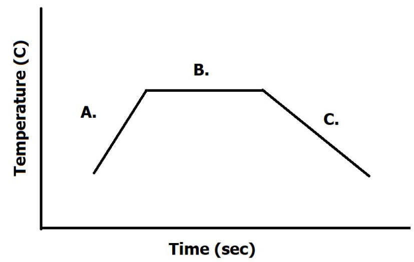
Computer Survival Skills in C1151 Laboratory
MCTC Chemistry
v.8.17

Objective: Introduce you to computerized data acquisition, handling and display in the chemistry laboratory.

Prelab Questions: Read through this lab handout and answer the following questions before coming to lab. There will be a quiz at the beginning of lab over this handout and its contents.

1. What is the LabPro device?
2. If the "Collect" button isn't green, what should you do?
3. Approximately how long (in seconds) is an experimental trial?
4. In the graph at right, which region corresponds to water that's losing heat energy?
5. What is required for an experimental trial to be successful?
6. What is the name of the app that we use to manipulate and graph data?
7. When entering an equation, what is the character that is always entered first?
8. What type of graph is always used in this class?
9. In a weight vs. time graph, what appears on the "Y" axis?
10. Given the following trendline equation, V = 1.443 X + 3.331, what is the value of the slope?
11. How do you know if a straight line fits your data well?
12. How many decimal places are required for all trendline equations in this class?
13. Before you leave at the end of the day, what must you do?



Lab Laptop Computer Overview

- Laptop batteries won't last an entire lab period. Obtain a laptop computer (front instructor's cabinet) and power supply (Green labeled Drawer). Connect them appropriately.
- Power up the computer, press "Enter" and type in your StarID and password. The laboratory computers are WiFi enabled. Once you log in you will have full network access.
- It may take several minutes for the computer to boot up so it's best to start this process early.

- Applications frequently used in the chemistry laboratory:
  - **Logger Pro** … Used to **collect** experimental data
  - **Excel** … Used to **manipulate and graph** experimental data
  - **Avagadro** … Used to **create and view virtual molecules**

- Overview of the data collection and manipulation process
  - Set up computer and LabPro device
  - Click on the LoggerPro app
  - Adjust data collection settings for your experiment
  - Start data collection by clicking on the "Collect" button
  - Stop data collection by clicking on the "Stop" button
  - Select and copy data from LoggerPro
  - Click on the Excel app
  - Paste data into Excel
  - Save your Excel data OFTEN.
    - USB flash drive
    - H:/ drive
    - Desktop (then email it to yourself)

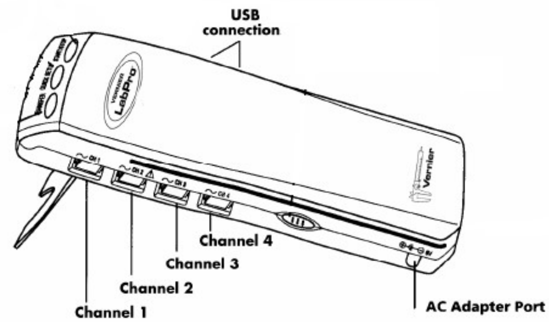
Experiment: Data Acquisition Setup

1. Obtain a laptop computer and charger. Connect the charger to a wall outlet and the laptop computer.

2. Plug in the Lab-Pro interface box power supply into an available outlet and the interface.

3. Plug the temperature probe into the Channel 1 (CH 1) position of the Lab-Pro Interface (Figure at right).

4. Connect the Logger Pro interface box to the computer using the USB cable.



5. Activate the LoggerPro software application.

6. Is the "Collect" button green? If it is not, check the interface box power cord and the USB cable connections.

7. Configure data acquisition. Click on the "Experiment" drop down menu and select "Data Collection." Now adjust the experiment length to be 5 minutes (300 seconds). Click DONE.

Experiment: Procedure

1. Fill a 250 mL beaker ¾ full with hot tap water.

2. Stir the hot water *vigorously* with the temperature probe.

3. Click the "Collect" button (Green button at the top right-hand corner) on the LoggerPro window to start data acquisition. LoggerPro will start recording the data.

