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Activity C12: Dalton's Law of Partial Pressure (Pressure Sensor)

Concept	*DataStudio*	*ScienceWorkshop* (Mac)	*ScienceWorkshop* (Win)
Gas laws	C12 Partial Pressure.DS	C12 Dalton's Law	C12_DALT.SWS

Equipment Needed	**Qty**	**Chemicals and Consumables**	**Qty**
Pressure Sensor (CI-6532A)	1	Calcium hydroxide solution	15 mL
Bottle (or flask), 250 mL	1	Candle	1
Connector, rubber stopper (w/sensor)	1	Clay, modeling	10 g
Graduated cylinder	1	Matches	1 bk
Rubber stopper, two-hole	1	Tape	1 roll
Tubing, plastic (w/sensor)	1		
Protective gear	PS		

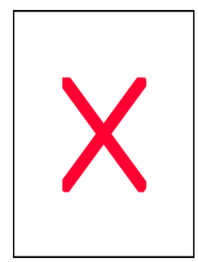
(*SAFETY CAUTION! Be very careful around any flame!)

What Do You Think?

How can you use Dalton's Law of Partial Pressure to determine the approximate percentage of oxygen and nitrogen in the air?

Take time to answer the 'What Do You Think?' question(s) in the Lab Report section.

Background



Dalton's Law of Partial Pressure states that the total pressure of a gas is equal to the sum of the pressure of each individual gas at a specific temperature.

$$P_t = \Sigma P_i$$

Where P_t is the total pressure of the gas and P_i is the pressure of each individual gas.

The combination of all the partial pressures of the gases that make up the atmosphere gives the total pressure of the atmosphere. The average pressure of the atmosphere is 101 kilopascals (kPa). Most of the pressure of the atmosphere results from nitrogen. Oxygen is the second most common gas in the atmosphere. The concentrations of carbon dioxide, argon, helium and xenon are so minor that they contribute very little to the overall pressure of the atmosphere.

Remove the oxygen in the atmospheric mixture in order to determine the amount of nitrogen in the atmosphere.

Be careful with matches and be careful with the burning candle.

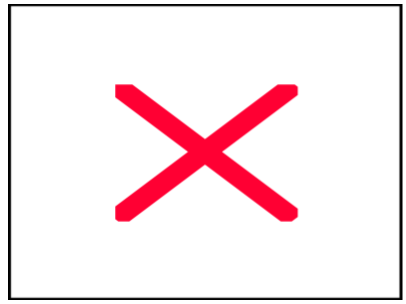
SAFETY REMINDERS

- Wear protective gear.
- Follow directions for using the equipment.
- Handle and dispose of all chemicals and solutions properly.

For You To Do

A burning candle consumes oxygen. If the candle burns in a closed container and you use a chemical to remove the carbon dioxide produced, the pressure in the container should decrease due to the removal of oxygen. The remainder of the partial pressure will be assumed to be due to nitrogen.

Use the Pressure Sensor to measure the change in pressure as a candle burns inside a container. Use calcium hydroxide to absorb carbon dioxide gas released during combustion. Use *DataStudio* or *ScienceWorkshop* to record and display the data. Use your data to determine the approximate percentage of oxygen in air.



PART I: Computer Setup

1. Connect the *ScienceWorkshop* interface to the computer, turn on the interface, and turn on the computer.
2. Connect the DIN plug of the Pressure Sensor to Analog Channel A on the interface.
3. Open the file titled as shown;

DataStudio	*ScienceWorkshop* (Mac)	*ScienceWorkshop* (Win)
C12 Partial Pressure.DS	C12 Dalton's Law	C12_DALT.SWS

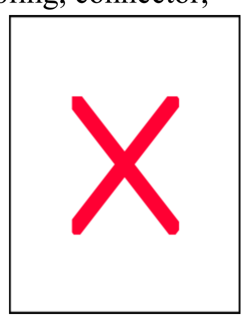
- The *DataStudio* file has a Graph display. Read the Workbook display for more information.
- The *ScienceWorkshop* document has a Graph display with a plot of the pressure versus time.
- Data recording is set at two measurements per second (2 Hz).

PART II: Sensor Calibration and Equipment Setup

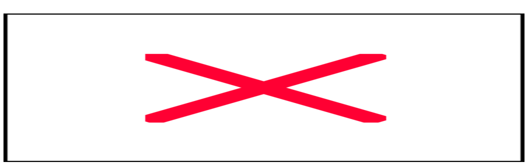
You do not need to calibrate the sensor.

Set Up the Equipment

- For this part you will need the following: glycerin, quick-release coupling, connector, plastic tubing, one-hole rubber stopper, Pressure Sensor, clay, straw, tape, candle.



1. Put a drop of glycerin on the barb end of a quick release coupling.



Put the end of the quick release coupling into one end of a piece of plastic tubing (about 15 cm) that comes with the Pressure Sensor.

2. Put a drop of glycerin on the barb end of the connector. Push the barb end of the connector into the other end of the plastic tubing.
3. Fit the end of the connector into the hole in the rubber stopper.

