IDEAL GAS EQUATION (OR) PERFECT GAS EQUATION (OR) EQUATION OF STATE:

By combining Boyle's law and Charles laws we get

1. PV = nRT

   PV = RT for 1 mole

2. PV = $\frac{m}{M}RT\left[n = \frac{m}{M}\right]$

   n = Number of moles of the gas

   m = Mass of the gas

   M = Molecular weight of the gas

3. P = $\frac{dRT}{M}; \frac{d_1}{d_2} = \frac{p_1}{p_2} \times \frac{T_2}{T_1}$

   d = density of the gas

4. R = $\frac{hdgV}{nT}$ (P=hdg)

   d = density of mercury (13.6gm/c.c)

   g = gravity (980 cm/ sec^2)

   h = height of mercury column (76 cm)

22. For a given mass of a gas, "nR' is constant. So

1. $\frac{PV}{T} = \text{constant}$
2. $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \rightarrow$ Known as equation of State
3. $\frac{d_1T_1}{P_1} = \frac{d_2T_2}{P_2}$

23. Numerical Values of R:

R is universal gas constant or molar gas constant.

$$R = \frac{PV}{nT}$$

The value of 'R' is independent of the nature of the gas and amount of gas but it depends on units of expression.

1. R = $\frac{22.4}{273}$ lit – atm / k / mole
2. R = 0.0821 lit - atm / k / mole
3. R = 82.1 ml - atm / k / mole
4. R = 62.4 lit - mm / k/ mole
5. R = 6.24×10^4 ml - mm / k/ mole
6. R = 8.314×10^7 ergs / k/ mole
7. R = 8.314×10^7 dyne. cm. / k/ mole
8. R = 8.314 j / k/ mole
9. R = 1.987 Cals / k/ mole
10. R = 0.002 K.Cals /k / mole
11. 5.28×10^{19} ev / k/ mole

24. The gas constant for a single molecule of the gas is known as BOLTZMAN CONSTANT (K)

K = $\frac{R}{N}$ (N = Avogadro'snumber)

K = 1.38 × 10^{-16} ergs/K/molecule

K = 1.38 × 10^{-23} Joules /K/molecule

25. A gas which obeys gas laws (or) Ideal gas equation under all conditions of temperature and pressure is known as ideal gas or perfect gas.
26. No gas is perfectly ideal in nature. Every gas deviates more or less from ideal nature. So all the known gases are real gases.
27. Real gases deviate from ideal behaviour at high pressures and low temperatures.
28. Real gases will show nearer ideal behaviour at low pressures and high temperatures.
29. Real gases can be liquefied easily at high pressure and low temperature. This is due to inter molecular attractions.
30. For ideal gases; $\frac{PV}{RT}$=Z; Z = compressibility factor; for ideal gases, Z = 1; for real gases Z>1 or < 1

GRAHAM'S LAW OF DIFFUSION:

1. The spontaneous inter mixing of gases to form a homogeneous mixture is known as the diffusion.
2. Gases diffuse from high pressure to the low pressure.
3. The Volume of gas (V) that diffuses in unit time is known as the rate of diffusion (r) of the gas **r =** $\boldsymbol{\frac{V}{t}}$; unit of rate of diffusion: c.c /sec

Graham's law:

4. At constant temperature and pressure the rate of diffusion of a gas is inversely proportional to the square root of its density (or) molar mass (or) vapour density.

   1) $r \propto \frac{1}{\sqrt{d}}$ 2) $r \propto \frac{1}{\sqrt{M}}$ 3) $r \propto \frac{1}{\sqrt{V.D}}$

5. For two gases diffusing under similar conditions of temperature and pressure.

   1) $\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}} = \sqrt{\frac{v.D_2}{v.D_1}} = \sqrt{\frac{M_2}{M_1}} = \frac{v_1}{v_2} \times \frac{t_2}{t_1}$

6. Under similar conditions of temperature and pressure if the time of diffusion is same for two different gases.

$$\frac{r_1}{r_2} = \frac{v_1}{v_2}$$

7. Under similar conditions of temperature and pressure if equal volumes of two gases diffuse.

$$\frac{r_1}{r_2} = \frac{t_2}{t_1}$$

8. If two gases are at different pressures and same temperature, $\frac{r_1}{r_2} = \frac{p_1}{p_2} \times \sqrt{\frac{M_2}{M_1}}$
9. Under similar conditions of P and T, $\frac{W_1}{W_2} = \sqrt{\frac{M_1}{M_2}} \times \frac{t_1}{t_2}$
10. Lighter gases diffuse rapidly than heavier gases.
11. The diffusion of a gas at high pressure into low pressure or vaccum, through a small hole is known as Effusion.

