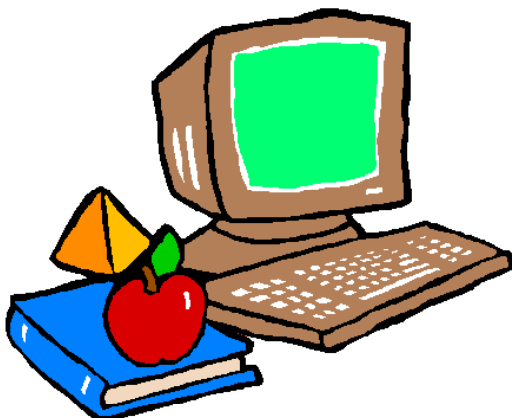


Spreadsheet Strategies

Applications and Ideas for High School Mathematics



Mathematics Education Students and Faculty
Wake Forest University
Fall, 2003

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<http://www.wfu.edu/~mccoy/spreadsheet.pdf/>

Questions or Comments: **mccoy@wfu.edu**

Level/Course: Algebra I

Solving problems using an algebraic formula is a common topic throughout the algebra curriculum. Once teachers and students master the syntax of entering equations in the spreadsheet, it becomes a useful tool for many topics. This particular application illustrates the Quadratic Formula.

Objectives: Students use the spreadsheet to solve a quadratic equation by the quadratic formula.

Activities:

In each cell of the spreadsheet, there are three options for data entry: numbers entered are treated as numbers, an entry preceded by the equal sign is a formula, and an entry preceded by a quotation mark is a label. When entering a formula, the data in other cells may be referenced by name A1, A2, etc. or by clicking in that cell to input it. A cell referenced by A4 is considered relative, and in the next row, it would use B4. To keep a value absolute (not dynamic), use the dollar sign. A\$4\$ would always use the value of A4. Or A\$4 would use the value of A4 or A5, etc. A large number of functions (including math and statistical functions) are built into the program, and may be accessed from Insert-Function.

The following example solves equations with the quadratic formula.

"Solving Equations by the Quadratic Formula"			
For equations of the form: $ax^2 + bx + c = 0$			
Given:	$x^2 - 5x + 3 = 0$	a =	1
		b =	-5
		c =	3
Solution1:	6.8028	"((-H9)+SQRT((H9^2)-4*H8*H10))/(2*H8))"	
Solution2:	3.1972	"((-H9)-SQRT((H9^2)-4*H8*H10))/(2*H8))"	
	<input type="text"/>		

Assessment:

- Classwork and homework

Level/Course: Algebra 3/ Trigonometry: This lesson can be modified to fit any course or level by changing the problems and answers.

Objective: Students will solve problems and be able to check their answers.

Activity:

Solve problems (first column) on a scrap sheet of paper, and then type in the answer in the cell next to the question (second column). Press enter. If the answer is right, then “Correct” will show up in the third column. Work all problems until they are all Correct.

Example:

	Problem	Answer	
	Find the Amplitude		
1	y=3sinx	3	Correct
2	y=-2cosx	2	Correct
	Find the Period		
3	y=cos3x	25	
4	y=tan2x	90	Correct
5	y=sec2x	72	

Example 2:(The numbers in black are the answers to the problem)

	Problem	Answer	
	Find the Amplitude		
1	y=3sinx		=IF(C3=3,"Correct", " ")
2	y=-2cosx		=IF(C4=2,"Correct", " ")
	Find the Period		
3	y=cos3x		=IF(C6=120,"Correct", " ")
4	y=tan2x		=IF(C7=90,"Correct", " ")
5	y=sec2x		=IF(C8=180,"Correct", " ")

Assessment:

This use of a spreadsheet for practice with immediate feedback is an efficient and effective means of assessment.

Level/Course: Geometry

This lesson fits with convex regular polygons. Learning how to compute and find relationships between interior, exterior, and central angles is a major concept in Geometry. It could also be used when starting the concepts dealing with apothems of regular polygons. This lesson is designed for students to see the relationships between these different angles.

