Properties of Gases

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DEFINITION

Gas.

A substance that has no well-defined boundaries and diffuses to fill any container in which it is placed.

1 Diffusion

DEFINITION

Diffusion.

Diffusion is the spontaneous spreading out of a substance, and is due to the natural movement of its particles.

- The volume of a sample of gas depends on it's temperature and pressure.

2 Units

2.1 Temperature

- We use the Kelvin scale of temperature for calculations.
- To convert $°C$ to K, add 273.
- $0°C = 273K$ (standard temperature).

2.2 Pressure

- Units are Pascals (Pa).
- $1 \times 10^5 Pa$ is normal atmospheric pressure or standard pressure.

2.3 Volume

- Measured in cm^3
- Labelled as L (liters)
- $1L = 1000cm^3$

3 Boyle's Law

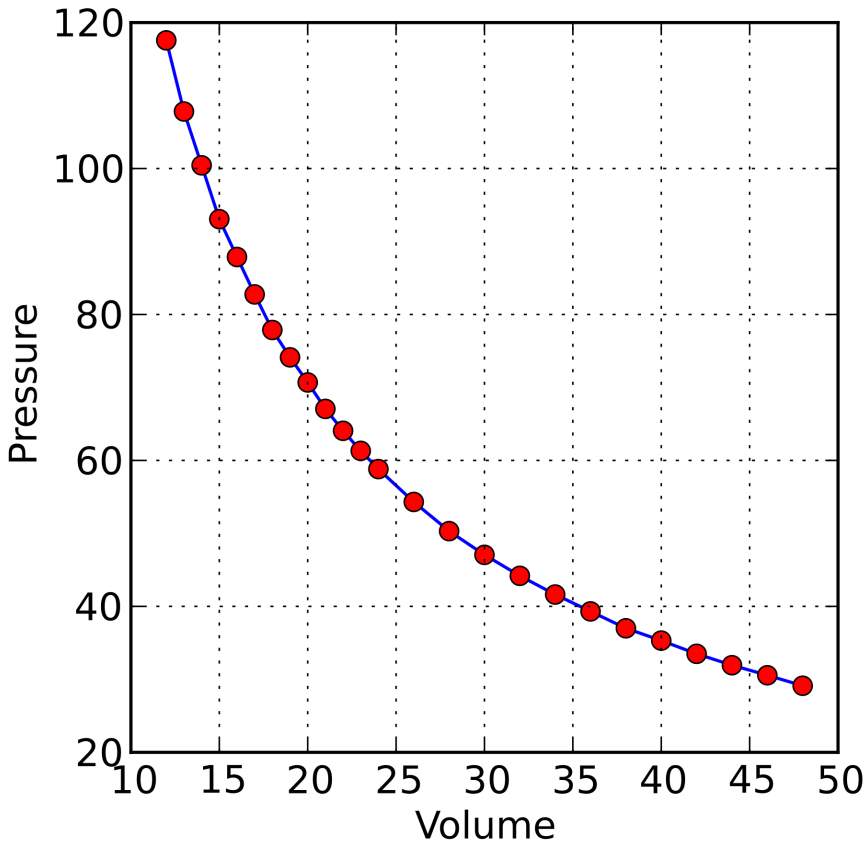

Figure 1: A diagram of Boyle's original data

- Boyle used a vacuum pump to investigate the way the volume of air varied with changing pressure.
- Boyle saw a relationship in his results and came up with boyle's law.

DEFINITION

Boyle's Law.

At a constant temperature the volume of a given mass of any gas is inversely proportional to the pressure of the gas.

4 Charles' Law

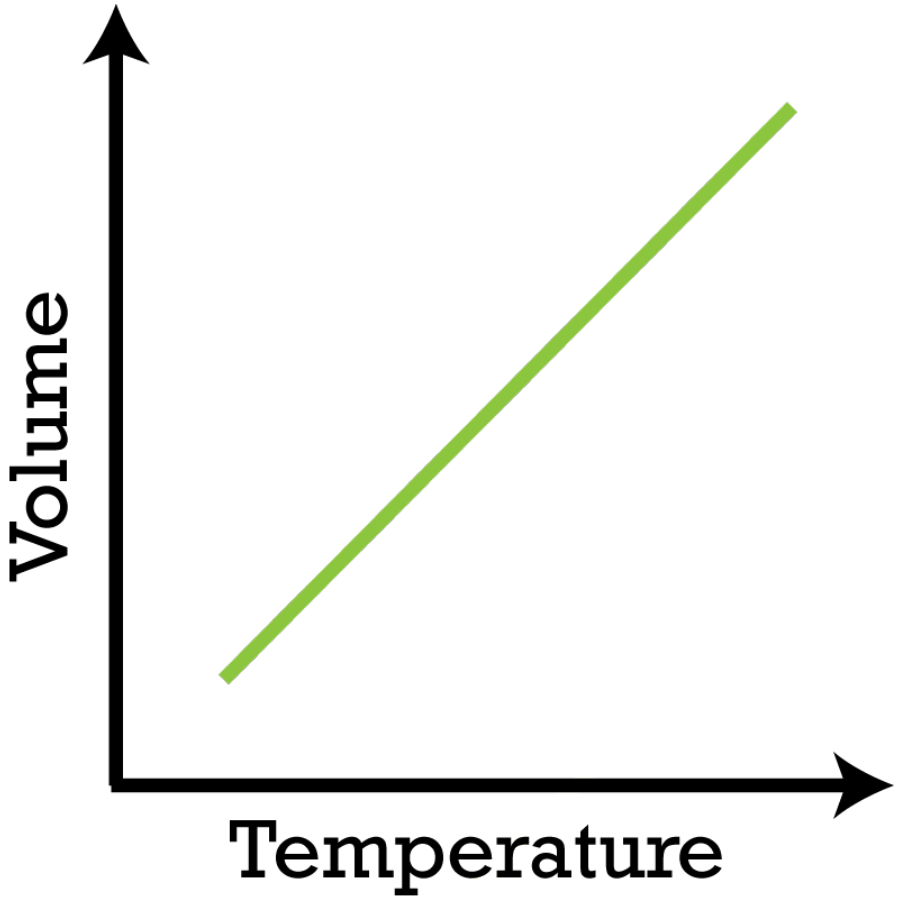

Figure 2: A graph showing Charles' Law

- Jacques Charles.
- Discovered that equal volumes of different gasses at constant pressure all expanded by the same amount when there is a rise in temperature.

DEFINITION

Charles' Law.

At constant pressure the volume of a given mass of any gas is directly proportional to the Kelvin temperature.

5 Combined Gas Laws

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

- Used to convert volume of a fixed mass of gas under one set of conditions of temperature and pressure to another.
- This formula is not in the log tables!

EXAMPLE 5.1

A sample of gas exerts a pressure of $83,326Pa$ *in a* $300cm^3$ *vessel at* $25°C$*. What pressure would this gas sample exert if it were placed in a* $500cm^3$ *container at* $50°C$*?*

Solution

$$P_1 = 83,326Pa \qquad P_2 = ?$$
$$V_1 = 300cm^3 \qquad V_2 = 500cm^2$$
$$T_1 = 25 + 273 = 298K \qquad T_2 = 50 + 273 = 323K$$

Note that the temperature must be in Kelvin.

$$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$$
$$\implies \frac{83326 \times 300}{298} = \frac{p_2 \times 500}{323}$$
$$\implies \frac{83326 \times 300 \times 323}{298 \times 500} = p_2$$
$$\implies p_2 = 54189.86Pa$$