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ملخص

ميكانيكا الموائع

إعداد : معاذ النحوي

Ch 2
Fluid properties

الطالب : معاذ النحوي
اللجنة : Civilittee

① mass density :- (ρ)

$$\rho = \frac{mass}{volume} = \frac{m}{V} = \boxed{\frac{Kg}{m^3}}$$ الوحدة معة

② specific wight :- (γ)

$$\gamma = \frac{weight}{Volume} = \boxed{\frac{N}{m^3}}$$

$$\gamma \Rightarrow \frac{mass * g}{volume} = \rho * g$$

③ specific Gravity :- "Relative density"

$$S.G = \boxed{\frac{\gamma_{fluid}}{\gamma_{H_2O}}} \Rightarrow \frac{\rho_{fluid} * \cancel{g}}{\rho_{H_2O} * \cancel{g}} \Rightarrow \boxed{\frac{\rho_{fluid}}{\rho_{H_2O}}}$$

④ Ideal gas law *equation of state* :-

$$P V = n R_u T$$

$$P V = \frac{mass}{molar\ mass} R_u T$$

$$P = \frac{mass}{V} * \frac{R_u}{molar\ mass} * T$$

n :- number of moles = $\frac{mass}{molar\ mass}$

Ru :- universal gas constant = 8.314

T :- Temp.

P :- Pressure

$$\boxed{P = \rho * R * T} \quad ; \quad R = \frac{R_u}{M_w}$$

⑤ Specific Heat (c) :-
- → Const. Pressure
- → Const. Volume

- ability of fluid to store thermal energy.

(*) قدرة السائل على تخزين الطاقة الحرارية .

- amount of Heat required to raise the Temp. of unit mass by 1 degree.

(*) كمية الحرارة المطلوبة لرفع درجة حرارة كتلة واحدة بمقدار درجة.

Specific Heat Ratio $(K) = \frac{C_p}{C_v}$

Range $= C_p - C_v$

⑥ Internal energy :- (u)

(*) خاصية تعبر عن الطاقة داخل المادة المبنية على العلاقة الجزيئية.

Energy :-
- → Kinetic energy طاقة حركية
- → Potential energy طاقة ساكنة
- → atonic structure (internal energy)

⑦ Enthalpy (H) :- the combination $(u + P/\rho)$

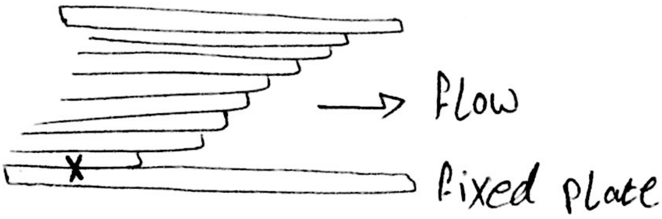
$$H = u + P\forall$$

⑧ viscosity :- " اللزوجة "

ability of fluid to resist deformation (flow) under shear stresses ; its depend on matter.

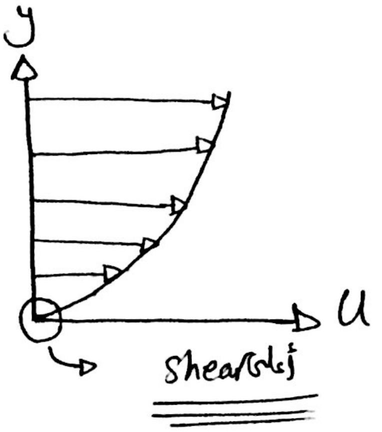
viscosity → Kintic viscosity ($\bar{\nu}$) {m^2/s} → مهم جداً

viscosity → dynamic viscosity (μ) {$Pa \cdot s$} → مهم جداً



المائع يتحرك على شكل طبقات .

أعلى قيمة shear عند $\boxed{X}$ وتقل عند الابتعاد عن النقطة .



y :- المسافة بين اللوحين

u :- السرعة على محور X

No slip condtion

تكون السرعة عندها ~ zero

(*) Newtonian and non-newtonian fluid :-

{1} Newtonian :- fluids for which the shear stress is directly propotional to the rate strain. ينطبق عليها قانون نيوتن

Ex:- water, air.

{2} Non-newtonian :- fluids for which the shear stress is not directly propotional to the rate strain.

Ex:- Paints, tooth past, catsup.

1 ⊛ viscosity equation :-

→ for liqiud :- $\mu = C e^{b/T}$, $\underline{\underline{C}}$, $\underline{\underline{b}}$ constant

→ for gas :-

⁎ used ⁎

$\bar{\nu} = \frac{\mu}{\rho}$

① $\frac{\mu}{\mu_0} = \left(\frac{T}{T_0}\right)^{3/2} \left(\frac{T_0 + S}{T + S}\right)$

② $\frac{\bar{\nu}}{\nu_0} = \frac{P_0}{P} \left[\frac{T}{T_0}\right]^{5/2} \left[\frac{T_0 + S}{T + S}\right]$

⊛ قيمة (μ_0) تحسب عند درجة حرارة (T_0) ⊛

Propلem:- $\underline{\underline{2-24}}$

The kinetic viscosity of metane @ ($15^\circ C$) [288 K] and 1 atm and atmosphric pressure is ($1.59 * 10^{-5}$) (m^2/s) using suther land equation and Ideal gas Law find the kinemetic @ ($200^\circ C$) and 2 atm pressure !!??

(S = 198 K). $\nu_0 = 1.59 * 10^{-5}$ $T_0 = 288 K$ $P_0 = 1 atm$

$\nu = ???$ $T = 473 K$ $P = 2 atm$

$$\frac{\bar{\nu}}{\bar{\nu}_0} = \frac{P_0}{P} \left[\frac{T}{T_0}\right]^{5/2} \left[\frac{T_0 + S}{T + S}\right]$$

$$\frac{\bar{\nu}}{1.59 * 10^{-5}} = \frac{1}{2} \left[\frac{473 K}{288 K}\right]^{5/2} \left[\frac{288 + 198}{473 + 198}\right]$$

Proplem:- 2.23 the dynamic viscosity of air @ (15°c) is ($1.78 * 10^{-5}$ N.s/m²), find the viscosity @ 100 c° ???

$\mu_o = 1.78 * 10^{-5}$ N.s/m²
$T_o = 15$°C, $T = 100$ C°, $S = 111$ K

$$\frac{\mu}{\mu_o} = \left(\frac{T}{T_o}\right)^{3/2} \left(\frac{T_o + S}{T + S}\right)$$

$$\frac{\mu}{1.78 * 10^{-5}} = \left(\frac{473}{288}\right)^{3/2} \left(\frac{288 + 111}{473 + 111}\right)$$

$$\mu = 2.56 * 10^{-5} \ N.s/m^2$$

Proplem:- 2.35 (نفس فكرة 2.37)

The velocity distribution for the flow of crode oil @ 310 K ($\mu = 383 * 10^{-5}$ N.s/m²) between two walls as shown given by $u = 100\ y\,(0,1 - y)$ m/s, y = 0,1m blot the velocity distribution and determine ((τ in walls))

$u = 100y(0,1 - y)$

$u = 100y * 0,1 - 100y^2$

$u = 10y - 100y^2$

$\frac{du}{dy}_{y \to 0} = 10 - 200y$

y = 0,1

$\tau = 383 * 10^{-5} * (10 - 20)$

$= -0,0383$ N/m²

y = 0 walls

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

$= 383 * 10^{-5} * 10 = +0,0383$ N/m²

⑨ Bulk Modulas of elasticity. (EV)

$$EV = \frac{-dp}{(dv/v)} = \frac{\text{change prussure}}{\text{fractional change in volume}}$$

Proplem 2.46

Calculate the pressure increse that must be applied to water to reduce its volume by 2 %, Ev = 2.2 GPa

$$Ev = \frac{-dp}{(dv/v)}$$

$$2.2\ GPa = \frac{-dp}{-2\%} \Rightarrow \boxed{dp = 22\ MPa}$$

Extra proplem:- Ch.2

4, 8, 10, 18, 33, 40, 46, 41, 49, 50, 63

fluid statics

((داخل الخنا ملق المحصورة))

gage

$P_{atm} = 101\ kPa \rightarrow P = 0\ Pa$ gage علان الارض

vaccume

$P = 0\ Pa$ abs الفتحر

$$P_{abs} = P_{atm} + P_{gage}$$

$$P_{abs} = P_{atm} - P_{vaccume}$$

* Hydraulic machines *

*Find F_1 and F_2 *

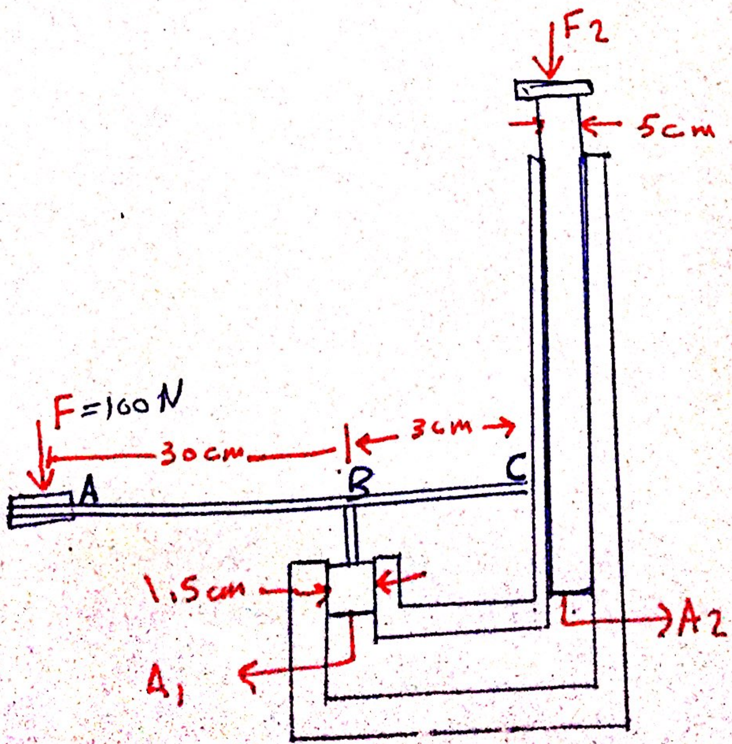
$P_1 = P_2$

$$\frac{F_1}{A_1} = \frac{F_2}{A_2} \Rightarrow \frac{1100\ N}{\frac{\pi}{4}(0.015)^2} = \frac{F_2}{\frac{\pi}{4}(0.05)^2} \Rightarrow \boxed{F_2 = 12.2\ KN}$$

* $\Sigma M_C = 0$

$100 * 0.33 - (0.03) F_1 = 0$

$$\boxed{F_1 = 1100\ N}$$



* Pressure variation with elevation

→ constant density (γ : const)

$\boxed{1}$ $\left[\underbrace{P}_{\text{static pressure}} + \underbrace{\gamma z}_{\text{elevation Presure}} = \underbrace{P_z}_{\text{Piezomatric Pressure}} \right] \Rightarrow$ constant

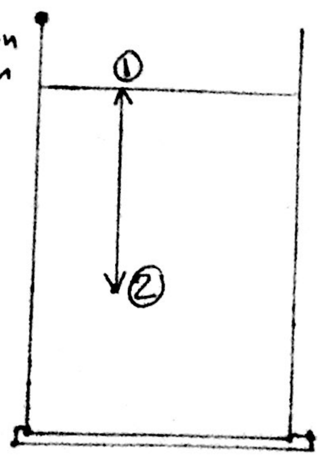
$\boxed{2}$ $\left[\frac{P_z}{\gamma} = \underbrace{\frac{P}{\gamma}}_{\text{Pressure head}} + \underbrace{z}_{\text{elevation head}} = \underbrace{h}_{\text{Piezomtric head}} \right]$

* Travels upword in $(+z)$ → (P) decrese ↓ يقل
* Travels down word in $(-z)$ → (P) increase ↑
* Travels horizonalplane ⇝ (P) constant

$\Rightarrow \left[P_1 + \gamma z_1 = P_2 + \gamma z_2 \right]$

Ex what is the Presure in adepth of (10m) in the tank :-

$P_1 = \text{Zero (gage)}(\underline{\text{or atm}})$ → لأنه مفتوح للهواء الجوي



$$\frac{P_1}{\gamma} + z_1 = \frac{P_2}{\gamma} + z_2$$

$$0 + 65 = \frac{P_2}{9810} + 55$$

$$P_2 = 98.1 \text{ KPa (gage)}$$

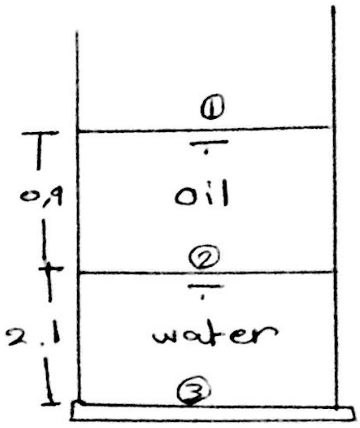
$\gamma_{water} = 9810 \ N/m^3$

Ex for the Tank shown, determine the Pressure at the bottom!!

$$\frac{P_1}{\gamma_{oil}} + z_1 = \frac{P_2}{\gamma_{oil}} + z_2$$

$$0 + 3 = \frac{P_2}{9810 * 0.8} + 2.1$$

$$\boxed{P_{2\,oil} = 7.063 \text{ kPa} = P_{2\,water}}$$



$\gamma_{water} = 9810 \text{ N/m}^3$

$S.G_{oil} = 0.8$

$$\frac{P_2}{\gamma_{water}} + z_2 = \frac{P_3}{\gamma_{water}} + z_3$$

$$\frac{7.063 \text{ kPa}}{9810} + 2.1 = \frac{P_3}{9810} + 0$$

$$\boxed{P_3 = 27.7 \text{ kPa}}$$

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* Pressure measurment devices:-

① Barometer:- Simple device that may be used to measure $\boxed{P_{atm}}$

Types:- ① mercury barometer.
② aneroid barometer.

② Piezometer:- measure $\boxed{\text{gage presure}}$

vertical Tube usually transparment شفاف

→ advantges:- ① simplicity ② direct measurment ③ accuracy

→ disadvantge:- ① Piezometer canot easily be used for mesuring presure in gas.
② limited to low Pressures

3 Bourdon - Tube Gage :- to masure Presore gage.

* advantge : 1 lowcost 2 reliable 3 easy to range

* disadvantges :- 1 dynamic pressure are deficoltte read

2 accuracy of the gage can be lower

4 manometer :* opten shaped like the letter "U"

* mesure Presure In flowing fluid.

5 Pressure Transducers :- device convert presore to electrical signal.

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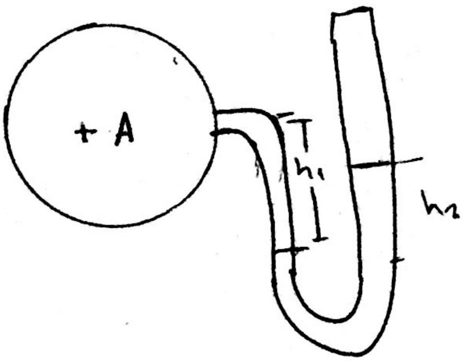
* manometer :-



$$P_A + \gamma h_1 - \gamma_2 h_2 = 0,0$$

عند الصعود الى الاعلى فإن الضغط يقل و نضع (-)

" النزول الى الاسفل فإن الضغط يزداد , نضع (+)

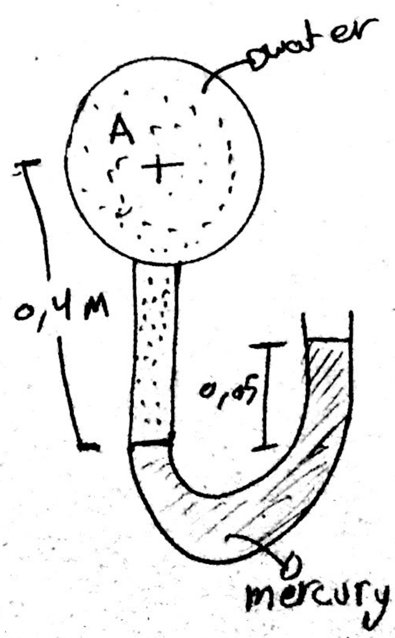
Proplem 3.31 Determine Presore in $\underline{A}$ (pipe center)

(S.G for mecury = 13.55), γ_{water} = 9810 N/m^3)

$$P_A + \cancel{\gamma}_{water} Z - \gamma_{mercury} Z = 0$$

$$P_A + (0,4 * 9810) - (9810 * 13.55 * 0,05) = 0$$

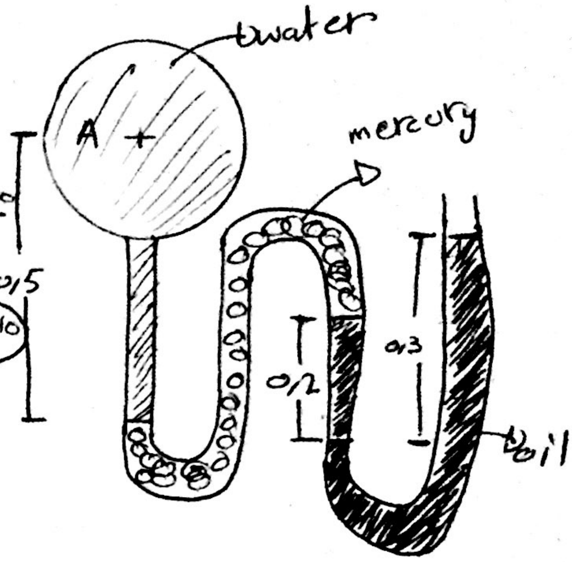
$$\boxed{P_A = 2722,2 \ Pa}$$



* example 8- Determine Pressure @ A (pipe center)

