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:

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

$$K = °C + 273$$

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.

$$\frac{P_1 \times V_1}{T_1} = \frac{P_2 \times V_2}{T_2} \quad \text{or} \quad P_1V_1T_2 = P_2V_2T_1$$

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 : $P_T = P_1 + P_2 + P_3 + \ldots$ The partial pressure of each gas is equal to the mole fraction of each gas x total pressure.

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

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 where P = pressure in atmospheres
V = volume in liters
n = number of moles of gas
R = Universal Gas Constant
0.0821 L•atm/mol•K
T = 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 20̄° C?
_____

3. What pressure will be exerted by 25 g of CO_2 at a temperature of 25° C and a volu of 50̄0 mL? _____

4. At what temperature will 5.00 g of Cl_2 exert a pressure of 900. torr at a volume 75̄0 mL? _____

5. What is the density of NH_3 at 80̄0 torr and 25° C? _____

6. If the density of a gas is 1.2 g/L at 745. torr and 20̄° 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 CO_2 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 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:

$$\frac{\text{rate}_1}{\text{rate}_2} = \sqrt{\frac{MM_2}{MM_1}}$$

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?

_____