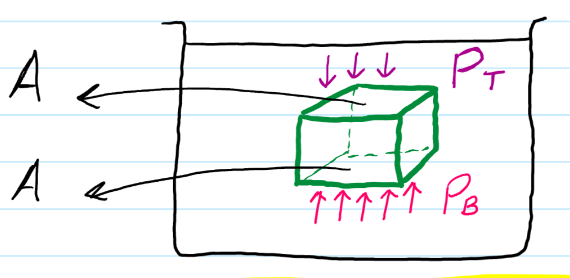
direction → force

define :- Upthrust is defined as the upward force which is experienced by any object if it is immersed in a fluid.

Why Upthrust acts :-

"Pressure Increases with the depth"



P_B = Pressure exerted on the bottom face
P_T = Pressure exerted on the top face

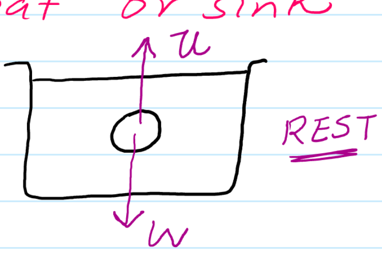
Since $P_B > P_T$

∴ This difference in Pressure b/w the top & the bottom surface exerts an upward force on the object which is known as "upthrust"

State why Upthrust :-
b/c of difference in Pressure b/w the Top and the Bottom Surfaces.

Side note

Q How do we determine whether an object will float or sink



if $W > U$ Sink
if $U > W$ float

formulas for calculating Upthrust

derivation "NOT" Required

$$U = (P_B - P_T)A \rightarrow (1)$$

A = Area of Top / Bottom face (provided that the areas are identical).

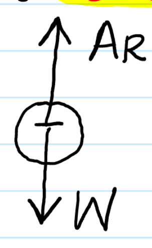
Q:: What if the areas are non-identical ?
Then the 1st formula is not applicable hence we use eq (2)

$$U = \rho_f \cdot g \cdot V_0 \rightarrow (2)$$

ρ_f = density of fluid
g = acc. of free fall
V_0 = Volume of the object.

· How to represent Upthrust in a diagram

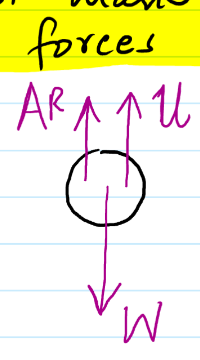
Ex.(1) An object is falling in AIR at constant Speed.



O levels (i) Mark the forces on the diagram?

Equation $W = A_R$ (wrong)

· Since we have now done Upthrust.
∴ We must mark not 2 but rather 3 forces on the diagram



Equation
$W = U + A_R$.

Briefly comment on the magnitude of each force ?

W = Largest

How to decide b/w A_R & U

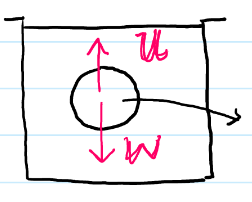
$U = \rho_f \cdot g \cdot V_0$ ∴ $U \propto \rho_f$

In this case object was falling in Air ∴ ρ_f(air) = v. Low
∴ U = smallest.

Increasing Order = U, A_R, W.

Ex. A gas molecule is stationary inside a Liquid column.

(i) Mark the forces on the diagram

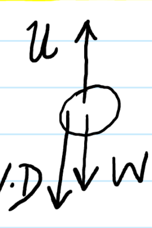


Q:: What about Air Resistance?

fluid alternate terms ::
(1) fluid Resistance
(2) drag force
(3) Viscous drag.

Since stationary ∴ Viscous drag is not marked / mentioned.

(ii) Mark forces if the gas molecule is moving upwards at constant speed ? → V.D (down)



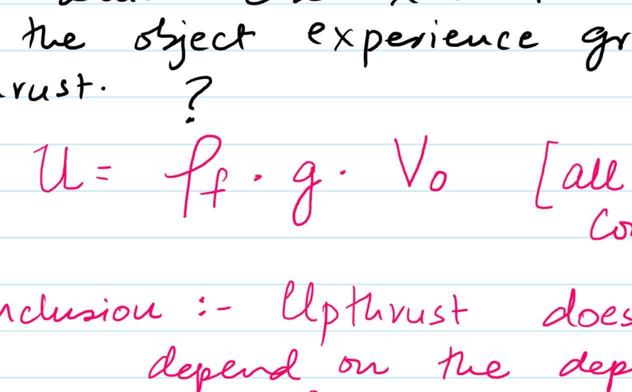
Since moving upwards ∴ Viscous drag downwards

(ii) Form an Equation $W + V.D = U$

(iii) Comment on magnitude
Increasing order
U = Largest.

Compare b/w V.D and W
gas molecule ∴ W (negligable)
W = smallest

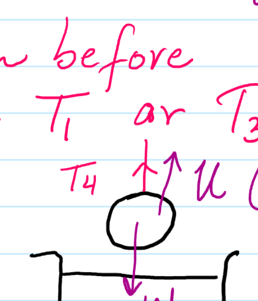
W, V.D, U.



Q In which case X or Y will the object experience greater upthrust. ?

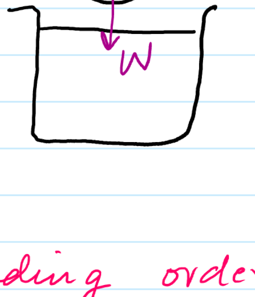
$U = \rho_f \cdot g \cdot V_0$ [all are Constant].

Conclusion :- Upthrust does not depend on the depth of immersion



$U = \rho_f \cdot g \cdot V_0$.
V_0 immersed has reduced ∴ U also decreases.

$T_3 + U = W$
U → reduces
T_3 → higher than before
$T_3 > T_1$ or $T_3 > T_2$.



$T_4 + U = W$
U → smallest
T_4 → Larger than T_1, T_2, T_3.

Ascending order.

$T_1 = T_2$, T_3, T_4