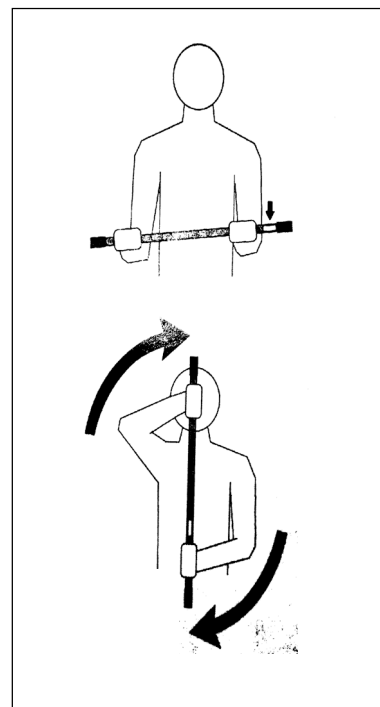


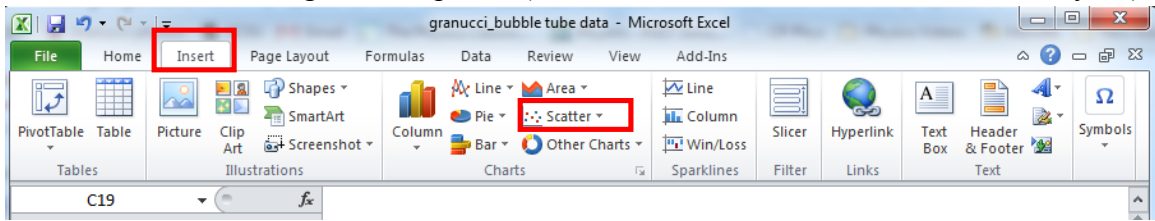
- C) Save the file on the desktop as “yourlastname_bubble tube data”. Be sure to save your file again often as you move through the procedures discussed below to make sure that you don’t end up having lost data or work should something go wrong with the computer.
- D) Chose one of the colored tubes to start with. It doesn’t matter which one. You will use them all. Find how long it takes for the bubble to travel various lengths in tube by following this procedure:

- Choose a length of time to allow the bubble to rise. The time you choose should be more than 3 seconds but shorter than the overall amount of time it takes the bubble to reach the top of the tube. (How long is that? You might want to measure this first).
- Hold the tube not quite horizontal, so the bubble is at one end as shown below.
- Flip the tube and start timing. Track the bubble with your finger. A second person should work the timer. When this person is ready to start timing they say “start!” and the person holding the tube should flip it over so that it is now vertical as shown below. As the bubble rises, the person holding the tube should move one finger along the tube, keeping it next to the bottom of the bubble.
- Wait the agreed upon time and note the position of the bubble. The person timing watches for the agreed upon time and then says “Stop”. At this point, stop moving your finger. Do not remove it from the tube until you are should you have the position accurately measured and recorded.
- Record the time and position in your data table.
- Repeat a) through e) four more times for other times between 3 seconds and the time it takes the bubble to move the entire length of the tube.
- Repeat a) through f) for the other two tubes.

