محاضرة (٢)

11 / 6 / 2012 mon.

* Dimension in units:-

→ 7 basic units

7 basic units		S.I	B.S
1) mass	(M)	kg	slug (Lbm)
2) Length	(L)	m	ft (in)
3) time	(T)	S	S
4) Temp	(θ)	K[C°]	R[F]
5) amount of matter	(N)	mole	mole
6) indensity of electrical current	(i)	Ampere	Ampere
7) intensity of Light	(C)	candela	candela.

1 Feet = 12 in.
= 0.3048 m

1 in = 2.54 cm

1 slug = 14.59 kg

1 Lbm = 0.453 kg

$g = 9.806 \frac{m}{s^2}$ (S.I)

$= 32.174 \frac{Ft}{s^2}$ (B.S).

→ Derived units:- can be obtained using certain eqn.

$$\text{velocity} = \frac{\text{distanse}}{\text{Time}}$$

$$[V] = \frac{L}{T} = \frac{m}{s}, \frac{Ft}{s}, \frac{in}{s}$$

$$[\forall] = L^3 = m^3, Ft^3, in^3$$

$$[\rho] = \frac{\text{mass}}{\text{Volume}} = \frac{kg}{m^3}, \frac{slug}{Ft^3} = \frac{Lbm}{in^3}$$

$$\text{velocity} = \frac{ds}{dt} \Rightarrow \frac{[S]}{[t]} = \frac{L}{T}$$

$$\text{acceleration} = \frac{dv}{dt} = \frac{ds^2}{dt^2} \Rightarrow [a] = \frac{[S]}{[t^2]} = \frac{L}{T^2}$$

→ For integration:-

$$\int F\,dy = [f][y]$$

$$\text{Force} = F = ma$$

$$[f] = [m][a] = \frac{M \cdot L}{T^2} \quad \frac{kg \cdot m}{s^2}$$

* Dimensional homogenity. كل المقادير يكون لها نفس النظام {تسعيرة}

in the primary dimension of each terms for given eqn. is the same the eqn. is set to be dimensionlly homogeneous.

* Grid method:-

Cancellation of unit.

$$g = 9.81 \frac{m}{s^2} = 9.81 \cdot \frac{m}{0.3048\,m} \cdot \frac{ft}{s^2}$$

$$= 32.174 \frac{ft}{s^2}$$

$$\rho_{H_2O} = 1000 \frac{kg}{m^3} = 1000 \cdot \frac{1\,kg}{14.59} \cdot 1\,slug \cdot \frac{0.3048^3}{m^3} \cdot \frac{m^3}{ft^3}$$

* Dimensianless Groups:- acombination of variables in which the primary dimensions are cancel out.

→ Mach No. $= \dfrac{\text{velocity}}{\text{velocity of sound}}$

→ $R_e = \dfrac{\rho V D}{\mu}$

* Fluid properties :-

→ properties Related to the mass and weight.

① Mass density $[\rho]$ = mass / volume

$$[\rho] = \frac{M}{L^3} , \frac{kg}{m^3} , \frac{slug}{ft^3} , \frac{lbm}{in^3}$$

* For water $\rho_{H_2O} = 1000 \frac{kg}{m^3}$ at $4^\circ c$
* " air $\rho_{air} \approx 1.2 \frac{kg}{m^3}$ at $20^\circ c$, 101.325 kpa.

table at the end of text book.

* Temp. Dependancy التأثر بالحرارة

For liquids density slightly changed with increasing temp., But For gases density significantly affected by temp.

② Specific weight. (γ)

$$\gamma = \frac{weight}{volume} , \frac{N}{m^3} , \frac{\frac{ML}{T^2}}{L^3} = \frac{M}{T^2 . L^2}$$

$$\gamma = \frac{M}{T^2 . L^2}$$

$$\gamma = \frac{weight}{volume} = \frac{mg}{V} = \rho g$$

$$\gamma = \rho g$$

♡ table includes γ for diff fluids at diff. temp.

③ Specific gravity (S, SG)

$$S,\ S_G = \frac{\gamma_{Fluid}}{\gamma_{water\ at\ 4C^\circ}} = \frac{\rho_{Fluid} * \cancel{g}}{\rho_{H_2O} * \cancel{g}}$$

$$S,\ S_G = \frac{\rho_{Fluid}}{\rho_{H_2O}}$$

→ For example oil with density 800 kg/m³

$$S_{G\,oil} = \frac{\rho_{oil}}{\rho_{H_2O}} = \frac{800}{1000} = 0.8$$

$[S_G] = [-]$ → dimension less

④ eqn. of state:-

For ideal gases.

$$P \cdot \forall = n \cdot R_u \cdot T$$

P → absolute press.
$\forall$ → total Volume
n → no. of moles
R_u → universal gas constant $8314 \frac{J}{kmole \cdot k}$
T → total absolute temp [k]

$$P\forall = \frac{n\ M}{M} R_u\, T$$

mass (= n M), gas cons. (= R_u / M)

where M is the molecular weight [kg/kmol]

$$P\forall = mass \cdot R \cdot T$$

$$P = \frac{mass}{\forall} R \cdot T$$

$$P = \rho R T$$

ex what the density of air at room temp. $20^\circ C$ and standard atmospheric pressure 101.325 kpa. , where $R_{air} = 0.287 \frac{kJ}{kg.k}$

$$\rho = \frac{P}{RT} = \frac{101.325 * 10^3}{0.287 * 10^3 * (293.15)}$$

→ حولناها إلى كلفن

* properties related to flow of heat :-
  specific heat ability of material to store thermal energy , and is defined to rise the temp. of a units mass one degree.
  → For Gases specific heat depens on the process by which the gas changes it state.
  C_v → constant volume specific heat.
  C_p → 〃 pressure 〃 〃

$$C_p > C_v$$
$$C_p - C_v = R$$

$$k = \frac{C_p}{C_v} \quad , \text{ specific heat Ratio.}$$

→ Reviwe :-

$$\rho = \frac{mass}{volume}$$

$$\gamma = \frac{weight}{volume} = \rho g$$

$$S_G = \frac{\gamma_{Fluid}}{\gamma_{H_2O}} = \frac{\rho_{Fluid}}{\rho_{H_2O}}$$

$$P V = n R_u T = \rho R T$$

$$k = \frac{C_p}{C_v} \rightarrow \text{For air } k = 1.4$$

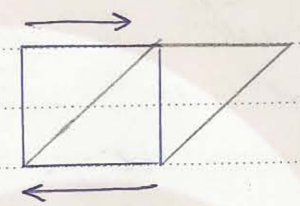
→ Viscosity اللزوجة

{Dynamic viscosity, absolute viscosity}

it a measure of a fluid resistance to deformation under shear stress.

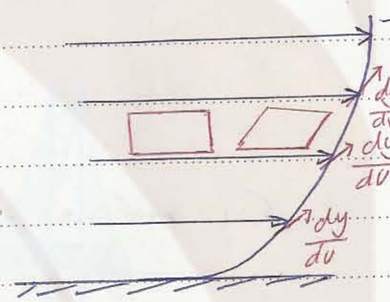
♡ in solid mechanics

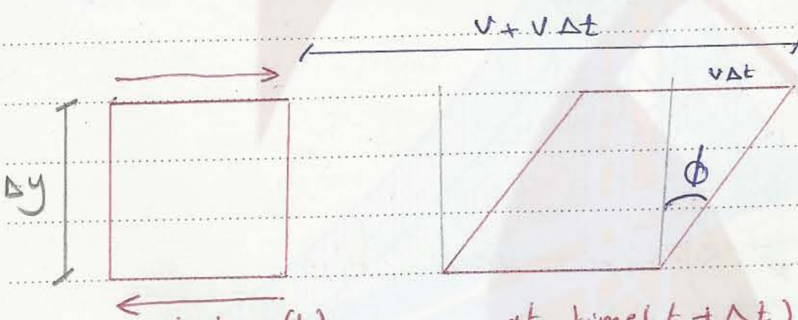
$\tau \propto$ Shear strain



♡ in Fluid mechanics

$\tau \propto$ Rate of strain





$$\Delta\phi = \frac{\Delta v \cdot \Delta t}{\Delta y}$$

$$\frac{\Delta\phi}{\Delta t} = \frac{\Delta v}{\Delta y}$$

, ϕ°, Rate of strain $= \frac{dv}{dy}$ = velocity gradiant.

$$\tau \propto \frac{dv}{dy} \Rightarrow \tau = \mu \frac{dv}{dy}$$

where μ is coffeciant of viscostiy {Daynamic, absolute viscosity.

$$\mu = \frac{\tau}{\left(\frac{dv}{dy}\right)} = \frac{M\,L}{\left(\frac{T^2}{L^2}\right)} = \frac{M}{L.T^2}$$

$$\left[\frac{dv}{dy}\right] = \frac{[v]}{[y]} = \frac{\frac{L}{T}}{L} = \frac{1}{T}$$

$$[\mu] = \frac{\frac{M}{LT^2}}{\frac{1}{T}} = \frac{M}{LT} = \frac{kg}{m.s},\ Pa.S,\ \frac{N.S}{m^2}$$

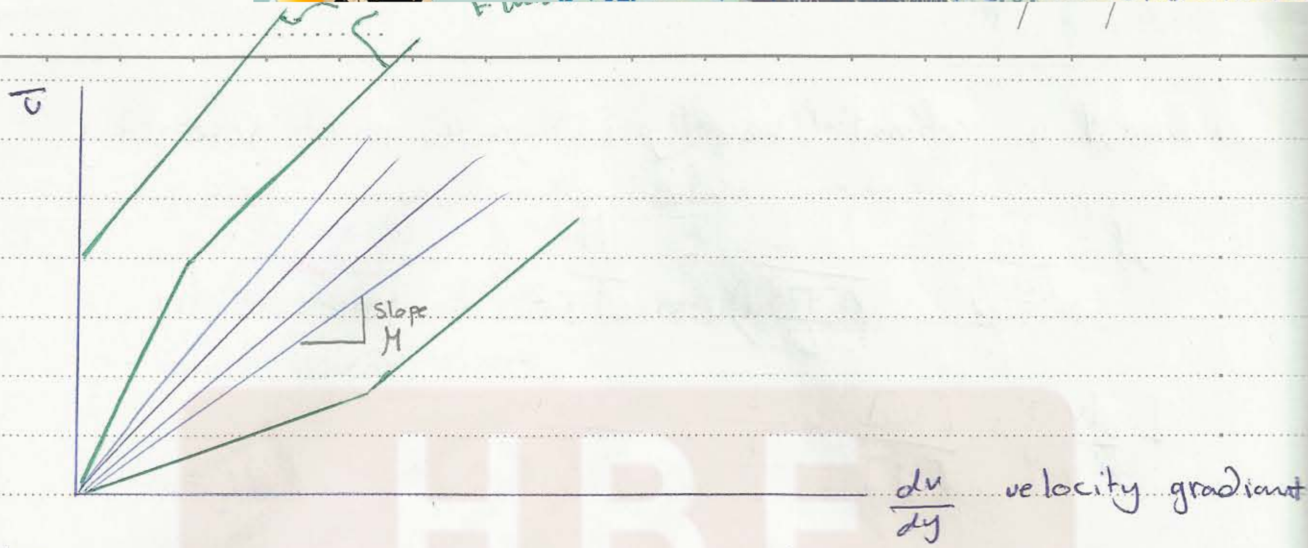
→ kinatic viscosity $\nu = \frac{\mu}{\rho}$

* two chartes at the end of the text book as function of temp.

note temp. Dependency :-
For liquied viscosity decrease with increasing temp.
and for gases increase with increasing temp.

♡ Newtanian and non Newtanian fluids.

Fluids that have abehavior corresponding to Newton law of visostiy called Newtanian Fluids
→ Linear relation ship between $\frac{dv}{dy}$



سؤال مهم جداً

Notes :-

① the slope of vairation curve must have afinite value , [impossible for the velocity vairation curve to be tangent to the solid boundary] .

→ if tangent $\frac{dy}{dv} = 0.0 \Rightarrow \frac{dv}{dt} = \infty$

$\tau = \infty$, impossible

② note that the slope of velosity vairation curve with distanse from the solid boundary $\frac{dv}{dt}$ decreases which mean that the τ decreasing with destance from the solid boundary [wall]

③ the velocity of the Fluids with respet to the solid surface is equal to zero
No relation ship condition

Surface tension σ $\left(\frac{N}{m}\right)$

Copillary effect.

→ responsible For the dew hang drop of blood rain to take sperical shape.

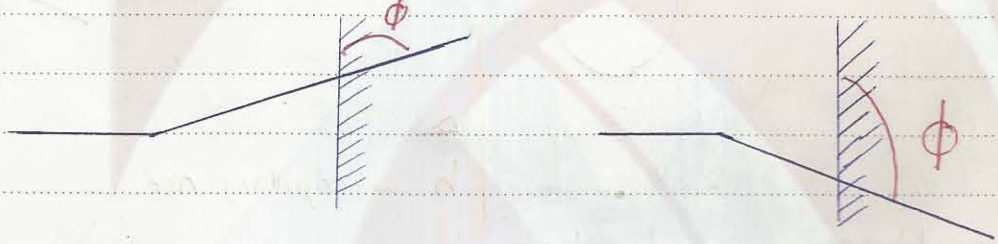
→ surfase tension is afunction of temp. and is not effected by pressure.

→ surfase tension can be changed by the addition of impurshies?

T	σ
0	0.076
20	0.075
100	0.059

* Capillary effect.

rise or fall of liquied in small diameter

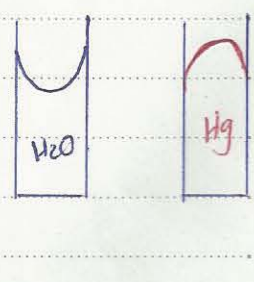


where ϕ is contact or wetting angle.

$\phi < 90°$ liquid wet surface.

$\phi > 90°$ // not wet //

$\phi_{Hg} = 130°$



13/6/2012 wedn.

