

03 - Formulas and Functions

1. Formula Basics

A formula is an equation that you use to perform calculations.

A formula **returns** a **result**.

Sample

The formula: **= 1 + 1**

Returns: **2**

Formula Requirements

You can type a formula in a cell or in the Formula Bar

A formula always begins with an = sign.

You have to press the ENTER key to let Excel know you're finished typing a formula.

(Don't click on another cell to try and tell Excel you're finished typing a formula).

(Following the = Sign) Formulas Can Contain

Constants – (for example: **222, 46, NY, NY37**)

Basic Math Operators – (**+ - * /**)

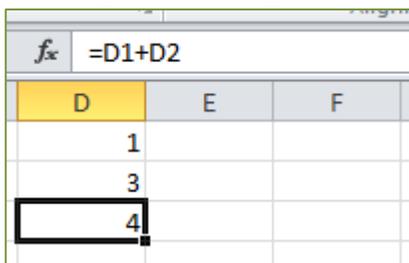
Cell Address(es) – (for example: **B12, C22**)

Parenthesis – (more on parenthesis below)

Functions – (for example: **=NOW()**)

2. Create a Workbook with Some Simple Formulas

Manually Create a Simple Formula



The screenshot shows an Excel spreadsheet with the following data:

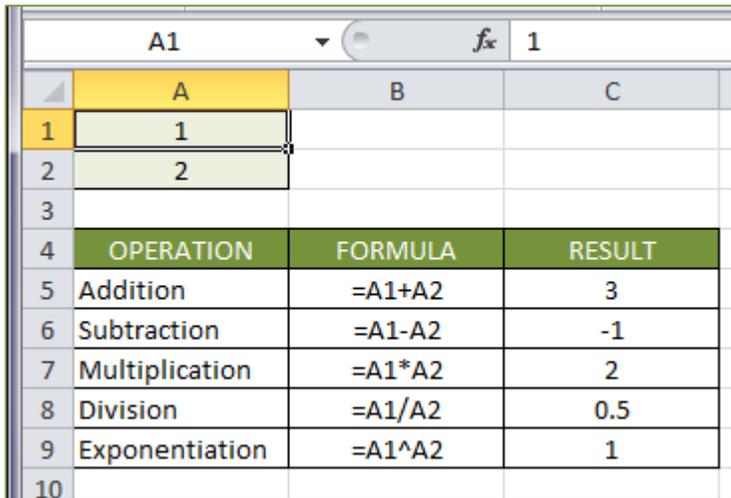
	D	E	F
1	1		
3	3		
4	4		

The formula bar at the top shows the formula **=D1+D2**.

Create Formulas by Pointing and Clicking

Remember – use the **Enter Key** to let Excel know the formula is finished. Don't click in another cell to try and tell Excel you've completed the formula – if Excel is still in edit mode (insertion point blinking in the Cell or Formula Bar) it will think you're still writing the formula.

Create the formulas in Column C by pointing and clicking.



The screenshot shows an Excel spreadsheet with columns A, B, and C. Column A contains the values 1 and 2. Column B contains formulas: =A1+A2, =A1-A2, =A1*A2, =A1/A2, and =A1^A2. Column C contains the corresponding results: 3, -1, 2, 0.5, and 1. The spreadsheet also shows a header row with 'OPERATION', 'FORMULA', and 'RESULT'.

	A	B	C
1	1		
2	2		
3			
4	OPERATION	FORMULA	RESULT
5	Addition	=A1+A2	3
6	Subtraction	=A1-A2	-1
7	Multiplication	=A1*A2	2
8	Division	=A1/A2	0.5
9	Exponentiation	=A1^A2	1
10			

3. Precedence

How to use parenthesis in formulas

Please Excuse My Dear Aunt Sally ([precedence.xlsx](#))

FORMULA	RESULT
=2+3*4	14
=(2+3*4)	14
=(2+3)*4	20
=2+(3*4)	14

4. Introduction to Functions

Functions

Use them to replace parts of more complicated formulas with an easy to use, built-in, formula. Excel has about 340 built-in functions available.

Sample

To find the average value of the contents of 4 cells use the AVERAGE function.