($S.G_{mercury} = 13.55$, 0.8_{oil}) $\gamma_{water} = 9810$

$$P_A + \gamma_{water} z_1 - \gamma_{mercury} z_2 + \gamma_{oil} z_3 - \gamma_{oil} z = 0$$



$$P_A + (9810 * 0,5) - (13.55 * 9810 * 0,2) + (0,2 * 0,8 * 9810)$$
$$- (0,3 * 0,8 * 9810) = 0$$

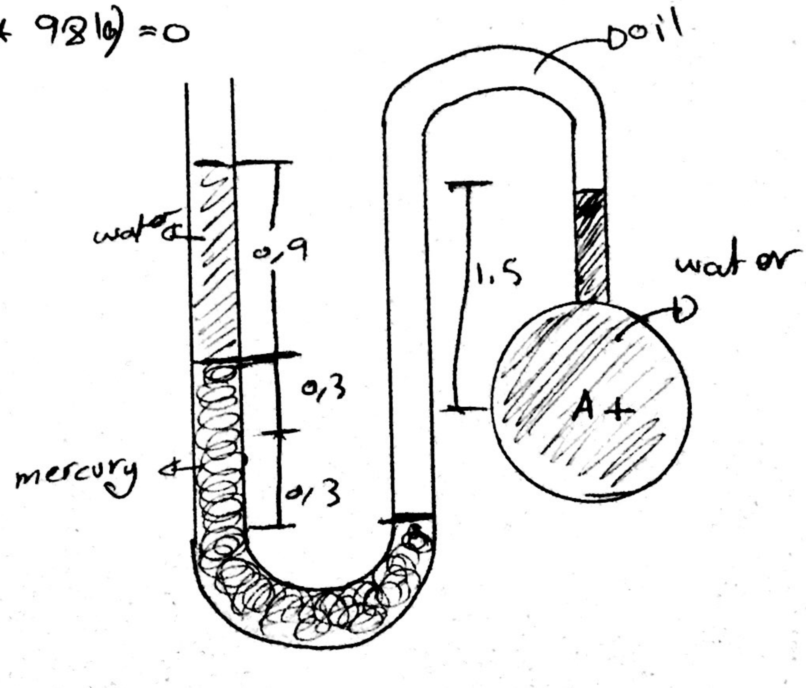
$$\boxed{P_A = 22,465 * 10^3 \; Pa}$$

* Problem 3.39 8- find Pressure @ the center of Pipe (A) ?!

($S.G_{oil} = 0,8$, $13,55_{mercury}$) $\gamma_{water} = 9810$

$$P_A - (1.5 * 9810) + (1.8 * 0,8 * 9810)$$
$$- (0,6 * 13,55 * 9810) - (0,9 * 9810) = 0$$

$$\boxed{P_A = 89172.9 \; Pa}$$

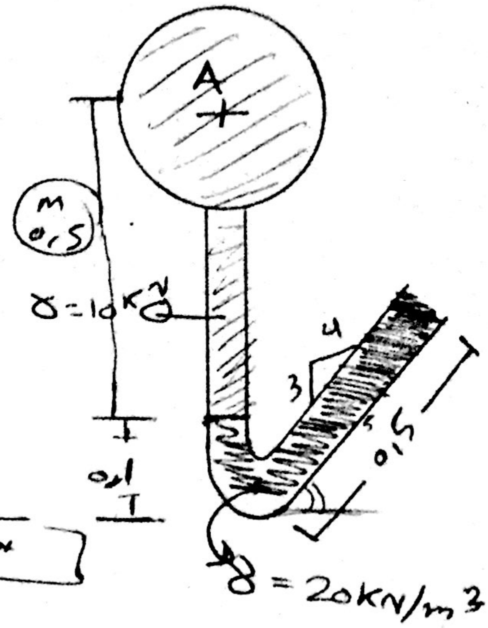


Proplem 3.33 g - what is the Presure @A ??

$$P_A + (0{,}5 * 10*10^3) + (0{,}1 * 20*10^3)$$

$$-\left(\frac{0{,}5}{5} *3 * 20*10^3\right) = 0$$

$$\boxed{P_A = -1000\ Pa}$$



* ملاحظة دائماً نستخدم الحافة العمودية لذلك حولنها على النسب الثلاثية

~~deflection manometer~~ * defrance Piezometric Prosure *

$$\left[P_{z_1} - P_{z_2} = (\gamma_B - \gamma_A)\,\Delta h \right]$$

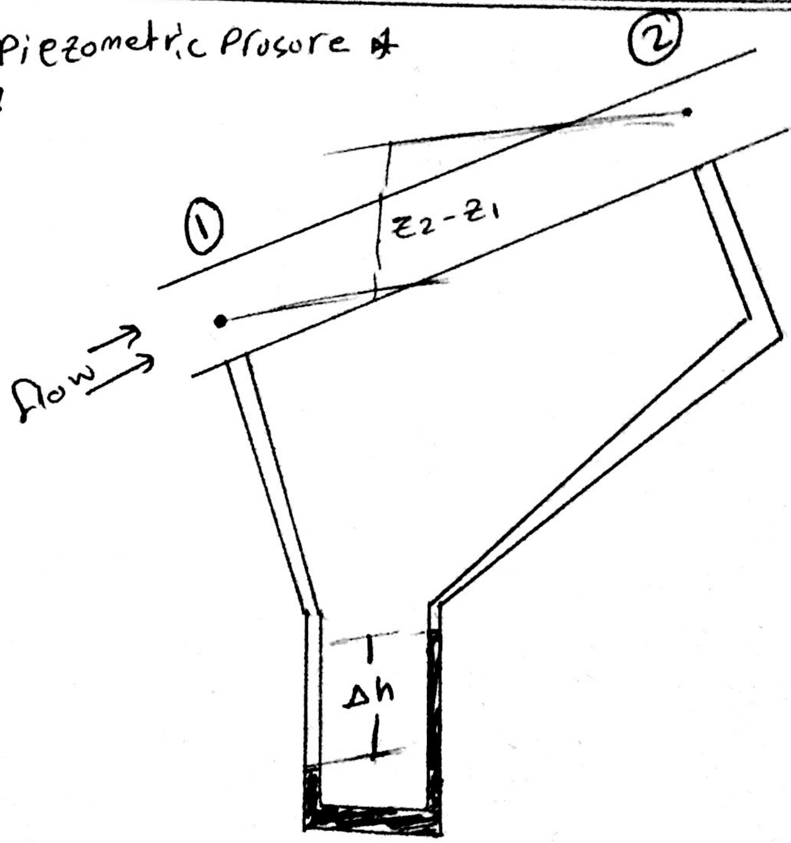
γ_B: له السائل في المانومتر

γ_A: له السائل في Pipe

Δh: defliction monmetr

* defrance Piezomtric head *

$$\left[h_1 - h_2 = \left(\frac{\gamma_B}{\gamma_A} - 1\right)\Delta h \right]$$



* Forces on plane surfaces (Panels)

→ $h = \bar{y} \sin\alpha$

→ $F_R = \bar{P} A$

→ $\bar{P} = \gamma \bar{y} \sin\alpha$

⇒ $\boxed{F = \gamma \bar{y} \sin\alpha \, A}$ → القوة المؤثرة على سطح البوابة

⇒ $\boxed{y_{cp} = \bar{y} + \dfrac{I}{\bar{y} A}}$ → المسافة بين سطح السائل ومركز تأثير القوة

* الية حل اسئلة البوابات :-

① حدد المسافة ($\bar{y}_c$) ... وهي المسافة من السطح السائل الى منتصف (centroid) البوابة

② من خلال ($\bar{y}_c$) احسب القوة الكاملة (F_R) من خلال $F_R = \gamma \bar{y}_c A \sin\alpha$

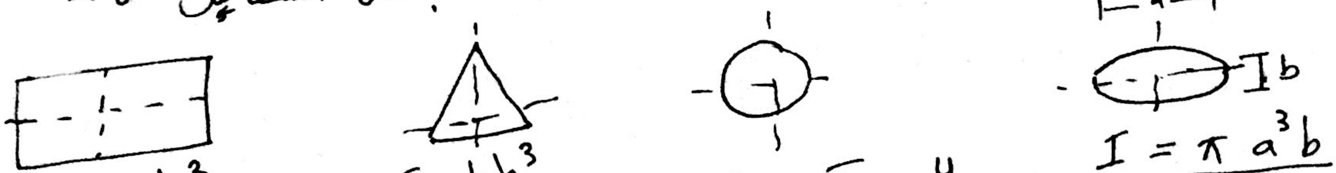
③ ثم احسب (y_{cp}) وهي مكان تأثير القوة ... من خلال

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

$\boxed{\text{ملاحظة *}}$ $y_c \neq y_{cp}$

* y_{cp} => مكان تأثير القوة * y_c منتصف البوابة

* بنسبة لـ (I) moment of Inertia نحسب مثل السابق :-



$I = \dfrac{bh^3}{12}$ $I = \dfrac{bh^3}{36}$ $I = \dfrac{\pi}{64} D^4$ $I = \dfrac{\pi a^3 b}{4}$

$A = \pi a b$

* example 3.10 : an elliptical gate covers the end of a pipe 4 m in diameter, if the gate is hinged at the top, what normal force required to open the gate when water is 8 m dee above the top of the pipe, Neglect the weight of gate!!

$\Rightarrow$ [illegible]

$\underline{d=4}$ $\underline{d=5}$

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

~~$\bar{y}_c$ (2.5 + 8 * cos 37)~~

$A = \pi ab = 3.14 * 2.5 * 2 = 15.71\ m^2$

$\bar{y}_c = 10 + 2.5 = 12.5$

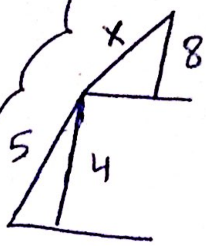
$\bar{y}_c \sin\alpha = 12.5 * \sin 53.1 = \boxed{10}$

* [illegible] *

$\boxed{h = \bar{y}_c \sin\alpha = 10}$

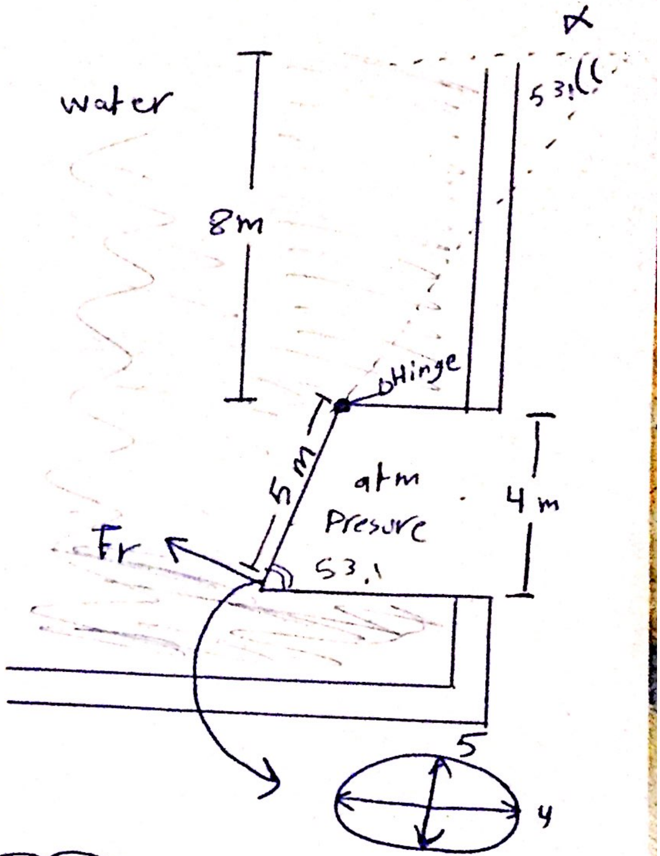
$F_R = 9810 * 10 * 15.71$

$\boxed{F_R = 154.1\ kN}$



$\frac{x}{8} = \frac{5}{4}$

$\boxed{x = 10}$



$y_{cp} = \bar{y}_c + \frac{I}{\bar{y}_c A} = 12.5 + \frac{24.54}{12.5 * 15.71}$

$I = \frac{\pi a^3 b}{4}$

$I = 24.54\ m^4$

$\boxed{y_{cP} = 12.65}$

$\bar{y}_{cP} - \bar{y}_c = 0.125$

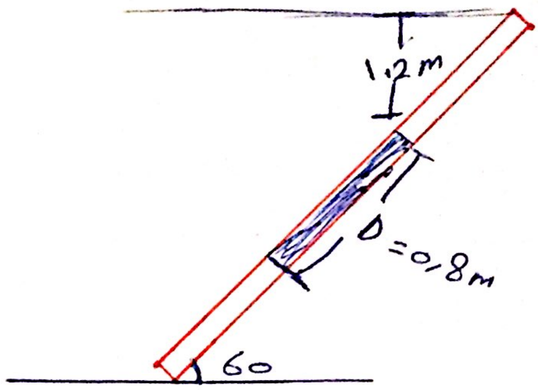
$\sum m_{Hinge} = 0$

$154.1 * 2.625 - F * 5 = 0$

$\boxed{F = 809\ kN}$

Proplem 3.58: as shown, around viewing window (Diameter = 0.8 m) is situated in alarge tank of seawater (S.G = 1.03), Find the hydrostatic force and locate it's line of action!

* Solution



$\bar{y}_c \sin\alpha = h = 1.2 + \left(\frac{0.8}{2}\sin 60\right)$

العمودي الارتفاع $= 1.546$ m

$\bar{y}_c = \frac{1.546}{\sin 60} = 1.786$ m

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

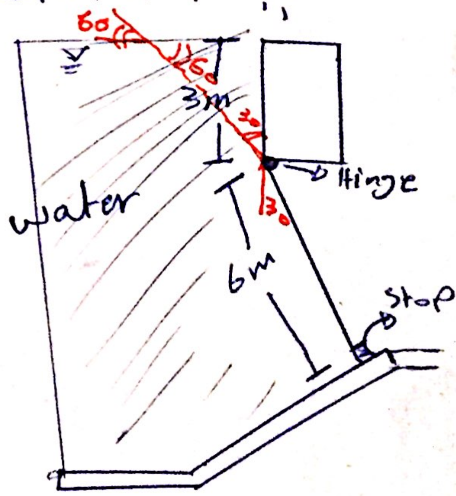
$= (1.03 * 9810)(1.546)\left(\frac{\pi}{4}(0.8)^2\right)$

$\boxed{F_R = 7.848 \text{ kN}}$

$\frac{\overline{y_{cp} - \bar{y}_c}}{b} = \frac{\pi (0.4)^4}{4 * 1.786 * \frac{\pi}{4} * (0.8^2)} = 0.022$ m

الشيء التي نزيدها
على نصف البوابة
لنعرف موقعها

Proplem 3.62 8- The gate shown is rectangular and dimensions (6m by 4m), what is the reaction @ Point A ??



$y_c \sin\alpha = h = 3 + 3\cos 30 = 5.598$ m.

$\bar{y}_c = \frac{5.598}{\sin 60} \Rightarrow \bar{y}_c = 6.464$

$F_R = 9810 * 5.598 * 6 * 4 = 1.318$ MN

$y_{cP} = y_c + \frac{I}{y_c A} = 6.464 + \frac{\frac{4 * 6^3}{12}}{6.464 * 6 * 4}$

$\boxed{y_{cP} = 6.928 \text{ m}}$

$\Sigma M_{stop} \Rightarrow (R_A * 6) - (1.318 * 10^6 * 2.536) = 0$

$\boxed{R_A = 557.07 \text{ kN}}$

* Force on curved surface.

$F_H = \bar{P} A$ → horizontal

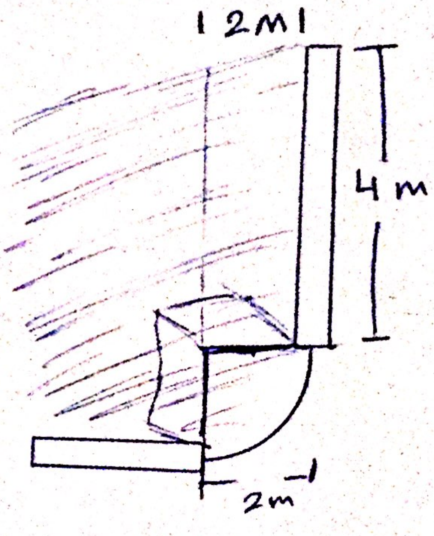
$F_V = W = \gamma \forall$

$F = \bar{P} A$

$\bar{P}$ → $P = \gamma h$

→ vertical

* <u>example 3.11</u> :- surface <u>AB</u> a circular arc with radius of (2 m) and ~~depth~~ a width of (1m) (into the paper), find the magnitude and line of action of the hydrostatic force acting on AB:



$\bar{y}_v = 4 + 1 = 5$

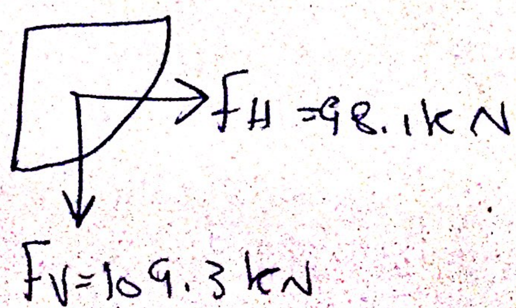
$F_H = \bar{P} A = \gamma h A = 9810 * 5 * 2 * 1 = 98.1 KN$

$y_{cp} = \bar{y}_v + \dfrac{I}{\bar{y}_v A} = 5 + \dfrac{\frac{1 * 2^3}{12}}{5 * 2 * 1} = 5.067 m$

$F_{V_1} = W = \gamma V = 9810 * \frac{1}{4} \pi (2)^2 * 1 = 30.8 kN$

$F_{V2} = \bar{P} A = \gamma h A = 9810 * 4 * 2 * 1 = 78.5 kN$

$F_V = 30.8 + 78.5 = 109.3 kN$



* Buoyancy قوة الطفو

⇒ fluidis in gravity field. الاتجاه عكس الوزن (لأعلى دائماً)

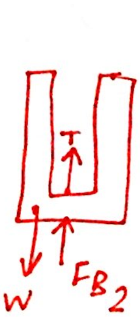
$$\left[F_b = \gamma_{fluid} * \forall \right]$$

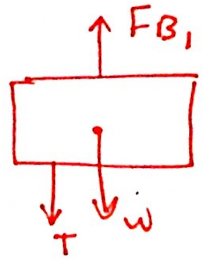
تعتمد قوة الطفو على مقدار γ كلما زادت γ زادت قوة الطفو.

