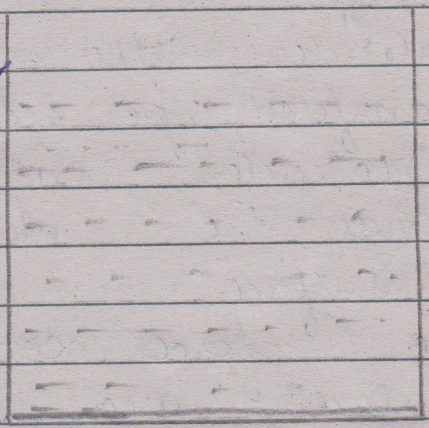
* Fluid Pressure and Surface tension :-

Ques:- What do you mean by fluid pressure illicite the cause of fluid pressure.

The force acting normally on unit area of a surface due to fluid is called the fluid pressure.



If the uniform force "F" acts normally on the area "A" of the surface then, pressure "P" on the surface is

$$P = \frac{F}{A}$$

The S.I unit of pressure is

N/m^2

or

Pascal.

C.G.S unit is $dyne/cm^2$

And

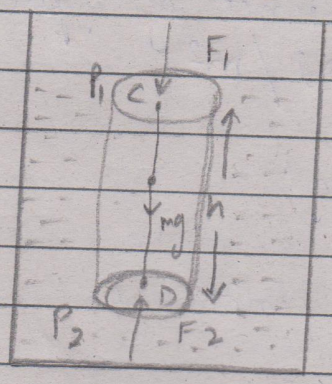
Dimensional formula is $[ML^{-1}T^{-2}]$

1) Cause of fluid pressure

According to the kinetic theory of gases a fluid is made of molecules and molecules are in random motion. They move throughout

the volume of fluid ——
and suffer collision ~~there is~~
with each other and with
the walls of containers due
to collision ~~the~~ there is
Change in the Momentum of
Molecules the Change in Momentum
transfered per second by these
Molecules on the Surface
gives the average force on the
Surface
The force considerd on unit
Surface area gives the fluid
pressure.

Ques :- Explain the effect of gravity on fluid pressure.



Consides a vessel having a liquid of Density ρ in equilibrium of Rest. let C and D two points inside the liquid at a vertical height "h"
imagine a Cylinder of liquid with Axes CD, cross-Sectional area A and Length h

The Mass of liquid in the imaginary cylinder

m = Volume x density

$$m = A \cdot h \cdot \rho$$

Let P_1 and P_2 be the pressure of liquid at point C and D respectively the action of the following vertical forces.

(i) Force $F_1 = P_1 \times A$ acting vertically downwards on the top phase of cylinder.

(ii) Force $F_2 = P_2 \times A$ acting vertically upwards on the lower phase of cylinder

(iii) Weight $mg = A \cdot h \rho g$ of the liquid cylinder acting vertically downwards.

At equilibrium of the rest the Net force on the liquid cylinder must be zero hence,

$$F_1 + mg - F_2 = 0$$

$$F_1 + mg = F_1 \Rightarrow P_1 A + Ah\rho g = P_2 A$$

$$Ah\rho g = P_2 A - P_1 A$$

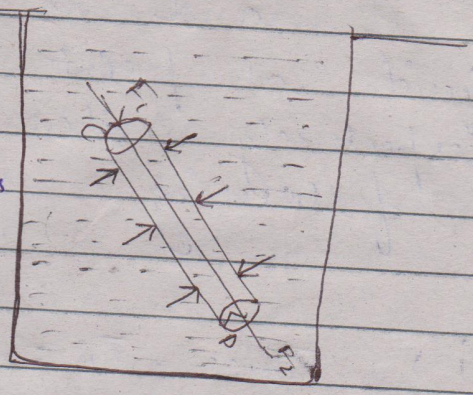
$$Ah\rho g = (P_2 - P_1) A$$

$$\boxed{h\rho g = P_2 - P_1}$$

Ques:- State and prove the pascals law:-

⇒ According to pascal's law the pressure exerted by fluid is transmitted equally in all directions throughout the Liquid.

pascals law if gravity effect is Neglected then pressure / liquid in eq" at every point of of rest is same.