	A	B	C
1	1	$=(A1+A2+A3+A4)/4$	2.5
2	2	$=AVERAGE(A1,A2,A3,A4)$	2.5
3	3		
4	4		
5			

Syntax

Function syntax is always: FUNCTIONNAME()

Arguments

Sometimes functions have Arguments – information that the function uses to return the result

Examples

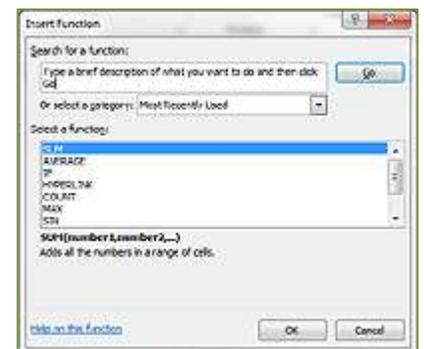
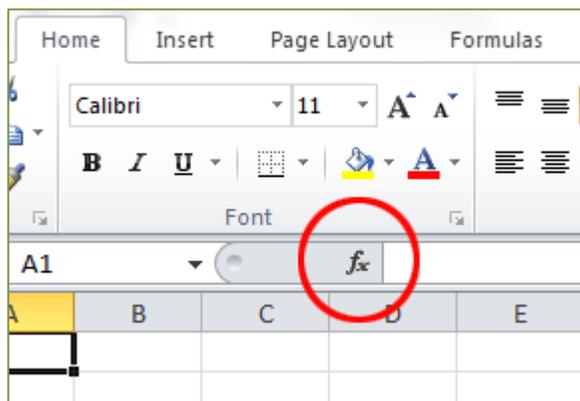
FUNCTION	NUMBER of ARGUMENTS	RESULT
$=PI()$	0	3.141592654
$=SQRT(9)$	1	3

Comparing a Formula and Function

A formula does not necessarily have to include any functions, or it can include many functions,

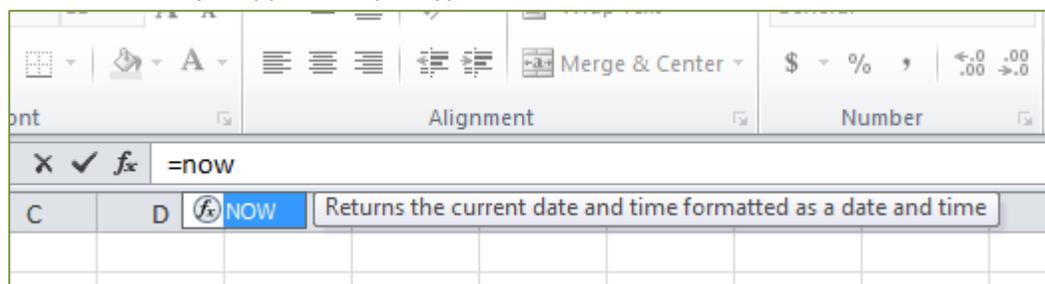
Function Help

Click the Function Button (fx)



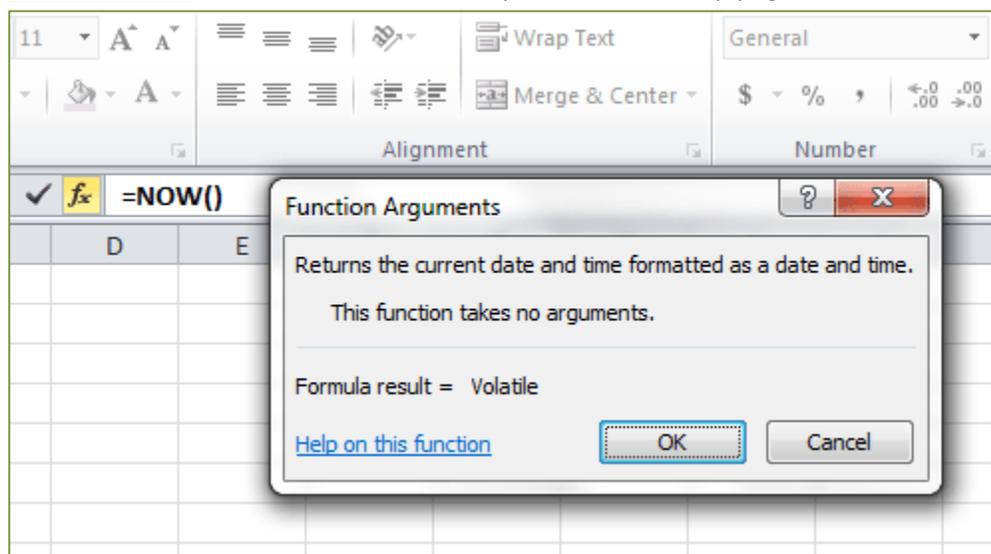
Opens the Insert Function dialog box and gives basic information about a function.

