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: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ 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	$\frac{P_1V_1}{\cancel{T_1}} = \frac{P_2V_2}{\cancel{T_2}}$	temperature
Charles' Law	$\frac{\cancel{P_1}V_1}{T_1} = \frac{\cancel{P_2}V_2}{T_2}$	pressure
Guy-Lussac's Law	$\frac{\cancel{P_1}\cancel{V_1}}{T_1} = \frac{\cancel{P_2}\cancel{V_2}}{T_2}$	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 45ºC. What is the volume of the gas if the pressure is increased to 175 psi and the temperature is increased to 320ºC?

- list the variables: $V_1 = 28$ L, $P_1 = 25$ psi, $T_1 = 45$ºC = 313 K; $V_2 = ?$, $P_2 = 175$ psi, $T_2 = 320$ºC = 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: $(25\text{ psi})(28\text{ L})(593\text{ K}) = (175\text{ psi})(V_2)(313\text{ K})$ $\qquad \frac{(25\text{ psi})(28\text{ L})(593\text{ K})}{(175\text{ psi})(313\text{ K})} = \frac{(175\text{ psi})(V_2)(313\text{ K})}{(175\text{ psi})(313\text{ K})}$

- 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 28ºC 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 4ºC?
4. The pressure of a piston with a volume of 650 cm^3 and 85ºC is 830 torr. It is heated to 350ºC 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 32ºC. 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 25ºC. 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?