24th February 2022

Lecture-18

⇒ Van der Waal's Interaction between two Surfaces.

Test : On THU / 3.3.22

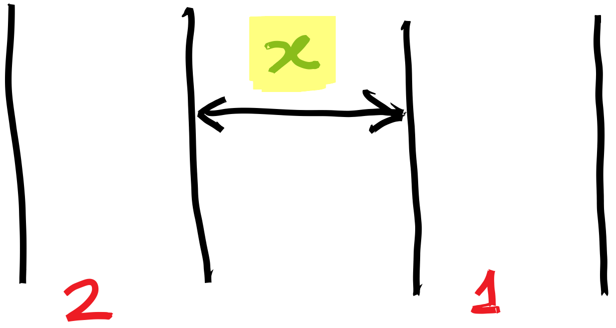
(Syllabus : Whatever has been covered till 23rd Feb, 22)

↓

Thin Film? → "Thin"

$$\underbrace{\omega(x)_a = -\beta x^{-6}}_{\text{Collission of ideal gas molecule}}$$

(Potential Energy of Interaction between two atoms / molecules)



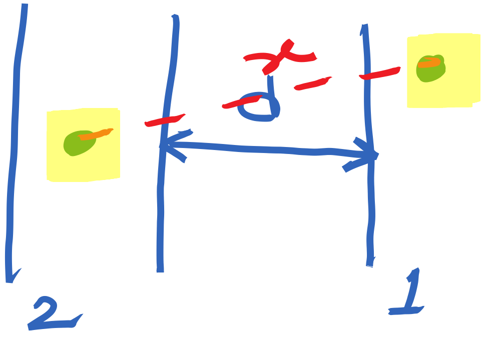
Vdw interaction between two Surfaces

Even at Contact there is going to be non zero (but very low) value of Spen. between the two Surfaces (d_o).

