EXPERIMENT 3A

Gas Laws

Introduction:

A gas consists of molecules moving rapidly in all directions. The molecules of the gas collide with each other and with the wall of the container in which they are confined. Because the molecules can move freely, a gas will always fill the container that it is in. A gas takes the shape of its container.

It is important for you to know something about the properties of gases. As you can see by reading the chapters on gases in your textbooks, every health professional is involved with gases. Oxygen is commonly used to help people who have trouble breathing. Many anesthetics (nitrous oxide, ether, cyclopropane, etc.) are gases. Some gases are poisonous (CO, Cl_2, SO_2, NO, O_3, etc.) and patients/clients sometimes need to be treated for toxic effects.

There are three general laws that describe the relationships among the three basic properties of gases. Each law is named after its discoverer, but the names are less important than understanding the relationships they represent.

Boyle's Law:

At constant temperature, the pressure of a gas is inversely proportional to the volume. In other words, If the temperature of a gas is held constant, as gas pressure increases, gas volume decreases. The correlation between pressure (P) and volume (V) can be descried as:

$$\mathbf{P_1V_1 = P_2V_2}$$

Charles' Law:

At constant pressure, the volume of a gas is directly proportional to its absolute temperature. In other words, If the pressure of a gas is held constant, as gas temperature increases, gas volume increases. The correlation between temperature (T) and volume (V) can be descried as:

$$\frac{\boldsymbol{V_1}}{\boldsymbol{T_1}} = \frac{\boldsymbol{V_2}}{\boldsymbol{T_2}}$$

Gay-Lussac's law:

At constant volume, the pressure of a gas is directly proportional to its absolute temperature. In other words, If the volume of a gas is held constant, as gas temperature increases, gas pressure increases. The correlation between temperature (T) and pressure (P) can be descried as:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

The Ideal Gas Law:

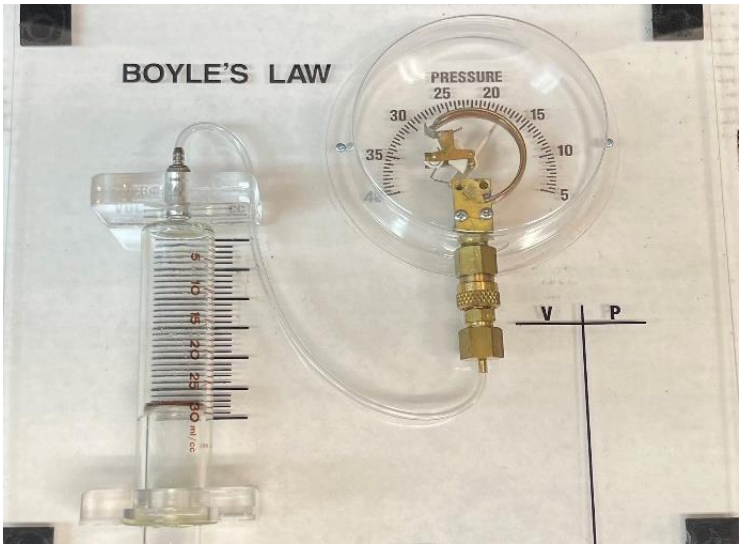
The Ideal Gas Law is obtained by combining Boyle's Law, Charles's Law and Gay-Lussac's law together. It illustrates the relationship between pressure, volume, and temperature for a fixed amount of gas:

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Procedure:

In today's experiment you will observe several demonstrations of the gas laws and then attempt to explain them using what you have learned.

1. The Boyle's Law apparatus (shown below) consists of a calibrated glass syringe connected to a direct-reading pressure gauge. There is a clear acrylic background, and marked against that background are a volume scale, pressure divisions, and a pressure-volume chart. As you change the volume of the gas with the syringe, the changes in pressure will be clearly projected on the screen. You are supposed to record the appropriate data in the table (page 3). If you wish, you may also graph the data and obtain the inverse variation curve of Boyle's law.