12. Grahams law of diffusion is applicable to effusion also.

13. The separation of the component gases from a gaseous mixture based on the difference in their rates of diffusion is known as Atmolysis.

14. Marsh gas or Ansil's apparatus alaram works on the principle of diffusion property of gases.

Applications of diffusion

1. In the detection of marsh gas in coal mines.
2. In the separation of gas mixtures
3. In the seperation of isotopes Ex: U^{235} can be seperated from U^{238} in the form of UF_6
4. In diluting poisionous and foul smelling gases.
5. In the determination of molecular weights and densities of gases.

DALTON'S LAW OF PARTIAL PRESSURES:

1. The total pressure exerted by a mixture of gases is equal to the sum of the partial pressures of component gases present in the mixture $P = P_1 + P_2 + P_3 + ...$
2. The partial pressure of a gas is the pressure exerted by that gas in the mixture of gases.
3. The partial pressure of a gas is equal to the product of its mole fraction and the total pressure of the mixture of gases.

$$P_i = \frac{n_i}{n} \times P$$

(n = total number of moles of all gases in the mixture)

Partial pressure$=\frac{\text{volume of gas}}{\text{Total volume}} \times$ Total pressure

- If two or more gases are at different pressures and occupying different volumes are forced in to a vessel of volume 'V' ;

  then $P_{Total} = \frac{p_1v_1+p_2v_2+...}{V}$
- Percentage of gas in the mixture

$$= \frac{\text{Partial pressure}}{\text{Total pressure}} \times 100$$

- If two different gases with equal masses are present in the mixture, the gas with less molecular weight has more partial pressure.
- If two different gases with different masses and different molecular weights but same volumes are mixed together, their partial pressures are same.
- Dalton's law of partial pressures is applicable the mixture of non reacting gases.

  Ex: $CO+CO_2$, N_2+O_2 H_2+N_2, H_2+O_2, SO_2+O_2,

  NO_2+O_2
- Dalton's law of partial pressures is not applicable for reacting gases

  Ex: $CO+O_2$, $NO+Cl$, $CO+Cl_2$, SO_2HCL_2,

  H_2+F_2, $NO+O_2$, NH_3+HCl

Aqueous Tension:

- The pressure exerted by water vapour which is in equilibrium with liquid water is called aqueous tension.
- It is denoted by "f"

- Aqueous tension increases with temperature.
- Water insoluble gases are collected over water and they become moist gases.
  $P_{dry\ gas} = P_{moist\ gas} - f$
- Water insoluble gases are generally collected over water. A gas collected over water is saturated with water vapour. Such a gas is called moist gas.
- The volume of a moist gas is generally measured at atmospheric pressure. So pressure of moist gas is equal to atmospheric pressure.
- The pressure of water vapour in a moist gas is known as aqueous tension.
- $P_{moist\ gas} = P_{dry\ gas}$ + aqueous tension
- The aqueous tension increases with temperature

Temperature	Aqueous tension
0^0C	4.579 mm
25^0C	23.8 mm
26^0C	25.2 mm
27^0C	26.7 mm
28^0C	28.35 mm
29^0C	30.0 mm
30^0C	31.8 mm
100^0C	760 mm

- Dalton's law of partial pressures is **not applicable** to the mixture of gases like
  1. CO and Cl_2 2. NO and Cl_2
  3. NO and O_2 4. H_2 and Cl_2
  5. SO_2 and Cl_2 6. NH_3 and HCl
- Dalton's law of partial pressures is applicable to the mixture of gases like
  1.N_2 and H_2 2. H_2 and O_2
  3. H_2 and O_2 4. SO_2 and O_2
  5. CO_2 and SO_2 6. NO_2 and O_2