Name: ____________________ Per: _____ Date: 5th

Notes - Gas Laws

What are the 4 variables that must be discussed when referring to gasses?

V, P, T, n (moles, amount of gas)

Why is it not necessary to discuss pressure when dealing with solids and liquids?

You can't compress solid + liquid

Boyle's Law: P + V are inversely proportional.

Equation	Variable	Constants
$P_1 \cdot V_1 = K_1$ (constant) $P_2 \cdot V_2 = K_2$ $K_1 = K_2$ $P_1 \cdot V_1 = P_2 V_2$	volume Pressure	Temp + amount of gas (n)

A balloon with a volume of 2.0 L is filled with a gas at 3 atmospheres. If the pressure were reduced to 0.5 atmospheres without a change in temperature, what would be the volume of the balloon?

G - given
U - unknown
E - equation
S - substitute
S - solve

G: $V_1 = 2.0L$, $P_1 = 3atm$, $P_2 = 0.5atm$

U: $V_2 = ?$

E: $\frac{P_1 V_1}{P_2} = \frac{P_2 V_2}{P_2}$

S+S: $V_2 = \frac{P_1 V_1}{P_2} = \frac{2.0L (3 atm)}{0.5atm} = 12L$

What temperature scale must be used when talking about gases? Kelvin (K)

Charles Law: T + V, direct

Equation	Variable	Constants
$\frac{V_1}{T_1} = K_2 = \frac{V_2}{T_2}$ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$	T V	P n

A 600 mL sample of nitrogen is heated from 27 °C to 77 °C at constant pressure. What is the final volume?

G: $V_1 = 600mL$, $T_1 = 27 + 273 = 300K$, $T_2 = 77 + 273 = 350K$

U: $V_2 = ?$

E: $T_2 \cdot \frac{V_1}{T_1} = \frac{V_2}{T_2} \cdot T_2$

$V_2 = \frac{T_2 V_1}{T_1} = \frac{350K \cdot 600mL}{300K} = 700mL$

Try these on your own...

A volume of 3.00 L of air is warmed from 50.0 to 100. degrees Celsius. What is the new volume if the pressure remains constant?

G U E S S

G: $V_1 = 3.00L$, $T_1 = 50 + 273 = 323K$, $T_2 = 100 + 273 = 373K$ (↓ kelvin)

U: $V_2 = ?$

E: $T_2 \cdot \frac{V_1}{T_1} = \frac{V_2}{T_2} \cdot T_2$

$V_2 = \frac{T_2 V_1}{T_1} = 3.46L$

A sample of gas occupies 2.00 L at 760. mmHg. What volume would the gas occupy at 400. mmHg?

G: $V_1 = 2.00L$, $P_1 = 760. mmHg$, $P_2 = 400. mmHg$

U: $V_2 = ?$

E: $\frac{P_1 V_1}{P_2} = \frac{V_2 P_2}{P_2} = \frac{P_1 \cdot V_1}{P_2} = 3.8L$

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Boyle's Law & Charles' Law Problems

Instructions: Complete the following problems.

Boyle's Law can be summarized mathematically as P*V = constant, which means that $P_1V_1 = P_2V_2$. Another way to think about the subscript 1 is initial and the subscript 2 means a final amount. What variable must be kept constant in order for this law to be true?? ____________________

1. If a 2.0 L sample of gas at 400 mmHg of pressure is moved to a 4.0 L container at a constant temperature, what is the new pressure?

G: $V_1 = 2.0L$, $P_1 = 400mmHg$, $V_2 = 4.0L$

U: $P_2 = ?$

E: $P_1V_1 = P_2V_2$

$= \frac{400mmHg(2.0L)}{4.0L}$ 200mmHg

2. If a 15.0 L sample of gas at 2 atm of pressure is compressed to 6 atm of pressure at a constant temperature, what will the new volume be?
   **HINT: It doesn't matter that the units for pressure are different from the previous problem.

5L

Charles' Law is written as V/T = constant, which means $V_1/T_1 = V_2/T_2$. It is NECESSARY to have the units for temperature in Kelvin, K. This means that you might have to convert the temperature from Celsius to Kelvin. Refer to the simulation from yesterday for help if you need it. What variable must be kept constant in order for this law to be true?? ____________________

3. If a 3.0 L sample of gas at a temperature of 400 K is cooled to a temperature of 150 K, what will the new volume of the gas be?

$V_1 = 3.0L$, $T_1 = 400K$, $T_2 = 150K$

U: $V_2 = ?$

E: $T_2 \frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{150K(3.0L)}{400K}$ = 1.125 L ~~= 8 L~~

4. A container holds 50.0 mL of nitrogen at 25 C and a pressure of 736 mmHg. What will the new volume be if the temperature increases to 35 C?
   **HINT: Does the number for pressure in this problem matter??

$V_1 = 50.0mL$, $T_1 = 25°C + 273 = 298K$, ~~$P_1 = 736mmHg = P_2$~~, $T_2 = 35 + 273 = 308K$

U: $V_2 = ?$

E: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

51.68 mL

5. A gas at 27.0 C has a volume of 6.00 L. What will the new temperature be if the volume is decreased to 2.50 L?

125K

$T_1 = 27.0 + 273 = 300K$, U: $T_2 = ?$

$V_1 = 6.00L$, $V_2 = 2.50L$

E: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$T_2 = \frac{V_2 T_1}{V_1}$

(1) $\frac{V_2 T_1}{V_1} = \frac{T_2}{V_2}$

(2) $T_2 \cdot \frac{V_1}{T_1} = \frac{V_2}{T_2} \cdot T_2 \cdot \frac{T_1}{V_1}$