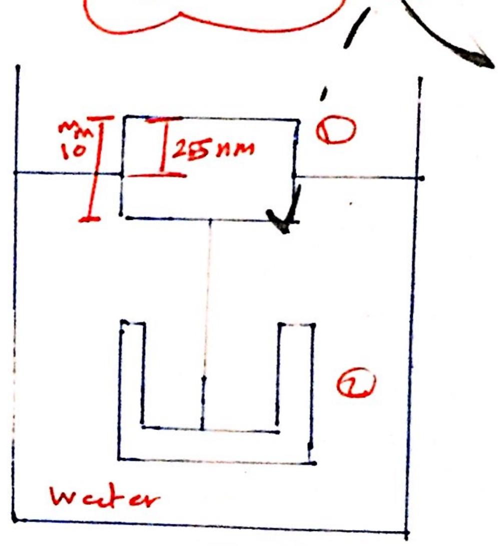
حجم الجسم المغمور

السؤال الامتحان مثل Problem 3.93 بوابة مع بيوني

(*)







$F_{B_1} = T + W_1$ $\qquad$ $F_{B_2} + T = W$

② hanging by a thin cord from a floating wood ①
the wood has a specific gravity ($S_1 = 0{,}3$) and dimensions of ($50 \times 50 \times 10$) mm, the metal part has a volume of (6600) mm^3, find the mass (m_2) of the metal part, and the tension on the cord ?!

$F_{B_1} = T + W_1$

$\gamma V = T + \gamma V$

$9810 * (50 * 50 * 7{,}5) * 10^{-9} = T + 9810 * 0{,}3 * (50 * 50 * 10) * 10^{-9}$

$$\boxed{T = 0{,}11036\ N}$$

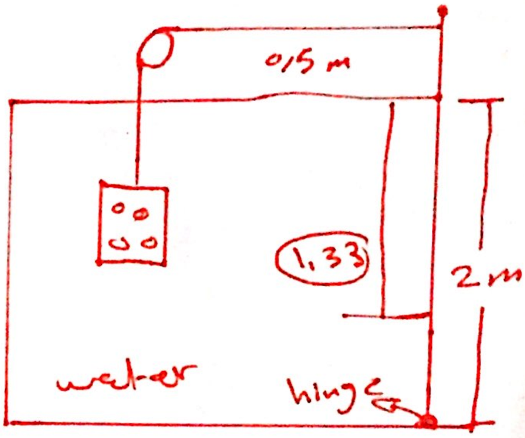
$T + F_{B2} = W_2$

$W_2 = 0{,}11036 + 9810 * 6600 * 10^{-9}$

$$\boxed{W_2 = 0{,}175\ N}$$

* Proplem 3.93 *   * مهم *

determine the minimum volume of concrete ($\gamma = 23,6\ kN/m^3$) needed to keep the gate (1 m wide) in a closed position??

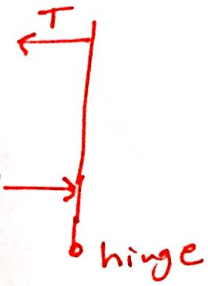


$\bar{y}_c \equiv h = 1m$

$F_R = 9810 * 1 * (2*1) = 19.62\ kN$

$y_{cp} - \bar{y}_c = \frac{I}{\bar{y}_c A} = \frac{\frac{1*2^3}{12}}{1*2*1} = 0,333$

$\boxed{1 + 0,33 =}$ الموقع



$\sum M_{hinge} = 0$

$T * (2.5) - F_R * (2 - 1.33) = 0$

$T = 5.258$

Now:-

$T + F_B = W$

$5.258 + V_{sub}\,\gamma_{H_2O} = \gamma_{conc}\,V_{sub}$

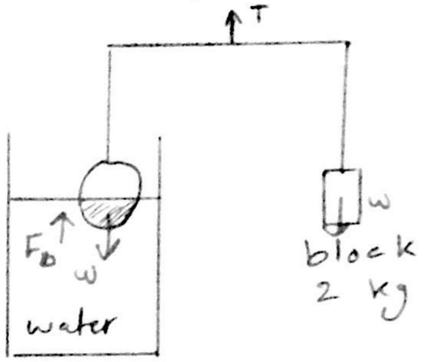
$V_{sub} = 3.813 * 10^{-4} = 0,3813\ m^3$

* فكرة السؤال تجمع بين (Bayoncy) وفكرة (Hydrostatic force) *

* مهم سؤال في 9 كلامات .

* اسئلة مهمة *

* what is the magnitude of the tension in the rope (in N) required to hold the 2-kg block when Half of the ball ($d = 21$ cm, $S = 0{,}75$) is incresed in water?



*

$$T + F_b = w_{block} + w_{ball}$$

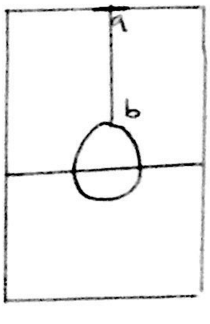
$$T + \frac{1}{2} \forall_{ball} * \gamma_w = mg + \gamma_w SG \forall_{ball}$$

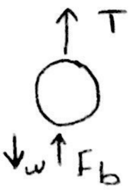
$$T + \frac{1}{2}\frac{4}{3}\pi\left(\frac{0{,}21}{2}\right)^3 * 9810 = 9{,}81*2 + 9810 * 0{,}75 * \frac{4}{3}\pi\left(\frac{0{,}21}{2}\right)^3$$

solver

$\boxed{T = 31{,}51}$

* what is the tension in the rope (ab) in (N) when Half of the ball ((its specific gravity $S.G = 5.5$ and diameter = 8 cm) is immersed in water?





$$T + F_b = w$$

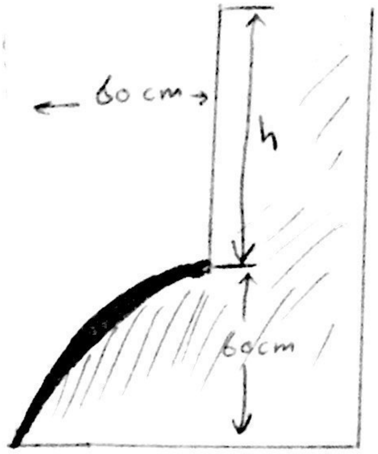
$$T = w - F_b$$

$$= \gamma_{ball} V_{ball} - \gamma_w V_{half\,ball}$$

$$= 9810 * 5.5 * \frac{4}{3}\pi(0{,}04)^3 - 9810 * \frac{1}{2}\frac{4}{3}\pi(0{,}04)^3$$

$\boxed{T = 13.15}$

* what is the $\boxed{\text{vertical component}}$ of force (in kN) acting on the circular gate shown. when water level above the gate h = 77 cm? The gate width is 38 cm into the Paper.



$F_V = F_{V1} + W \rightarrow$ الوزن فوق البوابة

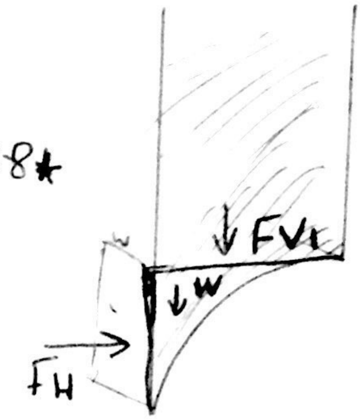
((دائماً نطلع اتجاه فوق البوابة))

$= \gamma_w h A + \gamma V$

$= 9810 * 0,6 * (0,6 * 0,38) + 9810 * 0,38 *$

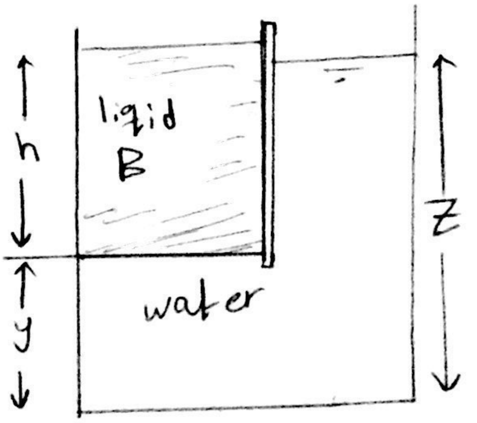
$* (\underbrace{0,6 * 0,6}_{\text{م.ع}} - \underbrace{\frac{1}{4}\pi (0,6)^2}_{\text{ربع دائرة}})$

$= 2010 \text{ N} \Rightarrow \boxed{2,01 \text{ KN}}$



* The Top Part of a water tank is divided into two compartments, as shown. ~~water~~ what is the density of Liquid B (in kg/m³) when h = 69 cm, y = 50 cm and Z = 95 cm?

solve



$P_B + \gamma_B h + \gamma_w y - \gamma_w Z = 0$

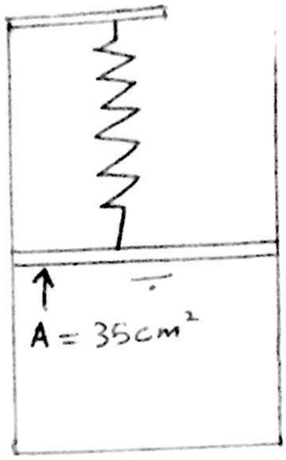
$0 + \gamma_B * 0,69 + 9810 * 0,5 - 9810 * 0,95 = 0$

$\gamma_B = 6397.78$ = specific wight

$\gamma_B = \rho g \Rightarrow \rho = \dfrac{\gamma_B}{g} = \dfrac{6397.78}{9,81}$

$\boxed{\rho = \text{density} = 652,17 \text{ kg/m}^3}$

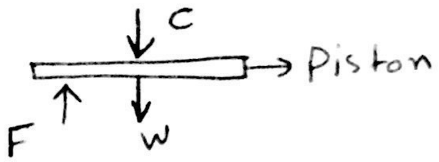
* A gas is contained in a vertical, frictionless piston-cylinder device. The piston has a mass of 4 kg and a cross-sectional area of
مهمة نأكد على تحليل القوة
35 cm^2 . A compression spring above the piston exerts a force of 160 N. If the atmospheric pressure is 100 kPa.



* what is the Absolute Pressure inside the cylinder [in kPa] ? [$g = 9,81\ m/s^2$]
مهم

Sol

$$F = C + w$$



$$w = 4 * 9,81 = 39,24$$

$$C = 160$$

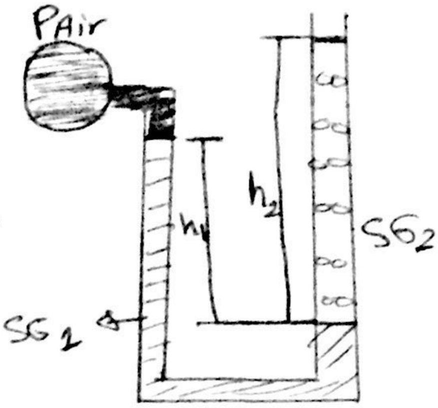
$$F = 160 + 39,24 = \cancel{\ldots}$$

$$\boxed{F = 199,24}$$

$$P_{gage} = \frac{F}{A} = \frac{199,24}{35 * 10^{-4}} = 56925,71$$

$$P_{abs} = 56925,71 + 100 * 10^3 = \boxed{156925,71\ Pa}$$

* consider a manometer attached to an air Pipe as shown. the specific gravity of one fluid ($SG_1 = 5,0$), $h_1 = 18cm$, $h_2 = 40cm$, the atmospheric Pressure $= 101,3$ KPa, and water Density $= 1000\ Kg/m^3$



→ what is the specific gravity of the other fluid (SG_2) when the gage Pressure of air is 50 KPa?

$$* \; S.G_{SG_2} = \frac{\gamma_{SG_2}}{\gamma_w} = \frac{147072,5}{9810} = \boxed{14,99}$$

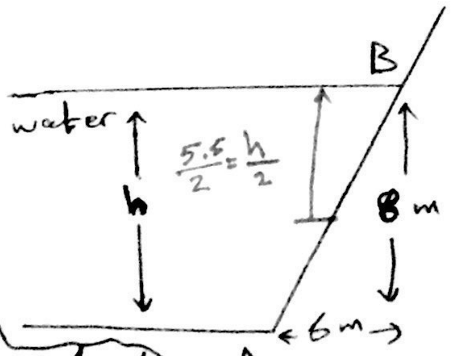
$$* \; P_{Air} + \gamma_{SG_1} * h_1 - \gamma_{SG_2} * h_2 = 0$$

$$50 * 10^3 + (5,0 * 9810)\,0,18 - \gamma_{SG_2} * 0,4 = 0$$

$$\boxed{\gamma_{SG_2} = 147072,5}$$

---

* consider the arrangment shown $h = 5.5m$, gate width $= 1.2m$ into the paper. what is the $\boxed{\text{hydrostatic Force}}$ acting on gate (in KN).



sol

$$F_R = \gamma h A$$

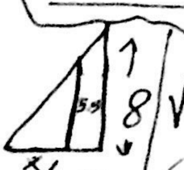
العرض الطول

$$= 9810 * \frac{5.5}{2} * (1.2 * 6.875)$$

$$\boxed{F_R = 222.56\ KN}$$

LD $\frac{8}{6} = \frac{5.5}{x}$

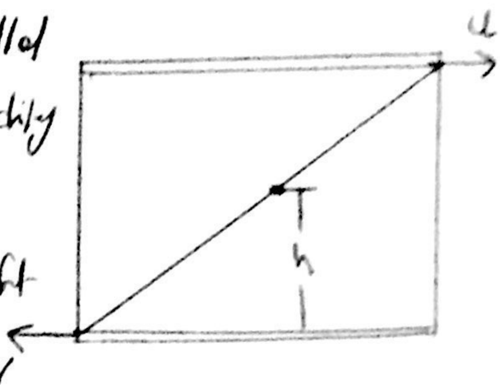
$\boxed{x = 4.125}$



$\sqrt{4.125^2 + 5.5^2}$ = الطول

6.875 = الطول

* Consider a fluid between two parallel plates. If the top plate moves with velocity ($u = 2$ m/s) to the right the lower plate moves with velocity ($v = 1$ m/s) to the left and the gap between the plates is 24-cm "Hint: velocity profile is LINEAR".



$V = 1$ m/s
$U = 2$ m/s

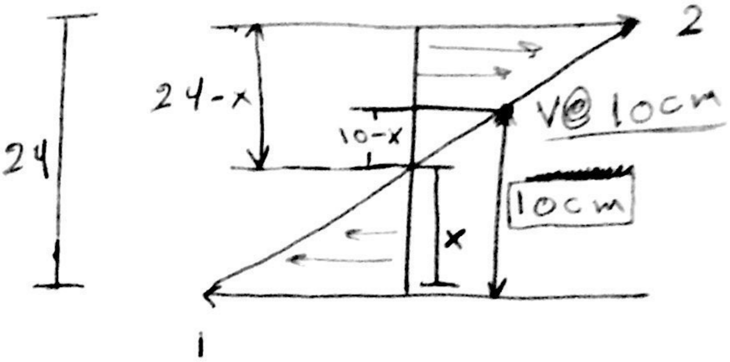
1) what is the velocity of fluid particle (in m/s) at ($h = 10$ cm from lower plate)

$$\frac{24 - x}{2} = \frac{x}{1}$$

$$x = 8$$

$$\frac{V @ 10cm}{2} = \frac{1}{8}$$

$$\boxed{V = 0.25 \text{ m/s}}$$



نقوم بعمل تشابه مثلثات
لايجاد قيمة x ثم عمل
تشابه مثلثات مرة اخرة
لايجاد مقدار السرعة.