Function Tool Tip – appears as you type a function name in the Formula Bar



Function Arguments and Function Help Page

Click on the Function Button (fx) when the insertion point is blinking on a function name in the Formula Bar. This exposes the Function Arguments dialog box and includes a [Help on this function](#) link. Click on the link to open a detailed help page for that function.



5. Some Simple Excel Functions – Illustrating Arguments

Function Parts Review

FUNCTIONNAME(argument(s))

Functions with No Arguments - Examples

=PI()

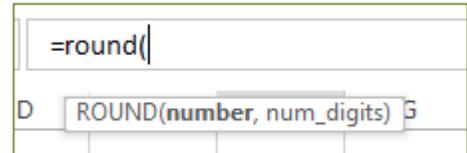
=NOW()

Functions with One Argument - Examples

=SQRT(*number*)
=INT(*number*)
=ABS(*number*)
=ROMAN(*number*)

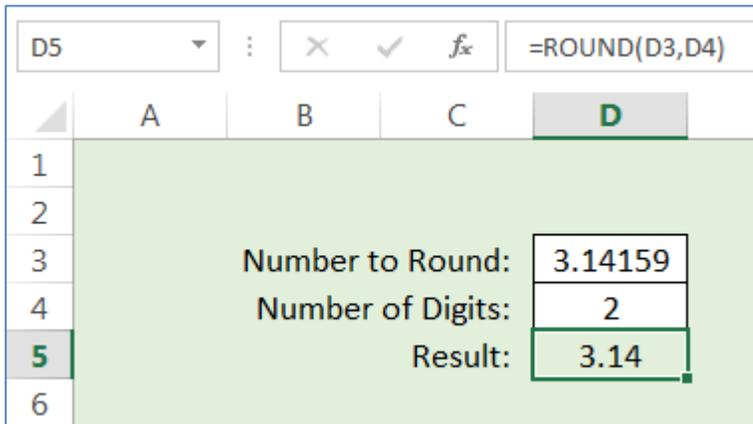
Function with Two Arguments – Examples

=ROUND(*number*, *num_digits*)
=MOD(*number*, *divisor*)

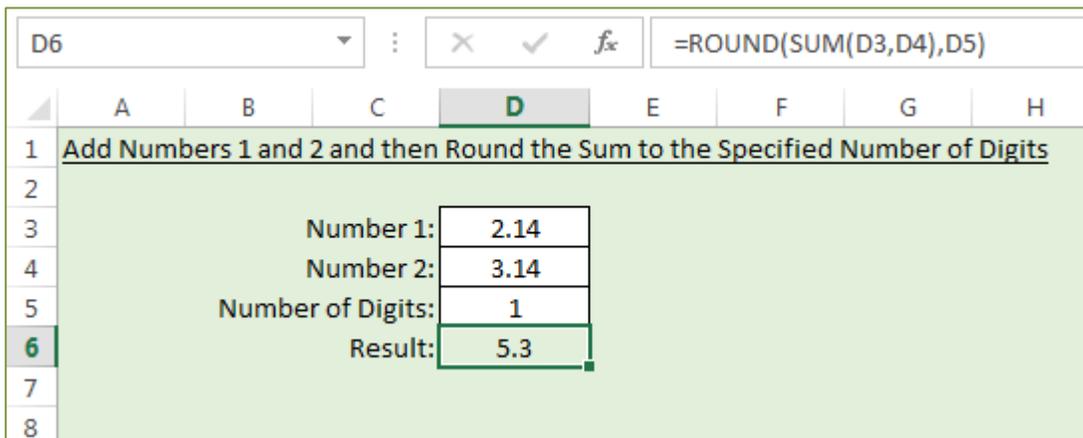


6. More on Function Arguments

Using a Cell Reference as an Argument – use ROUND



Using a Function as an Argument (Nesting)



7. Cell References and Ranges

Terminology

A cell reference is that cell's address (the reference refers to that cell's address)

A range is a reference to one or more (contiguous or non-contiguous) cells

Punctuation

Comma – use a comma to refer to separate non-contiguous (or contiguous) cells

The screenshot shows an Excel spreadsheet with the following data in column A:

	A	B	C	D	E	F
1	5					
2						
3	10					
4						
5	20					
6						
7	35					
8						

The formula bar shows the formula `=SUM(A1,A3,A5)`. A red arrow points from the formula bar to cell D7.

