Quantum Mechanics_ gas laws

This article outlines the historical development of the laws describing ideal gases. For a detailed description of the ideal **gas laws**and their further development, see Ideal gas, Ideal gas law and Gas.

The early gas laws were developed at the end of the 18th century, when scientists began to realize that relationships between the pressure, volume and temperature of a sample of gas could be obtained which would hold for all gases. Gases behave in a similar way over a wide variety of conditions because to a good approximation they all have molecules which are widely spaced, and nowadays the equation of state for an ideal gas is derived from kinetic theory. The earlier gas laws are now considered as special cases of the ideal gas equation, with one or more of the variables held constant.

Boyle's law

Boyle's law shows that, at constant temperature, the product of an ideal gas'spressure and volume is always constant. It was published in 1662. It can be determined experimentally using a pressure gauge and a variable volume container. It can also be found through the use of logic; if a container, with a fixed number of molecules inside, is reduced in volume, more molecules will hit the sides of the container per unit time, causing a greater pressure.

As a mathematical equation, Boyle's law is:

$$P_1V_1 = P_2V_2$$

where P is the pressure (Pa), V the volume (m^3) of a gas, and k_1 (measured injoules) is the constant from this equation—it is not the same as the constants from the other equations below.

This is known as Boyle's law which states: the volume of a given mass of gas is inversely proportional to its pressure, if the temperature remains constant. Mathematically this is:

$$V = k/P$$

where k is a constant (NOT Boltzmann's constant or Coulomb’s constant).

Charles' law

Charles's Law, or the law of volumes, was found in 1787 by Jacques Charles. It says that, for an ideal gas at constant pressure, the volume is directly proportional to its temperature.

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Gay-Lussac's law

Gay-Lussac's law, or the pressure law, was found by Joseph Louis Gay-Lussac in 1809. It states that the pressure exerted on the sides of a container by an ideal gas of fixed volume is proportional to its temperature.

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

Avogadro's law

Avogadro's law states that the volume occupied by an ideal gas is proportional to the number of moles present in the container. This gives rise to the molar volumeof a gas, which at STP is 22.4 dm^3 (or litres). The relation is given by

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

where n is equal to the number of moles of gas (the number of molecules divided by Avogadro's Number).

Combined and ideal gas laws

Main article: Ideal gas law

The combined gas law or general gas equation is formed by the combination of the three laws, and shows the relationship between the pressure, volume, and temperature for a fixed mass of gas:

$$PV = k_5 T$$

This can also be written as:

$$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$$

With the addition of Avogadro's law, the combined gas law develops into the Ideal gas law:

$$PV = nRT$$

where

P is pressure
V is volume
n is the number of moles
R is the universal gas constant
T is temperature (K)

where the constant, now named R, is the gas constant with a value of .08206 (atm•L)/(mol•K). An equivalent formulation of this law is:

$$PV = kNT$$

where

P is the absolute pressure
V is the volume
N is the number of gas molecules
k is the Boltzmann constant (1.381×10^{-23} J·K^{-1} in SI units)
T is the temperature (K)

These equations are exact only for an Ideal gas, which neglects various intermolecular effects (see real gas). However, the ideal gas law is a good approximation for most gases under moderate pressure and temperature.

This law has the following important consequences:

1. If temperature and pressure are kept constant, then the volume of the gas is directly proportional to the number of molecules of gas.
2. If the temperature and volume remain constant, then the pressure of the gas changes is directly proportional to the number of molecules of gas present.
3. If the number of gas molecules and the temperature remain constant, then the pressure is inversely proportional to the volume.
4. If the temperature changes and the number of gas molecules are kept constant, then either pressure or volume (or both) will change in direct proportion to the temperature.

Other gas laws

- Graham's law states that the rate at which gas molecules diffuse is inversely proportional to the square root of its density. Combined with Avogadro's law (i.e. since equal volumes have equal number of molecules) this is the same as being inversely proportional to the root of the molecular weight.

- Dalton's law of partial pressures states that the pressure of a mixture of gases simply is the sum of the partial pressures of the individual components. Dalton's Law is as follows:

$$P_{total} = P_1 + P_2 + P_3 + ... + P_n \equiv \sum_{i=1}^{n} P_i$$,

OR

$$P_{\text{total}} = P_{\text{gas}} + P_{\text{H}_2\text{O}}$$

where P_{Total} is the total pressure of the atmosphere, P_{Gas} is the pressure of the gas mixture in the atmosphere, and P_{H_2O} is the water pressure at that temperature.

- Henry's law states that:
  At constant temperature, the amount of a given gas dissolved in a given type and volume of liquid is directly proportional to thepartial pressure of that gas in equilibrium with that liquid.

  $$p = k_{\text{H}}\, c$$

References

- Castka, Joseph F.; Metcalfe, H. Clark; Davis, Raymond E.; Williams, John E. (2002).*Modern Chemistry*. Holt, Rinehart and Winston. ISBN 0-03-056537-5.
- Guch, Ian (2003). *The Complete Idiot's Guide to Chemistry*. Alpha, Penguin Group Inc. ISBN 1-59257-101-8.
- Zumdahl, Steven S (1998). *Chemical Principles*. Houghton Mifflin Company.ISBN 0-395-83995-5.

Source: http://wateralkalinemachine.com/quantum-mechanics/?wiki-maping=Gas%20laws