In figure, let there be a liquid in a vessel consides a cylinder inside the liquid with its Axis CD and its circular Surfaces with centre C and D.
Let the force on its Surfaces C and D respectively be F_1 and F_2 And area of cross-Section be A. then pressure on the surface C.

$$P_1 = \frac{F_1}{A}$$

or $F_1 = P_1 A$ — (1)

pressure on the Surface D is

$$P_2 = \frac{F_2}{A}$$

or $F_2 = P_2 A$ — (2)

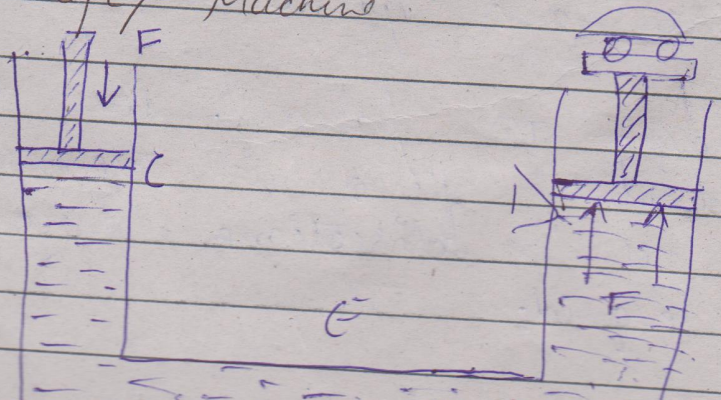
Since, the liquid is in equilibrium

hence, $F_1 = F_2$

$P_1 A = P_2 A$

$$\boxed{P_1 = P_2}$$

Q. explain the principle of the hydrolic lift / Machine



$$P = \frac{f}{a}$$

$$F = P \cdot b$$

$$F = \frac{f}{a} \cdot b$$

$$F = f \cdot \left(\frac{b}{a}\right) \qquad \frac{b}{a} > 1$$

it use to lift the heavy loads its working is based on pascals law in figure a simple hydrolic lift is shown in figure

C and D are two cylinder of different area of cross section they are connected to each other with a pipe E. Each cylinder having a air tight frictionless ~~Syst~~ pistons.

Let a, b be the area of cross-section of the pistons C and D respectively. and a << b the cylinders are filled with an in-compressible liquid.

Let a downward force f be applied on the piston of C then the pressure exerted on the liquid $P = \frac{f}{a}$

Acc. to pascals law this pressure is transmitted equally to piston of Cylinder D.

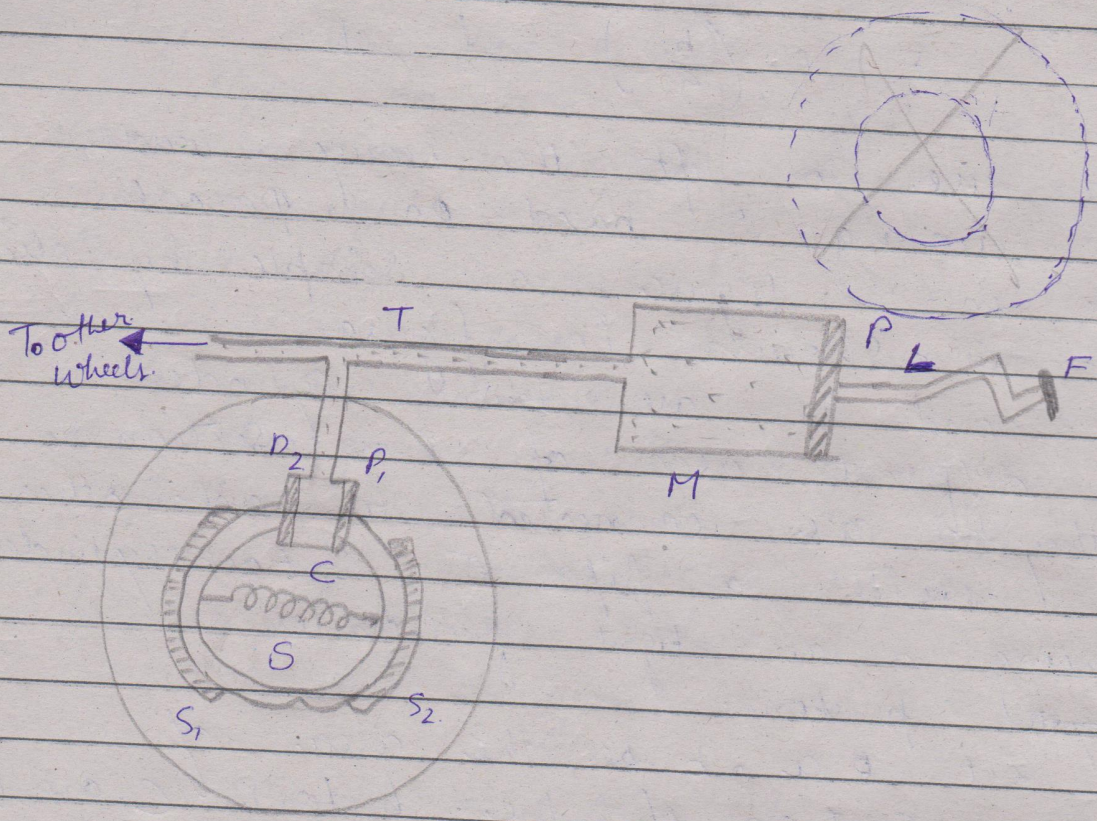
Hence upward force acting on the piston of Cylinder D.