Colon – use a colon to refer to a range of contiguous cells

Create the row 9 formulas – manually and by pointing, clicking, and dragging

The screenshot shows an Excel spreadsheet with the following data:

	A	B	C	D	E	F
1	Open Book New York/Office of the State Comptroller					
2	Thomas P. DiNapoli, State Comptroller					
3	Trend Report for City of Saratoga Springs					
4						
5	Expenditures	2009	2008	2007	2006	2005
6	Public Safety	13,506,611	13,498,748	12,794,466	11,686,319	11,095,667
7	Employee Benefits	9,890,970	9,485,981	8,964,143	9,464,911	8,660,225
8	Other	30,439,789	28,621,574	25,314,715	26,194,248	26,715,678
9	Total	53,837,370				
10						

The formula bar shows the formula `=SUM(B6:B8)`. A red arrow points from the formula bar to cell B9.

Combination of Comma(s) and Colon(s)

Calculate the total of the Public Safety and Other expenses from 2009 and 2007

Cell Addresses from Multiple Worksheets

([movie_ranks_summary.xlsx](#))

Syntax – 'SHEETNAME'!CELLADDRESS

The screenshot shows an Excel spreadsheet with the following data:

Year	Total Gross	Total Theaters
2005	\$7,697,503,356	
2006		
2007		
2008		
2009		
2010		
TOTALS	\$7,697,503,356	0

The formula bar at the top shows the formula `=2005!D102`. A red arrow points from the formula bar to cell C4 in the spreadsheet, which contains the value \$7,697,503,356.

8. AutoFill, Part II

Using Autofill with Cells That Have Formulas

Calculate the average Floor Height of all the skyscrapers and use the AutoFill handle

HEIGHT (ft)	Floors	Built	Floor Height
2717	163	2010	16.7
1971	95	2011	
1670	101	2004	
1614	101	2008	

In this example I formatted the borders, top row colors, and the decimal places showing in column G

9. Absolute versus Relative References

Using the \$ character to keep the reference to cell C14 absolute

The screenshot shows an Excel spreadsheet titled "New Windows Estimates". The formula bar at the top displays the formula `=C$14*G4`. A red arrow points to the `$14` part of the formula, indicating that the row reference is absolute. The spreadsheet contains two tables:

Floor	Windows	Number
1	Living Room	5
1	Dining Room	2
1	Play Room	3
1	Kitchen	2
1	Pantry	1
1	Bathroom	1
2	Bedroom	2
2	Bedroom	2
2	Bedroom	2
2	Bathroom	1
Total		21

Contractor	Cost Per Window	Total Cost
Marvin Windows and Doors	224.50	4,714.50
Bartlett Enterprises, Inc.	198.75	
Sears Home Improvement	219.20	
Window World	176.78	
Pella Windows and Doors	257.88	

Copying and Pasting Formulas

Instead of dragging a formula, you can copy and paste it

Complete the row 9 total formulas by copying and pasting

The screenshot shows an Excel spreadsheet with a formula bar displaying `=SUM(B6:B8)`. The spreadsheet contains the following data:

Expenditures	2009	2008	2007	2006	2005
Public Safety	13,506,611	13,498,748	12,794,466	11,686,319	11,095,667
Employee Benefits	9,890,970	9,485,981	8,964,143	9,464,911	8,660,225
Other	30,439,789	28,621,574	25,314,715	26,194,248	26,715,678
Total	53,837,370				