4. Measure the temperature of the hot water for 2 minutes while stirring the water at all times**.**

5. After two minutes, continue *vigorous* stirring and have your partner quickly add approximately 1/2 cup of ice.

6. Continue collecting data for an additional 3 minutes after the addition of ice.

7. Click the red "Stop" button in the top right corner when you have finished but do not exit LoggerPro.

8. Is your experiment a success? Your lowest temperature must be in the 5°C – 15°C range. If it isn't, you'll need to repeat the above procedure using more or less ice as needed.

Experiment: Data Transfer

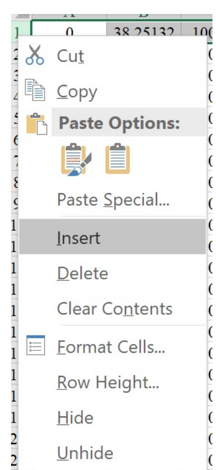
1. Launch the Excel app.

2. Select and copy the data for your successful experiment in the LoggerPro data table.

3. Click on cell A1 in Excel and paste (Ctrl V) your data into the spreadsheet

Data Analysis: Microsoft Excel Operations (Excel 365)

Inserting Column Titles



1. Select the first horizontal line of data by RIGHT clicking on the number "1" at the far left

2. Select "Insert" from the popup menu that appears. A blank line should be inserted above your data thus shifting your data downward one line.

3. Click on the cell above the first data column and enter the words "Time (sec)". Repeat the procedure for the second column using "Temperature (°C).

   Alternatively, a degree symbol can be made by turning the letter "o" into a superscript using the font menu.

	A	B
1	Time (sec)	Temp (°C)
2	0	38.25132
3	1	38.22652
4	2	38.20172

Calculations: Creating a formula

A formula calculates results based on numbers in your spreadsheet. You will create a formula that will convert all Celsius temperature measurements to Fahrenheit.

1. Click on the empty cell C2

2. Formula entry:
   a. Enter an equals sign "="

   b. Then enter: 1.8*B2+32 (This formula, $T_F = 1.8 \times T_C + 32$, converts the temperature in cell B2 from Celsius into Fahrenheit and places the value in cell C2)

	A	B	C
1	Time (sec)	Temp (°C)	
2	0	38.25132	=1.8*b2+32
3	1	38.22652	
4	2	38.20172	

   c. Press Enter.

   d. Click on cell C2 again.

   e. Now press *and hold* the "Ctrl" key. Press "c" to copy the contents of cell C2 which will now appear with a dotted line around it.

   f. Select the entire range of numbers (Drag) in the C column (from C3 to the end).

	A	B	C
1	Time (sec)	Temp (°C)	
2	0	38.25132	100.8524
3	1	38.22652	
4	2	38.20172	
5	3	38.20172	

   g. Press and hold the "Ctrl" key and then press "v" to paste into the selected columns.

3. Label the calculated column "Temperature (°F)"

	A	B	C
1	Time (sec)	Temp (°C)	Temp (°F)
2	0	38.25132	100.8524
3	1	38.22652	100.8077
4	2	38.20172	100.7631
5	3	38.20172	100.7631
6	4	38.17693	100.7185

Creating a Scatter Plot

In this exercise, you will select two columns of data and use them to construct a graph. The first column of data is the "independent" variable (Time) and is what is used for the "X" axis. Similarly, the other column of data is the "dependent" variable (Temperature: °F) and corresponds to "Y" axis values.

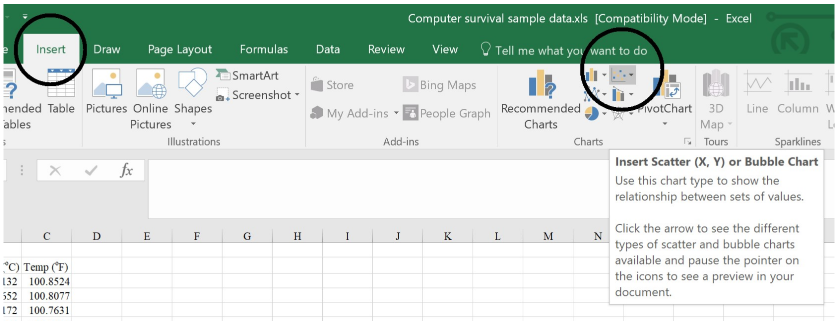
1. Select the two columns, time and Temp °F.
   Two non-neighboring columns can be selected as follows: (Click and drag over the first column. Then press and hold "Ctrl" while dragging over the second Fahrenheit column.)