* Reviwe

$\tau = \mu \frac{du}{dy}$, $\tau \propto \frac{\Delta \phi}{\Delta t}$ Rate of strain.

where μ: absolute viscosity , pa.s , $\frac{N.s}{m^2}$

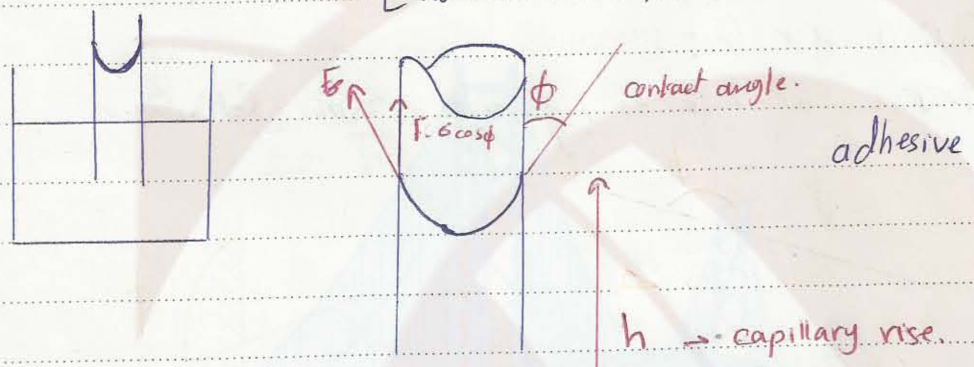
kinamatic viscosity $= \frac{\mu}{\rho}$, m^2

Surfface tension. σ $(\frac{N}{m})$

→ Droplet

→ Bubble.

→ capillary rise. [cohersive (similar molecular)]
[adhesive (diffrant ")]



adhesive > cohersive.

For equlebriam in y-direction:

$\Sigma F_y = 0$

$F_\sigma \cos\phi = mg = \rho \forall g$

$(\pi d \sigma)\cos\phi = \gamma \forall$

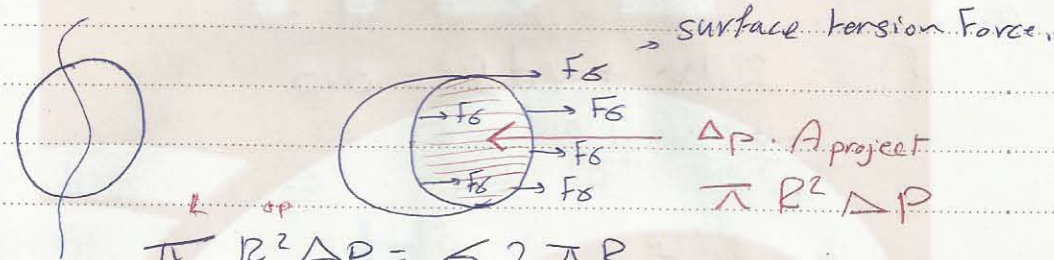
$\pi d \sigma \cos\phi = \frac{\pi}{4} d^2 h \gamma$

$$h = \frac{4 \sigma \cos\phi}{\gamma d}$$

♡ Capillary rise (h) effected by:

1) surface tension σ (which is a function of temp).
2) contact angle (rise in water fall in Hg $\phi = 130^\circ$)
3) inversely prop. to the dim.
4) 〃 〃 〃 〃 density $\gamma = \rho . g$.

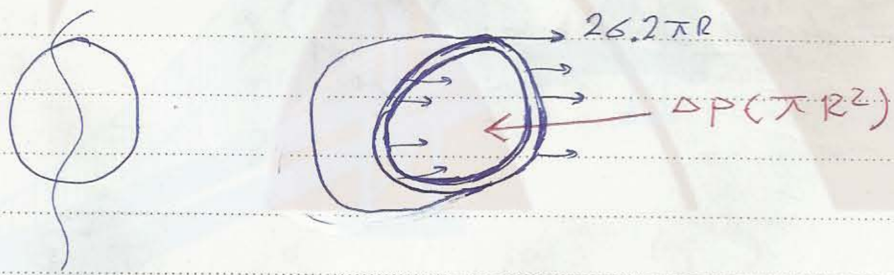
* Droplet



$$\pi R^2 \Delta p = \sigma \, 2\pi R$$

$$\Delta p = \frac{2\sigma}{R}$$

* Soap Bubble.



$$4\pi R \sigma = \pi R^2 \Delta p$$

$$\Delta p = \frac{4\sigma}{R}$$

* Bulk modulus of elasticity:

$$E_V = -\frac{\Delta P}{\frac{\Delta V}{V}} \quad (Pa).$$

ΔP → differantial pressuer

ΔV → differantial volume

V → total volume.

$E_V = 2.2$ Gpa.

mass $= \rho \forall$

cost.

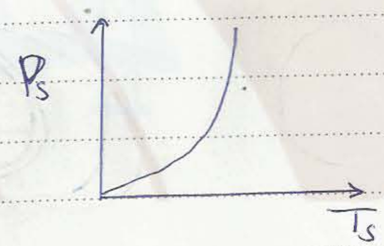
$$dM = \rho\, d\forall + v\, d\rho = 0.0$$

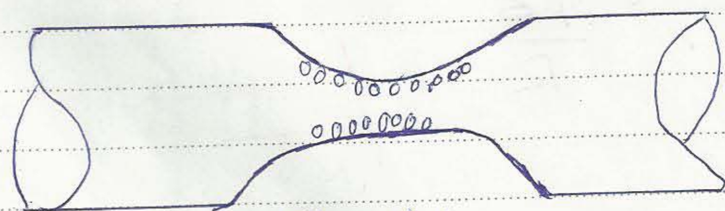
$$-\frac{d\forall}{\forall} = \frac{d\rho}{\rho}$$

$$E_V = \frac{dP}{\frac{d\rho}{\rho}} = \frac{\rho\, dP}{d\rho}$$

* vap pressure: (P_V)

the pressure at which liquid starts to vaporize and depend on tem:





Cavitation

التكهف

6th P.2-6 $\rho = ??$, $\gamma = ??$ $P = 300$ kPa. absolute , $T = 60°$

$P = \rho R T \Rightarrow \rho = \frac{P}{R.T}$ $R = \frac{R_u}{M}$

$\rho = \frac{300 \times 10^3}{518 * (60 + 273.15)} = 1.738 \frac{kg}{m^3}$ $= \frac{8314}{16}$

$= 519.62 \frac{J}{kg.k}$

$\gamma = \rho . g = (1.738)(9.81)$ $R = 0.518 \frac{kJ}{kg.k}$

$= 17.05 \frac{N}{m^3}$ مسكين

9th P.2-39 $\frac{M_{310}}{M_{280}}$ → temp O_2, Dose this Ratio have avalue:-

(a) Less than 1 (B) more than 1 (C) equal 1

because :- O_2 gas. $M \alpha T$

$M_{310} > M_{280}$

9th P.2-34 $u = a\left(\frac{y}{b}\right)^{1/6}$ → $u = 10 \frac{y^{1/6}}{0.002^{1/6}}$ مشتقة ⇒ $\frac{10}{0.002^{1/6}} . \frac{1}{6} . y^{-5/6}$

a = 10 m/s , b = 2mm

$\tau|_{y=1mm} = ??$

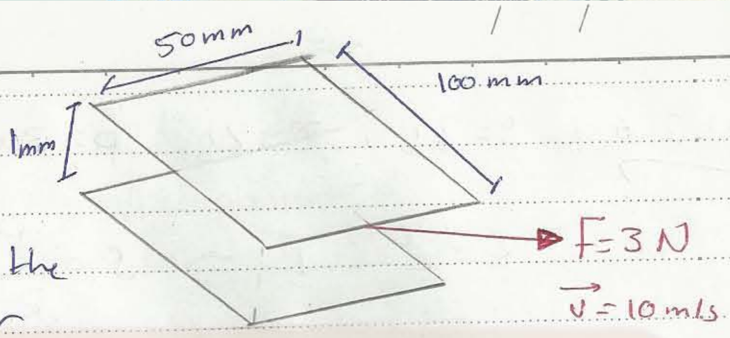
$\tau = \frac{M du}{d\ dy} = M \left[\frac{10}{6.0.002^{1/6}} (y^{-5/6})\right]$

$= 1.0 \times 10^{-3} \left[\frac{10}{6.0.002^{1/6}} y^{-5/6}\right]$

$= 1.48483$

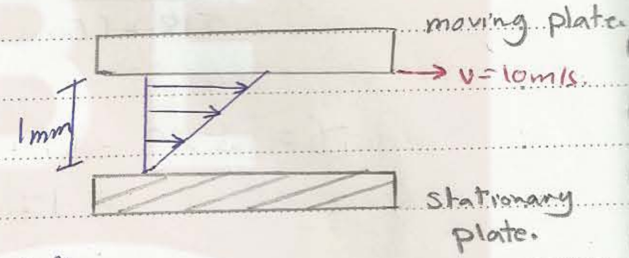
9th

P. 2.33



what is the viscosity of the Fluid? assume that a linear disterbution.

$$\tau = \mu \frac{du}{dy}$$



For linear Relationship.

$$\frac{du}{dy} \simeq \frac{\Delta v}{\Delta y} = \frac{10}{0.001} = 10\,000$$

$$\tau = FA = \mu \frac{\Delta v}{\Delta y}$$

$$\mu = \frac{F.A}{\frac{\Delta v}{\Delta y}} = \frac{(3)(0.1 * 0.05)}{10\,000} = 1.5 * 10^{-6}$$

محاضرة [٥]

→ Fluid static   14 / June / 2012 Thurs.

CH.3

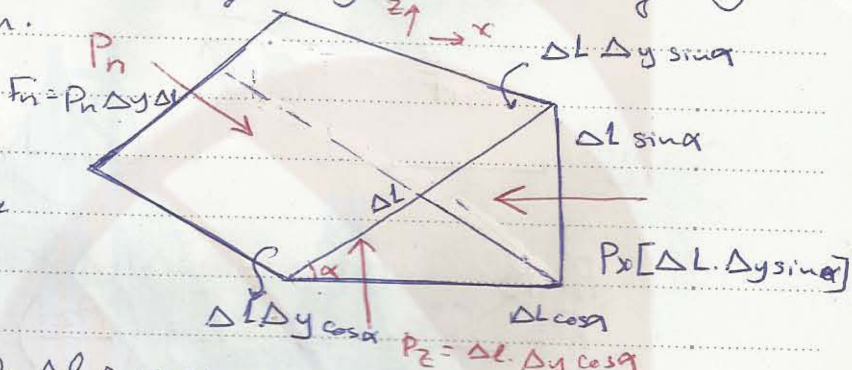
① only Fluids with velosity gradiant preduse shearing forces.

② only Fluid with at rest only normal forses exist
the normal force in Fluids is called pressure force

pressure :- force per unit area.

$$P = \lim_{\Delta A \to \delta_A} \frac{\Delta F}{\Delta A} = \frac{dF}{dA}$$ ← normal component of the force.

→ pressure intensity is ascaler guntity and act equally in all direction.



* For equilibrium in the x-direction

$\Sigma F_x = 0.0$

$P_n \Delta y . \Delta l \sin\alpha - P_x \Delta l \Delta y . \sin\alpha = 0.0$

$P_n = P_x$

* For equilibrium in the z direction.

$\Sigma F_z = 0.0$

$P_z \Delta l . \Delta y \cos\alpha - P_n \Delta l . \Delta y \cos\alpha -$
$\gamma(\frac{1}{2} \Delta l \cos\alpha . \Delta l . \sin\alpha) . \Delta y = 0.0$

$P_z = P_n$

$w = mg$
$= \rho . v . g$
$= \gamma . v$
$= \gamma(\frac{1}{2} \Delta l . \cos\alpha . \Delta l . \sin\alpha) \Delta y$

$$\frac{dp}{dz} = -\gamma$$

For uniform density Fluids

$\rho =$ constant throughout the Fluid

$\rho g = \gamma =$ constant

$$\frac{dp}{dz} = -\gamma \Rightarrow dp = -\gamma\, dt$$

$$p = -\gamma z + \text{const.}$$

$$p + \gamma z = \text{constant} \rightarrow \text{piezometric pressure.}$$

→ divided by γ

$$\frac{p}{\gamma} + z = \text{constant} = h$$

piezometric head (m)

this piezometric head is const. throughout a homogeneas.

→ if $\gamma \neq$ const.

$$\gamma = \rho g = \frac{P}{RT} g$$

$$\frac{dp}{dz} = \frac{-P}{RT} g$$

$$\frac{dP}{P} = -\frac{g}{RT} dz$$

$$\ln \frac{P_2}{P_1} = -\int \frac{g}{RT} dz$$

$$\ln \frac{P_2}{P_1} = -\frac{g}{RT_0} (z)$$

$$\frac{T_0}{T}$$

محاضرة [E.T]

17/ June/ 2012 Sun

Ch. 3 :- Fluid Statics.

→ pressure vairation with elevation

$$\frac{dp}{dz} = -\gamma$$

$$\frac{dp}{dl} = -\gamma \frac{dz}{dl}$$

incompressible fluid
$\rho =$ const.
$\gamma =$ const.

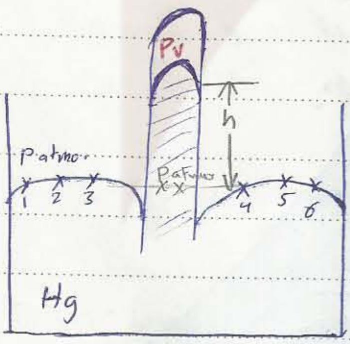
$p + \gamma z = p =$ const. = Piezometric pressure.

$\frac{N/m^2}{N/m^2}$ (m)

$\frac{p}{\gamma} + z =$ const. $= h =$ piezometric head.