Objectives:

Given the number of sides on a regular polygon, students will describe relationships seen between angles.

Activities:

Enter the number of sides on a regular polygon and see how the angles relate. Excel will display the interior, exterior, sum of interior, and central angles of that polygon.

Excel Steps:

1. Enter table containing number of sides.
2. Program cells that correspond with each measurement.
 Example (when A10 is the number of sides):
 1 interior angle, $=((A10-2)*180)/A10$
3. Finish

Sample Output:

<i>Number of side, n</i>	<i>1 interior angle</i>	<i>1 exterior angle</i>	<i>total sum of interior angles</i>	<i>1 central angle</i>
3	60	120	180	120
4	90	90	360	90
5	108	72	540	72
6	120	60	720	60
7	128.57143	51.428571	900	51.428571

Assessment:

- Individual classwork and homework.
- Provided worksheet.
- Use chart for prediction.
- Writing exercise involving relationships of angles.

Angles in Regular Polygons Worksheet

Name: _____

Date: _____

1. What is always true about the relationship between 1 exterior angle and 1 interior angle?

2. As 1 interior angle gets bigger what happens to the exterior angle?

3. As the number of sides change, how does the total sum of the interior angles change?

4. What is the relationship between 1 interior and 1 exterior angle to the total sum of interior angles?

5. What is the relationship between 1 interior angle and a central angle?

6. What is the relationship between 1 exterior angle and a central angle?

7. As the number of sides increase, what happens to each interior angle?

Level/Course: Discrete Mathematics

Objective: To solve problems involving permutations and combinations

There are some situations involving choices where the order in which those choices are made is important. There also situations where the order is not important.

To find the number of ways n elements can be arranged *in order* we use permutation. A way to help your students to remember that order matters for permutations is the example of phone numbers, 555-2163 and 555-2136 are not the same and it matters the order you dial the number. Combinations are counting problems where order does not matter. The use of card games can help students remember combinations since the order the cards are dealt does not change the “hand”.

Activity: Compute Combination: ${}_{10}C_2$

Excel Steps:

1. Highlight a cell. (A1)
2. Type in: = **combin(10,2)**
3. Enter

Activity: Compute Permutation: ${}_{10}P_2$

Excel Steps:

1. Highlight a cell. (B1)
2. Type in: = **permut(10,2)**
3. Enter

Activity: Compute Factorial: $8!$

Excel Steps:

1. Highlight a cell. (C1)
2. Type in: = **fact(8)**
3. Enter

Level/Course: Algebra I or II

The topic of graphing quadratic equations is covered in Algebra I and Algebra II, but similar procedures using spreadsheets to examine functions and their graphs could be used in more depth in Algebra II.

Objectives: Given a parabolic function, students will be able to predict features of the graph based on the sign of the leading coefficient and the value of the constant. Students will understand the graphic effect of changing the coefficient of x^2 , the coefficient of x , or the constant.

Activities:

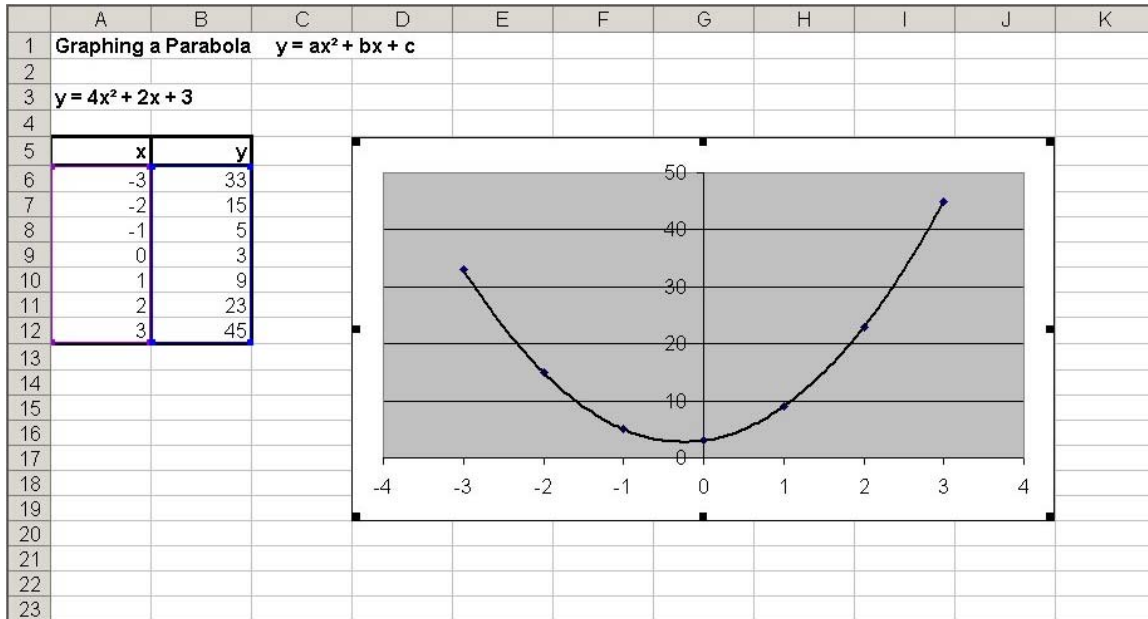
Enter the x-values and the function, allowing Excel to compute the y-values. Create an xy-scatter plot and add a trendline to display a graph of the parabola. Change various signs and values throughout the function to observe the resulting changes in the graph.

Excel Steps:

1. Enter x-values
2. Enter the function and direct it to fill in the y-value in the appropriate cell (ex. If the first x-value is in cell A6, the function $y = 4x^2 + 2x + 3$ would be entered in cell B6 as follows: $=4*(A6^2)+2*A6+3$)
3. Fill in the remaining cells in column B to compute the other y-values (the function in B6 can be dragged into the other cells so *Excel* changes the formula to fill in A7, A8, etc.)
4. Choose Chart
5. Select XY (scatter)
6. Finish
7. Chart – Add trendline – (Select polynomial of order 2)

Graphing Parabolas, Part 2

Sample Output:



Assessment:

- Students will graph parabolas without any graphing technology based on the features of the function discussed
- Students will enter functions into spreadsheets and create graphs to check the graphs they created

Level/Course: Algebra I

Linear regression is easily accomplished in a spreadsheet in a multiple representation format. The data are entered in a table, and the program presents a graphical and algebraic representation. The same method works equally well for curve fitting in nonlinear functions.

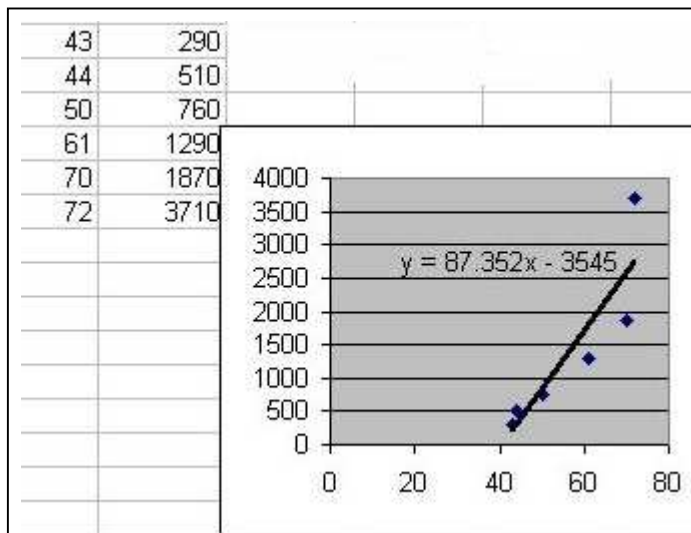
Objectives: Given a set of ordered pairs, students will graph the points, plot a least-squares regression line, and give the equation of the line.