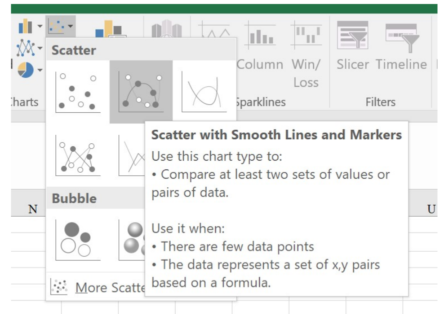
   Don't select the column labels.

   Only "Ctrl" and drag over the *second* column.

	A	B	C	D
1				
2	Time (s)	Temp (°C)	Temp (°F)	
3	0	38.25132	100.8524	
4	1	38.22652	100.8077	
5	2	38.20172	100.7631	
6	3	38.20172	100.7631	
7	4	38.17693	100.7185	
8	5	38.15214	100.6739	
9	6	38.12736	100.6293	
10	7	38.10259	100.5847	
11	8	38.10259	100.5847	
12	9	38.05306	100.4955	

2. Click on the "Insert" tab
   Select "Scatter with Smooth Lines and Markers"

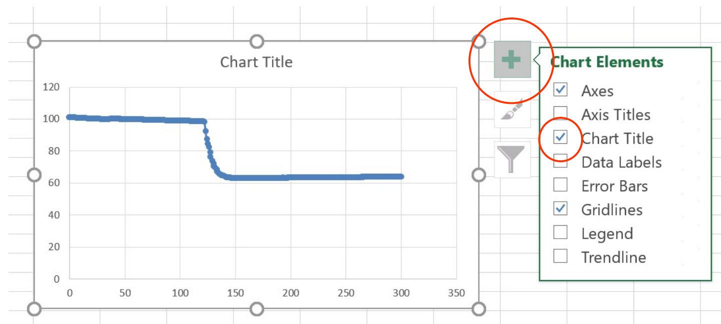




3. A graph will now appear on your spreadsheet

4. Click once on the graph to select it

5. Click on the "+" sign in the upper right hand corner to display the "Chart Elements".
   a. Click on the "Axis Titles" checkbox
   b. Click on your graph's axis titles and change them to
      i. Time (sec)
      ii. Temp (ºF)
   c. Click on your graph's "Chart Title" and change it to



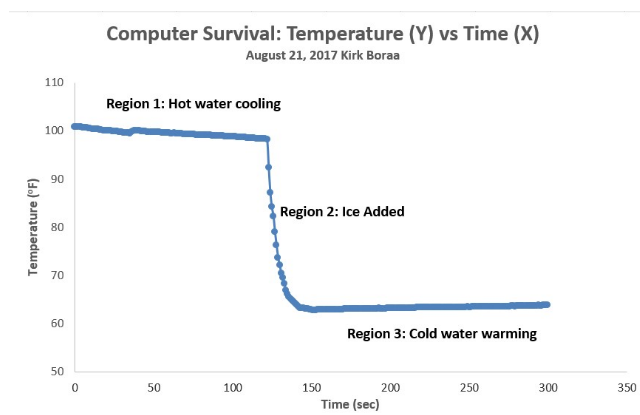
"**Computer Survival: Temperature (Y) vs. Time (X)**"
"Today's Date, Your Name"

Graph Modification

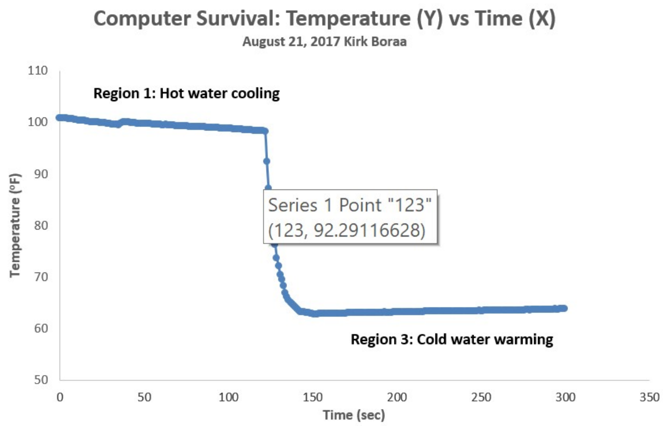
Adjust the Y axis (R-Click on the Y axis and choose "Format Axis"). Change the minimum value to 50ºF.

