# Pressure and Temperature

1. Insert a table of your pressure and temperature data. This table should include pressure, 1/pressure, temperature in Celsius, temperature in Kelvin, and 1/temperature in Kelvin.

**Table 1.** Pressure(kPa), 1/Pressure(1/kPa), Temperature(C), Temperature(K), 1/Temperature(K)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Pressure(kPa) | 1/Pressure(1/kPa) | Temperature(C) | Temperature(K) | 1/ Temperature(1/K) |
| 100.08 | 0.009992066 | 100.0 | 373.15 | 0.002679 |
| 99.57 | 0.010042182 | 95.0 | 368.15 | 0.002715 |
| 98.04 | 0.010200 | 90.0 | 363.15 | 0.002754 |
| 97.20 | 0.010288 | 85.0 | 358.15 | 0.002792 |
| 96.19 | 0.010396 | 80.0 | 353.15 | 0.002832 |
| 94.92 | 0.010535 | 75.0 | 348.15 | 0.002872 |
| 93.98 | 0.010641 | 70.0 | 343.15 | 0.002915 |
| 92.82 | 0.010774 | 65.0 | 338.15 | 0.002957 |
| 91.55 | 0.010923 | 60.0 | 333.15 | 0.003003 |
| 90.45 | 0.011056 | 55.0 | 328.15 | 0.003047 |
| 88.78 | 0.011264 | 50.0 | 323.15 | 0.003096 |
| 87.51 | 0.011427 | 45.0 | 318.15 | 0.003142 |
| 86.34 | 0.011582 | 40.0 | 313.15 | 0.003194 |
| 85.21 | 0.011736 | 35.0 | 308.15 | 0.003246 |
| 83.13 | 0.012029 | 30.0 | 303.15 | 0.003299 |
| 82.95 | 0.012055 | 25.0 | 298.15 | 0.003355 |
| 81.87 | 0.012214 | 20.0 | 293.15 | 0.003411 |
| 80.57 | 0.012412 | 15.0 | 288.15 | 0.003471 |
| 79.36 | 0.012601 | 10.0 | 283.15 | 0.003532 |
| 77.73 | 0.012865 | 5.0 | 278.15 | 0.003596 |
| 76.20 | 0.013123 | 0.4 | 273.55 | 0.003656 |

1. Insert a graph of pressure vs temperature (in K).

**Graph 1.** Pressure vs Temperature(K)

1. Insert a graph of 1/pressure vs temperature in K.

**Graph 2.** 1/Pressure(1/kPa) vs Temperature(K)

1. Using your data, explain whether pressure and temperature are directly or inversely proportional.

Pressure and Temperature are directly proportional because the graph of Pressure vs Temperature shows a linear line, while inverse graph of 1/Pressure vs Temperature shows a linear relationship, but negatively. This is shown as one variable increases, so does the other.

1. Using the plot that best describes the relationship between pressure and temperature, predict what the pressure (in kPa) of the system would be if the temperature of your system was 200 °C. Show all your work for full credit.

Y = 0.24090473X + 10.93037959

X = ( Temp(c) + 273.15)

X = 473.15

Y = 0.24090473(473.15) + 10.93037959

Y = 124.91445259

So the pressure would be 124.91445259 kPA.

1. Insert a graph of pressure vs temperature in Celsius.

**Graph 3.** Pressure(kPa) vs Temperature(C)

1. Calculate the value of absolute zero (in Celsius) based on your data. Show all work for full credit.

y = 0.24090473x + 76.73350793

0 = 0.24090473(tempabs\_zero) + 76.73350793

-76.73350793 / 0.24090473 = tempabs\_zero

tempabs\_zero = -318.51 C

1. Is your value in agreement with the known value of absolute zero? What are some factors of this experiment that could cause a deviation?

My value of -318.51 C is less than the known value of absolute zero, -273.15 C or 0 K. Some factors that may have caused this deviation is that the air that we used was not exactly ideal and the machine error that may have occurred. So the air that we used, wasn’t exactly pure oxygen, as it was a blend of O2 and CO2 and isn’t in any way an ideal gas. But we assumed the air was ideal (PV= nRT), so we’re not going to get a very exactly precise absolute zero temperature. Other factors being that our pipes may leak over time, our sensors aren’t giving us precise, accurate readings. These issues can shift the line of best fit up so that our x intercept becomes more negative. This makes sense in our instance, as -318.51 is more negative than true absolute zero. The temperature sensor not reading exactly the true temperature, and either the temperature of the beaker, or the ice at contact may also have caused the obtained values to not be precise.

