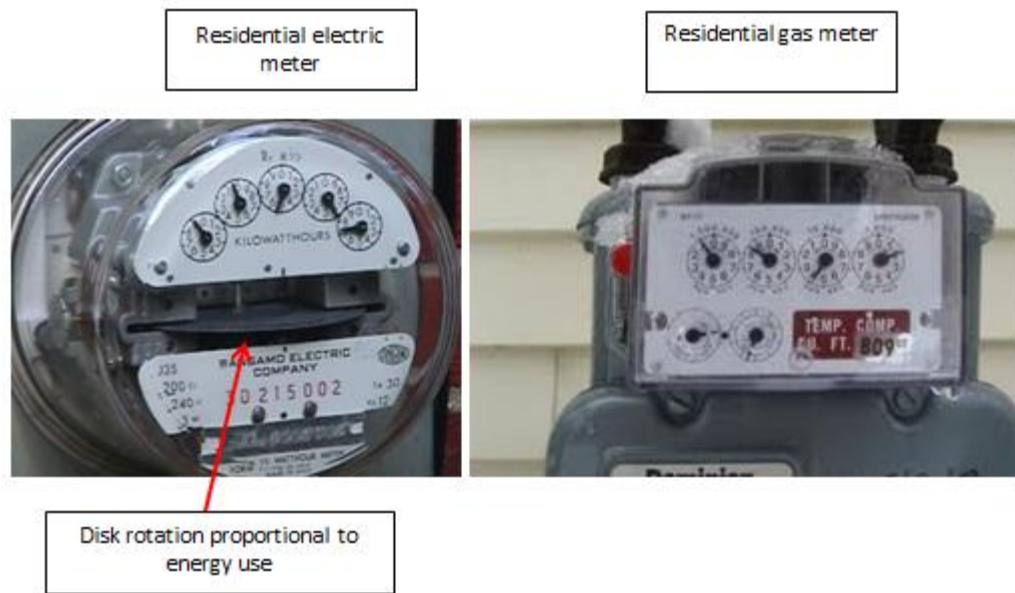
applied repeatedly to similar situations.

An energy audit begins with gathering data. It includes a list of energy consuming devices, their power ratings, their hours of operation, and their locations. Items that cycle on and off such as refrigerators are more difficult to estimate and can be measured individually with small plug-in meters, such as the one shown in Figure 10.30.



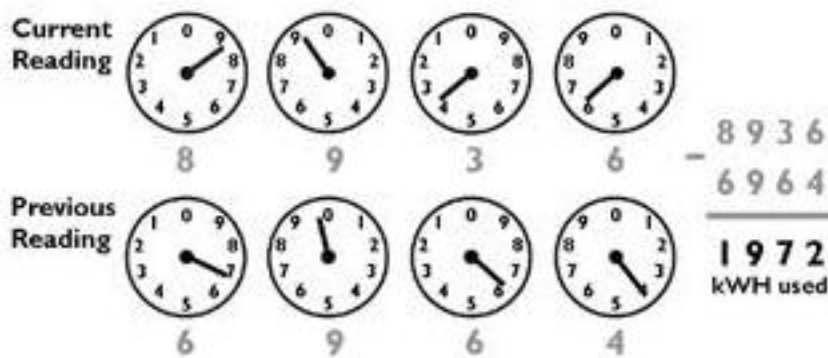
**Figure 10.30.** Plug-in electricity use monitor.

A history of energy use is obtained from utility bills or from direct observation of the electric and gas meters such as the electric and gas meters shown in Figure 10.31.



**Figure 10.31.** Residential electric and gas meters.

The meters have parts that rotate as electricity or gas passes through them. Newer meters have digital displays but older models have dials. For meters with dials, the spinning part is connected to the first gear in a row of small gears whose teeth interlock. For each full rotation of the first gear the next gear moves one-tenth of a revolution and the same relationship is true for each successive gear. In this manner, the rotation of the part within the meter can be expressed as multiples of ten. To reduce the number of parts and make the meters cheaper to manufacture, the gears rotate in opposite directions and so do the pointers connected to them. To read the dials, assume the pointers on the dials represent a four or five digit number. When the pointer is between two numbers on the dial, use the smaller of the two even if it is almost to the higher number. If it is between 9 and 0, think of the 0 as ten and use the 9. To determine how much energy has been used, read the meter at two different times, and then subtract the previous reading from the present reading, as shown in Figure 10.32.



**Figure 10.32.** Reading electric and gas meters.

Being able to translate the meter display into quantitative numbers allows the resident to experiment with energy saving strategies at intervals that are convenient and shorter than a month. The home or business owner could determine the energy used for a day under typical circumstances and then try using less energy the next day. By reading the meters before and after each time period, the electric and gas energy used during both days could be determined and the effect of the strategy determined.

Tip: Meters used on larger buildings are often set up to measure a portion of the total flow. If the front of the meter has a notation such as X10 it means that the meter measures one-tenth of the total and the meter reading should be multiplied by 10 to get the total quantity.

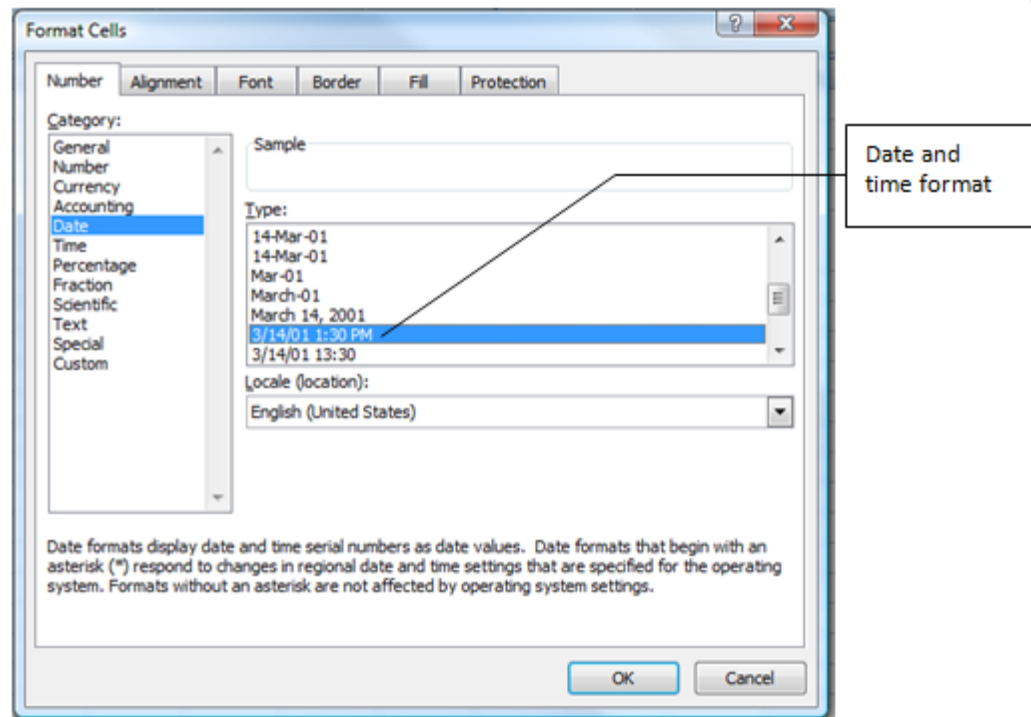
### ***Determining Energy Used from Electric Meter Readings***

In the following exercise, you will determine the kWh used based on three meter readings to determine if the energy use increased or decreased. If the intervals between meter readings are a day or so and they are not taken at the same time of day, the date and time should be recorded. Recall that time is stored as a decimal fraction of a day in personal computers.

