IDEAL GASES

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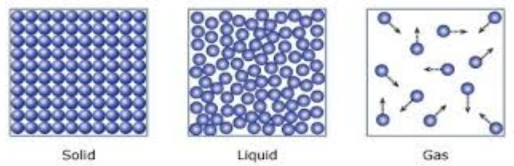
CHEM 105 A

Learning Objective

Explain the behavior of gas phase chemical systems at the particulate and macroscopic level using ideal gas behavior.

Introduction

Gases like oxygen, hydrogen, and nitrogen are a vital part of the Earth and the life that exists in it. Of the states of matter, gases are the most free flowing and have the most energy. The molecules will take the shape of their closed container and are constantly colliding with other molecules and the container itself (Mason). Gases have various properties but their behavior can largely be predicted by a few.



Ideal Gas/Kinetic Molecular Theory

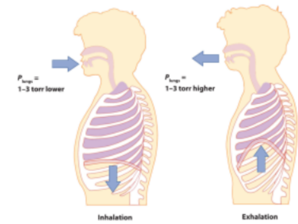
In order to predict the behavior or calculate the properties of gases, some assumptions must be made about the gases that may not necessarily apply to real world gases. They also provide an explanation on a molecular level as to why they act the way that they do. These assumptions include:

1. The particles are in constant, random motion
2. The molecules themselves do not react with each other (no repulsion or attraction between the molecules)
3. The volume of each molecule is negligible
4. The collisions between the molecules or with the container don't result in a loss of energy

These assumptions are applicable to real gases that are under low pressure (fewer interactions between molecules) or high temperature (increased speed results in fewer interactions) (Shapley).

Gas Law: Real Life Example - Breath

Arguably the most important application of this gas law in humans and other animals with lungs is respiration. For humans to breathe, the diaphragm that rests under the lungs first moves downwards, relieving the pressure on the lungs. This lower pressure causes air to rush in to fill the increasing volume. The opposite happens when the lungs exhale. The diaphragm moves upwards and puts pressure on the lungs, causing the volume to decrease and the air to be expelled (Bell).



Ideal Gas Law

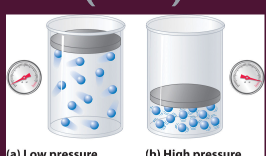
Ideal gases follow the ideal gas law, an equation used to model gas behavior.

$$PV=nRT$$

Pressure (P – atm)

The pressure of a gas is the force caused by molecules colliding with their container. A measure of gas pressure is the atmospheric pressure that gases in the environment place on surfaces under them which changes with altitude

Volume (V – L)



$$V \propto \frac{1}{P}$$

Boyle's Law shows that as the volume of the gas decreases, its pressure increases.

Moles (n – mol)

Avogadro's law found the volume of the gas increased as the number of moles increased.

$$V \propto n$$

Temperature (T – K)

The temperature of a gas is proportional to the molecule's kinetic energy and how quickly they are moving within the container. **Charles' Law** showed the direct proportionality between the temperature of the gas and its volume.

$$V \propto T$$

Root Mean Square Velocity

The important connection between molecule speed and the temperature of a gas can be modeled using this equation. It considers the kinetic energy produced by this movement, meaning that the mass of the molecules are also taken into consideration. The R in this equation must include Joules, so it will be 8.314 J/mol K.

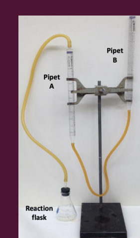
$$u_{rms} = \sqrt{\frac{3RT}{M}}$$

Gas Constant (R – $\frac{L \times atm}{mol \times K}$)

The gas constant is 0.082057. It is the proportionality that connects these three laws together to make the final ideal gas law.

Gas Law: Lab Data Collection

Applications of the gas law when in lab include measuring properties of gas produced in a reaction to determine properties of the reactants. Most of these labs require measuring the pressure, volume, and temperature of the gas to find the number of moles produced. Pressure and volume require creative methods to find, especially since gas reactants are free flowing and usually not very visible. Devices that use the comparison of the gas with the atmospheric pressure are often the most useful. In these, liquids are used to examine a difference in pressure and volume, with one being exposed to the atmosphere and the other only touching the gas reactant (Flowers *et al.*).



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