2) what is the shear stress (in N/m^2) at the lower plate? viscosity = 0.015 Pa.s.

$$\tau = \mu \frac{\Delta V}{\Delta y}$$

$$= 0.015 * \frac{(2 - (-1))}{0.24 - 0}$$

$$= \boxed{0.1875 \ N/m^2}$$

ch 4

معاذ النحوي

للجنة : civilittee

* Acceleration

$$\vec{a} = \underbrace{\left(V \cdot \frac{dV}{ds} + \frac{dV}{dt} \right)_{e_t}}_{\text{Tangintial acceleration}} + \underbrace{\left(\frac{V^2}{r} \right)_{e_n}}_{\text{normal acceleration}}$$

steady : $\frac{dV}{dt} = 0$

uniform :- $V \cdot \frac{dV}{ds} = 0$

→ $\frac{V^2}{r}$:- centripetal acceleration [لا يوجد تغير باتجاه الانبوب يكون صفر]

→ $\frac{dV}{dt}$:- local acceleration [in steady flow → local Acc. is zero]

→ $V \cdot \frac{dV}{ds}$:- convective acceleration [in uniform flow → conv. is zero]

مهم

Ex The velocity along pathe line is given by $V = B S^2 t^{1/2}$ where S is in meters and t is in seconds and B "constant" value. The raduis of curvature is 0,5 m.

① what is the acceleration along the path (m/s²) at $S = 2$ m, $t = 0,5$ seconds, $B = 0,3$??

$\boxed{\text{along pathe = Tangintial acc.}} = \left(V \cdot \frac{dV}{ds} + \frac{dV}{dt} \right)$, $V = B S^2 t^{1/2}$

$= B S^2 t^{1/2} * 2 B S t^{1/2} + \frac{1}{2} B S^2 t^{-1/2}$

$= 0,3 (2)^2 \left(\frac{1}{2}\right)^{1/2} * 2 * 0,3 * (0,5)^{1/2} + \frac{1}{2} * 0,3 * (2)^2 (0,5)^{-1/2}$

$= \boxed{1.5685}$ m/s²

② what Is the acceleration normal to the path (m/s^2)
$(\delta = 2,\ t = 0{,}5,\ \beta = 0{,}3)$

normal path = Normal Acc. = $\dfrac{V^2}{r}$ $\boxed{V = \beta s^2 t^{1/2}}$

$$\text{normal} = \frac{(\beta s^2 t^{1/2})^2}{r} = \frac{(0{,}3 * (2)^2 * (0{,}5)^{1/2})^2}{0{,}5}$$

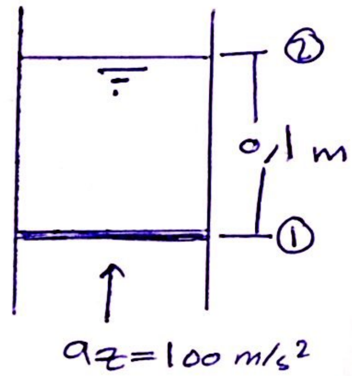
$$\text{normal} = \boxed{1.44}\ m/s^2$$

---

* Euler's equation.

$$\boxed{\frac{d(P + \gamma z)}{dL} = \rho a_z}$$

تستخدم عندما
يكون تسارع



Ex① find the gage presure on the piston
The water density is $10^3\ kg/m^3$.

$$-\frac{d}{dL}(P + \gamma z) = \rho a_L \Rightarrow -\int_1^2 d(P + \gamma z) = \int_1^2 \rho a_L\, dL \Rightarrow$$

$$\underset{0}{P_2} + \gamma z_2 - (P_1 - \underset{0}{\gamma z_1}) = -\rho a_L \Delta z$$

$$\gamma z_2 - P_1 = -\rho a_L \Delta z$$

$$9810 * 0{,}1 - P_1 = -1000 * 100 * 0{,}1 \Rightarrow \boxed{P_1 = 10{,}9\ KPa}$$

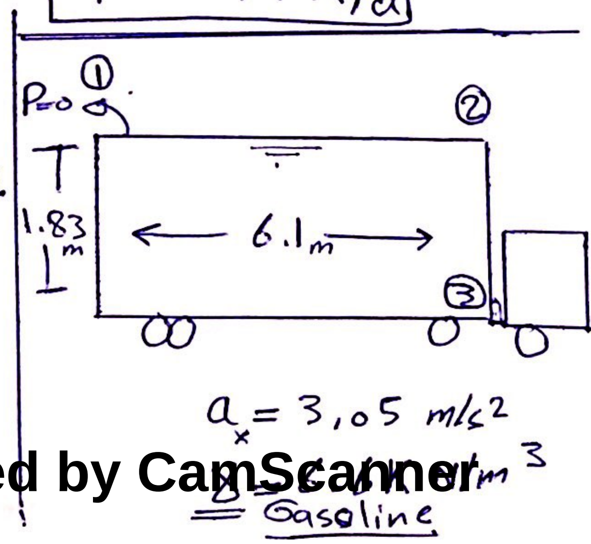
Ex②

① Find Pressure at top front?

$$-\frac{d(P + \gamma z)}{dL} = \rho a_L \Rightarrow \int_1^2 d(P + \gamma z) = -\int_1^2 \rho a_L dL$$

$$\cancel{P_1}^{0} + \cancel{\gamma z_1}^{0} - P_2 - \cancel{\gamma z_2}^{0} = -\rho a_L \Delta L$$

$$-P_2 = -\frac{6.6K}{9.81} * 3.05 * 6.1 \Rightarrow P_2 = 12{,}5\ KPa$$



$$SG = \frac{\overset{6.6K}{\gamma}}{\underset{9810}{\gamma}} = \frac{\rho}{\rho_{1000}}\ ?$$

$\Rightarrow$

② find maximum presure in the tank?

$$-\frac{d}{dL}(P+\gamma z) = \rho a_L \Rightarrow \int_2^3 d(P+\gamma z) = -\int_2^3 \rho a_L \, dL$$

$$P_2 + \gamma z_2 - P_3 - \gamma z_3 = -\rho \cancel{a_L}^{\,0} \Delta L$$

$$\Rightarrow P_2 + \gamma z_2 = P_3 + \gamma z_3$$

$$12.5 * 10^3 + 0 = P_3 + 6.6*10^3 * (-1.83)$$

$$\boxed{P_3 = 24.6 \text{ kPa}}$$

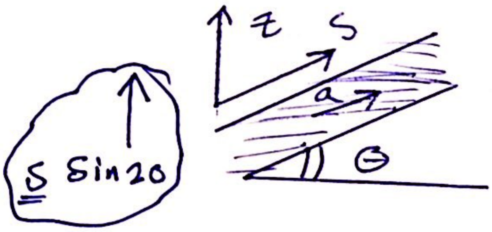
التسارع على محور X
ونحن نحسب على محور y
واذا كان التسارع صفر
نستطيع استخدام Haydrostatic

$$P_1 + \gamma z_1 = P_2 + \gamma z_2$$

Ex what presure gradient $(\partial P/\partial s)$ [KPa/m] is accelerate water over an inclined surface $\theta = 20°$ at rate of $(\frac{5}{11}g)\,m/s^2$??

Sol

$$-\frac{d}{ds}(P+\gamma z) = \rho a_s$$



$$\Rightarrow +\frac{dP}{ds} + \frac{d\gamma z}{ds} = -\rho a_s$$

$$\Rightarrow \frac{dP}{ds} = -\rho a_s - \frac{d\cancel{s}\sin 20\,\gamma}{\cancel{d s}}$$

$$\Rightarrow \frac{dP}{ds} = -\rho a_s - \sin 20\,\gamma$$

$$= -1000 * \left(\frac{5}{11}g\right) - \sin 20 * 9810 = \boxed{-7,81 \text{ KPa/m}}$$

* Pressure Distribution in Rotating flows.

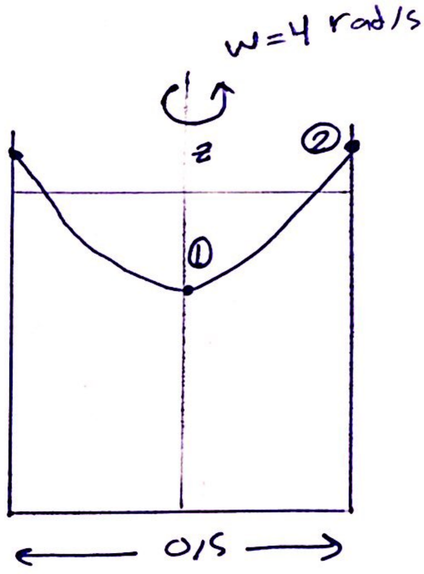
$$\rightarrow \quad P + \gamma z - \frac{\rho w^2 r^2}{2} = P + \gamma z - \frac{\rho w^2 r^2}{2}$$

or

$$\rightarrow \quad \frac{P}{\gamma} + z - \frac{w^2 r^2}{2g} = \frac{P}{\gamma} + z - \frac{w^2 r^2}{2g}$$

→ Pressure change in Rotating flows

Ex① Find elevation difference between centen and wal ??

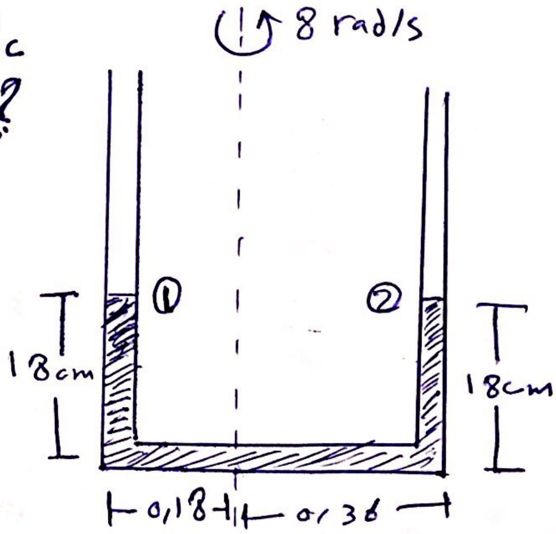


$$\cancel{\frac{P_1}{\gamma}}^{0} + z_1 - \cancel{\frac{w^2 r_1^2}{2g}}^{0} = \cancel{\frac{P_2}{\gamma}}^{0} + z_2 - \frac{w^2 r_2^2}{2g}$$

$$z_2 - z_1 = \frac{w^2 r_2^2}{2g} = \frac{4^2 * 0,25^2}{2 * 9,81}$$

$$\boxed{z_2 - z_1 = 0,051\,m}$$

Ex② If tube rotated about the eccentric axis 8 rad/s. what new levels of water?



$$\cancel{\frac{P_1}{\gamma}}^{0} + z_1 - \frac{w^2 r_1^2}{2g} = \cancel{\frac{P_2}{\gamma}}^{0} + z_2 - \frac{w^2 r^2}{2g}$$

$$z_2 - z_1 = \frac{w^2 r_2^2}{2g} - \frac{w^2 r_1^2}{2g} = \frac{(8)^2 (0,8)^2}{2 * 9,81}$$

$$- \frac{(8)^2 * (0,36)^2}{2 * 9,81} \Rightarrow 0,317$$

$$\boxed{z_2 - z_1 = 0,317} \rightsquigarrow ①$$

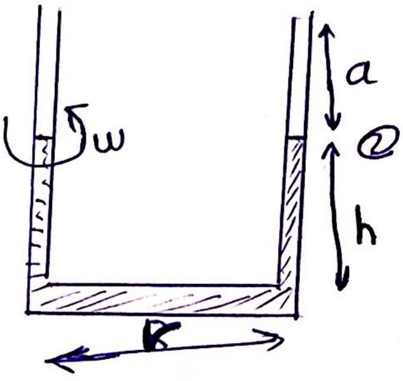
$$\boxed{z_1 + z_2 = 0,36} \rightsquigarrow ② \rightarrow \boxed{\text{stand before rotated}}$$

$$\boxed{z_2 = 0,338\,m}$$

$$\boxed{z_1 = 0,022\,m}$$

Ex

The monameter is oil [s = 0,82], the dimention r = 20 cm, h = 19 cm and h+a = 29 cm. what is the maximum allowable speed of rotation.



Sol

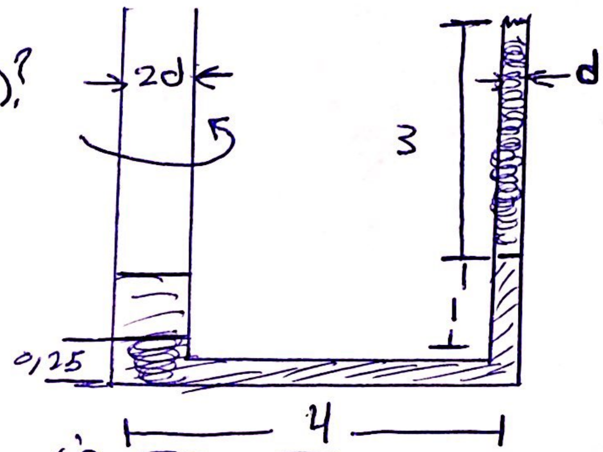
$$\cancel{\frac{P_1}{\gamma}}^{0} + z_1 - \cancel{\frac{w^2 r_1^2}{2g}}^{0} = \cancel{\frac{P_2}{\gamma}}^{0} + z_2 - \frac{w^2 r_2^2}{2g}$$

مقدار نقصان من الطرف الاخر $z_1 = z_2 - \dfrac{w^2 r_2^2}{2g}$

لانه max في طول الانبوب كامل

$$0,09 = 0,29 - \frac{w^2 (0,2)^2}{2g} \Rightarrow w = 9.9 \text{ rad/s}$$

Ex Find maximum rotation rate (rad/s)?



$$\cancel{\frac{P_1}{\gamma}}^{0} + z_1 - \cancel{\frac{w^2 r_1^2}{2g}}^{0} = \cancel{\frac{P_2}{\gamma}}^{0} + z_2 - \frac{w^2 r_2^2}{2g}$$

$$z_1 = z_2 - \frac{w^2 r_2^2}{2g}$$

$$0,25 = 4 - \frac{w^2 4^2}{2g}$$

$$\boxed{w = 2.144 \text{ rad/s}}$$

$$V_1 = V_2$$

$$\Delta h_1 d_1^2 = \Delta h_2 d_2^2$$

$$\Delta h_1 = \frac{d_2^2}{d_1^2} \Delta h_2$$

$$\Delta h_1 = \frac{d^2}{4d^2} \Delta h_2$$

$$\Delta h_1 = \frac{1}{4} \Delta h_2$$

$$\boxed{\Delta h_1 = \frac{3}{4}}$$

* Barnouli equation :-

$$\Rightarrow \underbrace{P + \gamma z}_{\text{Pizomtric Presure}} + \underbrace{\rho \frac{V^2}{2}}_{\text{kinetic Pressure}} = C$$

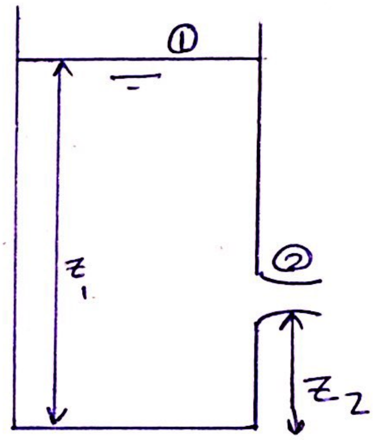
$$\Rightarrow \underbrace{\frac{P}{\gamma}}_{\text{Presure head}} + \underbrace{z}_{\text{elevation head}} + \underbrace{\frac{V^2}{2g}}_{\text{velocity head at Point}} = C$$

$$P + \gamma z + \frac{\rho V^2}{2g} = P + \gamma z + \frac{\rho V^2}{2g}$$

لو نستقره بين منطقتين

Ex

* elevation of the water tank is 10 m
find the velocity of the liquid.



$$\cancel{\frac{P_1}{\gamma}}^{0} + z_1 + \underbrace{\cancel{\frac{V_1^2}{2g}}^{0}}_{\text{لأنه قيمة صغيرة جدا}} = \cancel{\frac{P_2}{\gamma}}^{0} + z_2 + \frac{V_2^2}{2g}$$

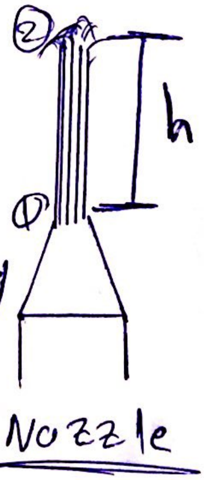
$$z_1 - z_2 = \frac{V_2^2}{2g} \Rightarrow 10 = \frac{V_2^2}{2g} \Rightarrow \boxed{V = 14\, m/s}$$

Ex

velocity as it exits the nozzle is 4 m/s
calculate high h ??

$$\cancel{\frac{P_1}{\gamma}}^{0} + \cancel{z_1}^{0} + \frac{V_1^2}{2g} = \cancel{\frac{P_2}{\gamma}}^{0} + z_2 + \cancel{\frac{V_2^2}{2g}}^{0}$$

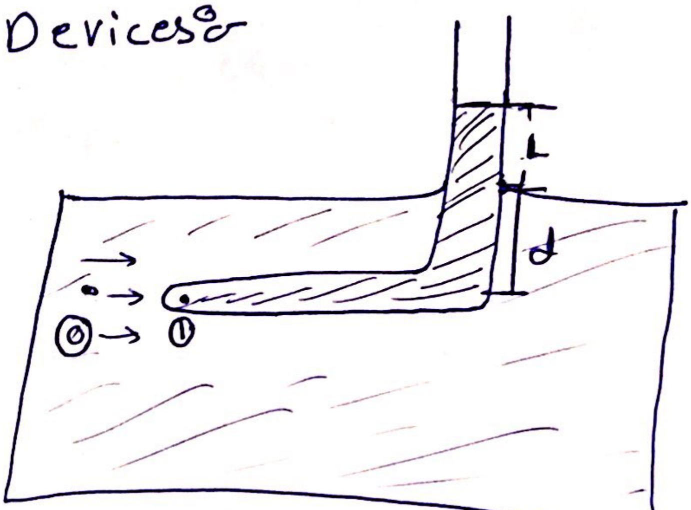
$$\frac{V_1^2}{2g} = z_2 \Rightarrow z_2 = h = \frac{(4)^2}{2g} = \boxed{0{,}8155\, m}$$



Nozzle

* velocity measorment Devices:

[1] stagnation tube



$$\frac{P_0}{\gamma} + \underbrace{\cancel{Z_0}}_{0} + \frac{V_0^2}{2g} = \frac{P_1}{\gamma} + \underbrace{\cancel{Z_1}}_{0} + \frac{V_1^2}{2g}$$

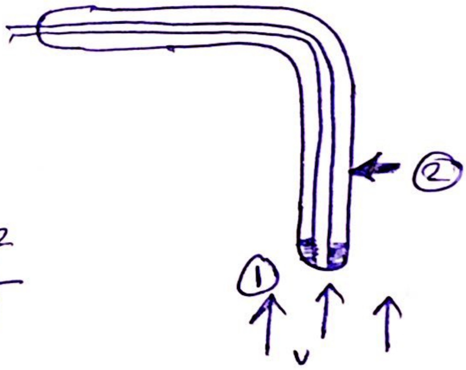
لانهم بنفس الارتفاع

$$\frac{P_0}{\gamma} + \frac{V_0^2}{2g} = \frac{P_1}{\gamma} + \frac{V_1^2}{2g}$$

$P_0 = \gamma d$, $P_1 = \gamma(d + l)$, $V_1 = 0$

$$V_0^2 = \frac{2(P_1 - P_0)}{\rho} \Rightarrow V_0^2 = 2gL \Rightarrow \boxed{V_0 = \sqrt{2gL}}$$

[2] Pitot static tube.