* pressure measurment devices :- أجهزة قياس الضغط

→ Parameter :- ⇒ adevices that is used to measur the atmospheric pressure.



$$P_{atm} = P_v + \gamma_{Hg} \cdot h$$

↓
vapor pressure

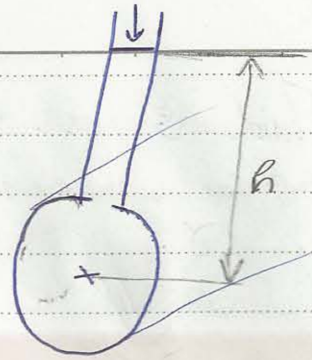
For mearcury (Hg)

$P_v = 0.000023$ PSI

$P_{atm} = 14.696$ psi

Vapor → هو الظروف التي تتحول عندها هو السائل الى الغاز

$$P_{atm} \simeq \gamma_{Hg} \cdot h$$

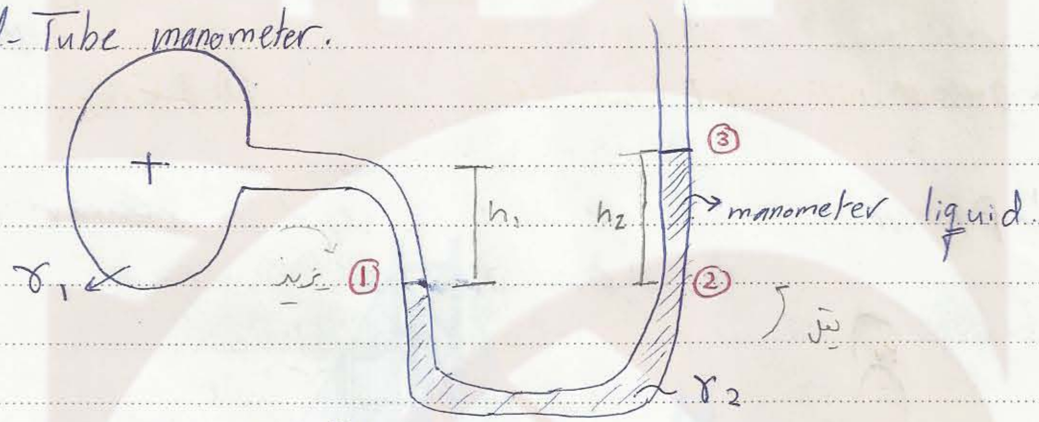


② Piezometer

$$p = \gamma_{fluid} \cdot h$$

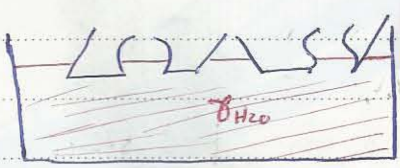
1. suitable for liquid only
2. not suitable for high pressure.
3. 〃 〃 〃 subatmospheric pressure.

③ U-Tube manometer.



$$P_A + \gamma_1 \cdot h_1 - \gamma_2 \cdot h_2 = 0$$

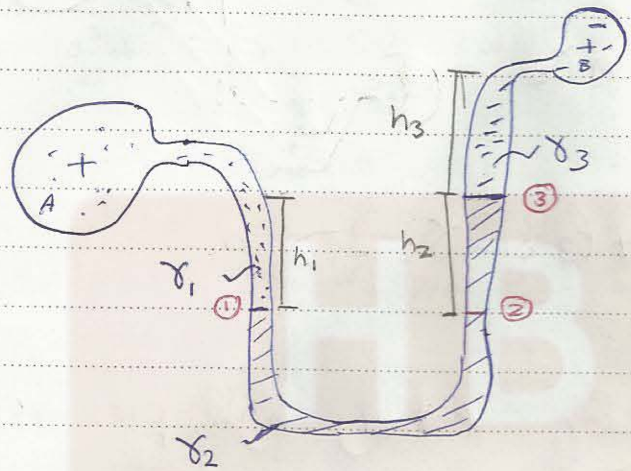
$$P_A = \gamma_2 \cdot h_2 - \gamma_1 \cdot h_1$$



→ here the pressure the same at all Point and only depends on depth.

ـ نفس الضغط عند المستوى الافقي الواحد

Differential U-tube manometer.



$$P_A + \gamma_1 h_1 - \gamma_2 h_2 - \gamma_3 h_3 = P_B \qquad (P_A - P_B)$$

$$P_A - P_B = \gamma_2 h_2 + \gamma_3 h_3 - \gamma_1 h_1$$

$$P_B + \gamma_3 h_3 + \gamma_2 h_2 + \gamma_1 h_1 = P_A$$

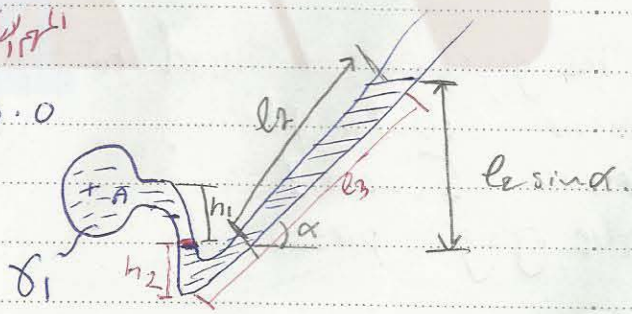
$$P_A - P_B = \gamma_2 h_2 + \gamma_3 h_3 - \gamma_1 h_1$$

⇒ Inclined monometer

المهم الارتفاع العمودي

$$P_A + \gamma_1 h_1 - \ell_2 \sin\alpha \, \gamma_2 = 0.0$$

$$P_A = \ell_2 \sin\alpha \, \gamma_2 - \gamma_1 h_1$$



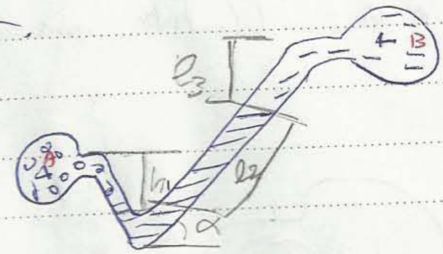
or

$$P_A + \gamma_1 h_1 + \gamma_2 h_2 - \ell_3 \sin\alpha \, \gamma_2 = 0.0$$

$$P_A = \ell_3 \sin\alpha \, \gamma_2 - \gamma_2 h_2 - \gamma_1 h_1$$

$$= (\ell_3 \sin\alpha - h_2)\, \gamma_2 - \gamma_1 h_1$$

⇒ Diff. Inclined manometer.



$$P_A + \gamma_1 h_1 - \ell_2 \cdot \sin\alpha\, \gamma_2 - \gamma_3 h_3 = P_B$$

$$P_A - P_B = \gamma_3 h_3 + \ell_2 \sin \gamma_2 - \gamma_1 h_1$$

→ manometer

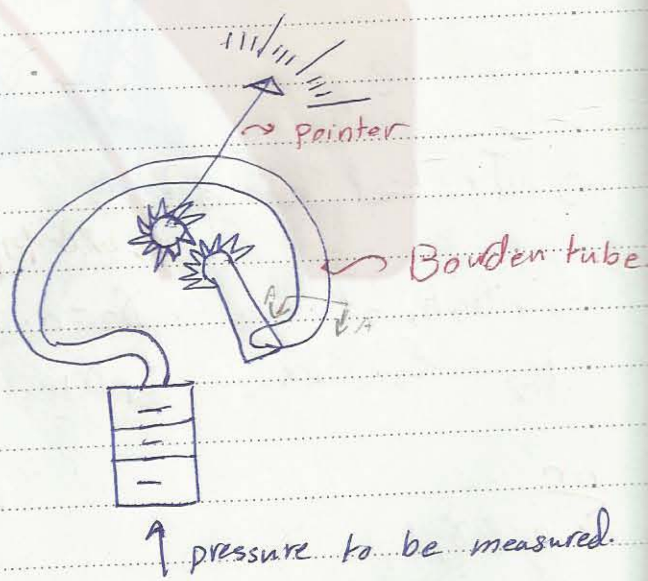
① is not suitable for relatively high pressure.

② is not suitable when there is variation in pressure.

③ Time consuming [not difficult to measure]

♡ pressure Transducers.

♡ Bourden gage



* this gage can be used to measure subatmospheric pressure [vacum] and +ve gage press.

[P > Patm]

محاضرة [V]

18/June 2012 mon

P. 3-11 $S.G_{oil} = ?$

$P_A + \gamma_{oil} * 1 = P_B$

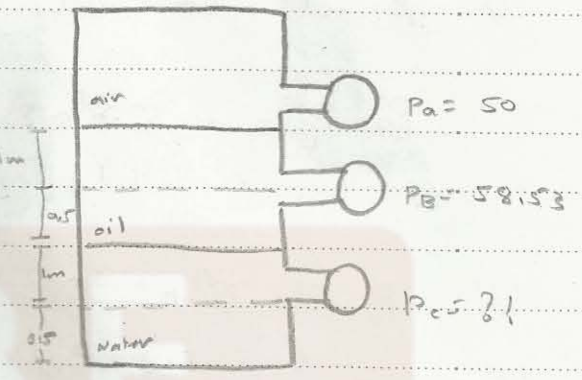
$50 * 10^3 + \gamma_{oil} * 1 = 58.53 * 10^3$

$\gamma_{oil} = 8.53 \ kN/m^3$

$P_B + 0.5 * \gamma_{oil} + \gamma_{wat} * 1 = P_C$

$58.53 * 10^3 + 0.5 * 8.53 * 10^3 + 9810 = P_C$

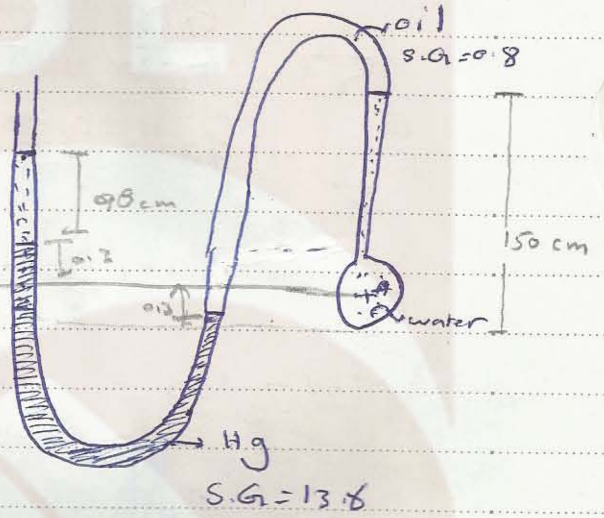
$P_C = 72.6 \ kpa$



P. 3-39

$P_A - 1.5(9810) + 1.8(0.8 * 9810)$
$-(13.6(9810) * 0.6) - 0.9(9810) = 0$

$P_A = 89.5 \ kpa$



eg. ① Determine the diff in pressure.
$P_A - P_B$

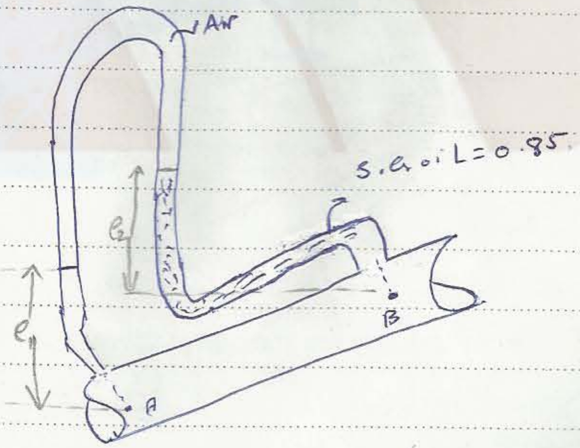
② the diff. in piezometric head.

$Z_A = 10 \ m$

$Z_B = 11 \ m$

$\ell_1 = 1 \ m$

$\ell_2 = 0.5 \ m$



① $P_B - \ell_2 \cdot \gamma_{oil} + \ell_1 \, \gamma_{oil} = P_A$

$$P_A - P_B = -0.5 * 0.85 (9810) + 1 * 0.85 * 9810$$
$$= 4.17 \text{ kpa.}$$

② $P_B - \ell_2 \cdot \gamma + \ell_1 \cdot \gamma = P_A$

$$\ell_1 = Z_B - Z_A$$

$$\frac{P_B}{\gamma} - \frac{\ell_2 \cdot \gamma}{\gamma} + \frac{(Z_B - Z_A) \cdot \gamma}{\gamma} = \frac{P_A}{\gamma}$$

$$\frac{P_A}{\gamma} + Z_B - \ell_2 - Z_A = \frac{P_A}{\gamma}$$

$$\frac{P_A}{\gamma} + Z_A - \left(\frac{P_B}{\gamma} + Z_B\right) = -\ell_2$$

$$h_A - h_B = -\ell_2$$
$$= -0.5 \text{ m.}$$

pezometric head

$p + \gamma z = \text{Con.}$

$\frac{p}{\gamma} + z = h = \text{piz.}$

$h_A - h_B$

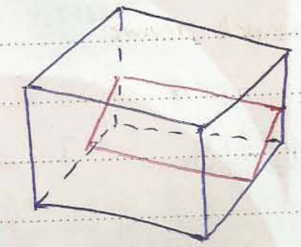
5-

♡ Hydrostatic force on plane surface.

→ Horizantal surface and surface that exposed to gas pressure essentially have anniform pressure disteribution, on the entire surface area.

Force = uniform pressure * area.