$$\boxed{F = P \cdot b}$$

$$P = \frac{f}{a}$$

$$F = \frac{f}{a} \cdot b$$

Q. Explain construction and working of hydrolic break.



Construction :-

It consist of a Master cylinder M filled with break oil and provided with air tight frictionless piston P. The piston is connected to break paddle F to leaver system L. The Master cylinder is connected to wheel cylinder C through a tube T. The wheel cylinder having 2 pistons P_1 and P_2. These pistons are connected to break shoe S_1 and S_2 respectively. The Spring S hold S_1 and S_2 position

Working :-

When a break paddle is pressed the lever system operates the piston P of a Master cylinder is ~~post~~ i push inwards. Their will be increase pressure on liquid at T. Which is transmitted equall P_1 and P_2 of Wheel Cylinder in-cordance with the pascal's Law due to it P_1 and P_2 Move outwards they force the break shoe to Move away from each with with is compressed the inner rim of wheel hece Retards the Motion of Wheel. When the pres on the break paddle is Released the break shoe Return to their Normal position by the action of Spring

Q. Write the Laws of Liquid Pressure.

Following are the Laws of liquid pressure.

1.) In a Stationary liquid presure is Same at all points lying in one horizontal plane.

2.) In Side a Stationary liquid pressure is Same at a point in all the directions.

3.) pressure at a point inside the Liquid is directly prop- to

Surface.

4.) pressure at a same depth in a different liquid is proportional to Density of liquid.

5.) Q. What do you Mean by Atmospheric pressure?

⇒ The weight acting on unit area of earth surface due to an air column of unit area of cross-section is called the Atmospheric pressure.

The Value of Atmospheric pressure.

$$P = 1.013 \times 10^5 \ N/m^2$$

$$P = h\rho g$$

$h =$ 76 cm or 0.76 m of the Mercury (Hg)

$\rho = 13.6 \times 10^3 \ kg/m^3$

$g = 9.8 \ m/s^2$

$$P = 0.76 \times 13.6 \times 10^3 \times 9.8$$

$$P = 1.013 \times 10^5 \ N/m^2$$

or

$$P = 1.013 \times 10^5 \ Pascal$$

$$1 \ bar = 10^5 \ N/m^2$$

1 torr = 1mm of Hg

Q. What do you mean by by and What are the factors affecting the upthrust force.

⇒ The property of liquid due to which it exerts an upward force on the body emerged inside it, is called byuoncy.

When the body is emerged in a liquid The liquid exerts an upward force on the body this is called upthrust or byolince force.