1. Start Excel. Navigate to the location of files for this class, and then open Ch10Rules.xlsx and then save the file as **Ch10RulesStudentName** using your own name in place of StudentName.
2. In Ch10RulesStudentName workbook, click the Electric sheet tab. In cell B2 type **=Today()** and press Enter. This function displays the current date.
3. Select cells A6:A8. On the Home tab, in the Number group, click the Number Format list arrow and at

the bottom of the list click More Number Formats. The Format Cells dialog box displays with the Number tab selected.

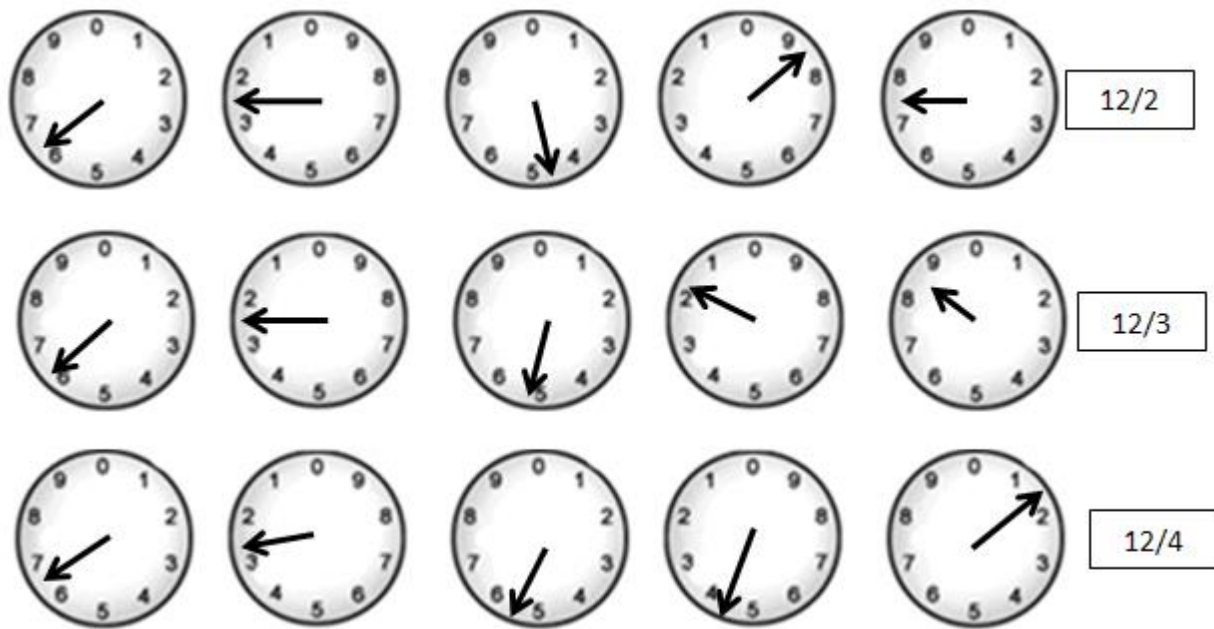
- Under Category click Date, and then scroll the list and click to select the Date/Time format shown in Figure 10.33 and then click OK.



**Figure 10.33.** Date and time format selected.

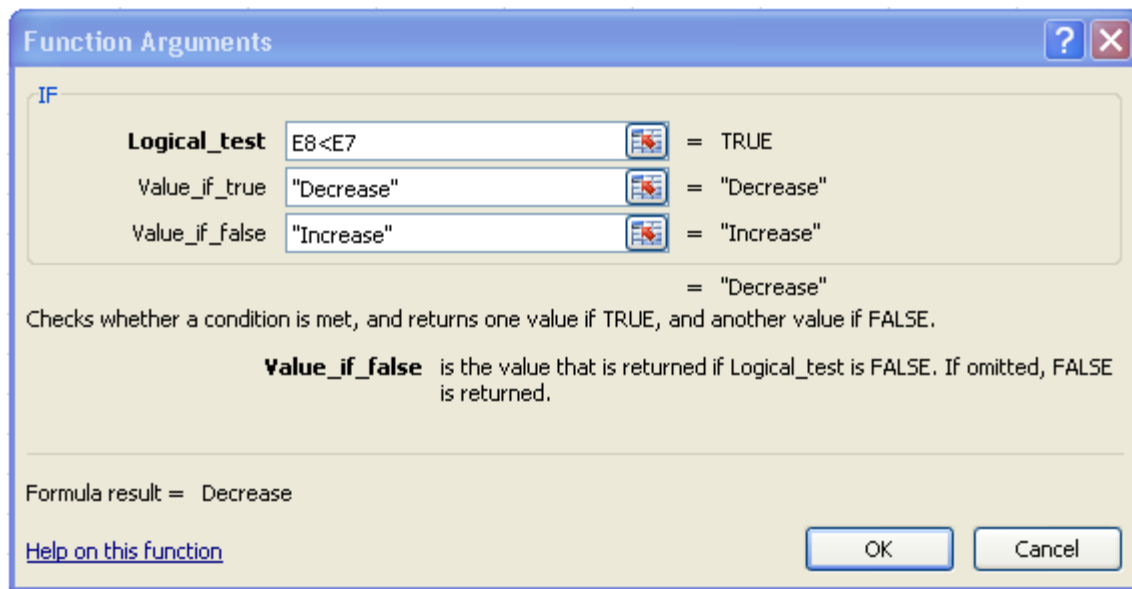
- In cell A6, type **12/2/10 8:00 AM**. In cell A7, type **12/3/10 11:00 AM**, and in cell A8, type **12/4/10 8:00 AM**.
- Examine the three rows of meters below in Figure 10.34. The first row is the meter reading for 12/2, the second row for 12/3 and the third row for 12/4. Using the rules described in the introduction, enter the three meter readings in cells B6:B8 for the three dates.





**Figure 10.34.** Meter displays for three dates.

7. In cell C7, write a formula to determine the difference in the first two meter readings: **=B7-B6** and fill it to cell C8. If the meter readings in cells B7:B8 are correct, the differences will be 31 and 23.
8. In D7 write a formula to determine the difference in amount of time for the first two days: **=A7-A6** and fill it down to cell D8
9. In E7 write a formula to determine the number of kWh used each day by dividing the meter difference by the difference in the days: **=C7/D7**. Fill this down to cell E8.
10. Select cells D7:E8 and format them with two decimals.
11. Click cell F8. On the Formulas tab, in the Function Library group, click the Logical button and then click IF to display the Function dialog box for the IF function. Recall that there are three arguments in the IF function: a logical test that is evaluated as true or false, what to do if it is true, what to do if it is false.
12. In the Logical\_test box type **E8<E7**, in the Value\_if\_true box type **"Decrease"**, in the Value\_if\_false box type **"Increase"**. Compare your screen with Figure 10.35. This conditional statement indicates if the usage increased or decreased from one day to the next.



