Introduction to Excel

Goals and Introduction

Welcome to the beginning of your physics lab experience! The lab is an essential part of the course where we use measurement in an attempt to quantify and confirm relationships in nature. The laboratory experience offers you the opportunity to test the theories and information you are covering in other parts of your course. Your primary goal in every lab exercise is to arrive at some sort of conclusion regarding the validity of the ideas or topics being discussed and to consider the uncertainties and errors that likely arise during the experimental process. In this lab, we shall explore the format of the lab exercises and go through a series of exercises intended to introduce you to Microsoft Excel and some of its features, some of which you will be required to use during the semester, and others that you may choose to use because they can be helpful in analysis.

Before you begin a lab activity, you should read the entire lab document. This is so that you use your time most efficiently when you are working on the lab.

Each lab and lab report (be sure to read *What Should Your Lab Report Look Like* in the general rubric on the same website where you found this lab!) is organized into five sections: **Goals and Introduction**, **Data**, **Data Analysis**, **Error Analysis**, and **Questions and Conclusions**.

The section entitled **Goals and Introduction** will provide you with an explanation of the physical theories and ideas involved with that lab including background and reference formulae that should mirror the topics and information you are encountering in the course. This section will also detail the goals for the lab exercise, illustrating the purpose of the data collection process.

The data collection process is explained in the **Data** section. The procedure in the lab document is broken down into a series of steps in order to help you move from one task to the next, being mindful that the order of these operations matters. You don't want to start measuring things when your measurement device hasn't been properly calibrated! You will be responsible for collecting and organizing your data. You should use a notebook to write down and clearly label your data, and later rewrite your data for presentation in your lab report. You do not need to write the procedure! This section should be where you show your collected data.

The steps for any required calculations are described in the **Data Analysis** section. It is here that you will use your data to test models and theories discussed in your class and in the introduction to the lab. Again, be mindful that you should label quantities clearly, with the units of measurement, especially anything that you calculate. Often, the instructions will ask you to label something in a specific manner. You should make sure that these quantities appear in your lab report with the details of how you arrived at their values, and organize the presentation of your analysis.

Upon completing your calculations in **Data Analysis** you will analyze the accuracy and/or precision of your results in the **Error Analysis** section. Typically, this will involve finding the percentage error between a calculated value and a theoretical or accepted value of a physical quantity (the period of a pendulum, or the value of the gravitational field on Earth, for example).

Lastly, you will have encountered several questions (often typed in boldface "**Question X**") in the lab report, likely in the **Data Analysis** and **Error Analysis** sections. Your answers should be identified and discussed in the final section of your lab report, the **Questions and Conclusions** section. This section is very different than the others in that you should treat this section as a writing assignment. This means your response should consist of complete sentences, proper paragraphs, smooth transitions, proper spelling – good writing practices that you have learned in your composition classes. You should always go beyond merely discussing the results to any specific questions. What were the sources of error that may have affected the results in the lab? Could those errors be eliminated in a future experiment somehow? If so, how? Or are these errors that we might always run into (such as the reaction time of a student using a stopwatch)? Did the lab aid you in solidifying your understanding of physics concepts, and if so, which ones? Are there remaining questions, or other things that might be interesting to test? All of these are the kinds of questions you should use in helping you write your final concluding statement in your lab report. You should always answer the specific questions in the lab first, giving each a short paragraph response, and finish with a paragraph summarizing your thoughts on these other kinds of questions that really apply to any lab activity.

You will also learn a little bit about statistics of data in this lab activity. This is so that you are prepared for using these kinds a measures during other lab activities throughout the semester.

Here, you will complete the lab entitled Introduction to Excel. This particular lab should be completed as an "at-home" activity, and turned in to your instructor by the prescribed date. Here, we will explore Microsoft Excel by following a detailed procedure where we learn how to input data, perform calculations with that data, make a graph of a dataset, and analyze the data on that graph. Excel is a program that you might find useful during the semester for aiding either the analysis of your data, or even just organizing your data for presentation in your lab reports.

Goals: (1) Learn how to use Microsoft Excel for data entry and analysis, including graphing
(2) Learn how to make a table for presentation of data, or results, in Microsoft Excel

Procedure

Equipment – computer with Microsoft Excel (If you do not have one that is okay! Head to a computer lab on campus! They will have Excel and allow you to print your results.)

