1. Cohesive vs Adhesive force

Cohesive force: b/w अणु of same substance (Hg - Hg)

Adhesive force: b/w differ substance mole. (परमाणु अलग अलग)

2. Surface tension

→ liq. have mini. Area

→ $S = \frac{F}{L}$

$F = mg + 2 \cdot S 2\pi r$ (2 times)

3.

$F_{ex} = mg + S \cdot 2\pi r$

$F_{ex} = mg + S(2x + 2y)$

4. Surface energy

$S = \frac{E}{A} \Rightarrow E = SA$ (A → surface Area, S → surface Tension)

Energy of drop

$E = S 4\pi r^2$

energy of Bubble

$E = 2S 4\pi r^2$

5. Stander question on surface energy

O O O O (r) → (R) n drops

∵ Vol^m is same. $\boxed{R = r n^{1/3}}$

$E_i = n S 4\pi r^2$

$E_f = S 4\pi R^2$

$E_i - E_f$ = incr. Temp of Bigger drop by ΔT

$\boxed{E_i - E_f = ms\Delta T}$

6. Bubble → drop बन जाता है

$t \lll r$ → R

∵ Vol^m of liq. same

$E_i = 2S 4\pi r^2$

$E_f = S 4\pi R^2 \Rightarrow (4\pi r^2)t = \frac{4}{3}\pi r^3$

$\boxed{E_i - E_f = ms\Delta T}$ $R = (3r^2 t)^{1/3}$

6. Excess pressure in liq. drop and Bubble:

Drop

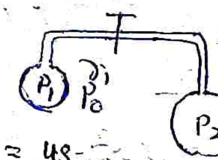
P_{ex} $P_1 - P_2 = \frac{2S}{r}$

Buble (in air)

$P_1 - P_2 = \frac{4S}{r}$

Bubble in (liq.)

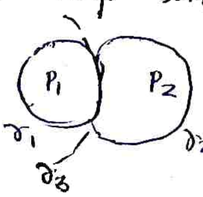
$P_1 - P_2 = \frac{2S}{r}$



$P_1 = \frac{4S}{r_1} + P_0$

$P_2 = \frac{4S}{r_2} + P_1$

7. Two soap bubbles in contact



$P_1 - P_0 = \frac{4S}{r_1}$

$P_2 - P_0 = \frac{4S}{r_2}$

$P_1 - P_2 = 4S\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$

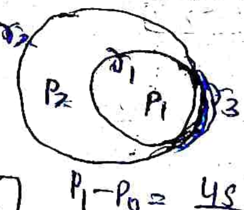
$\Rightarrow \boxed{r_3 = \frac{r_1 r_2}{r_2 - r_1}}$

Internally

$P_1 - P_2 = \frac{4S}{r_1}$

$P_2 - P_0 = \frac{4S}{r_2}$

$P_1 - P_0 = 4S\left[\frac{1}{r_1} + \frac{1}{r_2}\right]$

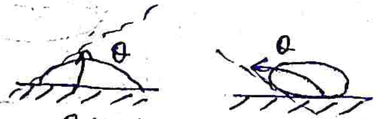


$P_1 - P_0 = \frac{4S}{r_3}$

$\boxed{r_3 = \frac{r_1 r_2}{r_1 + r_2}}$ r_3 will be smaller.

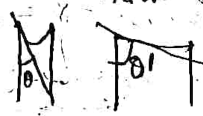
8. Angle of contact

C.F. < A.F.   C.F > A.F ex Hg



$\theta < 90°$ ↳ liq. wets the surface $\theta > 90°$

10. Insufficient tube length ($H < h$)

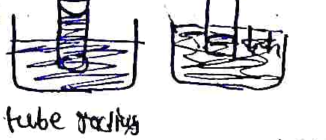


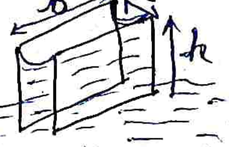
liq. overflow ✗

Contact angle ($\theta' > \theta$)

9. Capillary Action

(i) thin tube





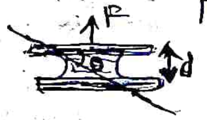
r: tube radius

R: meniscus

$h = \frac{2S\cos\theta}{r\rho g} = \frac{2S}{R\rho g} \Leftrightarrow \frac{2S\cos\theta}{d\rho g}$

H_2O $\boxed{\cos\theta = 1}$

11. Force to separate glass plate



$F = \frac{S}{L} = \frac{2SA}{d}\cos\theta$

$F = \frac{2SA\cos\theta}{d}$ $\boxed{\cos\theta = 1 \text{ if } H_2O}$

A: liq. cross section Area

1. Streamline & turbulent flow

- Velocity of fluid at a point always same
- Not

2. $\boxed{\text{Reynolds Number (Re)}}$

$$Re = \frac{\rho v d}{\eta}$$ → d: pipe cross sec^{n} dia

$Re < 1000 \longrightarrow$ streamline

$Re > 2000 \longrightarrow$ turbulent flow

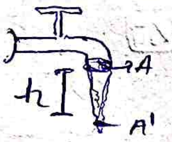
$1000 < Re < 2000 \rightleftarrows$ unsteady flow

