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Chemistry

For the IB Diploma

Brighter Thinking
Better Learning

Chapter 5

Ideal gases

Avogadro's law only applies to IDEAL GASES

The assumptions of the ideal gas model are as follows:

- An ideal gas consists of particles in constant, random motion.
- The particles have no volume (they are point masses).
- No forces exist between particles (except when they collide).
- All collisions between particles, and between particles and the wall of the container, are perfectly elastic (there is no change in the total kinetic energy of the colliding particles).
- Real gases deviate most from ideal behaviour at

– low temperatures

– high pressures

Boyle's law

$P \propto 1/V$

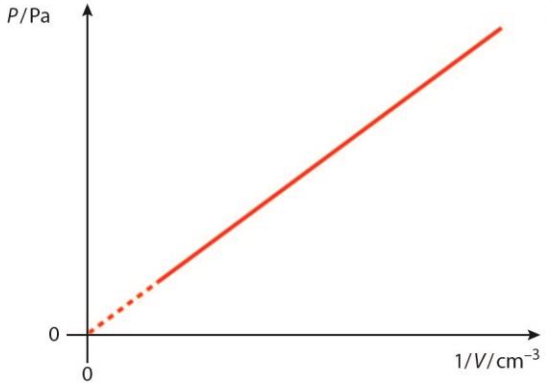


Figure 5.1: The relationship between pressure and 1/volume of a fixed mass of an ideal gas at constant temperature. The pressure and volume could also be in other units, e.g. m^3 and dm^3 for volume.

$PV = k$

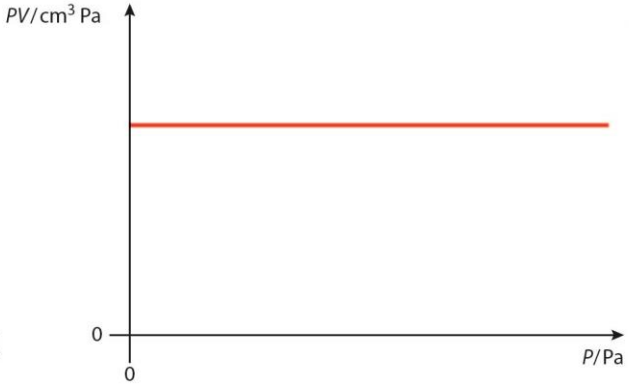


Figure 5.2: The relationship between *PV* and *P* for a fixed mass of an ideal gas at constant temperature.

$P = k/V$

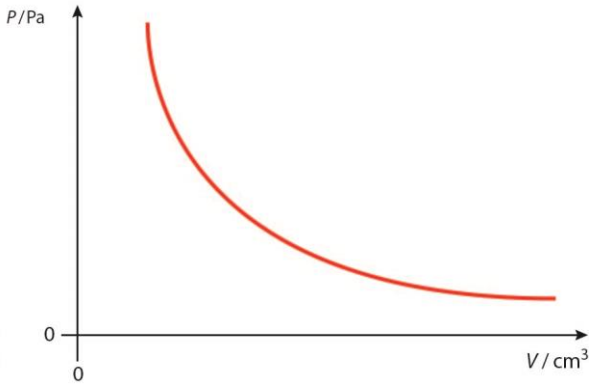


Figure 5.3: The relationship between the pressure and volume of a fixed mass of an ideal gas at constant temperature.

Boyle's law states that, at a constant temperature, the volume of a fixed mass of a given gas is inversely proportional to its pressure.

Charles' law

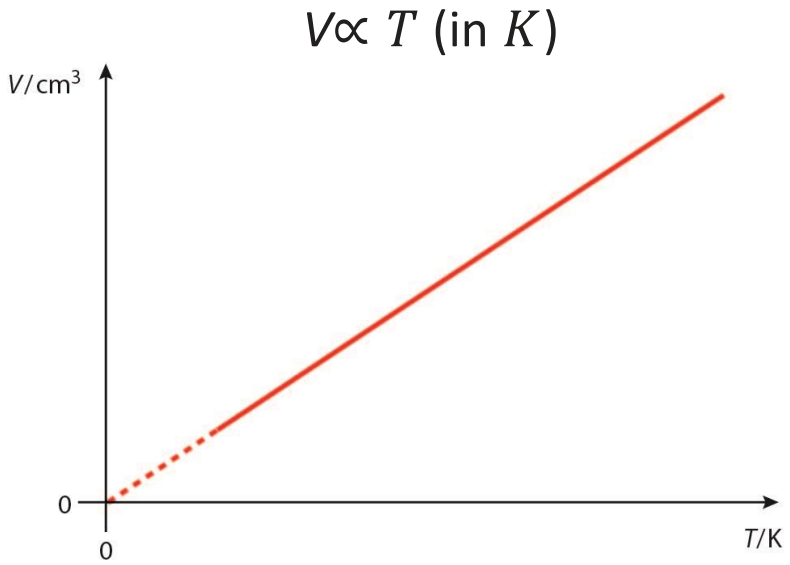


Figure 5.4: The relationship between the volume and temperature (in kelvin) of a fixed mass of an ideal gas at constant pressure. The graph is dashed at the end because we can't actually get to absolute zero.

