Chemistry 112

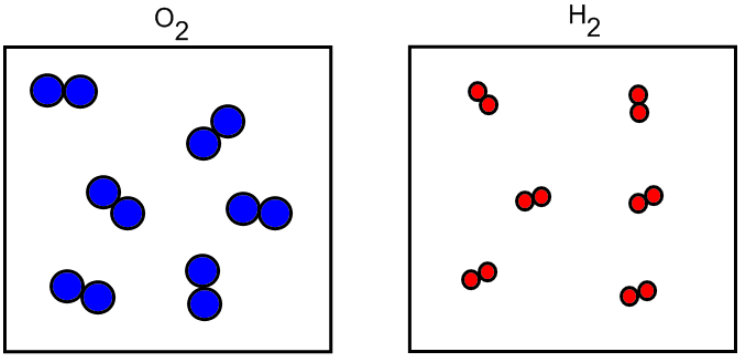
Learning Opportunities

May 4 – 8

The mole – volume relationship for gases

When measuring one mole of a liquid or solid substance it is easy to demonstrate because they occupy a definite space. When measuring one mole of a gaseous substance that is continuously moving and changing shape and volume, measuring must be done differently.

Avogadro's hypothesis states that equal volumes of gases at the same temperature and pressure contain equal numbers of particles. Due to the structure of gaseous compounds, the size of individual particles does not significantly affect the volume the substance occupies. The particles are so far apart that the space between the particles takes up much more space than the particles themselves.



Gas volume changes with changes in temperature and pressure. At high temperature or low pressure gases will increase in volume, while at low temperature or high pressure gases will decrease in volume.

To accommodate these changes, gas volumes are measured under Standard Temperature and Pressure (STP). STP represents a temperature of 0°C and a pressure of 101.3 kPa (1 atmosphere (atm)). At STP, one mole (6.02×10^{23} particles) of any gas occupies exactly 22.4L. This number is referred to as the Molar Volume of gas.

Molar volume of any gas = 22.4L/mol

See Molar volume – Sample problem

Practice problems

1. What is the volume of 0.0032 mol of CO_2 gas at STP?
2. What is the volume of 3.70 mol of N_2 gas at STP?
3. How many moles of He gas occupy 1.25 L at STP?
4. How many moles of C_2H_6 gas occupy 0.335 L at STP?
5. The densities of gases A, B, and C at STP are 1.25 g/L, 2.86 g/L and 0.714 g/L respectively. Calculate the molar mass of each and use this value to identify the gas as NH_3, SO_2, Cl_2, N_2 or CH_4.

Molar Volume in 2-step conversions

Adding molar volume to our list of calculations allows us to convert between grams, particles, volume of gas and moles. Every step in the conversion involves going to or from moles.

mass → moles → particles

mass → moles → volume of gas

Particles → moles → mass

Particles → moles → volume of gas

Volume of gas → moles → particles

Volume of gas → moles → mass

See Molar Volume 2-step conversions – Sample problem

Practice Problems

1. How many molecules are in 91.6 L of $N_{2(g)}$ at STP?
2. What is the mass of He in a 3.4 L balloon at STP?
3. What volume is occupied by 386 g of $CO_{2(g)}$ at STP?
4. What volume is occupied by 5.82 X 10^{25} molecules of $O_{2(g)}$ at STP?