Math Tutor ALGEBRAIC REARRANGEMENTS OF GAS LAWS

When you solve problems in chemistry, it's usually a bad idea to just start entering numbers into a calculator. Instead, doing a little pencil-and-paper work beforehand will help you eliminate errors. When using the gas laws, you do not need to memorize all of the equations because they are easily derived from the equation for the combined gas law, $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$. Study the table below. In each of Boyle's, Charles's, and Gay-Lussac's laws, one of the quantities—*T*, *P*, or *V*—does not change. By simply eliminating that factor from the equation, you obtain the equation for one particular gas law.

Gas law	Held constant	Cancellation	Result
Combined gas law	none	$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$	$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
Boyle's law	temperature	$\frac{P_1V_1}{\cancel{T_1}} = \frac{P_2V_2}{\cancel{T_2}}$	$P_1V_1 = P_2V_2$
Charles's law	pressure	$\frac{\cancel{P_1}V_1}{T_1} = \frac{\cancel{P_2}V_2}{T_2}$	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$
Gay-Lussac's law	volume	$\frac{P_1\cancel{V_1}}{T_1} = \frac{P_2\cancel{V_2}}{T_2}$	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

The conditions stated in the problem should make clear which factors change and which are held constant. This information will tell you which law's equation you need to use.

SAMPLE

A cylinder of nitrogen gas has a volume of 35.00 L at a pressure of 11.50 atm. What pressure will the nitrogen have if the contents of the cylinder are allowed to flow into a sealed reaction chamber whose volume is 140.0 L, and if the temperature remains constant?

Start with the combined gas law, and cancel the temperature, which does not change.

$$\frac{P_1V_1}{\cancel{T_1}} = \frac{P_2V_2}{\cancel{T_2}}; P_1V_1 = P_2V_2$$

You want to know the new pressure in the chamber, so solve for P_2.

$$\frac{P_1V_1}{V_2} = \frac{P_2\cancel{V_2}}{\cancel{V_2}}; \frac{P_1V_1}{V_2} = P_2$$

The resulting equation to use in solving the problem is $P_2 = \frac{P_1V_1}{V_2} = \frac{(11.50\text{ atm})(35.00\text{ L})}{140.0\text{ L}}$ = 2.875 atm.

PRACTICE PROBLEMS

1. A sample of gas has a pressure P_1 at a temperature T_1. Write the equation that you would use to find the temperature, T_2 at which the gas has a pressure of P_2.

2. An ideal gas occupies a volume of 785 mL at a pressure of 0.879 atm. What volume will the gas occupy at a pressure of 0.994 atm?