LAB SHEET · SIMULACIENCIA

Lab sheet: Gay-Lussac's law

Name	Class	Date	Set-up number

Aim

To find out how the pressure of a fixed amount of air changes when its temperature changes, without changing its volume, and to estimate the temperature at which the pressure would be zero.

Background

A trapped gas pushes on the walls of its container: that is its **pressure** (P). Here it is measured in kilopascals (kPa).

If we trap air in a rigid container, its volume cannot change. When it is heated, its pressure rises; when it is cooled, its pressure falls. **Gay-Lussac's law** (the pressure law) says that, at constant volume, pressure is proportional to absolute temperature:

P / T = constant

The temperature T must be in **kelvin** (K). To convert from degrees Celsius (t, in °C) to kelvin, add 273:

T = t + 273

To test it, you trap air in a flask, put the flask in a water bath, heat the water and read the temperature and the pressure. If the law holds, P / T should come out almost the same in every measurement.

Equipment

The practical is done in the simulated lab at simulaciencia.es/en/simulations/practica-gay-lussac, at the **Open** level.

- 250 mL flask closed with a stopper and connected by a tube to a three-way valve. The lever points to the outlet it closes: **pointing up**, the flask is open to the room air; **pointing down**, the air in the flask is trapped.
- Digital absolute pressure gauge (reads to 0.1 kPa).
- Thermometer from −10 to 110 °C (each mark is 1 °C) and a magnifier to read it.
- 600 mL beaker with ice water, on a hot plate with a stirrer.
- Lab jack with three heights: down, halfway and up.
- The set-up number your teacher gives you.

Before you start

Answer these before measuring.

1. Why must you close the valve before heating? What would happen if it stayed open?
2. Why must you raise the lab jack all the way up, so that the water covers the whole flask?

3. The hot plate stays hot after you switch it off. When will you switch it off if you want to measure at about 40 °C? Why must you wait before reading?

Answers

Method

1. Choose your set-up number in the panel.
2. With the valve **open** and the lab jack **down**, take the magnifier to the thermometer and read the room temperature. Put the yellow eye line at the end of the red column. Also read the pressure gauge: as the valve is open, it shows the room pressure. Write both in measurement 1.
3. Close the valve (lever pointing down). Do not open it again from now on.
4. Raise the lab jack all the way **up** so that the ice water covers the flask. Wait for the thermometer and the gauge to stop and write down measurement 2.
5. Switch on the hot plate and the **stirrer**. When the water is a few degrees below the temperature you want, switch the hot plate off. Wait for the thermometer and the gauge to stop, and write down the measurement.
6. Repeat step 5 until you have measurements near 20, 40, 60 and 80 °C. The hot plate switches itself off at 90 °C.

Results table

Measurement	Temperature t (°C)	Pressure P (kPa)	Temperature T = t + 273 (K)	P / T (kPa/K)
1 (room, valve open)				
2 (ice water)				
3				
4				
5				
6				

Calculations

Write each calculation with its numbers and units.

Calculation	Working and result
P / t with the temperature in °C, for measurements 4 and 6	
P / T with the temperature in kelvin, for the same measurements	
Mean of P / T	

Graph

On graph paper, plot pressure (vertical axis, from 0 to 120 kPa) against temperature in °C (horizontal axis, from −300 to 100 °C). Mark your points, draw the line of best fit with a ruler and extend it until it crosses the P = 0 axis.

Temperature at which the line reaches P = 0: ..... °C

Questions

1. Is P / t the same with the temperature in °C? And P / T in kelvin? Why do you think you need to use kelvin?
2. At what temperature does your line cross the P = 0 axis? What would it mean to cool the air below that temperature?
3. While there was still ice, the hot plate was giving out heat, but the water did not go above 0 °C. Where was that heat going?
4. What would have happened to your measurements if you had not waited for the thermometer and the gauge to stop? And if you had left the lab jack halfway?
5. Use the particle model to explain why the pressure of the air rises when it is heated.

Answers

Conclusion

Explain in a few lines how the pressure and temperature of a gas are related at constant volume, how you showed it, and what value you got for absolute zero.

Conclusion

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