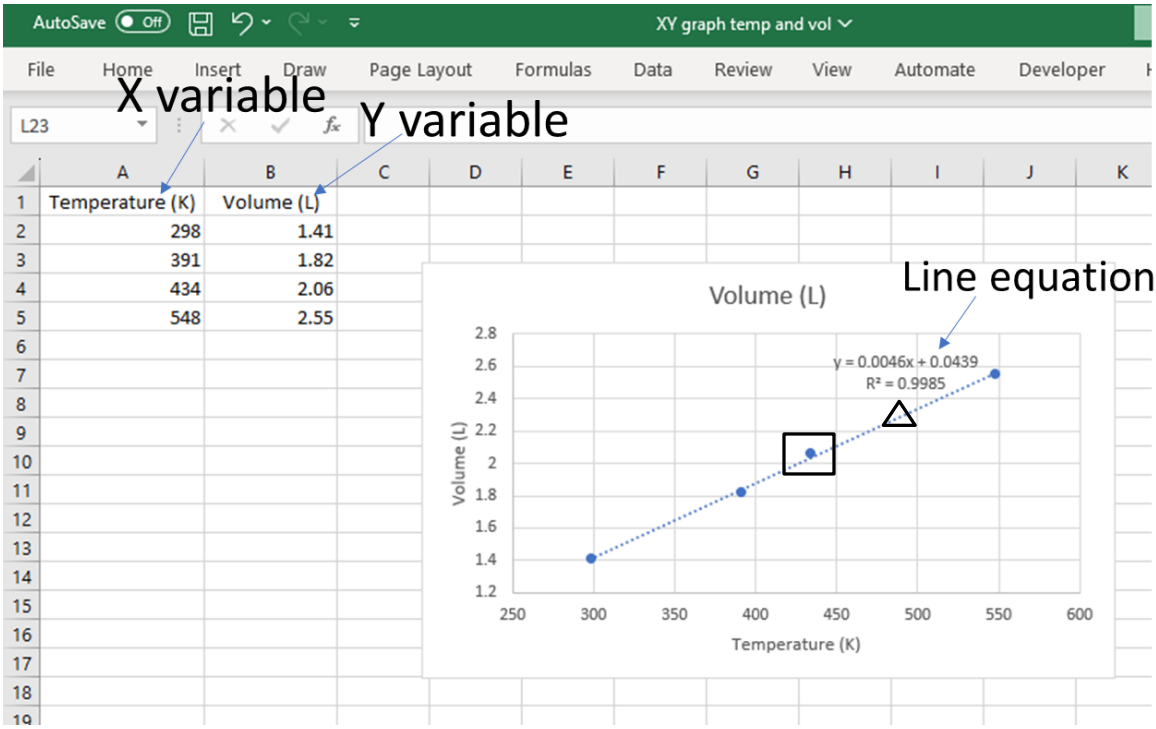
HOW CAN I MAKE THAT ICE MELT?

Group Member: Brodric Young **Group Member:** Clark Willford
Group Member: Kobe Bowser **Group Member:** Chris Johnson

18 minutes to next solid line

Information: The relationship between two sets of data can be examined with an XY scatter plot/graph using a spreadsheet program such as Excel or Google Sheets. The data in the spreadsheet is organized into an independent variable set (called the "X variable") and a dependent variable set (called the "Y variable"). The data can then be fit to a linear trendline. This trendline serves two primary purposes; 1) it evaluates how well the X and Y variables correlate, and 2) it produces a line equation which shows the mathematical relationship between the dependent variable and the independent variable.

Model 1: Graphing the relationship between volume and temperature.



Key Questions:

1. What is the relationship between temperature and volume?

2. What is the X variable? Temperature
3. What is the Y variable? Volume
4. Is Temperature (K) or Volume (L) the independent variable? Temperature

In the graph, the independent variable is the x-axis, and the dependent variable is the y axis. Make sure you can see this.

5. Each XY combination is represented in the graph as a solid circle. Put a small square around the (434 K, 2.06 L) combination in the graph.
6. A dashed trendline is inserted through the data points (or Temperature/Volume combinations). The trendline is a straight line of best fit through the data. How well the data points follow the trendline is indicated by the R^2 value. R^2 can range between 0 and 1. A value of 1 indicates that the data points follow the trend line *exactly*. Examine the R^2 value for the trendline in the model. How well do the data points follow the trendline?

   It's very close, the value is 0.9985 so it's 0.0015 away from exactly.

   Values greater than 0.97 are usually good for CHEM 105L students.
7. What is the line equation for the trendline?

   y = 0.0046x + 0.0439

   You should recognize that the line equation is of the form $y = mx + b$, where m is the slope and b is the y intercept.
8. The line equation allows value for a dependent value to be calculated if the independent value is known. Use the line equation to determine the volume if the temperature is 500 K. Mark this point on the trendline with a small triangle.

