

MOLAR VOLUME OF GASES

- For all gases at a special temperature & pressure, there must be a certain volume that contains one mole of particlescalled the **molar volume**
- **MOLAR VOLUME** $\frac{V}{n}$ is the space that is occupied by one mole of a gas (L/mol).
- It has been determined empirically that the molar volume of a gas at SATP is 24.8L/mol or 22.4 L/mol at STP
- **Molar volume (MV)** can be used as a conversion factor between the number of moles and the volume of a gas.

Sample Problem 1

What volume is occupied by 0.024mol of carbon dioxide gas at SATP?

therefore the volume of the carbon dioxide gas is 0.60L

Sample Problem 2

What volume does 3.5g of helium gas occupy at SATP?

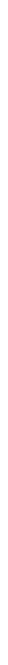
Therefore 3.5g of helium gas occupies 21.7L at SATP.

Sample Problem 3

A resealable 1.30 L container has a mass of 4.73 g. Nitrogen gas, N_2 gas, is added to the container until the pressure is 98.0 kPa at 22.0°C. Together, the container and the gas have a mass of 6.18 g. Calculate the molar volume of nitrogen gas at STP.

GIVEN:

REQUIRED : The molar volume of nitrogen gas at STP.



PARAPHRASE: The molar volume of nitrogen gas at STP is _____

ANSWER KEY:Sample Problem 1

What volume is occupied by 0.024mol of carbon dioxide gas at SATP?

$$\begin{aligned} \text{A: } n_{\text{CO}_2} &= 0.024 \text{ mol} \\ MV_{\text{SATP}} &= 24.8 \text{ L/mol} \\ V &= ? \end{aligned}$$

$$\begin{aligned} n &= MV/V, \quad MV = n \times V \\ V &= 0.024 \text{ mol} \times 24.8 \text{ L/mol} \\ &= 0.60 \text{ L} \end{aligned}$$

Therefore the volume of the carbon dioxide gas is **0.60L**

Sample Problem 2

What volume does 3.5g of helium gas occupy at SATP?

$$\begin{aligned} \text{A: } n_{\text{He}} &= 3.50 \text{ g} / 4.00 \text{ g/mol} \\ &= 0.875 \text{ mol} \end{aligned}$$

$$\begin{aligned} \text{now convert to volume at SATP} \quad & MV = n \times V \\ MV_{\text{He}} &= 0.875 \text{ mol} \times 24.8 \text{ L/mol} \\ &= 21.7 \text{ L} \end{aligned}$$

Therefore 3.5g of helium gas occupies 21.7L at SATP.

Sample Problem 3

A resealable-1.30 L container has a mass of 4.73 g. Nitrogen gas, N₂ gas, is added to the container until the pressure is 98.0 kPa at 22.0°C. Together, the container and the gas have a mass of 6.18 g. Calculate the molar volume of nitrogen gas at STP.

GIVEN:

$$P_i = 98.0 \text{ kPa}$$

$$V_i = 1.30 \text{ L}$$

$$T_i = 22.0 \text{ }^\circ\text{C or } 295 \text{ K}$$

$$m = 6.18 \text{ g} - 4.73 \text{ g} = 1.45 \text{ g}$$

$$P_f = 101.3 \text{ kPa}$$

$$V_f = ?$$

$$T_f = 0^\circ\text{C or } 273$$

REQUIRED : The molar volume of nitrogen gas at STP.

PLAN:

- Determine the number of moles:**
- Determine the volume under the new conditions (use combined gas law)
Find the molar volume:**

$$\text{molar volume} = \frac{V}{n}$$

SOLUTION:

$$n = \frac{m}{M}$$

$$n = \frac{1.45 \text{ g}}{28.02 \text{ g/mol}} = 0.0517 \text{ mol}$$

$$V_f = \frac{P_i V_i T_f}{T_i P_f} = \frac{(98.0 \text{ kPa})(1.30 \text{ L})(273 \text{ K})}{(295 \text{ K})(101.3 \text{ kPa})} = 1.16 \text{ L}$$

$$\frac{1.16 \text{ L}}{0.0517 \text{ mol}} = 22.4 \text{ L/mol}$$

PARAPHRASE: The molar volume of nitrogen gas at STP is 22.4 L