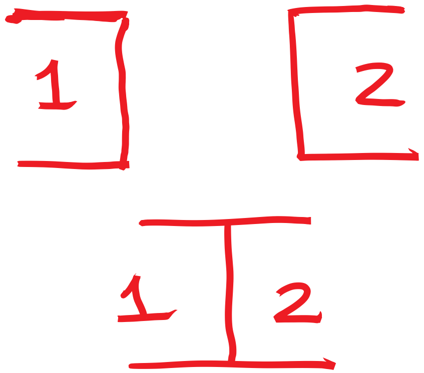
Range of values of x

$d_o \leq x \leq \infty$

van der waal's Interaction between two Surfaces



d is the sepn. distance varies from d_0 to ∞



$$\omega(x)_a = - \beta x^{-6}$$

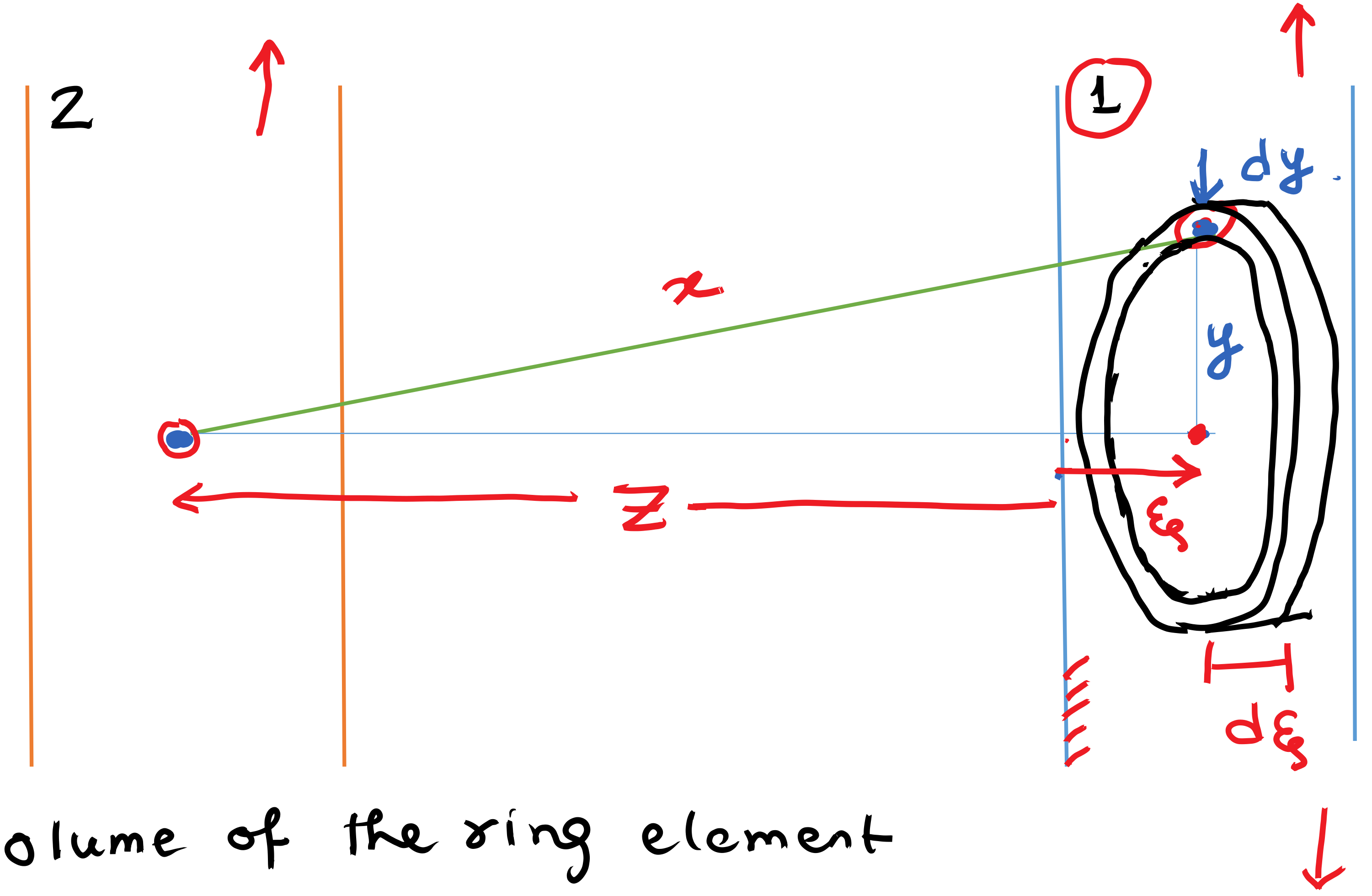
Collective Interaction between all such molecular pairs.

$$\Delta G_{12} = \gamma_{12} - (\gamma_1 + \gamma_2)$$

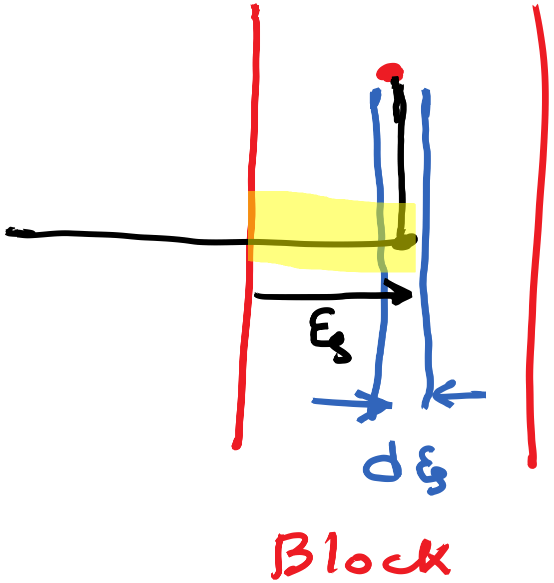
$$\Delta G_{11} = \underbrace{\cancel{\gamma_{11}}}_{0} - 2\gamma_1$$

We were taking $\gamma_{11} = 0$

There was no interface and so sepn $= 0$.



