FLUID STATICS

Fluid Mechanics

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Pascal Law states : The intensity of pressure at a point in a FLUID AT REST is same in all the directions

$$\boxed{Px = Py = P}$$

PASCAL'S LAW

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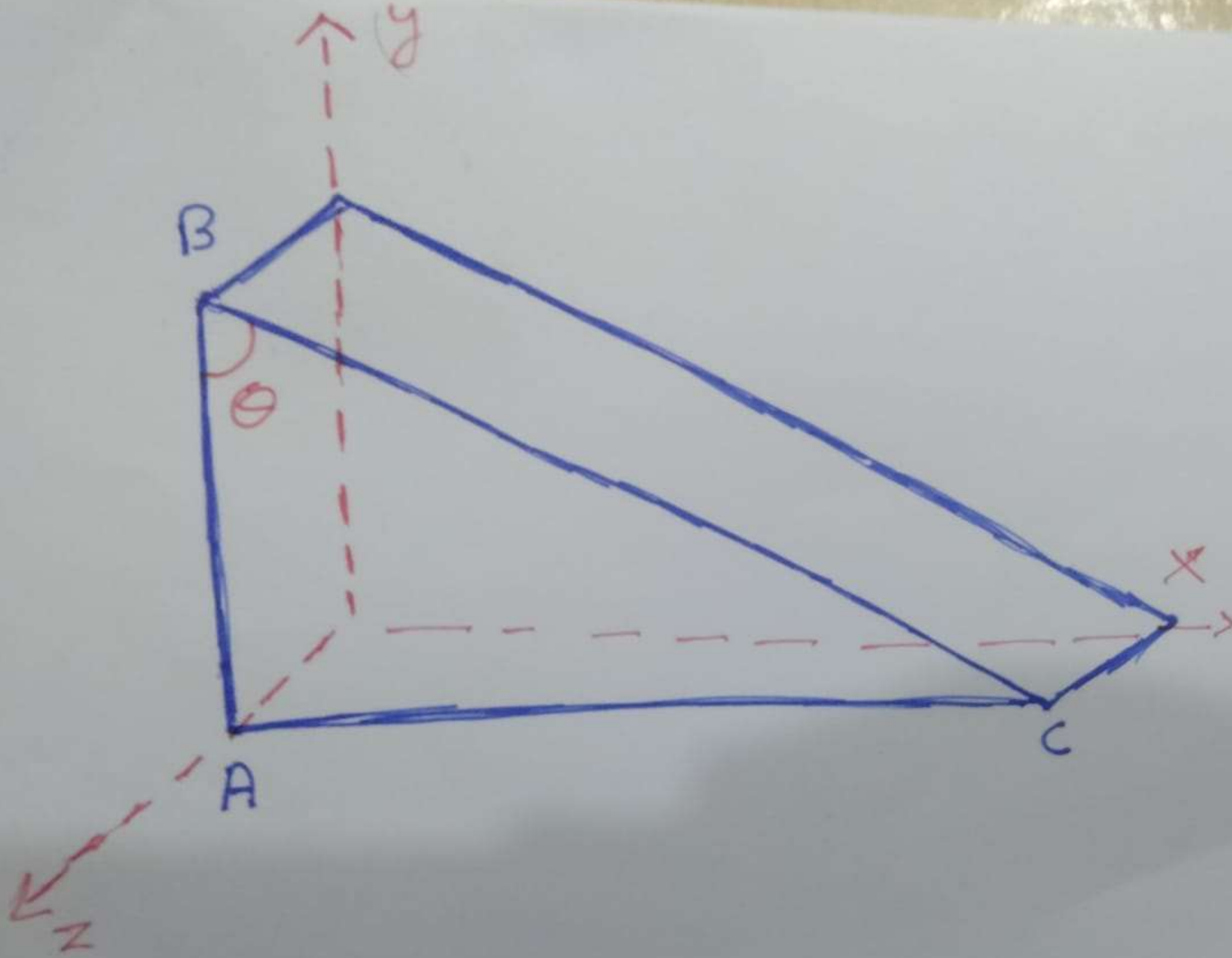
Consider an arbitrary fluid element of wedge shape in a fluid mass at rest . Width of the element is unity


