

Lecture two

Gas Laws: Pressure, Volume and Hot Air

Properties of Gases You can predict the behaviour of gases based on the following properties:

- Pressure
- Volume
- Amount (moles)
- Temperature

Lets review each of these briefly...

Pressure

Pressure is defined as the force the gas exerts on a given area of the container in which it is contained. The SI unit for pressure is the Pascal, Pa.

Pressure Units

- KEY UNITS AT SEA LEVEL
 - 101.325 kPa (kilopascal)
 - 1 atm
 - 760 mm Hg
 - 760 torr
 - 14.7 psi

Volume

Volume is the three-dimensional space inside the container holding the gas. The SI unit for volume is the cubic meter, m³. A more common and convenient unit is the liter, L.

Amount (moles)

Amount of substance is tricky. As we've already learned, the SI unit for amount of substance is the mole, mol. Since we can't count molecules, we can convert measured mass (in kg) to the number of moles, n, using the molecular or formula weight of the gas.

Temperature

Temperature is the measurement of heat...or how fast the particles are moving. Gases, at room temperature, have a lower boiling point than things that are liquid or

solid at the same temperature. Remember: Not all substance freeze, melt or evaporate at the same temperature. Water will freeze at zero degrees Celsius.

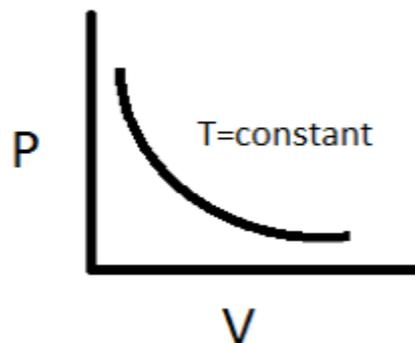
However alcohol will not freeze at this temperature.

STP : Standard Temperature & Pressure at 0°C 273 K and 1 atm or 101.325 kPa

Boyle's Law

This lesson introduces Boyle's Law, which describes the relationship between pressure and volume of gases.

$$P_1V_1 = P_2V_2$$

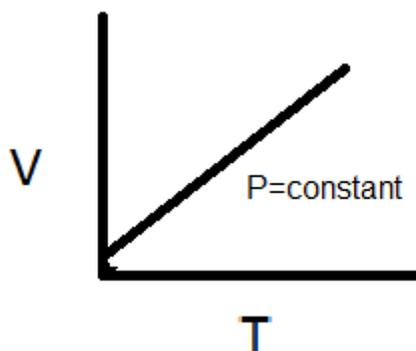


- This law is named for Charles Boyle, who studied the relationship between pressure, p , and volume, V , in the mid-1600s.
- Boyle determined that for the same amount of a gas at constant temperature, results in an inverse relationship: when one goes up, the other comes down.

Charles' Law

This lesson introduces Charles' Law, which describes the relationship between volume and temperature of gases.

$$V_1/V_2 = T_2/T_1$$



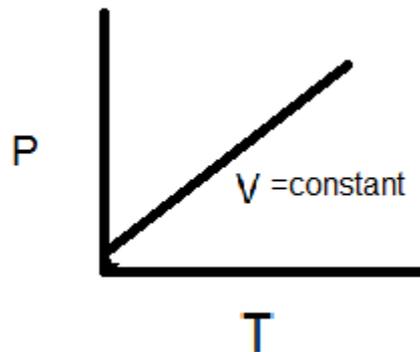
- This law is named for Jacques Charles, who studied the relationship volume, V , and temperature, T , around the turn of the 19th century.

- This defines a direct relationship: With the same amount of gas he found that as the volume increases the temperature also increases. If the temperature decreases than the volume also decreases.

Gay-Lussac's Law

The pressure and absolute temperature (K) of a gas are directly related at constant mass & volume.

$$P_1/P_2 = T_1/T_2$$



What does it mean?

- For a gas at constant mass and volume, the pressure and temperature are directly related.

Combined Gas Law

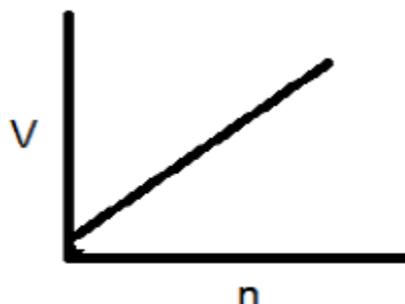
- It is a law that combines the previous laws into one.

$$P_1V_1/T_1 = P_2V_2/T_2$$

Avogadro's Principle

- Equal volumes of gases contain equal numbers of moles
- At constant temp & pressure
- True for any ideal gas

$$V_1/V_2 = n_1/n_2$$



What does it mean?

- For a gas at constant temperature and pressure, the volume is directly proportional to the number of moles of gas.

Dalton's Law of Partial Pressures

The total pressure of a mixture of gases equals the sum of the partial pressures of the individual gases.

$$P_{\text{total}} = P_1 + P_2 + P_3 + \dots$$

Ideal Gas Law

- UNIVERSAL GAS CONSTANT
- $R = 0.08206 \text{ L atm/mol K}$
- $R = 8.315 \text{ J/mol K}$