**Figure 10.35.** Conditional statement to determine if the kWh use was less.

13. Click OK. With cell F8 selected, on the Home tab, in the Styles group, click the Conditional Formatting button. Point to Highlight Cell Rules, and then click Equal To.
14. In the *Equal To* dialog box type **Decrease**, in the with box, click the arrow and then click *Green Fill with Dark Green Text*. Click OK and this conditional format is applied to cell F8. If the previous steps are done correctly, the word *Decrease* displays in green font with a green background in cell F8.

### **Compare Heat Energy Use from One Season to the Next Using Heating Degree Days**

Recall that the results of studies can be invalid if there are confounding variables that are not taken into account. When we try to evaluate the effectiveness of a strategy to reduce energy use for heating, it is necessary to consider the outside air temperature. If it was not the same for both periods of time that are being considered, the difference must be taken into account. This is accomplished by using **heating degree days**. The heating degrees for one day are found by taking the average of the high and low temperature for the day and subtracting from the outdoor temperature at which the heating system normally comes on, which is assumed to be 65 degrees F.

Tip: In most homes, the heat from electrical appliances, incoming sunlight, and human metabolism is enough to heat the home on mild days and the heating system does not come on until the outside temperature drops below 65 degrees. If you set your home thermostat to 65 degrees, the heating system would come on at a lower outdoor temperature so a lower reference temperature of about 60 degrees would be appropriate.

For example, if the high is 50 and the low is 30, the average is 40 degrees. For that day, the heating degrees are 25 (65-40). The weather bureau keeps a record of heating degrees for each day of the year for each weather station in the country. A list of heating degrees for the past three years is available as a data file in csv format from online sites such as [degreedays.net](http://degreedays.net), as shown in Figure 10.36. (BizEE 2010)

### Degree Days.net - Custom Degree Day Data

Degree Days.net calculates degree-day data for energy-saving professionals worldwide. The software is developed by [BizEE Software](http://BizEE Software) based on temperature data from [Weather Underground](http://Weather Underground).

**Degree Days.net**

Enter a weather station ID if you have one, or search for any city, state, ZIP code, or airport code.

Weather station ID

☒ "48197"

- ☒ Ypsilanti, MI, US ([map](#))
  - KYIP (airport): Ypsilanti, MI, US (83.53W,42.24N)
  - KARB (airport): Ann Arbor, MI, US (83.75W,42.22N)
  - KDTW (airport): Detroit Metro, MI, US (83.35W,42.21N)
  - KTTF (airport): Monroe, MI, US (83.43W,41.94N)
  - MKYIP: ASOS\_HFM YPSILANTI/WL RUN, MI, Belleville, MI, US (4mi/7km)
  - MKARB: ASOS\_HFM ANN ARBOR MUNICI, MI, Ann Arbor, MI, US (6mi/10km)
  - KMIANNAR26: Stonebridge, Ann Arbor, MI, US (7mi/11km)
  - KMIANNAR13: Rudolf Steiner High School, Ann Arbor, MI, US (7mi/12km)
  - KMIANNAR13: Rudolf Steiner High School, Ann Arbor, MI, US (7mi/12km)

Degree day type ☒ Heating ☐ Cooling

Temperature units ☐ Celsius ☒ Fahrenheit

Base temperature  ☐ Include base temperatures nearby

Breakdown ☐ Monthly ☐ Weekly ☒ Daily ☐ Average

Period covered

**Figure 10.36.** Source of heating degree days data.

The file, in comma separated values (csv) format, can be imported into a worksheet in Excel and used

to account for the difference in outdoor temperature when calculating the natural gas used per heating degree.

The SUMIF function can be used to find the sum of heating degrees between two dates. Recall that the SUMIF function has three arguments: the first argument is the range of cells to be considered, the second argument is a condition that is evaluated as TRUE or FALSE, and the third argument is the range of cells that are summed for those cells where the condition is TRUE. When working with the SUMIF function, the comparison criteria used in the second argument must be written carefully according to the syntax rules shown in the table in Figure 10.37.

<i>Type of Comparison</i>	<i>Syntax</i>	<i>Example</i>
<b>Comparison operator with a number</b>	"operator number"	"<300"
<b>Match a number</b>	number	300
<b>Comparison operator with a date</b>	"operator"&cellref	"<"&B10
<b>Match text</b>	"text"	"Melons"
<b>Comparison operator with text</b>	"operator text"	"< Melons"
<b>Match null or empty cells</b>	""	""

**Figure 10.37.** Syntax for SUMIF criteria.

The SUMIF function does not allow nesting of other functions as criteria and there is no BETWEEN option. To find the sum of heating degrees between two dates, the difference between two SUMIF functions is used.

**Tip:** Because there is no BETWEEN function in Excel, a workaround must be devised. To find the values between two numbers, you sum all the values equal to or less than the maximum value and then sum all of the values that are less than the minimum value. If you subtract them you get the difference between the two values including both values.

1. Click the HDD sheet tab. On the Formula Bar, click in the Name box, type **A9:A1109** and then press Enter to select the range of dates. Click the Name Box, type **WeatherDates** and then press Enter.
2. Repeat this process to name the range B9:B1109 as **HDD**. Click the Name box list arrow and confirm that

WeatherDates and HDD are listed as named ranges.

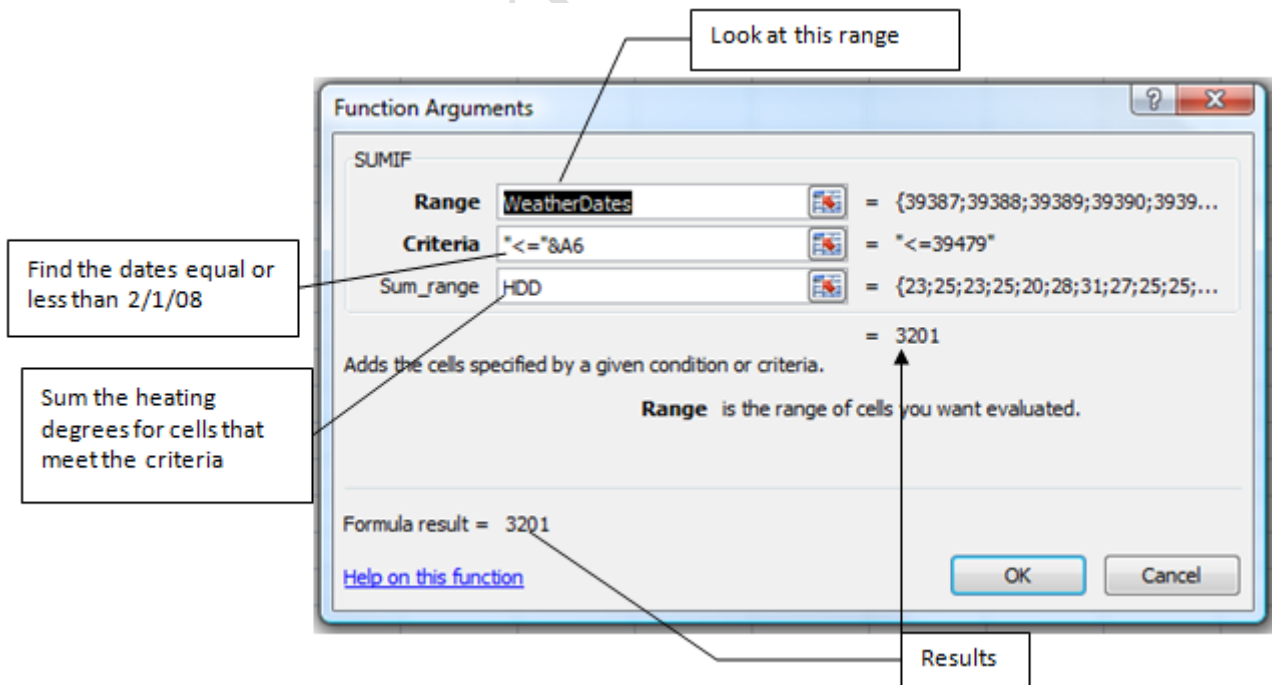
3. Click the NatGas sheet tab. In cell C6 type **=B6-B5** to calculate the amount of natural gas measured in CCF that was used between January 5, 2008 and February 1, 2008.

