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.

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

Constant P --> $P_1 =$ $P_2 =$

$V_1 = 3.5 L$ $V_2 = ?$

$T_1 = 27.0°C = 300.2 K$ $T_2 = -5.0°C = 268.2 K$

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

$$3.1 L = V_2$$

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?

$P_1 = 1.00 atm$ $P_2 = ?$

$V_1 = 2.25 L$ $V_2 = 1.00 L$

$T_1 = 25.0°C = 298.2 K$ $T_2 = 31.0°C = 304.2 K$

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

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

$$2.30 atm = P_2$$

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

← O_2

*Volume of a 10'x10'x8' room

O_2: 32.00 g O_2 = mol O_2

1 - Calculate moles of oxygen gas from the pressure, volume, and temperature using ideal gas equation.

2 - Convert moles oxygen gas to mass. Use FORMULA WEIGHT.

$PV = nRT$

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

$P = 1.18\ atm$ $\quad R = 0.08206\ \frac{L\cdot atm}{mol\cdot K}$

$V = 22650\ L$ $\quad T = 25.0°C = 298.2\ K$

① $n_{O_2} = \frac{(1.18\ atm)(22650\ L)}{(0.08206\ \frac{L\cdot atm}{mol\cdot K})(298.2\ K)} = 1092.222357\ mol\ O_2$

② $1092.222357\ mol\ O_2 \times \frac{32.00\ g\ O_2}{mol\ O_2} = 35000\ g\ O_2$

35.0 kg

~77 lb

CHEMICAL CALCULATIONS WITH THE GAS LAWS

$FW_{NaHCO_3} = 84.007\ g/mol$

$H_2SO_4(aq) + 2NaHCO_3(s) \rightarrow 2H_2O(l) + 2CO_2(g) + Na_2SO_4(aq)$

Given 25.0 g of sodium bicarbonate and sufficient sulfuric acid, what volume of carbon dioxide gas would be produced at 25.0 C and 0.950 atm pressure?

1 - Convert 25.0 grams sodium bicarbonate to moles. Use FORMULA WEIGHT.
2 - Convert moles sodium bicarbonate to moles carbon dioxide. Use CHEMICAL EQUATION.
3 - Convert moles carbon dioxide to volume. Use IDEAL GAS EQUATION.

(1) $84.007\ g\ NaHCO_3 = mol\ NaHCO_3$ (2) $2\ mol\ NaHCO_3 = 2\ mol\ CO_2$

$$25.0\ g\ NaHCO_3 \times \frac{mol\ NaHCO_3}{84.007\ g\ NaHCO_3} \times \frac{2\ mol\ CO_2}{2\ mol\ NaHCO_3} = 0.2975942481\ mol\ CO_2$$

(3) $PV = nRT$

$V = \frac{nRT}{P}$

$n = 0.2975942481\ mol\ CO_2$

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

$T = 25.0°C = 298.2\ K$

$P = 0.950\ atm$

$$V = \frac{(0.2975942481\ mol\ CO_2)(0.08206\ \frac{L\text{-}atm}{mol\text{-}K})(298.2\ K)}{0.950\ atm}$$

$= 7.67\ L\ CO_2$ at $25.0°C$, $0.950\ atm$

What volume would the gas in the last example problem have at STP?

STP: "Standard Temperature and Pressure" (0 C and 1 atm)

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

$P_1 = 0.950$ atm

$V_1 = 7.67$ L

$T_1 = 298.2$ K

$P_2 = 1$ atm

$V_2 = ?$

$T_2 = 0°C = 273.2$ K

$$\frac{(0.950 \text{ atm})(7.67 \text{ L})}{298.2 \text{ K}} = \frac{(1 \text{ atm}) V_2}{273.2 \text{ K}}$$

6.67 L at STP $= V_2$

REAL GASES

- The empirical gas laws (including the ideal gas equation) do not always apply.

  - The gas laws don't apply in situations where the assumptions made by kinetic theory are not valid.

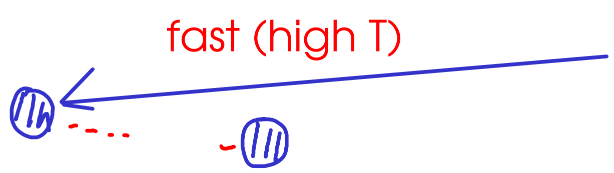
    - When would it be FALSE that the space between gas molecules is much larger than the molecules themselves?

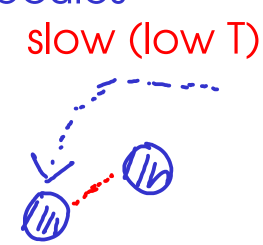
      - at high pressure, molecules would be much closer together!

    - When would it be FALSE that attractive and repulsive forces would be negligible?

      - at high pressure, attractions and repulsions should be stronger!

      - at low temperature, attractions and repulsions have a more significant affect on the paths of molecules





-The gas laws are highly inaccurate near the point where a gas changes to liquid!

- In general, the lower the pressure and the higher the temperature, the more IDEAL a gas behaves.