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 lecture and recitation. 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 come to lab, you should have completed the **Prelab** questions and have submitted your results online. Each set of the **Prelab** questions can be found on the Canvas course for your lab. Be sure to allow yourself enough time to complete these questions, as the results do affect your grade. You should always read through the **Goals and Introduction** section of the lab before attempting the **Prelab** questions, since you should find information there that will help you. Reading the entire lab write-up before arriving at lab is also important so that you use your time most efficiently when you are at the lab.

Each lab is organized into five sections: **Goals and Introduction**, **Procedure**, **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 lecture and recitation. 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 **Procedure** section. The procedure 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. While in lab, you should use a notebook to write down and clearly label your data, and later rewrite your data for presentation in your lab report. All elements of this section MUST be completed while you are in lab.

While the primary purpose of the lab meeting time is to collect data, you should also engage in the analysis of the 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.

Here, you will complete the lab entitled Introduction to Excel. This particular lab should be completed as an "at-home" activity, printed, and turned in to your lab instructor when you arrive at lab for the <u>first time</u>, during the second week of classes. 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.

<u>*Goals*</u>: (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, but there is much more that can be done.

9) Locate the cell “A10” and click on it. Type “X” and hit “enter”. This should put the symbol “X” in that cell.

10) Locate and click on the cell “B10”. Type “Y” and hit “enter”. This should put the symbol “Y” in that cell.

11) Locate and click on the cell “C10”. Type “Z” and hit “enter”. This should put the symbol “Z” in that cell.

You can select several cells at once if the changes you want to make to be applied over all the selected cells.

12) Click on the cell “A10” and hold the button while dragging over the cells “B10” and “C10”. Then let go of the button. This click-and-drag technique should select these three cells. They should be outlined by a border.

13) Make these selected labels bold by clicking on the “B” under the “Font” section of the “Home” tab. The X, Y, and Z should now be bold.

14) Excel can help you build a list of regularly spaced values. For example, click on the cell “A11” and 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”.

15) 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.

16) Carefully click on that small square, and while holding down the 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)

17) In order to generate the data set further, we will use Excel’s ability to create random numbers. Click on the cell “B11”. Then type “=RANDBETWEEN(0,100)”. This is a function that generates a random number between 0 and 100.

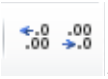
18) We would like to repeat this process in the cells below. Click on the cell “B11” again and note the small square in the lower right corner of the cell. Carefully click that square and hold the mouse button down. Drag the cursor downwards until you reach the cell “B30”, and then release the mouse button. You should see random numbers in the cells from “B11” to “B30”. We also could have accomplished this by using the “Copy” and “Paste” functions – copying the information in cell “B11”, select all of the destination cells, and pasting all at once.

19) Click on the cell “C11” and type “=SQRT(B11)”. This should be the square root of the value that is currently in the cell “B11”.

20) Click on the cell “C11” again and locate the small square in the lower right corner of the cell.

21) Carefully click on that small square and hold the button down while you drag the cursor downwards. When you reach the cell “C30”, release the mouse button. You should see that numbers have filled the cells from “C11” through “C30”. Click on the cell “C29” and look at the “value bar” just above the spreadsheet. It should say “=SQRT(B29)”. Again, we could also have accomplished this by using the “Copy” and “Paste” functions.

22) Note that we may not want to see so many digits in our calculations in Column C. This could be because of significant digit rules you will explore as the semester continues. We can change the format of the results in these cells so that only two digits are shown after the decimal, and have Excel round the results to the hundreths place. Click on cell "C11" and hold the mouse button down. Drag the cursor downwards until you reach the cell "C30". Then release the mouse button. The cells "C11" through "C30" should now be selected.

23) 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 cells "C11" through "C30" show exactly two digits to the right of the decimal (for example, "8.45").

24) Let us consider formatting our table for presentation and printing in our lab report. It is nice sometimes to show lines between cells so that the data are more clearly demarcated when printed. Click on the cell "A10" and hold the mouse button down. Then, drag the cursor down and to the right until you reach the cell "C30". This will select all of these cells.

25) 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.

Lastly, let us create a plot and find the equation of a regression line that best fits the data.

26) Build the following dataset in the cells E11 through F20:

1	2
2	4
3	7
4	10
5	11
6	13
7	15
8	16
9	17
10	20

27) Highlight the cells with the data in step 26 by clicking on the cell E11, holding the mouse button down, dragging down and to the left to cell F20, and then releasing the mouse button.

28) 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.

28) 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.

29) 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.

30) 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”.

30) (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”.

31) 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.

31) (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.

32) 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.

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 1: 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 2: 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 and 2 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.

Pre-Lab Questions

Please read through all the instructions for Introduction to Excel to acquaint yourself with the concepts. Since this lab is done "at home" rather than in the Physics Laboratory room, feel free to complete the Experiment before answering the following Pre-Lab questions (normally, Pre-Lab questions are due *before* the lab meeting). When you are ready, answer the following questions and type your answers into the Canvas quiz tool for the experiment Introduction to Excel, and submit it before the due date listed in Canvas.

PL-1) Which of the following is ***not*** a section you should expect to turn in as part of your Lab Report for a typical Experiment?

- (A) Introduction
- (B) Procedure
- (C) Data
- (D) Data Analysis
- (E) Error Analysis
- (F) Conclusions

PL-2) At a minimum, which of the following sections will be written (either longhand, or typed in a word processor like Microsoft Word) in complete sentences, like an English composition?

- (A) Introduction
- (B) Procedure
- (C) Data
- (D) Data Analysis
- (E) Error Analysis
- (F) Conclusions
- (G) both (A) and (F)

PL-3) Which of the following is ***not*** a valid equation with which Excel can perform a calculation? *[Hint: Remember, the quotation marks are not part of what you would type in, only the characters inside the " " would be typed into Excel]*.

- (A) "MEAN(H2:H4)",
- (B) "=SUM(X3:X206)",
- (C) "=AVERAGE(C9:C14)/6",
- (D) "=STDEV(K2:K8)/SQRT(7)",
- (E) "=10 + 20".

PL-4) This is an example of a numerical question you will encounter in future Pre-Labs. You perform a calculation and enter the result as a number. Usually, the question asks you to enter the number in specific units (like meters, or meters per second), so you may have to convert your answer to these units before entering it. The Canvas software will automatically grade the answer; you will get the full score if your answer is within some range of the correct answer, and no points if it is outside that range (so better to use too many rather than too few significant figures). Here is an easy calculation, to get you familiar with how to respond to this type of question through Canvas: **10 + 20 =**

PL-5) *True or False:* Excel, or other spreadsheet programs, are useful tools in organizing data and performing multiple calculations.

- True
- False