

## 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:

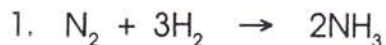
$$P_1 \times V_1 = P_2 \times V_2$$

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?  
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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?  
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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?  
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4. Ammonia gas occupies a volume of 450. mL at a pressure of 720. mm Hg. What volume will it occupy at standard pressure?  
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5. A 175 mL sample of neon had its pressure changed from 75 kPa to 150 kPa. What is its new volume?  
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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?  
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7. Chlorine gas occupies a volume of 1.2 liters at 720 torr pressure. What volume will it occupy at 1 atm pressure?  
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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?  
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# STOICHIOMETRY: VOLUME-VOLUME PROBLEMS

Name \_\_\_\_\_

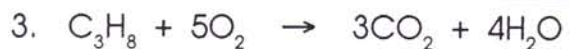


What volume of hydrogen is necessary to react with five liters of nitrogen to produce ammonia? (Assume constant temperature and pressure.)

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2. What volume of ammonia is produced in the reaction in Problem 1?

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If 20 liters of oxygen are consumed in the above reaction, how many liters of carbon dioxide are produced?

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If 30 mL of hydrogen are produced in the above reaction, how many milliliters of oxygen are produced?

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How many liters of carbon dioxide are produced if 75 liters of carbon monoxide are burned in oxygen? How many liters of oxygen are necessary?

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# THE MOLE AND VOLUME

Name \_\_\_\_\_

For gases at STP (273 K and 1 atm pressure), one mole occupies a volume of 22.4 L. What volume will the following quantities of gases occupy at STP?

1. 1.00 mole of  $H_2$

2. 3.20 moles of  $O_2$

3. 0.750 mole of  $N_2$

4. 1.75 moles of  $CO_2$

5. 0.50 mole of  $NH_3$

6. 5.0 g of  $H_2$

7. 100. g of  $O_2$

8. 28.0 g of  $N_2$

9. 60. g of  $CO_2$

10. 10. g of  $NH_3$

# 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

# 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?  
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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?  
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3. Hydrogen gas was cooled from 150° C to 50° C. Its new volume is 75 mL. What was its original volume?  
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4. Chlorine gas occupies a volume of 25 mL at 300 K. What volume will it occupy at 600 K?  
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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?  
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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?  
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7. Helium occupies a volume of 3.8 liters at -45° C. What volume will it occupy at 45° C?  
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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?  
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**Name:** \_\_\_\_\_ **Block:** \_\_\_\_\_

## **Ideal Gas and Combined Gas Law Problems**

Use the ideal gas law to solve the following problems (1-8) and the CGL for 9-15):

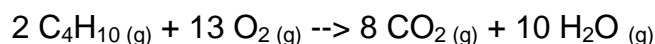
- 1) If I have 4 moles of a gas at a pressure of 5.6 atm and a volume of 12 liters, what is the temperature?
- 2) If I have an unknown quantity of gas at a pressure of 1.2 atm, a volume of 31 liters, and a temperature of  $87^{\circ}\text{C}$ , how many moles of gas do I have?
- 3) If I contain 3 moles of gas in a container with a volume of 60 liters and at a temperature of 400 K, what is the pressure inside the container?
- 4) If I have 7.7 moles of gas at a pressure of 0.09 atm and at a temperature of  $56^{\circ}\text{C}$ , what is the volume of the container that the gas is in?
- 5) If I have 17 moles of gas at a temperature of  $67^{\circ}\text{C}$ , and a volume of 88.89 liters, what is the pressure of the gas?
- 6) If I have an unknown quantity of gas at a pressure of 0.5 atm, a volume of 25 liters, and a temperature of 300 K, how many moles of gas do I have?