y
B
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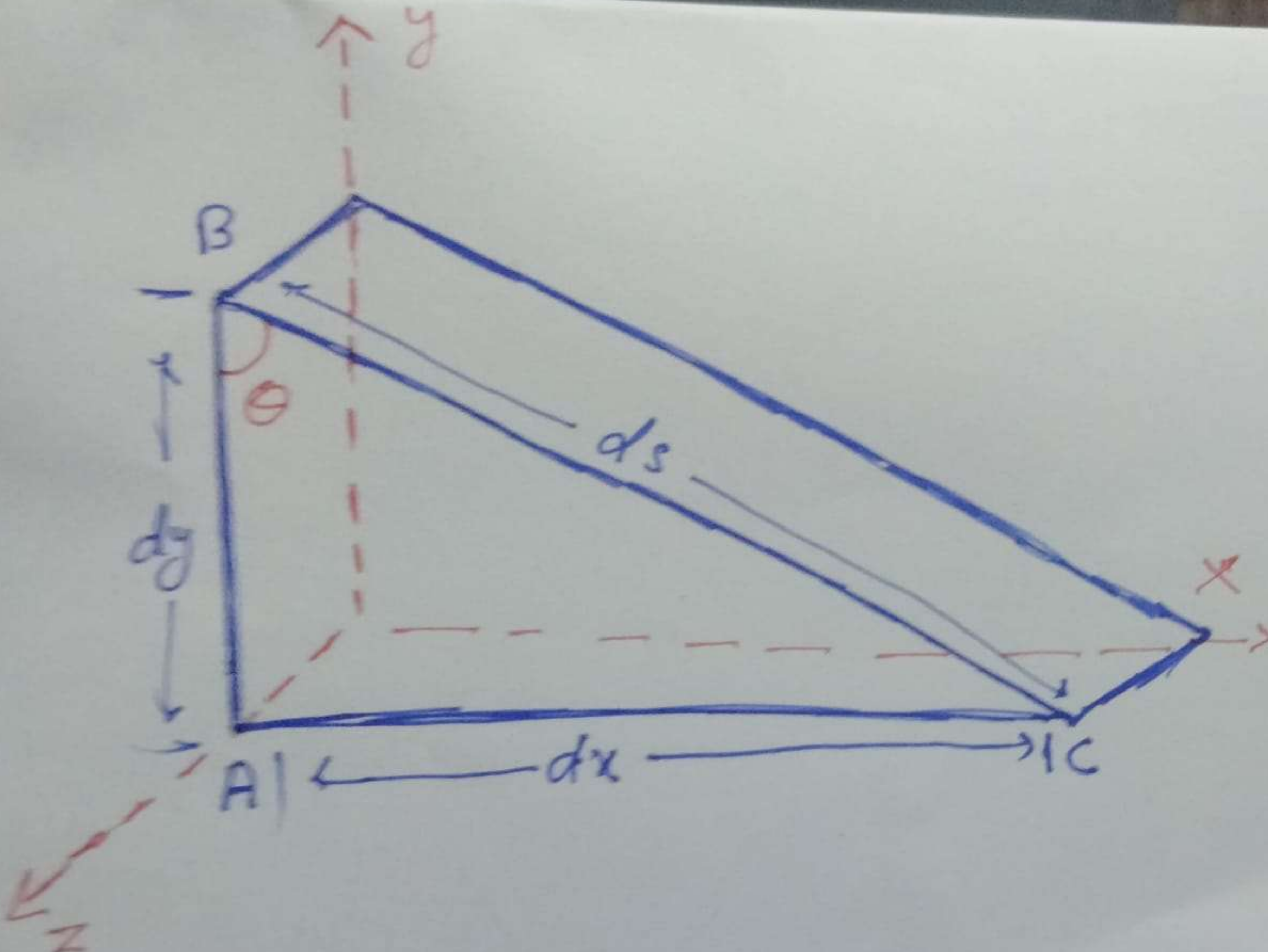