Activities:

Enter the set of data points, plot them, and then plot a line of best-fit, called a trendline. Excel will draw the least-squares regression line and give its equation.

Excel Steps:

1. Enter x and y data
2. Highlight data
3. Choose Chart
4. Select XY(scatter)
5. Finish
6. Chart - Add trendline - (Select Linear)
7. Options - Display equation on chart.

Sample Output:**Assessment:**

- Individual classwork and homework
- Group Projects with real-world data
- Use of the regression equation for prediction
- Writing exercises involving description of process and reflection on its use

Level/Course: Algebra II

This activity could be used at the introduction of a unit on matrix operations. Working as a class or in groups, students could explore how these operations work.

Objectives: Given a matrix, students will learn how to find the scalar multiple and determinant of the matrix. With a pair or matrices, students will learn how to multiply them.

Activities:*Multiplication by a Scalar*

Enter the matrix data and the appropriate equation. Excel will calculate the matrix's scalar multiple for a given scalar.

Excel Steps:

1. Enter matrix as it appears in question
2. Several columns over, highlight empty cells the same size as the original matrix
3. Where s is the scalar value, type =s* then highlight the original matrix and the cell values of the original matrix will appear in the equation
4. Press Ctrl-Shift-Enter to finish

Sample of Procedure:

	A	B	C	D
1				
2	3	5		=2*A2:B3
3	7	9		

Finding the Determinant

Enter the matrix data and `mdeterm(array)`, the Excel equation for determinants, then Excel will calculate the determinant of the matrix.

Excel Steps:

1. Enter matrix as it appears in the question
2. Several columns over, in an empty cell, type =mdeterm(
3. Highlight the original matrix
4. Type) to close the parentheses
5. Press Enter or Return to finish

Matrix Operations, Part 2

Sample of Procedure:

	A	B	C	D	E
1					
2		3	5	=mdeterm(A2:B3	
3		7	9	MDETERM(array)	
4					

Matrix Multiplication

Enter the data for the two matrices then use Excel equation `mmult(array1,array2)` to multiply the two matrices.

Excel Steps:

1. Enter first matrix as it appears in the question
2. Several columns over, enter the second matrix
3. Highlight empty cells in the size of the resulting matrix
4. While still highlighted, in one cell type `=mmult(`
5. Highlight the first matrix
6. Place a comma after the array numbers of the first matrix
7. Highlight the second matrix and end with a parentheses
8. Press Ctrl-Shift-Enter to finish

Sample of Procedure:

	A	B	C	D	E
1					
2		3	5	6	10
3		7	9	14	18
4					
5				=mmult(A2:B3,D2:E3	
6				MMULT(array1, array2)	

Assessment:

- Group project exploring the algebra behind matrix operations
- Using *Excel* to perform matrix operations
- Individual class work and homework
- Writing exercises describing discoveries about how matrix operations work

Matrix Operations Worksheet

Using *Excel*, follow the directions provided in class to perform the following matrix operations:

Multiplication by a scalar:

1) $2 \times \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} =$

2) $12 \times \begin{bmatrix} 3 \\ 5 \end{bmatrix} =$

3) $3 \times \begin{bmatrix} 1 & 2 & 1 \\ 2 & 1 & 3 \\ 1 & 3 & 1 \end{bmatrix} =$

4) $2 \times \begin{bmatrix} 3 & 5 & 6 \\ 2 & 4 & 3 \\ 7 & 9 & 10 \end{bmatrix} =$

- 5) How is the solution matrix related to the original matrix in the problem? What patterns do you see?