4. In cell D6 type **=DATEDIF(A5,A6,"d")** and then press Enter.

Tip: The DATEDIF function is an Excel function that finds the number of days, months, or years between two dates. It is not officially documented in the Excel manual or help files. This is a valuable tool that Excel "insiders" know about. The first argument is the earlier date, the second argument is the later date, and the third argument is either "d" for day, "m" for month, or "y" for year. The d, m, or y in the third argument must be inside quote marks.

5. In cell E6, write a formula to calculate the average CCF use per day by dividing the consumption in cell C6 by the days in cell D6. Format the results to display two decimals.

6. Click cell F6. On the Formulas tab, in the Function Library group, click the Math & Trig button and then click SUMIF. In the SUMIF Function Arguments dialog box, in the Range box type **WeatherDates**, in the Criteria box type **"<="&A6**, and in the Sum\_Range box type **HDD**. Compare your results with Figure 10.38.



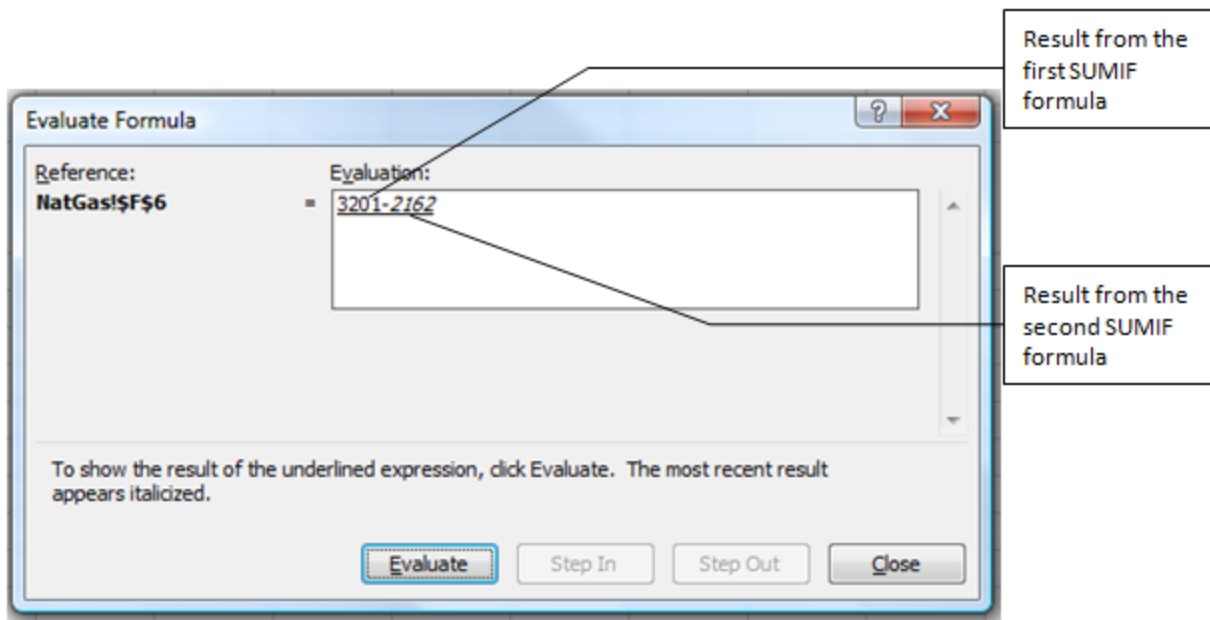
**Figure 10.38.** The SUMIF arguments to find and sum the heating degree days from the HDD

worksheet.

7. The results show as 3201. This is the sum of heating degrees prior to the date in A6 including the degree days on that day ( $\leq$ ). Click OK.
8. With cell F6 as the active cell, in the Formula bar, click at the end of the formula and edit the formula so it reads `=SUMIF(WeatherDates,"<="&A6,HDD)-SUMIF(WeatherDates,"<"&A5,HDD)`. Check to be sure you used a minus sign between `HDD)-SUMIF(`. The second SUMIF statement uses the less than operator to find the dates that are prior to the date in cell A5—1/5/2008. By subtracting this value from the first SUMIF calculation, the number of degree days between the two dates, including the degree days on both days, is found. The result is 1039.
9. Press Enter. Click cell F6. On the Formulas tab, in the Formula Auditing group, click the Evaluate Formula button.

Tip: The Evaluate Formula dialog box can be used to analyze a formula or to diagnose problems with a formula. When you click the Evaluate button in this dialog box, it steps through each of the arguments in the formula and displays the solution to each part of the formula.

10. In the *Evaluate Formula* dialog box, click the Evaluate button; the first argument of the SUMIF identifies the cell range. Click the Evaluate button again to analyze the second argument in the formula. Continue clicking the Evaluate button until the dialog box looks like the one in Figure 10.39.



**Figure 10.39.** The Evaluate dialog box analyzes the two SUMIF formulas.

11. Click Evaluate one more time and then click Close.
12. In cell G6 write a formula to calculate the Average use per HDD by dividing the Consumption in cell C6 by the heating degree days in cell F6. Format cell G6 to display two decimal places.
13. Copy the formulas in C6:G6 to C10:G10

Tip: By using relative references to the dates and readings in columns A and B in combination with range names for the weather dates and HDD, the complex formulas do not have to be rewritten which improves accuracy.

14. Click cell G10. On the Home tab, in the Styles group, click the Conditional Formatting button. Point to Highlight Cell Rules, and then click Less Than.
15. In the Less Than dialog box, in the first box type **G6**. Press Tab and change the format to Green Fill with Dark Green Text, and then click OK.
16. Observe that the average use of natural gas is more in January of 2009 (13.19 vs. 11.11) but it was much colder as indicated by the heating degrees (1356 vs. 1039). When adjusted for the colder weather, the average natural gas use per heating degree was reduced (.25 vs. .29). Compare your results with Figure 10.40.