Factors affecting upthrust :-

The upthrust on the body due to liquid depends on the following 2 factors

1.) Vol. of emerged part of the body :-

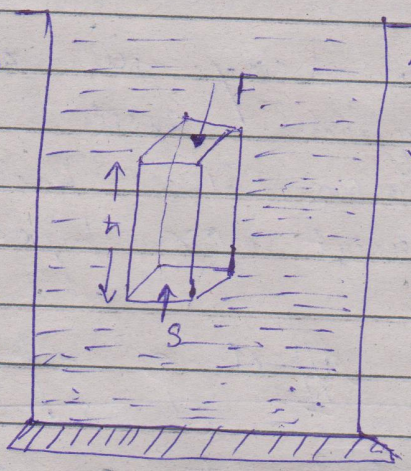
If greater the ~~er~~ vol. of emerged part of a body in a liquid, more is the upthrust on it.

2.) Density of Liquid :- Greater the Density of Liquid More is the upthrust on the body.

Q. State And prove the Archimides principle.

Ans: To the Archimides principle.

When a body is emerge completly or partly in a liquid at Rest; it loses some of its weight the loss in weight of a body in a liquid is equals to the weight of the Liquid displaced by the Emerge part of the body.



consider a rectangular body of height "h" and Mass "M" emerged in a Liquid of Density ρ. Let the top and bottom Faces of the body be parallel to the horizontal base of the Container. Let "x" be the Depth of the top face of body below the free surface of the liquid hence Depth of bottom face of the body = x+h

Let A be the cross-sectional area of the top or bottom face of the body. Hence,

Volume of Liquid displaced = Volume of the body

$V = Ah$

Mass of Liquid displaced

$M = V\rho$

$m = Ah\rho$ — (1)

$\boxed{P = h\rho g}$

Liquid pressure on the top face of the body.

$P_1 = x\rho g$

Vertical downward thrust on the top face of the body

$F_1 = P_1 A$

$F_1 = x\rho g A$ — (2)

Liquid pressure on the bottom face of the body.

$P_2 = (x+h)\rho g$

Vertical upward thrust on the bottom face of the body

$F_2 = P_2 A$

$F_2 = (x+h)\rho g A$ — (3)

from (2) and (3)

$F_2 > F_1$

Hence; Net upward thrust acting on the body.

$F = F_2 - F_1$

$F = (x+h)\rho g A - x\rho g A$

$F = (x+h-x)\rho g A$

$F = h\rho g A$

$F = \boxed{A h \rho} g$

$F = mg$

upward thrust F = weight of the displaced liquid

Actual weight of the body $(W) = Mg$.

Hence, observe weight on the body in liquid $= W - F$

$Mg - mg$

Thus observe weight of the body emerge in a liquid become less than its true or actual weight by an amount equal to the weight of the liquid displaced by the body.

Q. What do you mean by Cohesive ~~Forsive~~ and adhesive force.

The force of attraction b/w the molecule of same substance is called Cohesive force.

The force of attraction b/w the Molecules of different substance is called the adhesive force.

Q. What do you mean by Surface Tension. Write the Defination of the Surface Tension.

⇒ Concept :-

Liquid has a property that its free surface behaves like

Stretched elastic membrane and Has a Natural Tendency to contract i.e., the free surface of a Liquid Tends to occupy a Minimum Surface area. This property of Liquid is Called the Surface Tension.

Defination

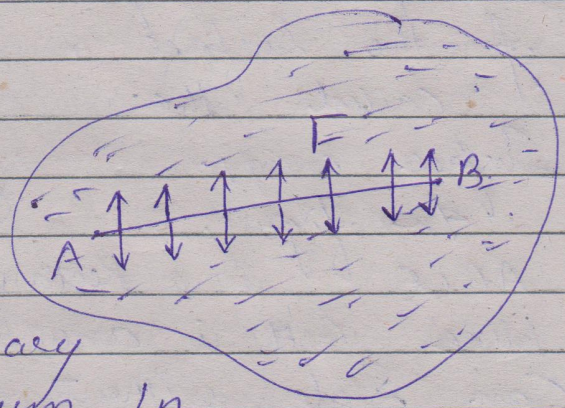
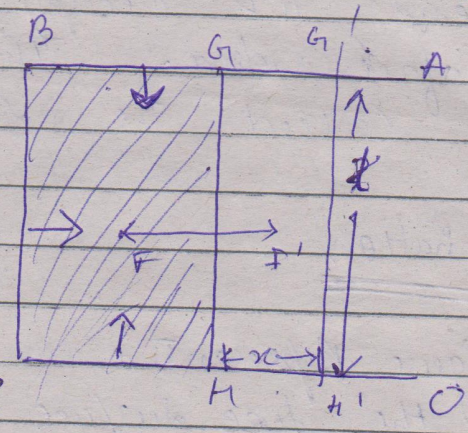