Use textboxes (found on Insert tab) to label the three regions of your graph.

Turn off the gridlines (available via the "+" menu)



Identifying Data Points



You can easily identify data points on your graph by hovering your mouse over a data point on the graph.

In the example at left, the cursor has been positioned over a data point corresponding to time=123 seconds and Temperature=92.29116628 °F.

Using the mouse in this way, determine the X,Y points that define the beginnings and endings of regions 1 and 3 of your graph. Write these ranges/points down on this handout.

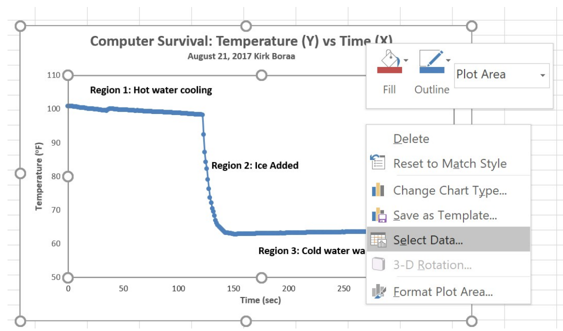
Be careful to identify points where the line is perfectly straight and NOT curved. Include no curved data points.

Trendline Analysis

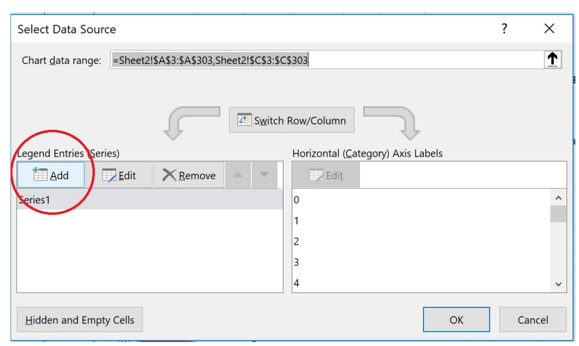
The word "<u>Trendline</u>" is Microsoft Excel's term for <u>straight line analysis</u>. *By specifying a range of data, you can instruct Excel to draw the best straight line through just that data.* Furthermore, Excel can also display the equation of the best straight line in y = mx + b form (slope intercept form).

We will be creating trendlines for regions 1 and 3 of the graph you've created. In these examples, the slope of the line is a number that tells us the rate of heating or cooling (i.e. degrees Celsius temperature change PER second.
You can create a Trendline for region 1 as follows:

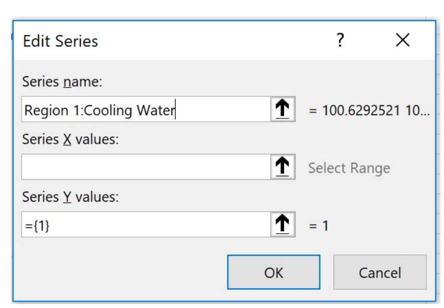
1. Create a new data series
   a. Right click in the center of the graph and choose Select Data from the pop up menu.



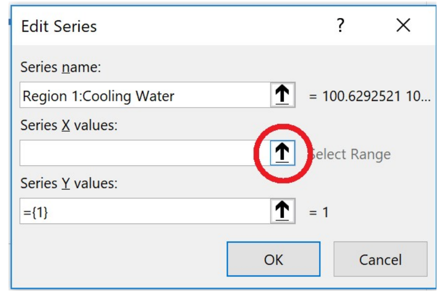
   b. In the "Select Data Source" window that opens, Click on the "Add" button



   c. When the "Edit Series" window opens, enter the name of the new series as "Region 1: Cooling Water"

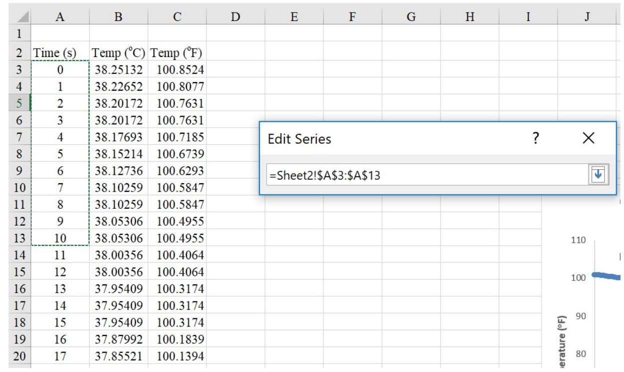


d. Click on the up arrow to the right of the X Values box.