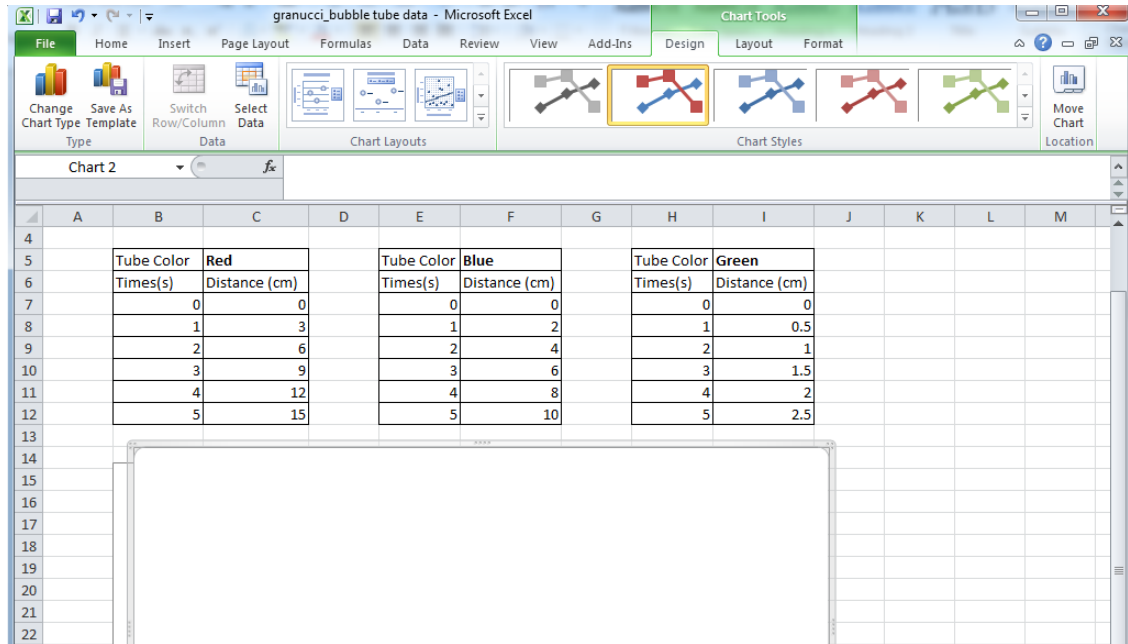


- E) Now you will generate one scatter plot graph that contains the information from all three data tables. You will insert a “trend line” or “best-fit line” for the data from each table as well as a legend. The final product should look like the graph shown at the end of this lab. You can follow the step-by-step instructions below if you are unsure of how to proceed.

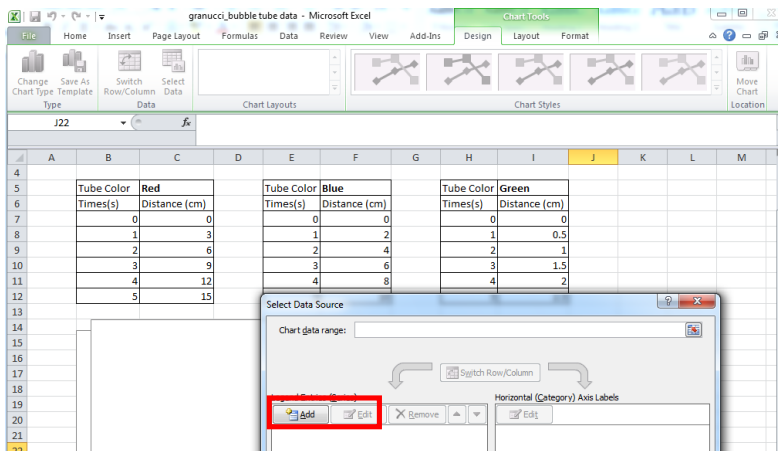
- a. Select the insert tab at the top of the excel sheet and select the scatter plot graph, the first choice with no lines connecting the data points (Never “connect the dots” in scientific analysis.)



