

BOYLE'S LAW

Name _____

Boyle's Law states that the volume of a gas varies inversely with its pressure if temperature is held constant. (If one goes up, the other goes down.) We use the formula:

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

Solve the following problems (assuming constant temperature).

1. A sample of oxygen gas occupies a volume of 250. mL at 740. torr pressure. What volume will it occupy at 800. torr pressure?

2. A sample of carbon dioxide occupies a volume of 3.50 liters at 125 kPa pressure. What pressure would the gas exert if the volume was decreased to 2.00 liters?

3. A 2.0 liter container of nitrogen had a pressure of 3.2 atm. What volume would be necessary to decrease the pressure to 1.0 atm?

4. Ammonia gas occupies a volume of 450. mL at a pressure of 720. mm Hg. What volume will it occupy at standard pressure?

5. A 175 mL sample of neon had its pressure changed from 75 kPa to 150 kPa. What is its new volume?

6. A sample of hydrogen at 1.5 atm had its pressure decreased to 0.50 atm producing a new volume of 750 mL. What was its original volume?

7. Chlorine gas occupies a volume of 1.2 liters at 720 torr pressure. What volume will it occupy at 1 atm pressure?

8. Fluorine gas exerts a pressure of 900. torr. When the pressure is changed to 1.50 atm, its volume is 250. mL. What was the original volume?

CHARLES' LAW

Name _____

Charles' Law states that the volume of a gas varies directly with the Kelvin temperature, assuming that pressure is constant. We use the following formulas:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \quad \text{or} \quad V_1 \times T_2 = V_2 \times T_1$$
$$K = ^\circ\text{C} + 273$$

Solve the following problems assuming a constant pressure.

1. A sample of nitrogen occupies a volume of 250 mL at 25° C. What volume will it occupy at 95° C?

2. Oxygen gas is at a temperature of 40° C when it occupies a volume of 2.3 liters. To what temperature should it be raised to occupy a volume of 6.5 liters?

3. Hydrogen gas was cooled from 150° C to 50° C. Its new volume is 75 mL. What was its original volume?

4. Chlorine gas occupies a volume of 25 mL at 300 K. What volume will it occupy at 600 K?

5. A sample of neon gas at 50° C and a volume of 2.5 liters is cooled to 25° C. What is the new volume?

6. Fluorine gas at 300 K occupies a volume of 500 mL. To what temperature should it be lowered to bring the volume to 300 mL?

7. Helium occupies a volume of 3.8 liters at -45° C. What volume will it occupy at 45° C?

8. A sample of argon gas is cooled and its volume went from 380 mL to 250 mL. If its final temperature was -55° C, what was its original temperature?

COMBINED GAS LAW

Name _____

In practical terms, it is often difficult to hold any of the variables constant. When there is a change in pressure, volume and temperature, the combined gas law is used.

$$\frac{P_1 \times V_1}{T_1} = \frac{P_2 \times V_2}{T_2} \quad \text{or} \quad P_1 V_1 T_2 = P_2 V_2 T_1$$

Complete the following chart.

	P_1	V_1	T_1	P_2	V_2	T_2
1	1.5 atm	3.0 L	20° C	2.5 atm		30° C
2	720 torr	256 mL	25° C		250 mL	50° C
3	600 mmHg	2.5 L	22° C	760 mmHg	1.8 L	
4		750 mL	0.0° C	2.0 atm	500 mL	25° C
5	95 kPa	4.0 L		101 kPa	6.0 L	471 K or 198° C
6	650. torr		100° C	900. torr	225 mL	150° C
7	850 mmHg	1.5 L	15° C		2.5 L	30° C
8	125 kPa	125 mL		100 kPa	100 mL	75° C

DALTON'S LAW OF PARTIAL PRESSURES

Name _____

Dalton's Law says that the sum of the individual pressures of all the gases that make up a mixture is equal to the total pressure or: $P_T = P_1 + P_2 + P_3 + \dots$. The partial pressure of each gas is equal to the mole fraction of each gas x total pressure.

$$P_T = P_1 + P_2 + P_3 + \dots \quad \text{or} \quad \frac{\text{moles gas}_x}{\text{total moles}} \times P_T = P_x$$

Solve the following problems.

1. A 250. mL sample of oxygen is collected over water at 25° C and 760.0 torr pressure. What is the pressure of the dry gas alone? (Vapor pressure of water at 25° C = 23.8 torr)

2. A 32.0 mL sample of hydrogen is collected over water at 20° C and 750.0 torr pressure. What is the volume of the dry gas at STP? (Vapor pressure of water at 20° C = 17.5 torr)

3. A 54.0 mL sample of oxygen is collected over water at 23° C and 770.0 torr pressure. What is the volume of the dry gas at STP? (Vapor pressure of water at 23° C = 21.1 torr)

4. A mixture of 2.00 moles of H_2 , 3.00 moles of NH_3 , 4.00 moles of CO_2 and 5.00 moles of N_2 exerts a total pressure of 800 torr. What is the partial pressure of each gas?

5. The partial pressure of F_2 in a mixture of gases where the total pressure is 1.00 atm is 300. torr. What is the mole fraction of F_2 ?

IDEAL GAS LAW

Name _____

Use the Ideal Gas Law below to solve the following problems.

$$PV = nRT \text{ where } P = \text{pressure in atmospheres}$$
$$V = \text{volume in liters}$$
$$n = \text{number of moles of gas}$$
$$R = \text{Universal Gas Constant}$$
$$0.0821 \text{ L} \cdot \text{atm/mol} \cdot \text{K}$$
$$T = \text{Kelvin temperature}$$

1. How many moles of oxygen will occupy a volume of 2.5 liters at 1.2 atm and 25° C?

2. What volume will 2.0 moles of nitrogen occupy at 720 torr and 20° C?

3. What pressure will be exerted by 25 g of CO₂ at a temperature of 25° C and a volume of 500 mL? _____
4. At what temperature will 5.00 g of Cl₂ exert a pressure of 900. torr at a volume of 750 mL? _____
5. What is the density of NH₃ at 800 torr and 25° C? _____
6. If the density of a gas is 1.2 g/L at 745. torr and 20° C, what is its molecular mass?

7. How many moles of nitrogen gas will occupy a volume of 347 mL at 6680 torr and 27° C? _____
8. What volume will 454 grams (1 lb) of hydrogen occupy at 1.05 atm and 25° C?

9. Find the number of grams of CO₂ that exert a pressure of 785 torrs at a volume of 32.5 L and a temperature of 32° C. _____
10. An elemental gas has a mass of 10.3 g. If the volume is 58.4 L and the pressure is 758 torrs at a temperature of 2.5° C, what is the gas? _____

GRAHAM'S LAW OF EFFUSION

Name _____

Graham's Law says that a gas will effuse at a rate that is inversely proportional to the square root of its molecular mass, MM. Expressed mathematically:

$$\frac{\text{rate}_1}{\text{rate}_2} = \sqrt{\frac{\text{MM}_2}{\text{MM}_1}}$$

Solve the following problems.

1. Under the same conditions of temperature and pressure, how many times faster will hydrogen effuse compared to carbon dioxide?

2. If the carbon dioxide in Problem 1 takes 32 sec to effuse, how long will the hydrogen take?

3. What is the relative rate of diffusion of NH_3 compared to He? Does NH_3 effuse faster or slower than He?

4. If the He in Problem 3 takes 20 sec to effuse, how long will NH_3 take?

5. An unknown gas diffuses 0.25 times as fast as He. What is the molecular mass of the unknown gas?
