TDC-I
Paper-I
Gaseous State

(By Van der Waal. 1873)

Law of Corresponding State

It states that when two gases at same reduced temperature and under the same reduced pressure are in corresponding states then they should both occupy same reduced volume.

✓ Reduced ~~Temperature~~ Pressure = It is defined as the ratio of actual pressure to the critical pressure of gas.

$$\pi = P_r = \frac{P}{P_c}$$

✓ Reduced ~~Press~~ Temperature = It is defined as the ratio of actual temperature of gas to the critical temperature of that gas

$$\tau = T_r = \frac{T}{T_c}$$

✓ ~~Critical Volume~~ Reduced volume is ratio of volume of gas to the critical volume

$$\phi = V_r = \frac{V}{V_c}$$

Using vanderwaal Equation of State at critical state $(v-v_c)^2=0$

$$V^3 - 3V_c V^2 + 3_c^2 V - V_c^3 = 0 \quad (I)$$

$$V^3 - \left(b+\frac{RT_c}{P_c}\right)V^2 + \frac{a}{P_c}V - \frac{ab}{V_c} = 0 \quad (II)$$

Equating variable, we have

$V_c = 3b$ $\quad$ $P_c = \frac{a}{27b^2}$ $\quad$ ~~$V_c^3 = \frac{ab}{P_c}$~~

$T_c = \frac{8a}{27Rb}$

$b = \frac{V_c}{3}$ $\quad$ $a = 3P_cV_c^2$

$R = \frac{8P_cV_c}{3T_c}$

vanderwaal Eqn.

$\left(P+\frac{a}{V^2}\right)(v-b) = RT$

We can write vanderwaal Eqn. in the Equivalent form

$$P = \frac{8P_cV_cT}{3T_c\left(V-\frac{V_c}{3}\right)} - \frac{3P_cV_c^2}{V^2}$$

$$\frac{P}{P_c} = \frac{8\left(\frac{T}{T_c}\right)}{3\left(\frac{V}{V_c}\right)-1} - \frac{3}{\left(\frac{V}{V_c}\right)^2}$$

$\left(P_r+\frac{3}{V_r^2}\right)(3V_r-1) = 8T_r$

Also

$$\pi = \frac{8T}{3\phi-1} - \frac{3}{\phi^2}$$

This Equation is called law of ~~corre~~ corresponding state or reduced Equation of states for real gas