z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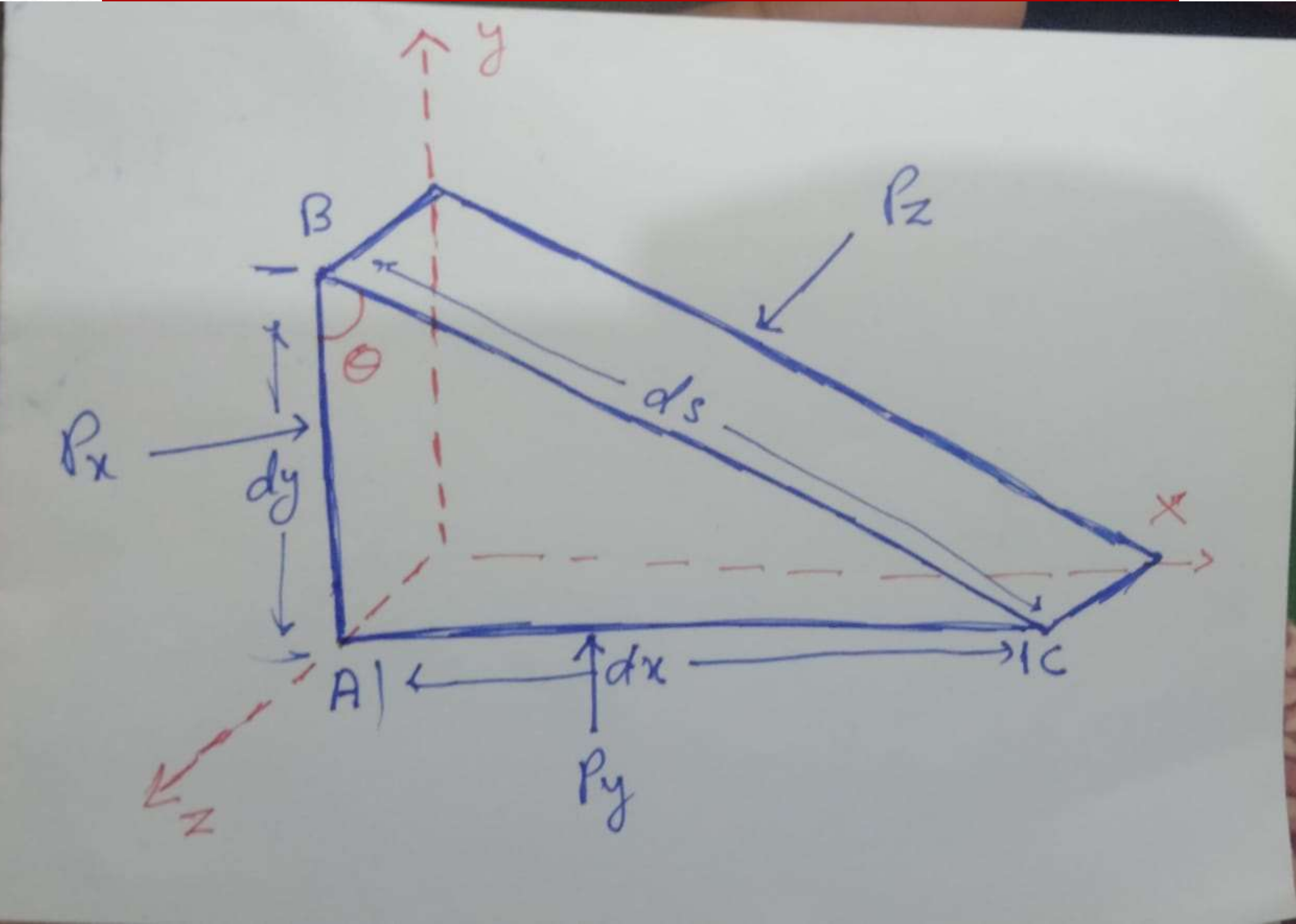