→ if aplane surface not horizantal and if it is acted on by ahydrostatic force such as that preduse by static fluid then the pressure is linearly dist. over the surface.



$$dF = P \cdot dA$$
$$= \gamma \cdot h \cdot dA$$
$$= \gamma \cdot y \cdot \sin\alpha \, dA$$

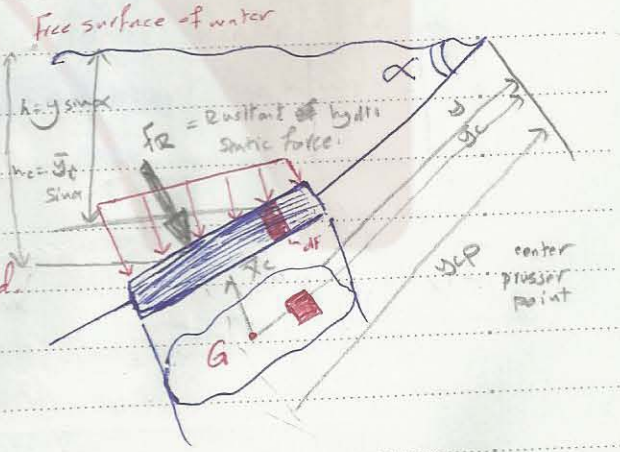
بالتكامل

$$F_R = \int dF = \int \gamma \, y \sin\alpha \, dA$$
$$= \gamma \sin\alpha \int y \cdot dA$$

First moment of area

$$\int y \cdot dA = \bar{y}_c \cdot A$$

y_c : y cordinate of the centroid.



$$\left[F_R = \gamma \sin\alpha \, \bar{y}_c \cdot A \right]$$

$$\left[= \gamma \cdot \bar{h}_c \cdot A \right] = \left[P_c \, A \right]$$

the last eqn. states that the hydrostatic force acting on an inclined plain is equal to the hydrostatic pressure at the centroid multiplied by the entir area.

moment about O:-

$$F_R \cdot y_{cp} = \int dF \cdot y$$

$$\gamma \, \bar{y}_o \sin\alpha \cdot A \cdot y_{cp} = \int \gamma \sin\alpha \, y \cdot dA \cdot y$$

$$\gamma \, \bar{y}_c \sin\alpha \cdot A \, y_{cp} = \gamma \sin\alpha \int y^2 \cdot dA$$

$$y_{cp} [\bar{y}_c \times A] = \int y^2 \cdot dA$$

→ second moment of area
moment of inertia. (I_o)

$$I_o = \bar{I}_c + \bar{y}_c^2 A \quad \text{parallel axis theorem.}$$

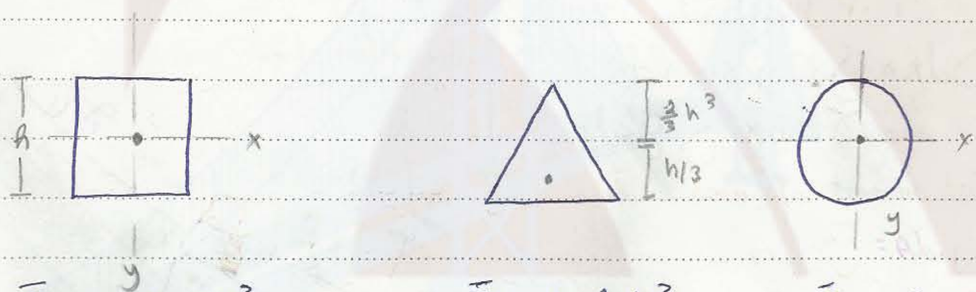
$$y_{cp} = \bar{y}_c + \frac{I}{\bar{y}_c \cdot A}$$

[A] girls — Quick revive.

$$F_R = P_c \cdot A = \gamma \cdot \bar{h}_c \cdot A = \gamma \cdot \bar{y}_c \cdot \sin\alpha \cdot A$$

$$y_{cp} = y_c + \frac{I}{\bar{y}_c \cdot A}$$

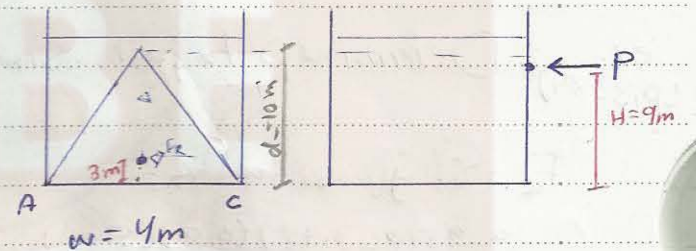
→ 2nd moment of area [moment of inertia]



$$\bar{I}_{xx} = \frac{1}{12} b h^3 \qquad \bar{I}_{xx} = \frac{1}{36} \cdot b \cdot h^3 \qquad \bar{I}_{xx} = I_{yy} = \frac{\pi}{4} R^4$$

ex. The triangular gate ABC is pivoted at the bottom edge AC and closes a triangular opening ABC in the wall of the tank
$w = 4m$, $H = 9m$, $d = 10m$:-
1) determine the hydrostatic F_R.
2) " " Force p required to hold gate closed.

$F_R = \bar{P}_c \cdot A$
$= \gamma_{H_2O} \cdot \bar{y}_c \cdot A$
$= 9810 (10-3) \frac{1}{2} (4*9)$
$= 1.236$ MN

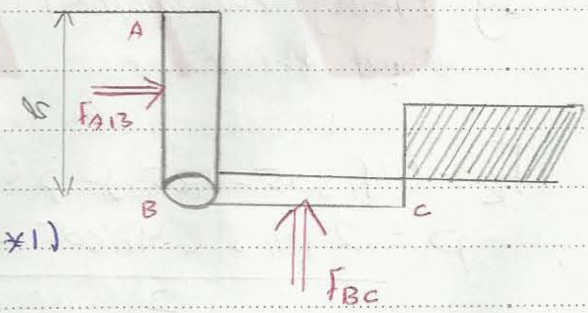


$y_{cp} = \bar{y}_c + \frac{I}{y_c \cdot A} = [10-3] + \frac{\frac{1}{36}(4)(9)^3}{7(\frac{1}{2})(4)(9)} = 7.643$ m.

By taking the moment about point A :-
$F_R [10-7] + P(9) = 0.0 \Rightarrow p = 323.69$ KN.

ex. the minimum water level in gate surface AB is 1 ft at what depth h will the gate automatically open? neglect the weight of gate, both AB, BC, point as a unit about the hinge B.

$F_{AB} = \gamma \cdot \bar{h}_c \cdot A$
$= \gamma \cdot (\frac{h}{2}) h(1)$ unit depth
$= \frac{1}{2} \gamma h^2$



$F_{BC} = \gamma \cdot \bar{h}_c \cdot A_{BC} = \gamma (h)(4*1)$
$= 4 \gamma h$

$y_{cp_{AB}} = \bar{y}_c + \frac{I}{\bar{y}_c \cdot A_{AB}} = \frac{h}{2} + \frac{\frac{1}{12}(1)(h^3)}{\frac{h}{2}(h)(1)}$

$= \frac{h}{2} + \frac{h}{6} = \frac{4h}{6} = 0.667 h$.

$\Sigma M_B = 0.0$

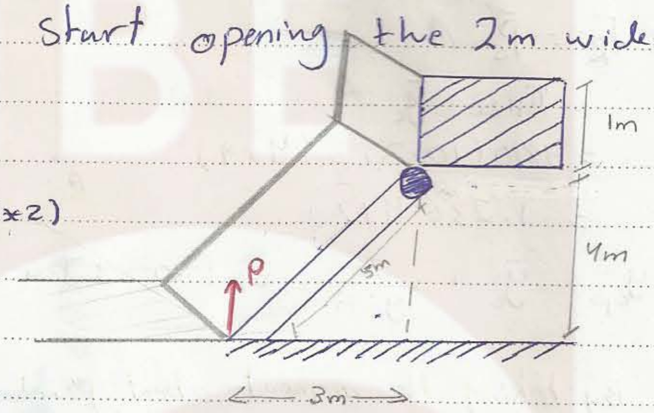
$-F_{AB}\,[h - 0.1667h] + F_{BC}\,[2] = 0.0$

$-\frac{1}{2}\gamma h^2 (0.333h) + 8\,h = 0.0$

$0.1667\,h^3 - 8h = 0.0$

So, $h = 0.0$ or $h = \sqrt{\frac{8}{0.1667}} = 6.93\ ft$

ex. (P.3-84) Determine p to just start opening the 2m wide gate.



$F_R = \gamma \cdot \bar{y}_c \cdot \sin\alpha \cdot A$

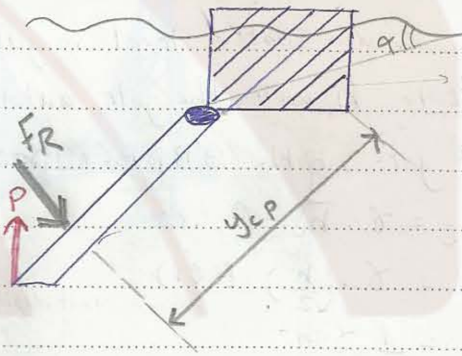
$= 9810(3.75)(0.8)(5*2)$

$= 294.3\ kN$

$y_{cp} = \bar{y}_c + \frac{I}{\bar{y}_c \cdot A}$

$= 3.75 + \frac{\frac{1}{12}(2)(5^3)}{(3.75)(2)(5)}$

$= 4.305\ m$



$1\ \sin\alpha = \frac{1}{0.8} = 1.25$

$\bar{y} = 1.25 + 2.5$

$= 3.75m$

By taking the moment about the hinge.

$F_R\,(4.305 - 1.25) - P(3) = 0.0$

$P = \frac{294.3\,(4.305 - 1.25)}{3} = 299.7\ kN$

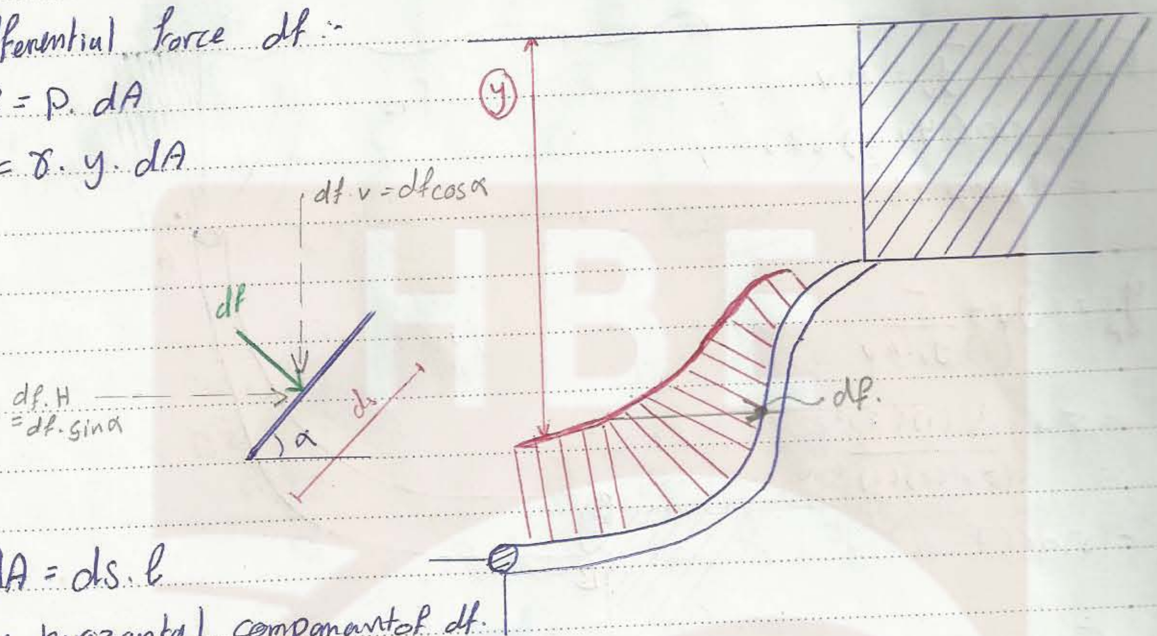
Hydrostatic force on curved surface.

depth of gate (ℓ)

differential force df :-

$df = P \cdot dA$

$= \gamma \cdot y \cdot dA$



$dA = ds \cdot \ell$

the horizantal componant of df.

$df_H = df \sin\alpha = \gamma \cdot y \cdot \ell \, ds \sin\alpha$

$= [\gamma \; y \cdot dA_v]$

$\int dF_H = F_H = \int \gamma \, y \, dA_v$

$= \gamma \int y \, dA_v = \gamma \cdot \bar{y}_v \, A_v$

this eqn. state that the horizantal componant of the hydrostatic force acting on a curved surface is equal to the pressure at the centroid of the vertical projection Area.

$$y_{cp} = \bar{y}_v + \frac{I}{\bar{y}_v \cdot A_v}$$

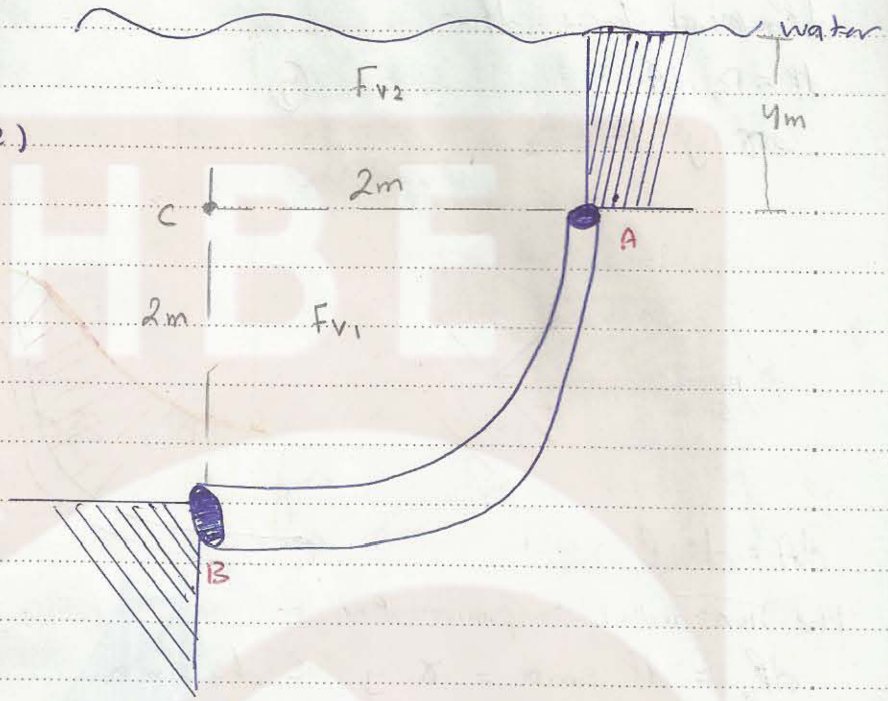
I → the second moment of Area for the vertical projection Area.

$\bar{y}_v$ → the y coordinate of the centroid of the vertical projection Area.

$dF_v = dF \cdot \cos\alpha$

$= \gamma \cdot y \cdot \ell \cdot ds \cos\alpha = \gamma \cdot d\forall$ → the volume of the liquid above the curve

ex. determine the component of the hydrostatic force acting on the gate AB.



