Unit 8 Part II: Gas Laws

I. 4 Variables that Describe

1. P = **Pressure**- Kilopascals, atmospheres, or millimeters of Mercury
   a) 1 atm = 760 mm Hg = 101.3 KPa
2. V= **Volume**- liters
3. n= **Amount** – number of moles – n
   a) could convert to grams (use MM)
4. T= Temperature- Kelvin
   a) k = 273 + °C

II. Ideal Gas Law: **PV = nRT**

R = ideal gas constant = $\frac{0.0821\ L\bullet atm}{K\bullet mole}$

III. Other Laws

1. start with PV=nRT
   a) Cross out **n & R** b/c constant
   b) 1 = initial 2 = final

1. Combined Gas Law:

$PV = \cancel{n}\cancel{R}T \rightarrow \frac{PV}{T} = \frac{\cancel{n}\cancel{R}\cancel{T}}{\cancel{T}} \rightarrow \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

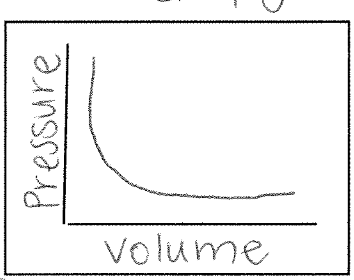
   c) Read question to determine what other variable can get crossed out....

Bath Time – Boyle's Law – Temperature Constant

$PV = \cancel{n}\cancel{R}\cancel{T}$

$P_1V_1 = P_2V_2$

inversley ∝



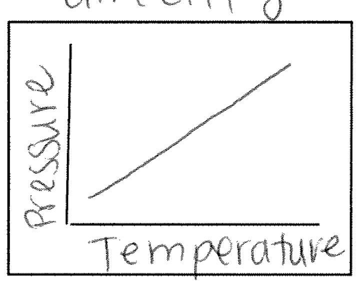
↑P ↓V
↓P ↑V

Leaves Very – Lussac's Law – Volume Constant

$\frac{P\cancel{V}}{T} = \frac{\cancel{n}\cancel{R}\cancel{T}}{\cancel{T}}$

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

directly ∝



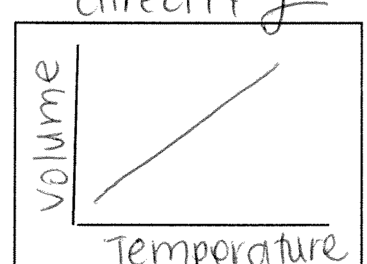
↑T ↑P

Clean People – Charles' Law – Pressure Constant

$\frac{\cancel{P}V}{T} = \frac{\cancel{n}\cancel{R}\cancel{T}}{\cancel{T}}$

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

directly ∝



↑T ↑V

Along with solving each, determine the law name and when applicable draw a graph showing the relationship.

1. Calculate the pressure, in atmospheres, exerted by 4.75L of gas containing 0.86 moles at 300K.

$PV = nRT$

$R = \text{constant} = 0.0821 \frac{L \cdot atm}{mole \cdot K}$

$\frac{0.86 \text{ moles} \times 0.0821 \frac{L \cdot atm}{mole \cdot K} \times 300K}{4.75L}$

4.5 atm

2. A 550.0 mL sample of nitrogen gas is warmed from 77.0°C to 80.0°C. Find the new volume if the pressure remains constant.

T_1 = 350.K, T_2 = 353K

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

$\frac{353K \times 550.0 mL}{350K} = 555mL$

3. Convert 338L at 6.38 x 10^3 kPa to its new volume at standard pressure. = 101.3kPa

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

$\frac{338L \times 6.38 \times 10^3 kPa}{101.3kPa}$ = 21287.66 = 2.13×10^4 L

4. If a gas in a closed container, with an original temperature of 25°C, is pressurized from 0.82 atm to 0.93 atm, what would the final temperature of the gas be? Would the gas particles be moving faster or slower?

T_1 = 298K, T_2 ?

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

$T_2 = \frac{P_2 T_1}{P_1}$

$\frac{0.93 atm \times 298K}{0.82 atm}$ = 337.98 = 340K

Now, try on your own paper

5. A gas takes up a volume of 1.7 x 10^4 liters, has a pressure of 2.3 atm, and a temperature of 25.8°C. If I raise the temperature to 350.K and lower the pressure to 152 kPa, what is the new volume in liters? (3.0x 10^4 L)
6. Calculate the volume, in liters, occupied by 0.425 moles of ammonia gas (NH_3) at 0.721 atm and 37°C. (15 L)
7. A gas has a pressure if 0.0370 atm at 50.0°C. What is the pressure at standard temperature? (3.13 x 10^{-2} atm)
8. Initially a gas has a pressure of 12 atm, a volume of 23 liters, and a temperature of 200K, and then the pressure is raised to 14 atm and the temperature increases to 300.K , what is the new volume of the gas? (30.L)
9. A gas occupies 1.00 L at standard temperature. What is the volume at 333.0 °C.(2.22L)
10. Determine the amount in moles of a gas is needed when there is 1.25L of O_2 at 805.6 mmHg and 250.K (0.0646 moles O_2)