




## Experiment C-14 Gay-Lussac's Law



### Objectives

- To learn about the Ideal Gas Law and Gay-Lussac's Law.
- To investigate the relationship between temperature and pressure in a sealed chamber while heating it up.

### Modules and Sensors

- PC + NeuLog application
- USB-200 module 
- NUL-203 Temperature logger sensor 
- NUL-210 Pressure logger sensor 

### Equipment and Accessories

▪ Gas study device	1
▪ Perforated rubber stopper	2
▪ Non-perforated rubber stopper	1
▪ 50 ml syringe	1
▪ Candle	3
▪ Lighter	1

- The items above are included in the Gas kit, GAS-KIT.

## Introduction

An ideal gas can be characterized by three parameters: pressure, volume and temperature, for a certain amount of gas. The law that shows the relationship between these factors is called the **Ideal Gas Law:  $PV = nRT$**  where **P** is the pressure of the gas (in atm units), **V** is its volume (in L units), **n** is the number of moles (one mol =  $6.022 \cdot 10^{23}$  molecules), **R** is the gas constant (atm\*L)/(mol\*K) and **T** is its temperature (in K units).

Suppose we double the temperature (in K) of a sample of gas while the volume and number of molecules remain the same. The pressure will also be doubled. According to Gay-Lussac's law, for a given amount of gas held at a constant volume, the pressure is proportional to the absolute temperature.

$$P = K_G T \text{ and } P_1 T_2 = P_2 T_1$$

$K_G$  is the proportionality constant ( $K_G = n \cdot R / V$ ).

In this activity, we will raise the temperature of a gas in a container while keeping the volume constant, in order to measure how this affects the pressure of the gas.

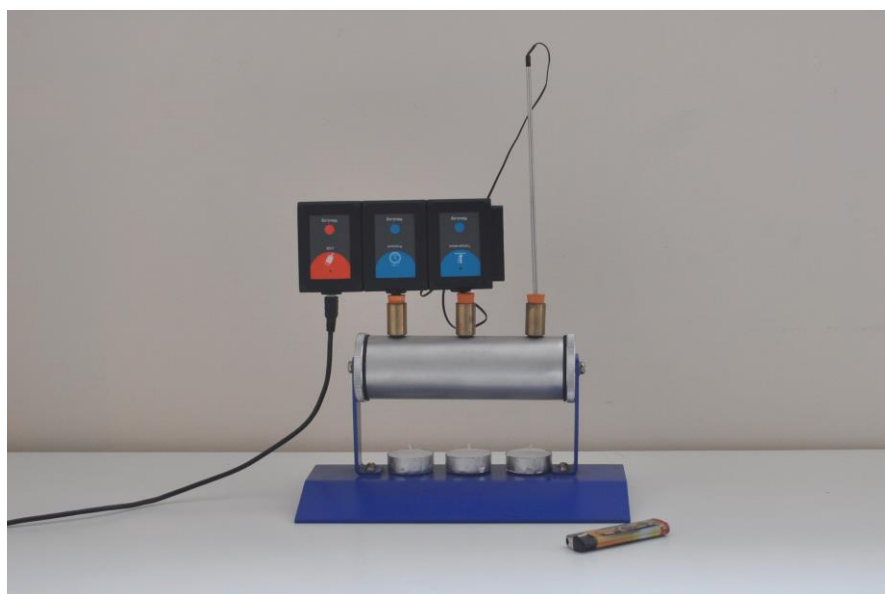
## Procedure

### Experiment setup

Note:




You will be working with an open flame. Make sure not to have any flammable material in the proximity of the experiment. Be very careful when working with high temperatures.

1. Set up the experiment as shown in the picture below.



2. Place the two perforated stoppers and the non-perforated stopper in the device. Each perforated stopper should be at one end.
3. Insert the temperature sensor probe in one perforated stopper.
4. Optional check: to verify that there is no air leak, insert a syringe with its plunger at the 50 ml position in the other perforated stopper. Press the syringe's plunger, release it and watch the plunger going back to the starting position. Remove the syringe and put the pressure sensor in its place.
5. Place three candles under the device (do not light them yet).

## Sensor setup

6. Connect the USB-200 module  to the PC.
7. Check that the temperature  and the pressure  sensors are connected to the USB-200 module in a chain.