Finding the Determinant:

1) $\det\left(\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}\right) =$

2) $\det\left(\begin{bmatrix} 3 \\ 5 \end{bmatrix}\right) =$

3) $\det\left(\begin{bmatrix} 1 & 2 & 1 \\ 2 & 1 & 3 \\ 1 & 3 & 1 \end{bmatrix}\right) =$

4) $\det\left(\begin{bmatrix} 3 & 5 & 6 \\ 2 & 4 & 3 \\ 7 & 9 & 10 \end{bmatrix}\right) =$

- 5) What patterns do you see in how the determinant relates to its' matrix?
How is the answer for the determinant for the matrix in problem 2 different?
What can you conclude from that?

Matrix Multiplication:

1) $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} \times \begin{bmatrix} 3 \\ 5 \end{bmatrix} =$

2) $\begin{bmatrix} 1 & 1 & 1 \\ 2 & 2 & 2 \\ 3 & 3 & 3 \end{bmatrix} \times \begin{bmatrix} 2 & 3 & 4 \\ 2 & 3 & 4 \\ 2 & 3 & 4 \end{bmatrix} =$

- 2) What patterns do you see in how the solution relates to the two original matrices in the problem 1? How about in problem 2? Can you combine your ideas to make a general statement for how to multiply any matrices?

Level/Course: Pre-Algebra, Algebra

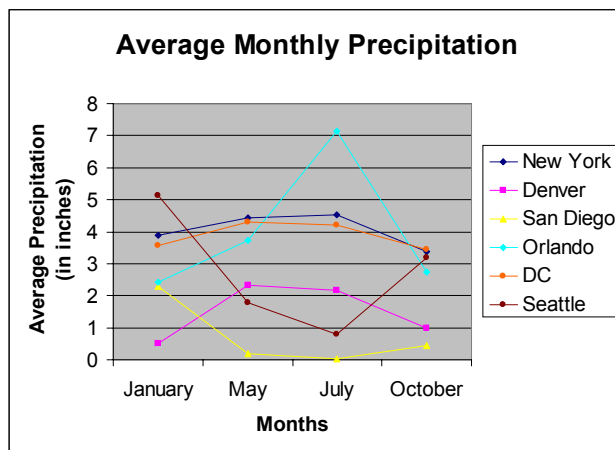
This activity should be completed by students so that they can see how real-world information/data can be put into graphs. This exercise is helpful because it allows students not only to see and use real-world data and how it pertains to them, but students are also able to utilize their statistical skills to interpret the information from those graphs.

Objectives: Given a table of information and data, students will interpret the given information and put in into a table. Then, students will be able to put this information into any type of graph. These graphs help the students interpret the data and also to make conclusions about the given information.

Activities: Gather data from a certain source (i.e. the Internet) and make a table organizing the data. Then, plot the data onto a graph. Excel will make the graph with various colors, appropriate titles, and a key to help understand the graph.

Sample Output:

Months	New York	Denver	San Diego	Orlando	DC	Seattle
January	3.88	0.51	2.28	2.43	3.57	5.13
May	4.43	2.32	0.2	3.74	4.29	1.78
July	4.53	2.16	0.03	7.15	4.21	0.79
October	3.39	0.99	0.44	2.73	3.43	3.19



Assessment:

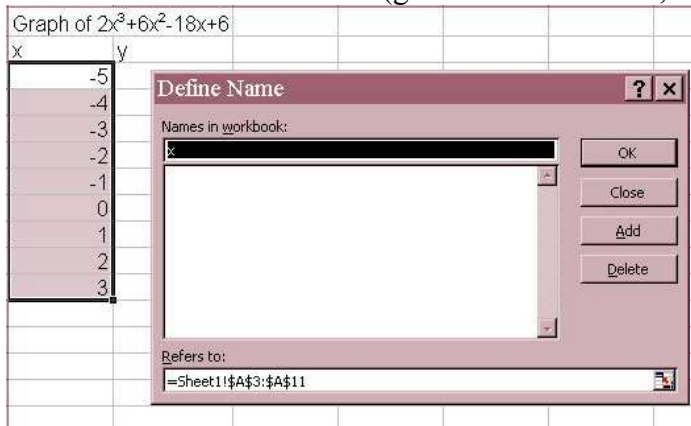
- Individual classwork and homework
- Group projects with real-world data (i.e. Web Quests)
- Written exercises involving a understanding of the graphs and interpretations of the given/collected data