$F_H = \gamma \cdot \bar{y}_v \cdot A_v$

$= 9810 \left(4 + \frac{2}{2}\right)(2)$

$= 98100$ N

$y_{cp} = \bar{y}_v + \frac{I}{y_v \cdot A_v}$

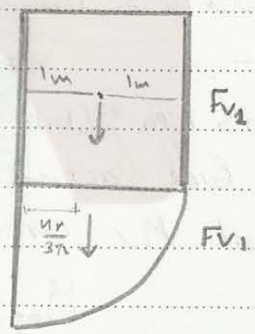
$= 5 + \frac{\frac{1}{12}(1)(2)^3}{5 * (2)(1)}$

نقطة تأثير المركبة الأفقية $= 5.0667$ m

$F_v = F_{v_1} + F_{v_2}$

$= \frac{\pi}{4} R^2 (1)(\gamma) + (R)(4)(1)(\gamma)$

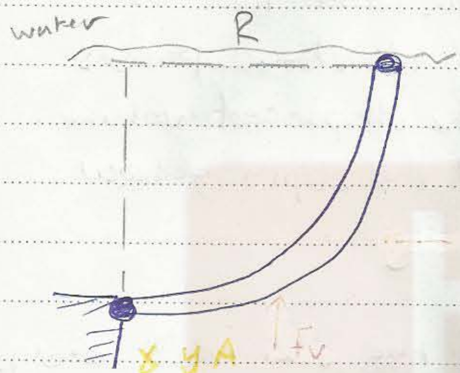
$= \frac{\pi}{4}(4)(9810) + 8(9810) = 109299$ N

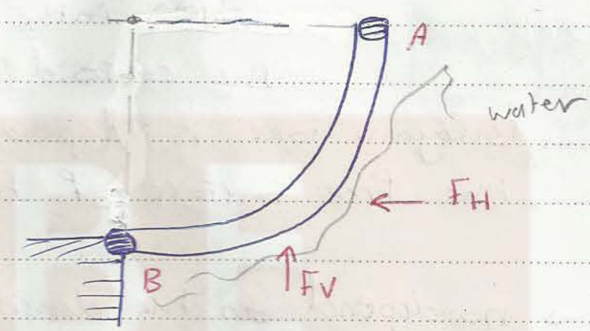


$109299\, x_{cp} = 78480(1) + 30819\left(\frac{4 * 2}{3\pi}\right)$

$x_{cp} = 0.96$

ex حيوه بدنا نشوف إنو اذا كان المائع داخل او خارج البوابة ايش بيأثر





$F_H = \gamma \frac{R}{2} . R . (1)$

$= \frac{1}{2} \gamma R^2$

$y_{cp} = \frac{R}{2} + \left(\frac{\frac{1}{12}(1)(R^3)}{\frac{12}{2}(R)} \right)$

$F_V =$ weight above the AB

$= \gamma \left(\frac{\pi}{4} R^2 \right)(1) = \frac{\pi}{4} \gamma R^2$

$F_H = \gamma \left(\frac{R}{2} \right)(R)(1)$

$= \frac{1}{2} \gamma R^2$

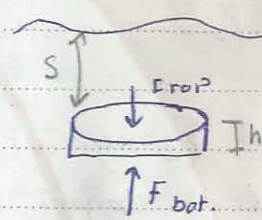
$F_V = \gamma . R . R . (1)$

$= \gamma R^2 - \gamma R^2 + \frac{1}{4} \pi R \gamma$

$= \frac{\pi}{4} \gamma R^2$

⇐ نفس الشيء بالمقدار (القوة العمودية و القوة الافقية)

* Buoyancy and Stability



Free surface area of Fluid

$F_{top} = \rho . g . SA$

$F_{bot} = \rho_F . g (S+h) A$

there is a net force in the upward direction

$F_B = F_B - F_{top}$

$= \rho_F \, g (S+h) A - \rho_f . g . SA$

$= \rho_f . g . hA = \gamma_{fluid} . \forall_{plate}$

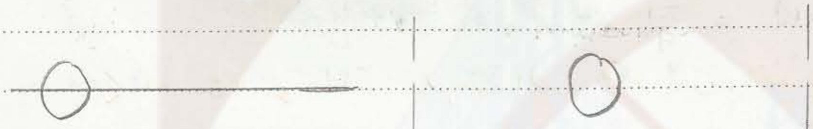
Buoyant Force: which is equal to the weight of the displaced volume and line of action in the upward direction passes the centroid of the displaced volume.

→ Buoyant Force: is independent of the depth below the free surface of the density.

→ no depend on the density of the immersed body.

* Archimedis principle.

the bouyant force acting on an immersed body is equal to the weight of displaced liquid, and it acts in the volume in the upward direction



Floating $\rho_b < \rho_f$ | Suspended $\rho_p = \rho_f$

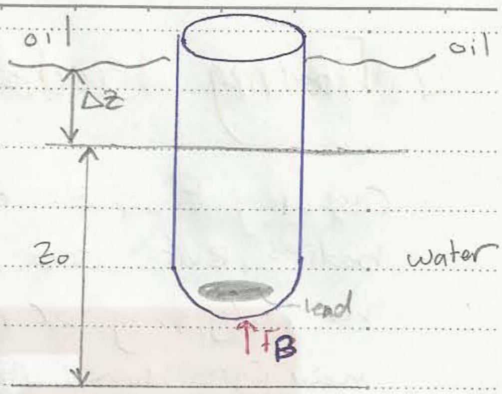
→ Buoyant F_B is a function of the fluid density (ρ) for gases the boyant force is expected to be small there for it may be neglected.

→ Hydrometer:-

a simple device that may be used to measure specific gravity of fluid.

$$S.G = \frac{\gamma_{fluid}}{\gamma_{H_2O}} = \frac{\rho_{Fl} \cdot g}{\rho_{H_2O} \cdot g} = \frac{\rho_{Fl}}{\rho_{H_2O}}$$

$W_{hydro} = F_B = \gamma_{H_2O} \cdot \forall$
$= \gamma_{H_2O} \cdot A \cdot Z_o$
$= \gamma_{H_2O} \cdot A \cdot Z_o$



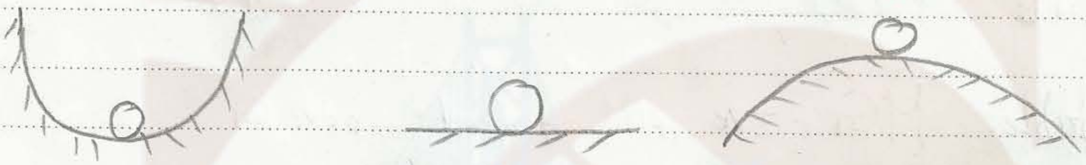
~ For oil ⇒

$W_{hy} = \gamma_{oil} \cdot A \, (Z_o + \Delta z)$
$= W_{hydro}$

$\gamma_{H_2O} \, A \cdot Z_o = \gamma_{oil} \cdot A \cdot (Z_o + \Delta z)$

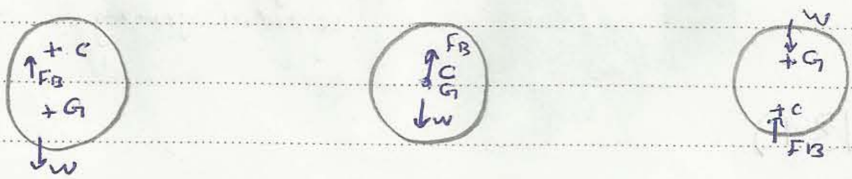
$S.G = \dfrac{\gamma_{fluid}}{\gamma_{H_2O}} = \dfrac{Z_o}{Z_o + \Delta z}$

* Stability of immersed and floating bodies.



Stable | neutral stable | unstable.

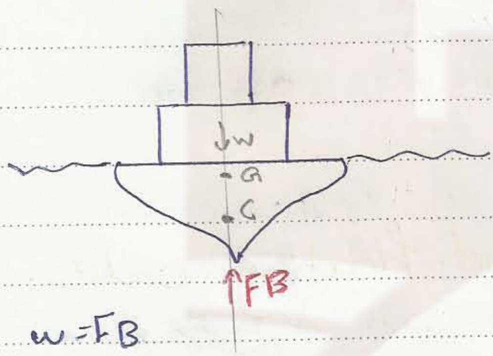
→ The stability of immersed and floating body depends on the position of C [center of the Buoyancy] and G [center of gravity.]



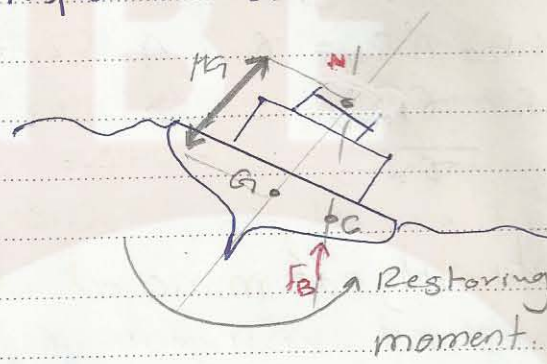
Stable. heavy bottom body [submarine] | neutral | unstable.

Floating Bodies:-

Case 1, case 2 are indentical to that for immersed bodies, But case 3 For floating body with G above C the body may or may be not stable depending on the new position of C respect to G.

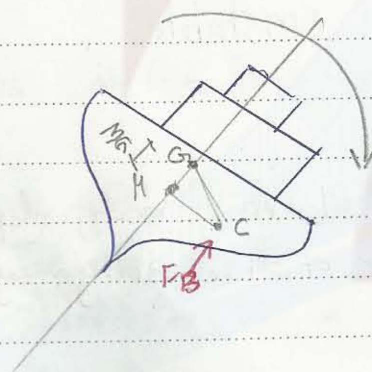


w = FB



M: meta center point of intersection of the line of action bought force before and after rotate.

Stable. MG : +ve , M located above G.



over turning moment

unstable , MG : −ve , M below G

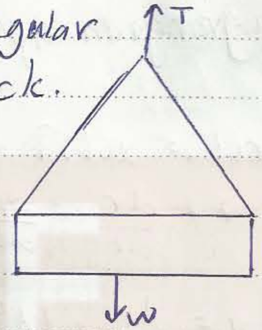
$$MG = \frac{I}{V_{dis}} - CG$$

CG: Distance between center of body and center of gravity.

p. (3-134)

24 / June / 2012 Sun

ex. a crane is used to lower weight into the sea [$\rho = 1025 \frac{kg}{m^3}$] for an underwater construction, determine the tension in the rope of the crane due to a rectangular (0.4 X 0.4 X 3) m, concrete block.

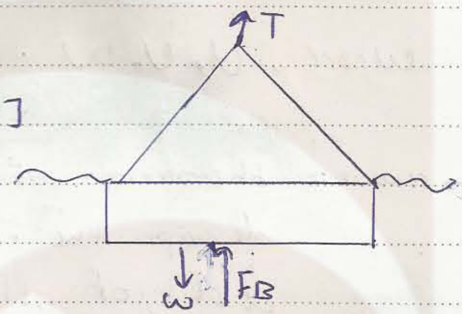


$\Sigma F = \text{zero}$ معلقة بالهوا

$T = W = mg$

$= 0.48 * 9.81 * 23000$

$= 10.18 \text{ kN}$



$\Sigma F = T + F_B - W = 0$

$T = W - F_B = 10.18 - [\gamma_{water} * 0.48]$

$= 5.9$

p. (3.13).

محاضرة [١٤]

25 / June / 2012 mon

CH(4) Fluid in motion

→ velocity , acceleration

CH.4

→ Lagrangran approach.

$$r(t) = x(t)\hat{i} + y(t)\hat{j} + z(t)\hat{k}$$

$$v = \frac{dr}{dt} = \frac{dx}{dt}\hat{i} + \frac{dy}{dt}\hat{j} + \frac{dz}{dt}\hat{k}$$

$$v = \frac{dr}{dt} = u\hat{i} + v\hat{j} + w\hat{k}$$

where, u, v, w component of the velocity.

→ remark:- the motion of one molecule is not adequate to descripe the flow, you have to find the velocity of all molecures, and to solve equation of motion ($\Sigma F = ma$)

→ Eulerian approach:-

$$u = f_1(x, y, z, t)$$
$$v = f_2(x, y, z, t)$$
$$w = f_3(x, y, z, t)$$

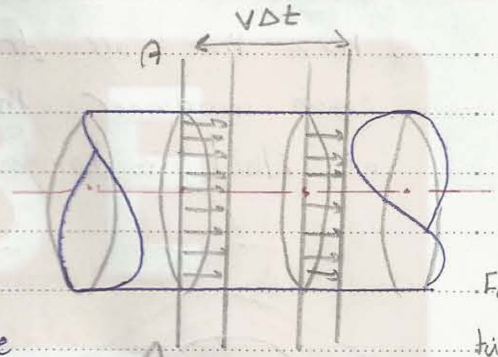
$$\vec{a} = a_x\hat{i} + a_y\hat{j} + a_z\hat{k} \qquad \rightsquigarrow a_x = \frac{dy}{dt}$$

$$a_x = \overset{u}{\frac{dx}{dt}}\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y}\overset{v}{\frac{\partial y}{\partial t}} + \frac{\partial u}{\partial z}\overset{w}{\frac{dz}{dt}}$$

* Rate of flow :-

the volume of fluid ΔV that pressure section ΔA during time interval.

$\Delta V = (V \Delta t) A$ → cross section area of the fluid passge.



For turbulent flow

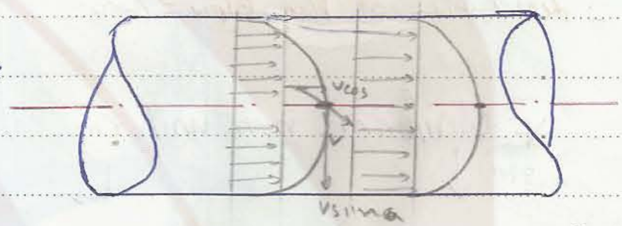
→ rate of flow volumetric flow rate

Discharge $Q = \frac{\Delta V}{\Delta t} = \frac{V \cancel{\Delta t} A}{\cancel{\Delta t}} = VA$

$Q = \frac{L}{T} * L^2 = \frac{L^3}{T}$ $\quad (\frac{m^3}{s}, \frac{ft^3}{s}, \frac{L^3}{s})$

in most cases velocity verise across the passege.

$Q = \int v \, dA$



For laminar flow

*acceleration :- the rate of change in fluid particles with respect to time.

