Excel Lookups

Lookups are an important analytical tool in Excel. A *lookup formula* returns a value from a table by looking up another related value. A common telephone directory (remember those?) provides a good analogy. If you want to find a person's telephone number, you first locate the name (look it up) and then retrieve the corresponding number.

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Basic Lookup Formulas

You can use the Excel basic lookup functions to search a column or row for a lookup value to return another value as a result. Excel provides three basic lookup functions: `HLOOKUP`, `VLOOKUP`, and `LOOKUP`. In addition, the `MATCH` and `INDEX` functions are often used together to return a cell or relative cell reference for a lookup value.

The VLOOKUP function

The `VLOOKUP` function looks up the value in the first column of the lookup table and returns the corresponding value in a specified table column. The lookup table is arranged vertically (which explains the *V* in the function's name). The syntax for the `VLOOKUP` function is:

```
=VLOOKUP(lookup_value,table_array,col_index_num,range_lookup)
```

The VLOOKUP function's arguments are as follows:

- lookup_value: The value to be looked up in the first column of the lookup table.
- table_array: The range that contains the lookup table.
- col_index_num: The column number within the table from which the matching value is returned.
- range_lookup: Optional. If TRUEor omitted, an approximate match is returned. (If an exact match is not found, the largest value that is less than lookup_value is returned.) If FALSE, VLOOKUPwill search for an exact match. If VLOOKUPcan't find an exact match, the function returns #N/A.

A very common use for a lookup formula involves an income tax rate schedule as shown in Figure 1 - Using VLOOKUP to Lookup a Tax Rate . The tax rate schedule shows the income tax rates for various income levels. The following formula (in cell B3) returns the tax rate for the income in cell B2:

=VLOOKUP(B2,D2:F7,3)

	A	B	C	D	E	F
1				Income is Greater Than or Equal To...	But Less Than or Equal To...	Tax Rate
2	Enter Income:	$32,650		$0	$2,650	15.00%
3	The Tax Rate is:	31.00%		$2,651	$27,300	28.00%
4				$27,301	$58,500	31.00%
5				$58,501	$131,800	36.00%
6				$131,801	$284,700	39.60%
7				$284,701		45.25%
8						

Figure 1 - Using VLOOKUP to Lookup a Tax Rate

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The lookup table resides in a range that consists of three columns (D2:F7). Because the last argument for the `VLOOKUP` function is `3`, the formula returns the corresponding value in the third column of the lookup table.

Note that an exact match is not required. If an exact match is not found in the first column of the lookup table, the `VLOOKUP` function uses the next largest value that is less than the lookup value. In other words, the function uses the row in which the value you want to look up is greater than or equal to the row value but less than the value in the next row. In the case of a tax table, this is exactly what you want to happen.

The HLOOKUP function

The HLOOKUPfunction works just like the VLOOKUPfunction except that the lookup table is arranged horizontally instead of vertically. The HLOOKUPfunction looks up the value in the first row of the lookup table and returns the corresponding value in a specified table row.

The syntax for the HLOOKUPfunction is: HLOOKUP(lookup_value,table_array,row_index_num,range_lookup)

The HLOOKUPfunction's arguments are as follows:

- lookup_value: The value to be looked up in the first row of the lookup table.
- table_array: The range that contains the lookuptable.
- row_index_num: The row number within the table from which the matching value is returned.
- range_lookup: Optional. If TRUEor omitted, an approximate match is returned. (If an exact match is not found, the next value less than lookup_valueis returned.) If FALSE, HLOOKUP will search for an exact match. If HLOOKUPcan't find an exact match, the function returns #N/A.