y
B
P_z
θ
P_x
ds
dy
x
A
dx
C
P_y
z

Surface force :

1- force acting on the X- axis

2- force acting on the y-axis

3- force acting on slant side

Body force :

Weight of the fluid element

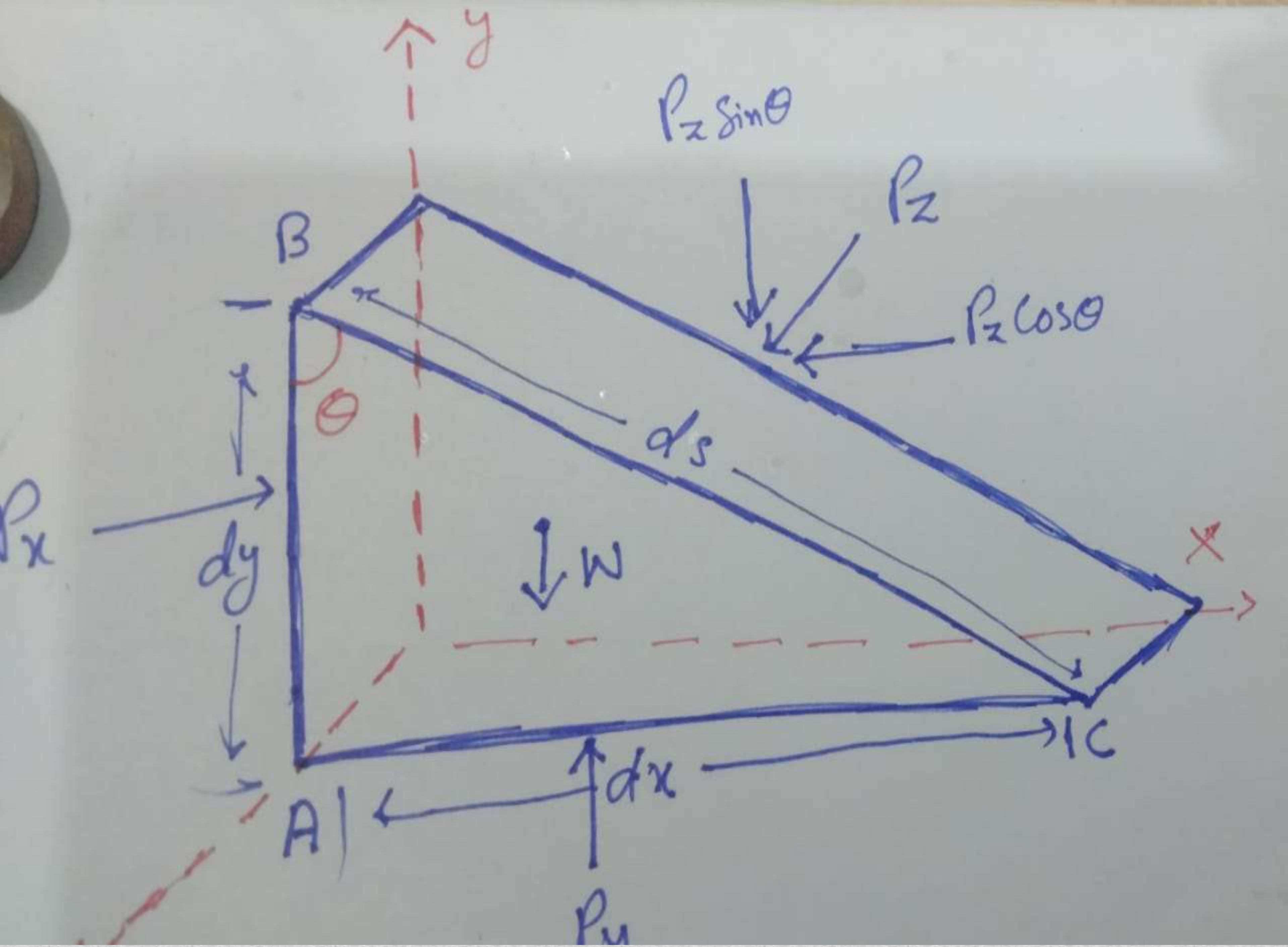
P = F/ A

F= P . A

Fx = (Px) (dy) (1)= Px. dy

Fy = (Py) (dx) (1) = Py.dx

F= (Pz) (ds)(1) = pz.ds



y
B
A
C
X
θ
Pz Sinθ
Pz
Pz Cosθ
Px
Py
dy
dx
ds
W

$$W = m.\,g$$

$$W = \boldsymbol{\varrho\ .\ V\ .\ g}$$

Because $\boldsymbol{\varrho = m/v}$

$$\boldsymbol{W = \varrho\ .\ g\ .\ \tfrac{1}{2}\,(dx.dy.1)}$$

$$\text{Cos}Q = dy / ds$$

$$dy = ds.\ \text{Cos}Q$$

$$\text{Sin } Q = dx / ds$$

$$dx = ds.\ \text{sin}Q$$

- As this element is at rest so the algebraic sum of all the forces acting in the same direction will be zero