In General :-

$Q = \int \bar{v} \cdot dA$

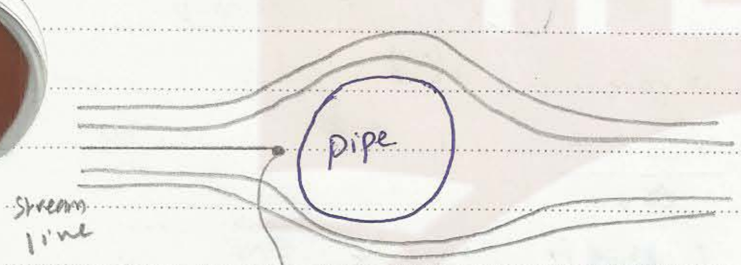
$\bar{V} \cdot A = \int v \cdot dA$

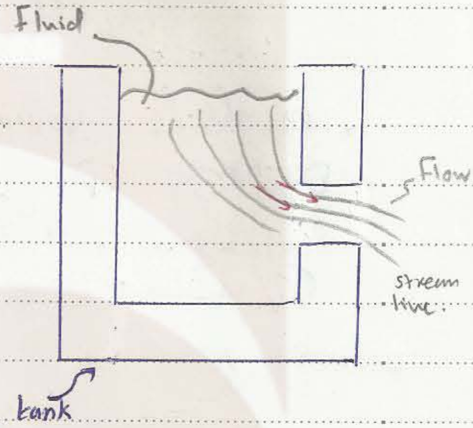
↳ average or mean velocity. $\quad \bar{V} = \frac{Q}{A} = \frac{\int v \, dA}{A}$

♡ Stream line and flow pattern:- عبارة عن خطوط موجودة في مجال التدفق تعين السرعة والاتجاه لـ التدفق الموجود.

→ Lines in flow filed to give information about speed and direction of the flow.

→ these line are drawn in the flow field in such amanner that velocity of each moleenle of fluid is tangent to the stream line of this point.





- this point called stagnation point.
- deceleration of the flow = Zero

* Uniform, non uniform flow:-

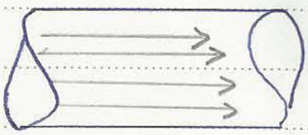
no convective acceleration

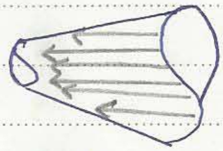
the velocity dosen't change from one point to another

$$\frac{dv}{ds} = 0$$

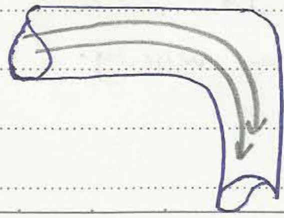
velocity change with space.

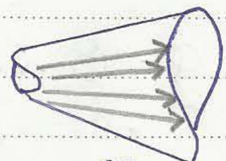
$$\frac{dv}{ds} \neq 0$$





nozzle





diffuser

* Steady and un Steady flow:-

no local acceleration

→ steady:- velocity dosent chang with respect to time. $\frac{dv}{dt} = 0$

→ non steady:- $\frac{dv}{dt} \neq 0$

* Lominar and Turbulent flow:-

→ turbulent:- mixing effect, eddy current and dominants.

→ lominar:- " " is negligible.

$$Re = \frac{\rho . V . d}{\mu}$$

Coefficient to distangish the fluid flow.

ρ:- density
V:- velocity
d:- diameter
μ:- dynamic viscocity

$Re < 2000$ → lominar flow

$Re > 2000$ → turbulent flow.

* Flow with respect to dimension:-

→ one dimensional flow. (flow in pipe)

→ Two " " (" between two Plate)

→ Three " "

* Flow with respect to boundary:-

→ Bounded flow.

→ semi-Bounded flow

→ Un bounded flow.

محاضرة [١٣]

ديناميكا * Tangental and normal Componant of acceleration *

$$V = v(s,t)$$

$$a_t = \frac{dv}{dt} = \frac{dv}{ds} \cdot \frac{ds}{dt} + \frac{dv}{dt} \cdot \frac{dt}{dt}$$

So ;

$$\boxed{a_t = \frac{\partial v}{\partial s} \cdot \frac{\partial s}{\partial t} + \frac{\partial v}{\partial t}}$$

$$\boxed{a_n = \frac{V_s^2}{r} \quad ; \ r := \text{radius of curveture}}$$

مهم ♡ Revive for Euler's approch

$$U = F_1(x, y, z, t)$$

$$a_x = \underbrace{U \cdot \frac{du}{dx} + V \cdot \frac{du}{dy} + w \frac{du}{dz}}_{} + \boxed{\frac{du}{dt}}$$

$$a_y = U \cdot \frac{dv}{dx} + V \cdot \frac{dv}{dy} + w \frac{dv}{dz} + \frac{dv}{dt}$$

$$a_z = U \cdot \frac{dw}{dx} + V \cdot \frac{dw}{dy} + w \cdot \frac{dw}{dz} + \frac{du}{dt}$$

Convective $\bar{a}$ with respect to space.

local $\bar{a}$ with respect to time

* Basic control Volume approach.

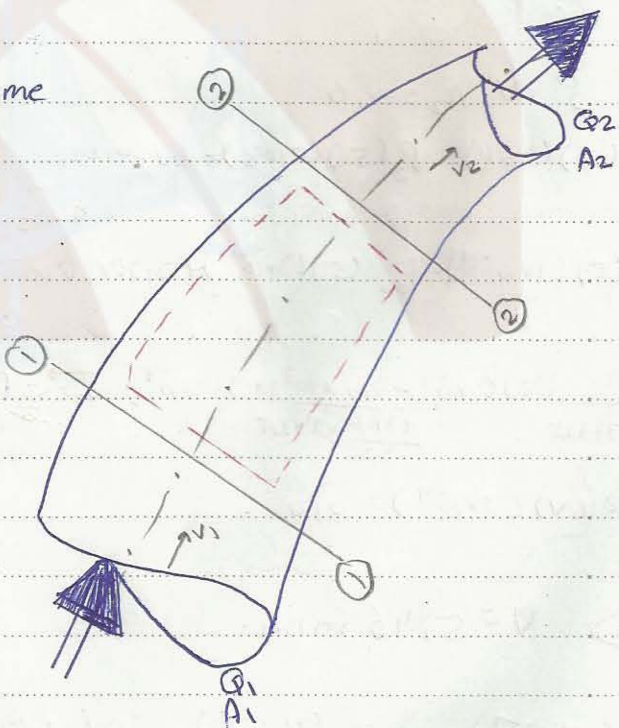
control volume maybe defined as aregion in space (contaning quantity of mater) to establishes to aid in solving flow problems.

The region is surrounding by surface which is Called control surface, this surface separates the control from surrounding.

(B) → Extensive property → depend on mass :- $\forall$, E β

(β) → Intensive property → indepdent of mass : T, ρ, V β

* considar the control volume



$$Q_1 = V_1 . A_1 = V_1 A_1 \cos\theta_1$$
$$= V_1 . A_1 \cos 180$$
$$Q_1 = - V_1 . A_1$$

$$Q_2 = V_2 . A_2 = V_2 . A_2 \cos 0$$
$$Q_2 = V_2 . A_2$$

$Flow_{out} - Flow_{in}$

$$V_2 . A_2 - V_1 . A_1 = \sum V . A$$

<u>ex.</u> the velocity field for fluid is given by

$$v = \underbrace{2x^2 t}_{u}\ \hat{i} + \underbrace{3xy^2}_{v} \cdot \hat{j} + \underbrace{2xz}_{w}\ \hat{k}$$

Find a_x at $(1,2,2)$ when $t = 1$ sec.

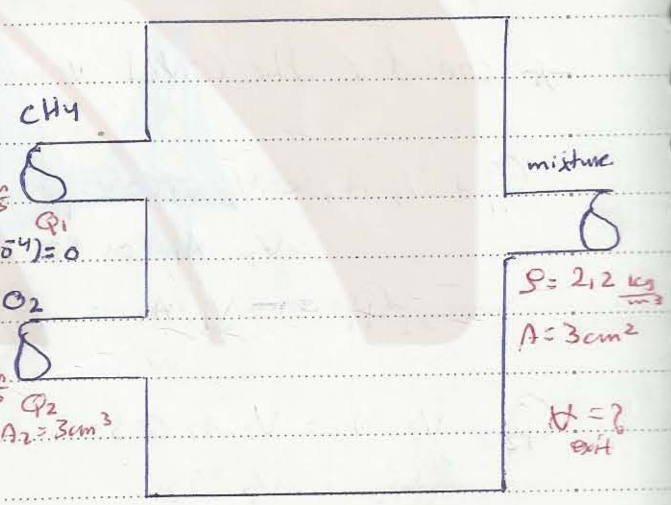
ع الجلاون $a_x = (2x^2)(4x)t^3 + 0\,(3xy^2) + 0\,(2xz) + (2x^2)$

$= 10\ m/s^2$

اجبار $a_y = 6x^2 \cdot y^2 \cdot t + 18\,(x^2)(y^3)$

اختيار $a_z = 2x^2 t \cdot (2z) + 0 + (2xz)(2x) + 0$

p(4,78) <u>ex.</u> Determine the exist velocity.



$\sum \rho \cdot V \cdot A_2 = 0.0$

$\frac{P}{RT} \sim \rho_1 (5)(0.01) + \rho_2 (5)(0.03) = 2.2 \cdot 0.03$

$-\rho_{CH_4} (5)(1\times10^{-4}) - \rho_{O_2} (5)(3\times10^{-4}) + 2.2(V)(3\times10^{-4}) = 0$

$-\frac{200\times10^3}{\frac{8314}{16}\times 373.15}(5)(1\times10^{-4}) - \frac{200\times10^3}{\frac{8314}{32}\times 373.15}(5)(3\times10^{-4})$

$+\ 2.2\,(V)(3\times10^{-4}) = 0.0$

$\Longrightarrow V = 5.46\ m/sec$

p(4,27) , p(4,46) , p(4,54)

Reynold's Transport therom.

$$\left.\frac{dB}{dt}\right|_{sys} = \frac{d}{dt}\int_{c.v} \rho.\beta.d\forall + \int_{c.s} \rho\beta v.dA$$

→ Continounty equation

$B = \text{mass} = m$, $\beta = \frac{B}{m} = \frac{m}{m} = 1$

$$\left.\frac{dm}{dt}\right|_{sys} = \frac{d}{dt}\int_{c.v} \rho(1).d\forall + \int_{c.s} \rho(1)\vec{V}.d\vec{A}$$

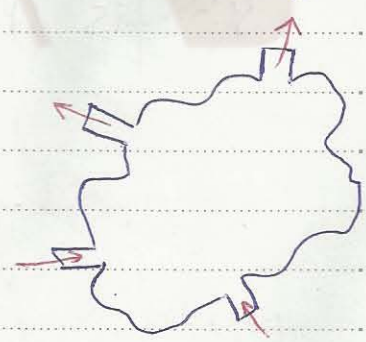
by definition the amount of matter in the system is cons.

$$\left.\frac{dm}{dt}\right|_{sys} = \text{Zero}.$$

$$\int_{c.s} \vec{V}.dA = -\frac{d}{dt}\int_{c.v} \rho.d\forall$$ ⇒ integral Form of continouty eqn.

→ For steady flow.

$\int_{c.s} \rho.\vec{V}.dA = 0$ خروج



→ For uniform velocity

$\Sigma\, \rho.\bar{V}.A = 0, 0$ دخول

حل أمثلة الاختبار
خلينا بكيرع شام بالبيان

* For one-dimentional $\overset{\text{steady}}{\text{fluid}}$:- $\rho \Rightarrow$ cons. incompressible

$$\Sigma \rho . V . A = 0.0$$

$\rho_1 = \rho_2 = \text{const.}$

$$\rho_1 . V_1 A_1 = \rho_2 . V_2 . A_2$$

$$V_1 A_1 = V_2 . A_2$$

$$Q_1 = Q_2$$

مهم p (4, 78)

مهم p (4, 82)

p (4, 85)

ex. (4, 8)

→ Reviwe:-

Continuity equation in the differintal form

$$\frac{\partial}{\partial x}(\rho u) + \frac{\partial}{\partial y}(\rho v) + \frac{\partial}{\partial z}(\rho w) + \frac{\partial \rho}{\partial t} = 0.0$$

where (u, v, w) the componant of the velocity in (x, y, z) respectively.

ρ:- is the density of fluid.

$$\vec{\nabla} = \frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}$$ → gradian

$$\frac{DZ}{Dt} = u\frac{\partial H}{\partial x} + v\frac{\partial H}{\partial y} + w\frac{\partial H}{\partial z} + \frac{\partial H}{\partial t}$$ → substantive derivation

$$\rho[\vec{\nabla} \cdot \vec{V}] + \frac{D\rho}{\Delta t} = 0.0$$

For steady state incompressible fluid:

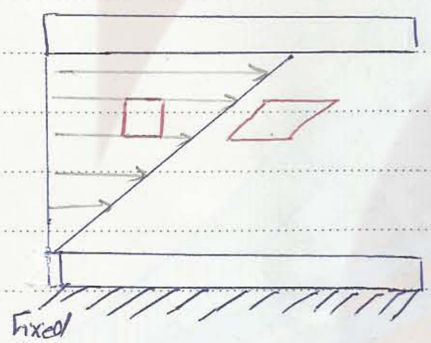
دائرة في الاتجاه

$\rho = \text{const} \Rightarrow \frac{\partial}{\partial t}(\text{any thing}) = \text{Zero}$

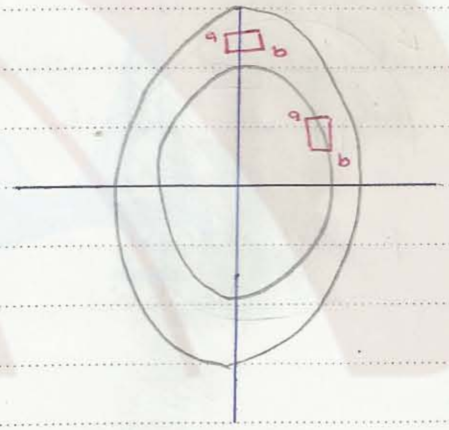
$$\nabla \cdot \bar{V} = 0.0 = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0.$$

دوران دوامات

Rotation and vorticity



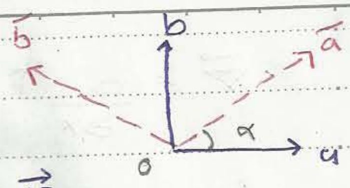
Deformation.