HINT: There are many different versions of Excel in circulation, and they often have different names for commands and menus, and the steps for complex tasks like creating and analyzing graphs (charts) varies. The instructions here are based on the Windows version of Excel 2010. You will see some alternate instructions at times for Excel in Macintosh (shown in red), though most instructions are identical in either platform. If you have trouble, You should consider seeing someone in the Library Learning Commons to get some help!

1) Open a blank (new) worksheet in Microsoft Excel. Typically, this will happen automatically when you open the program.

You should see a grid of *cells*. Each cell can contain text, a value, or an equation. Note that there is a bar along the top of the spreadsheet that contains a letter for each column. Likewise, there is a bar along the left side of the spreadsheet that contains a number for each row. This defines a label for every cell in the sheet. For example, the cell in the upper-left corner is referred to as "A1" since it is the cell in column A and row 1. The cell just below A1 is called "A2" because it is in column A and row 2. Using the column and row labels, every cell is a unique location in the spreadsheet.

For our experience here, we will create a data set, perform some calculations, and plot some of the data for visualization and further analysis. First, we will try some basic arithmetic.

2) To begin, locate the cell "A1" and click on it (for a two-button mouse, "click" means a left-click throughout this document). Type "20" and hit "enter" (or "return"). This should put the number 20 in that cell.

3) Next, locate the cell "B1" and click on it. Type "10" and hit "enter". This should put the number 10 in that cell.

HINT: The equals sign (=) at the beginning of the characters in a cell tells Excel that the text after it is to be a calculation (equation), not a label or number. Throughout this lab, you should type the characters *inside* the quotation marks, not the " " themselves.

4) Now, we will add those two numbers. You, of course, know that they add to 30. It may seem simple, but there are times when it is advantageous to have Excel perform this calculation repeatedly. Locate the cell "C1" and click on it. Type "=A1+B1" and hit "enter." You should see the number 30.

5) There is another way to setup the calculation from step 4. Just to practice this, locate the cell "C2" and click on it. Type "=" and then click on the cell "A1". Then, type "+" and click on the cell "B1." Then, hit "enter." You should see the number 30 in the cell "C2." Click on the cell "C2" once and look at the "value bar" just above the spreadsheet (it has a "*fx*" in front of it). You should see the same formula you saw earlier. This is just another way of creating the same formula.

6) To subtract, locate the cell "D1" and click on it. Type "=A1-B1" and hit "enter." You should see the number 10 in that cell.

7) To multiply, locate the cell "E1" and click on it. Type "=A1*B1" and hit "enter." You should see the number 200 in that cell.

8) Locate the cell "F1" and click on it. Type "=A1/B1" and hit "enter." You should see the number 2 in that cell.

We have now practiced the four basic arithmetic operations. The next most commonly used operations are taking the square root of a number, or raising it to a power.

9) Locate the cell "G1" and click on it. Type "=SQRT(4)" and hit "enter." You should now see the number 2 in that cell, which is the square root of 4.

10) Locate the cell "H1" and click on it. Type "=4^2" and hit "enter." You should now see the number 16 in that cell, which is 4 squared.

11) Locate the cell "I1" and click on it. Type "=1/3" and hit "enter." You should now see the number 0.33333… with 3s filling up the cell.

Sometimes when you preform calculations, you get a really long decimal number, or one that never ends in the case of 0.33333… We can change the format of the cell so that only two digits are shown after the decimal, and have Excel round the results to the hundredths place. Click on cell "I1"

12) Look at the "Number" section on the "Home" tab. There you will see a drop-down menu that currently says "General". Click on that drop-down menu and select "Number". There are symbols just below the drop-down menu that will allow you to keep more or fewer numbers after the decimal. They look like this: . Be sure that the numbers in the cell "I1" show exactly two digits to the right of the decimal (0.33).

Excel can also help you build a list of regularly spaced values – for example, a list from 1-20.

13) Click on the cell "A11," type the number "1," and hit "enter." Then, type the number "2" and hit "enter". You should see the number 1 in cell "A11" and the number 2 in cell "A12."

14) Now, click on the cell "A11" and while holding the button drag to include the cell "A12". You should have those two cells selected now. Observe the small square in the lower right corner of your selected area.

15) Carefully click on that small square, and while holding down the mouse button, drag the cursor downwards along the column. You should be seeing numbers filling the cells in the A column. Drag downwards until you reach the cell "A30" and see the number "20" in that cell. Then let go of the mouse button. You should see the numbers 1 through 20 in the cells "A11" through "A30". (Note: You may have to use the "Fill" command under the "Home" tab in some versions of Excel for Macintosh, in lieu of finding the small square).