3. $\boxed{\text{Ideal fluid}}$:
- incompressible
- non-viscous
- stream flow
- no rotational effect

4. eq^{n} of continuity :—

$$\frac{dV}{dt} = A.\frac{dx}{dt} = AV = \text{const.}$$

Volume flow Rate



Bernoulli's eq^{n}

$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{const.}$$

Pressure: $\frac{\text{energy}}{\text{Volume}}$ — $\frac{KE}{Vol.}$ — $\frac{PE}{Vol.}$

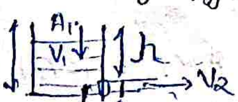
$\boxed{m \to \rho}$

6. P-V Relation

for horizontal flow

$$\frac{\text{Loss in pressure energy}}{\text{Volume}} = \frac{\text{gain in KE.}}{\text{Vol.}}$$

7. Speed of Efflux! Toricelli's Law



$$(P_0 + \rho g h) - P_0 = \frac{1}{2}\rho V_2^2 - \underbrace{\frac{1}{2}\rho V_1^2}_{\simeq 0}$$

$$\rho g h = \frac{1}{2}\rho V_2^2$$

$$V_2 = \sqrt{2gh}$$

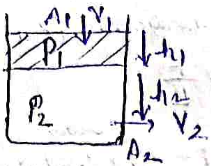
(2) Range $R = V_2\sqrt{\frac{2(H-h)}{g}} = 2\sqrt{\underbrace{h}_{\text{উপর}}\underbrace{(H-h)}_{\text{নীচ}}}$

Rmax. $\frac{dR}{dh} = 0 \Rightarrow h = \frac{H}{2}$

$R_{max.} = H$

⑧ Speed of efflux!

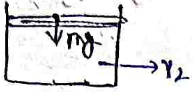
ⓐ



$$\rho_1 g h_1 + \rho_2 g h_2 = \frac{1}{2}\rho_2 V_2^2$$

ρ_2 → যে জল বাইরে বেরোচ্ছে

ⓑ

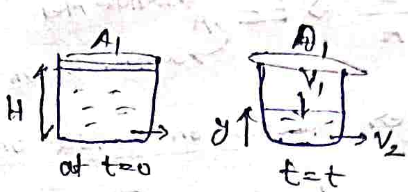


$$\left(P_0 + \rho g h + \frac{mg}{A}\right) - P_0 = \frac{1}{2}\rho V_2^2$$

⑨ Vessel emptying time

$$A_1V_1 = A_2V_2$$

$$A_1\left(-\frac{dy}{dt}\right) = A_2\sqrt{2gy}$$



$$\int_H^y \frac{dy}{\sqrt{y}} = -\frac{A_2}{A_1}\sqrt{2g}\int_0^t dt$$

$$2(\sqrt{y} - \sqrt{H}) = -\frac{A_2}{A_1}\sqrt{2g}\,.t$$

$$\Rightarrow t = \frac{A_1}{A_2}\sqrt{\frac{2}{g}}\left(\sqrt{H} - \sqrt{y}\right)$$

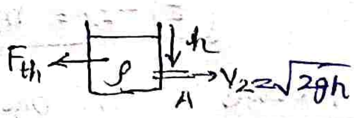
to empty. $y = 0$, $t = t_0$

$$\boxed{t_0 = \frac{A_1}{A_2}\sqrt{\frac{2H}{g}}}$$

10. Thrust on vessel

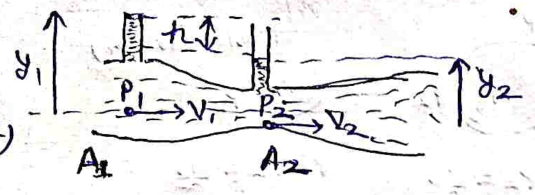
$$F_{th} = \rho A V^2$$

$$F_{th} = \rho A\, 2gh$$



11. Venturimeter

ⓐ



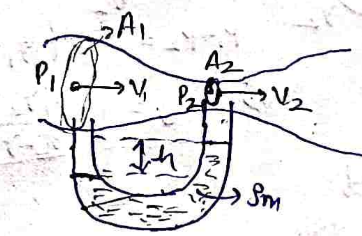
$$P_1 - P_2 = \frac{1}{2}\rho(V_2^2 - V_1^2)$$

$$\because A_1V_1 = A_2V_2$$

$$\Rightarrow \rho g h = \frac{1}{2}\rho V_1^2\left[\left(\frac{A_1}{A_2}\right)^2 - 1\right]$$

$$V_1 = \sqrt{\frac{2gh}{\left(\frac{A_1}{A_2}\right)^2 - 1}}$$

ⓑ



$$P_1 - P_2 = \frac{1}{2}\rho V_2^2 - \frac{1}{2}\rho V_1^2$$

$$\Rightarrow \rho_m g h = \frac{1}{2}\rho\left(\frac{A_1V_1}{A_2}\right)^2 - \frac{1}{2}\rho V_1^2$$

$$V_1 = \sqrt{\frac{2\rho_m g h}{\rho\left(\left(\frac{A_1}{A_2}\right)^2 - 1\right)}}$$

Soap bubble is energy 2 times