10. Using Names

Creating a Named Range

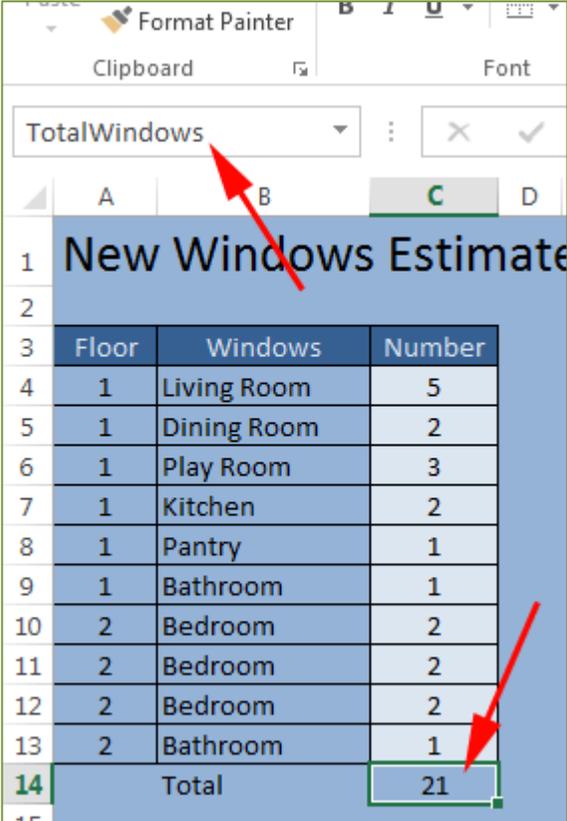
Using a Named Range in Calculations

Viewing and Editing Named Ranges

Formulas tab

Defined Names group

Name Manager



The screenshot shows an Excel spreadsheet titled "New Windows Estimate". The spreadsheet has columns A, B, and C. Row 3 is the header row with columns "Floor", "Windows", and "Number". Rows 4-13 list various rooms and their window counts. Row 14 is a summary row with "Total" in column B and "21" in column C. A red arrow points to the "TotalWindows" dropdown menu in the formula bar, and another red arrow points to the cell containing "21" in row 14, column C.

	A	B	C	D
1	New Windows Estimate			
2				
3	Floor	Windows	Number	
4	1	Living Room	5	
5	1	Dining Room	2	
6	1	Play Room	3	
7	1	Kitchen	2	
8	1	Pantry	1	
9	1	Bathroom	1	
10	2	Bedroom	2	
11	2	Bedroom	2	
12	2	Bedroom	2	
13	2	Bathroom	1	
14		Total	21	
15				

Advantages of using named ranges

Makes formulas easier to understand and maintain

No absolute/relative reference problems

Names display in formula auto complete dropdown (don't have to type entire name)

11. Statistical Functions

Statistical Functions – SUM(), AVERAGE(), MEDIAN(), MODE(), MAX(), MIN()

	A	B	C	D	E
1	Grammy Award Ceremony Locations, televised era (1971 - 2014)				
2	Venue	Number			
3	Felt Forum	1		Sum	44
4	Hollywood Palladium	4		Average	5.5
5	Madison Square Garden	2		Median	3
6	Radio City Music Hall	5		Mode	1
7	Shrine Auditorium	16		Max	16
8	Staples Center	14		Min	1
9	Tennessee Theatre	1			
10	Uris Theater	1			
11					

The syntax for all these statistical formulas is the same.

In the example above, the formula for cell E4 could be either of these:

=AVERAGE(B3, B4, B5, B6, B7, B8, B9, B10)

=AVERAGE(B3:B10)

Using Statistical Functions with Named Ranges

Using named ranges can make it easier to work with statistical functions

Apply named ranges to Superbowl data, for example create named ranges and then compute:

Average winning score

Maximum winning margin

Using AVERAGE, Blank Cells versus Zeros

	A	B
1	1	1
2		0
3	2	2
4		0
5	3	3
6	2	1.2
7	Average	

12. Date Functions

Formatting a Date

How Excel Interprets a Date (number of days from 1/1/1900 – which is day number 1)

Custom Date Formatting Shorthand (Format Cells/Number tab/Custom)

Characters you can use for a custom date format: [space], [comma], /, m, d, y

Example: `mmm yy` would display the date 3/12/2014 as **Mar 14**

For m, d, y – can use (for example): m, mm, mmm, mmmm

See `date_shorthand.xlsx`

Date Math

Add or Subtract Dates (example - project start date and end date)