Figure 2 - Using HLOOKUP to Lookup a Tax Rate shows the tax rate example with a horizontal lookup table (in the range E1:J3). The formula in cell B3 is:

=HLOOKUP(B2,E1:J3,3)

	A	B	C	D	E	F	G	H	I	J
1				Income is Greater Than or Equal To...	$0	$2,651	$27,301	$58,501	$131,801	$284,701
2	Enter Income:	$21,566		But Less Than...	$2,650	$27,300	$58,500	$131,800	$284,700	
3	The Tax Rate is:	28.00%		Tax Rate	15.00%	28.00%	31.00%	36.00%	39.60%	45.25%
4										

Figure 2 - Using HLOOKUP to Lookup a Tax Rate

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Combining an HLOOKUP with a VLOOKUP

Our second example uses the HLOOKUP function as an argument in a VLOOKUP formula that returns the price of an item depending upon the quantity ordered by a customer. Customers are given price breaks based on the number of units purchased on an item-by-item basis. Individual sales price levels are set for the following ranges: zero to nine items, ten to twenty- four items, twenty-five to forty-nine items, and fifty items or more.

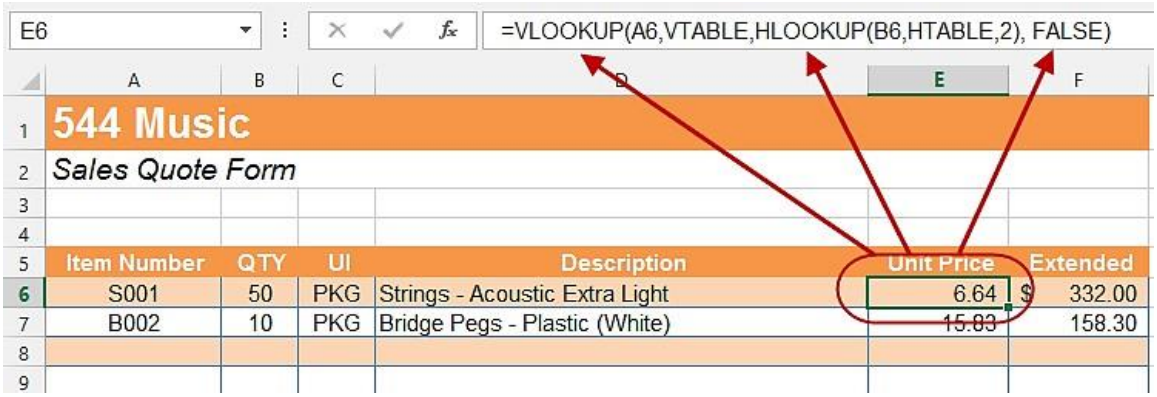

Figure 3 - Using HLOOKUP Nested with VLOOKUP and the FALSE Argument

In this case, the HLOOKUP function supplies the third argument – the column index – of the VLOOKUP function as shown in **Figure 3**. In ascending order from left to right in the first row of HTABLE, the defined name that references the horizontal table array is the values 1, 10, 25, and 50, which coincide with the minimum values of the sales price levels. The second row contains the column numbers – 4, 5, 6, and 7 – from which to retrieve the item prices in the VLOOKUP table array. For example, if the quantity entered was 23, the HLOOKUP function would return 5, the column from which to retrieve the price for the item selected.

You should also notice that in the formula shown in **Figure 100**, the FALSE argument is in place. The reason for this is because, in default, the VLOOKUP function finds and returns information related to the largest value found that is *less than or equal to* the lookup value. If the False argument had not been set in our formula, VLOOKUP would have either returned incorrect information or would have presented us with an #NA! error, since the data was not properly sorted.

Looking up an exact value

As demonstrated in the previous examples, VLOOKUP and HLOOKUP don't necessarily require an exact match between the value to be looked up and the values in the lookup table. An example is looking up a tax rate in a tax table. In some cases, you may require a perfect match. For example, when looking up an employee number, you would require a perfect match for the number.

To look up an exact value only, use the VLOOKUP (or HLOOKUP) function with the optional fourth argument set to FALSE.

