Dalton's law of partial pressures.

(1) According to this law, "When two or more gases, which do not react chemically are kept in a closed vessel, the total pressure exerted by the mixture is equal to the sum of the partial pressures of individual gases."

Thus, $P_{\text{total}} = P_1 + P_2 + P_3 + ...$

Where $P_1, P_2, P_3, ...$ are partial pressures of gas number 1, 2, 3 ....

(2) **Partial pressure** is the pressure exerted by a gas when it is present alone in the same container and at the same temperature.

Partial pressure of a gas

$$(P_1) = \frac{\text{Number of moles of the gas } (n_1) \times P_{\text{Total}}}{\text{Total number of moles } (n) \text{ in the mixture}} = \text{Mole fraction } (X_1) \times P_{\text{Total}}$$

(3) If a number of gases having volume $V_1, V_2, V_3 ......$ at pressure $P_1, P_2, P_3 ....$ are mixed together in container of volume V, then,

$$P_{\text{Total}} = \frac{P_1V_1 + P_2V_2 + P_3V_3 .....}{V}$$

or $= (n_1 + n_2 + n_3 .....) \dfrac{RT}{V}$ $(\because PV = nRT)$ or $= n\dfrac{RT}{V}$ $(\because n = n_1 + n_2 + n_3 .....)$

(4) **Applications:** This law is used in the calculation of following relationships,

(i) Mole fraction of a gas (X_1) in a mixture of gas $= \dfrac{\text{Partial pressure of a gas } (P_1)}{P_{\text{Total}}}$

(ii) % of a gas in mixture $= \dfrac{\text{Partial pressure of a gas } (P_1)}{P_{\text{Total}}} \times 100$

(iii) Pressure of dry gas collected over water: When a gas is collected over water, it becomes moist due to water vapor which exerts its own partial pressure at the same temperature of the gas. This partial pressure of water vapors is called aqueous tension. Thus,

$$P_{\text{dry gas}} = P_{\text{moist gas}} \text{ or } P_{\text{Total}} - P_{\text{water vapour}}$$

or $P_{\text{dry gas}} = P_{\text{moist gas}}$ – Aqueous tension (Aqueous tension is directly proportional to absolute temperature)

(iv) Relative humidity (RH) at a given temperature is given by :

$$RH = \frac{\text{Partial pressure of water in air}}{\text{Vapour pressure of water}}.$$

(5) **Limitations:**This law is applicable only when the component gases in the mixture do not react with each other. For example, N_2 and O_2, CO and CO_2, N_2 and Cl_2, CO and N_2 etc. But this law is not applicable to gases which combine chemically. For example, H_2 and Cl_2, CO and Cl_2, NH_3, HBr and HCl, NO and O_2 etc.

Note: N_2 (80%) has the highest partial pressure in atmosphere.

(6) Another law, which is really equivalent to the law of partial pressures and related to the partial volumes of gases is known as Law of partial volumes given by Amagat. According to this law, "When two or more gases, which do not react chemically are kept in a closed vessel, the total volume exerted by the mixture is equal to the sum of the partial volumes of individual gases."

Thus, $V_{\text{Total}} = V_1 + V_2 + V_3 + \ldots\ldots$

Where $V_1, V_2, V_3, \ldots\ldots$ are partial volumes of gas number 1, 2, 3.....