	A	B	C	D	E	F	G
1	<b>Natural Gas</b>						
2							
3	<b>Previous Use</b>						
			Consumption		Average		Average
4	Date	Reading	in CCF	Days	use per day	HDD	use per
5	1/5/2008	38977					HDD
6	2/1/2008	39277	300	27	11.11	1039	0.29
7							
8	<b>Recent Use</b>						
9	1/2/2009	3977					
10	1/28/2009	4320	343	26	13.19	1356	0.25

**Figure 10.40.** Energy used was less when adjusted for heating degree days.

## Key Takeaways

- The dials on a gas or electric meter represent numerals in a number. The number represents the quantity of gas or electricity that has passed through the meter. When the pointer is between two numbers, use the lower value. If it is between 0 and 9, think of the zero as 10. [10.3.1]
- The IF function has three arguments. The first is the criterion and it is a combination of cell references and comparison operators. The second argument is what formula, function, or display to use if the criterion is TRUE, the third argument is what to do if the criterion is FALSE. Conditional formatting can be applied using dialog boxes found on the Home tab in the Styles group. [10.3.2]
- Heating degrees are calculated each day by taking the average of the high and low temperature for the day and subtracting that average from the outdoor temperature at which the heating system comes on, which is typically 65 degrees. The sum of the heating degrees for the days equal to or prior to a given date minus the sum of the heating degrees prior to an earlier date yields the degree days between the dates. The comparison operator <= is used for the later date and < is used for the earlier date to be sure to include the heating degrees on the two dates. [10.3.3]
- The DATEDIF function determines the days, months, or years between two dates even if the dates span a change in month, year, or leap year. The first two arguments are the later date and the earlier date. The third argument is "d", "m", or "y" to indicate days, months, or years between the two dates. [10.3.4]
- Complex formulas can be evaluated a step at a time by using the Evaluate Formula dialog box found on the Formulas tab in the Formula Auditing group. [10.3.5]



## 4 Applying Business Rules

### Learning Objectives

1. Identify at least two companies that provide business credit ratings and two types of rating reports they provide. [10.4.1]
2. Translate business rules into phrases that correspond well with comparison operators and logic functions. [10.4.2]
3. Isolate variables for use in business rules. [10.4.3]
4. Convert business rules phrases into logical formulas for making business decisions. [10.4.4]
5. Protect worksheets or hide columns to prevent accidental overwrites. [10.4.5]

Businesses have policies that are used to guide decisions. Those policies can be translated into logical statements that combine comparison operators with logical functions so that a worksheet can be used to facilitate comparisons and evaluation of options.

#### ***Using Financial Ratings in Business Rules***

Before a business commits itself into a relationship with another business, the managers want to be sure the other company can fulfill its agreements in a timely manner. One way to check on the financial health of a company and how it behaves towards its creditors is to get a credit report on the company. Industry leaders in the credit reporting business are: (Highbeam Business 2010)

- Equifax
- Experian Information Solutions (formerly TRW)
- Moody's Investor Services
- Dun & Bradstreet (D&B)
- Trans Union LLC

A common task within companies is to choose between bidders on contracts. Before the bids are evaluated and compared, the companies that are submitting the bids are evaluated to determine if they can deliver on the contract if it is awarded to them. If this is a new relationship, the company might obtain a credit report. Typical reports include information on how much credit they have available, how far behind they are on

paying their debtors, and an estimate of the likelihood of failure in the next twelve months. Figure 10.41 is a sample report from Equifax. (Equifax 2010)

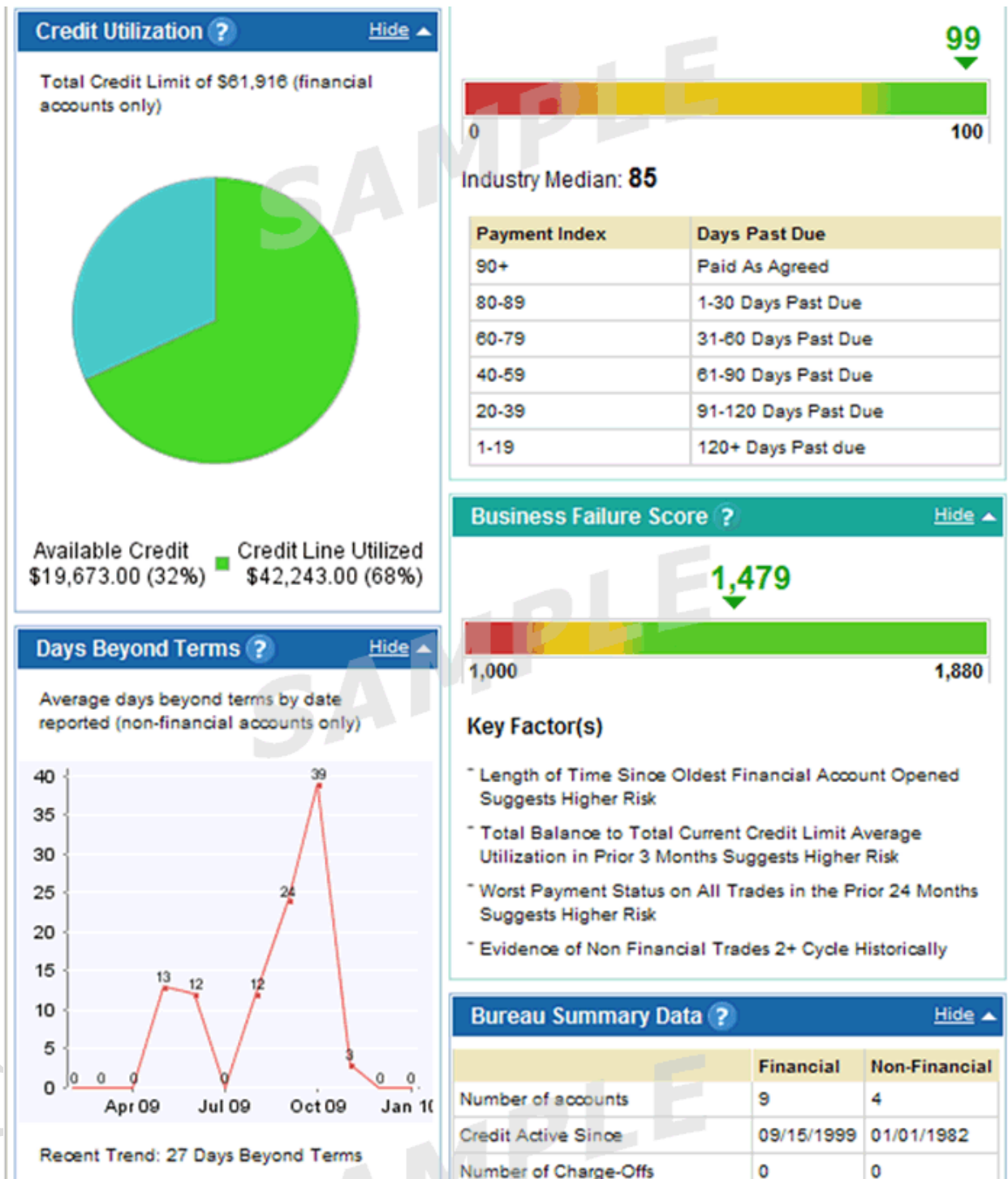


Figure 10.41. Sample reports from Equifax.

Developing industries, such as alternative energy, often have many companies that will not be in business for more than two years; therefore, it is important to choose partners carefully. Similarly, it is important for a company to manage its finances and debt payments to keep its own scores high enough to qualify for partnerships.

The first step is to develop a policy to determine what companies are qualified to bid on contracts. For example, the policy might be:

*Bidders that have received at least three contracts must have an average rating of 90% or higher for their performance on the last three contracts. Bidders that have received fewer than three previous contracts must have an Equifax payment score of at least 80 and a business failure score above 1340.*

In the next worksheet, you will develop business rules to determine which companies are qualified to compete for contracts. You will begin by rewording the preceding policy statement into separate parts.

