Name: * Key *
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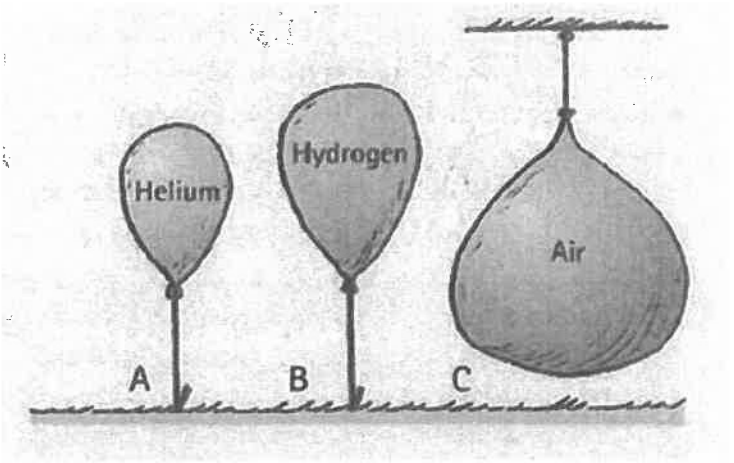
Chemistry 11
Calculating Molar Volume

Amedeo Avogadro was fascinated by gases and used them in many of his experiments. After working with gases for many years he came up with the hypothesized:

If gases are subjected to the same conditions (temperature and pressure) then they will occupy the same space



HOW BIG IS MOLAR VOLUME**?**

- **Molar volume is dependent on exposing gases to the** Imposed conditions
- **For the purposes of this course we will be using the Standard Temperature and Pressures (** STP **) of:**

  0°C **and** 1 atm (101.3 kPa)

- **Please note that is STP is different from the value used in your textbook (where pressure is set at** 100.0 kPa**), therefore some of the answers in the key will be off**
- **The chemistry staff at EMS have decided to use the volume value for 1atm of pressure which is** 22.4 L / 1 mol **of gas.**

$$\frac{22.4\ L}{1\ mol\ Xg} \quad \text{or} \quad \frac{1\ mol\ Xg}{22.4\ L}$$

Types of Molar Volume calculations:

Here are sample calculations that you will be asked to do, **calculate** the:

C. **number of moles** of a gas at STP (when given the volume (in L)
D. **number of moles** of a gas at STP(when given a value other than L)
C. **volume** of a gas at STP (when given the number of moles)

Example A:

How many **moles** are in 50.0 L of Oxygen gas at STP?

First identify that you have a gas at STP therefore you can use 22.4 L / 1 mol

Then set up your expression to allow for unit conversions:

50.0 L	$\frac{1\text{ mol}}{22.4\text{ L}}$	=	2.23 mol O_2 (g)

Example B:

How many **moles** are there in 250.0 mL of Carbon dioxide gas at STP?

First identify that you have a volume value other than L and you need to convert!
Second identify that you have a gas at STP therefore you can use 22.4 L / 1 mol

Then set up your expression to allow for unit conversions:

250.0 mL	$\frac{1\cdot10^{-3}\text{ L}}{1\text{ mL}}$	$\frac{1\text{ mol}}{22.4\text{ L}}$	=	$1.12\cdot10^{-2}$ mol CO_2 (g)

Example C:
If you have 0.75 moles of Nitrogen monoxide gas at STP, what **volume** does it fill?

First identify that you have a gas at STP therefore you can use 22.4 L / 1 mol
Second identify if you are asked to solve for a volume other than L...if so:
Convert!

Then set up your expression to allow for unit conversions:

0.75 mol	$\frac{22.4\text{ L}}{1\text{ mol}}$	=	17 L NO (g)

MOLAR VOLUME CALCULATIONS
PART A: Calculate the number of moles of gas present in the following volumes of gas at STP

1. 375 mL of phosphorous pentachloride gas

375 mL	$\frac{1 \cdot 10^{-3} L}{1 mL}$	$\frac{1 mol}{22.4 L}$	= $1.67 \cdot 10^{-2}$ mol PCl_5

2. 5.0 L of hydrogen gas

5.0 L	$\frac{1 mol}{22.4 L}$	= 0.22 mol H_2

3. 450.0 mL of dinitrogen tetroxide gas

450.0 mL	$\frac{1 \cdot 10^{-3} L}{1 mL}$	$\frac{1 mol}{22.4 L}$	= $2.01 \cdot 10^{-2}$ mol N_2O_4

4. 30 L of Helium gas

30 L	$\frac{1 mol}{22.4 L}$	= 1 mol He

5. 85.7 cL of nitrogen gas

85.7 cL	$\frac{1 \cdot 10^{-2} L}{1 cL}$	$\frac{1 mol}{22.4 L}$	= $3.83 \cdot 10^{-2}$ mol N_2

PART B: Calculate the volume occupied by each of these gases at STP.

1. **number of L** in 12.5 mol of NH_3 (g)

$$12.5 \text{ mol} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 2.80 \cdot 10^2 \text{ L } NH_3$$

2. **number of mL** in 0.350 mol oxygen gas

$$0.350 \text{ mol } O_2 \times \frac{22.4 \text{ L}}{1 \text{ mol}} \times \frac{1 \text{ mL}}{1 \cdot 10^{-3} \text{ L}} = 7840 \text{ mL } O_2$$

3. **number of L** in 6.02×10^{23} mol of Argon gas

$$6.02 \cdot 10^{23} \text{ mol} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 1.35 \cdot 10^{25} \text{ L Ar}$$

4. **number of dL** in 180 mol of Hydrogen gas

$$180 \text{ mol} \times \frac{22.4 \text{ L}}{1 \text{ mol}} \times \frac{1 \text{ dL}}{1 \cdot 10^{-1} \text{ L}} = 4.0 \cdot 10^4 \text{ dL } H_2$$

5. **number of L** in 15.0 mol of Nitrogen dioxide gas

$$15.0 \text{ mol} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 336 \text{ L } NO_2$$