ملخص مادة..

ميكانيكا موائع

لجنة الميكانيك

Polytechnic

بسم الله الرحمن الرحيم

الحمد لله والصلاة والسلام على سيدنا محمد وعلى اله وصحبه أجمعين . الحمد لله حمدا كثيرا طيبا مباركا يليق بجلال وجهه وعظيم سلطانه , الحمد لله الذي جعل لنا من العلم نورا نهتدي به والحمد لله الذي من علينا بأتمام هذا الملخص لمادة " ميكانيكا الموائع ".

نتقدم نحن " لجنة الميكانيك " بتلخيصنا هذا الى زملائنا الطلاب والى كل من يجمعنا بهم رباط العلم سائلين المولى أن يتقبله منا وأن ينال اعجابكم , وأن لا نكون قد قصرنا أو أهملنا فيه .

نحيطكم علما بأن هذا التلخيص لا يغني عن شرح المدرس في المحاضرة والرجوع الى الكتاب .
حيث تتطلب المادة حل الكثير من الأسئلة والرجوع الى جداول المادة في اخر الكتاب.

المرجع المعتمد لكاتب التلخيص هو :
ENGINEERING FLUID MECHANICS 10th edition

نسأل الله لكم التوفيق ودوام النجاح والتفوق .
لجنة الميكانيك

UOLOADED BY AHMAD JUNDI

- INTRODUCTION :

(Fluid)

1- At Rest
- Liquid &Gasses. (First Exam)
- Solid. (statics)

2- At motion
- Liquid &Gasses. (Second Exam)
- Solid. (Dynamic)

المــائع هو أي مادة قابله للإنسياب أو الإنتشار مثل السوائل والغازات ^^

CHAPTER TWO: "FluidProperties "

للمائع عدة خصائص سنتكلم عن هذا الخصائص في هذا الشابتر ..

Mass Density "ρ "

Is defined as the Ratio of Mass of Volume At a point.

The densities of common fluids are given in Tables A.2 to A.5.

$$\rho = \frac{Mass}{Volume} kg/m^3$$

For Example:

ρ = 1000 kg / m ^{3} (Water @ 0 C ^{0})
ρ = 985 kg / m ^{3} (Water @ 100 C ^{0})

Notes:

- For Liquids (massdensity) Decreases Slightly with increasing temperature.
- For Gasses (mass density) Significantly change with Change temperature.

Specific weight "γ "

Is Defined as The gravitational force per unit volume of fluid, or simply the weight per unit volume.

$$\gamma = \rho * g \ (N/m^2)$$

Specific weights of common liquids are given in Table A.4.

For Example:

γ = 9810 N/ m^{٣}(Water @ 0 C ^{o})

γ = 12.65 N/ m^{٣}(Air @ 0 C ^{o})

Specific Gravity " S , SG "

Is Defined the ratio of the specific weight of a given fluid to the specific weight of water at the standard Reference temperature 4° C.

$S.G = \gamma_{Fluid}/\gamma_{Water.}$

$= \rho_{Fluid} \ / \ \rho_{water}$

For Example:

$S.G_{Hg} = 13.6$

2.5 Calculate the density and specific weight of carbon dioxide
At a pressure of 300 absolute and 60° C.

$\rho ? \quad \gamma ?$

$$PV = mRT$$

$$\rho = \frac{P}{RT} = \frac{300}{(189)(60+273)}$$

[From table A.2]

$$= \boxed{4.77 \ kg/m^3}$$

$$\gamma = \rho * g$$

$$= 4.77 * 9.81$$

$$= \boxed{46.764 \ N/m^3}$$

Ideal Gas Law

The*ideal gas law*relates important thermodynamic properties, and is often used to calculatedensity.

$$P\ V = nRuT$$

Where :

*P*is the absolute pressure.
*V*is the volume.

n is the number of moles .
R_u is the universal gas constant (the same for all gases) .
T is absolute temperature.

.

.

$$P V = mRT$$

Where:

m is mass .
R is a number of gases(given in Table A.2)

EXAMPLE 2.1: Air at standard sea-level pressure (p 101 kN/m2) has a temperature of 4° C. What is the density of the air?

$$P = \rho R T$$

$$\rho = \frac{P}{RT} = \frac{101 \times 10^3}{287(273+4)}$$

$$= \boxed{1.27 \ Kg/m^3}$$

2.7 Natural gas is stored in a spherical tank at a temperature of10° C. At a given initial time, the pressure in the tank is 100 kPa gage, and the atmospheric pressure is 100 kPa absolute. Sometimelater, after considerably more gas is pumped into the tank, the pressure in the tank is 200 kPa gage, and the temperature is still 10° C.
What will be the ratio of the mass of natural gas in the tank when P =200 k pa gage to that when the pressure was 100 kPa gage?