1. Explain the pressure-temperature relationship using the concepts of molecular velocity and molecular collisions.

Molecular velocity is directly proportional to temperature. If a substance becomes hotter and increases in temperature, the individual molecules’ velocities are higher, and this means the faster particles are striking the walls of the container faster and with more force, this leads to an increase in pressure, due to the equation for Pressure being

# Pressure and Volume

1. Insert a table of your pressure and volume data. This table should include pressure, 1/pressure, and volume in mL.

**Table 2.** Pressure(kPa), 1/Pressure(kPa), Volume(mL)

|  |  |  |
| --- | --- | --- |
| Pressure(kPa) | 1/Pressure(1/kPa) | Volume(mL) |
| 194.7 | 0.0051361 | 5 |
| 125.33 | 0.0079789 | 8 |
| 100.87 | 0.0099138 | 10 |
| 85.13 | 0.011747 | 12 |
| 73.11 | 0.013678 | 14 |
| 64.53 | 0.015496 | 16 |
| 57.6 | 0.017361 | 18 |

1. Insert a graph of pressure vs volume.

**Graph 4.** Pressure(kPa) vs Volume(mL)

1. Insert a graph of 1/pressure vs volume.

**Graph 5.** 1/Pressure (1/kPa) vs Volume(mL)

1. Using your data, explain whether pressure and volume are directly or inversely proportional.

Pressure vs Volume, we can see that it’s an inverse relationship, because the graph of P/V shows a downwards trend. When compared to the 1/P vs V graph, we see that the inverse has basically linearized the data, and has a much better linear fit, given the almost 1 R2 value.

1. Using the plot that best describes the relationship between pressure and volume, predict what volume (in mL) would result in a pressure of 10.0 kPa. Show all your work for full credit.

y = 0.00094048x + 0.00046440

1/10.0 = 0.00094048x + 0.00046440

.1 – 0.00046440 = 0.00094048x

X = (.1 – 0.00046440) / 0.00094048

X = 105.85 mL

1. Explain the pressure-volume relationship using the concepts of molecular velocity and molecular collisions.

If we already stated and understand that Pressure is caused by molecules hitting the walls of a container, reducing the volume and size of the container effectively reduces the area that the molecules can strike, meaning more molecules are likely to cover the smaller area more often, as they have to travel less, and reach smaller distances. But if we expanded the volume, keeping n,T constant, than the molecules have to travel farther, and cover more surface area, meaning that they hit the container walls much less, meaning that Pressure is decreasing. So as volume increases, pressure decreases, indicating a inverse relationship.

# Conceptual Understanding

1. You performed this experiment using air, which we know is a mixture of several gases. Would the results of this experiment be improved if we used a sample of pure nitrogen? Why or why not?

N2 Gas is much more of a truly idea gas, as compared to air. The air we use in our experiments is a solution of many gases, and is in no way ideal. However, if we used an ideal gas like N2, we’d be able to get much more accurate experiment results, as ideal gases follow the law of PV = nRT much better than regular gases, meaning that we would have gotten better sample data, and most likely more accurate calculations, especially for the absolute zero calculation.

1. A student plots their data after performing this experiment and has the following graph. They checked that the pressure and temperature probe were properly calibrated and functioning properly. What happened during the experiment to cause this? Explain in great detail (think molecular level) what is happening at the beginning, middle, and end of the experiment. Use your knowledge of Kinetic molecular theory.

# Pressure (kPa) vs Temperature (K)

88

90

92

94

96

98

100

102

290

300

310

320

330

340

350

360

370

380

Pressure (kPa)

Temperature (K)

***Figure 1****.* Empirical relationship between pressure and temperature. But the end looks a little funky.

The beginning of the experiment starts at approximately 370 kelvin, and the student started to put in ice, to cool down the water, and slow down the molecules as temperature decreased, leading to pressure decreasing. We see a direct, linear proportion until 340K. But using our equation PV=nRT, the cork or the pipes or the stopper or something must have loosened, letting our enclosed vial of air escape, and even though the student kept putting in ice to cool down the beaker, the pressure slowly came back to atmospheric pressure.

## Lab Notebook Pages

Attach **ALL** lab notebook pages for this experiment.





