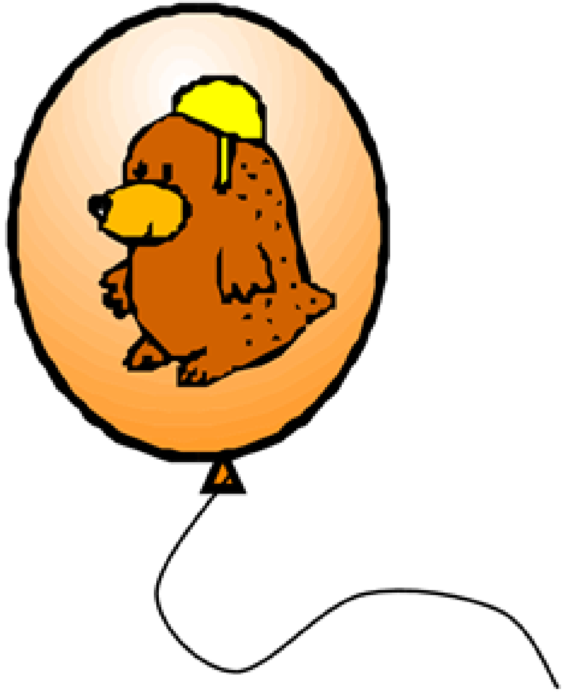
Density & Molar Volume

NHL Puck

Sponge Puck



Outcome:

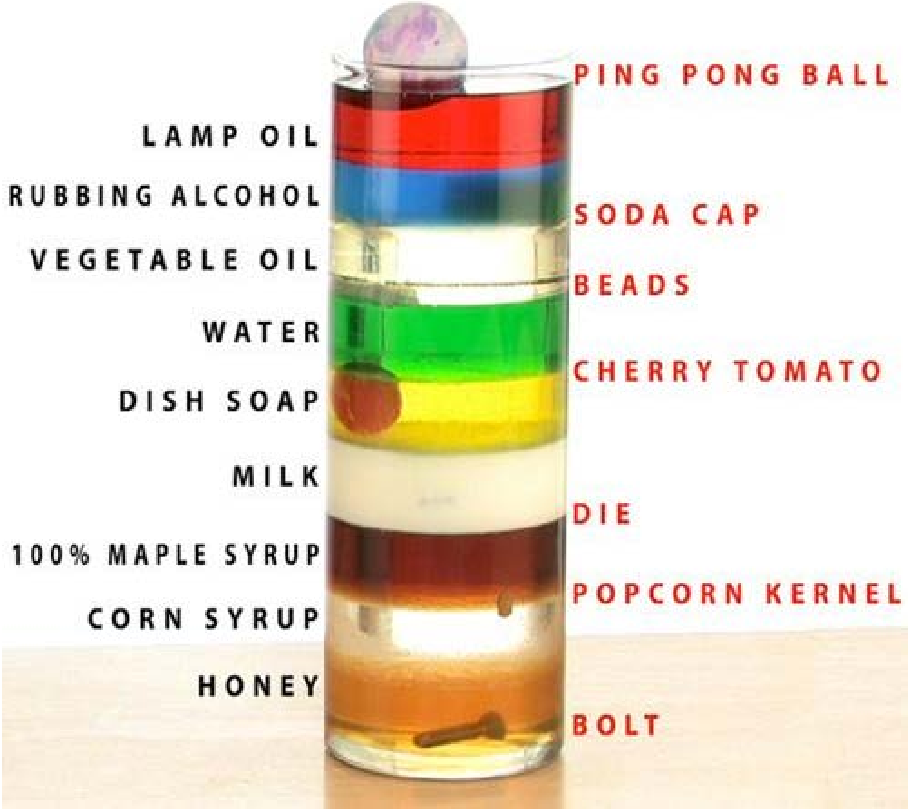
Calculate the volume of a given mass of a gaseous substance from its density at a given temperature and pressure. *Include Molar Volume*