- 7) If I have 21 moles of gas held at a pressure of 78 atm and a temperature of 900 K, what is the volume of the gas?
- 8) If I have 1.9 moles of gas held at a pressure of 5 atm and in a container with a volume of 50 liters, what is the temperature of the gas?
- 9) If I initially have a gas at a pressure of 12 atm, a volume of 23 liters, and a temperature of 200 K, and then I raise the pressure to 14 atm and increase the temperature to 300 K, what is the new volume of the gas?
- 10) A gas takes up a volume of 17 liters, has a pressure of 2.3 atm, and a temperature of 299 K. If I raise the temperature to 350 K and lower the pressure to 1.5 atm, what is the new volume of the gas?
- 11) A gas that has a volume of 28 liters, a temperature of 45 °C, and an unknown pressure has its volume increased to 34 liters and its temperature decreased to 35 °C. If I measure the pressure after the change to be 2.0 atm, what was the original pressure of the gas?

- 12) A gas has a temperature of  $14^{\circ}\text{C}$ , and a volume of 4.5 liters. If the temperature is raised to  $29^{\circ}\text{C}$  and the pressure is not changed, what is the new volume of the gas?
- 13) If I have 17 liters of gas at a temperature of  $67^{\circ}\text{C}$  and a pressure of 88.89 atm, what will be the pressure of the gas if I raise the temperature to  $94^{\circ}\text{C}$  and decrease the volume to 12 liters?
- 14) I have an unknown volume of gas at a pressure of 0.5 atm and a temperature of 325 K. If I raise the pressure to 1.2 atm, decrease the temperature to 320 K, and measure the final volume to be 48 liters, what was the initial volume of the gas?
- 15) If I have 21 liters of gas held at a pressure of 78 atm and a temperature of 900 K, what will be the volume of the gas if I decrease the pressure to 45 atm and decrease the temperature to 750 K?

**Gas Law Practice. On a separate sheet of paper, please solve/answer the following problems.**

1. 3.00 moles of a gas are placed in a 4.55 L container at 245 °C. What is the pressure in kPa?
2. 65.85 grams of nitrogen gas are placed in 17.5 L container. The pressure is 1988 mm Hg. What is the temperature, in °C?
3. A gas is placed in a 2.00 L container at 25 °C and 550.0 mm Hg. The gas is now compressed to a volume of 0.75 L at constant temperature. What is the new pressure?
4. a) A gas is placed in a heavy container. The container is now heated. What happens to the gas and why?  
b) A gas is placed in a container with a moveable piston. It is then cooled down at constant pressure. What happens? Explain.  
c) A gas is placed in a container at a certain temperature and pressure. More gas is added and in order to keep the pressure and volume constant the temperature had to change. Was the container heated or cooled? Explain.
5. A gas is placed in a 3.45 L container at 45 °C and 2.7 atm. It is then compressed to a pressure of 8.25 atm and a volume of 0.550 L. What is the new temperature?
6. Butane (C<sub>4</sub>H<sub>10</sub>) is a fuel used in many lighters. The reaction is as follows:



- a. If 26.7 L of O<sub>2</sub> react at STP, how many liters of butane are needed at STP?
  - b. 24.57 moles of water are formed. How many liters of butane were reacted at STP?
  - c. 13.6 L of butane are reacted at STP, how many grams of carbon dioxide are formed?
7. 5.0 moles of a gas is put into a container of 2.0 L. More gas is added to the flask so that there is now 15 moles of the gas present. What must the new volume be if temperature and pressure are to remain constant?
  8. A 7.0 L container is filled with 10.0 moles of a gas. The pressure is read at 4.00 atm, what is the temperature of the gas, in °C?
  9. 3.0 L of a gas has a pressure of 12.0 atm. What is the new pressure if the gas is expanded to 17.0 L?
  10. A gas is at 135 °C and 455 mm Hg in a 2.00 L container. It is cooled down to a temperature of 25 °C. If it is kept in the same container, what is its new pressure?
  11. 155.0 grams of oxygen gas are put in a 4.50 L container at 35 °C. What is the pressure, in kPa?
  12. A gas in a piston is heated up. If the pressure remains the same, what will happen to the volume? Why?