The NOW() Function

Write a formula to calculate your age, in years

Time Math

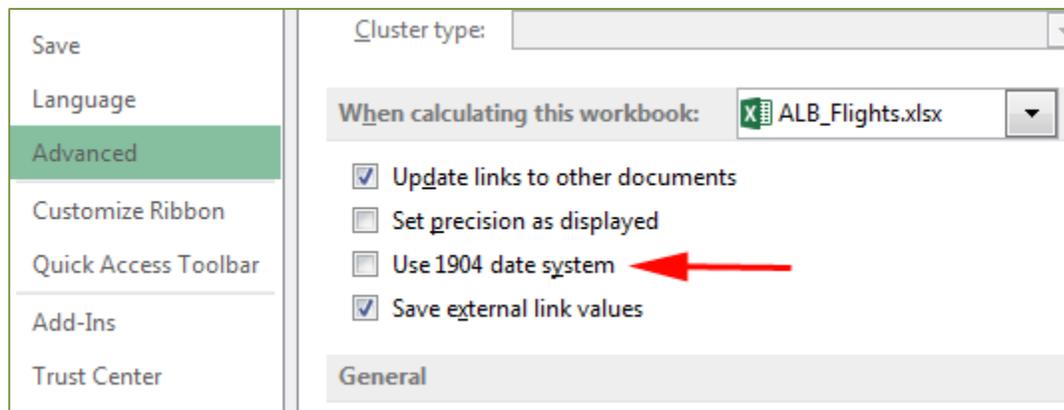
(`ALB_Flights.xlsx`)

The 1900 Date System cannot handle negative time values.

	A	B	C	D	E	F	G	H
	Carrier Code	Date	Flight Number	Tail Number	Destination Airport	Scheduled Departure Time	Actual Departure Time	Difference
1								
2	US	1/1/2009	1411	N529AU	CLT	8:30	8:26	0:04
3	US	1/1/2009	1439	N516AU	CLT	14:40	14:46	#####
4	US	1/1/2009	1611	N963UW	CLT	18:55	19:02	#####
5	US	1/1/2009	1853	N962UW	PHL	18:33	18:20	0:13
6	US	1/2/2009	1411	N444US	CLT	8:30	8:30	0:00
7	US	1/2/2009	1439	N533AU	CLT	14:40	15:53	#####

Date Systems (1/1/1900 vs. 1/1/1904)

Options/Advanced/When calculating this workbook:



Other Date Functions

DATE

fx =date(
D	E	F	G	H	I	J
	Year	Month	Day	Date		
	1972	2	22	=date(
				DATE(year, month, day)		

DAY, MONTH, YEAR

fx =day(
E	F	G	H	I
Date	Year	Month	Day	
2/22/72	1972	2	=day(
			DAY(serial_number)	

WEEKDAY (note – includes an optional argument)

fx =weekday(E2,						
E	F	G	H	I	J	K
DATE	DAY OF WEEK					
5/10/1980	=weekday(E2,					
	WEEKDAY(serial_number, [return_type])					
	1 - Numbers 1 (Sunday) through 7 (Saturday)					
	2 - Numbers 1 (Monday) through 7 (Sunday)					
	3 - Numbers 0 (Monday) through 6 (Sunday)					
	11 - Numbers 1 (Monday) through 7 (Sunday)					
	12 - Numbers 1 (Tuesday) through 7 (Monday)					
	13 - Numbers 1 (Wednesday) through 7 (Tuesday)					
	14 - Numbers 1 (Thursday) through 7 (Wednesday)					
	15 - Numbers 1 (Friday) through 7 (Thursday)					
	16 - Numbers 1 (Saturday) through 7 (Friday)					
	17 - Numbers 1 (Sunday) through 7 (Saturday)					

13. PMT – a Financial Function

Using the PMT Function

fx		=PMT(F2%/12,F3,-F1)	
		PMT(rate, nper, pv, [fv], [type])	
Loan Amount:			20,000
Annual Interest Rate:			2.5
Term in Months:			120
Monthly Payment:		=PMT(F2%/12,F3,-	

14. IF

Using IF to Evaluate a Condition

C4		fx		=IF(INT((NOW()-C3)/365)<16,"Child","Adult")					
	A	B	C	D	E	F	G	H	I
1	Admission Fee Calculator								
2									
3	Enter Date of Birth:	2/22/2013			Fee Schedule				
4	Admission Type:	Child			child	\$5.00			
5	Admission Fee:	\$5.00			adult	\$10.00			
6									