Data on Boyle's Law

Volume (cc)	Pressure (lb/sq in)	Constant (cc-lb/sq in)
10		
15		
20		
25		
30		

Average value of the constant: _____

2. The instructor will demonstrate the operation and adjustment of a Bunsen burner.

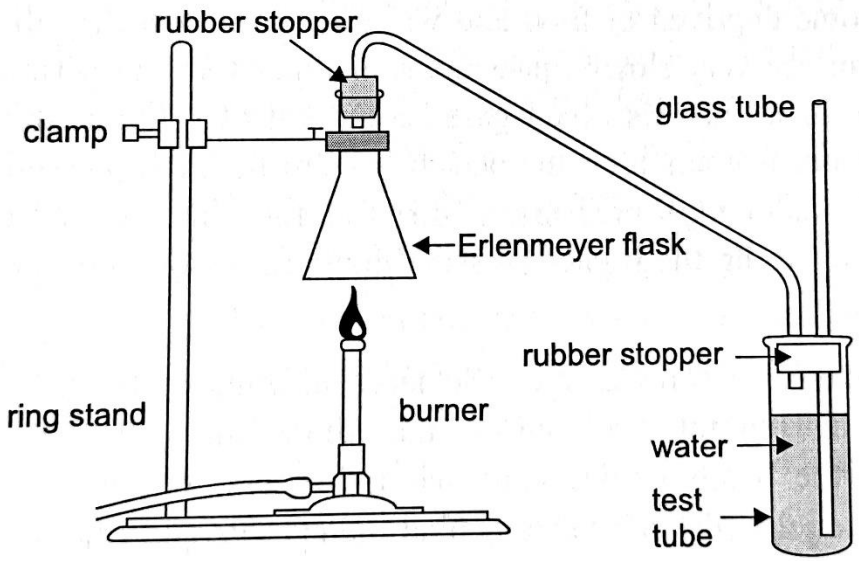
Note the color and intensity of the flame as the air hole and gas supply are adjusted, and answer the questions below.

a. What is a Bunsen flame? How is a Bunsen flame produced?

b. What are the different types of Bunsen flames? How can you distinguish them?

c. What safety precautions should be taken when using a Bunsen burner?

3. In this demonstration, the “empty” flask is gently heated, with a Bunsen burner. Note the change in the level of the liquid and answer the questions.



a. How does the pressure of a gas change with increasing temperature?

b. What scientific laws or principles are demonstrated in this experiment?

4. The instructor will demonstrate the effect of atmospheric pressure by rapidly condensing steam inside an aluminum can.

Add about 15–20 mL of water into a soda can. Using tongs, place the can upright on Bunsen burner. Heat the can until the water inside starts boiling and you can clearly see steam escaping from the opening. This should take 2–3 minutes. Quickly and carefully remove the hot can from the heat source. Immediately invert the can (opening down) and plunge it into cold water (add ice if available for a greater effect).

a. What did you observe when the can was placed in the cold water?

b. What scientific laws or principles are demonstrated in this experiment?

ANSWER ALL OF THE FOLLOWING QUESTIONS BASED ON TODAY'S LAB FOR THE QUIZ IN THE NEXT LAB.

1. At constant temperature, as the pressure increases, the volume _____.

2. At constant temperature, as the pressure decreases, the volume _____.

3. At constant volume, as the temperature increases, the pressure _____.

4. At constant volume, as the temperature decreases, the pressure _____.

5. At constant pressure, as the temperature increases, the volume _____.

6. At constant pressure, as the temperature decreases, the volume _____.

7. As the pressure on a sample of a gas increases at constant temperature, the volume of the gas

A) remains the same B) decreases C) increases

8. As the pressure of a gas at 101.3 KPa is changed to 50.65 KPa at constant temperature, the volume of the gas

A) remains the same B) decreases C) increases

9. As the pressure on a sample of a gas increases at constant temperature, the mass of the gas

A) remains the same B) decreases C) increases

10. The volume of a given mass of an ideal gas at constant pressure is

A) inversely proportional to the Celsius temperature

B) inversely proportional to the Kelvin temperature

C) directly proportional to the Celsius temperature

D) directly proportional to the Kelvin temperature

11. As the temperature on a sample of a gas increases at constant pressure, the volume of a gas

A) remains the same B) decreases C) increases

12. As gas occupies a volume of 30 mL at 273 K. If the temperature is increased to 364 K while the pressure remains constant, what will be the volume of the gas?

A) 40 mL B) 20 mL C) 30 mL D) 60 mL

13. A gas sample has a volume of 25.0 mL at a temperature of 75.0 ℃ and 1.00 atmosphere of pressure. What will be the final temperature of the gas (in degree Celsius) if the volume increases to 50.0 mL and the pressure remains constant? *[Write the correct formula. Show all work. Indicate the correct answer with an appropriate unit.]*

14. A sample of gas has a volume of 800 mL at −23.0 °C and 300 Torr. What would the volume of the gas be at 227.0 °C and 300 Torr? *[Write the correct formula. Show all work. Indicate the correct answer with an appropriate unit.]*