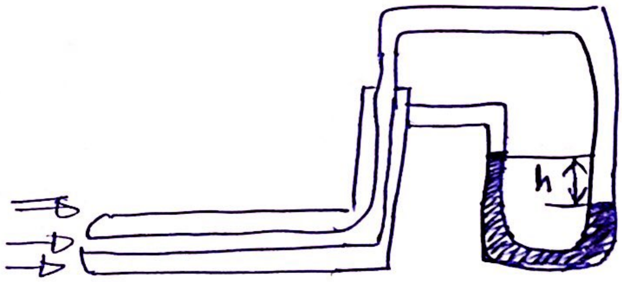
$$\frac{P_1}{\gamma} + Z_1 + \frac{V_1^2}{2g} = \frac{P_2}{\gamma} + Z_2 + \frac{V_2^2}{2g}$$

$V_1 = 0$.

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

$$\boxed{V_2 = \sqrt{\frac{2\Delta P_Z}{\rho}}} \Rightarrow$$

Ex Pitot-static Probe concected a water manometer. $h = 9.2$ cm what air velocity (m/s)?
$\rho_{Air} = 1.25$ kg/m³.



$$P_{Z1} - P_{Z2} = \gamma h (\gamma_m - \gamma_P)$$
$$= 0.092(9810 - 0)$$
$$= 902.52$$

$$V = \sqrt{\frac{2\Delta P_Z}{\rho}} = \sqrt{\frac{2 * 902.52}{1.25}}$$

$$\boxed{= 38.00}$$

* Rotation and varticity

$$\begin{bmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{d}{dx} & \frac{d}{dy} & \frac{d}{dz} \\ u & v & w \end{bmatrix}$$

$$\Omega_z = \frac{1}{2}\left(\frac{dv}{dx} - \frac{du}{dy}\right)$$

$$\Omega_x = \frac{1}{2}\left(\frac{dw}{dy} - \frac{dv}{dz}\right)$$

$$\Omega_y = \frac{1}{2}\left(\frac{dw}{dx} - \frac{du}{dz}\right)$$

$\boxed{\Omega \rightarrow \text{Rotation}}$

$\boxed{2\Omega \rightarrow \text{Varticity}}$

$$\Omega = \Omega_x i + \Omega_y j + \Omega_z k$$

$\boxed{\text{Irrotation } \Omega = 0}$

Ex The velocity fidd of a steady, incompressible flow is given b $V = (x^2 - xy)\,i + (0{,}5\,y^2 - 2xy)\,j$, what is the vorticity of this flow at $x = 2.25$ $y = 1.5$.

((اذا اعطاني متجاهين بأخذ دائما "الثالث"))

Sol

$$\Omega_z = \frac{1}{2}\left(\frac{dv}{dx} - \frac{du}{dy}\right) = \frac{1}{2}\left(-2y - (-x)\right)$$

$$\boxed{\begin{aligned} V &= 0{,}5\,y^2 - 2xy \\ u &= x^2 - xy \end{aligned}}$$

$$\Omega_z = \frac{1}{2}\left(-2(1.5) + 2.25\right)$$

$$\text{rotation} = \Omega_z = -0{,}375$$

$\boxed{\text{Varticity} = 2\Omega_z = -0{,}75}$

ch 5

* control volume: is oregion in space that allows mass to flow in and cutit.

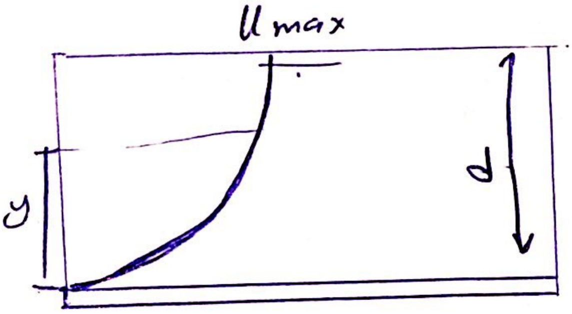
* volume flow Rate : is the volume of fluid that Passes through an area per unit time.

$$Q = \int_A V \cdot dA \quad (\text{discharge})$$

* mean velocity $\Rightarrow \bar{V} = \dfrac{Q}{A}$

* mass flow rate $\Rightarrow \dot{m} = \rho Q = \rho V A$

Ex velocity has distribution across $\dfrac{U}{U_{max}} = \left(\dfrac{y}{d}\right)^{1/2}$. what discharge in the channel if water is 2m deep(d=2m). the channel is 5m wide, and maximum velocity is 3m/s?



Sol

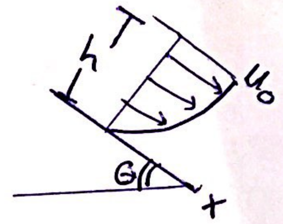
$$Q = \int_A V\, dA = \int_0^y U_{max}\left(\frac{y}{d}\right)^{1/2} dx\, dy$$

$$\Rightarrow \int_0^2 3 * \left(\frac{y}{2}\right)^{1/2} * 5\, dy \Rightarrow \frac{15}{\sqrt{2}} \int_0^2 y^{1/2}\, dy$$

$$\Rightarrow \frac{15}{\sqrt{2}} * \frac{2y^{3/2}}{3} = \boxed{Q = 20\, m^3/s}$$

1,2 * Ex

The rectAngular channel shown is 0,75 m wide "into the Paper" and the water velocity chages according to $U(y) = U_o\,(y/h)^{0{,}723}$ m/s.
what is the Average velocity in the channel [in m/s]? $U_o = 0{,}89$ m/s, $\theta = 30°$, $h = 56$ cm.



$$\bar{V} = \frac{Q}{A} = \frac{0{,}2169}{0{,}56 * 0{,}75} \Rightarrow \boxed{\bar{V} = 0{,}517}$$

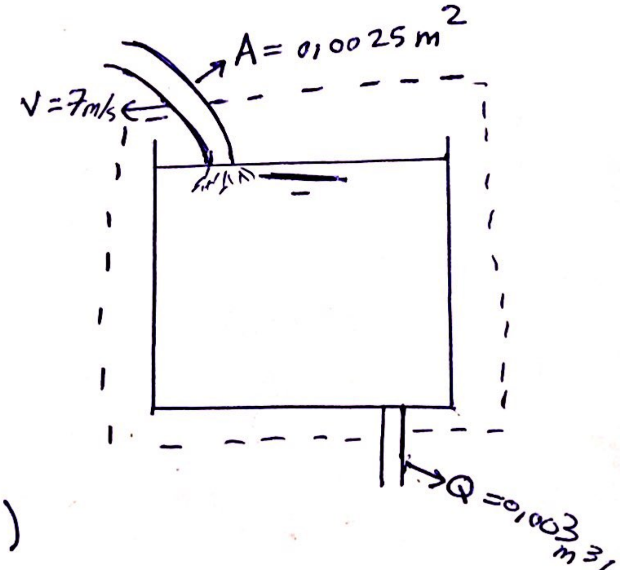
$$Q = \int_A V\,dA = \boxed{\int_0^{0{,}56} 0{,}89\left(\frac{y}{0{,}56}\right)^{0{,}723} * 0{,}75\,dy} = 0{,}2169\ m^3/s$$

* Continuty Equation

$$\left\{\begin{matrix}\text{The Accumulation rate}\\ \text{of mass in the control}\\ \text{volume}\end{matrix}\right\} + \left\{\begin{matrix}\text{The net out flow rate}\\ \text{of mass through}\\ \text{the control surface}\end{matrix}\right\} = 0$$

$$\frac{d}{dt} m_{cv} + \sum m_o - \sum m_i = 0$$

Ex
what water accumolating in (or evacuting from) the tank?



$$\frac{dm_{cv}}{dt} + \sum m_o - \sum m_i = 0$$

$$\Rightarrow \frac{dm_{cv}}{dt} = \sum \dot{m}_i - \sum \dot{m}_o = 0$$

$$= \rho V A_i - \rho V A_i$$

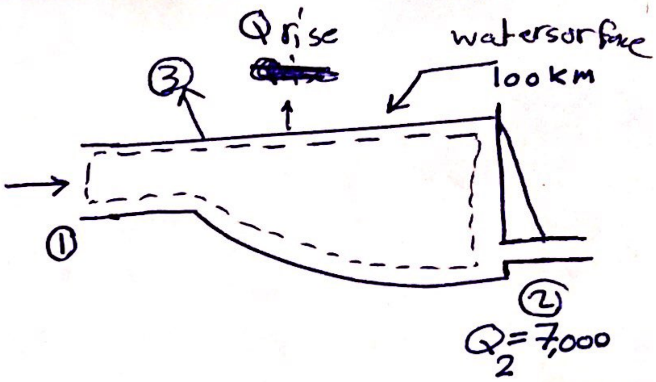
$$= 1000 * 7 * 0{,}0025 - (1000 * 0{,}003)$$

$$= \boxed{14.5\ kg/s}$$

Ex

* what is the $\boxed{\text{rate of rise}}$ (velocity) of water in the reservoir?

$11{,}300 = Q_1$



$$\boxed{\frac{dm_{cv}}{dt} = 0 \Rightarrow \text{contant C.V}}$$

$\Sigma m_o - \Sigma_i = 0$

$(\rho Q_2 + \rho Q_3) - \rho Q_1 = 0$

$1000 * 7000 + 1000 Q_3) - 1000 * 11{,}300 = 0$

$Q_3 = 4{,}300$

$V = \text{rate of rise} = \frac{4{,}300}{100 * 10^6} = 4.3 * 10^{-5}\ m/s$

or

$\boxed{\text{الداخل = الخارج}}$

$Q_1 = Q_3 + Q_2$

$11300 = Q_3 + 7000$

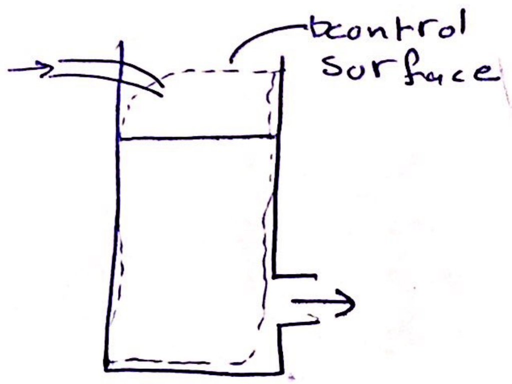
$\boxed{Q_3 = 4300\ m^3/s}$

1,000

Ex water enters a circular tank $D = 0{,}3m$ at rate of 6 Liters/s and leaves a rate of 5 Liters/s. what is the of change of water hight in the tank. (cm/s).

sol

$$\frac{d \boxed{m_{cv}}}{dt} + \Sigma m_o - \Sigma m_i = 0 \qquad (m_{cv} = \rho V)$$



$$\frac{dh}{dt} * \cancel{\rho} * A_{tank} + \cancel{\rho} * 0{,}005 - \cancel{\rho} * 0{,}006 = 0$$

$$\frac{dh}{dt} * \frac{\pi}{4}(0{,}3)^2 - 0{,}001 = 0$$

$$\boxed{\frac{dh}{dt} \simeq 0{,}0141\ m/s}$$

* continuity Equation for flow in a Pipe.

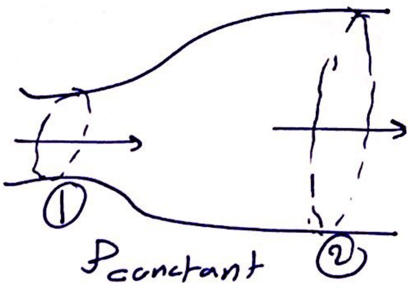
→ control volume constant in the Pipe.

$$\cancel{\frac{dm_{cv}}{dt}} + \sum \dot m_o - \sum \dot m_i = 0$$

$$\boxed{\dot m_o = \dot m_i}$$

$$\boxed{Q_o = Q_i}$$

$$\boxed{A_2 V_2 = A_1 V_1}$$



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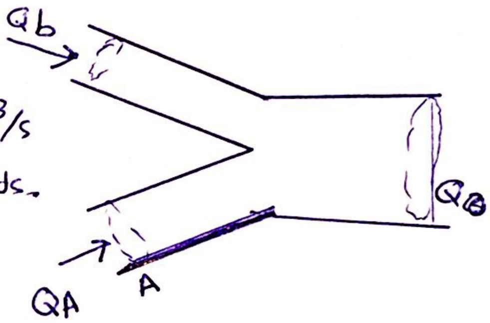
* Q 5.46

* Volume flowe rate of strem A $\boxed{Q_A = 0.02t}$ m^3/s and stremB $\boxed{Q_B = 0.008\, t^2}$ m^3/s, where t seconds. the exit area of the Pipe $\boxed{0.01\, m^2}$.



* Find velocity at the exit when t = 1 Second

$$Q_B = Q_A + Q_B$$
$$= 0.02t + 0.008\, t^2$$

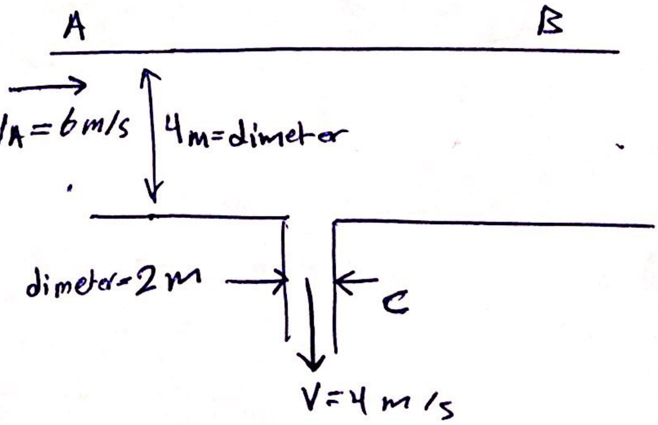
$$\underset{t=1}{Q_o} = 0.02 + 0.008 = \boxed{0.028\, m^3/s}$$

$$V = \frac{Q}{A} = \frac{0.028}{0.01} = \boxed{2.8\, m/s}$$

---

* Q 5.58

what is the velocity of the flow of water in leg B of the tee shown.



$$Q_{in} = Q_{out}$$

$$Q_A = Q_B + Q_c$$

$$6 * \frac{\pi}{4}(4)^2 = V_B * \frac{\pi}{4}(4)^2 + 4 * \frac{\pi}{4}(2)^2$$

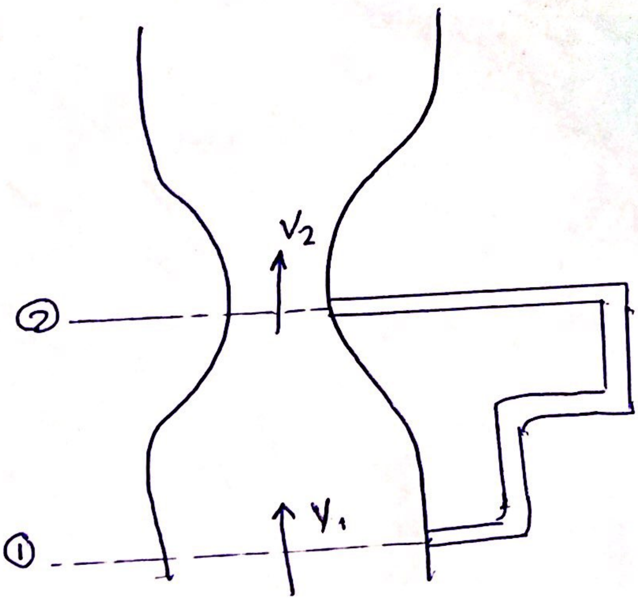
$$96 = 16V + 16$$

$$\boxed{V_B = 5\, m/s}$$

* water density 1000 kg/m^3

$\frac{A_2}{A_1} = 0,5 \qquad V_1 = 10\ m/s$

Find Pressure defference ?



