THIS PACKET BELONGS TO: J. Hansen DATE: _____ P#: ___

Gas Laws Unit

Kinetic Molecular Theory of Gases:

1. Gas particles do not attract or repel
2. Gas particles small and virtually no volume
3. " " constant random motion
4. Same Avg. kinetic energy at a given temp.

Gas Laws Unit Vocabulary

~~temperature measured in Kelvin (0 K)~~

Pressure - The force per unit of area on a surface. Caused by collision of molecules.
Standard: 1 atm = 760 mm Hg (torr) = 101.3 kPa

Volume - The amount of area involved.
Standard: 22.4 (L) liters

Temp. - Measure of the motion of gas particles.
Standard: 0 °C is Standard Temperature—in Kelvin this would be +273

STP - Refers to conditions at "Standard Temperature and Pressure".

Diffusion - The spreading of gas particles through constant motion.
Ex. Smelling something from far away.

Compress - The "pushing together" of gas particles

Diffuse - The "spreading out" of gas

Barometer - Instrument used to measure pressure

Notes

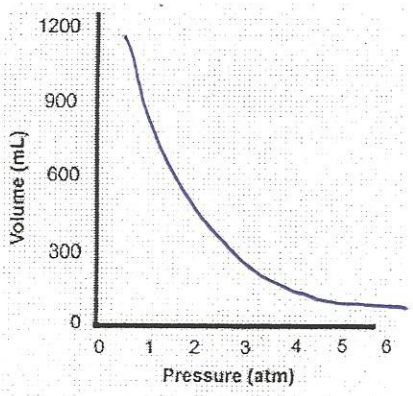
Boyle's Law $P_1V_1 = P_2V_2$

Temp. is held CONSTANT

Inverse relationship between pressure and volume

* Pressure INCREASES so volume decreases

* Pressure DECREASES so volume increases



Sample Problems:

1. To compress nitrogen at 1 atm from 750 mL to 500 mL, what must the new pressure be if the temperature is kept constant?

$P_1 = 1$ $P_2 = X$
$V_1 = 750$ $V_2 = 500$

$P_1V_1 = P_2V_2$
$1(750) = X(500)$
$X = 1.5\text{atm}$

2. A gas occupies 1.56L at 1.00atm. What will be the volume of this gas if the pressure becomes 3.00atm?

$P_1 = 1$ $P_2 = 3.0$
$V_1 = 1.56$ $V_2 = X$

$P_1V_1 = P_2V_2$
$1(1.56) = 3X$
$\frac{1.56}{3} = \frac{3X}{3}$
$X = .52L$

3. A gas occupies 4.31L (V_1) at a pressure of 0.755 atm (P_1). Determine the volume if the pressure is increased to 1.25 atm (P_2).

$P_1V_1 = P_2V_2$
$.755(4.31) = 1.25(x)$
$X = 2.6L$

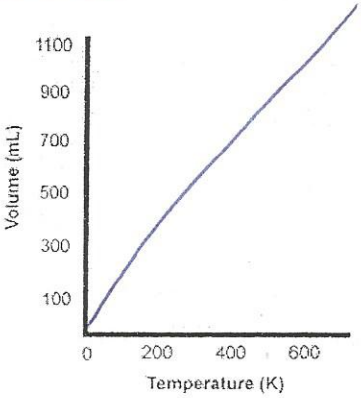
Charles's Law $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

Pressure held CONSTANT

Direct relationship between temperature and volume

* Volume INCREASES so temperature increases

* Volume INCREASES so temperature increases



** Things to remember: Temperature must be in Kelvin

Celsius + 273 = Kelvin

Convert the following:

0°C = 273 K

-273°C = 0 K

+273
-23°C = 250 K
250
25°C = 298 K

273
+25
298

Volume can be measured as liquid ml or solid cm^3

(see next page for sample problems)

Notes

Combined Gas Law

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

(#moles) Nothing is held CONSTANT

Sample Problems:

1. The pressure of a 2.00 L sample of a gas is 3.50 atm, and its temperature is 127°C. The gas is heated until it has a new volume of 3.00 L and a new pressure of 5.25 atm. What is its new temperature?