$$P = \rho RT$$

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

$$m = \frac{PV}{RT}$$

$$\frac{m_2}{m_1} = \frac{\frac{P_1 \cancel{V_1}}{\cancel{R_1} \cancel{T_1}}}{\frac{P_2 \cancel{V_2}}{\cancel{R_2} \cancel{T_2}}} = \frac{P_2}{P_1}$$

$$= \frac{300}{200}$$

$$= \boxed{1.5}$$

"abs" P لازم يكون ال *

$$P_{abs.} = P_{gauge} + P_{atm}$$

2.10 A 10 m3 oxygen tank is at 15°C and 800 kPa. The valve is opened, and some oxygen is released until the pressure in the tank drops to 600 kPa. Calculate the mass of oxygen that has been released from the tank if the temperature in the tank does not change during the process.

$V = 10\ m^3$
oxygen
$T_1 = 15C°$ | $T_2 = 15C°$
$P_1 = 800\ kPa$ | $P_2 = 600\ kPa$

$$\rho_1 = \frac{P_1}{RT} = \frac{800 * 10^3}{(260)(288)}$$

$$\boxed{\rho_1 = 10.68\ kg/m^3}$$

$$\rho_1 = \frac{m_1}{V} \Rightarrow m_1 = 10.68 * 10 = \boxed{106.8\ kg}$$

$$\rho_2 = \frac{P_2}{RT} = \frac{600 * 10^3}{(260)(288)} = \boxed{8\ kg/m^3}$$

$$m_2 = \rho_2 V = 8 * 10 = \boxed{80\ kg}$$

$$\Delta m = m_1 - m_2$$

$$= 106.8 - 80$$

$$= \boxed{26.8\ kg}$$

#

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Properties Involving Thermal Energy:

Specific Heat:
The property that describes the capacity of a substance to store thermal energy.

Internal Energy :
The energy that a substance possesses because of the state of the molecular activity in the substance.

Enthalpy:
It is the scale the total energy.

Viscosity:

(Also called *dynamic viscosity*, or *absolute viscosity)*

{shear stress} ={shear modulus} · {strain}

{shear stress} = {viscosity} · {rate of strain}

$$\tau = \mu \frac{d\theta}{dt}$$

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

$$\mu = \frac{\tau}{dv/dy} \quad \text{pa. s}$$

For Example:

$\mu = 10^{-3}$ pa. S (Water @ 20 C°)
$\mu = 1.8 * 10^{-5}$ pa. S (Air @ 20 C°)

A common unit of viscosity is the *poise*

Poise = $\frac{g}{cm.s}$ = 0.1 pa. S

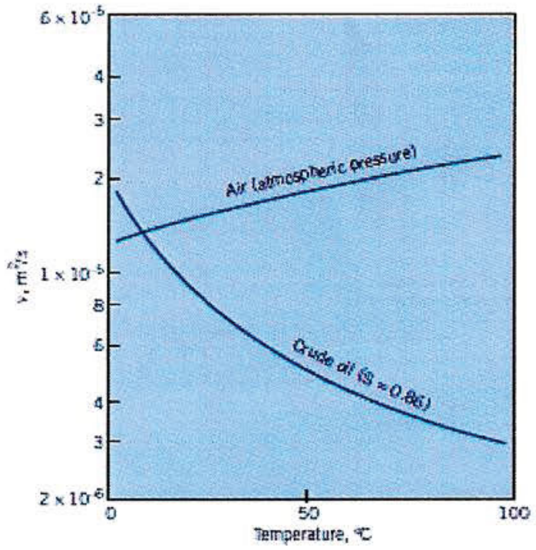
Kinematic Viscosity "ν"

$$\nu = \frac{\mu}{\rho} \ (m^2/s)$$

For Example:

ν= 10^{-6} m^2/s (Water @ 20 C⁰)

Temperature coff. Viscosity:



نلاحظ من الشكل السابق أن معامل اللزوجه يزداد في حال ازدياد درجه الحرارة (في الغازات).
ونلاحظ أيضآ أن معامل اللزوجه يقل في حال ازدياد درجة الحرارة (في السوائل) .

Viscosity Equation:

1-In Liquids :

$\mu = c\, e^{b/T}$

Where c&b are Constant .

2-In Gases :

Sutherland's equation

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

Where

μ_0 is the viscosity at temperature T_0

S is Sutherland's constant (given in Table A.2)

For Example:

$S = 111\ K\ (Air)$

EXAMPLE 2.2: The dynamic viscosity of water at 20° C is $1.00 \cdot 10^{-3}$ N · s/m² and the viscosity at 40° C is $6.53 \cdot 10^{-4}$ N · s/m². Using Eq. (2.9), estimate the viscosity at 30° C.