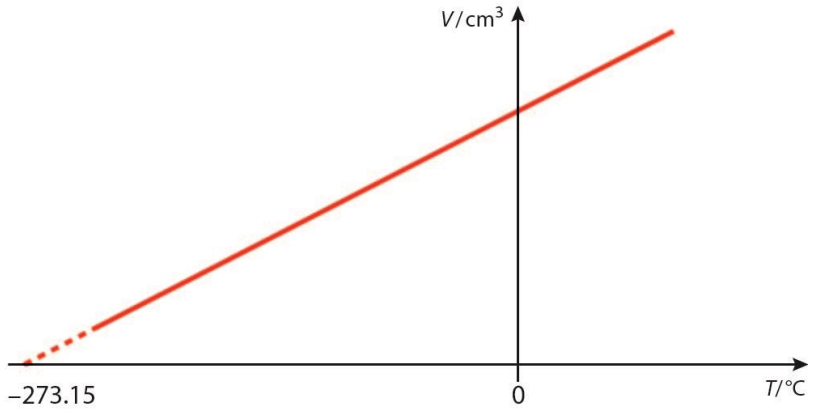
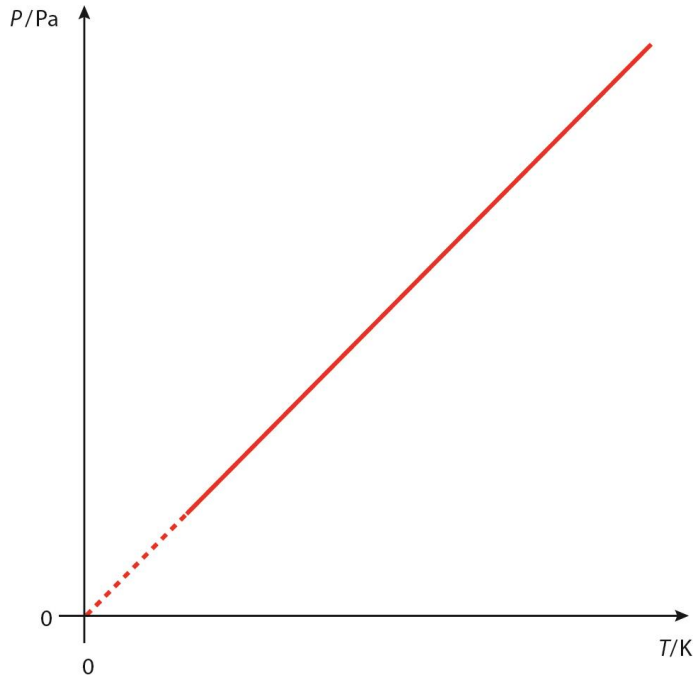


Figure 5.5: The relationship between the volume and temperature (in °C) of a fixed mass of an ideal gas at constant pressure. As can be seen, the temperature at which the volume of an ideal gas is zero would be −273.15 °C. This temperature is absolute zero.

Charles' law states that the volume of a fixed mass of an ideal gas at constant pressure is directly proportional to its absolute (kelvin) temperature.

Gay-Lussac's law



$P \propto T$ (in K)

Figure 5.6: The relationship between the pressure and temperature (kelvin) of a fixed mass of an ideal gas at constant volume.

For a fixed mass of an ideal gas at constant volume, the pressure is directly proportional to its absolute (kelvin) temperature

Overall gas law equation

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Ideal gas equation

$$PV = nRT$$

$R = 8.31\ \text{J K}^{-1}\ \text{mol}^{-1}$

pressure: Pa

volume: m^3

temperature: K

The relationship between the amount (number of moles) of a gas and its volume

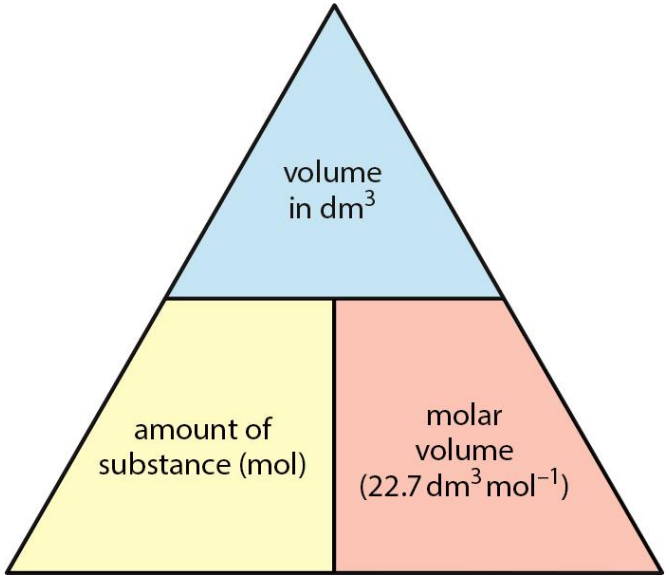


Figure 5.7: The relationship between the amount (number of moles) of a gas and its volume at STP.

Molar volume of an ideal gas can be calculated by rearranging the ideal gas equation to $V = n \times RT/P$ and substitute $n = 1$ mol.