Density Review

$D = \frac{m}{V}$

Density:

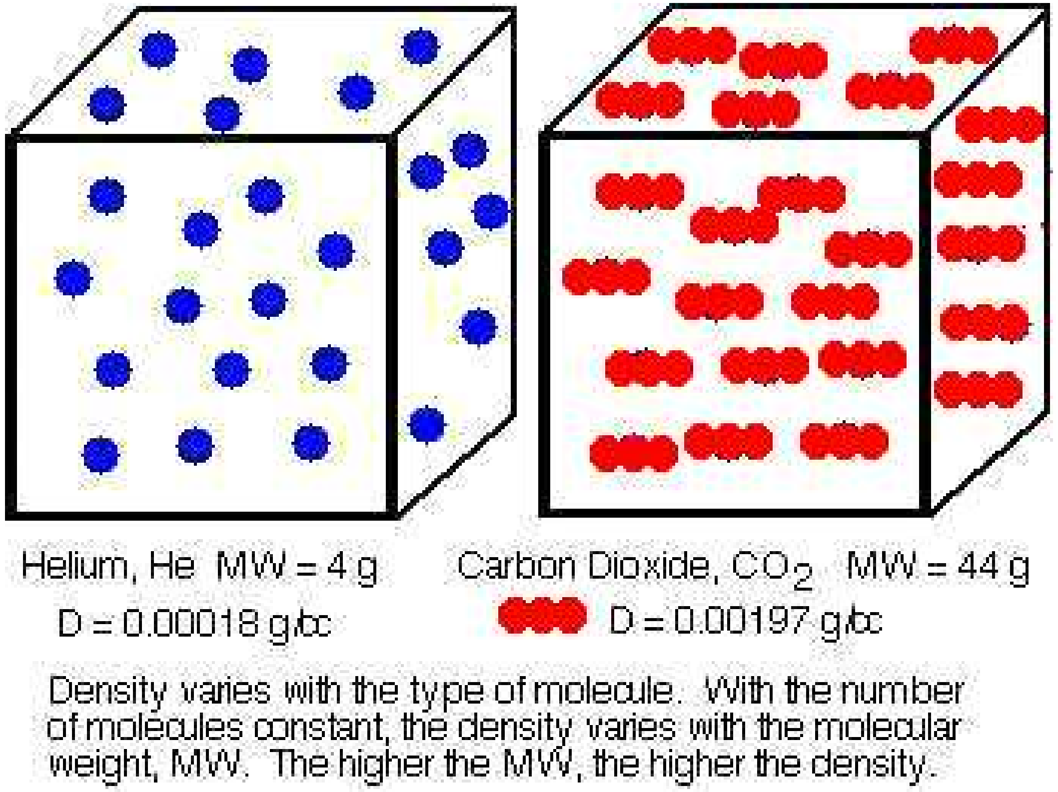
- Is the **MASS** of a substance in a **SPECIFIC VOLUME** and can be measured in units like **g/L, g/mL, g/cm³**, etc.
- Is a characteristic **PHYSICAL PROPERTY** of different substances. (i.e. foam is less dense than rubber)



http://publish.illinois.edu/cenayciencias/density-lesson/

Density Review

The **SAME VOLUMES** of different gases will have different **DENSITIES**, even with the same number of particles because of their **MOLAR MASSES**…



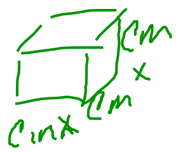
http://chemistry.elmhurst.edu/vchembook/123Adensitygas.html

Density Review

We can think of density like a ratio (just like molar mass).