Level/Course: Algebra II

Objectives: Given a function and a range of x values, students will use spreadsheets to obtain corresponding y values, graph the function, and find the zero's of the function.

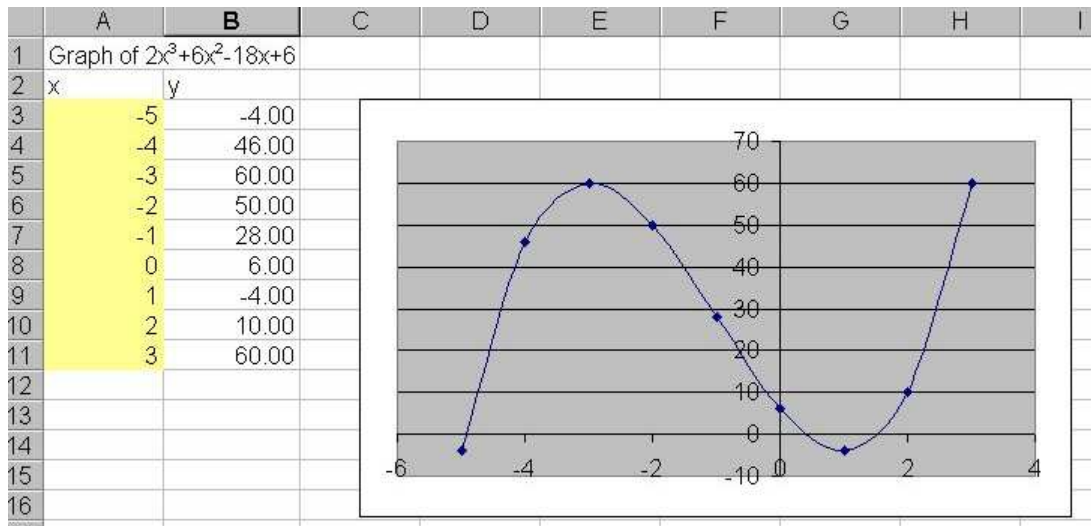
Excel Steps

1. Enter x values
2. Define cells of x values as variables in the given equation.
 - Highlight column of x values
 - **Insert-Name-Define** (give variable a name, in this case, x)-**OK**



4. Graph function

- Highlight x and y values
- **Insert-Chart- XY Scatter**-Choose appropriate chart type- **Finish**



Solving Polynomial Equations, Part 2

5. From the data and the graph determine approximately where zero's occur.
6. Use "Goal Seek" to evaluate function at $y=0$ to find the values.
 - Highlight appropriate y-value cell. (the one before each sign change in y, in this case, cells B3, B8, and B9).
 - **Tools-Goal Seek-** Enter 0 in the "To Value" Box, and corresponding x-value cell name in the "By Changing Cell" Box – **OK**

	A	B	C	D	E
1	Graph of $2x^3+6x^2-18x+6$				
2	x	y			
3	-5	-4.00			
4	-4	46.00			
5	-3	60.00			
6	-2	50.00			
7	-1	28.00			
8	0	6.00			
9	1	-4.00			
10	2	10.00			
11	3	60.00			

7. Repeat for each suspected zero.

x	y
-4.94338	0.00
-4	46.00
-3	60.00
-2	50.00
-1	28.00
0.390902	0.00
1.552473	0.00
2	10.00
3	60.00

Level / Course: Advanced Placement Statistics or Discrete Mathematics or Statistics

Objectives:

Statistics involves many calculations that once understood are easily calculated using technologies. Technologies used typically include a TI-83 calculator, MiniTab, Fathom, or SPSS. Often overlooked for this same purpose of calculating statistics is Microsoft Excel. Excel is more readily available in the real world, hence why not teach students to use Excel to perform statistical procedures?