1. In Ch10RulesStudentName workbook, click the Bidders sheet tab.
2. The first rule is really two rules, either of which is sufficient, begin by stating this fact with the word *or* in the sentence. In cell B3, type **Bidders must qualify under rule 1 or rule 2.**
3. The first rule uses the phrase *Bidders that have received at least three contracts*. Anticipate the use of the COUNT function and the >= operator. In A4, type **1) Bidders have a count of previous contracts greater than or equal to three**
4. The next phrase in the first rule is *must have an average rating of 90% or higher for their performance on the last three contracts*. Anticipate the use of the AVERAGE function and the >= comparison operator. Edit the text in cell A4 by adding **AND have an average of evaluation ratings greater than or equal to 90% on the three most recent contracts.**
5. The first phrase in the second rule is *Bidders that have received fewer than three previous contracts*. Anticipate the use of the COUNT function and the < operator. In cell A5, type **2) Bidders have a count of previous contracts less than three**

6. The next phrase in the second rule is *must have an Equifax payment score of at least 80*. Anticipate the use of the  $\geq$  comparison operator. This rule requires the world knowledge that higher scores are better to interpret the words *at least*. In cell A5, append the phrase by adding **AND have an Equifax payment score greater than or equal to 80**
7. The last phrase is joined to the previous phrase with the word *and* which does not need translation. The last phrase is *a business failure score above 1340*. Anticipate the use of the  $>$  operator. In cell A5, append the phrase by adding **and a failure score greater than 1340**.
8. The next step is to create rules that will be tested with the data from each applicant. Click cell A6. Notice that cell A6:D6 have been merged together. Type **Payment score  $\geq$**  press tab and in cell E6, type **80**
9. In A7, type **Failure score  $>$**  and then in E7 type **1340**
10. In A8, type **Average contract rating  $\geq$**  and then in E8 type **90** Compare your worksheet with Figure 10.42.

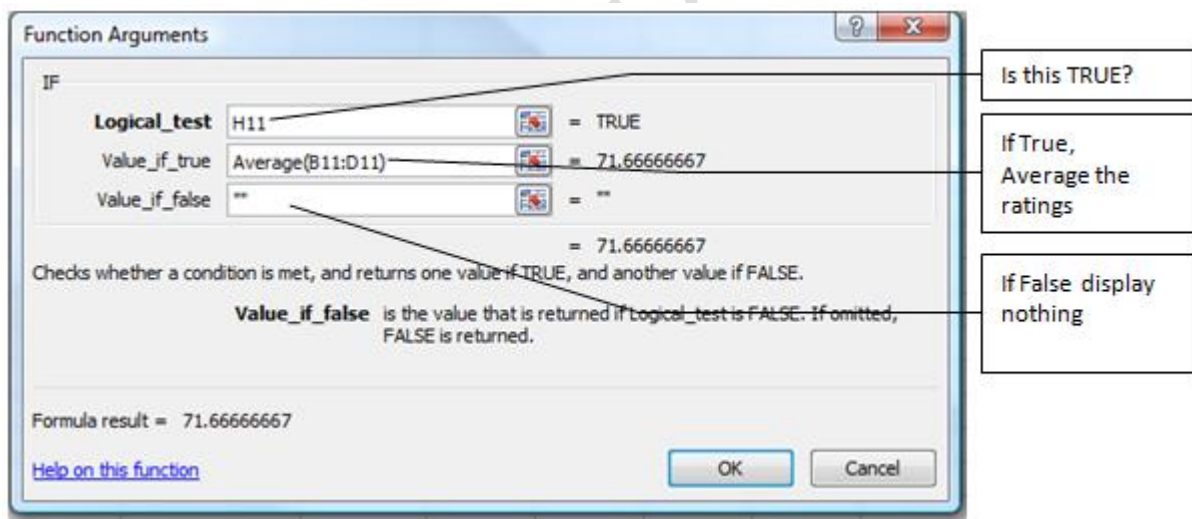
	A	B	C	D	E	F	G
1	<b>Qualified Bidders</b>						
2							
3	<b>Business Rules:</b>	Bidders must qualify under rule 1 or rule 2.					
4	1) Bidders have a count of previous contracts greater than or equal to three AND have an average of evaluation ratings greater than or equal to 90% on the three most recent contracts.						
5	2) Bidders have a count of previous contracts less than three AND have an Equifax payment score greater than or equal to 80 AND a failure score greater than 1340.						
6	Payment score $\geq$				80		
7	Failure score $>$				1340		
8	Average contract rating $\geq$				90		

**Figure 10.42.** Rules written on the worksheet using comparison operators.

To translate the phrases of the rules into formulas, use a separate cell for each phrase. Work from left to right within the rule and then combine the results of the rules with AND or OR logic at the end. Next you

translate the statements using functions and logical if statements to test if each bidder qualifies based on the rules.

11. In cell G11, type **=COUNT(B11:D11)** This formula counts the number of contracts for the vendor listed in row 11. The result should be 3.
12. In cell H11, type **=IF(G11>=3,TRUE,FALSE)** This formula determines if the number in cell G11 is greater than or equal to 3. If it is the results displays TRUE, if not the results display FALSE. The result should be TRUE.
13. Click cell I11. On the Formulas tab, in the Function Library group, click the Logical button and then click IF. Click the Logical\_Test box and then click cell H11. The test determines if this cell is true.
14. In the Value\_if\_true box, type **AVERAGE(B11:D11)**, and in the Value\_if\_False box type **""**. Compare your dialog box with Figure 10.43.

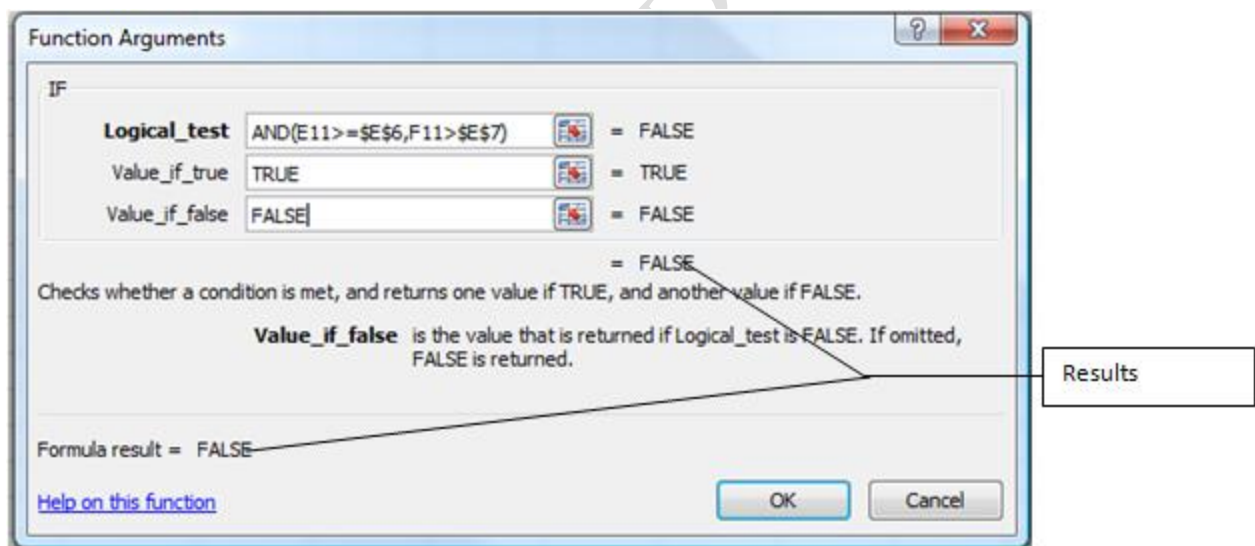


**Figure 10.43.** If there have been three previous contracts, the average is calculated.

15. Click OK. Format cell I11 to display one decimal place.
16. Click cell J11 and display the IF Function Argument dialog box again. In the Logical\_test box type **AND(H11,I11>=\$E\$8)**, in the Value\_if\_true box type **TRUE**, and in the Value\_if\_false box type **FALSE**.  
Examine the dialog box. This IF statement tests if both H11 is true—there are 3 or more contracts— and


the rating is higher than the minimum rating in cell E8. If both conditions are true, then TRUE will display, if either one is not true, then FALSE will display. An absolute cell reference to the required value in cell E8 is used so this function can be filled down the column. For the first bidder, they have enough contracts, but their rating is not high enough so they do not qualify under the first rule.