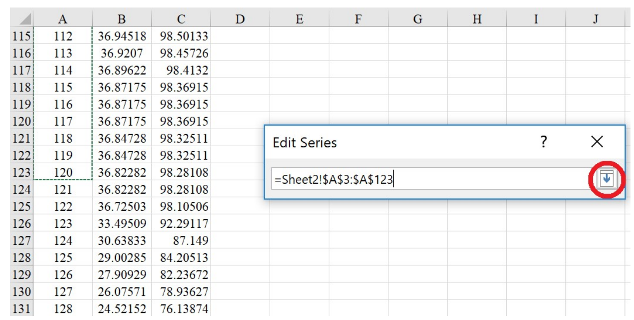


e. Click and drag over the X values corresponding to your Region 1. Note in the example at right, only X values 1 .. 10 have been selected.

X= 1 to 120 correspond to the Region 1 X values for this particular data set.

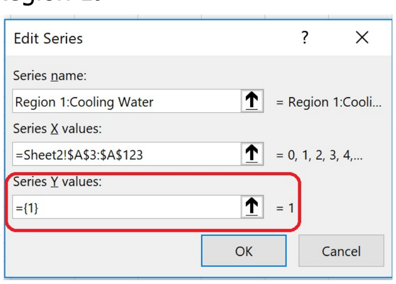


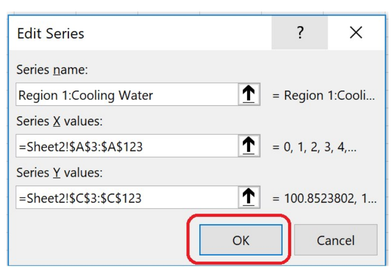
f. Click on the down arrow button in the Edit Series window to accept your selection of X data values.



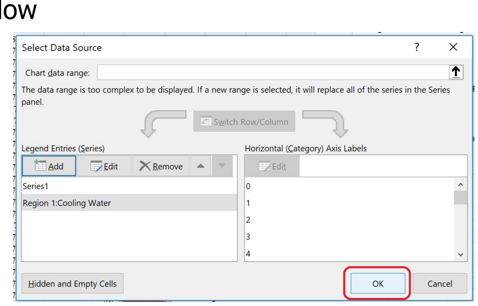
g. Repeat the above procedure for the corresponding Region 1 Y values and then click OK.

Be sure to select the Fahrenheit temperatures that correspond only to the data range you've identified for Region 1.

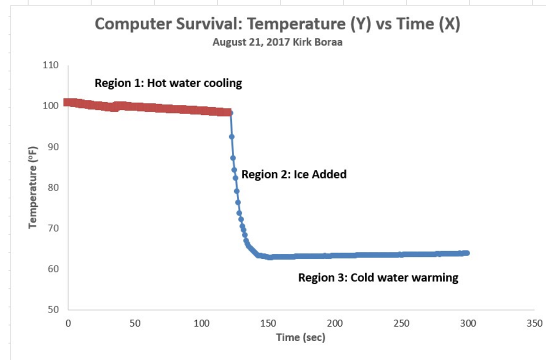




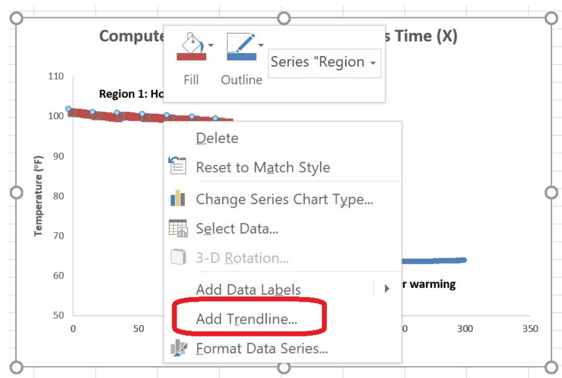
h. Click "OK" on the Edit Series window



i. Your graph should look like the one at right. The new Region 1 series will be highlighted in a different color; in this case RED.