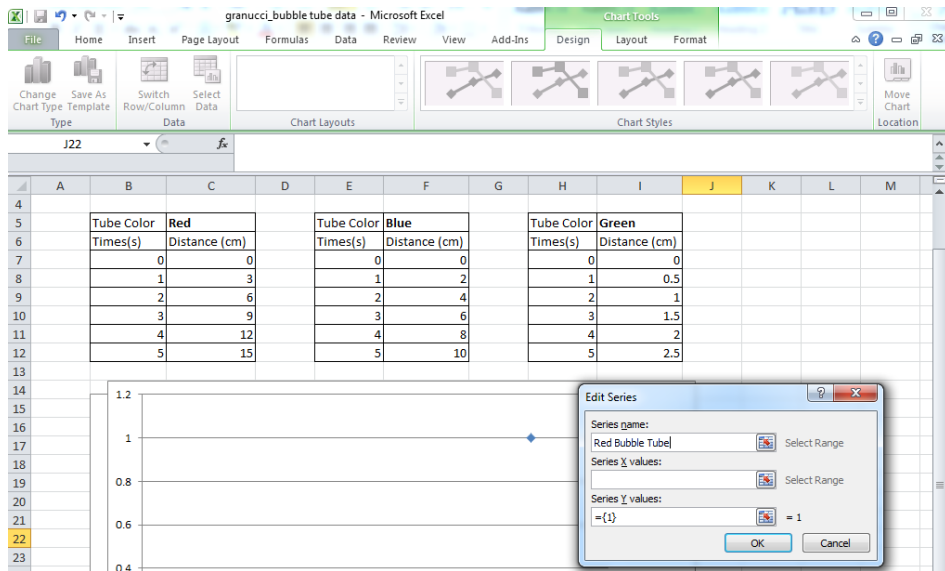
- b. Move the empty box away from your data and resize appropriately.




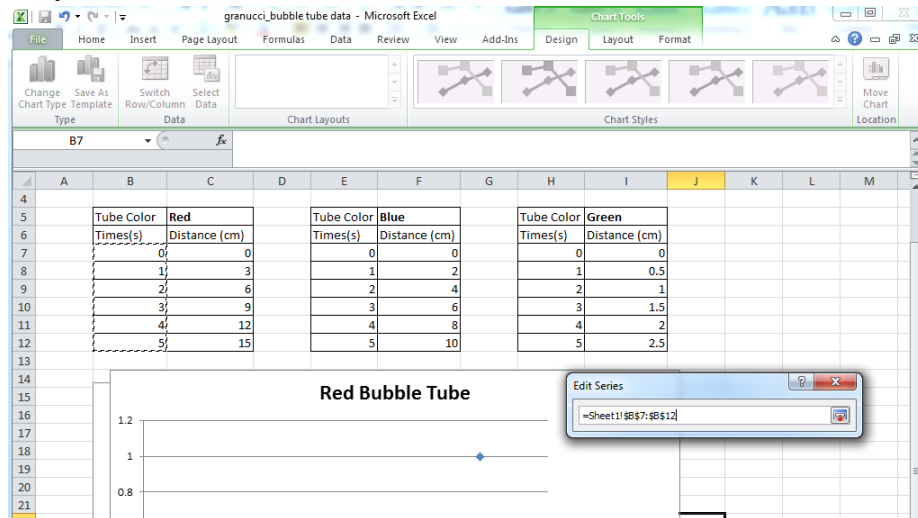
- c. Right click on the blank graph and click “Select Data”
 d. Click on the button “Add” to add data.



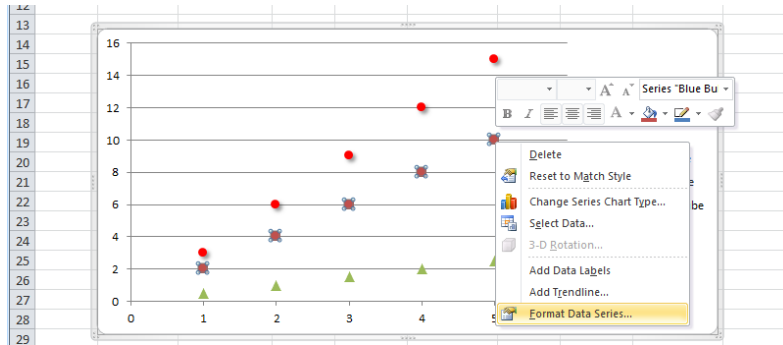
- e. Enter in “Series Name” the color of the first bubble tube for which you have data.