Ex) The density of aluminum is 2.7g/cm^3

$$\frac{2.7g}{1cm^3} \quad OR \quad \frac{1cm^3}{2.7g}$$



cm^3

Density Calculations

Examples:

1. If 10ml of water weighs 10g, what is the density of water?

g/ml

$$\frac{10g}{10ml} = 1\ g/ml$$

2. If a diamond has a density of 3.51g/cm^3, what would be the mass of a 1cm^3 diamond?

$$1cm^3 \times \frac{3.51\ g}{1\ cm^3} = 3.51g$$

Density Calculations

Examples:

3. Copper has a density of 8.92g/cm^3. What would be the volume occupied by 18g of copper?

$$18g \times \frac{1\,cm^3}{8.92\,g} = 2.02\,cm^3$$

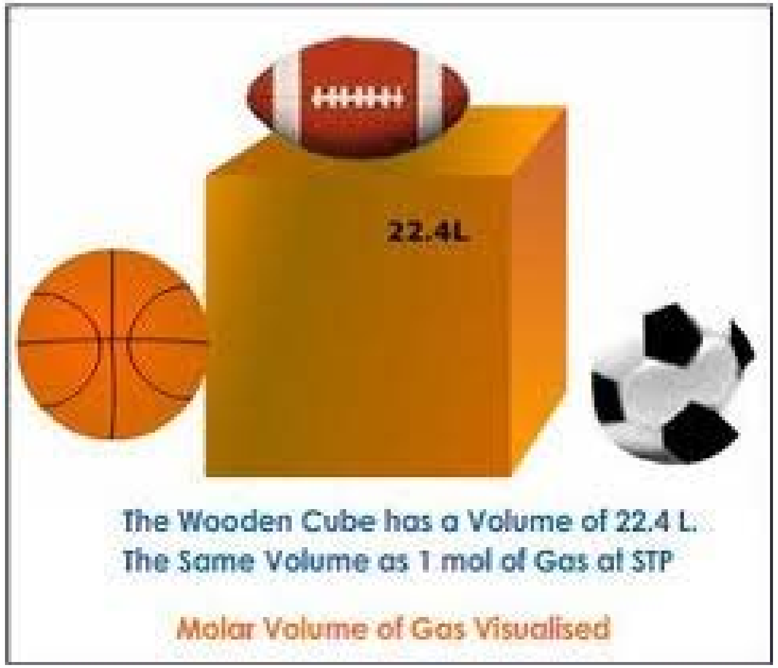
Molar Volume (MV)

Molar Volume is the **VOLUME** occupied by **1 MOLE** of a **GAS**.

At Standard Temperature and Pressure, (**STP)** (***0 °C, 101.3 kPa***)
1MOL of a **GAS** occupies **22.4 L**. Therefore,

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

At STP only



http://www.tutorvista.com/content/science/science-i/atoms-molecules/molecular-mass-mole.php

At **ROOM TEMPERATURE** (**25**°C), **1 MOLE** of a **GAS** will occupy **24.4L**

Molar Volume (MV)

If we know the volume occupied, we can calculate the number of moles present:

Examples:

1. Calculate the number of moles of O_2 gas that occupies 67.2L at STP.

$$67.2\,L \times \frac{1\,mol}{22.4\,L} = 3\,mol$$

Molar Volume (MV)

Examples (con't):

2. Calculate the volume of 3.0 mol of O_2 gas at STP.

$$3.0\,mol \times \frac{22.4\,L}{1\,mol} = 67.2\,L$$

3. What is the mass of 1L of nitrogen gas at STP?

→ N_2

$$1\,L \times \frac{1\,mol}{22.4\,L} = 0.045\,mol \times \frac{28\,g}{1\,mol} = 1.26\,g\,N_2$$

Molar Volume (MV)

We can prove the molar volume of gases using their densities at STP…

Calculate the molar volume of hydrogen gas if its density is 0.08999 g/L at STP.

H_2

L/mol

assume 1 L H_2

$$0.08999\,g \times \frac{1\ mol}{2.02\ g} = 0.0445\ mol$$

$$\text{molar Volume} = \frac{1\,L}{0.0445\ mol} = 22.47\ L/mol$$