Mathematically $V \propto n$ at constant T and p

$\Rightarrow \quad V = k.n$

For the same value of number of moles at constant temperature and pressure the proportionality constant 'k' will be a universal constant. At 0°C and 1 atm the value of k for 1 mole of gas is 22.4 litres.

Ideal Gas Law Equation of State

Combination of Boyle's law, Charle's law and Avogadro's law gives the ideal gas equation.

Boyle's law $V \propto \frac{1}{p}$ if T is constant.

Charle's law $\rightarrow$ $V \propto T$ if P is constant.

and Avogadro's law $\rightarrow$ $V \propto n$ if P and T are constant.

Thus, $V \propto \frac{nT}{P}$ i.e. $PV \propto nT$ $\rightarrow$ or $\boxed{PV = nRT}$

Where R is molar gas constant

or $\boxed{PV = RT}$ for 1 mole of gas

Numerical values of R

(i) $R = \frac{PV}{T}$ (For one mole of gas)

Since one mole of a gas at one atm pressure and 0°C (273 K) occupies a volume of 22.4 litre.

Then $R = \frac{1 \times 22.4}{273} = 0.0821$ litre atm mol^{-1} k^{-1}.

(ii) If pressure is taken in dyne/cm^2 and volume in ml.

$$R = \frac{76 \times 13.67 \times 981 \times 22400}{273} = 8.314 \times 10' \text{ erg } k^{-1} \text{ mol}^{-1} \text{ (CGS units)}$$

(iii) Since $1J = 10^7$ erg

ThusR = 8.314 J $mole^{-1}$ k^{-1}. (SI units)

(iv) Again, Since 1 calorie = 4.184×10^7 erg.

$$R = \frac{8.314 \times 10^7}{4.184 \times 10^7} = 1.987 \approx 2 \text{ calorie mol}^{-1} \text{ k}^{-1}$$

(v) If pressure is taken in bar so that volume is 22.7 dm^3

$$k = \frac{1 \times 22.7}{1\text{mole} \times 273\text{k}} = 0.083 \text{ bar } m^3 k^{-1} mol^{-1}$$

Dalton's Law of Partial Pressure

At a given temperature the total pressure exerted by two or more non reacting gases occupying a definite volume is equal to the sum of the partial pressure of the component gases,

Mathematically,

$$P = P_A + P_B + P_C + P_D + \text{.....}$$

where P is the total pressure and P_A, P_B, P_C ..... are the partial pressures of the gases A, B, C, ... respectively.