Chemistry 101 Laboratory
Fall 2005 - 2006

Lecture 6

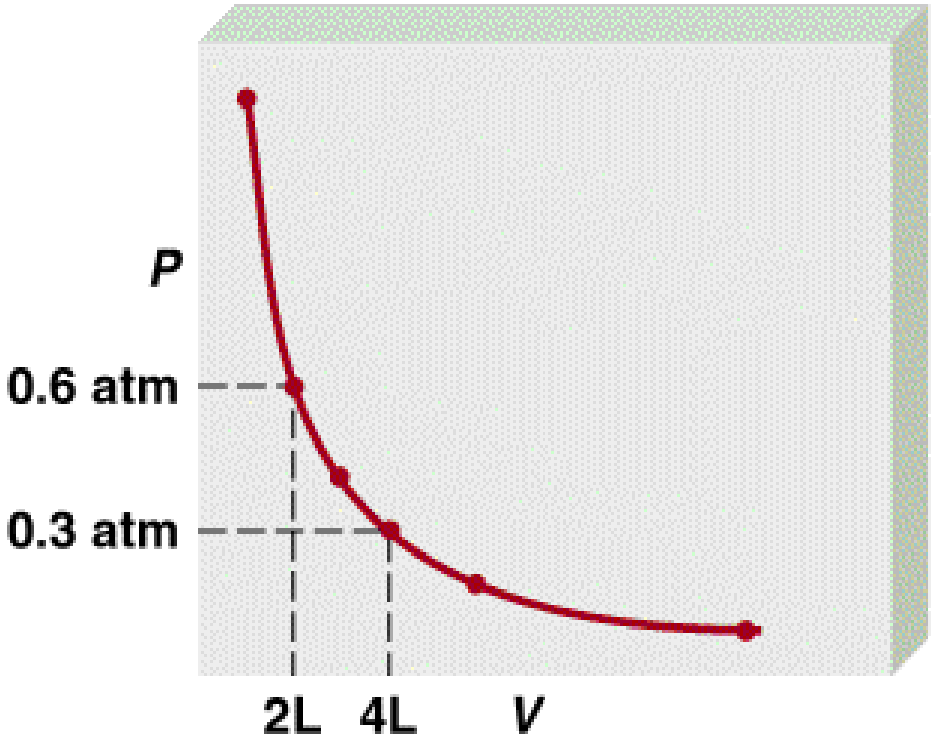
Gas Laws

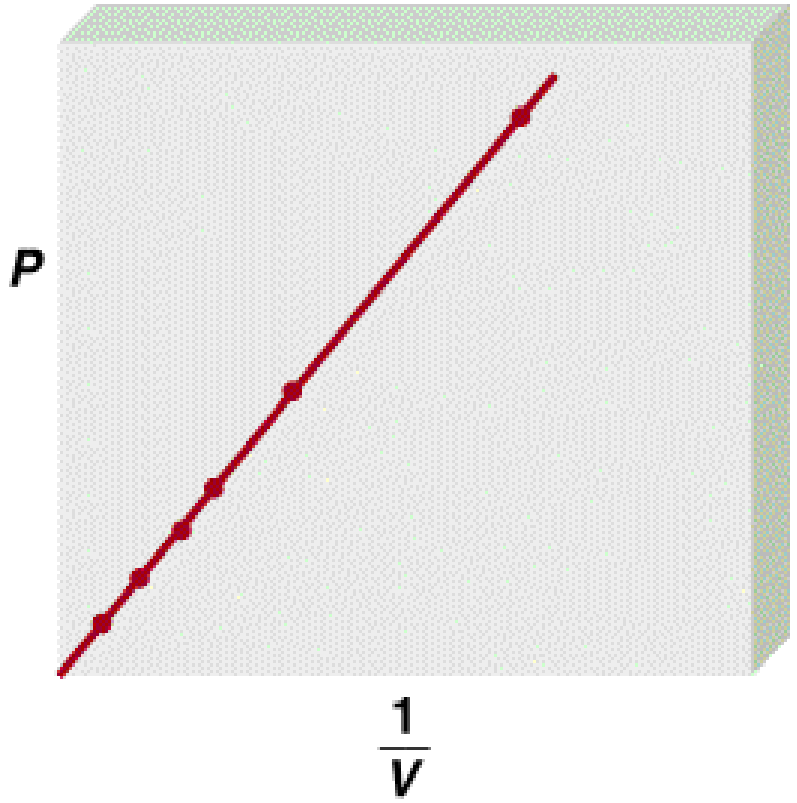
Purpose

- To study pressure, volume and temperature relationships of a fixed amount of gas