Nested IF

C5		fx		=IF(C3<10001,C3*F4,IF(C3>20000,C3*F6,C3*F5))				
	A	B	C	D	E	F	G	H
1	Commission Structure							
2								
3	Sale Price:	30,000			Commission Schedule			
4					0 - 10,000	5%		
5	Commission Paid:	6,000.00			10,001 - 20,000	10%		
6					20,001 +	20%		
7								

15. VLOOKUP

Using VLOOKUP to Evaluate Many Conditions

([grade_array.xlsx](#))

E2									
=VLOOKUP(D2,scores,2)									
	A	B	C	D	E	F	G	H	I
1	StudentID	Student First	Student Last	Score	Grade			Score Array	
2	NW92486	Kathy	Reed	85.8	B+			0	F
3	NW135187	Jeffrey	Tucker	98.5				65	D
4	NW77939	Nick	Hill	70.5				70	C-
5	NW117042	Arletta	Glode	74.8				75	C
6	NW79402	Holly	Brimmer	75.4				77	C+
7	NW88216	Michelle	Brust	70.1				80	B-
8	NW98764	Angela	Wilson	57.6				82	B
9	NW134238	Jerri	Raga	74.7				85	B+
10	NW58914	Shawn	Harrington	77.7				90	A-
11	NW79022	Jenna	Morse	52.0				95	A
12	NW32191	Daniel	Sawn	51.6					

16. Text Functions

Case

UPPER(), LOWER(), PROPER()

Concatenate

CONCATENATE, &

([senators.xlsx](#))

E2					
=B2 & " " & A2 & " (" & C2 & "-" & D2 & ")"					
	A	B	C	D	E
1	LAST	FIRST	PARTY	STATE	SUMMARY
2	Akaka	Daniel K.	D	HI	Daniel K. Akaka (D-HI)
3	Alexander	Lamar	R	TN	
4	Ayotte	Kelly	R	NH	

Extract

RIGHT(), LEFT()

SEARCH(), LEN()

MID()

(nys_reps.xlsx)

Sample 1

E2		: X ✓ fx		=LEFT(B2,SEARCH(", ",B2)-1)	
	A	B	C	D	E
1	District	Name	Party	FIRST	LAST
2	1	Bishop, Timothy	D	Timothy	Bishop
3	2	Israel, Steve	D	Steve	Israel
4	3	King, Pete	R	Pete	King

Sample 2

D2		: X ✓ fx		=RIGHT(B2,LEN(B2) -SEARCH(", ",B2)-1)	
	A	B	C	D	E
1	District	Name	Party	FIRST	LAST
2	1	Bishop, Timothy	D	Timothy	
3	2	Israel, Steve	D	Steve	
4	3	King, Pete	R	Pete	

17. Errors

Warnings - Possible errors (green triangle)

Saratoga expenditures – message about not including all cells with numbers

4			
5	Expenditures	2009	2008
6	Public Safety	13,506,611	13,498
7	Employee Benefits	9,890,970	9,485
8	Other	30,439,789	28,621
9	Total	53,837,370	51,606
10			
11			
12			
13			
14			
15			
16			
17			
18			

Formula Omits Adjacent Cells
Update Formula to Include Cells
Help on this error
Ignore Error
Edit in Formula Bar
Error Checking Options...

Common Error Warnings

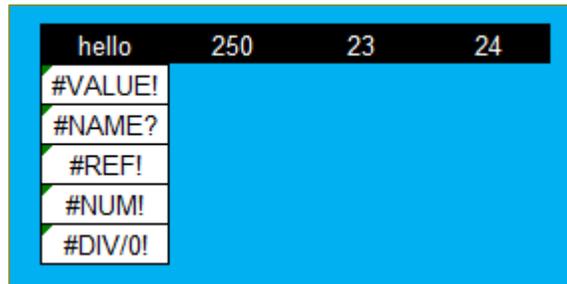
- Number formatted as text
- Formula omits adjacent cells

Ignoring warnings

- Select, right-click, choose Ignore Error

Error Message - Definite errors –

see [errors.xlsx](#) spreadsheet



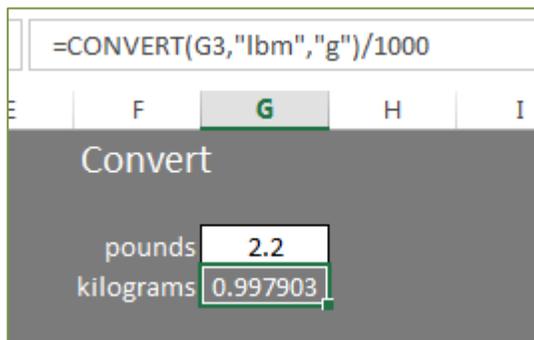
Handling Errors

IFERROR(value, value_if_error)