Activities:

See attached sheets for some sample outputs from Excel. These are just a few of the many calculations Excel will perform. For more commands, the “HELP” feature of Excel is great when you type in ‘statistics.’

Statistical Test:

To perform statistical procedures such as t-test and z-test you will first need to load the data analysis package.

Note that this is preloaded on some, to check click on “TOOLS” on the menu bar. If you see DATA ANALYSIS (and you can select it) you’re ready to go. If not, under the TOOLS menu, click on “ADD INS” and select the “Analysis Tool Pak” and then load.

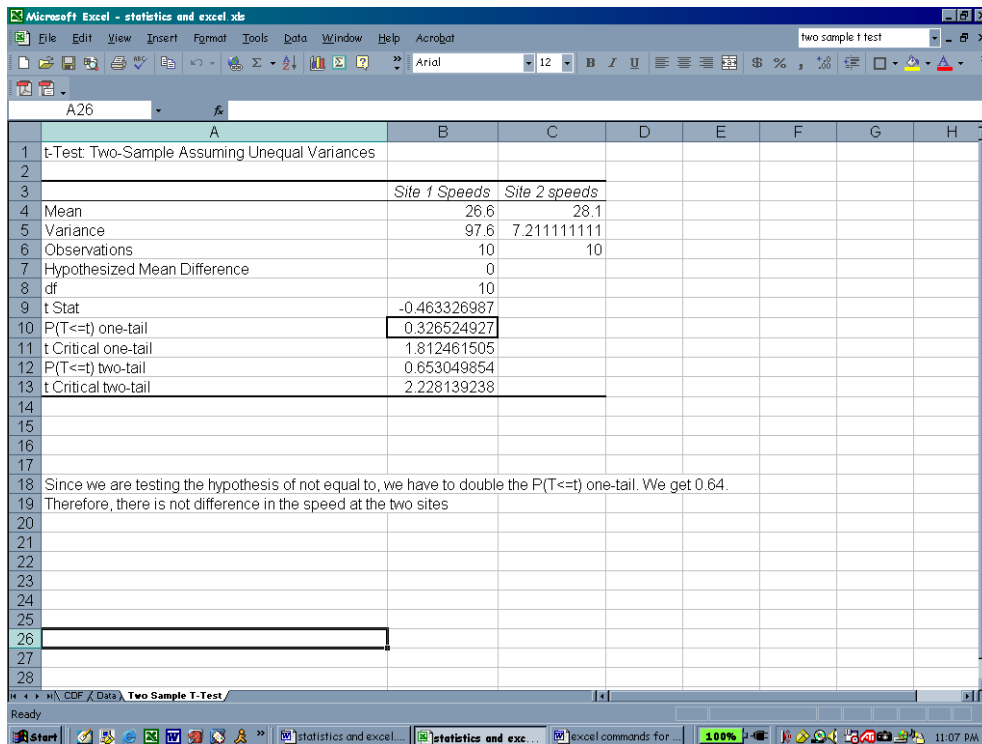
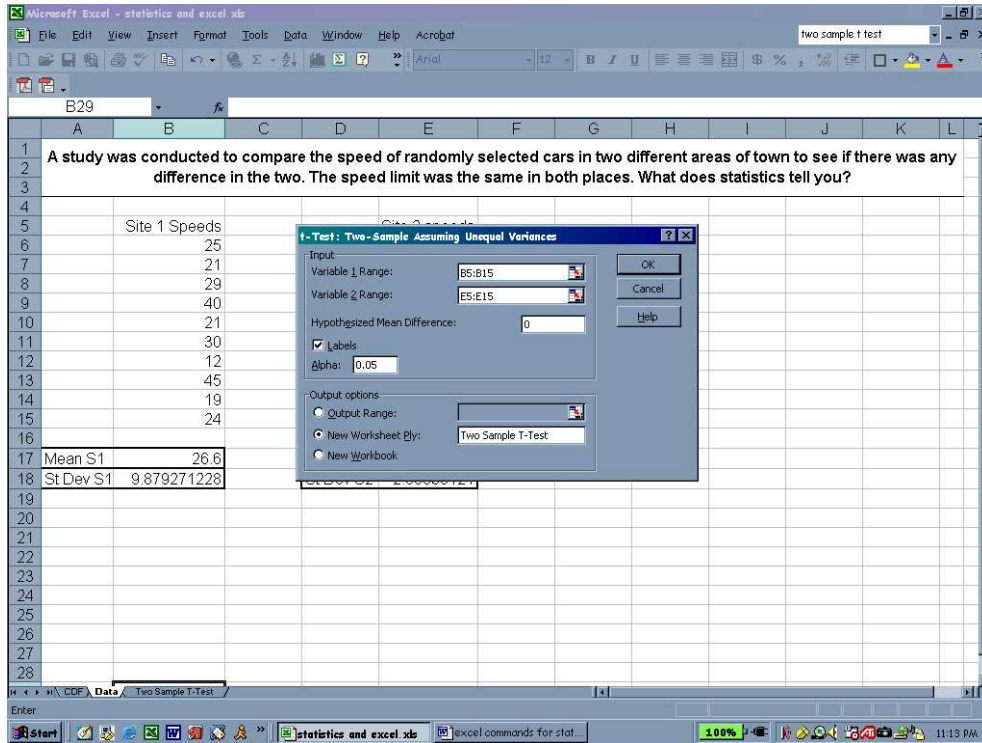
The following is one of many statistical tests Excel will perform.