   P_1 = P_2 =

   V_1 = V_2 =

   T_1 = T_2 =

   $\frac{3.5(2)}{400} = \frac{(5.25)3}{X}$ $X = 900K$

2. What is the volume of gas at 2.00 atm and 200K if its original volume was 300L at 0.25 atm and 400K?

   $\frac{2(X)}{200} = \frac{.25(300)}{400}$ 18.75L

3. What is the volume at 1 atm and 25°C of 720mL of a gas collected at 20°C and 3.00 atm pressure?

   $\frac{1(720)}{298} = \frac{3(X)}{293}$ 235.9L

Notes

Dalton's Law of Partial Pressure

$P_{total} = P_1 + P_2 + P_3 + \ldots$ or $\frac{\text{moles gas x}}{\text{total moles}} \times P_T = P_X$

Sample Problems:

1. If the total air pressure is 0.99 atm, the partial pressure of carbon dioxide is 0.05 atm, and the partial pressure of hydrogen sulfide is 0.02 atm, what is the partial pressure of the remaining air?

   .05 + .02 + x = .99

   x = .92 atm

2. A metal tank contains three gases: oxygen, helium, and nitrogen. If the partial pressures of the three gases in the tank are 35 atm of O_2, 5 atm of N_2, and 25 atm of He, what is the total pressure inside of the tank?

   P_{total} = 35 + 5 + 25

   65 atm

3. A container contains a mixture of helium and argon gases. There are 4.0 moles of helium and 6.0 moles of argon. The total pressure of the combined gases is 2.00 atm. What is the partial pressure of the argon gas?

   OMIT

4. When 7.00 moles of gas A and 3.00 moles of gas B are combined, the total pressure exerted by the gas mixture is 1.0 atm. What is the partial pressure exerted by gas A in this mixture?

   OMIT

Notes

$P_1V_1 = P_2V_2$

Boyles' Law

Use Boyles' Law to answer the following questions:

1) 1.00 L of a gas at standard temperature (273K) and pressure (1atm) is compressed to ~~473 mL~~ .473L. What is the new pressure of the gas?

$1(1) = P(.473)$

$P = 2.11 atm$

2) In a thermonuclear device, the pressure (P_1) of 0.050 liters (V_1) of gas within the bomb casing reaches 4.0×10^6 atm. When the bomb casing is destroyed by the explosion, the gas is released into the atmosphere where it reaches a pressure of 1.00 atm (P_2). What is the volume (V_2?) of the gas after the explosion?

$4 \times 10^6 (.05) = 1(x)$

$x =$ 200,000L Large "fall out" zone

3) Synthetic diamonds can be manufactured at pressures of 6.00×10^4 atm. ✓ Nice to know If we took 2.00 liters (V_1) of gas at 1.00 atm (P_1) and compressed it to a pressure of 6.00×10^4 atm (P_2), what would the volume of that gas be?

$1(2) = 6 \times 10^4 (x)$

.00003 or $3 \times 10 \times 10^{-5}$ L

4) The highest pressure ever produced in a laboratory setting was about 2.0×10^6 atm. If we have a 1.0×10^{-5} liter sample (V_1) of a gas at that pressure, then release the pressure until it is equal to 0.275 atm (P_2), what would the new volume of that gas be?

$2 \times 10^6 (1 \times 10^{-5}) = .275(x)$

$20 = .275x$

$x = 72.7$L

HW 1

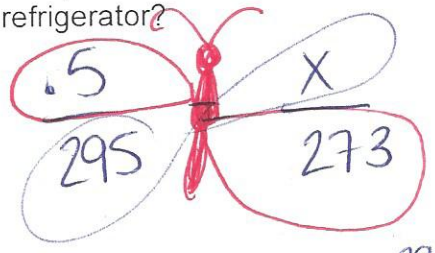
$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Charles' Law Worksheet

T_2 273 (277K)

1) The temperature inside my refrigerator is about 4° Celsius. If I place a balloon in my fridge that initially has a temperature of 22° C and a volume of 0.5 liters, what will be the volume of the balloon when it is fully cooled by my refrigerator?

273 + 22 = T_1 295



$295x = .5(273)$

$x = .462\,L$

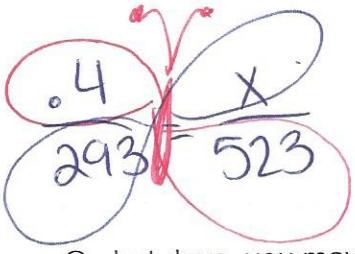
$T_1 = 293$

2) A man heats a balloon in the oven. If the balloon initially has a volume of 0.4 liters and a temperature of 20 °C, what will the volume of the balloon be after he heats it to a temperature of 250 °C?