   2.3439

9. Constructing the graph from the model yourself. Each member of your group must do this on their own laptop.
   a. Open a blank workbook in Excel.
   b. Place the appropriate labels (Temperature (K) and Volume (L)) in the first two columns. Place the values in the two columns.
   c. Highlight the entire region of the filled cells. Select "Insert" and find the x-y scatter plot option. Make sure the plot is selected which does not connect the lines (see picture).

      
   d. Add axes labels to improve readability. Highlight your chart, select the plus icon next to your chart (see picture), and then select "Axis Titles". Label the x-axis with Temperature (K) and the y-axis with Volume (L).

      
   e. Change the range of values displayed on the x and y axes to improve readability. Select the x axis on your chart. A Format Axis box will appear on the right. Under Bounds change the minimum to 250 and the maximum to 600. Select the y axis on your chart. Change the minimum to 1.2 and the maximum to 2.8.
   f. Insert a trendline through your data by doing the following:
      i. Right-click on any data point on the graph.

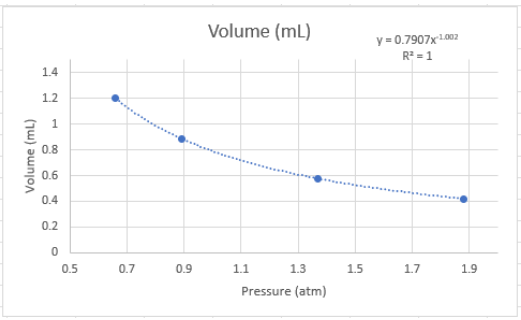
ii. Select the option "Add Trendline".
iii. The options for the trendline appear on the right. Select "Display Equation on chart" and "Display R-squared value on chart". Make sure "linear" is the trendline option selected.

g. Your graph should look like the one in the model. Nice work!!!

Exercises:

10. A pressure-volume relationship was studied, and the following data was obtained.

Pressure (atm)	Volume (mL)
0.659	1.20
0.892	0.887
1.37	0.577
1.88	0.420



a. What is the relationship between pressure and volume?

As pressure increases, volume decreases.

b. Construct a graph with a nice appearance in Excel. Try the different trendline options. Which option offers the best fit for the data? Power With your cell phone, take a picture of the graph with the R^2 value and trendline equation.

Insert picture of the graph with the trendline and R^2 value. Crop and size this picture so that it has a nice appearance.

11. Using the trendline equation, calculate the volume if the pressure is 1.09 atm. How do you know this is a good estimate for the actual volume at this pressure?

0.725. Both the pressure and the volume are between two other data points in the table.

Entire class discussion:

Information: Ice Melt (or deicer) is used to prevent the buildup of ice or to break up pre-formed ice into liquid slush. You are going to set up an experiment, acquire data, and analyze the data to address how Ice Melt performs these functions.

Method development:

Items needed for *each member* of the group: Styrofoam cup (cups on first bench), scoopula, thermometer, 50 mL graduated cylinder, 50 mL beaker, and strainer.

12. What is the freezing point of pure water? 0 °C.
13. There is often some error in a measuring device such as a thermometer. Each person in the group needs to fill their Styrofoam cup about ¼ full of ice. Add a small amount of tap

water and stir with the scoopula (careful not to put a hole in the cup). Take the minimum temperature reading with the thermometer. 0.5 °C.

14. What do you think will happen to the freezing point of pure water if Ice Melt is added?

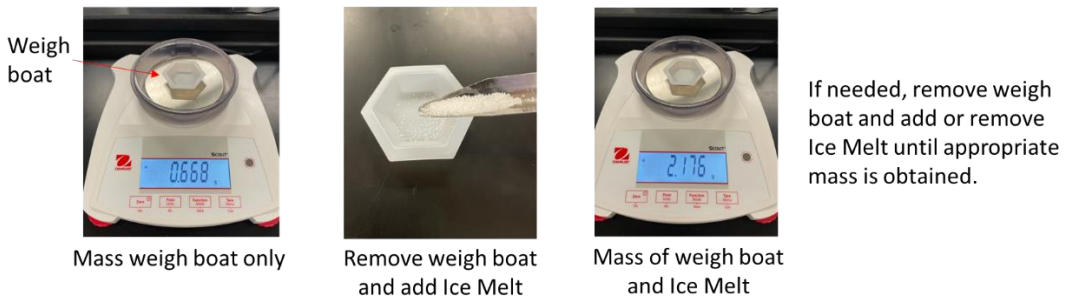
It will decrease

15. You are going to study the change in freezing point of pure water when adding Ice Melt. Describe a method to determine how the freezing point of pure water changes with *increasing* amount of Ice Melt?

We have the freezing point of water without any Ice Melt so now you can just do similar measurements of the temperature with increasing amounts of Ice Melt.

Individual data collection (each person in the group will acquire their own data):

16. Dump out the contents of your Styrofoam cup in the sink.
17. The below information will assist you in setting up the equipment to make the appropriate Ice Melt solution and determine its freezing point.
    a. Determine the mass of a clean, dry 50 mL beaker (place in the table below).
    b. Add water until near the 20 mL mark on the 50 mL beaker and record the mass.
    c. Determine the mass of the water in the beaker (place in the table below). This value should be close to 20 grams. If it is not, add or remove water.
    d. Make a specified Ice Melt solution in the 50 mL beaker with the added water. Each member of the group will make an Ice Melt solution with a different amount of Ice Melt. A group member will have to do more than one if you only have three in your group. Make assignments and circle the mass you will be using.
        i. ~~Approximately 2 g Ice Melt~~
        ii. Approximately 4 g Ice Melt
        iii. ~~Approximately 6 g Ice Melt~~
        iv. Approximately 8 g Ice Melt
    e. Measure out the amount of Ice Melt using a weigh boat and record the mass from the balance (see technique below). Place this value in the table below.