- To verify some of the known gas laws experimentally, namely Boyle's law and Gay-Lussac's law

Boyle's Law: the volume of a fixed amount of a gas is inversely proportional to the gas pressure at constant temperature.



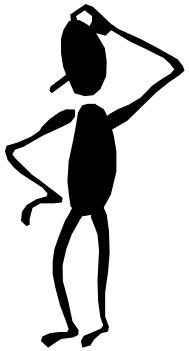


$P \propto 1/V$

$P \times V = \text{constant}$

$P_1 \times V_1 = P_2 \times V_2$

Constant temperature
Constant amount of gas



A sample of chlorine gas occupies a volume of 946 mL at a pressure of 726 mmHg. What is the pressure of the gas (in mmHg) if the volume is reduced at constant temperature to 154 mL?

$$P_1 \times V_1 = P_2 \times V_2$$

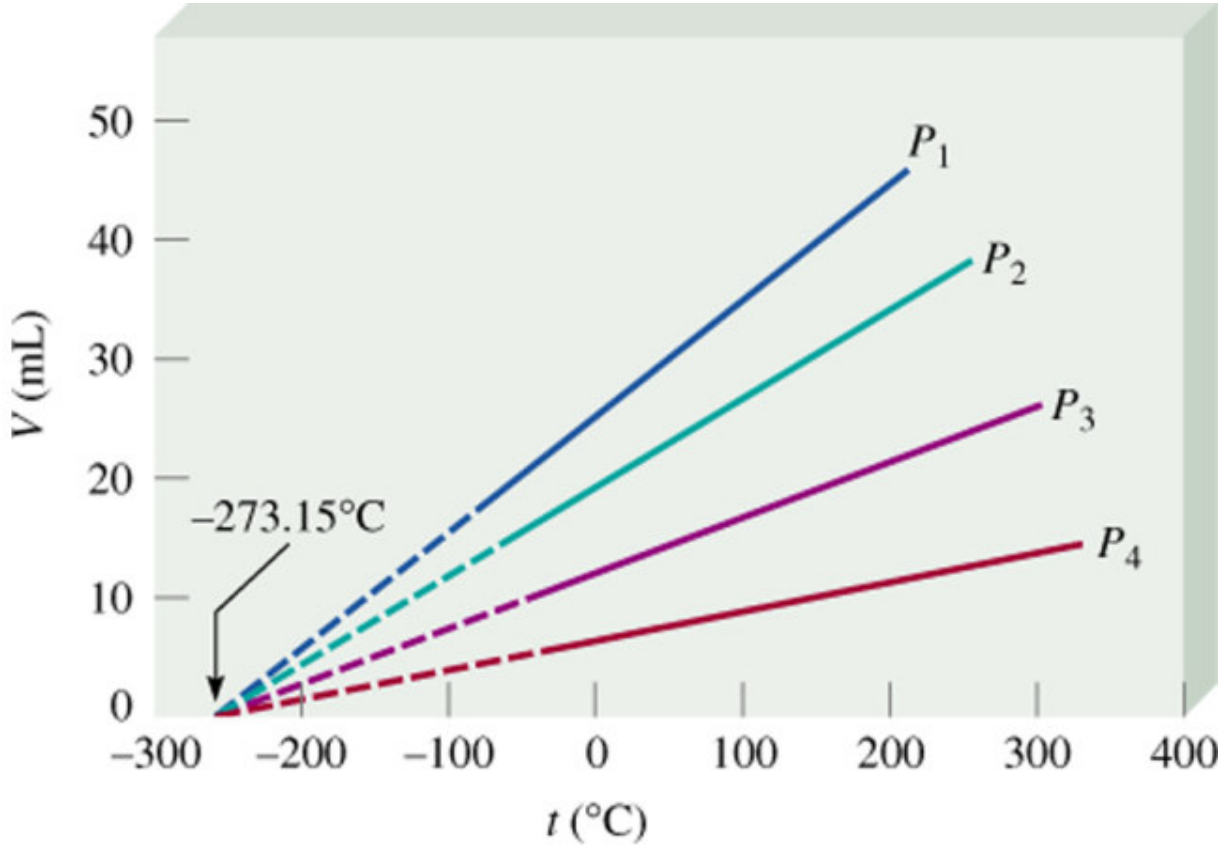
$P_1 = 726$ mmHg $\qquad P_2 = ?$

$V_1 = 946$ mL $\qquad V_2 = 154$ mL

$$P_2 = \frac{P_1 \times V_1}{V_2} = \frac{726 \text{ mmHg} \times 946 \cancel{\text{mL}}}{154 \cancel{\text{mL}}} = 4460 \text{ mmHg}$$

Charle's Law: the volume of a fixed amount of a gas is directly proportional to the absolute temperature of the gas at constant pressure.

Zero volume at zero Kelvin is theoretical. Gases condense to liquids at higher temperatures.



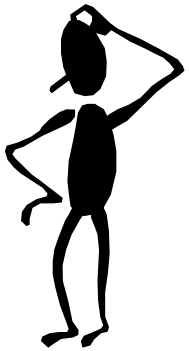
$V \alpha T$

V = constant x T

$V_1/T_1 = V_2/T_2$

Temperature **must** be in Kelvin

T (K) = t (^{0}C) + 273.15



A sample of carbon monoxide gas occupies 3.20 L at 125 ^{0}C. At what temperature will the gas occupy a volume of 1.54 L if the pressure remains constant?

$$V_1/T_1 = V_2/T_2$$

$V_1 = 3.20$ L $\qquad V_2 = 1.54$ L

$T_1 = 398.15$ K $\qquad T_2 = ?$