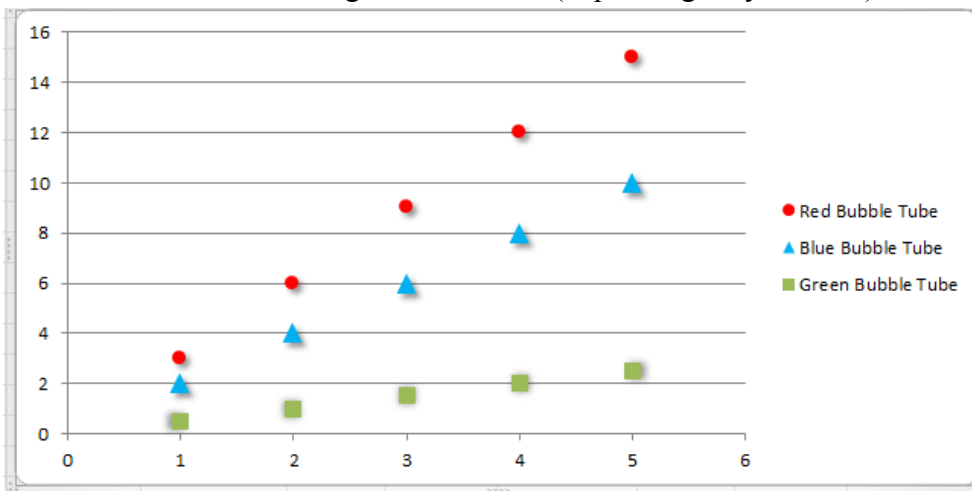
- f. Under “Series X values”, select the  button and highlight the x-values of your data. This will be the time data you’ve collected.



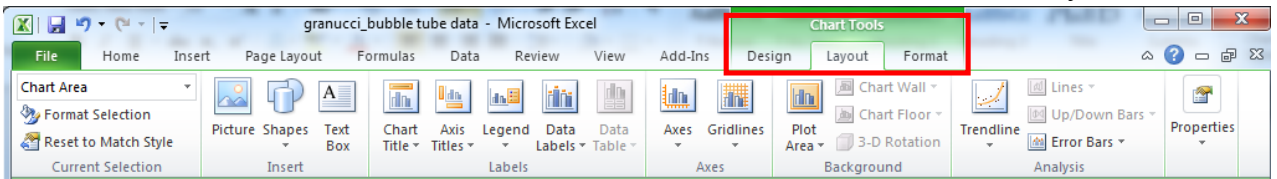
- g. Repeat for “Series Y values” and highlight the distances for your Y-data.
 h. You should see a plot of data points on your graph.
 i. Repeat steps d – f for each color bubble tube. When all are plotted, select OK.
 j. Observe your data. Be sure that the data points are the right color and shape:
1. Red Bubble Tube Data – Red Circles
 2. Blue Bubble Tube Data – Blue Triangles
 3. Green Bubble Tube Data – Green Squares
- ii. To change the format of your data point, right click on one of the data points and select **“Format Data Series”**



- iii. Marker Options – Changes the shape and size of data point
 - iv. Marker Fill – Changes the color
 - v. Marker Line – Changes the line feature, but do not include a line
 - vi. Marker Line Color – Select “No Outline” to get rid of the outline color
 - vii. Shadow/Glow – You may add shadow or Glow at your own discretion.
- k. You should have something similar to this (depending on your data):

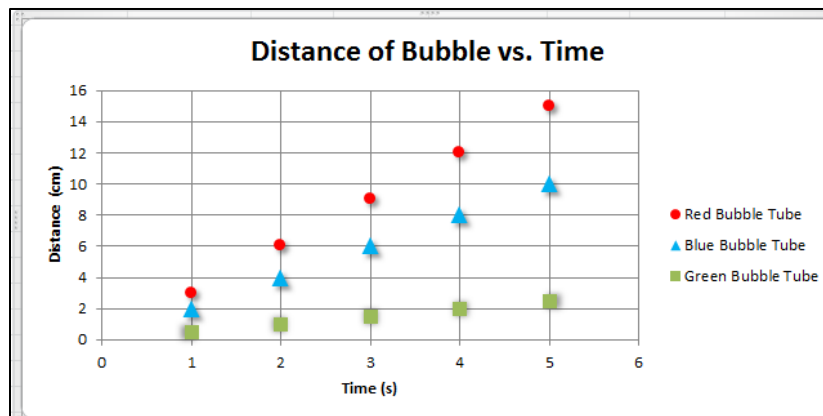


- l. Your data now needs axis labels and a title. Under chart tools, select the “Chart Layout Tab”

