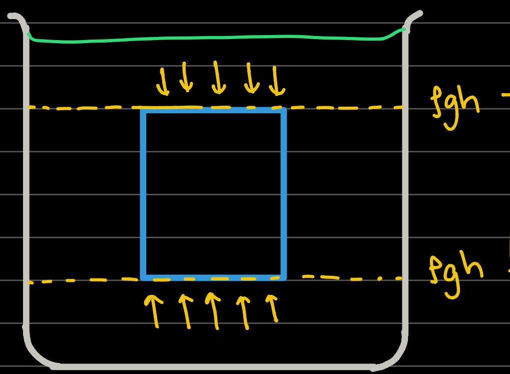
Upthrust

Definition: An upward force experienced by any object when it is immersed in a fluid

Why the force of upthrust acts upon a partially or fully submerged object

As we know, pressure increases with the depth.
Therefore, if an object is immersed in a fluid, it's bottom face will always experience more pressure as compared to the top face



→ This value is the greater of the two because of a greater value for "h" / depth

Upthrust acts because of pressure difference between the top and bottom faces

Calculating upthrust:

1. $u = (P_B - P_T)A$ where P_B = Pressure on bottom surface
   P_T = Pressure on top surface
   A = Area of the object on which the pressure acts
   u = upthrust

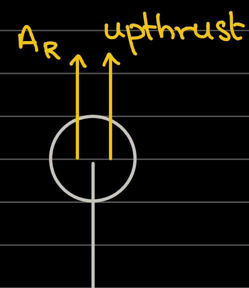
   ↓ can only be used when the top and bottom areas are identical

2. $u = \rho_f \cdot g \cdot V_o$ where ρ_f = Density of the fluid
   g = gravitational acceleration
   V_o = Volume of the object

Example:
An object is falling through air at constant speed

(i) Mark the forces
Done

(ii) Comment on the magnitude of each force
Weight is the greatest force of the three.
Since ρ_f is the least, upthrust must be the smallest force



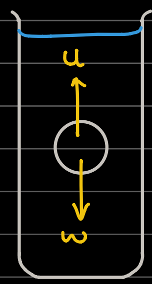
Increasing order : upthrust , air resistance , weight

Example :

A gas molecule is stationary inside a liquid column.

i) Mark the forces on the diagram.

Done



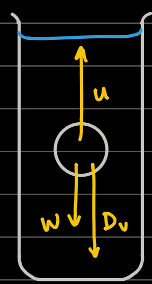
where u = upthrust
w = weight

ii) Explain why fluid resistance / drag force / viscous drag was not drawn ?

This is because viscous drag only occurs when the object is moving through a fluid. Since the object in this case is stationary, there will no viscous drag upon it and the forces will be balanced, hence upthrust = weight.

iii) Mark forces on the second, identical diagram if the object was moving upwards at a constant speed.

Done



where u = upthrust
w = weight
Dv = viscous drag

iv) Comment briefly on the magnitudes of the marked forces.

u = w + Dv

Therefore, increasing order : w , Dv , u

Q.t.S = why, though? why is weight necessarily less than the viscous drag.

PRESSURE

↳ Extension of O Lvls. content

Solid + Fluids (Liquids & Gases)

$P = \frac{F}{A}$ or $P = \frac{W}{A}$ → Nm^{2} for solids

$P = \rho gh$ where ρ = density
g = gravitational acceleration
h = depth

Derivation of $P = \rho gh$

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

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

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

$P = \frac{(\rho \times v)g}{}$

where F = force
A = Cross sectional area of fluid prism / cylinder
W = weight
m = mass
g = gravitational acceleration
ρ = density of fluid
h = height of fluid prism / cylinder

A

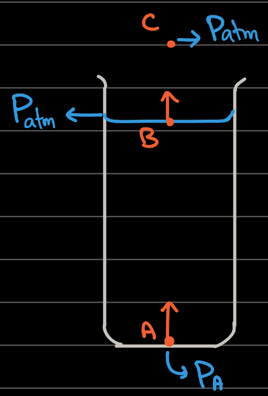
$$P = \frac{(\rho \times \cancel{A} \times h)g}{\cancel{A}}$$

$$P = \rho g h$$

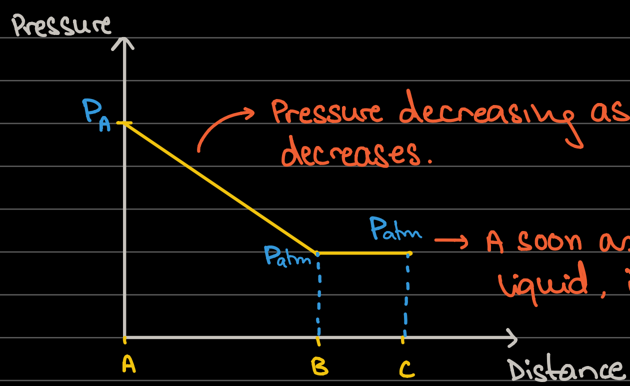
Atmospheric Pressure $= 1.01 \times 10^5$ Pa

$= 760$ mm of Mercury

Graph of Pressure against distance



Q. A partice travels from A to C via B.
Sketch a graph to show pressure experienced by the particle against the distance that it travels.



Pressure decreasing as the depth below the surface decreases.

A soon as the particle emerges from the liquid, it only experiences the atmospheric pressure, which is constant, thus the graph is a horizontal line from B onwards.