FLUIDS

Pressure exerted by a liquid

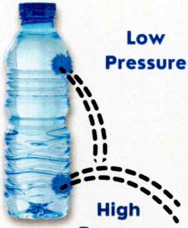
$$p = \rho g h$$

Up/Down accelerating container

$$p = \rho g_{eff} h$$

Horizontal accelerating container

$$\tan\theta = \frac{a}{g}$$



Pascal's Law

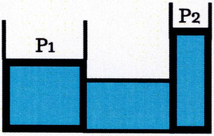
The increase in pressure at a point in the enclosed liquid in equilibrium is transmitted equally in all directions in the liquid.

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

Relative Density
(Specific density)

ρ_l = density of liquid

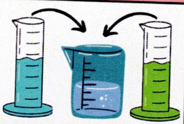
ρ_w = density of water



$$P_1 = P_2$$

Density of Mixture of Substances

For Same Mass	For Same Volume
$\rho_M = \dfrac{2\rho_1\rho_2}{\rho_1+\rho_2}$	$\rho_M = \dfrac{\rho_1+\rho_2}{2}$



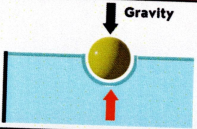
Archimedes Principle

When a body is partially or fully immersed in a liquid, it loses some of its weight and it is equal to the weight of the liquid displaced by the immersed part of the body.

Buoyancy

v = volume of submerged solid
ρ = density of the liquid

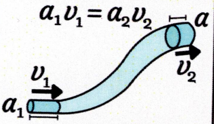
$$F = v\rho g$$



Hydrodynamics

Equation of continuity

If a liquid is flowing n streamline flow in a pipe of non-uniform cross-sectional area, then rate of liquid across any cross-section remains constant.



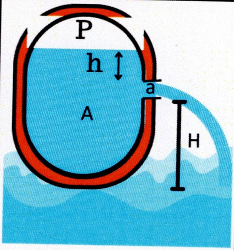
av=constant

Bernoulli's Theorem

If an ideal liquid is flowing in streamlined flow, then total energy, i.e. sum of pressure energy, kinetic energy and potential energy per unit volume remains constant at every cross-section of the tube.

$$p + \frac{1}{2}\rho v^2 + \rho g h = \text{constant}$$

Torricelli's Theorem



Velocity Efflux	Acceleration
$v = \sqrt{2gh}$	$\frac{2\rho Agh}{(m_{water} + m_{tank})}$
Time required to make the tank empty	$t = \frac{A}{a}\sqrt{\frac{2H}{g}}$
Range $R = 2\sqrt{hh_0}$	$F_T = 2\rho Agh$

Viscous Force (Viscosity)	Stoke's Law
$\frac{dv}{dx}$ = velocity gradient A=area of cross-section η = coefficient of viscosity $F = -\eta A \frac{dv}{dx}$	When a small spherical body falls in a liquid column with terminal velocity, then viscous force acting on it is $F = 6\pi\eta r V_r$

Terminal Velocity

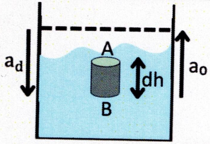
σ=density of object ρ= density of liquid	$V_T = \frac{2r^2(\sigma - \rho)}{9\eta} g$	$\sigma < \rho$: Body falls down $\sigma > \rho$: Body moves up

Pressure at depth	Gauge pressure at depth
$P = P_a + \rho g h$ P_a = atmospheric pressure h=depth	$P - P_a = \rho g h$ P=absolute pressure

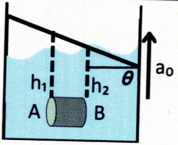
Surface Tension of liq-air interface	$S_{la} = \frac{W}{2l} = \frac{mg}{2l}$
Loss in surface energy	ΔT=Tx(Change in surface area)

Reynold's Number

$R = \frac{\rho V D}{\eta}$	V=velocity of fluid w.r.t fluid D=characteristic linear dimension

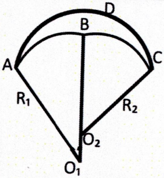
Dynamic viscosity of fluid	Kinematic viscosity of fluid
$\eta = \frac{\sigma_s(\text{Distance b/w layers})}{(\text{Sheer velocity})}$	$v = \frac{\eta}{\rho}$
Now; Reynold's number	
R < 2000	Flow is steady
3000 < R < 2000	Flow becomes unsteady
R > 3000	Flow is turbulent
Surface area of soap bubble	**W.D. on soap bubble**
$2 \times 4\pi R^2$	Change in Surface area $\times T_s$
Atmospheric pressure with height	
$p = p_0 e^{-\frac{\rho_0}{p_0}gh}$	ρ_0 = density of air p= pressure at height 'h' above earth's surface
Liquid in accelerated vessel	
 $P = P_0 + \rho g_{eff} h$	**Upward acceleration** $g_{eff} = g + a_0$ **Downward acceleration** $g_{eff} = g - a_0$

Horizontal acceleration



$$\tan\theta = \frac{a_0}{g}$$

Excess pressure on curved surface



$$p = 2s\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

Effect of Temperature on surface tension

$$T = T_0\left(1 - \frac{\theta}{\theta_c}\right)^n$$

T_0 = S. T. at 0°C

θ = Absolute temp. of liquid

n = constant

θ_c = critical temp

Rate of Volume Flow through Pipe (Poiseuille's Formula)	$Q = \frac{\pi \Delta p r^4}{8\eta l}$
Surface Tension	
Surface Tension	$S = \frac{F}{l} = \frac{E}{A}$ = Force per unit length = Energy per unit area
Surface Energy	$\Delta E = S\Delta A$
Work done in Splitting a Bigger drop into n smaller Droplets	**When n liquid drop coalesce to form one drop Percentage Loss in Energy**
$W = 4\pi S^2(n^{1/3} - 1)$	$\text{Loss\%} = \left(\frac{1}{n^{1/3}} - 1\right) \times 100$
Excess Pressure inside a Liquid Drop	**Excess Pressure inside a Soap Bubble**
$P_i - P_0 = \frac{2S}{R}$	$P_i - P_0 = \frac{4S}{R}$
Radius of Interface in Double Bubble	**Radius under isothermal condition**
$\frac{1}{R} = \frac{1}{R_1} - \frac{1}{R_2}$	two bubble coalesce $r = \sqrt{r_1^2 + r_2^2}$
Ascent of Liquid in a Capillary Tube	$h = \frac{2S\cos\theta}{r\rho g}$