Fluid Mechanics

* $R.D = \dfrac{\rho_{material}}{\rho_{water}}$, * $P = 1.01 \times 10^5 \ Pa = 1 \ atm$

$= 1 \ atm = 760 \ gm/cm^3$

* $P = P_0 + \rho g H$, $P_0 \simeq 10^5 \ Pa$

Barometer

$\rho_{Hg} = 13.6 \ gm/cc.$

Force exerted to wall :-

$$F = \frac{b \rho g h^2}{2}$$

$$\text{Torque}, \ \tau = \frac{b \rho g h^3}{6}$$

To stop rotation, $x = \dfrac{h}{3}$ from base

Archemedic Principal

$$\boxed{F_B = \rho_l V_D g = mg}$$

Buoyancy decreases with increase in Temperature

* $W_1 \ (\text{in air}) = (V_c \rho_c g + V_a \rho_a g)$

$W_2 \ (\text{in water}) = W_1 - (V_c + V_a) \rho_l g$

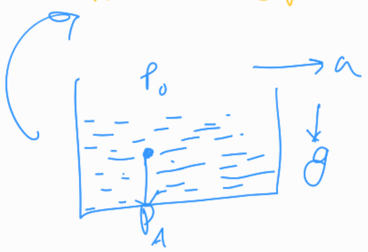
Accelerating Liquid

* $\uparrow a \Rightarrow P = P_0 + \rho (a+g) h$

* $\tan \theta = \dfrac{a}{g}$

* $a \downarrow \Rightarrow P = P_0 + \rho (g-a) h$

* $P_A = P_0 + \rho \sqrt{a^2 + g^2} \ x$



(*) $P_A = P_B + \rho a l$, l = length b/w P_A and P_B

(*) $\rho_M > \rho_W$ (sink)

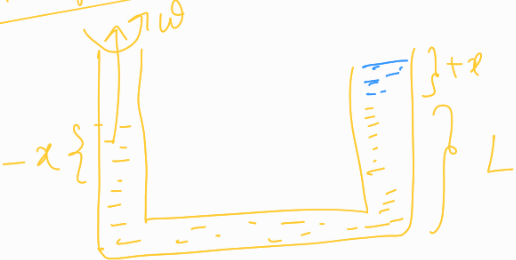
$\rho_M < \rho_W$ (floats)

Rotating Vessel

$$\boxed{H = \frac{\omega^2}{2g} R^2}$$

(*) Area comes out $\rightarrow \left(\frac{\pi R^2 H}{2}\right)$

(*) Specific Case :-



$$\Rightarrow x = \frac{\omega^2}{2g} \times \frac{l^2}{2}$$

Flow Rate :-

$m^3/s = A \times v$

= Area × velocity.

Reynold's Number :→

$$R = \frac{\rho v d}{\eta}$$

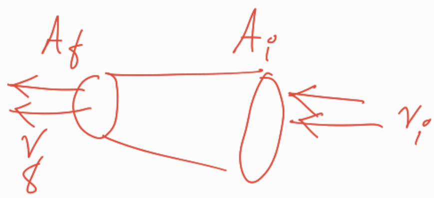
, v = velocity
d = diameter of pipe
η = coefficient of visc.

$0 < R < 2000 \longrightarrow$ Streamline flow

$2000 < R < 3000 \longrightarrow$ Mixed

$R > 3000 \longrightarrow$ Turbulent flow

Eqn of Continuity



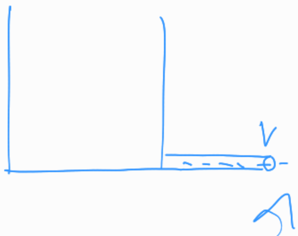
$$\boxed{A_i V_i = A_f V_f}$$

Bernoulli's Equ^n :-

Based on energy conservation →

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

$$\boxed{V = \sqrt{\frac{2gH}{1-\left(\frac{a}{A}\right)^2}}}$$



if $\frac{a}{A} << 1$

then

⊛ $V = \sqrt{2gH}$.

Q

⇒ Using Bernoulli's equ^n →

$$\Rightarrow \cancel{P_0} + \cancel{\rho} g\left(\frac{2H}{3}\right) + 2\cancel{\rho} g\frac{H}{3} = \cancel{P_0} + \frac{1}{\cancel{2}}\cancel{2\rho}\, v_2^2$$

$$\Rightarrow \frac{2gH}{3} + \frac{2gH}{3} = v_2^2$$

$$\Rightarrow \frac{4gH}{3} = v_2^2$$

$$\Rightarrow v_2 = \sqrt{\frac{4gH}{3}}$$ (Ans)

Forces

- Adhesive
  - Glass → H_2O
- Cohesive
  - water - water
  - glass - glass

Surface Tension

$$\boxed{S = \frac{F}{l}}$$

S depends on :→
liq. and temp

⊛ soaps helps in cleaning clothes bc-z it lowers the surface tension of the solution.

⊛ Surface Area stored per unit volume is Surface Tension.

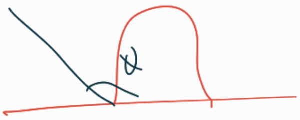
$$\boxed{\frac{\Delta U}{\Delta A} = S}$$

Excess Pressure :–

(i) Drop :– $\Delta P = \frac{2S}{R}$

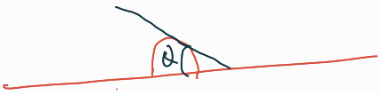
(ii) Bubble :– $\Delta P = \frac{4S}{R}$

Contact Angle



$\theta > 90^\circ$

$F_{cohesive} > F_{adhesive}$



$\theta < 90^\circ$

$F_{cohesive} < F_{adhesive}$

Capillary Tube :→

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

$R\cos\theta = r$

R ↳ Radius of meniscus.

Viscosity

$$F_v = A\,\eta\,\frac{\Delta v}{z}$$

η → Pa-S

η → coefficient of viscosity

$\frac{\Delta v}{z}$ → velocity Gradient

1 Pa-S = 10 poise

Stock's Law (used in falling)

$$F_v = 6\pi\eta R v$$

Terminal velocity →

$$V_T = \frac{2}{9}\frac{R^2 g}{\eta}(\rho_m - \rho_e)$$

Poiseuille Eqn for Rate of flow

$$V = \frac{\pi(\Delta P) P r^4}{8\eta l}$$