MOLAR VOLUME OF GASES

- For all gases at a special temperature & pressure, there must be a certain volume that contains one mole of particles ….called 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?

A: n_{CO_2}=0.024mol
MV_{SATP}=24.8L/mol
V= ?

n=MV/V, MV=n x V
V=0.024mol x 24.8L/mol
=0.60L

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?

A: n_{He}=3.50g/ 4.00g/mol
=0.875mol

now convert to volume at SATP MV= n x V
MV_{He}= 0.875mol x 24.8L/mol
= 21.7L

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:

$P_1 = 98.0\ kPa$ $\quad\quad$ $P_f = 101.3\ kPa$

$V_1 = 1.30\ L$ $\quad\quad$ $V_f = ?$

$T_1 = 22.0\ °C$ or $295\ K$ $\quad\quad$ $T_f = 0°C$ or 273

$m = 6.18\ g - 4.73\ g = 1.45\ g$

REQUIRED : The molar volume of nitrogen gas at STP.

PLAN:

1. **Determine the number of moles:**

2. **Determine the volume under the new conditions (use combined gas law)**
   Find the molar volume:

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

SOLUTION:

$$n = \frac{m}{M} \qquad n = \frac{1.45g}{28.02g/mol} = 0.0517mol$$

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

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

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