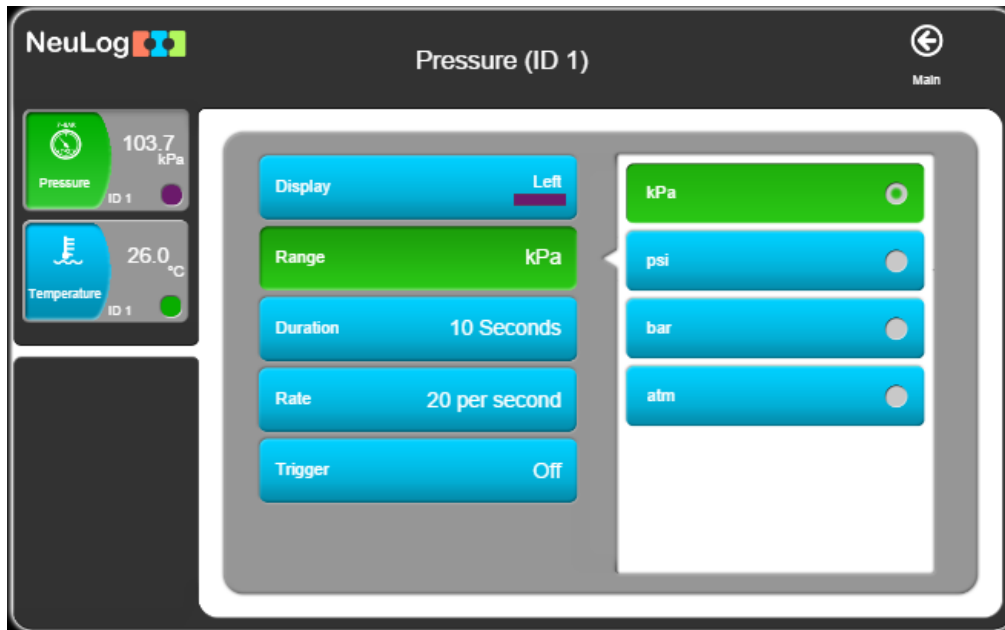
### Note:



The following application functions are explained in short. It is recommended to practice the NeuLog application functions (as described in the user manual) beforehand.

8. Run the NeuLog application and check that the sensors are identified.

## Settings

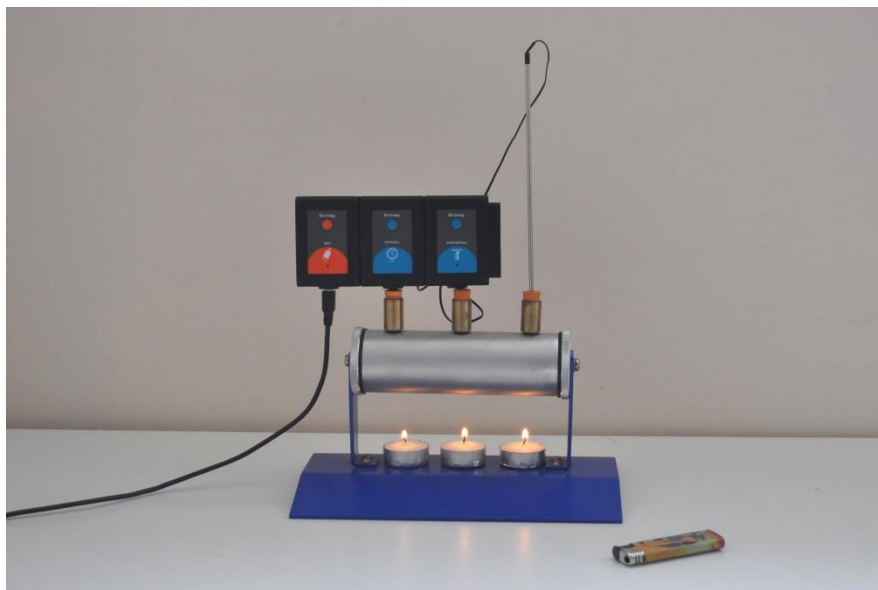
9. Click on the pressure **sensor's module** box.
10. Select the kPa button to change the sensor's mode.







11. Click on the  icon to go back to the graph.
12. Click on the **Run Experiment** icon  and set the:  
Experiment duration to 2 minutes  
Sampling rate to 5 per second

