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 kelvin 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: $\dfrac{P_1V_1}{T_1} = \dfrac{P_2V_2}{T_2}$ This equation could be memorized instead of memorizing Boyle's law, Charles' law, and Guy-Lussac's law. Each of these other gas laws can be derived from the combined gas law by canceling out the variable that does not change.

Law	Equation	Constant Variable
Boyle's Law	$\dfrac{P_1V_1}{\cancel{T_1}} = \dfrac{P_2V_2}{\cancel{T_2}}$	temperature
Charles' Law	$\dfrac{\cancel{P_1}V_1}{T_1} = \dfrac{\cancel{P_2}V_2}{T_2}$	pressure
Guy-Lussac's Law	$\dfrac{P_1\cancel{V_1}}{T_1} = \dfrac{P_2\cancel{V_2}}{T_2}$	volume

USEFUL EQUATIONS

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \qquad T_K = T_C + 273$$

example

A 28 L sample of gas has a pressure of 25 psi when the temperature is 45°C. What is the volume of the gas if the pressure is increased to 175 psi and the temperature is increased to 320°C?

- list the variables:

$V_1 = 28$ L $\qquad P_1 = 25$ psi $\qquad T_1 = 45°C = 313$ K
$V_2 = ?$ $\qquad P_2 = 175$ psi $\qquad T_2 = 320°C = 593$ K

- substitute into the equation:

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \qquad \frac{(25\,\text{psi})(28\,\text{L})}{(313\,\text{K})} = \frac{(175\,\text{psi})(V_2)}{(593\,\text{K})}$$

- cross-multiply and simplify:

$$(25\,\text{psi})(28\,\text{L})(593\,\text{K}) = (175\,\text{psi})(V_2)(313\,\text{K}) \qquad \frac{(25\,\cancel{\text{psi}})(28\,\text{L})(593\,\cancel{\text{K}})}{(175\,\cancel{\text{psi}})(313\,\cancel{\text{K}})} = \frac{(175\,\cancel{\text{psi}})(V_2)(3\cancel{13}\,\cancel{\text{K}})}{(175\,\cancel{\text{psi}})(3\cancel{13}\,\cancel{\text{K}})}$$

- solve:

$V_2 = 7.6$ L

Solve the following problems.

1. A canister containing air has a volume of 85 cm^3 and a pressure of 1.45 atm when the temperature is 310 K. What is the pressure when the volume is increased to 180 cm^3 and the temperature is reduced to 280 K?

2. Air is transferred from a 75 L tank where the pressure is 125 psi and the temperature is 288 K to a tire with a volume of 6.1 L and a pressure of 25 psi. What is the new temperature?

3. A helium balloon at 28°C has a volume of 1.8 L and a pressure of 102 kPa. What is the volume of the balloon when is rises into the atmosphere where the pressure is 85 kPa and the temperature is 4°C?

4. The pressure of a piston with a volume of 650 cm^3 and 85°C is 830 torr. It is heated to 350°C and compressed to a volume of 65 cm^3. What is the new pressure?

5. A gas tank has a volume of 28.1 m^3 and a pressure of 18.4 atm. The temperature of the gas is 32°C. What is the Celsius temperature when the gas is put in an 11.2 m^3 tank with a pressure of 22.7 atm?

6. A metal can is able to withstand 3800 kPa before is bursts. The gas in the can has a volume of 235 mL and the pressure is 110 kPa at 25°C. If the can is crushed to a volume of 8.5 mL and the temperature does not change will it burst? What is the pressure of the gas in the can?