- $(Px \,.\, dy) - (Pz \cos Q)(ds) = 0$

  $Px \,.\, dy = Pz \,.\, ds.\cos Q$

  $Px \,.\, dy = Pz \,.dy$

$$\boxed{\mathbf{Px = Pz}}$$

- $(P_y \,.\, dx) - (P_z \sin Q)(ds) - (\boldsymbol{\varrho \,.\, g \,.\, \tfrac{1}{2}\, dx.dy.}) = 0$

$$P_y \,.\, dx = P_z \,.\, ds.\ \sin Q$$

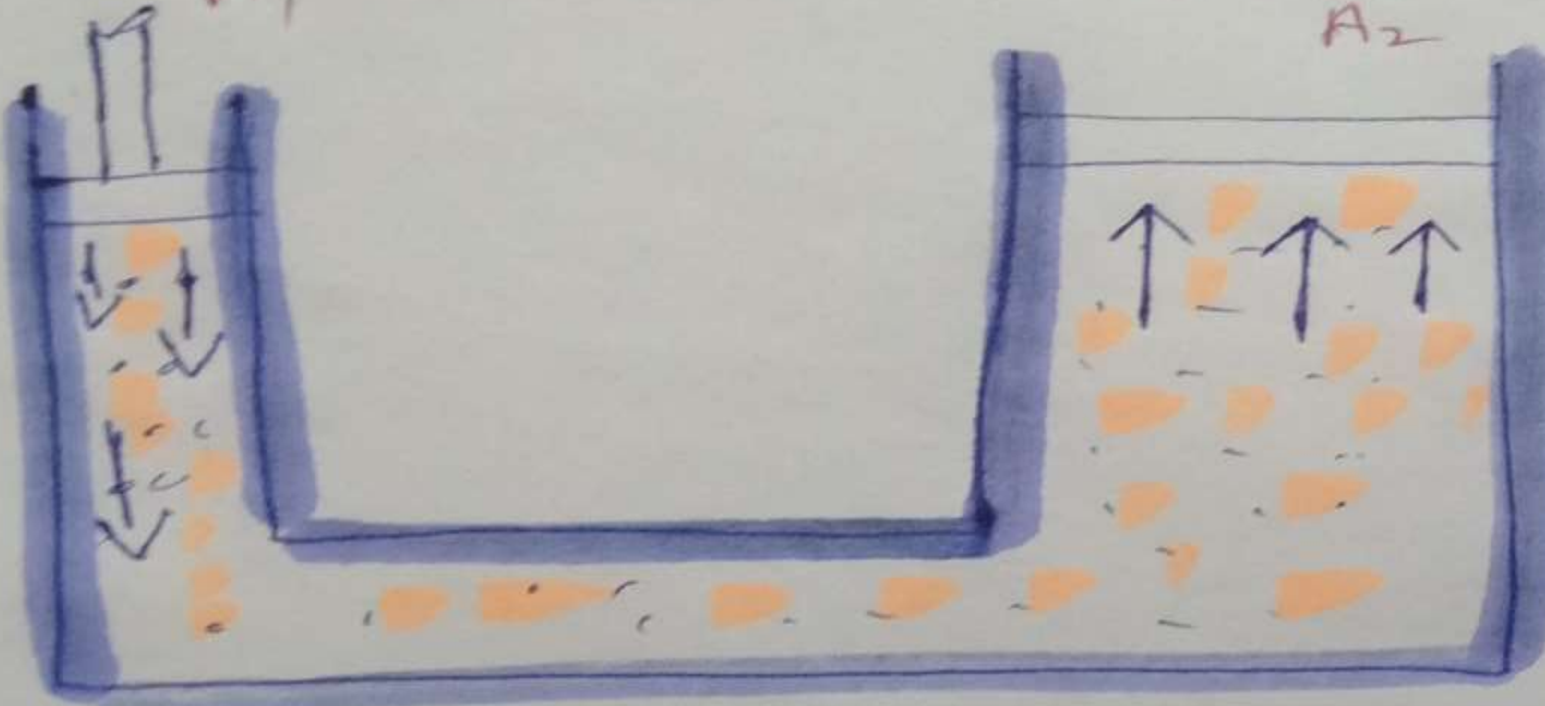
$$P_y \,.\, dx = P_z \,.dx$$

$$\boxed{\mathbf{P_y = P_z}}$$

Pascal’s principle, also called **Pascal’s law**, in fluid (gas or liquid) mechanics, in a fluid at rest in a closed container, a pressure change in one part is transmitted without loss to every portion of the fluid and to the walls of the container.