16) Lets finish building the following data set as shown in the table below. You've already created the left column of numbers, the list from 1-20. Enter the other column of values in "B11" through "B30."

1	2
2	4
3	7
4	10
5	11
6	13
7	15
8	16
9	17
10	20
11	23
12	26
13	29
14	32
15	35
16	36
17	38
18	39
19	43
20	46

17) Lets bold all the numbers in the table we just created. Simply highlight all the cells in the table by clicking the top cell with the number "1" in it and then drag the mouse down to the bottom right cell with the number "46" in it. Next, click on the bold icon in the menu bar, or simply press cntrl+b.

Now, we will make a graph with this data and fit a trend line to it.

18) Highlight the cells with the data in step 16 by clicking on the cell "A11," holding the mouse button down, dragging down and to the left to cell "B30," and then releasing the mouse button.

19) Click on the tab labeled "Insert". Then, in the "Charts" section, click on the chart labeled "Scatter". This will bring up a drop-down menu. Select "Scatter with Only Markers." This should automatically create your chart on the spreadsheet, and bring you to a tab called "Chart Tools" and "Design." If not, navigate to that tab now.

19) (For the Mac) Click on the tab, or drop-down menu labeled "Insert" and select or click on "Chart". You must then selecte the X Y Scatter chart called "Marked Scatter." This should automatically create your chart on the spreadsheet. It should leave you in a tab called "Charts > Chart Layout"; if not, navigate to that tab now if able. Otherwise, proceed to the next step.

20) You should now see a graph of our data. Choose one of the data points on the chart and click on it. If you are careful in doing this, you should see all of the data points become outlined, as the data have been selected.

21) Go back up to the "Chart Tools" tab and click on the "Layout" portion of the tab. Under the "Analysis" section, you should see a button called "Trendline." Click on this and observe the options on the drop-down menu that appears. Select "More trendline options."

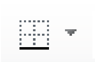
21) (For the Mac) Under the "Analysis" section, you should see a button called "Trendline." Click on this and observe the options on the drop-down menu that appears. Select "Trendline Options."

22) Be sure to click on "linear" since our data appear to be linear, and near the bottom, select "Display Equation on Chart." Then, click on the "Close" button. You should see a best-fit trendline for the data on your chart and the slope – intercept form of the equation for that line should be on the chart. Click and drag the equation so that it is clearly visible on the chart.

22) (For the Mac) Be sure to click on "linear" since our data appear to be linear. On the left side of the window, click "Options" and check the box for "Display Equation on Chart." Then, click on the "OK" button. You should see a best-fit trendline for the data on your chart and the slope –

intercept form of the equation for that line should be on the chart. Click and drag the equation so that it is clearly visible on the chart.

If you were to print out your spreadsheet currently, you'd find that there are no gridlines around your table on the page. The light grey lines in Excel are only visible on your computer screen. In order to have gridlines around your table when printing, you have to tell Excel where you would like gridlines.

23) Select the table of data ("A11" to "B30") you used to produce your graph, and go to the "Font" section of the "Home" tab and you should see a symbol just below the font that looks like this: . Click on this symbol and select "All Borders". This should cause gridlines to appear around each of the values and labels in the table you have now created! If you wanted, you could select this entire table by clicking and dragging as before, copy it, and paste it onto another spreadsheet, or into Microsoft Word, if you were writing a lab report.

24) You should size your chart as you see fit and print the worksheet you have created as you performed this lab. Be sure that you have completed all of the above instructions before printing. It is always a good idea to save your work in case it is needed later in the semester. You may bring your own thumb drive to lab (plugs into the back of the Macs in lab), or email your results to yourself in lab.

During each physics lab you will be collecting data that is supposed to show you how a particular law of physics works. Statistics will help you evaluate and discuss your data. For this introductory course, knowing how to determine the mean and the standard deviation is all you will have to know. To explore these ideas, and to see how you can use Excel to give you this information, let's consider rolling a pair of dice and adding the result to generate a set of data.

25) In cell "J1" enter "=RANDBETWEEN(1,6)". This function tells Excel to generate a random number between 1 and 6, and this corresponds to our first die roll. Since we need 20 values for our chart, this is a perfect opportunity to use Excel's ability to copy a function to multiple cells. Click on cell "J1." Then, drag the small black square in the bottom right corner down to row cell "J20." We now have 20 dice roll values in the "J" column.