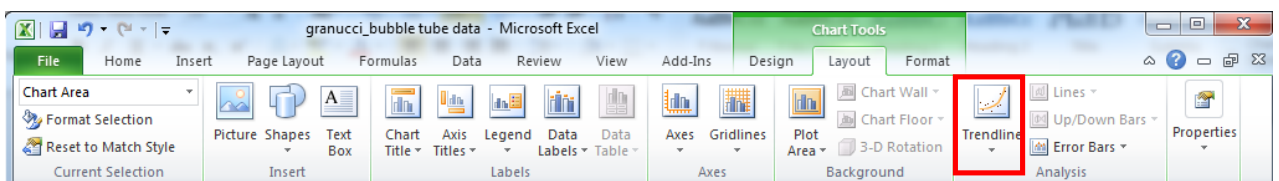


Below you will see Chart Title, Axis, etc. Use these tabs to create a title, axis labels and you may change the gridlines as you see fit.

Example:



- m. Next, you will add a trendline for each set of data points. Under chart tools, select LAYOUT and then select TRENDLINE

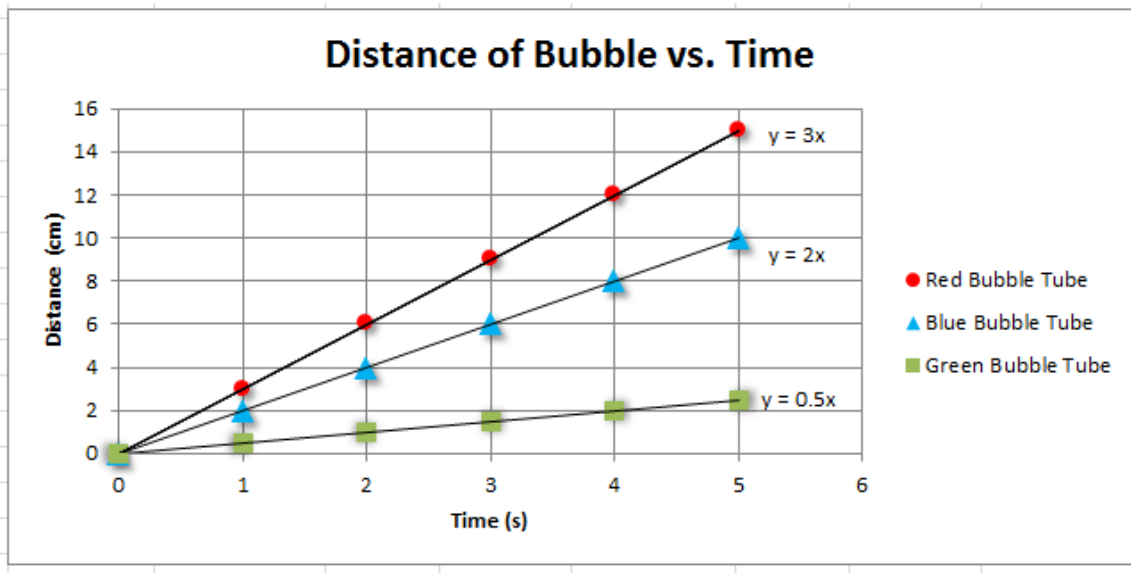


- n. Select “MORE TRENDLINE OPTIONS” at the bottom and then select “Red Bubble Tube”.
- o. Select “LINEAR TREND” and “DISPLAY EQUATION ON CHART” and “DISPLAY R²”. Drag the displayed equations to a more appropriate position if necessary.

| Time (s) | Distance (cm) |
|----------|---------------|
| 0 | 0 |
| 1 | 2 |
| 2 | 4 |
| 3 | 6 |
| 4 | 8 |
| 5 | 10 |

- p. Repeat this for each color.
- q. Delete the “Linear Trendline” from your legend by selecting each one and deleting it. Be sure not to delete your entire legend.