LAW OF TRANSMISSIBILITY OF PRESSURE

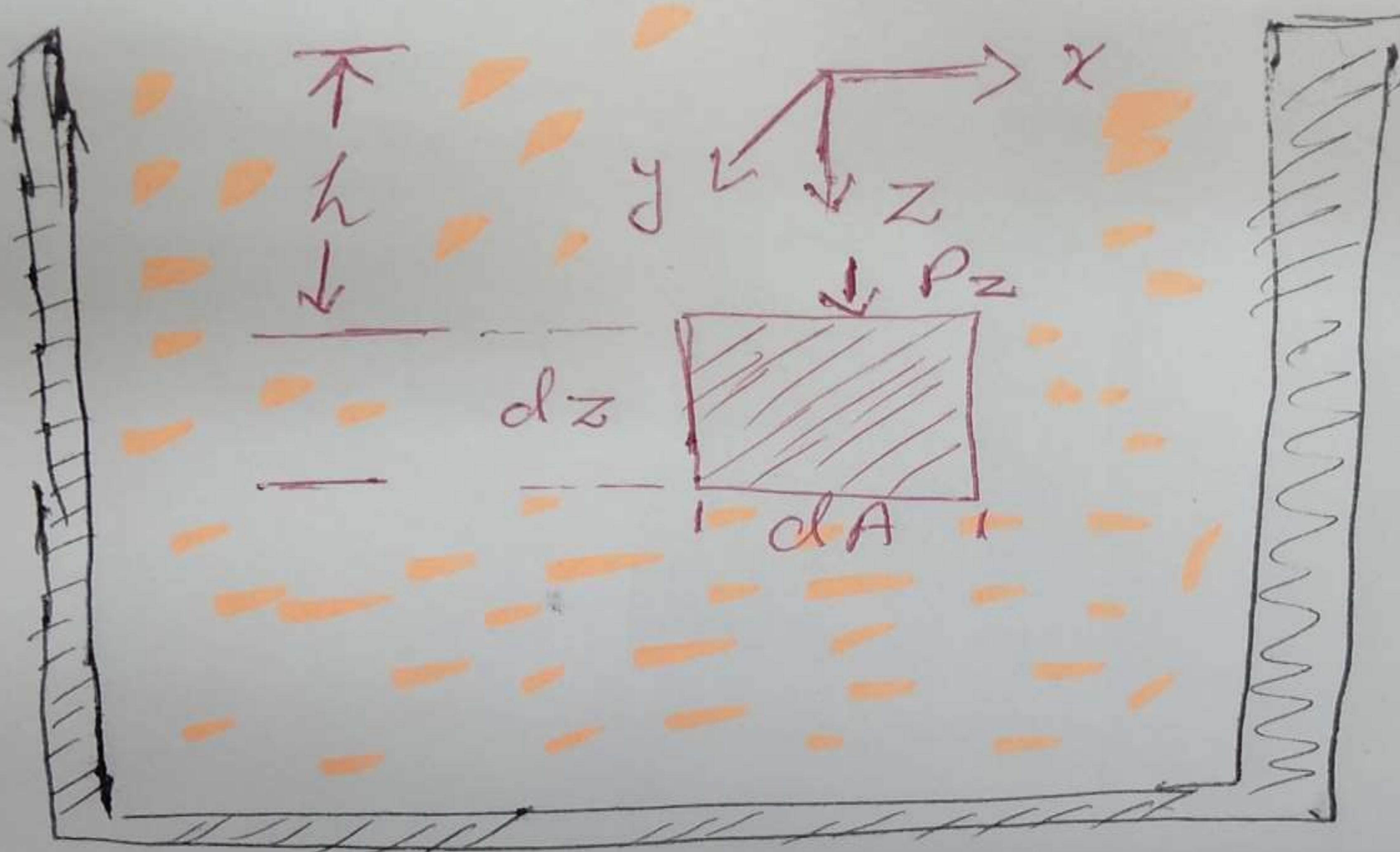
$$P_1 = \frac{F_1}{A_1} \qquad P_2 = \frac{F_2}{A_2}$$