j. Right click on the red highlighted data series and choose the "Add Trendline" option.



k. The "Format Trendline" window will open up to the right of the graph. (Right)

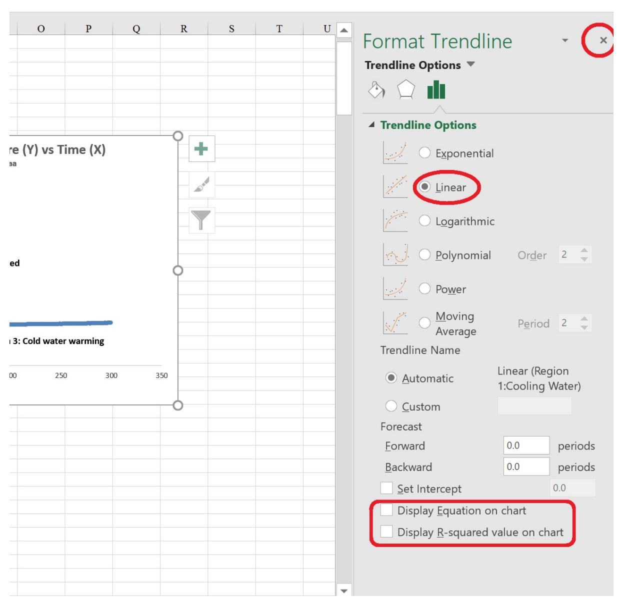
In the "Format Trendline" window opens, make the following changes:

i. Linear (Default)

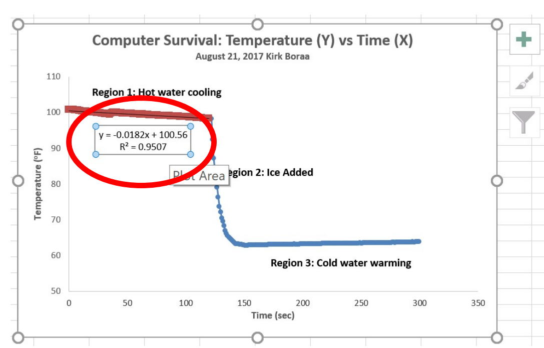
ii. Check Display Equation on Chart

iii. Check Display R-squared value on Chart

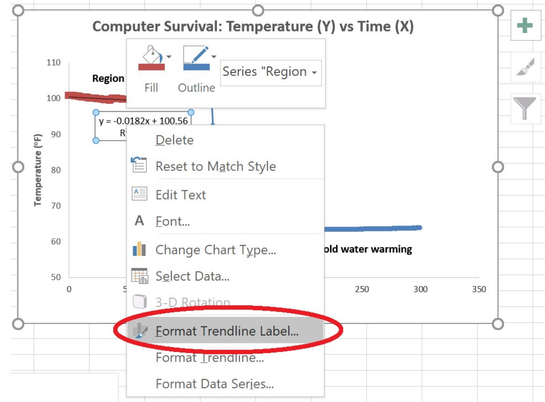
iv. Click "X" when finished



l. The trendline equation and R-Squared value will now be displayed on your graph. Drag this box to a clear region of the graph but not far from region 1 (where it belongs).

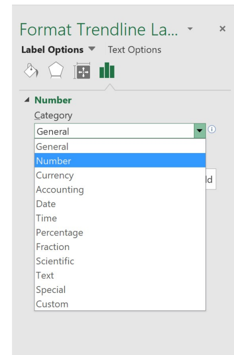


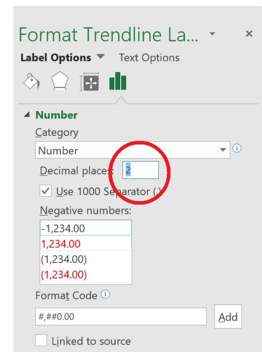
m. Frequently, we'll use the trendline equation as we perform calculations. For this reason, it is important to display a trendline equation that has more than the default number of significant figures. Right click on the trendline equation box and choose "Format Trendline Label."



n. Choose "Number" from the drop down list in the Format menu that opens to the right of the graph.