Rotation

The fluid Rotation $\bar{\omega}$, is avarge angular velocity of any two mutually perpendicular line element of the particles in each plane.

$$\vec{\omega} = \omega_x \hat{i} + \omega_y \hat{j} + \omega_z \hat{k}$$



$$\vec{\omega} = \frac{\vec{\omega}_{oa} + \vec{\omega}_{ob}}{2} = \frac{1}{2} \vec{\nabla} \times \vec{V}$$

$$= \frac{1}{2} \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ u & v & w \end{vmatrix}$$

$$= \frac{1}{2} \left(\hat{i} \left(\frac{\partial w}{\partial y} - \frac{\partial v}{\partial z} \right) - \hat{j} \left(\frac{\partial w}{\partial x} - \frac{\partial u}{\partial z} \right) + \hat{k} \left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} \right) \right)$$

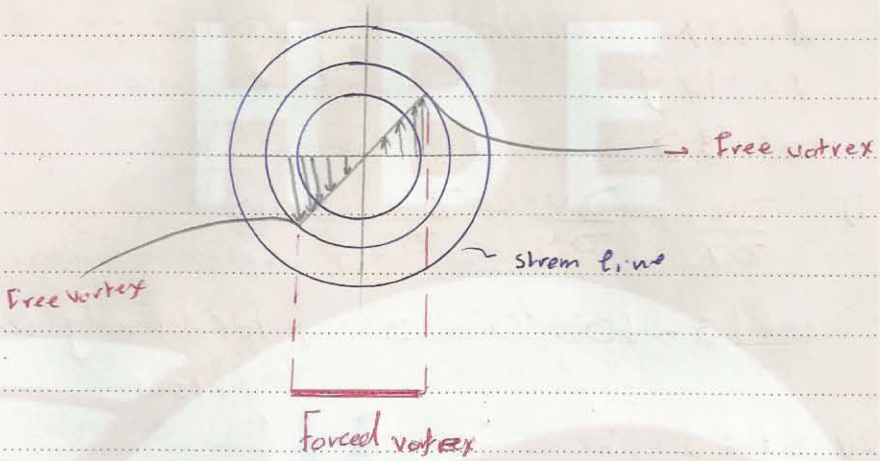
if $\bar{\omega} = 0.0 \rightarrow$ irrotational flow

$\bar{\omega} \neq 0.0 \rightarrow$ rotational flow

vorticity $= \underset{\text{curl}}{2\omega} = \nabla \times \bar{V}$

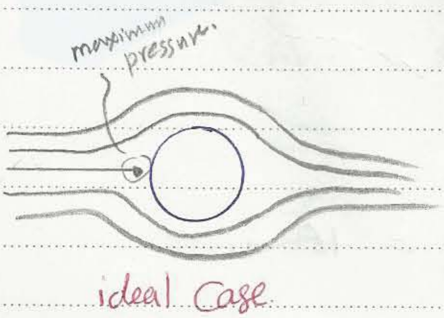
* (Vortex)

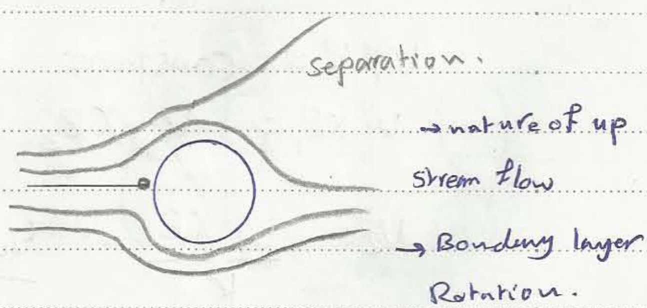
a flow for which a stream lines are concentric circles.



→ Forced Vortex :- is a vortex in which velocity is leanrly propotional to the distance from the center of the vortex.

→ Free vortex :- is a vector in which the product (V) velocity (R) radian is equal to Constant





ex. a flow is represented by the velocity field: $\bar{V} = 10x\hat{i} - 10y\hat{j} + 30\hat{k}$, Determine the field

1) possible incommpressible flow.
2) irrotational.

→ solution:–

$u = 10x$

$v = -10y$

$w = 30$

1) $\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0.0$

$10 - 10 + 0 = 0$, for steady incommprossible flow.

2) $$\omega = \frac{1}{2}\begin{vmatrix} i & j & k \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ 10x & -10y & 30 \end{vmatrix}$$

$= \frac{1}{2}\left[\hat{i}(0-0) - \hat{j}(0-0) + \hat{k}(0-0)\right] = 0$ → irrotational flow.

ex. a free vortex has a velocity of 40 m/sec. at R = 4 km from the vortex center find the velocity at 10 km from the center.

$V \times R =$ constant

$V_1 \times R_1 = V_2 \times R_2$

$V_2 = \frac{V_1 \times R_1}{R_2} = \frac{40 * 4000}{10000} = 16$ m/sec.

CH.5

* Pressure variation in flowing fluid.

→ pressure diffrance below and above the wing → lift force.
→ blood pressure is responsible on motion of blood.

* Basic causes for pressure variation :-

1) pressure vairation due to (gravity) → pressure vairation with elevation.

$$\frac{dp}{dz} = -\gamma$$

incommpressible flow

$$dP = -\gamma \, dz$$

$$p + \gamma z = p = \text{constant}.$$

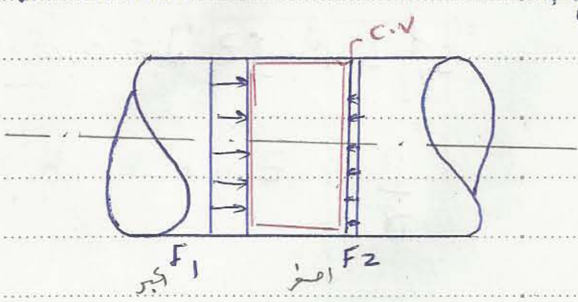
$$\frac{P}{\gamma} + z = h = \text{piezometric head}.$$

→ hydrostatic = no acceleration.

2) acceleration.
3) viscouse resistance.

→ To accelerate a fluid in acertian direction there most be a net force in that direction.

→ The pressure must be decrease in that direction of flow.

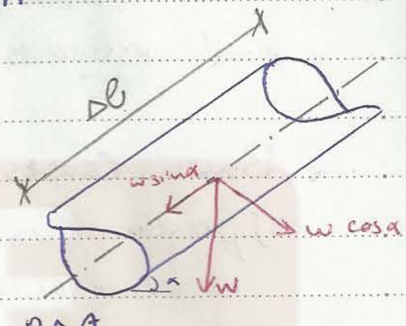


$F_1 = P_1 . A_1$ $F_2 = P_2 . A_2$

* Pressure vairation due to weight and acceleration.

$\Delta W = \gamma . \forall \quad , \quad W = \gamma \, \Delta L \, \Delta A$

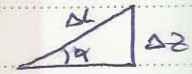
$\forall = \Delta l . \Delta A$



$\Sigma F_l = m a_l$

$P \, \Delta A - (p + \Delta p) \Delta A - \gamma \Delta L . \Delta A . \frac{\Delta z}{\Delta L} =$

$\underbrace{\rho \, \Delta A \; \Delta L}_{\rho . \forall} \, a_l$



$\sin\alpha = \frac{\Delta z}{\Delta L}$

$$\frac{-p}{\Delta L} - \gamma \frac{\Delta z}{\Delta l} = + \rho \, a_l$$

By taking the limit :-

$$\frac{-dp}{dl} - d \frac{\gamma \, \Delta z}{\Delta L} = \rho \, a_l$$

$$\frac{-d}{dl} [P + \gamma z] = \rho \, a_l \Rightarrow$$ Euler's equ. for Fluid in motion.

For acceleration.

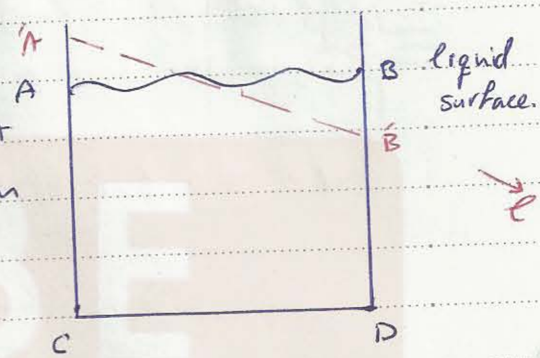
$$\frac{-d}{dL} [P + \gamma z] = 0.0 \Rightarrow P + \gamma z = \text{constant}.$$

$$\frac{P}{\gamma} + z = h.$$

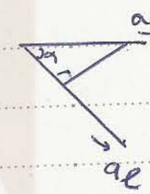
examples of pressure vairation resulting from acceleration.

→ Uniform liquid tank :-

to accelerate this tank of fluid in the x- direction there most be anet force in the x- direction



→ applying Euler's equ. along the line ÁB́ (ℓ- direction)



$$\frac{-d}{d}(P + \gamma Z) = \rho \cdot a_\ell$$

$$\frac{dP}{d\ell} = 0 \longrightarrow \frac{-d\,\gamma z}{d\ell} = \rho \cdot a_\ell = \rho\, a_x \cdot \cos\alpha$$

forr imcommpressible flud. ρ = cons. → γ = cons.

$$\frac{-dz}{d\ell} = \frac{a_x \cdot \cos\alpha}{g}$$

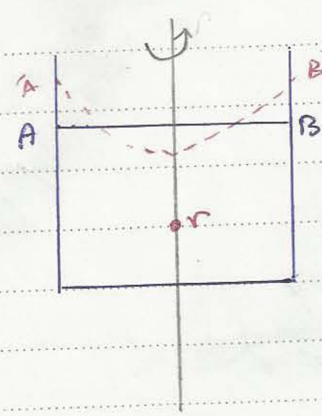
$$\sin\alpha = \frac{a_x}{g}\cos\alpha \implies \frac{\sin\alpha}{\cos\alpha} = \tan\alpha = \frac{a_x}{g}$$

→ Rotation of tank.

$a_r = \frac{V^2}{r}$

$v = r w$

$$\frac{-d}{dr}[P + \gamma z] = \rho\, a_r$$



$$\frac{\partial}{\partial r}[P + \gamma z] = \rho\,\frac{r^2 w^2}{r}$$

$$d[P + \gamma z] = \rho\,\frac{r^2 w^2}{r}\,dr$$

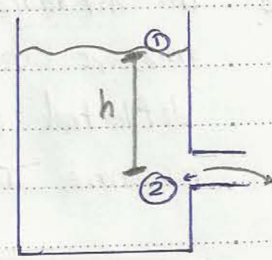
بعد اجراء التكامل

$$P + \gamma z = \frac{\rho r^2 w^2}{r} + C$$

$$p + \gamma z - \frac{1}{2}\rho r^2 w^2 = \text{cons.}$$

$$P_1 + \gamma z_1 - \frac{1}{2}\rho r_1^2 w_1^2 = P_2 + \gamma z_2 - \frac{1}{2}\rho r_2^2 w_2^2$$

ex Prove that $v = \sqrt{2gh}$ for the following.



$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2$$

0 gage pressure. atmospheric   0 (continuity eqn)   atmospheric

$$V_1 \cdot A_1 = V_2 \cdot A_2 \Rightarrow \frac{V_2^2}{2g} = Z_1 - Z_2 \qquad , Z_1 - Z_2 = h$$

$$\frac{V_2^2}{2g} = h \Rightarrow V_2 = \sqrt{2gh} \quad \#$$

ex what the pressure gradiant is required to accelerate water $\rho = 1000 \frac{kg}{m^3}$, in a horizontal pipe of Rate $6\ m/s^2$.

Using Euler's method (eqn):-

$$-\frac{\partial}{\partial t}(P + \gamma z) = \rho\, a_x$$

$$-\frac{\partial P}{\partial t} - \gamma \frac{\partial z}{\partial t} = \rho\, a_t$$

0 horizontal

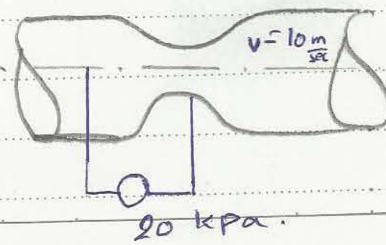
$$\frac{dp}{dt} = -1000\,(6) = -6000\ \frac{Pa}{m}.$$

P(5-59) ✓ , P(5-60)

ex $$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2$$

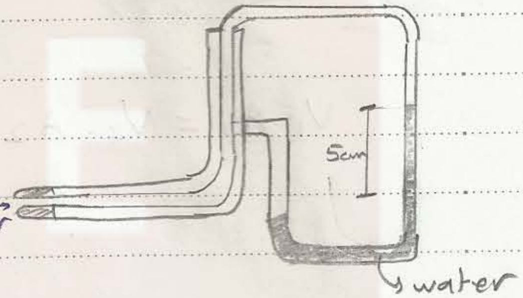
$$\frac{P_1 - P_2}{\gamma} = \frac{V_2^2 - V_1^2}{2g} \Rightarrow \frac{20 \times 10^3}{9810} = \frac{10^2 - V_1}{2 * 9.81}$$

$$V_1 = 7.11\ m/sec$$



$V_1 8$

ex. an air manometer is connected to a pitot tube used to measure velocity of the air if the manometer is deflected by (5 cm) what is the velocity, assume T= 290 k , p = 105 kpa



