Chemistry Study Materials for Class 11
(NCERT Based Notes of Chapter- 04)
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States of Matter

Gas Laws

These are some relationships connecting the measurable properties of gases like pressure (P), temperature (T), volume (V) and number of moles (n). These are:

1) Boyle's Law (Pressure – Volume Relationship)

It states that at constant temperature, the volume of a fixed mass of gas is inversely proportional to its pressure. Mathematically,

$P \alpha 1/V$

Or, P = k x 1/V, where k is the proportionality constant.

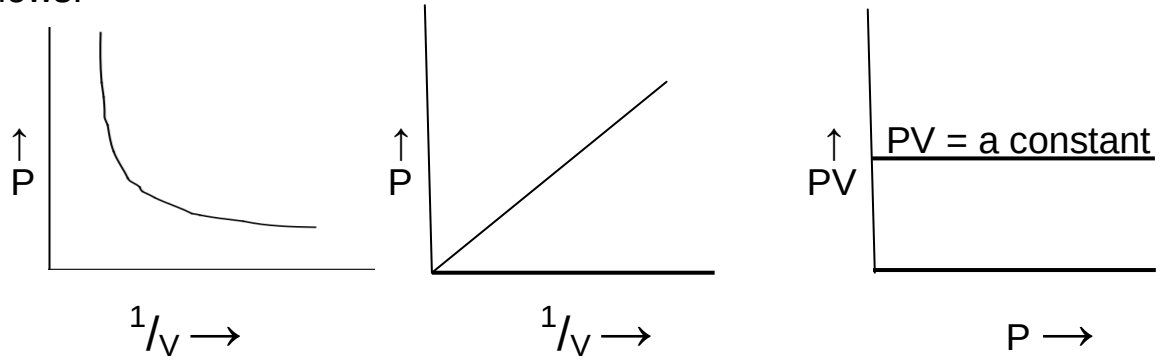
PV = k, a constant

Consider a fixed amount of gas at constant temperature T. Let V_1 & P_1 are its initial volume and pressure respectively. Let the gas undergoes expansion, so that its final volume and pressure becomes V_2 and P_2.

Then according to Boyle's law,

$P_1V_1 = P_2V_2$

If we plot graphs between pressure against volume, pressure against 1/volume and PV against P at constant temperature, the graphs obtained are as follows:



These graphs are obtained at constant temperature and are called **isotherms**. We know that density = mass/volume

i.e., d = m/V

If we put value of V in this equation from Boyle's law equation, we get the relationship, d = (m/k) x p

i.e. At constant temperature, pressure is directly proportional to the density of a fixed mass of the gas.

2) Charles' Law (Temperature – Volume Relationship)

It states that at constant pressure, volume of a fixed mass of gas is directly proportional to its temperature.

Mathematically, **$V \alpha T$**

Or, $V = k \times T$

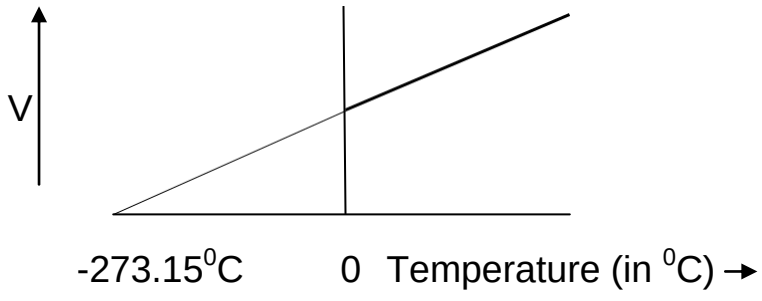
Or, $V/T = k$, a constant

Consider a fixed amount of gas at constant pressure P. Let V_1 be its volume at a temperature T_1 and V_2 be its volume at a temperature T_2.

Then according to Charle's law

$$\mathbf{V_1/T_1 = V_2/T_2}$$

If volume is plotted against temperature at constant pressure, the graph obtained is as follows.



Since the graph is obtained at constant pressure, it is called **isobar**.

If we extend the graph to temperature axis (X-axis), the graph will meet at -273.15^{0}C. At this temperature, the volume of the gas becomes zero.

This lowest hypothetical or imaginary temperature at which gases are supposed to occupy zero volume is called ***Absolute zero of temperature*** and the scale of temperature based on absolute zero is called ***Absolute scale of temperature***. All gases become solid or liquid before reaching this temperature.

3) Gay Lussac's Law (Pressure - Temperature Relationship)

It states that at constant volume, pressure of a fixed amount of a gas is directly proportional to the temperature.

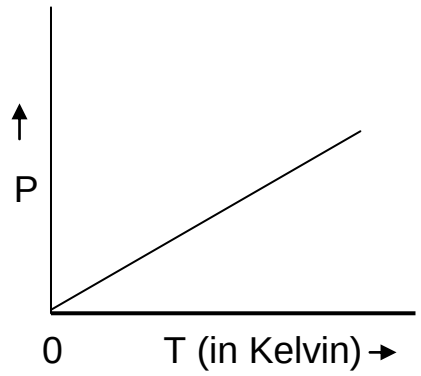
Mathematically,

P α T

Or, P = a constant x T

Or, **P/T = a constant**

If we plot a graph between pressure and temperature of a fixed mass of gas at constant volume, the graph obtained is as follows:



4) Avogadro Law (Volume – no. of moles or Amount Relationship)

It states that equal volumes of all gases under the same conditions of temperature and pressure contain equal number of moles or molecules.
This means that at constant temperature and pressure, the volume of a gas is directly proportional to its number of moles (n) or molecules (N).

i.e., **V α n**, the number of moles

or, V = k x n, where k is a constant

We know that number of moles (n) = mass in gram (w)/molar mass (M)

i.e., $n = w/M$

So the above equation becomes:

$$V = k \times w/M$$

Or, $M = k \times w/V$

Or, $M = k \times d$

Or, $M \alpha d$

i.e., the density of a gas is directly proportional to its molar mass.

Standard Temperature and Pressure (STP)

Standard temperature and pressure (also called NTP, the normal temperature and pressure) means 273.15 K (0°C) temperature and 1 bar pressure. These values approximate freezing temperature of water and atmospheric pressure at sea level.

At STP molar volume of an ideal gas or a combination of ideal gases is 22.71 L mol^{-1}.

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