To perform a two-sample t-test (or z-test, depending on if you are dealing with a population or a sample):

- Click on “Tools” from the menu bar
- Select “Data Analysis”
- Choose the appropriate statistical test, t-test or z-test. (I used t-test: two sample unequal variances assumed.)
- Enter the appropriate columns of data in the first two boxes. (Again you can use a colon to indicate a series in a row or column.) IMPORTANT NOTE: You must enter the first cell in these boxes as the cell above or before your first actual number! (see pictures below)
- For Hypothesized Mean Difference enter 0.
- If you have given your data sets labels, click show labels.
- Click Ok!
- Your statistical test will appear as another worksheet on the tabs below.

Statistical Calculations, Part 2

Below are the screenshots of my two sample, unequal variance t-test:



Excel commands for Statistical Procedures:

Basics:

Statistical Procedure	Excel Input
Average or MEAN of a given set of data. Assuming the data is entered in a row or column.	=average(first cell with entry : last cell with entry)
Standard Deviation of an entire population	=stdevp(first cell : last cell)
Standard Deviation of a sample from a larger population	=stdev(first cell : last cell)

Pertaining to the Cumulative Distributive Function (CDF):

Statistical Procedure	Excel Input
Standardize a value, x.	=standardize(x, mean, standard deviation)
The Cumulative Distributive Function of a standardized z-score.	=normsdist(z)
The inverse CDF, given a probability (or proportion).	=normsinv(probability)
X< (area to the left)	=normdist(x, mean, standard deviation, True)
X> (area to the right)	=1-normdist(x, mean, standard deviation, True)
# > X > # (area in-between two values, specifically “high” and “low”)	=(normdist(high, mean, standard deviation, True) – normdist(low, mean, standard deviation, true))

For a Chi-Squared Statistic:

Statistical Procedure	Excel Input
Chi-Squared distributive value of “chi”	=chidist(chi, degrees of freedom) Note: Degrees of freedom=(number of columns – 1)*(number of rows -1)