18. – CONVERT – a Conversion Function

Using Excel's CONVERT Function - CONVERT(number,from_unit,to_unit)

Note – when you type the formula a popup menu will display with unit choices



19. Other Formula Topics

Paste Values

E2 : ✕ ✓ fx =CONVERT(D2,"ft","m")

	A	B	C	D	E
1	Building	City	Country	HEIGHT (ft)	HEIGHT (m)
2	Burj Khalifa	Dubai	UAE	2,717	828
3	Abraj Al-Bait Towers	Mecca	KSA	1,971	601
4	Taipei 101	Taipei	Taiwan	1,670	509
5	Shanghai World Financial Center	Shanghai	China	1,614	492

D2 : ✕ ✓ fx =CONVERT(#REF!,"ft","m")

	A	B	C	D
1	Building	City	Country	HEIGHT (m)
2	Burj Khalifa	Dubai	UAE	#REF!
3	Abraj Al-Bait Towers	Mecca	KSA	#REF!
4	Taipei 101	Taipei	Taiwan	#REF!
5	Shanghai World Financial Center	Shanghai	China	#REF!

Transposing

	A	B	C
1	Year	Total Gross	Total Theaters
2	2005	7,697,503,356	288,191
3	2006	7,886,480,093	294,117
4	2007	8,509,635,974	285,635
5	2008	8,522,863,503	295,807
6	2009	9,856,086,040	294,998
7	2010	9,292,840,746	311,071

	A	B	C	D	E	F	G
1	Year	2005	2006	2007	2008	2009	2010
2	Total Gross	7,697,503,356	7,886,480,093	8,509,635,974	8,522,863,503	9,856,086,040	9,292,840,746
3	Total Theaters	288,191	294,117	285,635	295,807	294,998	311,071

Using Goal Seeker

The image shows an Excel spreadsheet with the following data:

	A	B	C	D	E	F	G
1	Using Excel as a Monthly Payment Calculator						
2							
3		Interest Rate (Annual):			2.50%		
4		Term (months):			120		
5		Loan Amount:			20,000		
6							
7		Monthly Payment:			\$188.54		

The formula bar for cell E7 shows: $=PMT(E3/12,E4,-E5)$

Data tab/Data Tools group/What-If Analysis drop down/Goal Seek

The Goal Seek dialog box is shown with the following settings:

- Set cell: E7
- To value: 151
- By changing cell: \$E\$4

Buttons: OK, Cancel

The image shows the Excel spreadsheet after the Goal Seek operation. The monthly payment in cell E7 is now \$151.00. The formula bar still shows $=PMT(E3/12,E4,-E5)$.

	A	B	C	D	E	F	G	H	I	J
1	Using Excel as a Monthly Payment Calculator									
2										
3		Interest Rate (Annual):			2.50%					
4		Term (months):			155.1429749					
5		Loan Amount:			20,000					
6										
7		Monthly Payment:			\$151.00					
8										
9										
10										

The Goal Seek Status dialog box is shown with the following information:

- Goal Seeking with Cell E7 found a solution.
- Target value: 151
- Current value: \$151.00

Buttons: Step, Pause, OK, Cancel

20. Applying Excel Formula Concepts

Calculate the Entire Time of an Album

	A	B	C	D	E
1	U2, The Joshua Tree				
2					
3		Track_Number	Track_Name	Track_Minutes	Track_Seconds
4		1	Where the Streets Have No Name	5	38
5		2	I Still Haven't Found What I'm Looking For	4	38
6		3	With or Without You	4	56
7		4	Bullet the Blue Sky	4	32
8		5	Running to Stand Still	4	18
9		6	Red Hill Mining Town	4	54
10		7	In God's Country	2	57
11		8	Trip Through Your Wires	3	33
12		9	One Tree Hill	5	23
13		10	Exit	4	13
14		11	Mothers of the Disappeared	5	12
15					
16				Total Time:	
17					

Total Time:	50:14
-------------	-------