Mass weigh boat only | Remove weigh boat and add Ice Melt | Mass of weigh boat and Ice Melt

    f. Transfer the Ice Melt to the water in the 50 mL beaker and stir until dissolved. Record the maximum temperature of the solution and record below.

g. Fill the Styrofoam cup approximately ½ full of ice and acquire the mass of the cup and ice (place value in table).
h. Pour the Ice Melt solution into the Styrofoam cup and stir gently (don't puncture the cup). Record the minimum temperature and place this value in the table.
i. Using the strainer, carefully remove only the water from the ice-water mixture and put all the remaining ice back in the Styrofoam cup. Record the mass of the Styrofoam cup with the remaining ice and place value in the table.
j. Determine the mass of water originating from the melted ice by subtracting the Styrofoam cup with remaining ice from the Styrofoam cup initially ½ full of ice (place value in table).
k. Determine the final mass of the water in which the Ice Melt is dissolved. This is done by adding the water used to initially dissolve the Ice Melt in the 50 mL beaker to the water originating from the melted ice. Place value in table.

Mass of 50 mL beaker	31.095
Mass of 50 mL with water	50.276
Mass of water added to beaker	19.181
Mass of Ice Melt	4.005
Maximum temperature of dissolving Ice Melt (°C)	35
Mass of insulated cup ½ full of ice	72.455
Minimum temperature (°C)	-5
Mass of insulated cup and remaining ice	59.277
Mass of water originating from melted ice	13.178
Final mass of water dissolving Ice Melt	32.359

18. Calculate the concentration of your Ice Melt solution by dividing the grams of Ice Melt by the final mass of water dissolving Ice Melt. Show your work below.

$$\frac{4.005}{32.359} = 0.124$$

19. Determine the actual freezing point of your Ice Melt solution by *subtracting* the freezing point of pure ice water from the minimum temperature in the table. Show your work.

$$-5 - 0.5 = -5.5$$

<u>Compilation of group data and group analysis:</u>

20. In the table below, input the concentration of the Ice Melt Solution and *actual* freezing point for each group member.

	Ice Melt Concentration	Freezing Point (°C)
No Ice Melt added	**0**	**0**
Approximately 2 grams Ice Melt	0.0696	-3
Approximately 4 grams Ice Melt	0.124	-5.5
Approximately 6 grams Ice Melt	0.154	-6
Approximately 8 grams Ice Melt	0.192	-6

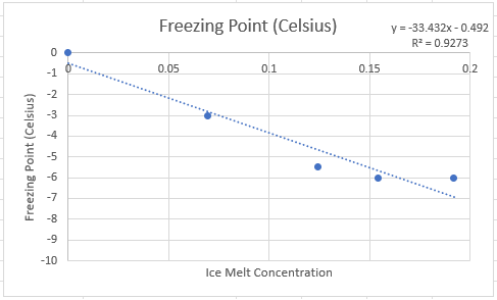
Ask the teacher or lab assistant to check your work for the calculations above before proceeding.

21. What is the correlation between Ice Melt Concentration and actual freezing point?

    The higher the Ice Melt Concentration, the lower the freezing point.

22. Using Excel, each group member will create an XY scatter plot of your group's data (X variable is Ice Melt Concentration). Add a *linear* trendline. If one of the points looks far off the line, perform this concentration again.
    a. What is the equation of your line? $y = -33.432x - 0.492$
    b. What is the R^2 value? 0.9273
    c. With your cell phone, take a picture of your XY scatter plot. The picture needs to display the equation and R^2 value for the line.
    d. The equation you just determined from your Excel graph is called a calibration curve and can be used to calculate the freezing point of an Ice Melt solution with a known concentration. Use your equation to determine the freezing point of an Ice melt solution having a concentration of 0.36. Show your work below.

Insert picture of the



$$-33.432\,(0.36) - 0.492 = -12.528$$

<u>Class data:</u> In the class data sheet (link in Canvas), input the trendline equation and R^2 value for your group.

Make sure all items are clean and return them to the drawer or bench. Finish cleaning any glassware used by rinsing with distilled water. Before you leave, ask the teacher or lab assistant to examine your data and laboratory space. Note: Your data must be entered into the spreadsheet before you leave.

<u>Application of principles (to be completed individually)</u>:

23. From your experiment above, how does Ice Melt prevent the buildup of ice or to break up pre-formed ice into liquid slush?

    It lowers the freezing point so it makes the water have to be a much colder temperature than usual to be frozen into ice.

24. Why is there is a limit to how much Ice Melt can lower the freezing point temperature?

The saturation has a limit where the solute can become only so concentrated and after that it doesn't make much of a difference