$$F_1 / A_1 = F_2 / A_2$$

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

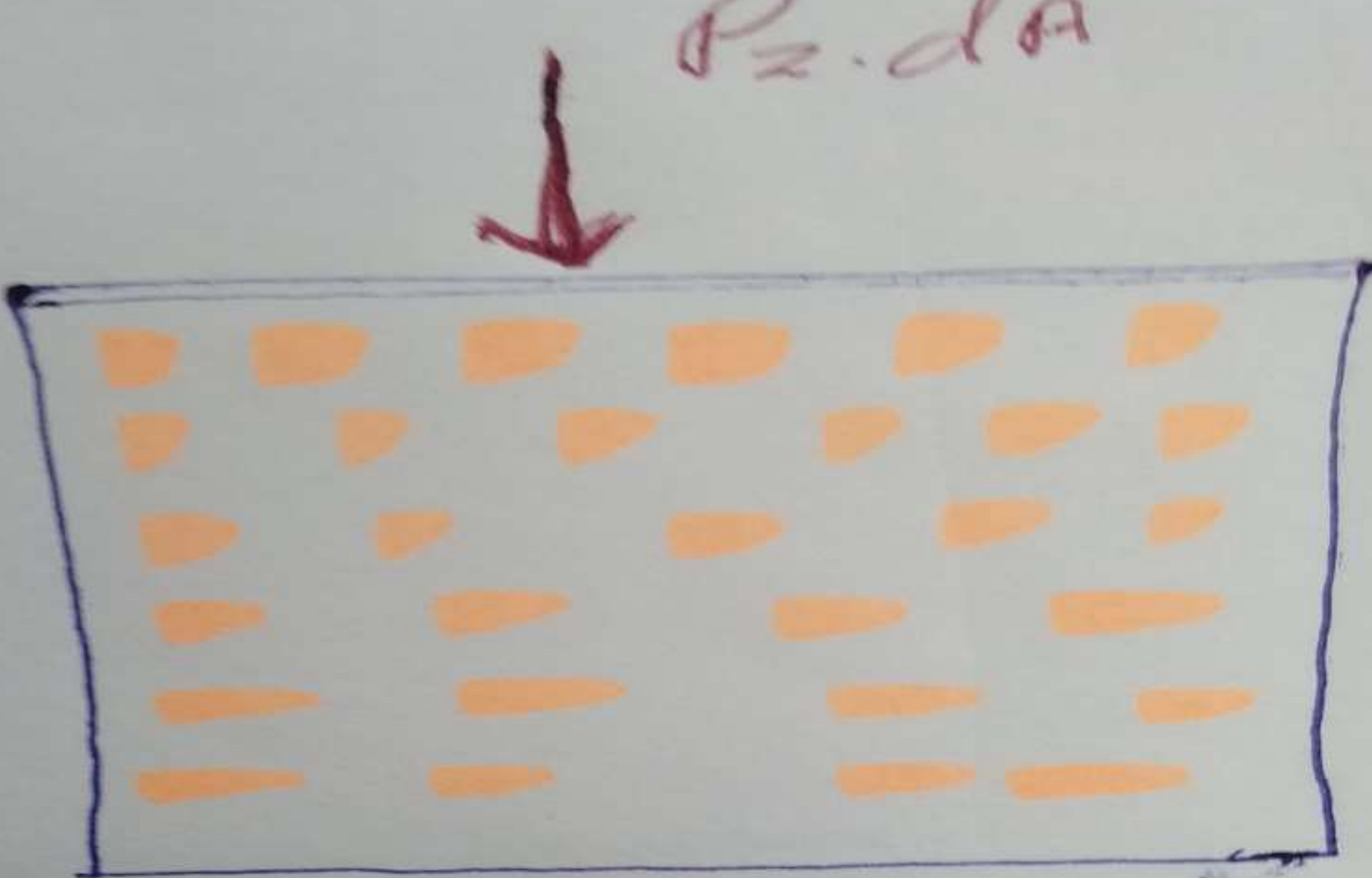
- The pressure exerted by a fluid at equilibrium at a given point within the fluid, due to the force of gravity. Hydrostatic pressure increases in proportion to depth measured from the surface because of the increasing weight of fluid exerting downward force from above.



