

Combined Gas Law (Chem Worksheet 14-3)

Name _____

Boyle's Law shows that the pressure and volume of a gas are inversely related. **Charles' Law** shows that the volume/temperature and volume of a gas are directly related. These two relationships can be combined into a single equation known as the **combined gas law**. The formula for the combined gas law is: $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$. This equation could be rearranged instead of memorizing Boyle's Law, Charles' Law, and

Gay Lussac's Law. Each of these other gas laws can be derived from the combined gas law by controlling out the variable that does not change.

Law	Equation	Constant Variable
Boyle's Law	$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$	temperature
Charles' Law	$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$	pressure
Gay Lussac's Law	$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$	volume

SIMPLE CALCULATIONS

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \quad P_2 = P_1 + 273$$

Example

A 10.0 liter sample of gas has a pressure of 950 torr when the temperature is 300K. What is the volume of the gas if the pressure is increased to 1100 torr, assuming the temperature is constant?

Given: $V_1 = 10.0 \text{ L}$

$P_1 = 950 \text{ torr}$

$P_2 = 1100 \text{ torr}$

$T_1 = 300 \text{ K}$

$T_2 = 300 \text{ K}$

Unknown: volume

$V_2 = ?$

$P_1 = 950 \text{ torr}$

$P_2 = 1100 \text{ torr}$

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

$V_2 = ?$

$P_1 = 950 \text{ torr}$

$P_2 = 1100 \text{ torr}$

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

$V_2 = ?$

$P_1 = 950 \text{ torr}$

$P_2 = 1100 \text{ torr}$

Answer: $V_2 = 8.5 \text{ L}$

$V_2 = ?$

$P_1 = 950 \text{ torr}$

$P_2 = 1100 \text{ torr}$

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

$V_2 = ?$

$P_1 = 950 \text{ torr}$

$P_2 = 1100 \text{ torr}$

Conclusion: $V_2 = 8.5 \text{ L}$

$V_2 = ?$

$P_1 = 950 \text{ torr}$

$P_2 = 1100 \text{ torr}$

Solve the following problems:

- A container containing air has a volume of 100 mL and a pressure of 1.00 atm when the temperature is 300 K. What is the pressure when the volume is decreased to 50 mL and the temperature is reduced to 200 K?
- Air is contained in a 10.0 L tank when the pressure is 1.00 atm and the temperature is 300 K. It is a gas with a volume of 10.0 L and a pressure of 1.00 atm. What is the new temperature?
- A helium balloon at 100 K has a volume of 1.0 L and a pressure of 1.00 atm. What is the volume of the balloon when it rises into the atmosphere where the pressure is 0.50 atm and the temperature is 200 K?
- The pressure of oxygen with a volume of 100 mL and 100 K is 1.00 atm. It is heated to 200 K and compressed to a volume of 50 mL. What is the new pressure?
- A gas with a volume of 10.0 L and a pressure of 1.00 atm, the temperature of the gas is 300 K. What is the volume temperature when the gas is put in a 5.0 L tank with a pressure of 1.00 atm?
- A container is able to withstand 1000 atm before it bursts. The gas in the container has a volume of 10.0 L and the pressure is 1.00 atm at 300 K. If the gas is heated to a volume of 5.0 L and the temperature does not change will it burst? What is the pressure of the gas in the tank?