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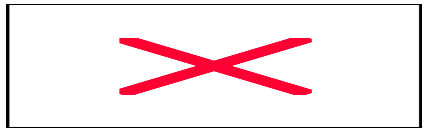
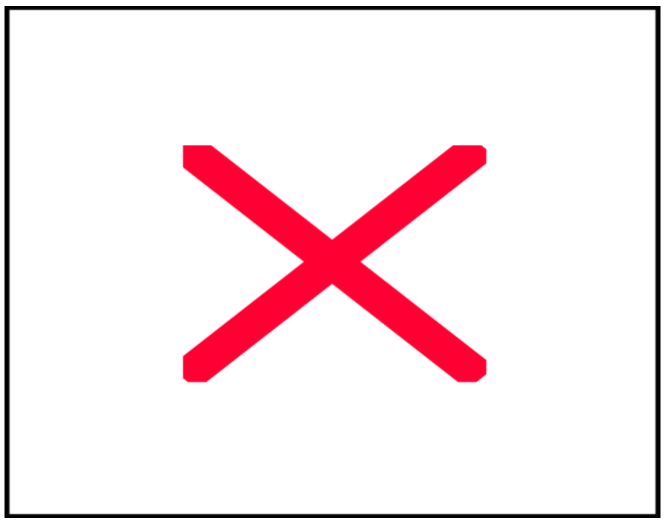
4. Align the quick-release coupling on the end of the plastic tubing with the pressure port of the Pressure Sensor. Push the coupling onto the port, and then turn the coupling clockwise until it clicks (about one-eighth turn).



5. Use a piece of clay to attach the candle to bottom of the rubber stopper. (Note: Do not let the clay cover the hole.) Make sure that when the rubber stopper is put into the bottle (or flask), the tip of the candle is at least halfway into the bottle. (Note: Use a straw and tape to extend the distance of the candle into the bottle if needed.)



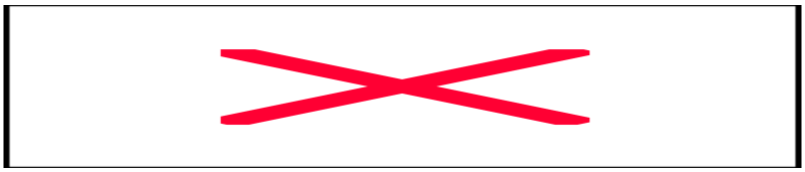
Set Up the Bottle

6. Put 15 mL of saturated calcium hydroxide solution into the bottle.

- When you are ready to record data you will hold the bottle sideways. Then you will light the candle and put the candle/rubber stopper into the bottle.

PART III: Data Recording

1. When you are ready, light the candle. Start recording data. (Hint: Click ‘Start’ in *DataStudio* or click ‘REC’ in *ScienceWorkshop*.)
2. Tilt the bottle sideways. Insert the burning candle and then CAREFULLY but quickly force the rubber stopper into the top of the bottle. Be sure there is a tight seal between the rubber

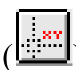
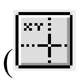


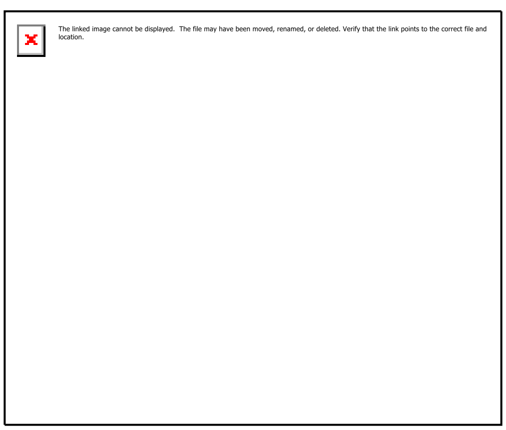
stopper and the bottle. Hold the bottle sideways as the candle flame burns.

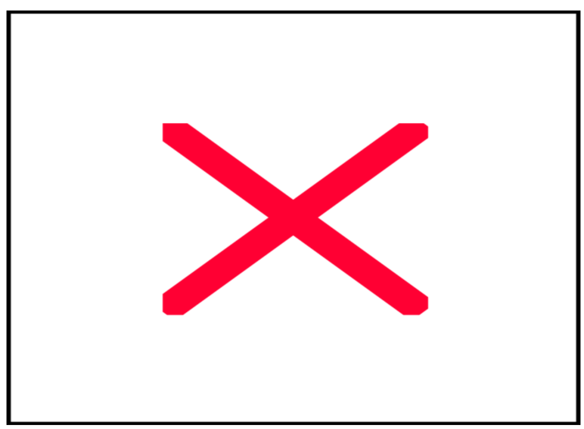
3. When the candle flame is completely extinguished, stop recording data.
4. Remove the candle/rubber stopper from the bottle. Fill the bottle with water to rinse out the products of combustion.
5. Dispose of the water as instructed.

Analyzing the Data

1. Use the Graph display to find the initial pressure inside the bottle and the final pressure after the candle flame went out.

- (Hint: Use the ‘Smart Tool’ () in *DataStudio* or the ‘Smart Cursor’ () in *ScienceWorkshop*.)





2. Record the initial and final pressures in the Lab Report section.

Record your results in the Lab Report section.

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Lab Report - Activity C12: Dalton's Law of Partial Pressure

What Do You Think?

How can you use Dalton's Law of Partial Pressure to determine the approximate percentage of oxygen and nitrogen in the air?

Data Table

Data	Measurement	Value
1	Starting pressure (O_2 + N_2)	kPa
2	Ending pressure (N_2 alone)	kPa
3	Change in pressure (O_2 alone)	kPa
4	Percentage of O_2 in air (Data 3 ÷ Data 1)	%
5	Percentage of N_2 in air (Data 2 ÷ Data 1)	%

Questions

1. How does your calculated value for the percentage of oxygen in air compare to the accepted value?

2. How does your calculated value for the percentage of nitrogen in air compare to the accepted value?

3. What are possible sources for error in this experiment?