GAS LAWS

- were derived by experiment long before kinetic theory, but agree with the kinetic picture!

Boyle's Law:

$$PV = \text{constant}$$

True at constant temperature

$$P_1V_1 = \text{constant} \qquad P_2V_2 = \text{constant}$$

$$\boxed{P_1V_1 = P_2V_2}$$

True at constant temperature

Charles's Law:

$$\frac{V}{T} = \text{constant}$$

True at constant pressure, and using ABSOLUTE temperature

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

True at constant pressure, and using ABSOLUTE temperature

Combined gas law:

$$\frac{PV}{T} = \text{constant}$$

Must use ABSOLUTE temperature units!

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Must use ABSOLUTE temperature units!

↑ amount (moles) of gas must be constant.

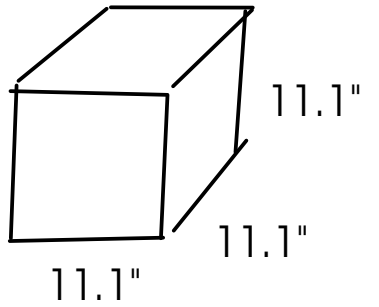
Avogadro's law:

- a mole of any gas at the same conditions has the same volume.

1 mol gas molecules @ 0°C and 1 atm

volume = 22.4 L

"STP"
Standard Temperature and Pressure



= 22.4 L

Ideal gas law:

$$\frac{PV}{T} = \text{constant}$$

... but this constant actually depends on the amount of gas!

$$= n \times \text{"}R\text{"}$$

The ideal gas constant.

$$0.08206 \ \frac{L \cdot atm}{mol \cdot K}$$

... combining these together ...

$$\frac{PV}{T} = nR$$

$$\boxed{PV = nRT}$$

P = pressure atm

V = volume L

T = ABSOLUTE temperature K

R = ideal gas constant

n = number of moles of gas molecules

A balloon is taken from a room where the temperature is 27.0 C to a freezer where the temperature is -5.0 C. If the balloon has a volume of 3.5 L in the 27.0 C room, what is the volume of the balloon in the freezer. Assume pressure is constant.

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$, $P_{constant} \rightarrow \frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{(3.5L)}{(300.2K)} = \frac{V_2}{(268.2K)}$

$3.1L = V_2$ in freezer

$V_1 = 3.5L$

$T_1 = 27.0°C = 300.2K$

$V_2 = ?$

$T_2 = -5.0°C = 268.2K$

2.25 L of nitrogen gas is trapped in a piston at 25.0 C and 1.00 atm pressure. If the piston is pushed in so that the gas's volume is 1.00 L while the temperature increases to 31.0 C, what is the pressure of the gas in the piston?

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

$\frac{(1.00atm)(2.25L)}{(298.2K)} = \frac{P_2(1.00L)}{(304.2K)}$

$2.30atm = P_2$

$P_1 = 1.00atm$

$V_1 = 2.25L$

$T_1 = 25.0°C = 298.2K$

$P_2 = ?$

$V_2 = 1.00L$

$T_2 = 31.0°C = 304.2K$

Calculate the mass of 22650* L of oxygen gas at 25.0 C and 1.18 atm pressure.

O_2

O_2: 32.00 g O_2 = mol O_2

* Volume of a 10'x10'x8' room

1- Use PV=nRT to calculate the MOLES of oxygen gas in the room.
2 - Convert moles of oxygen gas to mass. Use FORMULA WEIGHT.

① $PV = nRT$

$n = \frac{PV}{RT}$

$P = 1.18 atm$

$V = 22650 L$

$R = 0.08206 \frac{L \cdot atm}{mol \cdot K}$

$T = 25.0°C = 298.2 K$

$$n_{O_2} = \frac{(1.18 atm)(22650 L)}{(0.08206 \frac{L \cdot atm}{mol \cdot K})(298.2 K)} = 1092.222357 mol\ O_2$$

② $1092.222357 mol\ O_2 \times \frac{32.00 g\ O_2}{mol\ O_2} = \boxed{35000 g\ O_2}$ 35.0 Kg ~77 lb