$$\frac{P_1+\gamma z_1}{\rho z_1} + \frac{\rho V_1^2}{2} = \frac{P_2+\gamma z_2}{\rho z_2} + \frac{\rho V_2^2}{2}$$

$$Pz_1 - Pz_2 = \rho \frac{V_2^2}{2} - \frac{\rho V_1^2}{2}$$

$$= \frac{\rho V_1^2}{2}\left(\frac{V_2^2}{V_1^2} - 1\right)$$

$$= \frac{\rho \cancel{V_1}^2}{2}\left(\frac{A_1^2}{A_2^2} - 1\right)$$

$$= \frac{\rho V_1^2}{2}\left(\frac{1^2}{0,5^2} - 1\right)$$

$Q = Q$

$V_1 A_1 = V_2 A_2$

$\frac{V_2}{V_1} = \frac{A_1}{A_2} = \frac{1}{0,5}$

$$= \frac{1000*(10)^2}{2} * 3 = 150\ kPa$$

لا تنسوني بدعائكم، ووالدي برحمة .

ch 6

((معاذ النحوي))
{civilittee}

* momentum Equation

$$\left\{\begin{array}{c}\text{sum of forces acting}\\ \text{on the matter on the}\\ \text{control volume}\end{array}\right\} = \left\{\begin{array}{c}\text{Time rate of change}\\ \text{of momentum in}\\ \text{control volume}\end{array}\right\} + \left\{\begin{array}{c}\text{net out flow rate of}\\ \text{momentum through}\\ \text{control surface}\end{array}\right\}$$

$$\sum F = \frac{d}{dt}\int_{cv} v\rho\, d\forall + \sum_{cs} m_o V_o - \sum_{cs} m_i V_i$$

((الاعلى دائماً في العادة صفر))
لانه نحتاج الى ثلاثي الابعاد

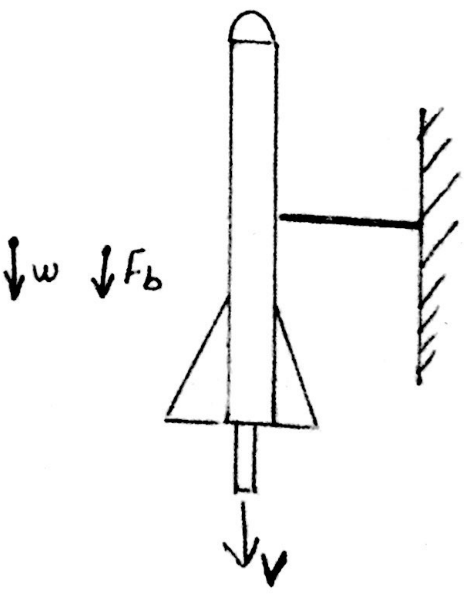
$M_o V_o = \rho VA \cdot V = \rho V^2 A$

$m_i V_i = \rho VA \cdot V = \rho V^2 A$

$$\boxed{\begin{aligned}\sum F_x &= \sum m_o V_{ox} - \sum m_i V_{ix}\\ \sum F_y &= \sum m_o V_{oy} - \sum m_i v_{iy}\\ \sum F_z &= \sum m_o V_{oz} - \sum m_i v_{iz}\end{aligned}}$$

ملاحظة : دائماً نوجد $\sum F_x$
عن طريق التحليل في
الستاتيك ثم تساوي
$\boxed{\sum M_o V_{ox} - \sum m_i v_i}$ في $\sum F_x$

Ex 6.1 rocket = 40g [redacted] dimeter = 1 cm
$V = 450$ m/s $\rho = 0.5$ kg/m^3



* Find Force F_b ??

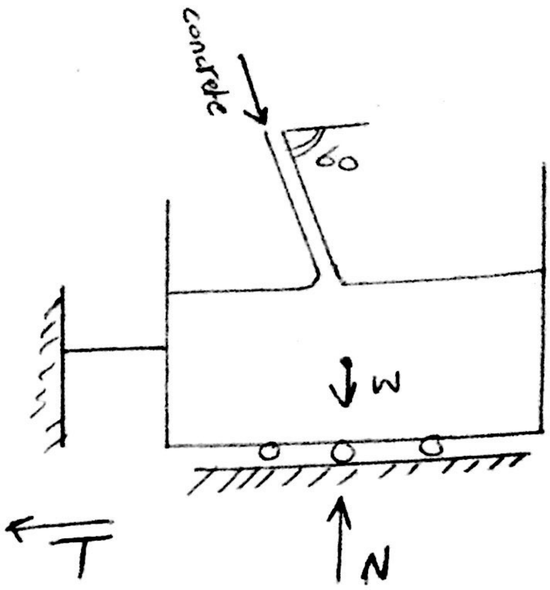
$\sum F_y = \sum F_y$

$-F_b - mg = -\rho V^2 A$

$F_b = \rho v^2 A - mg$

$= 0.5 * (450)^2 * \frac{\pi}{4}$ [redacted] $(0.01)^2 + (-40*9.81)$

$\boxed{F_b = 756 N}$



Ex 6.2 The strem of concrete has a density of $\rho = 150\ kg/m^3$, $A = 1\ m^2$, and speed $V = 10\ m/s$, weight 800 g. Determine Tenhion??

1/ $\sum F_x = -T$

2/ $\sum F_y = N - W$

$\sum F_x = \sum m_o v_{o_x}^{0} - \sum m_i v_{i_x}$

3/ $\sum F_x = -\rho V^2 A \cos 60$

$\sum F_y = \sum m_o V_{o_y}^{0} - \sum m_i V_{i_y}$

4/ $\sum F_y = -(-\rho V^2 A \sin 60)$

$-T = -\rho V^2 A \cos 60$

$T = (150)(10)^2(1)\cos 60$

$\boxed{T = 7500 N}$

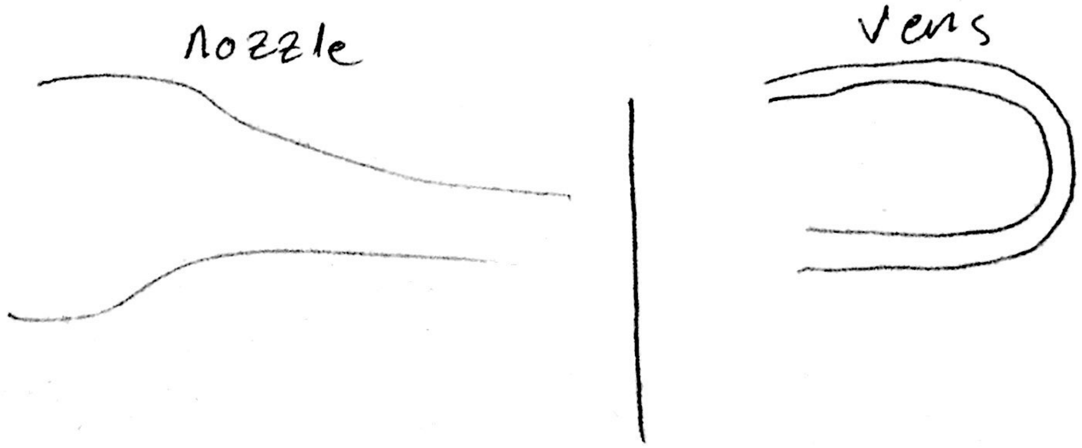
$N - W = -(-\rho V^2 A \sin 60)$

$N - 800 = +150\,(10)^2 * 1 * \sin 60$

$\boxed{N = 13.7 * 10^3 N}$

---

* Nozzle and vens



* Prop 6.77

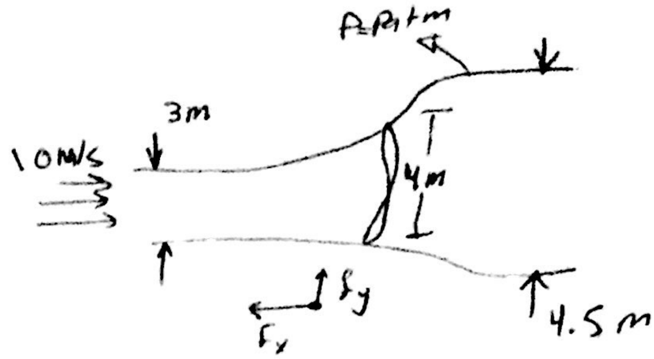
$\rho = 1.2\ kg/m^3$

Detrmine the thrust on the mill.

دفع

طاحونة

$f_x = ?$
$f_y = ?$



$Q_1 = Q_2$

$V_1 A_1 = V_2 A_2$

$\frac{10 * 3^2}{(4.5)^2} = V_2 = \boxed{4.44\ m/s}$

$\sum F_y = F_y = 0$ لا يوجد ردفعل كاس عمود y

$\sum f_x = f_x = \sum m_o v_{ox} - \sum m_i V_{ix}$

$= \rho v^2 A - \rho v^2 A$

$= 1.2 * (10)^2 \frac{\pi}{4} 3^2 - 1.2(4.4)^2 * \frac{\pi}{4} (4.5)^2$

$f_x = 471.99\ N$

$\boxed{F = 471.99\ N}$

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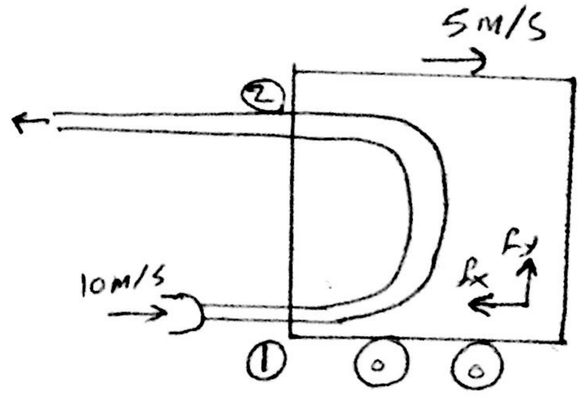
* Prop 6.86

velocity car = 5 m/s

density ρ = 1000 kg/m3

Velocite Nozzle = 10 m/s

Aree nozzle = 0.0012 m^2



$\boxed{\begin{array}{l} V_{track} = 5 m/s \\ V_{nozzle} = 10 m/s \end{array}}$ $\longrightarrow$ $V_1 = V_2 = \underset{nozzle}{10} - \underset{track}{5} = 5\ m/s$

لانه السيارة تتحرك فتعمل على نقصان سرعة في Nozzle.

$\sum F_x = -F_x = -\rho v^2 A - (\rho v^2 A) = -1000(5)^2(0.0012) - 1000(5)^2(0.0012)$

حسب فرضنا

لانه باتجاه محور x السالب

$+F_x = +60$

$\boxed{F_x = 60 N}$

(3)

"10"12 &

* water is emplying from the tank through a side pipe that has two outlet nozzles, as shown. i.e. $A_0 = 4A_1 = 4A_2 = 0.020\ m^2$. Also, $h = 17\ m$ and pressure above the water surface ($P = 42\ KPa$ gage). assume ideal conditions, no head loss, $V_1 = V_2$ neglect height of the vertical nozzle.

A) what is the maximum height "L" the vertical jet will reach ??

B) what is the gage pressure "P_0" inside pipe (in kPa)?

C) what is the Horizontal force component acting through the bolts of the flange that is needed to keep the flange in place (in KN)?

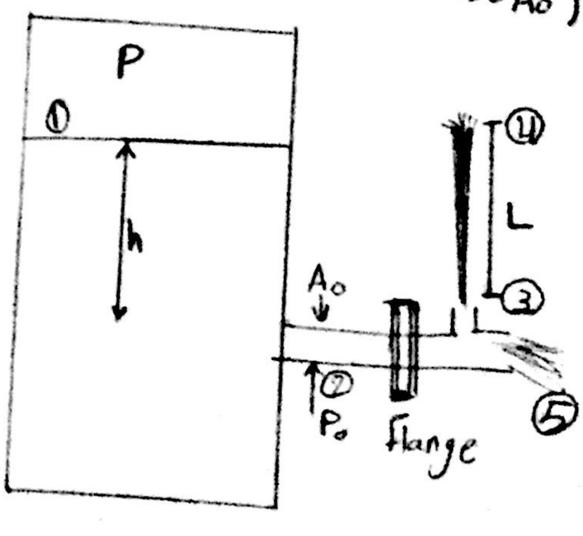
D) what is the vertical force compent acting through the bolts of the flange that is needed to keep the flange in place (in KN)?

E) what is the rate at which tank water level changes (in m/s) when the tank cross sectional area ($A_{tank} = 120 A_0$)?

Sol

A) Bernolli between ① & ③

find (v) at vertical jet.



$$\frac{P_1}{\gamma} + z_1 + \frac{V_1^2}{2g} = \frac{P_3}{\gamma} + z_3 + \frac{V_3^2}{2g}$$

$$\frac{42}{9.81} + 17 + 0 = 0 + 0 + \frac{V_3^2}{2g}$$

$$\boxed{V_3 = 20.43\ m/s}$$

between ③ & ④

$$\frac{P_3}{\gamma} + z_3 + \frac{V_3^2}{2g} = \frac{P_4}{\gamma} + z_4 + \frac{V_4^2}{2g}$$

$$0 + 0 + \frac{(20.43)^2}{2g} = 0 + z_4 + 0$$

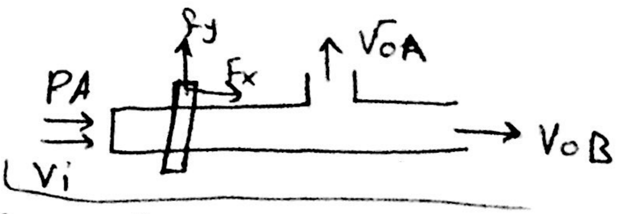
$$\boxed{h = z_4 = 21.27\ m}$$

(B)
$$\frac{P_1}{\gamma} + z_1 + \frac{V_1^2}{2g} = \frac{P_5}{\gamma} + z_5 + \frac{V_5^2}{2g}$$
$$\frac{42}{9.81} + 17 + 0 = 0 + 0 + \frac{V_5^2}{2g}$$
$$\boxed{V_5 = 20{,}43 \text{ m/s}}$$

$$Q_2 = Q_3 + Q_5$$
$$V_2 A_2 = V_3 A_3 + V_5 A_5$$
$$V_2 (0{,}02) = 20{,}43 (5 * 10^{-3}) + 20{,}43 (5 * 10^{-3})$$
$$\boxed{V_2 = 10{,}215 \text{ m/s}}$$

$$\frac{P_1}{\gamma} + z_1 + \frac{V_1^2}{2g} = \frac{P_2}{\gamma} + z_2 + \frac{V_2^2}{2g}$$
$$\frac{42}{9.81} + 17 + 0 = \frac{P_2}{\gamma} + 0 + \frac{(10{,}215)^2}{2g}$$
$$\boxed{P_2 = 156{,}6 \text{ KPa}}$$

(C)
$$\Sigma F_x = \Sigma \dot{m}_o v_{o_x} - \Sigma \dot{m}_i v_{i_x}$$
$$P_2 A + f_x = \rho V^2 A_o - \rho V^2 A_i$$



$$156{,}6 * 0{,}02 + f_x = 1000 (20{,}43)^2 (5 * 10^{-3}) - (10{,}215)^2 * (1000) * (0{,}02)$$
$$f_x = -3132 \text{ N}$$

(D)
$$f_y = \Sigma \dot{m}_o v_{o_y} - \Sigma \dot{m}_i v_i$$
$$= \rho V^2 A$$
$$= 1000 (20{,}43)^2 * (5 * 10^{-3})$$
$$\boxed{f_y = 2086.9 \text{ N}}$$

$$\frac{dm}{dt} + \Sigma \dot{m}_o - \Sigma \dot{m}_i = 0$$
$$\frac{dh}{dt} \rho A_{tank} + \rho V A + 0 = 0$$
$$\frac{dh}{dt} \rho A_{tank} = -\rho V A$$
$$\frac{dh}{dt} = \frac{-V A_2}{A_{tank}} = \frac{19 * 0{,}005}{2{,}4}$$
$$= \boxed{0{,}039 \text{ m/s}}$$

من برنولي

$$V = \sqrt{2gh - \frac{P}{\gamma}} = \sqrt{2 * 9{,}81 * 17 - \frac{42}{9{,}81}} = 19$$

* Energy Equation

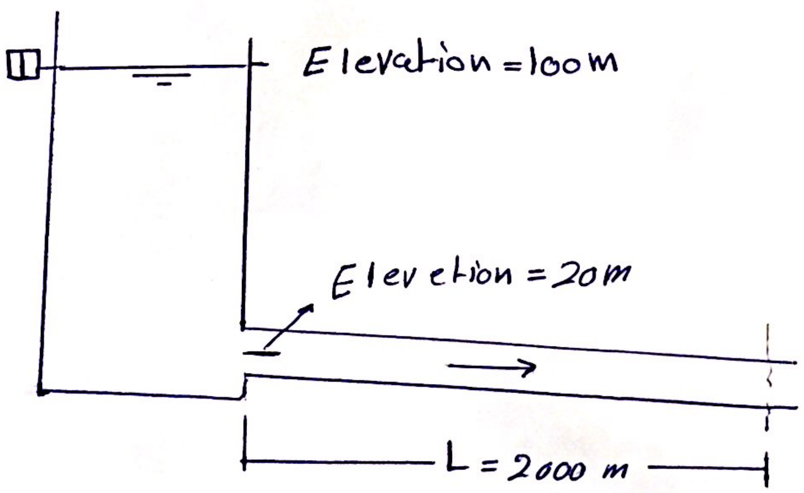
{ net rate of thermal energy enterning system } - { net rate at which system does work on environment } = { rate of change of energy of the mater witin the system }

$$\left(\frac{P_1}{\gamma} + \alpha_1 \frac{V_1^2}{2g} + Z_1\right) + h_p = \left(\frac{P_2}{\gamma} + \alpha_2 \frac{V_2^2}{2g} + Z_2\right) + h_t + h_L$$

(head caried by flow into the cv) + (head Pumps) = (head caried by flow out) + (head Turbine) + (head loss)

Ex

* $h_L = \dfrac{0.02\left(\frac{L}{D}\right)V^2}{2g}$
* $D = 0.2\,m$
* $Q = 0.06\ m^3/s$
* $\alpha_2 = 1$
* what Pressure inthe pipe?