Figure Represents the free surface of a Liquid on which an imaginary Line AB is Drawn In any Direction. The Surface on either Side of this Line exerts an attractive force on the Surface on other Side This Force Lies on the plane of the Surface and is Normal to the Line AB. If the Length of Line AB is l and the Total force Acting on it is F then Surface Tension $T = \frac{F}{l}$

if $l = 1$ then $T = F$

Surface Tension of Liquid is Define as the force per unit Length in the plane of the liquid Surface Acting Normally on either Side of an imaginary line drawn in that Surface.

What do you Mean Surface energy. Derive the expression for Surface energy.



The potential energy Store per unit Area of the Surface is called the Surface energy.

In figure, ABCD is a Rectangular frame of wire GH is another wire which Can Slide without friction. a film is formed without emerging it in a Soap Solution. The film has 2 Rectangular Surfaces the Upper and Lower Surface.

The force on the wire GH due to Surface Tension is

$$F = T \cdot 2l \quad \text{---(1)}$$

When T is the Surface Tension of Liquid. To keep the wire GH at its position a force = F acting outwards is Required on it, if the wire GH is displaced to a distance x by the force F then work done on the Wire

$$W = F \cdot x$$

$$W = T \cdot 2l \cdot x$$

$$W = T \cdot \Delta A \quad \text{---(2)}$$

if $\Delta A = 1$ then;

$T = W$

Hence, The Surface Tension of a Liquid is equal to the work Require to increase the Surface Area of Liquid film by Unity at the Constant Temperature.

Ques:- Derive the expression for Work Done when a big Drop Divides in Small droplets or small drops Combine to form a Big Drop.

When a big Liquid Drop Splits into a No. of Small Drop of equal Size we have to do Some work and the Surface energy of Some Drops increase. When Small Liquid Drop each of equal Size Combine to form a big drop Some energy is Released. And then the Surface energy is decreases.

Let a big Drop of Radius R Splits into n Small Drops each of Radius r then;

Vol. of big Drop = n × Vol. of one Small Drop.

$$\frac{4}{3}\pi R^3 = n \times \frac{4}{3}\pi r^3$$

$$R^3 = n r^3$$

$$\boxed{R = n^{3} \cdot r} \quad \text{(1)}$$

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

Surface Area of 1 big Drop $= 4\pi R^2$

Surface Area of n Small Drop $= n \times 4\pi r^2$

$= n \times 4\pi \left(n^{-\frac{1}{3}} \cdot R\right)^2$

$= n \times 4\pi n^{-\frac{2}{3}} \cdot R^2$

$= n^{\frac{1}{3}} \cdot 4\pi R^2$

Increase in Surface Area.

$\Delta A = n^{\frac{1}{3}} \cdot 4\pi R^2 - 4\pi R^2$

$\Delta A = 4\pi R^2 \left(n^{\frac{1}{3}} - 1\right)$

$W = T \cdot \Delta A$

$\Rightarrow W = T \cdot 4\pi R^2 \left(n^{\frac{1}{3}} - 1\right)$

$W = 4\pi R^2 T \left(n^{\frac{1}{3}} - 1\right)$

Q. A Niddle of Length 5 Cms is on the Surface of Water the Surface of Tension of Water 7.3×10^{-2} N/m What force is Needed other than the weight of a Niddle to Lift the Niddle above the Surface of Waters.

$\Rightarrow F = T \cdot 2L$

$\Rightarrow F = 7.3 \times 10^{-2} \times 10$

$\Rightarrow F = 73 \times 10^{-2}$