Area = dA

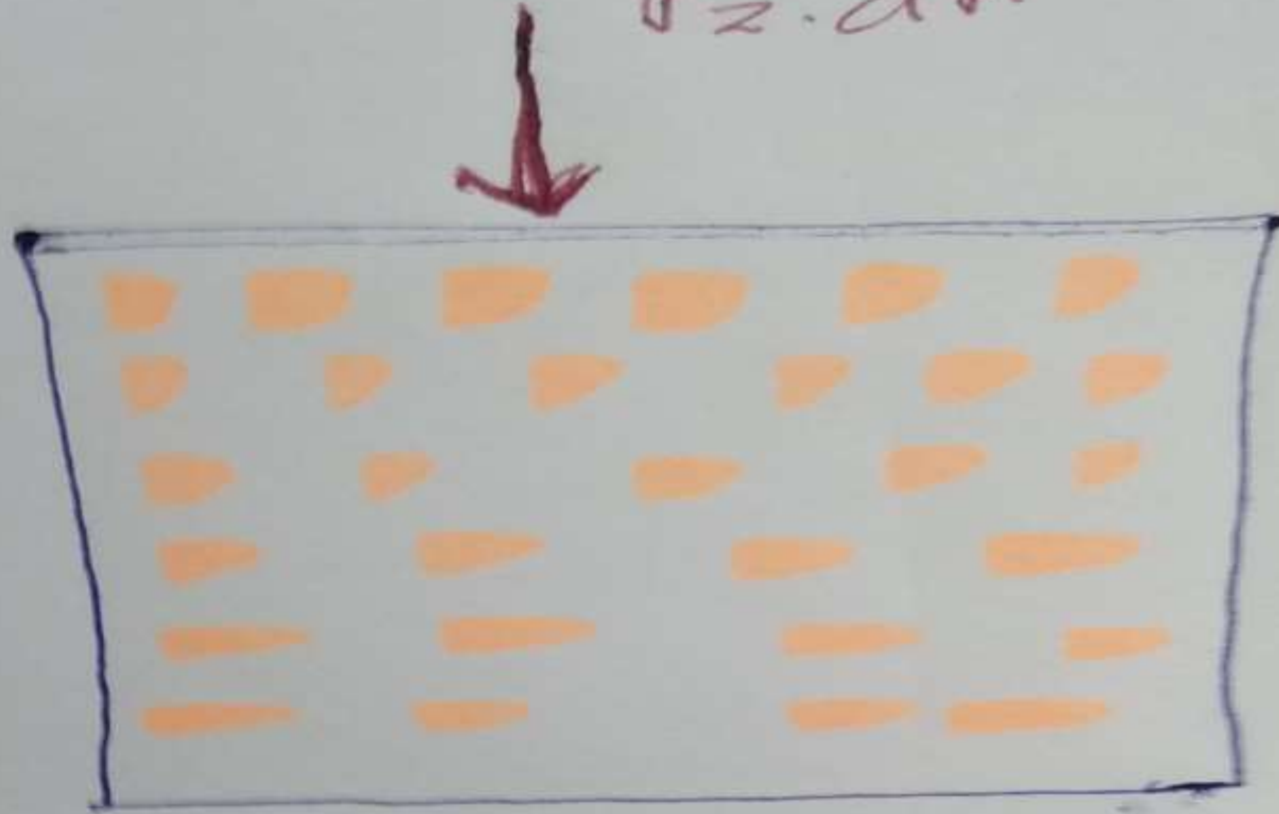
Pressure = P_z

hieght = h



$$dv = dA \cdot dz$$

$P_z \cdot dA$



$dV = dA \cdot dz$

$\left(P_z + \frac{dP_z}{dz} \cdot dz\right) dA$

- Volume of fluid element v = dA . Dz
- Weight of fluid element dw = **ϱ . g .dV**

dw = $\boldsymbol{\varrho . g .dA.dz}$

Submission of forces in Z-direction

(Pz.dA + ϱ . g .dA.dz) – (Pz + dPz/dz . dz) dA

Pz.dA + ϱ . g .dA.dz – Pz .dA + dPz/dz . dA. dz

Submission of forces in Z-direction

= (Pz.dA + ϱ . g .dA.dz) – (Pz + dPz/dz .dz) dA

= Pz.dA + ϱ . g .dA.dz – Pz .dA + dPz/dz . dA. dz

$\cancel{\text{= Pz.dA}}$ + ϱ . g .dA.dz – $\cancel{\text{Pz.dA}}$ + dPz/dz dA . dz

dPz/dz . dA.dz = ϱ . g .dA.dz

dPz/dz = ϱ . g

$dPz/dz = \varrho \cdot g$

$dP = \varrho \cdot g \cdot dz$

$dP = \gamma \cdot dz$

$$\int_{Patm}^{Pa} dp = \int_{0}^{h} \gamma \cdot dz$$

$Pa - Patm \quad = \gamma \cdot h - 0$

$Pa \quad = \gamma \cdot h + Patm$

$Pa \quad = \varrho \cdot g \cdot h$