o. Enter "8" in the Decimal Places window

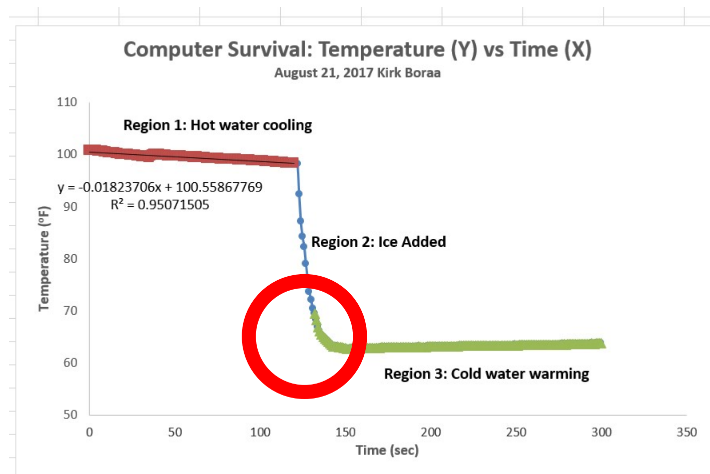




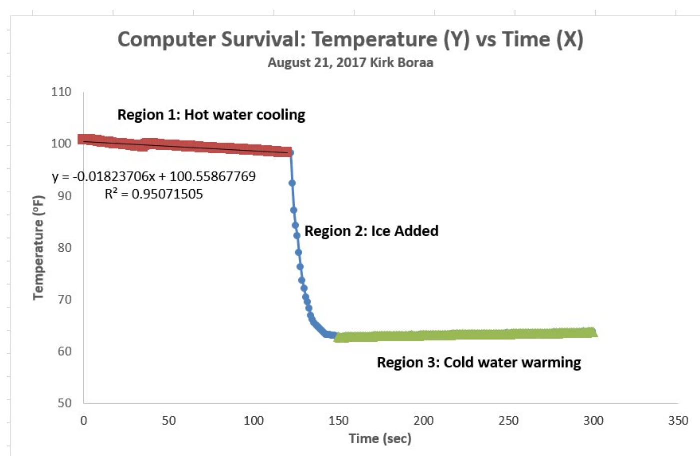
p. **<u>Repeat the procedure above for region 3 of the graph.</u>**

Note that Region 3 has been *incorrectly* identified in the graph at right.

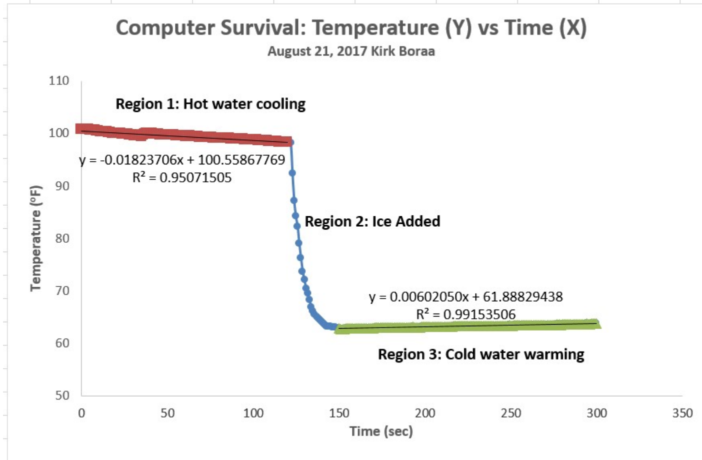
Only the Straight Line segment of Region 3 should be selected. However, in this case, a significant number of data points that make up the upward curve have been mistakenly selected.



In the graph at right, the Region 3 data series has been correctly adjusted to include only those data points that are along the straight line that represents Region 3.



Trendline analysis: What does it mean?



The trendline equations you generate will be in the form of

$$\mathbf{y = mx + b}$$

However, in our experiment, didn't use X's and Y's, rather we have "Time" and "Temperature".