Sol

$$\frac{P_1}{\gamma} + \alpha_1 \frac{V^2}{2g} + z_1 + h_P = \frac{P_2}{\gamma} + \alpha_2 \frac{V_2^2}{2g} + z_2 + h_t + h_L$$

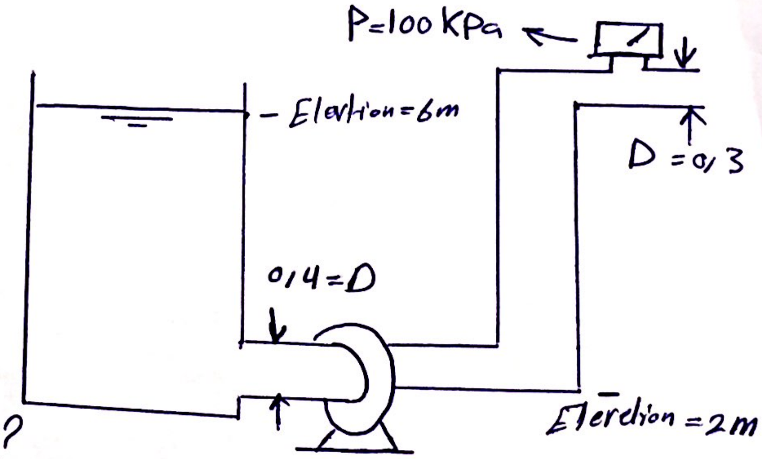
$$0 + 0 + 100 + 0 = \frac{P_2}{9810} + \cancel{\alpha} \frac{V_2^2}{2g} + 20 + 0 + \frac{0{,}02\left(\frac{L}{D}\right)V_2^2}{2g}$$

$$V_2 = \frac{Q}{A} = \frac{0{,}06}{\frac{\pi}{4}(0{,}2)^2} = \boxed{1{,}9\ m/s}$$

$$100 = \frac{P_2}{9810} + \frac{(1{,}9)^2}{2g} + 20 + \frac{0{,}02\left(\frac{2000}{0{,}2}\right)(1{,}9)^2}{2g}$$

$$\boxed{P_2 = 418\ kPa}$$

Ex



* $Q = 0{,}35$
* $h_L = 2\frac{V^2}{2g}$
* $\alpha = 1$
* what power must the Pumb subbly?

sol

$$\frac{P_1}{\gamma} + \alpha \frac{V_1^2}{2g} + z_1 + h_P = \frac{P_2}{\gamma} + \alpha_2 \frac{V_2^2}{2g} + z_2 + h_t + h_L$$

$$0 + 0 + 6 + h_P = \frac{100\,000}{9810} + \frac{\left(\frac{0{,}35}{\frac{\pi}{4}(0{,}3)^2}\right)^2}{2g} + 10 + 0 + 2\frac{\left(\frac{0{,}35}{\frac{\pi}{4}(0{,}3)^2}\right)^2}{2g}$$

$$h_P = 17.94\ m$$

$$P = Q\,\gamma\,h_{(P,t)} \Longrightarrow = (0{,}35)(9810)(17{,}94)$$

$$\boxed{P = 61.6\ kW}$$

Power

ch 8

* Common Groups

- Pressure coefficient $C_p = \dfrac{P_1 - P_0}{\frac{1}{2}\rho U^2}$

- Shear stress coefficient "friction" $C_f = \dfrac{\tau}{\frac{1}{2}\rho U^2}$

- Force coefficient $C_F = \dfrac{F}{\frac{1}{2}\rho U^2 L^2}$

* the general functional form for all the π-groups

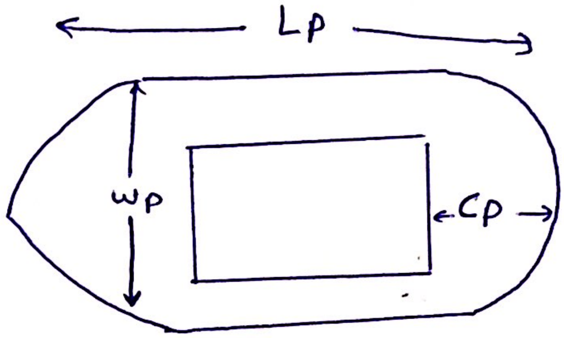
- $Re = \dfrac{\rho U L}{\mu}$

- $Fr = \dfrac{U}{\sqrt{gL}}$

- $M = \dfrac{U}{\sqrt{Ev/\rho}}$

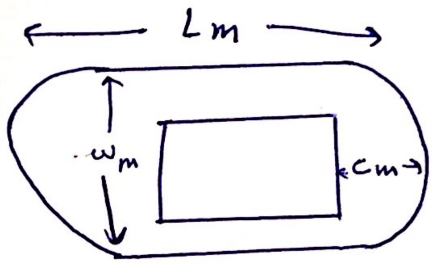
- $We = \dfrac{\rho L U^2}{\sigma}$

* Similitude



$$\frac{C_m}{C_p} = \frac{L_m}{L_p} = \frac{W_m}{W_p} = L_r$$

$L_r \Rightarrow$ Scale ratio



* Dynamic Similitude

- $Fr_m = Fr_p \Rightarrow \dfrac{U_m}{\sqrt{gL_m}} = \dfrac{U_p}{\sqrt{gL_p}}$

- $Re_m = Re_p \Rightarrow \dfrac{\rho_m U_m L_m}{\mu_m} = \dfrac{\rho_p U_p L_p}{\mu_p}$ $\boxed{\nu = \dfrac{\mu}{\rho}}$

Ex If speed of blimp through still air is 10 m/s and, a 1/10 scale model is to be tested, what air speed in the wind tunnel is needed for dynamicly similar conditions? Same pressure and temprature.

$$Re_m = Re_p \Rightarrow \frac{V_m L_m}{\nu_m} = \frac{V_p L_p}{\nu_p} \Rightarrow V_m = \frac{\nu_m}{\nu_p} * \frac{L_p}{L_m} * V_p$$

$$V_m = 1 * 10 * 10 = 100\ m/s$$

Ex large venturi meter is calibrated by means of a $\boxed{1/10}$ Scale model using the prototype liquid. what is the discharge ratio Q_m/Q_p for similarity? If $\Delta P = 300\,kPa$ modle what ΔP Similar ports in the prototype for dynamically similar?

Sol

$$Re = Re_p \quad (1)$$

$$\frac{V_m L_m}{\nu_m} = \frac{V_p L_p}{\nu_p}$$

$$\frac{V_m}{V_p} = \cancel{\frac{\nu_m}{\nu_p}} \frac{L_p}{L_m} = \frac{L_p}{L_m}$$

$$\frac{Q_m}{Q_p} = \frac{V_m A_m}{V_p A_p} = \frac{L_p}{L_m}\left(\frac{L_m^2}{L_p^2}\right) = \frac{L_m}{L_p} = \frac{1}{10}$$

$$CP_m = CP_p \quad (2)$$

$$\frac{\Delta P_m}{\rho_m V_m^2} = \frac{\Delta P_p}{\rho_p V_p^2}$$

$$\Delta P_p = \Delta P_m \left(\frac{\rho_p}{\rho_m}\right)\left(\frac{V_p}{V_m}\right)^2$$

$$\Delta P_p = 300 * 1 * \left(\frac{1}{10}\right)^2 = \boxed{3{,}0\ kPa}$$

Ex The scale ratio between a model dam and its prototype is 1/16. in the model test. the velocity of flow near the crest of the spil way was measured to be 2.3 m/s :

[1] what is the corresponding prototype velocity (in m/s)?

$L_r = \frac{1}{16}$ $\quad V_m = 2.3 \quad V_p = ?$

$Fr_m = Fr_p$

$$\frac{V_m}{\sqrt{g h_m}} = \frac{V_p}{\sqrt{g h_p}} \Rightarrow V_p = V_m \sqrt{\frac{h_p}{h_m}} \rightarrow \frac{16}{1}$$

$$V_p = 2.3 * \sqrt{16} = 9.2 \text{ m/s}$$

[2] If the model discharge is 0,13 m^3/s. what is the Prototype discharge (in m^3/s)?

$Q_m = 0{,}13 \ m^3/s \quad Q_p = ??$

$$\frac{A_m}{A_m} * \boxed{\frac{V_m}{\sqrt{g h_m}} = \frac{V_p}{\sqrt{g h_p}}} * \frac{A_p}{A_p}$$

$$\frac{\cancel{\frac{\pi}{4}} D_m^2}{\cancel{\frac{\pi}{4}} D_m^2} * \frac{V_m}{\sqrt{h_m}} = \frac{V_p}{\sqrt{h_p}} * \frac{\cancel{\frac{\pi}{4}} D_p^2}{\cancel{\frac{\pi}{4}} D_p^2}$$

$$\frac{Q_m}{D_m^2 \sqrt{h_m}} = \frac{Q_p}{D_p^2 \sqrt{h_p}} \Rightarrow Q_p = \sqrt{\frac{h_p}{h_m}} * \left(\frac{D_p}{D_m}\right)^2 * Q_m$$

$$Q_p = \sqrt{16} * 16^2 * 0{,}13$$

$Q_p = 133.12 \ m^3/s$

(4)

فضاء التحوكي
Civilittee

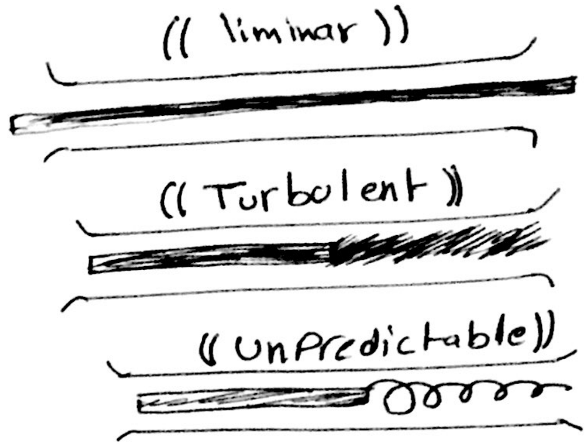
ch 10

flow in conduits

$Re \leq 2000$

$Re \geq 3000$

$2000 \leq Re \leq 3000$



$$* \quad Re = \underbrace{\frac{VD}{\nu} = \frac{\rho VD}{\mu}}_{\text{مهمات}} = \frac{4Q}{\pi D \nu} = \frac{4\dot{m}}{\pi D \mu} \quad *$$

→ Total Head loss = Pipe head loss + component head loss ←

* Pipe head loss $= h_L = \dfrac{f \overset{\text{جمع اطوال}}{L}}{\underset{\text{Pipe} \leftarrow}{D}} \dfrac{V^2}{2g}$

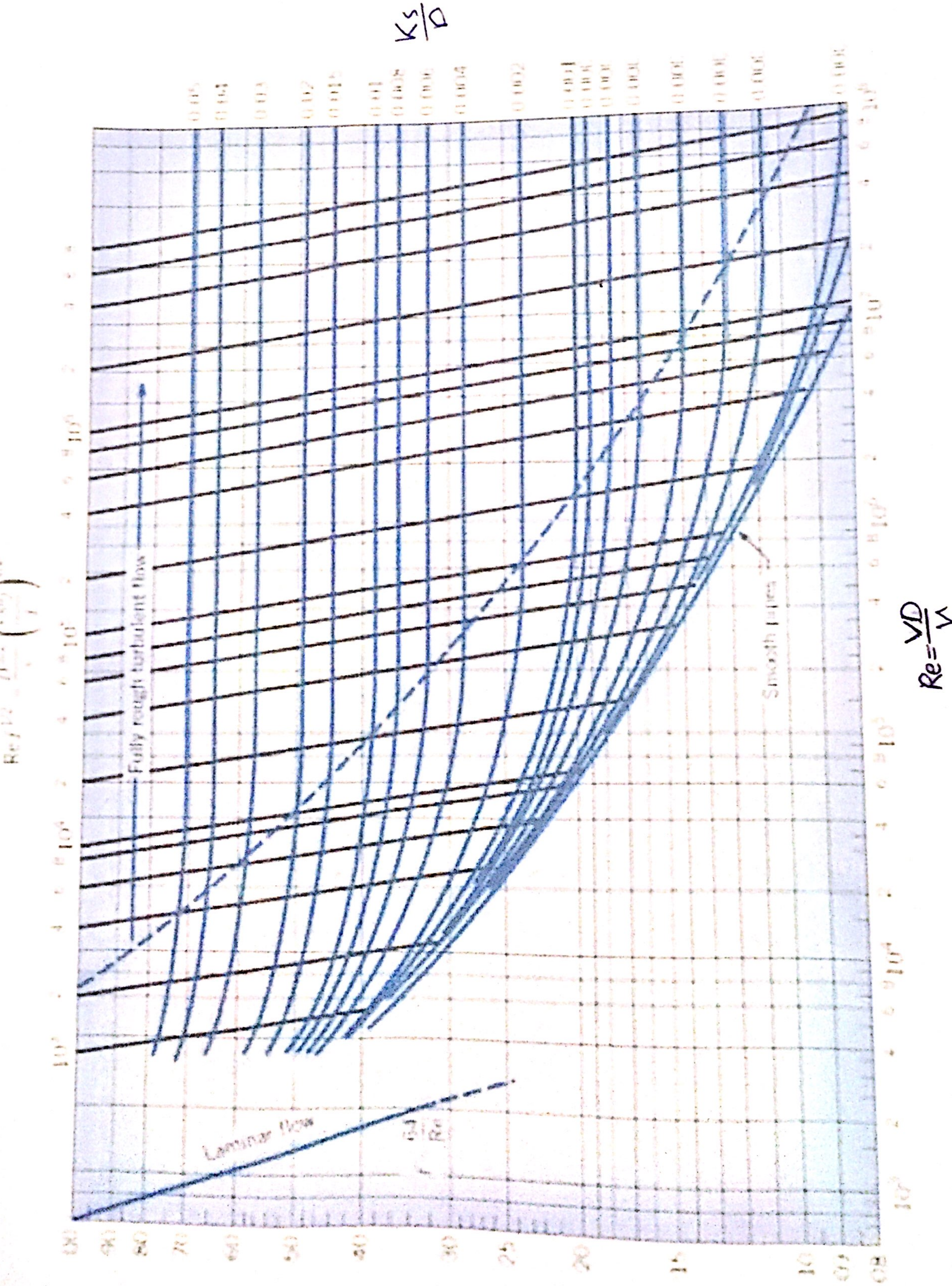
$f \leq 2000 \rightarrow$ liminar $\rightarrow f = \dfrac{64}{Re}$

$f \geq 3000 \rightarrow$ Turbulent $\rightarrow f = \dfrac{0.25}{\left[\log\left(\dfrac{K_s}{3.7D} + \dfrac{5.74}{Re^{0.9}}\right)\right]^2}$

$\rightarrow$ moody Diagram $\left(\dfrac{K_s}{D}\right)(Re)$

* component head loss ((minor)) $= h_L = K \dfrac{V^2}{2g}$

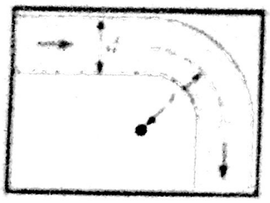
((K يتم حسابه من الجدول في الامتحان))



K_s/D
Fully rough turbulent flow
Smooth pipes
Laminar flow
$\frac{64}{Re}$
$Re = \frac{VD}{\nu}$

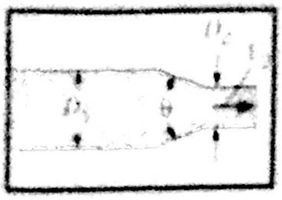
(2)

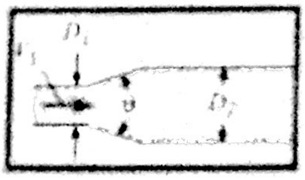
(3)



90° smooth bend		With vanes	$K_b = 0.2$
		r/d	
		1	$K_b = 0.35$
		2	0.19
		4	0.16
		6	0.21
		8	0.28
		10	0.32
Threaded pipe fittings	Globe valve—wide open		$K_v = 10.0$
	Angle valve—wide open		$K_v = 5.0$
	Gate valve—wide open		$K_v = 0.2$
	Gate valve—half open		$K_v = 5.6$
	Return bend		$K_b = 2.2$
	Tee		
	Straight-through flow		$K_t = 0.4$
	Side-outlet flow		$K_t = 1.8$
	90° elbow		$K_b = 0.9$
	45° elbow		$K_b = 0.4$