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Figure 4 - Looking Up an Exact Match shows a worksheet with a lookup table that contains employee numbers (column D) and employee names (column E). The lookup table is named EmpList. The formula in cell B2, which follows, looks up the employee number entered in cell B1 and returns the corresponding employee name:

=VLOOKUP(B1,EmpList,2,FALSE)

B2 =VLOOKUP(B1,EmpList,2,FALSE)

	A	B	C	D	E
1	**Employee No.:**	972		**Employee No.**	**Employee Name**
2	**Employee Name:**	Sally Rice		873	Charles K. Barkley
3				1109	Francis Jenikins
4				1549	James Brackman
5				1334	Linda Harper
6				1643	Louise Victor
7				1101	Melinda Hindquest
8				1873	Michael Orenthal
9				983	Peter Yates
10				972	Sally Rice
11				1398	Walter Franklin
12					

Figure 4 - Looking Up an Exact Match

Because the last argument for the VLOOKUP function is FALSE, the function returns a value only if an exact match is found. If the value is not found, the formula returns #N/A. This result, of course, is exactly what you want to happen because returning an approximate match for an employee number makes no sense. Also, notice that the employee numbers in column D are not in ascending order. If the last argument for VLOOKUP is FALSE, the values need not be in ascending order.

Looking up a Value to the Left with the Lookup Function

The VLOOKUP function always looks up a value in the first column of the lookup range. But what if you want to look up a value in a column other than the first column? It would be helpful if you could supply a negative value for the third argument for VLOOKUP — but Excel doesn't allow it.

Figure 5 - Looking Up a Value to the Left illustrates the problem. Suppose that you want to look up the batting average (column B, in a range named Averages) of a player in column C (in a range named Players). The player you want data for appears in a cell named LookupValue. The VLOOKUP function won't work because the data isn't arranged correctly. One option is to rearrange your data, but sometimes that's not possible.

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F3 =LOOKUP(LookupValue,Players,Averages)

	A	B	C	D	E	F	G
1	At Bats	Average	Player		Player to lookup:	Gomez	
2	0	0.000	Henderson				
3	9	0.333	Mazden		Average	0.160	<-- LOOKUP
4	12	0.333	Albertson		At Bats:	25	<-- LOOKUP
5	14	0.286	Perez				
6	16	0.313	Mendez				
7	23	0.217	Gonzolez				
8	24	0.333	Deerberg				
9	25	0.160	Gomez				
10	28	0.321	Talisman				
11	30	0.300	Hardy				
12	36	0.139	Klorber				
13	41	0.390	Darvin				
14	43	0.186	King				
15	44	0.341	Nester				
16	51	0.333	Jackson				
17							

Figure 5 - Looking Up a Value to the Left

One solution is to use the LOOKUP function, which requires two range arguments. The following formula (in cell F3) returns the batting average from column B of the player name contained in the cell named LookupValue:

=LOOKUP(LookupValue,Players,Averages)

Using the LOOKUP function requires that the lookup range (in this case, the Players range) is in ascending order. In addition to this limitation, the formula suffers from a serious problem: If you enter a nonexistent player (in other words, the LookupValue cell contains a value not found in the Players range), the formula returns an incorrect result — and you won't even know it.

IFERROR

IFERROR was added to the function library with the 2007 release of Excel and serves as a "one stop shop" for users who build error trapping capabilities into their formulas, because it addresses errors of all types with just one function. In previous versions of Excel, you had to build error capture functionality into your formulas manually and therefore had to consider all the possible types of errors that could occur. With IFERROR, the formula will behave as directed, no matter what type of error is returned. The syntax for IFERROR is as follows.

IFERROR(original value or formula, value if error)