273 + 20 = 293 (V_1)

250 + 273 = 523

T_2 523 K



$293x = .4(523)$

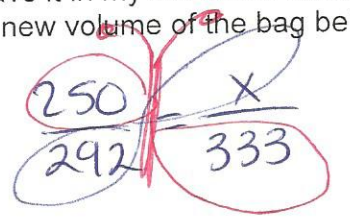
$x = .713\,L$

3) On hot days, you may have noticed that potato chip bags seem to "inflate", even though they have not been opened. If I have a 250 mL bag at a temperature of 19 °C, and I leave it in my car which has a temperature of 60° C, what will the new volume of the bag be?

V_1 T_1 292 (273 + 19 = 292)

+273

T_2 333



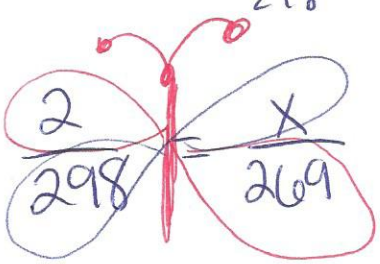
$292x = 250(333)$

$x = 285\,ml$

4) A soda bottle is flexible enough that the volume of the bottle can change even without opening it. If you have an empty soda bottle (volume of 2 L) at room temperature (25 °C), what will the new volume be if you put it in your freezer (-4 °C)?

273 − 4 = 269

+273 = 298



$298x = 2(269)$

$x = 1.8\,L$

HW 3

Name: _____ **Lussac's Law Worksheet**

1. Write the equation for Gay Lussac's Law. Define the symbols used.

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

Pressure & Temperature

2. What gas law variable is constant in Gay-Lussac's Law?

Volume

3. A rigid container has an initial pressure of 1.50 atm at 294 K. What will the pressure be if the temperature is increased to 394 K?

$\frac{1.50}{294} = \frac{x}{394}$

$294x = 1.5(394)$

$x = 2.01\text{ atm}$

4. The pressure inside a container is 1.10 atm at a temperature of 330 K. What would the pressure be at 348 K?

$\frac{1.10}{330} = \frac{x}{348}$

$330x = 1.10(348)$

$x = 1.16\text{ atm}$

5. A rigid container is at a temperature of 65 °C. When heated to 224 °C, the pressure was 2.20 atm. What was the initial pressure?

$65 + 273 = 338$

$224 + 273 = 497$

$\frac{x}{338} = \frac{2.20}{497}$ (P)

$497x = 338(2.2)$

$x = 1.496\text{ atm}$

6. If a gas in a closed container is pressurized from 1520 kPa to 1621 kPa and its original temperature was 298 K, what would the final temperature of the gas be?

$\frac{1520}{298} = \frac{1621}{x}$

$1520x = 298(1621)$

$x = 317.8\text{ K}$

7. At -23 °C a gas had a pressure of 0.853 atm. At what temperature would it be at 1.32 atm?

8. The pressure in an automobile tire is 2.00 atm at 300 K. At the end of a road trip the pressure has risen to 2.20 atm. What is the temperature of the air in the tire, assuming the volume has not changed?

9. A balloon is filled with helium gas to a pressure of 1140 mm Hg when the temperature is 295 K. If the temperature changes to 318 K, what will the pressure of the helium in the balloon?

10. A cylinder of gas has a pressure of 4.40 atm at 298 K. At what temperature will it reach a pressure of 6.50 atm?

HW 5

5) If I have 17 liters of gas at a temperature of 67 ^{0}C and a pressure of 88.89 atm, what will be the pressure of the gas if I raise the temperature to 94 ^{0}C and decrease the volume to 12 liters?

6) I have an unknown volume of gas at a pressure of 0.5 atm and a temperature of 325 K. If I raise the pressure to 1.2 atm, decrease the temperature to 320 K, and measure the final volume to be 48 liters, what was the initial volume of the gas?

7) If I have 21 liters of gas held at a pressure of 78 atm and a temperature of 900 K, what will be the volume of the gas if I decrease the pressure to 45 atm and decrease the temperature to 750 K?

8) If I have 2.9 L of gas at a pressure of 5 atm and a temperature of 50 ^{0}C, what will be the temperature of the gas if I decrease the volume of the gas to 2.4 L and decrease the pressure to 3 atm?

9) I have an unknown volume of gas held at a temperature of 115 K in a container with a pressure of 60 atm. If by increasing the temperature to 225 K and decreasing the pressure to 30 atm causes the volume of the gas to be 29 liters, how many liters of gas did I start with?

HW 7