Thus, if you obtain an equation that looks like this (Region 1 in graph at right):

y = -0.01823706 x + 100.55867769

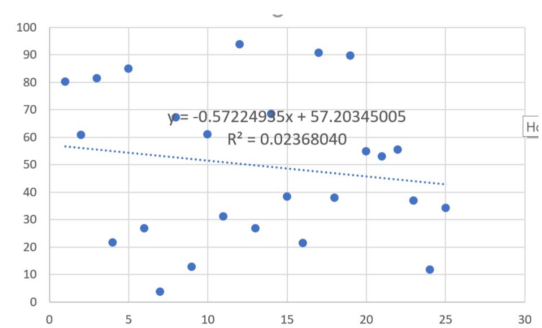
It really means:

Temp = -0.01823706 × **Time** + 100.55867769

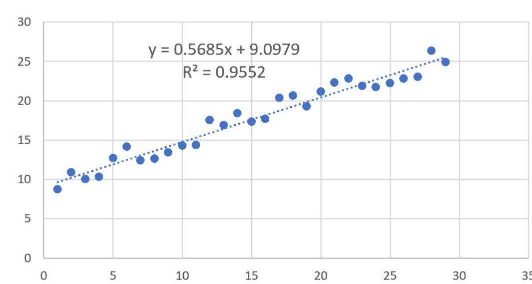
The slope (-0.01823706) is *negative* because the temperature is *DROPPING* at a rate of 0.01823706 degrees Celsius per second (rise/run = °F/sec for units).

What is R^2?

In these exercises, R^2, also know as the correlation coefficient, is a value that indicates how well your data fits a straight line. The closer R^2 is to "1" the better the data fits a straight line.



For example, in the graph at right, the R^2 is near zero: approximately 0.0236. We tells us that a straight line doesn't match our data very well. (In fact, this graph was created from random data!)



On the other hand, the data in the second graph is visibly much closer to being on a straight line! Consequently, R^2 = 0.9552, is much closer to "1". Points on a perfect straight line will yield R^2 = 1.00

At the end of the day…

1. Don't leave lab today without knowing you have a secure, intact and accessible Excel file!!!

2. Be sure to SHUT DOWN the computer and put away all Logger pro accessories, the laptop charger and the laptop computer in their correct locations.

3. Leave your cleaned and dried glassware neatly on the benchtop. The next lab section will re-use your equipment.

4. Wipe the benchtop with a damp SPONGE available at the sinks. Do not leave the lab counters covered in water.

5. Have your instructor sign your data sheet (Next page) before you leave. You will not receive credit without an instructor's signature and date.

Prelab Questions: Answers!

1. It lets the computer know what the temperature probe reads.
2. Look for loose connections or missing connections. Make sure the computer is attached to the LabPro device by the USB cable. Make sure the temperature probe is plugged into Channel 1
3. About 300 seconds (5 minutes)
4. When heat energy is lost by a material it's temperature frequently drops. This corresponds to region "C".
5. The lowest temperature reached must be between five and 15 degrees Celcius.
6. Excel
7. An equals sign
8. Scatter plot. Never use the "Line graph" option.
9. Weight (Y)
10. 1.443 (positive)
11. The R^2 value will be close to "1"
12. Eight
13. Clean up. Neatly put away all cables, computers, & glassware. Wipe down all surfaces with a wet sponge. Lastly, obtain the instructor's initials and date.

C1151 Data Sheet
Computer Survival Skills
Instructor Initials_____

Name_______________________
Date of Exp. _________________
Lab Section _________________

- Your individual experimental report will be due at the beginning of the next lab session.
- Staple a printout of the Excel graph (No Data Tables) to this report.
  (Click on the graph before printing to print only the graph.)

Answer the following questions. (Your answers in your words. No credit given for copied answers)

1. a. In Region 1, the temperature drops because heat is lost by the hot water. Where is hot water's heat energy going?

   ____

   b. How does the temperature change when heat energy is gained? What region on your graph corresponds to the water gaining heat energy?

   ____

   c. If no ice is added in this experiment, what temperature will be eventually reached by the hot water if we wait long enough?

   ____

2. a. What are the slope values (include sign) for regions 1 & 3.

   ____

   b. Explain why these slopes have different signs
   (The words "heat energy" and "temperature should be used in your answer).

   ____

   ____

   ____

3. How will regions #1 and #3 on your graph change if the experiment is conducted in a highly insulated Styrofoam cup instead of a beaker?

   ____

   ____

4. The temperature probe you used is only sensitive at its very tip. Knowing this, why is it important not to let the temperature probe touch the bottom or sides of the beaker while making temperature measurements?

   ____

   ____

5. Use your trendline equation for Region #1 to determine approximately how long in hours it would take the hot water to cool to room temperature if no ice was added. Show all work below for credit.