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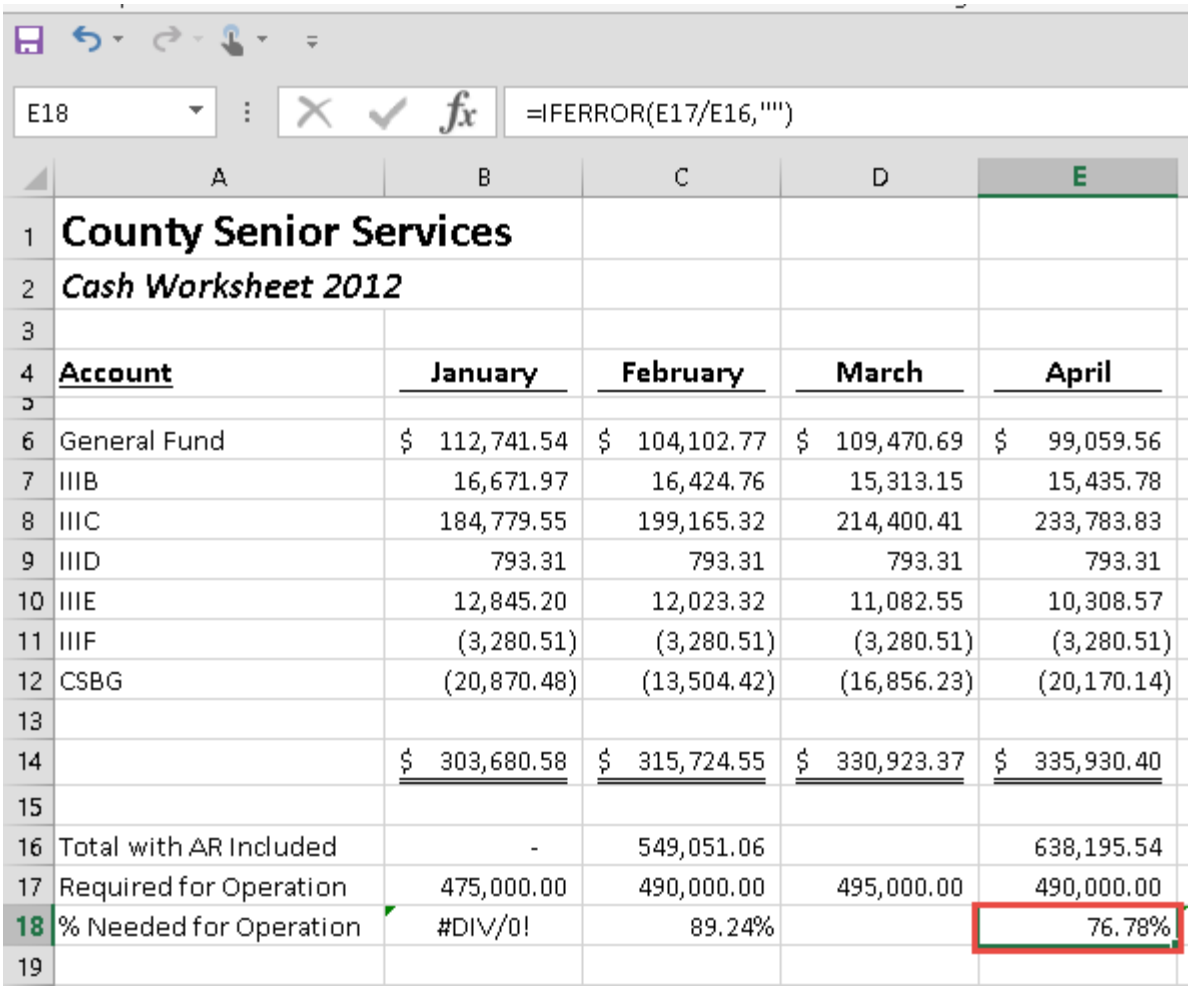
In this example, the formula in the **% Needed for Operation** row uses the IFERROR function to trap **#DIV/0** errors. Before IFERROR, users had to use an IF function to test whether the divisor was zero. Based on the test, the formula would then complete the division calculation or display some desired number, character, or text. The worksheet shown in **Figure 6** - Using IFERROR to Trap for All Errors illustrates the process of using IFERROR to trap errors.



	A	B	C	D	E
1	County Senior Services				
2	*Cash Worksheet 2012*				
3					
4	Account	January	February	March	April
5					
6	General Fund	$ 112,741.54	$ 104,102.77	$ 109,470.69	$ 99,059.56
7	IIIB	16,671.97	16,424.76	15,313.15	15,435.78
8	IIIC	184,779.55	199,165.32	214,400.41	233,783.83
9	IIID	793.31	793.31	793.31	793.31
10	IIIE	12,845.20	12,023.32	11,082.55	10,308.57
11	IIIF	(3,280.51)	(3,280.51)	(3,280.51)	(3,280.51)
12	CSBG	(20,870.48)	(13,504.42)	(16,856.23)	(20,170.14)
13					
14		$ 303,680.58	$ 315,724.55	$ 330,923.37	$ 335,930.40
15					
16	Total with AR Included	-	549,051.06		638,195.54
17	Required for Operation	475,000.00	490,000.00	495,000.00	490,000.00
18	% Needed for Operation	#DIV/0!	89.24%		76.78%
19					

Figure 6 - Using IFERROR to Trap for All Errors

If there is an error this formula returns a blank.

