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.

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

$V_1 = 3.5\ L$ | $V_2 = ?$

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

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

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?

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

$P_1 = 1.00\ atm$ | $P_2 = ?$

$V_1 = 2.25\ L$ | $V_2 = 1.00L$

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

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

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

← O_2

*Volume of a 10'x10'x8' room

Use the ideal gas equation to find the MOLES of gas ...

$$PV = nRT$$

→ Find the moles of gas ... 'n' ... and then convert the moles of gas to mass using formula weight of oxygen gas.

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

$P = 1.18\ atm$

$V = 22650\ L$

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

$T = 25.0°C = 298.2\ K$

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

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

(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 g sodium bicarbonate to moles using formula weight.
2 - Convert moles sodium bicarbonate to moles carbon dioxide using chemical equation
3 - Convert moles carbon dioxide to VOLUME using IDEAL GAS EQUATION

$84.007\ g\ NaHCO_3 = mol\ NaHCO_3$ | $2\ mol\ NaHCO_3 = 2\ mol\ CO_2$

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

(1) (2)

$PV = nRT$

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

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

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

$T = 25.0°C = 298.2\ K$

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

7.67 L of 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)

We can solve for the new volume with either the ideal gas equation or the combined gas law ...

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

$n = 0.2975942481 \text{ mol } CO_2$ $P = 1 \text{ atm}$

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

$T = 0°C = 273.15 \text{ K}$

$$V = \frac{(0.2975942481 \text{ mol } CO_2)(0.08206 \frac{L \cdot atm}{mol \cdot K})(273.15 \text{ K})}{(1 \text{ atm})} = 6.67 \text{ L at STP}$$

Alternatively, we could use the combined gas law:

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

$P_1 = 0.950 \text{ atm}$ $P_2 = 1 \text{ atm}$

$V_1 = 7.67 \text{ L}$ $V_2 = ?$

$T_1 = 298.2 \text{ K}$ $T_2 = 273.15 \text{ K}$

$$\frac{(0.950 \text{ atm})(7.67 \text{ L})}{(298.2 \text{ K})} = \frac{(1 \text{ atm}) V_2}{(273.15 \text{ K})} ; V_2 = 6.67 \text{ L at STP}$$