

Boil, Toil, and Trouble: The International Boiling Point Project Data Analysis

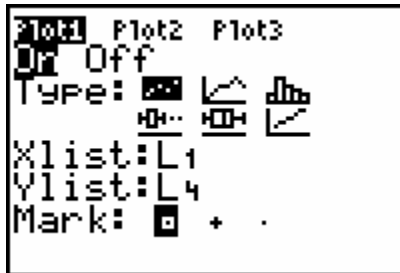
Step 1: Plotting and Analyzing the Data

Make 3 graphs and 1 chart using the results from all schools to see which variable in the experiment has the strongest correlation to boiling point. The variable that has the strongest correlation to boiling point is the factor that is most responsible for making water boil.

Using the STAT capabilities of the calculator, enter the data into lists as described below.

- Volume of Water into L₁
- Elevation into L₂
- Average Room Temp into L₃
- Average Boiling Point into L₄

Your first graph should plot volume of water vs. average boiling point. Set up your stat plot (2nd then Y=) to look like this:



This set-up puts volume of water on the x-axis (as the independent variable) and average boiling point on the y-axis (as the dependent variable). Then press WINDOW to set the range for your graph. Use an Xmin that is just less than the lowest value in your Xlist and an Xmax that is just higher than your highest value. Do the same for your Ylist values. Remember, putting a value in Xscl and Yscl tells the calculator how often you want a mark on the axes of the graph. Now press GRAPH to see your stat plot. Draw your stat plot below, and record your entries for the WINDOW screen.

FIGURE 1: Average Boiling Point vs. Volume



WINDOW
Xmin=
Xmax=
Xscl=
Ymin=
Ymax=
Yscl=
Xres=

Now find the line of best fit for the points on the graph. Use STAT, CALC, LinReg(ax+b) to enter the screen found on the next page onto your home screen. Recall that "a" is the slope (in math, you use "m") and "b" is the y-intercept.

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LinReg(ax+b) L1,  
L4,Y1
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Equation for Average Boiling Point vs. Volume

Y=

The first symbol in the screen above (L_1) represents your independent variable, the second (L_4) represents your dependent variable, and the third (Y_1) tells the calculator to put the linear equation into your Y= screen. Push ENTER. Then press GRAPH. Draw this line of best fit on the graph you drew above. Use the Y= screen to find the equation for the line of best fit. Write it above (use significant figures to avoid all the extra decimal places).

Now, make a graph of boiling point vs. elevation (by changing L_1 to L_2 in the stat plot screen). Set the window, and do the linear regression to find the best-fit line (change L_1 to L_2 and also change Y_1 to Y_2). Draw the graph here, record the window, and write the equation for the line.

FIGURE 2: Average Boiling Point vs. Elevation



WINDOW

Xmin=
Xmax=
Xscl=
Ymin=
Ymax=
Yscl=
Xres=

Equation for Average Boiling Point vs. Elevation

Y=

Now, make a graph of boiling point vs. average room temperature. Set the window, and do the linear regression to find the best-fit line. Draw the graph here, record the window, and write the equation for the line.

FIGURE 3: Average Boiling Point vs. Average Room Temperature



WINDOW

Xmin=
Xmax=
Xscl=
Ymin=
Ymax=
Yscl=
Xres=

Equation for Average Boiling Point vs. Avg. Room Temp.

Y=

Finally, make a chart that shows the types of heating devices used and the boiling points reached using each kind of device.

type of device	# of schools using that	average boiling point

Step 2: Understanding the Graphs and Charts

We used the calculator to draw a "line of best fit" or "trend line" through the data in each of the 3 graphs. If many of the data points lie on or close to the line of best fit, you can rest assured that there's a good strong relationship between the two variables. In other words, if the line of best fit accurately represents the trend in data, then there is probably a strong correlation between the two variables. If the data is scattered and it is difficult to draw a line of best fit or the data doesn't appear to lie on or near the line of best fit, then there probably is no correlation between the two variables you have graphed.

Knowing the equation of the line will help you predict what the boiling point will be at other points. You could even predict what the boiling point might be for a school in a different location.

Looking at the chart that you constructed, if you see that each type of device always has a boiling point close to the same number, then there probably is a good correlation between boiling point and heating device. If the boiling point varies from device to device, there probably isn't any strong relationship between the two.

Step 3: Drawing Conclusions

Now that you have completed analyzing the data from "Boil, Boil, Toil and Trouble: The International Boiling Project" you will conclude this project with a final report. The format of a laboratory report allows scientists to share their data and conclusions so that others can repeat their steps. Scientists also have to be able to explain their findings. You will also be required to explain what you observed while conducting this lab and analysis. You will do that in an essay as outlined below.

Parameters:

- 2-3 pages with 1 inch margins
- 12 point Times New Roman or Arial
- No spelling or grammar errors

Address the following questions:

1. Which factor in the experiment (room temp, volume of water, elevation, or type of heating device) showed the strongest correlation to boiling point? Give examples of your evidence.
2. What was your original hypothesis? Were you surprised with your results? Were you surprised at the results shared on the Internet?
3. What explanation can you give for your results? (see chapter 9, section 9.6)
4. Pick two cities in the world (outside of Virginia). Find their altitudes (either on the Internet or in a book – check with the media center for help). Using the equation that you found from the graph of average boiling point vs. elevation, calculate the boiling point in each of those two cities. Is it higher or lower than we found here? Why?
5. How important is accuracy of measurements in this experiment? Were there any possibilities for inaccurate measurements in your experiment? What might they be?

Grading Scheme

“A” level paper = Good organization, well-developed statements with evidence, few grammatical or spelling errors, answers each question fully, demonstrates full understanding of the project and the conclusions.

“B” level paper = Good organization, statements with evidence, few grammatical or spelling errors, answers most questions, demonstrates moderate understanding of the project and conclusions

“C” level paper = Fair organization, some statements supported with evidence, spelling and grammatical errors, answers most questions, some confusion about project and/or conclusions

“D” and lower = Poor organization or not given in essay format, lack of evidence given, spelling and grammatical errors, confusion about project and/or conclusions

Directions for Writing a Good Essay

There is more than one way to write a good essay. As you know, there are many different types of essays. If you go to the writing section of a bookstore you can pick up one of the many “How To” books. The outline below is a basic essay format. It works well for many different subject areas and purposes. If you would like to use another format for this assignment, you may. However, make sure that your essay has an introduction, conclusion, and that the middle is not just a jumble of sentences. The sentences in a paragraph should have some connection to each other. You don’t have to answer the questions in any particular order. Also, essays need to have a main idea (the thesis). Each of the paragraphs in your essay needs to relate to this thesis.

Sample Format

- Title (can be serious or cute but must have something to do with the project)
- Introduction (introduce the project, thesis sentence should be the last sentence)
- Take as many body paragraphs as you need. Some of the questions can be grouped into a single paragraph if they seem to go together. Also, use transition words to help your sentences and paragraphs fit together (like however, therefore, also, etc.)
- Conclusion (restate your thesis in slightly different words, answer any remaining questions, and finish up with some final thoughts)

Grading

The project is worth 70 points, and point values are outlined below:

- Data and Analysis (20 total)
 - Graphs with ranges and equation (3 each)
 - Chart (3)
 - Original Data Sheets (8)
- Conclusion Essay (50 total)
 - Questions answered with support (10 for question 1, 5 for each of questions 2-5)
 - Spelling and grammar (5)
 - Interesting introduction with a thesis (5)
 - Fitting conclusion (5)
 - Format (font, margins, etc.) (5)