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.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}, \text{ and } P_1 = P_2 \rightarrow \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$V_1 = 3.5L$

$T_1 = 27.0°C = 300.2K$

$V_2 = ?$

$T_2 = -5.0°C = 268.2K$

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

$$3.1L = V_2$$

(volume in freezer)

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?

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

$P_1 = 1.00\,atm$

$V_1 = 2.25L$

$T_1 = 25.0°C = 298.2K$

$P_2 = ?$

$V_2 = 1.00L$

$T_2 = 31.0°C = 304.2K$

$$\frac{(1.00\,atm)(2.25L)}{(298.2K)} = \frac{P_2(1.00L)}{(304.2K)}; \quad P_2 = 2.30\,atm$$

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 - Use IDEAL GAS EQUATION (PV=nRT) to find MOLES of oxygen gas.
2 - Convert moles oxygen gas to mass. Use FORMULA WEIGHT.

$PV = nRT$ | $P = 1.18\ atm$ | $R = 0.08206 \frac{L \cdot atm}{mol \cdot K}$

$n = \frac{PV}{RT}$ | $V = 22650\ L$ | $T = 25.0°C = 298.2\ K$

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

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) $PV = nRT$

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

$n = 0.2975942481\ mol\ CO_2$ $P = 0.950\ atm$

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

$T = 25.0°C = 298.2\ K$

$$V = \frac{(0.2975942481\ mol\ CO_2)(0.08206 \frac{L \cdot atm}{mol \cdot K})(298.2\ K)}{(0.950\ atm)} = 7.67\ L\ @\ 25.0°C,\ 0.950\ atm$$

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

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

Use the combined gas law ...

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

$P_1 = 0.950$ atm $P_2 = 1$ atm

$V_1 = 7.67$ L $V_2 = ?$

$T_1 = 298.2$ K $T_2 = 0°C = 273.2$ 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 @ STP $= V_2$

$$2\,NH_4NO_3(s) \longrightarrow 2\,N_2(g) + O_2(g) + 4\,H_2O(g)$$

At 300.°C, ammonium nitrate violently decomposes to produce nitrogen gas, oxygen gas, and water vapor. What is the total volume of gas that would be produced at 1.00 atm by the decomposition of 15.0 grams of ammonium nitrate?

To simplify the calculation, calculate the TOTAL MOLES OF GAS instead of treating each gas separately.

FW NH_4NO_3 = 80.052 g/mol

1 - Convert 15.0 grams ammonium nitrate to moles. Use FORMULA WEIGHT.
2 - Convert moles ammonium nitrate to TOTAL MOLES GAS. Use CHEMICAL EQUATION.
3 - Convert TOTAL MOLES OF GAS to volume. Use IDEAL GAS EQUATION.

(1) 80.052 g NH_4NO_3 = mol NH_4NO_3 (2) 2 mol NH_4NO_3 = 7 mol gas (2+1+4=7)

$$15.0\,g\,NH_4NO_3 \times \frac{mol\,NH_4NO_3}{80.052\,g\,NH_4NO_3} \times \frac{7\,mol\,gas}{2\,mol\,NH_4NO_3} = 0.655823146\ mol\ gas$$

(3) $PV = nRT$

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

$n = 0.655823146$ mol gas $P = 1.00$ atm

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

$T = 300.°C = 573\ K$

$$V = \frac{(0.655823146\ mol\ gas)(0.08206\ \frac{L\cdot atm}{mol\cdot K})(573\ K)}{(1.00\ atm)} = 30.8\ L \text{ @ } 300.°C,\ 1\ atm$$