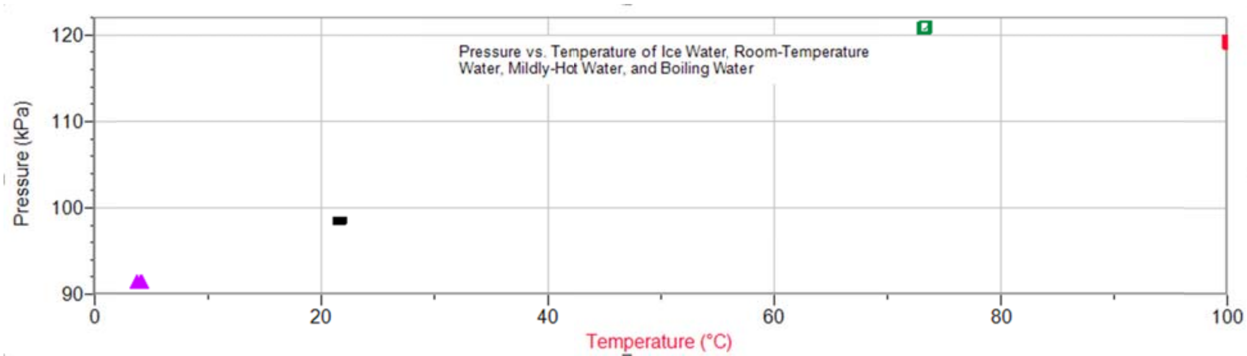
# Pressure-Temperature Relationship in Gases

By Brian Su, Andrew Wang, and Gabriel Lee

Through this lab, the students observed the relationship between pressure and temperature, Gay Lussac's Law. They found a strong positive linear relationship between the two variables, modeled by the following equation: (Pressure in kPa) = 4.753 + 0.318(Temperature in Kelvin). This was determined through the measuring of the pressure of the gas in a 125mL flask in beakers at various temperatures: freezing, room temperature, mildly-hot, and boiling. The students concluded that pressure and temperature are directly proportional to one another.

**Data Analysis**




The above data shows a positive linear association between pressure and temperature. A linear regression test conducted on the above data shows the following linear equation: (Pressure in kPa) = 4.753 + 0.318(Temperature in Kelvin) and an r-squared value of .92, indicating a strong relationship between the two variables. However, it is important to notice that the pressure at 73 degrees Celcius is higher than the pressure at 100 degrees Celcius. This can be explained by the fully submerged beaker during our measurement of the pressure of mildly-hot water and the only half-submerged beaker during our measurement of the pressure of boiling water. To boil water, a hot plate was heating the beaker and its contents at its maximum possible temperature, making submerging the flask with our bare hands dangerous and requiring us to use a ring clamp to suspend the flask into the beaker. Because a 1500 mL beaker was used, it was impossible to lower the entire flask into the beaker, creating an amalgram of room temperature air and boiling hot water surrounding the beaker. Although the temperature of the boiling hot water read 100 degrees Celcius, the flask did not, because of the surrounding room temperature air, thus resulting in a lower pressure reading than that of the former beaker.

1. The two experimental factors that were kept constant were the volume of gas and the volume of the flask.
2. Pressure is directly proportional to temperature.
3. An increase in temperature results in the increase in force and frequency with which the gas particles collide with the walls of a container, thereby increasing the pressure.
4. P=kT
5. The values of 0.329, 0.334, 0.349, and 0.319 are fairly close to one another and can be assumed to be constant.
6. Using a linear regression line, the pressure at 200K should be 68.35kPa, whereas the pressure at 400K should be 131.95kPa.

| EXP. NUMBER | EXPERIMENT SUBJECT | DATE | |
|---|---|---|---|
| | Pressure - Temperature Relationship in Gases | 5/29/12 | |
| NAME | LAB PARTNER | LOCKER/DESK NO. | COURSE & SECTION NO. |
| Brian Su | Gabriel Lee, Andrew Wang | | |

Data

| Pressure (KPa) | Temperature (°C) | Temperature (K) | Constant, K (P/T) ~~or P·T~~ |
|---|---|---|---|
| 91.18 | 4.0 | 277.0 | 0.329 |
| 98.55 | 21.7 | 294.7 | 0.334 |
| 120.77 | 73.4 | 346.4 | 0.349 |
| 119.15 | 100.0 | 373.0 | 0.319 |

Observations

- Condensation was observed on the ice-water bath
- Bubbling in the boiling water bath
- Little action was happening ~~along~~ in the mildly-hot and room temperature beakers

| SIGNATURE | DATE | WITNESS/TA | DATE |
|---|---|---|---|
| | | | |



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## Conclusion

In the "Pressure-Temperature Relationship in Gases" Lab, the students observed a strong positive linear association between pressure and temperature. This directly proportional relationship can be modeled using the following equation obtained through a regression test of the data: (Pressure in kPa) = 4.753 + 0.318(Temperature in Kelvin). Though an anomaly was observed between the pressure of the gases at 73 degrees Celcius and 100 degrees Celcius, it can be explained by the surroundings of the beaker during measuring the pressure (see data analysis).

Multiple errors could have affected the nature of the data in this experiment. On the most basic level, the errors can be accounted by limits in lab design as visual judgments were used in the interpretation of the freezing points on the graphs. Given the complexities and subtleties of the data, visual judgments are an inaccurate method compared to more precise mechanical methods. In addition, the temperature was still changing during the measurements as energy is continuously flowing, thereby altering the data and resulting in crisscrossing data points. Furthermore, the use of 1.5L beakers because of the lack of 1L beakers complicated the fourth set of data, thereby making it not follow the precise trend of the pressure vs. temperature relationship.

From this lab, students observed Gay-Lussac's pressure vs. temperature relationship at work. As temperature increased, so did pressure. To continue studying this relationship, students could observe the heating of a balloon in a confined container or immerse themselves in the mechanics of gas meters. This lab could be improved by keeping the contents of the beaker at a more constant temperature, instead of the rather fluctuating temperature at which the students measured the pressure of the flask at.

Overall, through conducting this experiment, the students gained insight into Gay Lussac's Law and the relationship between pressure and temperature.