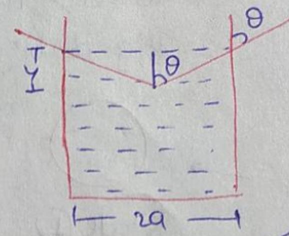
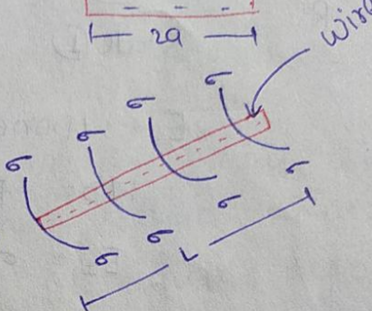
lecture ③

Pb

Given, $a >>> y$

weight of wire per unit length $= d$



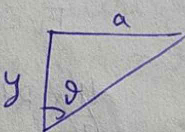


$2\sigma \cos\theta \cdot \cancel{L} = d \cdot \cancel{L}$

$\sigma = \dfrac{d}{2\cos\theta}$

$\boxed{\sigma = \dfrac{d}{2 \cdot \frac{y}{a}}}$ or when $w = mg$ $\boxed{\sigma = \dfrac{mg}{2L \times \frac{y}{a}}}$

$\boxed{\sigma = \dfrac{d \cdot a}{2y}}$



$\cos\theta = \dfrac{y}{\sqrt{a^2 + y^2}}$

$= \boxed{\dfrac{y}{a} \approx \dfrac{y}{a}}$

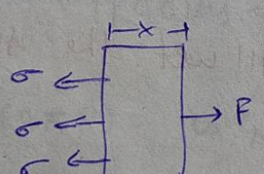
Concept of surface energy :-

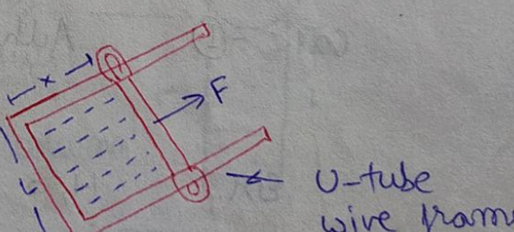
It is the amount of work done stored in the form of energy in the formation of surface or fill

surface energy $= \sigma . A$

$A =$ surface area

Work done $= F . x$





$F = \sigma . l$

$= 2\sigma . L . x$

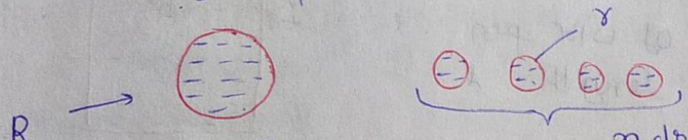
$= \sigma (2 . L . x)$

$= \boxed{\sigma (A)}$ $A =$ surface Area

[multiply with 2 b/c of two sides]

Prob ** W.B. Radius $= R$

Big drop



State ① n drops State ②

$E_1 + W.Done = E_2$

$W.D = E_2 - E_1$

$E_1 = \sigma(A) = \sigma \times (4\pi R^2)$

$E_2 = \sigma(A) = \sigma \times (4\pi r^2)$

$\frac{4}{3}\pi R^3 = \frac{4}{3}\pi r^3 . n$ [volume$_1$ = volume$_2$]

$\boxed{r = \frac{R}{n^{\frac{1}{3}}}}$

Workdone $= E_2 - E_1$

$= \sigma(4\pi r^2)n - \sigma(4\pi R^2)$

$= \sigma(4\pi \frac{R^2}{n^{\frac{2}{3}}} . n) - \sigma(4\pi R^2)$

$= \sigma(4\pi R^2 n^{\frac{1}{3}}) - \sigma(4\pi R^2)$

$= \boxed{4\pi\sigma R^2 (n^{\frac{1}{3}} - 1)}$

W.Done $= E_2 - E_1$

$= \sigma(4\pi R^2) - \sigma(4\pi r^2) \times n$

$= \sigma(4\pi R^2) - \sigma(4\pi \frac{R^2}{n^{\frac{2}{3}}} . n)$

$= \sigma(4\pi R^2)(n^{\frac{1}{3}} - 1)$

Wetting and non-wetting :-

→ Adhesive force (b/w different kind of molecules)

→ Cohesive force (b/w same kind of molecule)

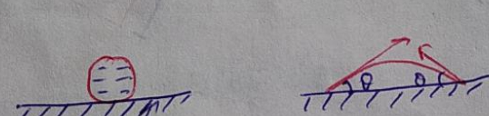
case - ① Adhesive Force >>> cohesive force

liquid will wet the surface

Ex. H_2O on glass

θ = angle of contact

$\left(\theta < \frac{\pi}{2}\right)$

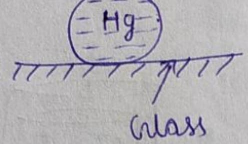


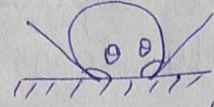
glass

case- ② cohesive force >>> Adhesive force

liquid will not wet the surface

Ex: Hg on glass



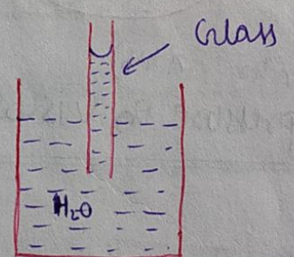


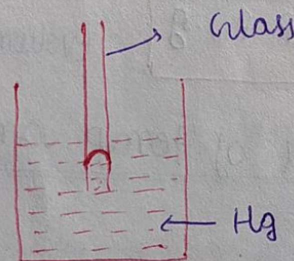
($\theta > \frac{\pi}{2}$)

