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.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \text{ ; constant } P: \quad \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$V_1 = 3.5\,L$ $\quad$ $V_2 = ?\,L$

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

$$\frac{3.5\,L}{300.2\,K} = \frac{V_2}{268.2\,K} \text{ ; } V_2 = \boxed{3.1\,L \text{ in freezer}}$$

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?

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

$P_1 = 1.00\,atm$ $\quad$ $P_2 = ?$

$V_1 = 2.25\,L$ $\quad$ $V_2 = 1.00\,L$

$T_1 = 25.0°C = 298.2\,K$ $\quad$ $T_2 = 31.0°C = 304.2\,K$

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

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 the ideal gas equation (PV=nRT) to find moles oxygen.
2 - Convert moles oxygen to mass using FORMULA WEIGHT

$PV = nRT$ | $P = 1.18\ atm$ $T = 25.0°C = 298.2\ K$

$n = \frac{PV}{RT}$ | $V = 22650\ L$

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

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 $$1092.222357\ mol\ O_2 \times \frac{32.00\ g\ O_2}{mol\ O_2} = 35\bar{0}00\ g$$

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 g sodium carbonate to moles. Use FORMULA WEIGHT.
2 - Convert moles sodium bicarbonate to moles carbon dioxide gas. Use CHEMICAL EQUATION.
3 - Convert moles carbon dioxide to volume. Use IDEAL GAS EQUATION.

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

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

(1) (2)

(3) $PV = nRT$

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

$n = 0.2975942481\ mol\ CO_2$ $T = 25.0°C = 298.2\ K$

$R = 0.08206\ \frac{L \cdot atm}{mol \cdot K}$ $P = 0.950\ atm$

$$V = \frac{(0.2975942481\ mol\ CO_2)\left(0.08206\ \frac{L \cdot atm}{mol \cdot K}\right)(298.2\ K)}{(0.950\ atm)} = 7.67\ L$$

7.67 L of CO_2 @ 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)

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let's solve the problem with the combined gas law...

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

$P_1 = 0.950$ atm $\quad P_2 = 1$ atm

$V_1 = 7.67$ L $\quad V_2 = ?$

$T_1 = 298.2$ K $\quad T_2 = 273.15$ K

$$\frac{(0.950\text{ atm})(7.67\text{ L})}{(298.2\text{ K})} = \frac{(1\text{ atm})V_2}{(273.15\text{ K})}$$

$$\boxed{6.67\text{ L at STP}} = V_2$$

Alternate solution: You can use PV=nRT to find the volume at STP, since you already know how many moles of gas there are...

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

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 this calculation, we'll calculate the TOTAL MOLES OF GAS instead of the individual moles of each gas!

$FW\ NH_4NO_3 = 80.052\ g/mol$

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

(1) $80.052\ g\ NH_4NO_3 = mol\ NH_4NO_3$

(2) $2\ mol\ NH_4NO_3 = 7\ mol\ gas$ $(2+1+4=7)$

$$15.0\ g\ NH_4NO_3 \times \frac{mol\ NH_4NO_3}{80.052\ g\ NH_4NO_3} \times \frac{7\ mol\ gas}{2\ mol\ NH_4NO_3} = 0.6558237146\ mol\ gas$$

(3) $PV = nRT$

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

$n = 0.6558237146\ mol\ gas$

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

$T = 300.°C = 573\ K$

$P = 1.00\ atm$

$$V = \frac{(0.6558237146\ mol\ gas)\left(0.08206\ \frac{L\cdot atm}{mol\cdot K}\right)(573\ K)}{(1.00\ atm)} = 30.8\ L$$

30.8 L at 300°C, 1 atm