Calculating Slope: Soda Can Implosion Activity

Author
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Audience
9th Grade

Duration
1 hour

Purpose: To reinforce calculating slope and the equation of a line. For a closed system of constant volume, the ideal gas law approximates that pressure and temperature will have a linear relationship. The relationship between pressure and temperature can be visualized by a soda can implosion demonstration. When the pressure on the outside of a can is much greater than the pressure on the inside of the can, the can will quickly implode to reestablish equilibrium. After this demonstration, the students will be challenged to measure the slope and calculate the equation of a line describing pressure and temperature data simulated for superheated steam in a can ($V = 10.8 \text{ L/mol}$). It is the goal of this activity that the students can recognize the linear nature of the data and that the equation of a line can be used to fit the data. They can then calculate the slope using two of the data points and the y-intercept using the slope and another data point.

Materials:
Soda Cans, Hot Plate, Tongs, Ice Cold Water Bath, Can Implosion Activity Worksheet

Procedure:
1. Place a small amount of water in the soda can.
2. Heat the soda can on the hot plate until the water boils. Allow the water to boil for approximately 15 seconds.
3. Remove the soda can from the hot plate using the tongs. Place the can in the ice cold water bath with the can opening facing straight down. The can will instantaneously implode. Have each student try imploding a can.
4. Have students complete the Can Implosion Activity Worksheet.

Reference:
Can Implosion Experiment

You have just seen a demonstration of a can imploding when quickly moved from hot to cold temperature. We will now look at some data collected from a similar experiment and use the concept of slope to determine a relationship between pressure and temperature.

Sample Data collected from a can implosion experiment:

<table>
<thead>
<tr>
<th>Temperature (K)</th>
<th>Pressure (atm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>3.80</td>
</tr>
<tr>
<td>600</td>
<td>4.56</td>
</tr>
<tr>
<td>700</td>
<td>5.32</td>
</tr>
<tr>
<td>800</td>
<td>6.08</td>
</tr>
</tbody>
</table>

1. Plot this data on the attached graph paper. **Hint:** Plot Pressure on the y-axis and Temperature on the x-axis.

2. Looking at the data, hypothesize an equation describing the relationship between temperature and pressure.

3. Using the data and your equation above, what is the slope and y-intercept of the equation?
Can Implosion Experiment Solutions

You have just seen a demonstration of a can imploding when quickly moved from hot to cold temperature. We will now look at some data collected from a similar experiment and use the concept of slope to determine a relationship between pressure and temperature.

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1. Plot this data on the attached graph paper. **Hint:** Plot Pressure on the y-axis and Temperature on the x-axis. **See Attached Plot**

2. Looking at the data, hypothesize an equation describing the relationship between temperature and pressure.

\[
Pressure = m \times Temperature + b
\]

3. Using the data and your equation above, what is the slope and y-intercept of the equation?

\[
Slope = \frac{P_2 - P_1}{T_2 - T_1} = \frac{5.32 - 4.56}{700 - 600} = 0.0076
\]

\[
b = Pressure - m \times Temperature = 6.08 - 0.0076 \times 800 = 0
\]

\[
Pressure = 0.0076 \times Temperature
\]