Your final graph should look like this (but with your own data)



Answer the following questions in complete sentences. Show your work! If you need extra space to show any calculations, include them on a separate sheet of paper.

- 1) About how far did the bubble in the green tube travel in 6.5s?
*To find out, right click on your green trendline and select “**FORMAT TRENDLINE**”. Then type in a value under “FORECAST” that will extend your trendline far enough to give a value for 6.5s. For Example, “2”. This will extend your trendline 2 units allowing you to find the distance at 6.5s. Once you determined your answer, revert you trendline back to normal. You may choose to increase the number of tick marks on the axes for more precise reading of the distance on the graph scale. Check your answer by solving the equation given by Excel for Y when X=6.5*

| | B | C | D | E | F | G |
|---|---|----|---|---|----|---|
| 0 | | 0 | | 0 | 0 | |
| 1 | | 3 | | 1 | 2 | |
| 2 | | 6 | | 2 | 4 | |
| 3 | | 9 | | 3 | 6 | |
| 4 | | 12 | | 4 | 8 | |
| 5 | | 15 | | 5 | 10 | |

- 2) How far did the bubble in the red tube travel in 6.5s?
- 3) How far did the bubble in the blue tube travel in 6.5s?
- 4) Determine the slope of the trendline from the equation generated by Excel.
 - a. Red _____
 - b. Blue _____
 - c. Green _____
- 5) Which set of data was most linear? Using the regression coefficient, R^2 value, determine which data set had a better linear correlation. Linear correlation given by R^2 tells how close the data points are to lying on the same straight line. R is calculated by Excel using a formula that can only produce values from zero up to (but not including) one. If Excel reports $R^2 = 1$, please right click on the "1" and re-format this number to be displayed to enough decimal places such that it is not rounded up to 1.

For physical science experiments:

- | | |
|---------------------------|---|
| Best correlation: | $R^2 = 0.999$ nines in the first 3 or more dp's |
| Acceptable correlation: | $R^2 = 0.9$ or higher |
| Unacceptable correlation: | R^2 less than 0.9 |

6) If you have time or your instructor requires you to do so, calculate the slopes of the graphed lines by hand. Follow these steps:

a. Mark two points on the line, label them "A" and "B." The points should be on the line, and far apart. Try to choose points that will make it easy to read the distance and time measurements.

b. Point "A" corresponds to a distance of _____, and a time of _____.

Point "B" corresponds to a distance of _____, and a time of _____.

c. Use your answers from part "b" above to calculate the rise and run:

Rise = _____ cm - _____ cm = _____ cm.

Run = _____ s - _____ s = _____ s.

d. Now calculate the slope of line: Slope = Rise divided by Run = _____ cm/s.

e. Compare these slopes to the ones you've calculated in your lab using a percent error.

a. Red _____

b. Blue _____

c. Green _____

Which one was the best? Offer an explanation of why.

Lastly, save your file one more time and print.

For printing purposes, be sure that your work all fits appropriately within letter-sized pages. To check this, select the **Page Layout** Tab at the top of the excel sheet. Next select **Guidelines** “**PRINT**”. You will see a dotted line appear on your spreadsheet. This is where the page ends (if you were to print). You must adjust you data table and/or questions to fit within the page boundaries. Its okay to have multiple pages, but you must not cut off data/text/graphics/etc. Each person should hand in their answers AND a copy of the printed graph and table. You may also be asked to submit your Excel work by either copying to your instructors USB drive or by e-mailing to your instructor.