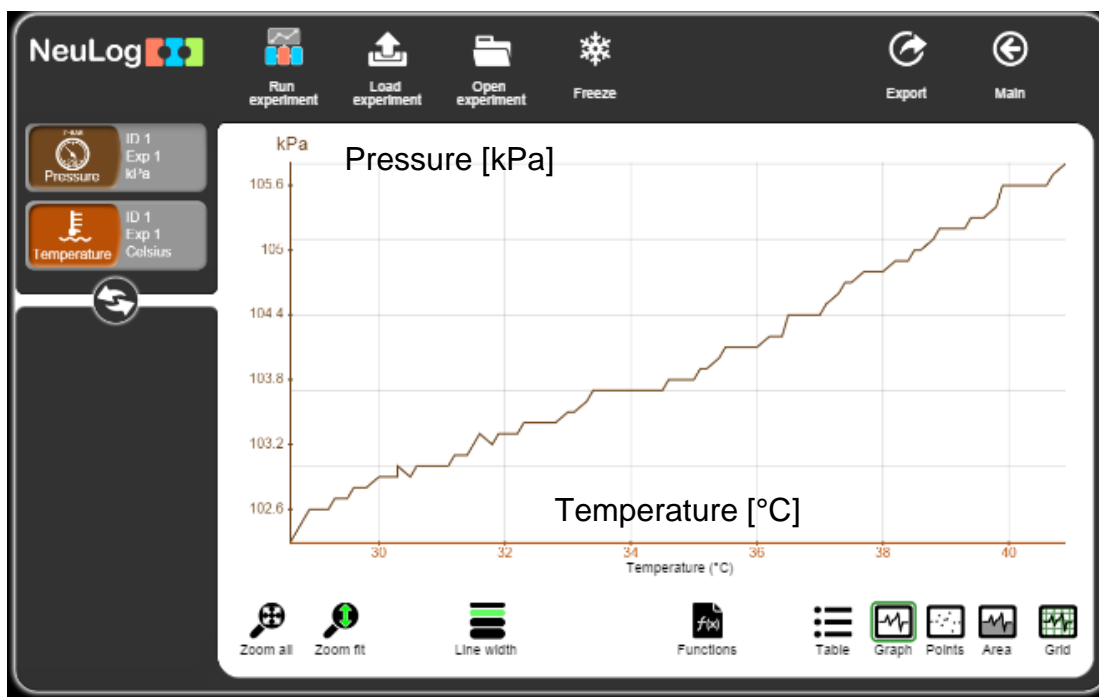
## Testing and measurements

- Carefully light the candles and wait about 30-60 seconds before starting the measurement.



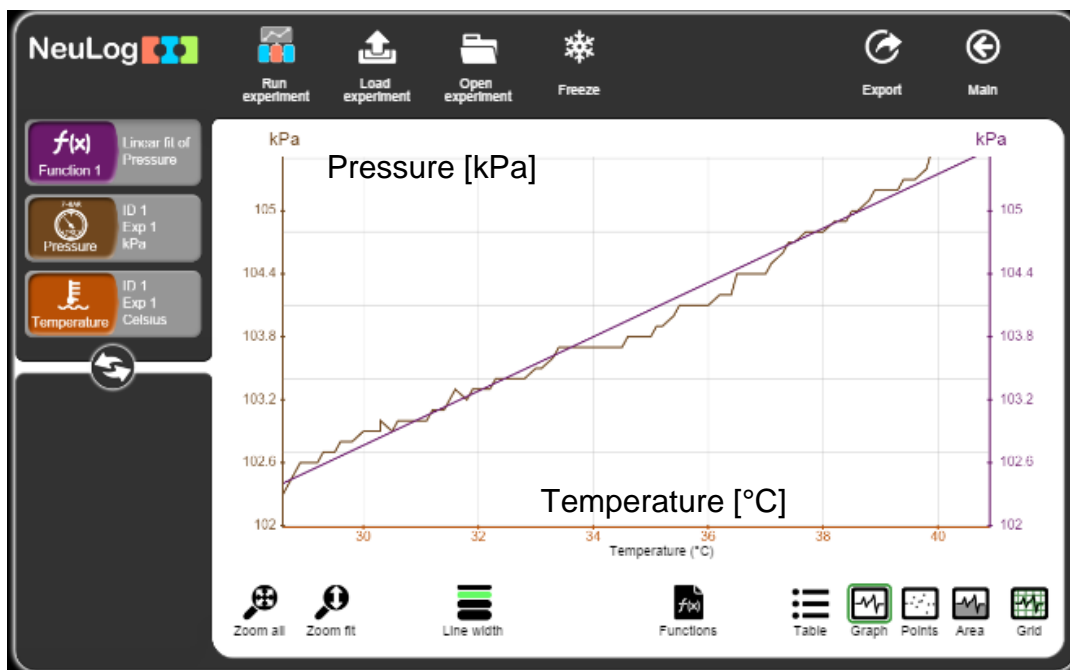
- Click on the **Record** icon  to start the measurement. If the temperature reaches 50 °C stop the measurement. It is recommended to hold the pressure sensor's body during the measurement.
- Click on the **Arrows** icon  in order to see the sensor's values during the measurement.
- Blow off the candles after the measurement is over and do not touch the device while it is still hot.
- Click on the **Functions** icon .
- Click on the **x axis** button and choose the **Temperature** sensor as the x axis (after clicking on "sensor").
- Click on the **Zoom fit** icon .

20. Your graph should be similar to the following:



21. Click on the **Export** Icon  and then on the **Save value table (.CSV)** button to save your graph.
22. Click on the  icon to go back to the graph.
23. Click on the **Functions** icon . Make sure that Parameter A is **Pressure**.

24. Click on the **Functions** button on the left of the screen and then click on the **Linear fit of A** button.
25. Click on the Linear fit module on the left side of the screen to get the equation.



26. You will get an equation that describes the relation between temperature and pressure in the gas device.



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## Summary questions

1. Were you able to get a straight line? What would have been the pressure if you had kept heating the device to 50° C?
2. Explain the connection between temperature and pressure in terms of molecule velocity.
3. What happens when you heat up an elastic balloon? Explain your answer by using the Ideal Gas Law:  $PV = nRT$ . What is the name of the specific law that describes what happens?