Table 10.5 LOSS COEFFICIENTS FOR VARIOUS TRANSITIONS AND FITTINGS

Description	Sketch	Additional Data		K
Pipe entrance		r/d		K_e
$h_L = K_e V^2/2g$		0.0		0.50
		0.1		0.12
		>0.2		0.03
Contraction			K_C	K_C
$h_L = K_C V_2^2/2g$		D_2/D_1	$\theta = 60°$	$\theta = 180°$
		0.00	0.08	0.50
		0.20	0.08	0.49
		0.40	0.07	0.42
		0.60	0.06	0.27
		0.80	0.06	0.20
		0.90	0.06	0.10

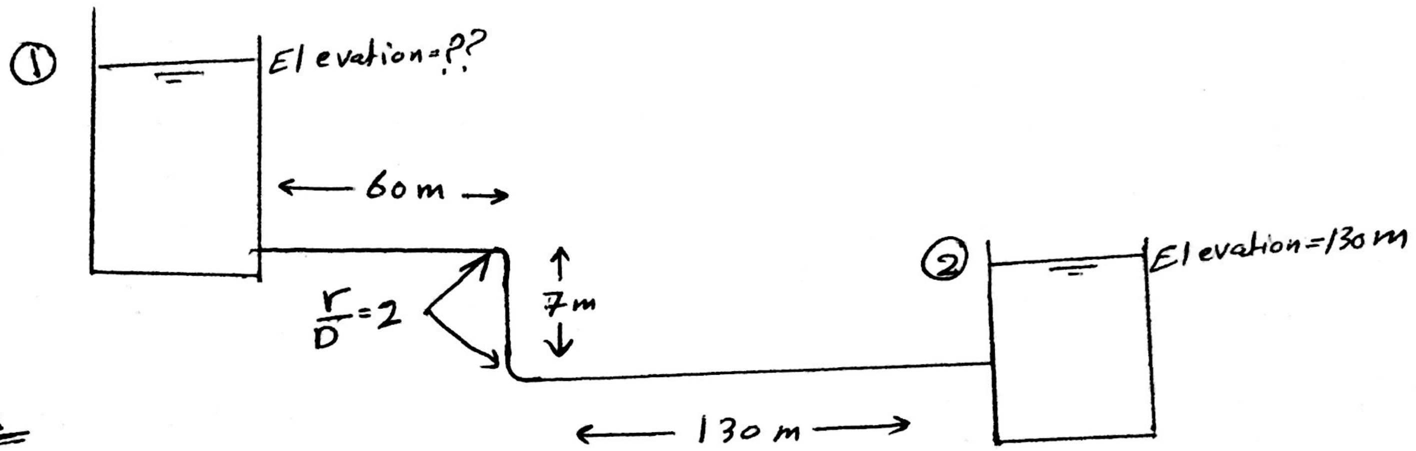
Description	Sketch	Additional Data		
Expansion			K_E	K_E
$h_L = K_E V_1^2/2g$		D_1/D_2	$\theta = 20°$	$\theta = 180°$
		0.00		1.00
		0.20	0.30	0.87
		0.40	0.25	0.70
		0.60	0.15	0.41
		0.80	0.10	0.15

Description	Sketch	Additional Data	K
90° miter bend		Without vanes	$K_b = 1.1$
		With vanes	$K_b = 0.2$

(4)

$$\left(\left(h_L = \sum_{\text{Pipes}} f \frac{L}{D}\frac{V^2}{2g} + \sum_{\text{components}} k \frac{V^2}{2g}\right)\right)$$

Ex If oil $(\nu = 4 * 10^{-5}\ m^2/s)(S = 0.9)$ flows from the upper to lower resevoir at rate $(0.028\ m^3/s)$ in the 15 cm $\underbrace{\text{smooth Pipe}}_{Ks=0}$, what is the elevation of the oil surface in the upper reservoir ?



Sol

$$\frac{P_1}{\gamma} + \alpha_1 \frac{V_1^2}{2g} + Z_1 + h_P = \frac{P_2}{\gamma} + \alpha_2 \frac{V_2^2}{2g} + Z_2 + h_t + h_L$$

$$0 + 0 + Z_1 + 0 = 0 + 0 + 130 + 0 + h_L$$

$$\underline{\underline{Z_1 = Z_2 + h_L}}$$

$$h_L = f\frac{L}{D}\frac{V^2}{2g} + \sum k \frac{V^2}{2g}$$

$$= \frac{V^2}{2g}\left(f\frac{L}{D} + \underline{\underline{K_e}} + \underline{\underline{K_E}} + 2\underline{\underline{K_b}}\right)$$

الداخل في Pipe   اثنا رجعنا Pipe   الانحناء في Pipe

(5)

$$* \; Re = \frac{VD}{\nu} = \frac{1.58\,(0.15)}{4 * 10^{-5}} \qquad \left\{ V = \frac{Q}{A} = \frac{0.028}{\frac{\pi}{4}(0.15)^2} \right.$$

$$\boxed{Re = 5.93 * 10^{3}} > \text{Turplene} \qquad \boxed{V = 1.58\ \text{m/s}}$$

$$\boxed{f} = \frac{0.25}{\left[\log\left(\frac{K_s}{3.7D} + \frac{5.74}{Re^{0.9}}\right)\right]^2} = \frac{0.25}{\left[\log\left(0 + \frac{5.74}{5930^{0.9}}\right)\right]^2} = \underline{\underline{0.036}}$$

or

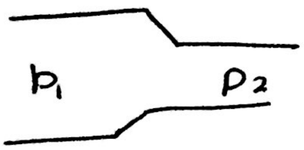
$\boxed{f}$. moody Digram ((لاكن القانون احق)) ((ماتكتبه في الامتحان))

$$Z_1 = (130) + \frac{(1.58)^2}{2 * 9.81}\left(0.036 * \frac{(197)}{(0.15)} + 2(0.19) + (0.5) + (1)\right)$$

$$\boxed{Z_1 = 136\ \text{m}}$$

ملاحظة

(1)

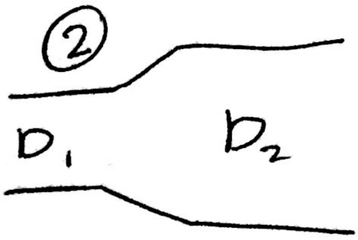


في الجدول

$\frac{D_2}{D_1}$ $\frac{\text{صغير}}{\text{كبير}}$ → D_1 اذا كانت كبيرة جداً فنعتبر النسبة صفر

$$\frac{D_2}{D_1} \approx 0$$

(2)



في الجدول

$\frac{D_1}{D_2}$ $\frac{\text{صغير}}{\text{كبير}}$ → D_2 اذا كانت كبيرة نعتبر النسبة

$$\frac{D_1}{D_2} \approx 0$$

(3) مثل (Pipe → tank) dimeter ~~[illegible]~~ التنك كبير

(6)

→ $\frac{r}{d} \approx 0$ عندما تصغر قيمة r

r $\bar{D}$ >0,2 [illegible]

Ex

what Power Pump supply to the system to pump the oil from the lower reservoir to the upper resrvoir at rate of 0,2 m^3/s ?? Sketch HGL and EGL for system.

sol

$$\frac{P_1}{\gamma} + K_1\frac{V^2}{2g} + Z_1 + h_P = \frac{P_2}{\gamma} + K_2\frac{V^2}{2g} + Z_2 + h_T + \sum h_L$$

$$0 + 0 + 100 + h_P = 0 + 0 + 112 + 0 + \sum h_L$$

$$h_P = 12 + \sum h_L$$

$$\sum h_L = \frac{V^2}{2g}\left(f\frac{L}{D} + K_e + K_E\right)$$

$$= \frac{(2.83)^2}{2*9{,}81}\left(0{,}019 * \frac{150}{0{,}3} + 0{,}03 + 1\right)$$

$$\boxed{\sum h_L = 4.3\,m}$$

$$h_P = 12 + 4.3 = 16.3\,m$$

$$P = Q\gamma h_P = 0{,}2 * (940 * 9{,}81) * 16.3$$

$$\boxed{P = 30{,}1\,kW}$$

$$V = \frac{Q}{A} = \frac{0{,}2}{\frac{\pi}{4}(0{,}3)^2} = 2.83\,m/s$$

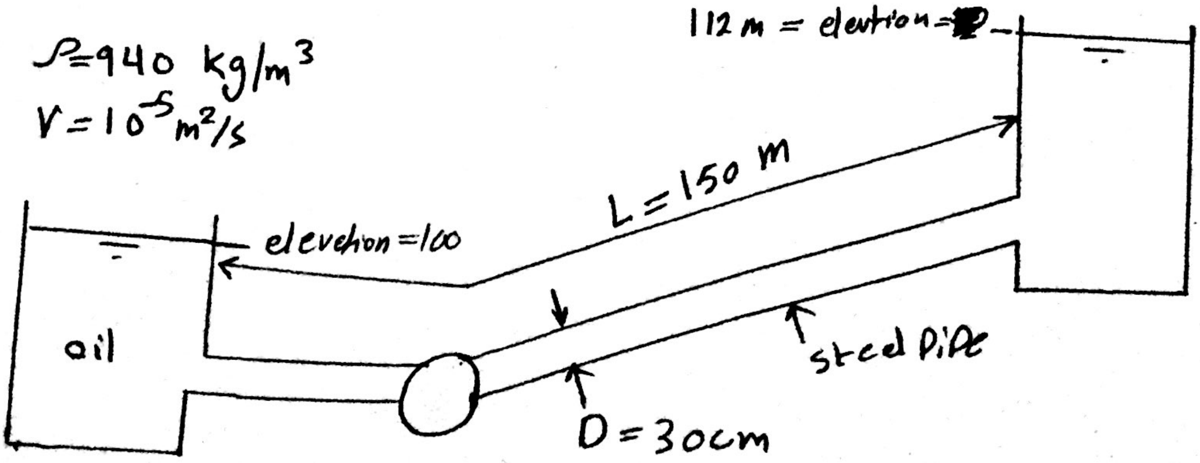
$$Re = \frac{VD}{\nu} = \frac{2.83 * 0{,}3}{10^{-5}} = 8.5 * 10^4$$

$$\frac{K_s}{D} = \frac{4.6 * 10^{-5}}{0{,}3} = 1.5 * 10^{-4}$$

f moody digram $= f = 0{,}019$

$$f_{equation} = \frac{0{,}25}{\left[\log\left(\frac{K_s}{3.7D} + \frac{5.74}{Re^{0{,}9}}\right)\right]^2} = \underline{\underline{0{,}019}}$$

fig

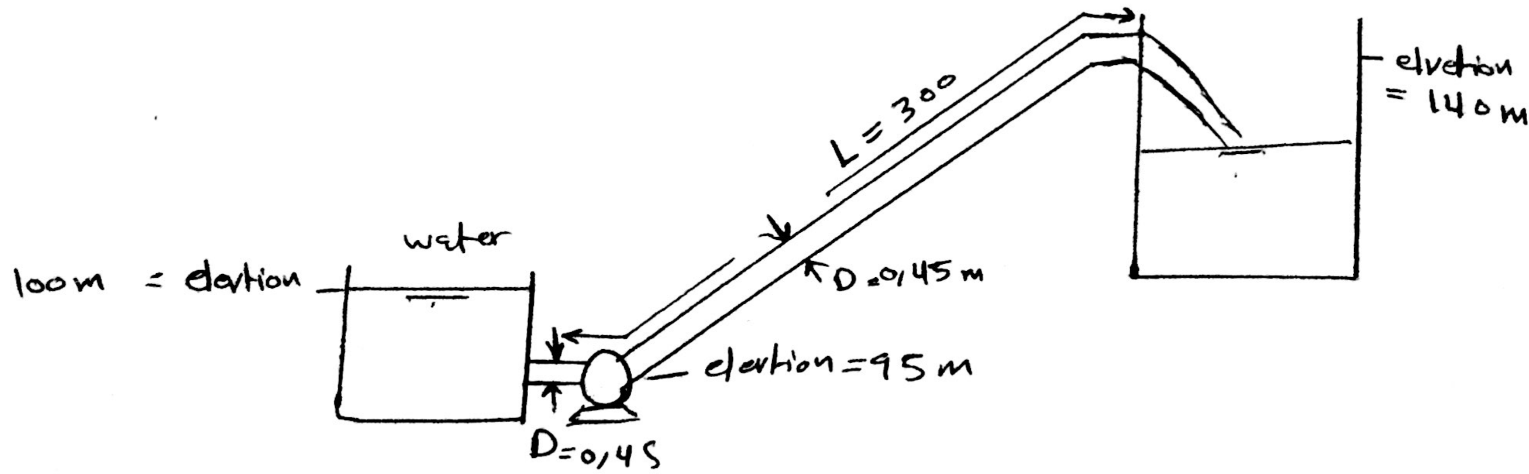


محاضرة 12

[illegible] **Ex** * water is pumped at rate of 0,325 m^3/s from reservoir and out through the pipe. The pipe has a Total Length of 300 m and a diameter of 0,45 m. the Piping System contains :- Two Gate Valves wid open.

مهمة

a) what is the flow velocity in the pipe (m/s)?
b) what is the type of flow?
c) what is the friction factor and the major head loss in (m)?
d) what is the minor head loss (in m)?
e) what the pump head (in m) and power must be supplied to produce this discharge (in kw)?



*** Additional date**

✓ water viscosity $= 1.31 * 10^{-6}\ m^2/s$ → الوحدة مهمة → $(Pa/m^2)\ N.s/m^2$ * اذا كانت نحولها الى Kintic vescosity $\nu = \frac{\mu}{\rho}$

✓ At the entrance r/d 7 0,2

*** Valves date**

Globe valve - wide open $k_v = 10$
Angle valve - wide open $k_v = 5$
Gate valve - wide open $k_v = 0,2$

Surface roughness Date (k_s)
✓ Steel = 0,046 mm ←
Copper = 0,0015
Rubber = 0,025

(8)

Sol

a) $V = \dfrac{Q}{A} = \dfrac{0.325}{\frac{\pi}{4}(0.45)^2} = 2.044 \ m/s$

b) $Re = \dfrac{VD}{\nu} = \dfrac{2.044 * 0.45}{1.31 * 10^{-6}} = 7.02 * 10^5$

$Re > 3000 \rightarrow$ Turblent flow

c) $f = \dfrac{0.25}{\left[\log\left(\frac{k_s}{3.7D} + \frac{5.74}{Re^{0.9}}\right)\right]^2} = 0.014$

k_s steel $\rightarrow$ 0.046 mm

$h_{L_{major}} = f \dfrac{L}{D} \dfrac{V^2}{2g} = 0.014 * \dfrac{300}{0.45} * \dfrac{(2.044)^2}{2g} = 1.98 \ m$

d) $h_{L_{minor}} = \dfrac{V^2}{2g}(k_e + k_E + 2k_V)$

داخل

خارج

معطى في السؤال

$= \dfrac{(2.044)^2}{2g}\left(0.03 + 1 + 2(0.2)\right] = 0.304 \ m$

e) $\dfrac{P_A}{\gamma} + Z_A + \dfrac{V_A^2}{2g} + h_p = \dfrac{P_B}{\gamma} + Z_B + \dfrac{V_B^2}{2g} + h_T + \Sigma h_L$

$0 + 100 + 0 + h_p = 0 + 140 + \dfrac{(2.044)^2}{2g} + 0 + (1.98 + 0.304)$

$h_p = 40 + \dfrac{(2.044)^2}{2g} + (1.98 + 0.304)$

$\boxed{h_p = 42.5 m}$

$P = \gamma Q h_p = 9810 * 0.325 * 42.5 = \boxed{135.49 \ kW}$

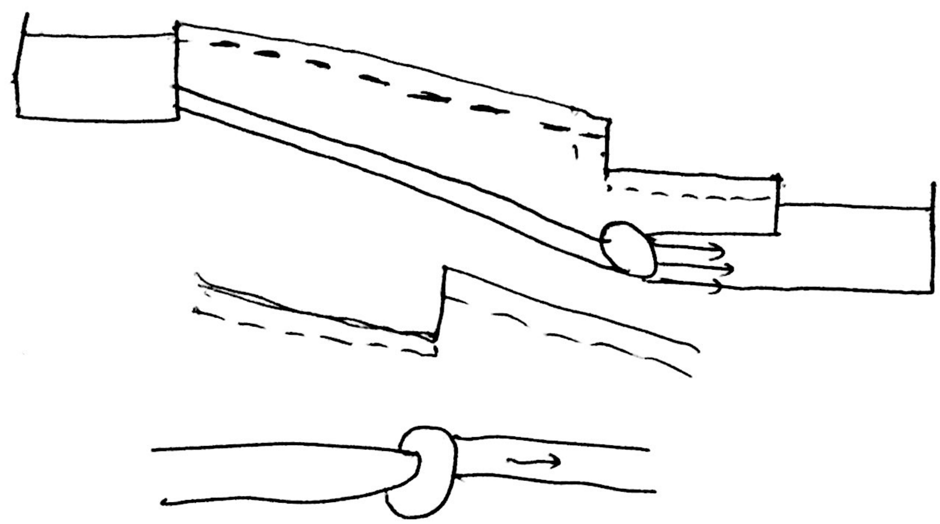
* EGL ————

  HGL - - - - -

* دائماً الخطوط تنزل بشكل قطري. بسبب الاحتكاك الناتج عن الانبوب. سواء كان الانبوب طالع او نازل.

* في PumP الخطوط ترتفع.

* في Turbine الخطوط تنزل.



مهم !!

* $EGL = HGL + \frac{V^2}{2g}$

قصطلي   قصطل   V = ??

$HGL = \frac{P}{\gamma} + z$