B. Sc
Group-A

Reduced Equation of State

vander waal's equation is

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

Let

$$P = \alpha P_c,\ V = \beta V_c \text{ and } T = \gamma T_c \quad \text{---(ii)}$$

Constants are α, β and γ.

Substituting the value of eq^n (ii) in eq^n (i)

we get

$$\left(\alpha P_c + \frac{a}{(\beta V_c)^2}\right)(\beta V_c - b) = R\gamma T_c \quad \text{---(iii)}$$

We know

$$P_c = \frac{a}{27b^2},\ V_c = 3b \text{ and } T_c = \frac{8a}{27Rb}$$

These values putting in equation (iii)

$$\left(\frac{\alpha a}{27b^2} + \frac{a}{\beta^2 9b^2}\right)(3\beta b - b) = R\gamma \frac{8a}{27Rb}$$

$$\Rightarrow \left(\frac{\alpha \beta^2 a + 3a}{27 b^2 \beta^2}\right) b(3\beta - 1) = \gamma \frac{8a}{27b}$$

$$\Rightarrow (\alpha \beta^2 + 3)(3\beta - 1) =$$

$$\gamma \frac{8a}{27 b^2 a} \times 27 b^2 \beta^2$$

$$\Rightarrow (\alpha \beta^2 + 3)(3\beta - 1) = \frac{\gamma 8}{\beta^2}$$

$$\Rightarrow \left(\frac{\alpha + 3}{\beta^2}\right)(3\beta - 1) = 8\gamma$$

$$\boxed{\left(\alpha + \frac{3}{\beta^2}\right)(3\beta - 1) = 8\gamma}$$

This is known as reduced equation of state

α is reduced Pressure

β is reduced volume

γ is reduced Temperature

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or,
Value of R

$PV = nRT$ ideal gas eqn.

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

- P = Pressure
- V = Volume
- n = no. of moles
- T = Temperature

$$= \frac{N}{m^2} \quad \frac{m^3}{mol\ K}$$

N =

$$= \frac{N m}{mol\ K}$$

Force (F) × Length (l) = Work (W) → unit Jule

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

S.I Unit
- $P = \frac{N}{m^2}$
- $V = m^3$
- n = mol
- T = K

Newton	× Meter	= Jule
N	m	J
F	l	w