Another IFERROR Example

Here is the formula in cell D5 in the example below.

=IFERROR(VLOOKUP(C5,B13:F25,3,FALSE), "Item Not Found")

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The result of using IFERROR along with VLOOKUP is shown in **Figure 7**, along with a formula that returns an approximate match for comparative purposes.

D5 =IFERROR(VLOOKUP(C5,B13:F25,3,FALSE), "Item Not Found")

Inventory Lookup with IFERROR

		Description	Price	QOH	UM	
Enter Item Number	C004	Item Not Found				Using **FALSE** argumant with IFERROR
		Creme, Hand and Body, 16 oz	12.99	72	EA	Using no (**TRUE**) argumant

Column				
1	2	3	4	5
Item	**UM**	**Description**	**Unit Price**	**QOH**
C001	EA	Creme, Aloe Vera Hand, 9 oz	6.99	143
C002	EA	Creme, Extra Moisturizing Hand, 9 oz	7.49	109
C003	EA	Creme, Hand and Body, 16 oz	12.99	72
L001	EA	Lotion, Organic Body, 9 oz	7.99	68
L002	EA	Lotion, Organic Body, 16 oz	14.99	148
L003	EA	Lotion, Organic Body, 24 oz	21.99	106
L201	EA	Lotion, Extra Moisturizing Body, 9 oz	6.99	165
L202	EA	Lotion, Organic Hand and Body, 9 oz	8.49	138

Figure 7 - Results of Using IFERROR and VLOOKUP Together

Looking up a Value from Multiple Lookup Tables

You can, of course, have any number of lookup tables in a worksheet. In some situations, your formula may need to decide which lookup table to use. **Figure 8** - The Use of Multiple Lookup Tables shows an example.

D2 =VLOOKUP(C2,IF(B2<3,Table1,Table2),2)

Sales Rep	Years	Sales	Comm. Rate	Commission
Benson	2	120,000	7.00%	8,400
Davidson	1	210,921	7.00%	14,764
Ellison	1	100,000	7.00%	7,000
Gomez	2	87,401	6.00%	5,244
Hernandez	6	310,983	9.25%	28,766
Kelly	3	43,902	2.00%	878
Martin	2	121,021	7.00%	8,471
Oswald	3	908	2.00%	18
Reginald	1	0	1.50%	0
Veras	4	359,832	9.25%	33,284
Wilmington	4	502,983	10.00%	50,298

<3 Years Tenure	
Amt Sold	Rate
0	1.50%
5,000	3.25%
10,000	3.50%
20,000	5.00%
50,000	6.00%
100,000	7.00%
250,000	8.00%

3+ Years Tenure	
Amt Sold	Rate
0	2.00%
50,000	6.25%
100,000	7.25%
200,000	8.25%
300,000	9.25%
500,000	10.00%

Figure 8 - The Use of Multiple Lookup Tables

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This workbook calculates sales commission and contains two lookup tables: G3:H9 (named Table1) and J3:K8 (named Table2). The commission rate for a particular sales representative depends on two factors: the sales rep's years of service (column B) and the amount sold (column C). Column D contains formulas that look up the commission rate from the appropriate table. For example, the formula in cell D2 is:

=VLOOKUP(C2,IF(B2<3,Table1,Table2),2)

The second argument for the `VLOOKUP` function consists of an `IF` formula that uses the value in column B to determine which lookup table to use. The formula in column E simply multiplies the sales amount in column C by the commission rate in column D. The formula in cell E2, for example, is:

=C2*D2

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