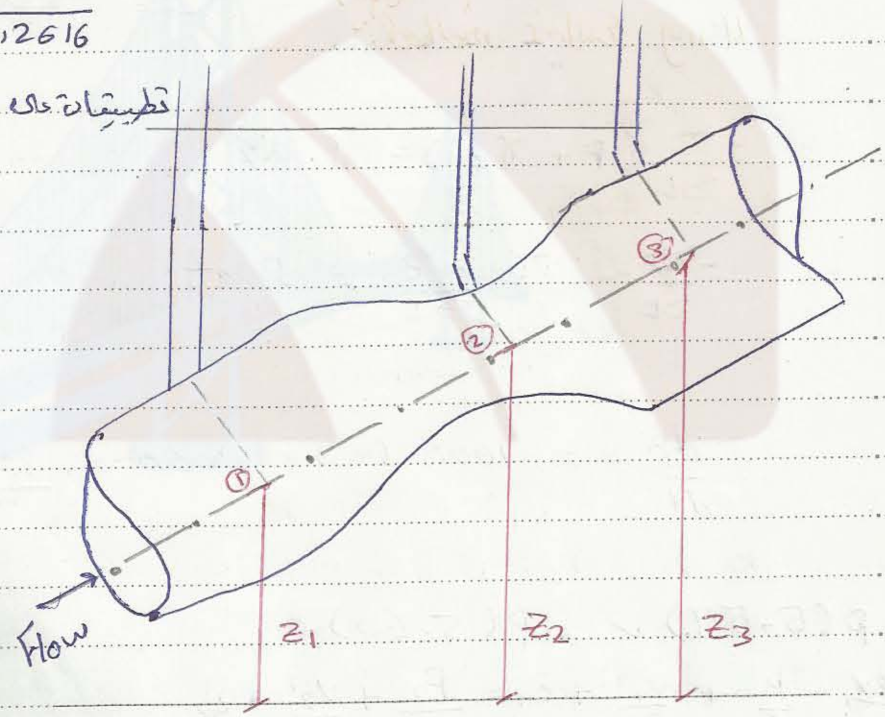
$$v = \sqrt{\frac{2\,\Delta P}{\rho}}$$

$$\Delta p = \gamma_{H_2O} * 0.05$$
$$= 9810 * 0.05 = 490.5\ Pa$$

$$\rho = \frac{P}{RT} = \frac{105 * 10^3}{287 * 290} = 1.2616$$

$$v = \sqrt{\frac{2\,(490.5)}{1.2616}} = 27.88\ m/sec.$$

→ تطبيقات على برنولي



$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2 = \frac{P_2}{\gamma} + \frac{V_3^2}{2g} + Z_3 \quad [m]$$

pressure head

velocity head

elevation head

الشروط:-
1) steady
2) incompressible
3) continuous
4) irrotational
5) no heat
6) no shaft
7) no vis cover

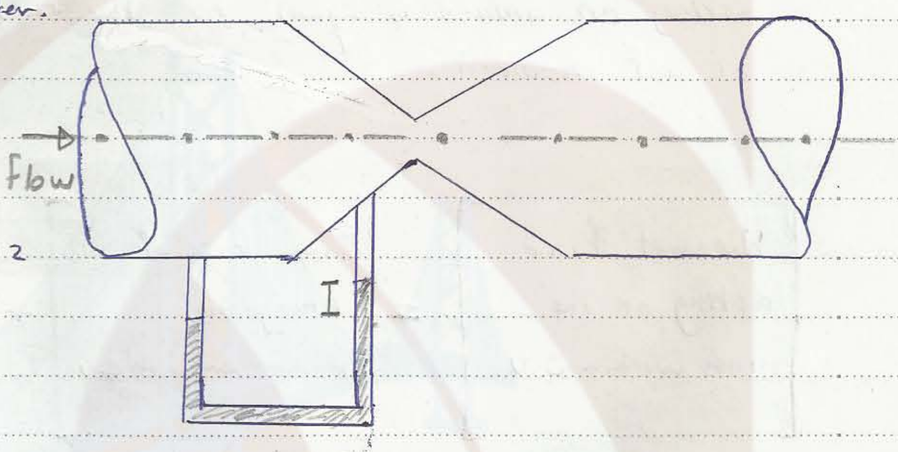
or

$$P_1 + \frac{1}{2}\rho V_1^2 + \gamma Z_1 = \text{constant.} \quad [pa]$$

*

ventari tube meter.

1) continuity eqn.



$m_1 = m_2$

$\rho_1 \cdot V_1 \cdot A_1 = \rho_2 \cdot V_2 \cdot A_2$

→ incompressible

$\rho_1 = \rho_2$

$V_1 A_1 = V_2 A_2 \rightarrow U_1 = \frac{V_2 \cdot A_2}{V_1}$

So, Bernoly eqn:

$$\frac{V_2^2}{2g} - \frac{V_1^2}{2g} = \frac{P_1 - P_2}{\gamma}$$

Momentum Principle

CH-6

B : extenssive property
β : intenssive property

$$B = \int \beta \, dm = \int \beta \rho \, d\forall \qquad \text{where} \quad B = m\bar{v}$$
$$\beta = \frac{m\bar{v}}{m} = \bar{v}$$

$$\Sigma F = \frac{d(m\bar{v})}{dt} = \frac{d}{dt}\int_{C.V} \rho V \, d\forall + \int_{C.S} \rho V \cdot V \, dA$$

→ Newton's second law :- the total summation of forces acting on amass is equal to the rate of change of act moment.

$$\begin{bmatrix} \text{the net force} \\ \text{acting on the} \\ \text{mass within C.V} \end{bmatrix} = \begin{bmatrix} \text{Time rate of} \\ \text{change on} \\ \text{momuntum with C.V} \end{bmatrix} + \begin{bmatrix} \text{net out flow} \\ \text{of momuntum} \\ \text{through the C.S} \end{bmatrix}$$

$$\Sigma F = \Sigma F_B + \Sigma F_s$$

body force: the force act through out the volume of the body [Gravitational and electromagnatic]

↳ surface force. : the force transmitted through the C.S
(1) Prussure force, (2) force transmitted through solid surface.

* For steady state condition.

$$\frac{d}{dt}\int_{C.V} \rho \, V \, d\forall = 0.0$$

$$\Sigma F = \int_{C.S} \rho . \bar{V} . \vec{V} . dA$$ → variable velocity distribution across the flow passage.

$$\Sigma F = \Sigma \rho \, \bar{V} . \vec{V} . A$$ → uniform velocity distribution

$$= \Sigma \, m_{out} V_{out} - \Sigma m_{in} V_{in}$$ across the flow passage.

* momentum eqn. in the cartesian coordinate system *

$$\Sigma F_x = \frac{d}{dt}\int_{C.V} \rho . V_x . d\forall + \int_{C.S} \rho . V . V . dA$$

$$\Sigma F_y = \frac{d}{dt}\int_{C.V} \rho . V_y . d\forall + \int_{C.S} \rho . V_y . V . dA$$

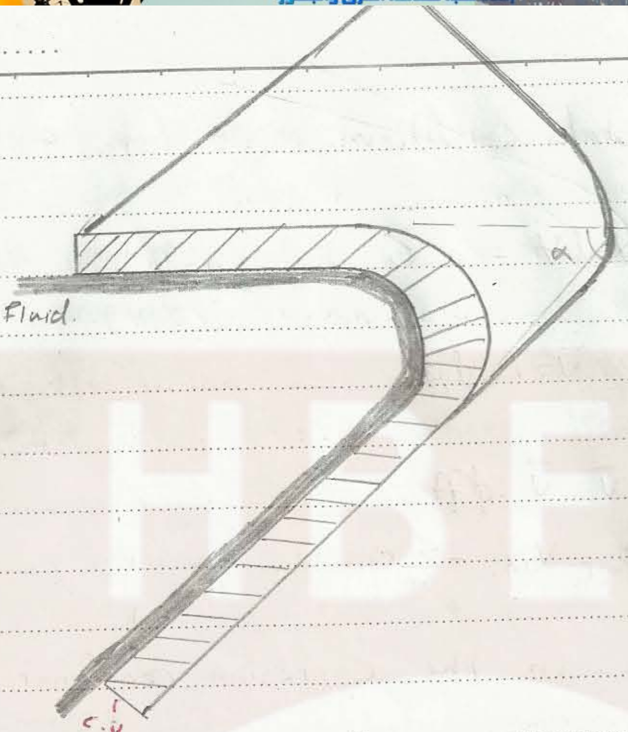
$$\Sigma F_z = \frac{d}{dt}\int_{C.V} \rho \, V_z . d\forall + \Sigma \, m_{out} . V_{out\,(z)} - \Sigma \, m_{in} \, V_{in\,(z)}.$$

* Jet Deflected aplate or Van

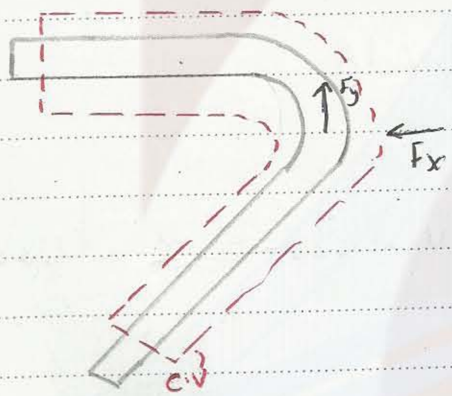
assumption :-

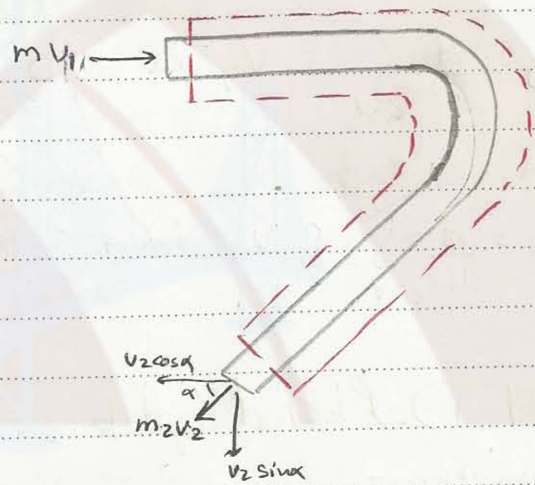
1) pressure of the stream (تدخل) entering the plate is equal to the stream pressure leaving it

2) the velocity of the jet is not appreciably changed.



اول خطوة هي وضع الاحداثيات





Force diagram.

Momentum Diagram

(x-momentum)

$$\Sigma F_x = \frac{d}{dt}\int_{c.v} \rho\, V_x\, dV + \Sigma \dot{m}_{out} \cdot V_{out(x)} - \Sigma \dot{m}_{in}\, V_{in(x)}$$

0 — Steady state condition

$-F_x = \dot{m}_{out} V_{out(x)} - \dot{m}_{in} V_{in}(x)$ $\quad \dot{m}_{in} = \dot{m}_{out} = \dot{m} = \rho Q$.

$= \rho Q [V_{out(x)} - V_{in}(x)]$

$+F_x = \rho Q [\cancel{+} V_2 \cos\alpha - V_1]$

$F_x = \rho Q [V_2 \cos\alpha + V_1]$

(y - momentum)

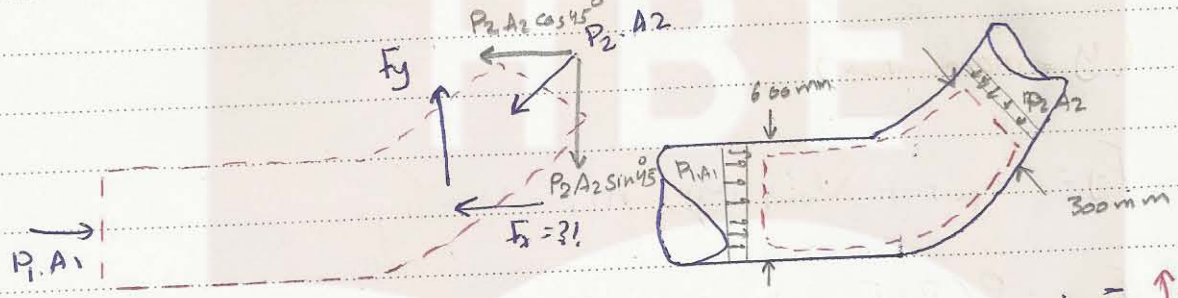
$F_y = \dot{m}_{out} + V_{out}(y) - \dot{m}_{in} \underbrace{V_{in}(y)}_{zero}$

$F_y = \rho Q [- V_2 \sin\alpha]$

So, the assumed direction not correct, so F_y is down ward direction

p(6-20)

ex A 45° reducing pipe-bend is a horizontal plane tapers from 600mm diameter at inlet to 300mm diameter at outlet the gage pressure at inlet is 140 kpa and the Rate of flow of (H_2O) through the bend $0.425 \frac{m^3}{sec}$ neglecting friction, calculate the Force acting by the water on the bend.



(x-momentum)

$$\Sigma F_x = \frac{d}{dt}\int_{c.v} \rho V_x \, d\forall + \Sigma \dot{m}_{out} V_{out(x)} - \Sigma \dot{m}_{in} . V_{in(x)}$$

0 steady state condition.

$\dot{m} = \rho Q = \dot{m}_{in} = \dot{m}_{out}$

$$P_1 . A_1 - P_2 . A_2 \cos 45 - F_x = \dot{m}_{out} . V_{2x} - \dot{m}_{in} V_{1x}$$

$$P_1 A_1 - P_2 . A_2 \cos 45 - F_x = \rho Q \, [V_2 \cos 45 - V_1] \quad \rightarrow (1)$$

$$V_1 = \frac{0.425}{(\frac{\pi}{4})(0.6)^2} = 1.5 \text{ m/sec.}$$

$$V_2 = \frac{0.425}{(\frac{\pi}{4})(0.3)^2} = 6 \text{ m/sec}$$

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + \cancel{Z_1} = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + \cancel{Z_2}$$

$\{Z_1, Z_2\}$ horizontal

$$\frac{140 * 10^3}{9810} + \frac{1.5^2}{19.62} = \frac{P_2}{9810} + \frac{6^2}{19.62}$$

$P_2 = 123.125$ kPa.

نعوض في المعادلة ①

$F_x = 32265$ N

(y-momentum)

$$-P_2 . A_2 . \sin 45° + F_y = m_{out} \sin 45° - \text{zero}$$

$$123.125 * 10^3 * 0.707 * \frac{\pi}{4}(0.3^2) - 1000 * 0.425 * 0.707 = F_y$$

$F_y = 6123.11$ N.

p (6.13) and p (6.26)