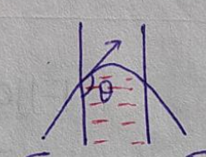
For Hg
[$\theta = 130^\circ - 140^\circ$]

capillary effect :

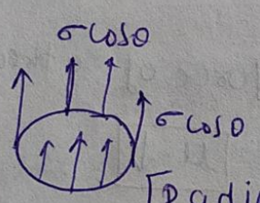
When a tube of very-2 small diameter is emerge in a liquid then the liquid rise or fall inside tube this rise or fall of liquid depend upon the wetting and non-wetting nature of liquid with a tube surface. this whole phenomenon is known as capillary effect and





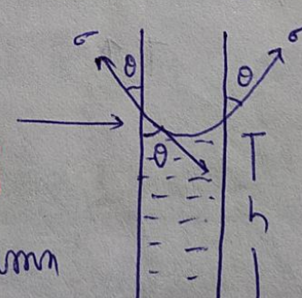


Zooming effect



[Radius = R]

[Apex of meniscus]



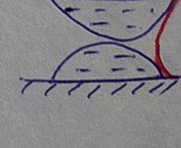
$\sigma \cos\theta (2\pi R) =$ w.t of liquid column

$= M.g$

(volume of cylinder $= \pi r$

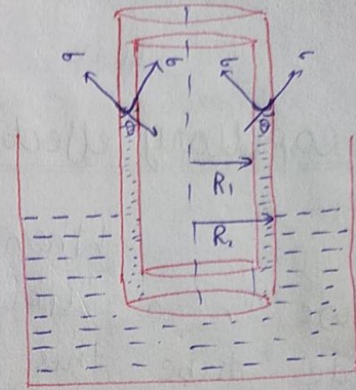
$\sigma \cos\theta (2\cancel{\pi}\cancel{R}) = \rho(\cancel{\pi} R^{\cancel{2}} h).g$

$$\boxed{h = \frac{2\sigma \cos\theta}{\rho . g . R}}$$



* To neglect the capillary effect diameter should be sufficiently large

Prob



$(\sigma \cos\theta)(2\pi R_2) + \sigma\cos\theta(2\pi R_1)$

$=$ weight

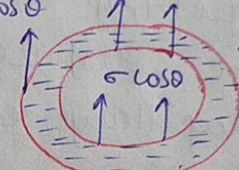
$= \rho\pi(R_2^2 - R_1^2) \cdot h \cdot g$

$\sigma\cos\theta(2\cancel{\pi})(\cancel{R_2 + R_1})$

$= \rho\cancel{\pi}(R_2 - R_1)(\cancel{R_2 + R_1}) h \cdot g$

$\sigma\cos\theta \times (2) = \rho(R_2 - R_1) \cdot h \cdot g$

$$\boxed{h = \frac{2\sigma\cos\theta}{\rho(R_2 - R_1) \cdot g}}$$ **



(volume of cylinder $= \pi r^2 h$)

Effect of temp. and pressure on viscosity

- Liquid
- dynamic viscosity (μ)

$T\uparrow =$ intermolecular force of attraction will also decrease $\Rightarrow \boxed{\mu \downarrow}$.

$$\boxed{T\uparrow = \mu\downarrow}$$

Kinematic viscosity → (ν)

$$\nu = \frac{\mu}{\rho} \quad \downarrow$$

$$\boxed{T\uparrow = \nu\downarrow}$$

At 1 atm, T = 20°C

$\mu_{water} = 1 \times 10^{-3} \frac{N \cdot s}{m^2}$

$\rho_{water} = 998\ kg/m^3$

$\nu_{water} = 10^{-6}\ m^2/s$

$\mu_{air} = 1.8 \times 10^{-5} \frac{N \cdot s}{m^2}$

$\rho_{air} = 1.205\ kg/m^3$

$\nu_{air} = 1.494 \times 10^{-5}\ m^2/s$

For gas →

Dynamic viscosity → (μ)

$T \uparrow \rightarrow$ Resistance in the path of molecules increase $\mu \uparrow$

$\boxed{T\uparrow = \mu \uparrow}$

Kinematic viscosity → (ν)

$\nu = \frac{\mu \uparrow}{\rho \downarrow}$ $\qquad P = \rho . R . T$

$\boxed{T\uparrow = \nu \uparrow\uparrow}$ $\qquad \boxed{\rho \propto \frac{1}{T}}$

Effect of Pressure

Liquid

- Dynamic viscosity

$\boxed{P\uparrow = \mu \text{ (remain same)}}$

- Kinematic viscosity

$\nu = \frac{\mu}{\rho}$ μ ← No change, ρ ← negligible

$\boxed{P\uparrow = \nu}$ (remain same)

Gases

- Dynamic viscosity

$\boxed{P\uparrow = \mu \text{ [Remain same]}}$

- Kinematic viscosity

$\nu = \frac{\mu}{\rho}$ μ ← No change

$\boxed{P\uparrow = \nu \downarrow}$

Pressure and it's measurement

" Existance of molecule in a system is the existence of pressure

Math $\quad P = \frac{F}{A}$ (External normal force or pressure force)