26) In cell "K1" enter "=RANDBETWEEN(1,6)". This will correspond to our second die roll. We need 20 values for this as well; select cell "K1," and then drag the small black square in the bottom right corner down to cell "K20".

27) Next we need to add the results of our two die rolls together, so in cell "L1" enter "=J1+K1". This formula tells Excel to add our two die rolls together and put the sum in cell "L1." To do this

for the remaining cells, click cell “L1” and drag the small black square down to cell “L20” and you should now see the rest of the column fill with numbers.

Graphs are a fantastic way to summarize your results. Instead of having the reader add up how many times each number showed up, they can look at a graph and quickly see this information. We will create a type of graph called a histogram that will show us how many times each number occurs in our list of 20 numbers.

28) Highlight your column of data by clicking cell “L1” and then dragging your cursor down to the end of your list of numbers, then click on the tab labeled “Insert”. Then, in the “Charts” section, click on the chart labeled “histogram”.

29) Double click on the histograms x axis and select “format axis”. Then select “bin width” and change the number in the box to 1.0”. Your histogram should now have a bar for each possible die combination (2,3,4,...12). The notation (2,3] means that that bar on the graph contains any number from 2 to 3, but not including the number 2 itself. If we were using decimal numbers (such as 2.3) this notation would become more important, but for this exercise, just look at the number on the right of the label.

30) Create more values for your chart so that there are a total of 100 dice rolls (Think about using Excel’s ability to copy functions to other cells). You should notice that the histogram begins to look like a bell curve (If you do not see the histogram update, recreate it for the 100 rolls following a process similar to Step 28). This shape hints at the distribution of dice totals being a Gaussian, or normal, distribution. While this opens the door to a whole slew of statistical measures, we are going to just focus on two: mean and standard deviation.

31) The mean is also known as the average of a set of data. You’ve probably calculated averages before by hand, but you can have Excel do the work for you. To find the mean of your data set click on cell “L102” and type in “=AVERAGE(L1:L100)” This tells Excel to find the average of the numbers from cell “L1” to cell “L100”.

32) Next, we would like to determine the standard deviation of our data. The standard deviation is a measure of our uncertainty in how far the next measurement will fall from the mean value. If almost all of our data is about the same number, then our data set has very low standard deviation. But, if we have lots of different numbers spread out over a wide range, then our standard deviation will be quite large.

To find the standard deviation of your data set, click on cell “L103” and type in “=STDEV(L:L100)”. This tells Excel to find the standard deviation using all the numbers from cell “L1” to “L100.” Note, your should probably also explore online, and read about the process of finding a mean and standard deviation by hand. Being able to quickly calculate these quantities in Excel is not a substitute for understanding how they are found, nor is it the end of data analysis. For example, you should consider looking up “standard deviation of the mean,” and understand how this is different from standard deviation. Consult your TA with any questions you have about these measures throughout the semester.

Question 1: What is the “standard deviation of the mean,” and how is it different from “standard deviation?”

33) To finish up this lab, format your spreadsheet in an attractive way (titles, boarders, etc) and prepare it for being printed and turned into your TA.

Data Analysis

(Note: Questions in bold should always be addressed in the Conclusion of your lab report. They are shown here because you will normally encounter them in the Data Analysis and Error Analysis sections)

Question 2: Explain why it is important to label items, and to use features like “All Borders” in your spreadsheet. Consider the point of view of the TA reading your Lab Report, and the point of view of a doctor or other professional reading the results of a lab report in a career setting.

Question 3: What is the value of the slope in the trendline on your graph? If you extended the line back to $x = 0$, what value would you obtain for y? Use the trendline to predict the y value at $x = 6.5$. How might this process of fitting a line to data be useful in future Experiments?.

Error Analysis

There is no error analysis for this lab.

Questions and Conclusions

Be sure to address Questions 1-3 in your conclusion. Then, discuss the ease or difficulty with which you completed this lab. Describe your experience with completing the procedure. Excel is a program that can perform a wide variety of calculations and handle a large amount of data. Its uses extend far beyond physics. Consider your major or career path, and describe how you think it could be utilized in your other classes or later in a job setting.

HINT: Review the expectations for the different sections of the lab report discussed on pages 1-2 above, to be sure your lab report is complete. Turn in your complete lab report at the first scheduled meeting of your lab section, usually during the second week of classes.