17. Click OK. Click cell K11 and display the IF Function Argument dialog box again. In the Logical\_test box type **AND(E11>=\$E\$6,F11>\$E\$7)**, in the Value\_if\_true box type **TRUE**, in the Value\_if\_false box type **FALSE**. Examine the dialog box. This IF statement tests the second rule: does the bidder meet the financial ratings. The Payment rating in cell E11 must be greater than or equal to the value in cell E6, and the value in cell F11 must be greater than the value in cell E7. If both conditions are true, then TRUE will display, if either one is not true, then FALSE will display. Absolute cell references to the required values are used so this function can be filled down the column. Compare your dialog box to Figure 10.44.



**Figure 10.44.** If statement to test if both financial ratings have been met.

18. Click OK. Click cell L11 and display the IF Function Argument dialog box again. In the Logical\_test box type **AND(G11<3,K11)**, in the Value\_if\_true box type **TRUE**, in the Value\_if\_false box type **FALSE**. Examine the dialog box, and then click OK. This tests if the contractor would qualify as a new bidder: they have less than 3 contracts, and meet the financial requirements.

19. In cell M11, type **=OR(J11,L11)**. This statement returns TRUE if the contractor qualifies under the first rule—cell J11—or the second rule—cell L11.
20. Select cells G11:M11. Point to the fill handle in the corner of cell M11 and fill down to row 17.
21. Notice that there are green triangles in the corner of some of the cells in column G and column I. Click cell G12, point to the Error Checking button  and read the ScreenTip that displays. Click the Error Checking button and from the list of options click Ignore Error, which hides the green triangle. Repeat this for other cells that display a green triangle.

Tip: The green triangles are Error Flags used to warn you that there may be an error in a formula and the Error Checking button displays an explanation of the suspected error. When you click the Error Checking button a list of options display; you can ignore the error, get help with the error, or get a more detailed explanation. In this case, there is no error. The adjacent numbers should not be included in the formula.

22. Select cells M11:M17. On the Home tab, in the Styles group click the Conditional Formatting button. Point to Highlight Cell Rules and then click Equal To. In the Equal To box type **TRUE**, in the with box, click the list arrow and then click Custom Format.
23. In the displayed Format Cells dialog box, be sure the Font tab is displayed. In the Font Style box click Bold. Click the Fill tab. Under Background Color, in the last row, click the third color from the left—Orange, then click OK. Click OK in the Equal to dialog box. This creates a custom conditional format and cell M13, M14 and M16 display this special format because the bidders in these rows qualify under the rules that were tested.
24. Compare your worksheet to Figure 10.45. If the results in column M do not match, chose one of the results that does not match, and then work the logic backward to find the error.



	A	B	C	D	E	F	G	H	I	J	K	L	M
6	Payment score >=				80								
7	Failure score >				1340								
8	Average contract rating >=				90								
9	<div> <div>Rule 1</div> <div>Rule 2</div> </div>										Either		
		Ratings on Most Recent Contracts			Payment Rating	Failure Score	Count of Previous Contracts	Three or more contracts	Average Rating	Qualified as Experienced	Meets Financial Rating Requirement	Qualified as New	Qualified
10	Bidder												
11	ABC	75	90	50	85	1300	3	TRUE	71.7	FALSE	FALSE	FALSE	FALSE
12	RQ		85	90			2	FALSE		FALSE	FALSE	FALSE	FALSE
13	DD	85	90	95			3	TRUE	90.0	TRUE	FALSE	FALSE	TRUE
14	RP			95	83	1450	1	FALSE		FALSE	TRUE	TRUE	TRUE
15	DM	90	75	65			3	TRUE	76.7	FALSE	FALSE	FALSE	FALSE
16	KR				85	1500	0	FALSE		FALSE	TRUE	TRUE	TRUE
17	NM		90	85			2	FALSE		FALSE	FALSE	FALSE	FALSE

**Figure 10.45.** Three qualified bidders.

### **Protecting a Worksheet**

To create a template that might be used by other people in the company to evaluate bidders, it might be a good idea to prevent them from accidentally overwriting the complex formulas in columns G through L. One method is to protect the cells to prevent accidental changes and the other is to hide the columns that contain them.

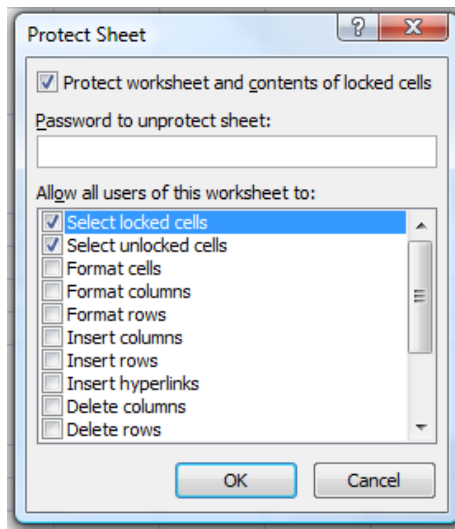
1. Select cells A4:A5, hold down the Ctrl key and select cells E6:E8, and A11:F17. These are the cells that can be changed. Compare your screen with Figure 10.46.



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	<b>Qualified Bidders</b>												
2													
3	<b>Business Rules:</b>					Bidders must qualify under rule 1 or rule 2.							
4	1) Bidders have a count of previous contracts greater than or equal to three AND have an average of evaluation ratings greater than or equal to 90% on the three most recent contracts.												
5	2) Bidders have a count of previous contracts less than three AND have an Equifax payment score greater than or equal to 80 AND a failure score greater than 1340.												
6	Payment score >=				80								
7	Failure score >				1340								
8	Average contract rating >=				90								
9							Rule 1			Rule 2		Either	
10		Ratings on Most Recent Contracts			Payment Rating	Failure Score	Count of Previous Contracts	Three or more contracts	Average Rating	Qualified as Experienced	Meets Financial Rating Requirement	Qualified as New	Qualified
11	Bidder	ABC	75	90	50		3	TRUE	71.7	FALSE	FALSE	FALSE	FALSE
12		RQ		85	90	85	1300	2	FALSE	FALSE	FALSE	FALSE	FALSE
13		DD	85	90	95			3	TRUE	90.0	TRUE	FALSE	TRUE
14		RP			95	83	1450	1	FALSE	FALSE	TRUE	TRUE	TRUE
15		DM	90	75	65			3	TRUE	76.7	FALSE	FALSE	FALSE
16		KR				85	1500	0	FALSE	FALSE	TRUE	TRUE	TRUE
17		NM		90	85			2	FALSE	FALSE	FALSE	FALSE	FALSE

**Figure 10.46.** Cells that can be changed are selected so they can be unlocked.

- On the Home tab, in the Cells group, click the Format button. At the end of the list click Format cells. In the dialog box that displays, click the Protection tab, and then click to remove the check mark next to Locked. These cells are no longer locked into the same protection condition as the rest of the worksheet. Click OK.
- On the Review tab, in the Changes group click the Protect worksheet button. The Protect Sheet dialog box displays as shown in Figure 10.47. You can protect a worksheet with or without a password.