$$x^2 = y^2 + (z+\xi)^2$$

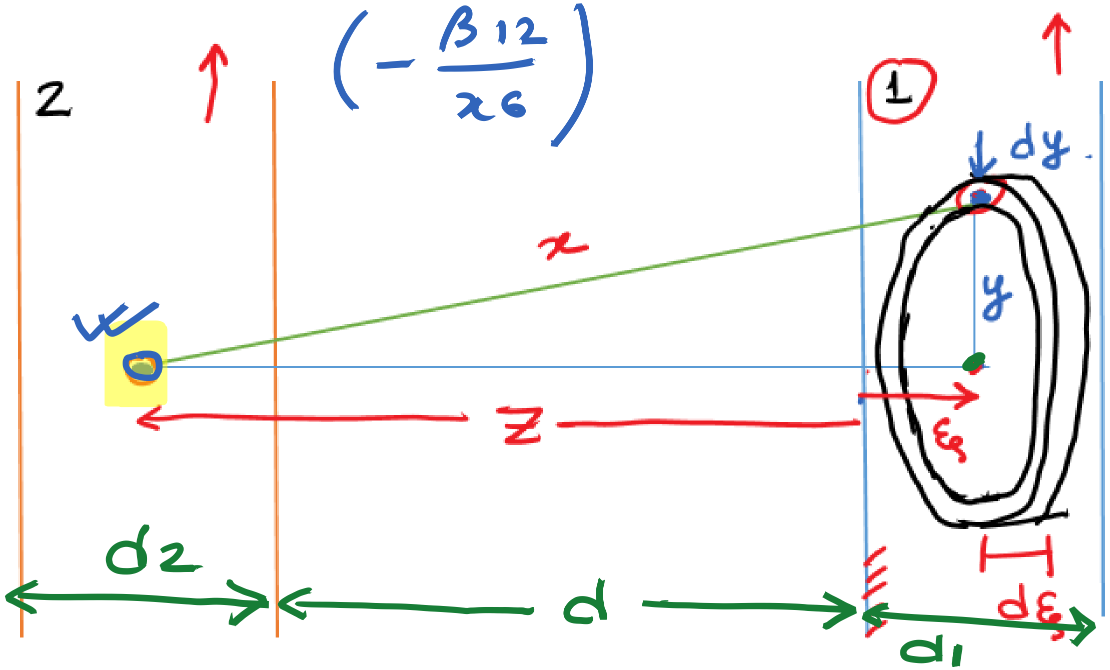


Volume of the ring element

$$dV = 2\pi y \, dy \, d\xi$$

No of molecules present in unit volume.

$$\frac{\text{No.}}{\text{Vol}} = \frac{\text{No.}}{\text{mole}} \times \frac{\text{mole}}{\text{vol.}} = \frac{\text{No.}}{\text{mole}} \times \frac{\text{mole}}{\text{mass}} \times \frac{\text{mass}}{\text{volume}} = \frac{N_A}{M_1} \cdot \rho_1$$



No. of molecules present in the ring $= (2\pi y\, dy\, d\xi)\left(\frac{\rho_1 N_A}{M_1}\right)$

Total Energy of interaction between one molecule of 2 with all molecules of 1 is:

$$\Rightarrow (2\pi y\, dy\, d\xi)\left(\frac{\rho_1 N_A}{M_1}\right)\left(-\frac{\beta_{12}}{x^6}\right) \leftarrow ??$$

The total energy of Interaction of one molecule of 2 with ALL molecules of 1

$d\xi$ from 0 to d_1

dy from 0 to ∞

$$\phi'' = \int_{\xi=0}^{\xi=d_1}\int_{y=0}^{y=\infty}\left(-\frac{\beta_{12}}{x^6}\right)\left(\rho_1\frac{N_A}{M_1}\right)(2\pi y\, dy\, d\xi)$$

$$\Phi'' = \int_{\xi=0}^{\xi=d_1} \int_{y=0}^{y=\infty} \left(-\frac{B_{12}}{x^6}\right)\left(\rho_1 \frac{N_A}{M_1}\right)\left(2\pi y \, dy \, d\xi\right).$$

$$= \frac{-2\rho_1 N_A \pi B_{12}}{M_1} \int_{\xi=0}^{\xi=d_1} \int_{y=0}^{y=\infty} \frac{y \, dy \, d\xi}{\left[(z+\xi)^2 + y^2\right]^3}$$

$$\int_{y=0}^{y=\infty} \frac{y \, dy}{\left[(z+\xi)^2 + y^2\right]^3} = \frac{1}{4} \cdot \frac{1}{(z+\xi)^4}$$

$$\frac{1}{4} \int_{\xi=0}^{\xi=d_1} \frac{d\xi}{(z+\xi)^4} = \frac{1}{12}\left[\frac{1}{z^3} - \frac{1}{(z+d_1)^3}\right]$$

$$\phi'' = \frac{-\rho_1 N_A \pi \beta_{12}}{6 M_1} \left[\frac{1}{z^3} - \frac{1}{(z+d_1)^3} \right]$$