$T_1 = 125\ (^0\text{C}) + 273.15\ (\text{K}) = 398.15$ K

$$T_2 = \frac{V_2 \times T_1}{V_1} = \frac{1.54\ \text{L} \times 398.15\ \text{K}}{3.20\ \text{L}} = 192\ \text{K}$$

Gay-Lussac's Law

The pressure of a fixed mass of gas, at constant volume, is directly proportional to the Kelvin temperature.

$$P \propto T$$

$$P = \text{constant} \times T$$

$$P_1/T_1 = P_2/T_2$$

At a temperature of 40ºC an oxygen container is at a pressure of 2.15 atmospheres. If the temperature of the container is raised to 100ºC what will be the pressure of the oxygen?

$P_1 = 21.5$ atm $\qquad T_1 = 40ºC = 313$ K

$P_2 = ?$ $\qquad T_2 = 100ºC = 373$ K

$$P_1 / T_1 = P_2 / T_2$$

$$P_2 = P_1 T_2 / T_1 = (21.5 \text{ atm}) (373 \cancel{\text{K}}) / 313 \cancel{\text{K}}$$

$$P_2 = 25.6 \text{ atm}$$

Experimental Procedure

I- Boyle's Law:

- The gas studied will be air and it will be confined in a syringe connected to a pressure sensor.
- A change in the volume of air in the syringe, 2 mL at a time, is done and the change in resulting pressure is measured at a constant temperature.
- Plot a graph of Volume vs. Pressure and a graph of Inverse Volume vs. Pressure

Experimental Procedure (cont'd)

II- Gay Lussac's Law:

- The gas studied will be air and it will be confined in a flask connected to a pressure sensor.

- A change in the temperature of air in the flask is done and the change in resulting pressure is measured at constant volume.

- Plot Temperature vs. Pressure

Report

For both parts I and II

- Include a print out of your graphs
- Answer the questions