**Figure 10.47.** Protect Sheet dialog box is used to protect a worksheet from changes.

4. Do not type a password. Click OK and notice that the name under the Protect Sheet button has changed to Unprotect Sheet.
5. Click in any cell where the formulas are located—G11:M17 and attempt to change a formula. A message displays to warn you that the cell you selected is protected and therefore read-only. Click OK to close the message.
6. Click the Unprotect Sheet button to remove the protection.
7. Select columns G:L, right-click on one of the selected column headings and then click Hide.
8. On the Review tab, in the Changes group, click the Protect Sheet button. In the Protect Sheet dialog box, click OK. The interim steps are hidden and the worksheet is protected except for the unlocked cells, as shown in Figure 10.48.

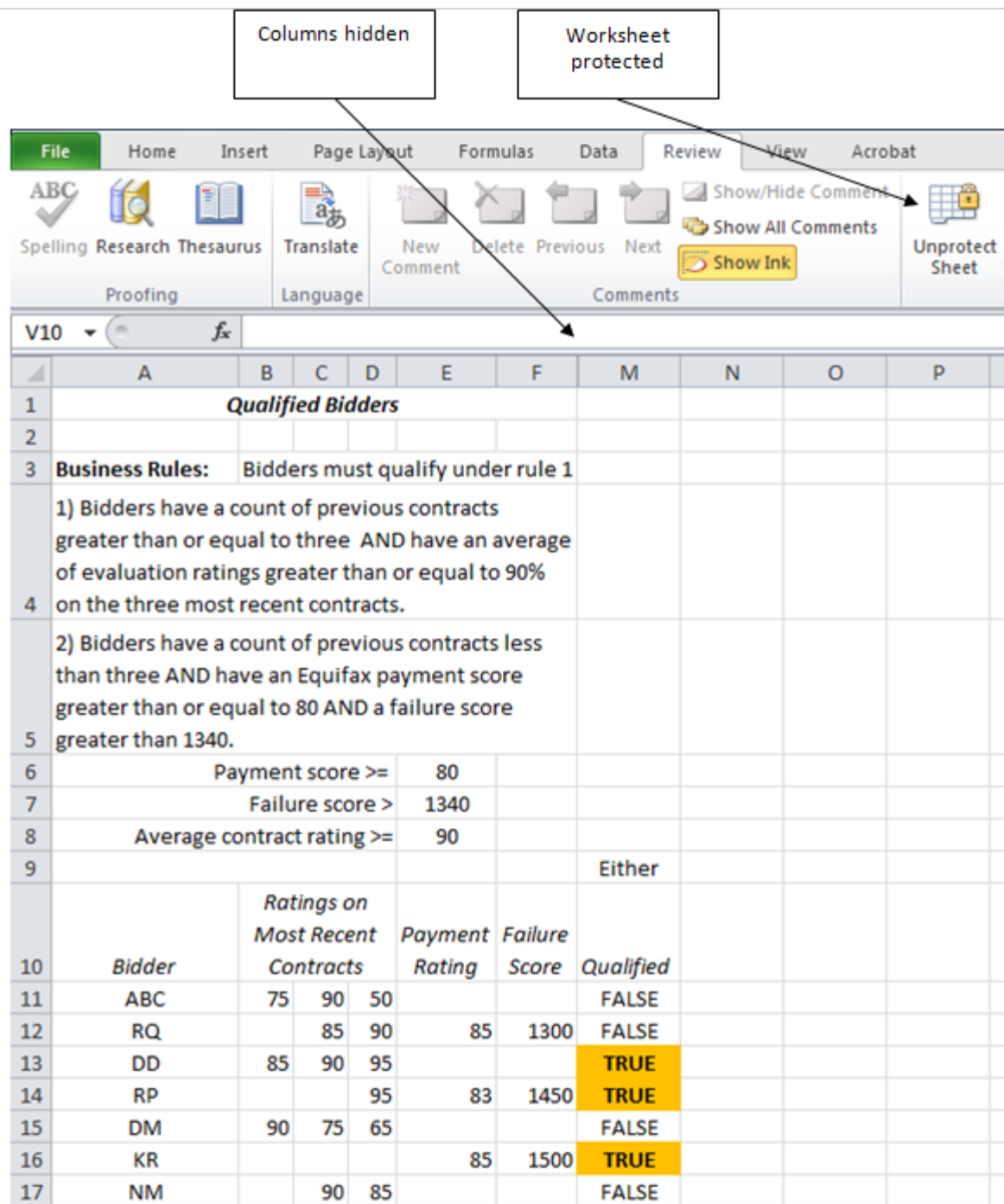


Figure 10.48. Interim steps hidden and formulas protected.

9. You now have a tool that will allow you to evaluate bidders quickly, consistently, and accurately. Save your work.

## Key Takeaways

- Several companies provide ratings of the financial health of businesses. Two of the largest are D&B (Dun and Bradstreet) and Equifax. They provide similar reports that rate how they pay their bills and an estimate of the likelihood that they will go out of business in the next twelve months. [10.4.1]
- If a rule is really two or more separate rules label them separately. Identify phrases that can be replaced by phrases that match the structure of comparison operators. For example, replace *at least* with *greater than or equal to*. [10.4.2]
- Identify specific numbers within the rules that might be used in formulas or changed in later rule revisions. Place those numbers in their own cells. [10.4.3]
- Use a separate cell for evaluating phrases in the rules and then combine them with logic statements in other cells. This practice makes it easier to troubleshoot the rules. [10.4.4]
- Unlock the cells that are supposed to be changed and then protect the worksheet to prevent changes to the cells that are still locked. Alternatively, hide the columns that have the intervening steps. [10.4.5]

## Key Terms

### Compact Fluorescent Lamps

Fluorescent lamps that are coiled to make them small enough to replace light bulbs.

### Conditional formatting

Ability to change the format of a cell based on the evaluation of a criteria.

### Energy audit

Detailed list of energy consuming devices that usually consists of a description, location, power rating, and hours of operation.

### Heating degrees

For each day, the average of the high and low temperature is subtracted from a reference temperature at which the heating system activates—usually 65 degrees. The difference is the heating degrees for that day.

### Light Emitting Diodes (LED)

Transistor-like devices that emit light.

### Syntax

Rules that govern how functions are written

## World knowledge

Collection of facts and contexts of a wide range of topics.

## Works Cited

BizEE. *BizEE Degree Days*. 2010. <http://www.degreedays.net/> (accessed November 7, 2010).

Equifax. *Small Business*. 2010. [http://www.equifax.com/small-business/home/en\\_sb](http://www.equifax.com/small-business/home/en_sb) (accessed November 8, 2010).

Highbeam Business. *Credit Reporting Services*. 2010. <http://business.highbeam.com/industry-reports/business/credit-reporting-services> (accessed November 8, 2010).

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