Liquid

$\mu = C e^{b/T}$

$\ln\mu = \ln C + b/T$

$\ln(10^{-3}) = \ln C + b/(20+273)$

$\ln(6.53 * 10^{-4}) = \ln C + b/(40+273)$

$T = 20 \rightarrow \mu = 10^{-3}$ pa.s

$T = 40 \rightarrow \mu = 6.53 * 10^{-4}$ pa.s.

$-6.908 = \ln C + 0.00341\, b$

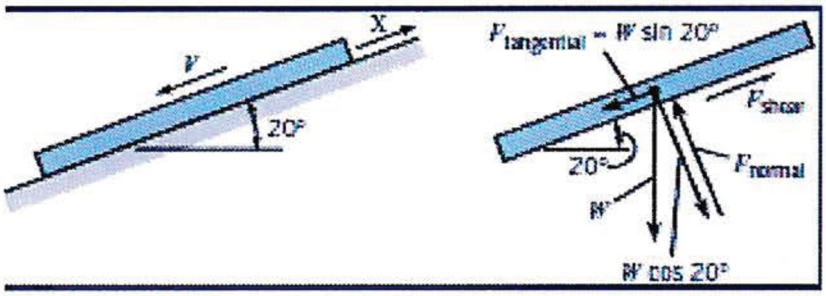
$-7.334 = \ln C + 0.00319\, b\ (*-1)$

$\boxed{b = 1936.36\ K}$ $\boxed{C = 1.357 * 10^{-4}}$

$\mu|_{@30C^\circ} = 1.357 * 10^{-4}\, e^{-1936.36/303}$

$\mu = 8.089 * 10^{-4}$ pa.s

EXAMPLE 2.3: A board 1 m by 1 m that weighs 25 N slides down an inclined ramp (slope= 20) with a velocity of 2.0 cm/s. The board is separated from the ramp by a thin film of oil with a viscosity of 0.05 $N \cdot s/m^2$, Neglecting edge effects, calculate thespace between the board and the ramp.



* Free body

$$F_t = F_{shear}$$

$$W \sin 20 = \tau A$$

$$w \sin 20 = \mu \frac{dv}{dy} A$$

$$dy = \frac{\mu \, dv \, A}{W \sin 20}$$

$$= \frac{0.05 \, (2 * 10^{-2}) \, (1 * 1)}{25 \, (\sin 20)}$$

$$dy = 1.169 * 10^{-4} \, m$$

2.23 The dynamic viscosity of air at 15° C is $1.78*10^{-5}$ N · s/m². Using Sutherland's equation, find the viscosity at 100° C.

Air (Gas)

$T = 15C° \longrightarrow \mu_0 = 1.78 * 10^{-5}$ pa.s

$T = 100C° \longrightarrow \mu$?!

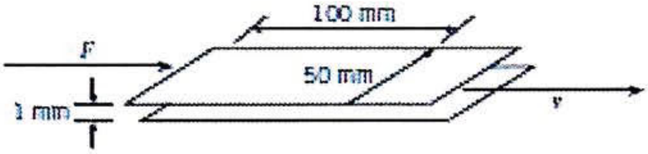
$$\frac{\mu}{\mu_0} = \left(\frac{T}{T_0}\right)^{3/2} \frac{T_0 + S}{T + S}$$

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

$$\mu = 1.78 * 10^{-5} \left(\frac{100 + 273}{15 + 273}\right)^{3/2} \left(\frac{288 + 111}{373 + 111}\right)$$

$$\mu = 2.15 * 10^{-5} \text{ pa.s}$$

2.33 The sliding plate viscometer shown below is used to measure the viscosity of a fluid. The top plate is moving to the right with a constant velocity of 10 m s in response to a force of 3 N.
The bottom plate is stationary. What is the viscosity of the fluid?
Assume a linear velocity distribution



$$F = \tau A$$

$$\tau = \frac{F}{A} = \frac{3}{(50)(100)(10^{-6})} = \boxed{600\,N/m^2}$$

للتحويل من mm إلى m

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

$$\mu = \frac{600}{\frac{10}{(1\times10^{-3})}} = \boxed{0.06\ pa.s}$$

2.34 The velocity distribution for water (20=C) near a wall is given by $u = a(y/b)^{1/6}$, where a =10 m s, b =2 mm, and y is the distance from the wall in mm. Determine the shear stress in the water at y = 1 mm.

$$u = a(y/b)^{1/6}$$

$$\frac{du}{dy} = \frac{a}{b^{1/6}} \frac{1}{6y^{5/6}}$$

$$\frac{du}{dy} = \frac{a}{6b}\left(\frac{b}{y}\right)^{5/6}$$

@ $y = 1\,mm$

$$\frac{du}{dy} = \frac{10}{6(2*10^{-3})}\left(\frac{2*10^{-3}}{1*10^{-3}}\right)^{5/6}$$

$$\boxed{\frac{du}{dy} = 1485\ s^{-1}}$$

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

$$= 1*10^{-3}\ (1485)$$

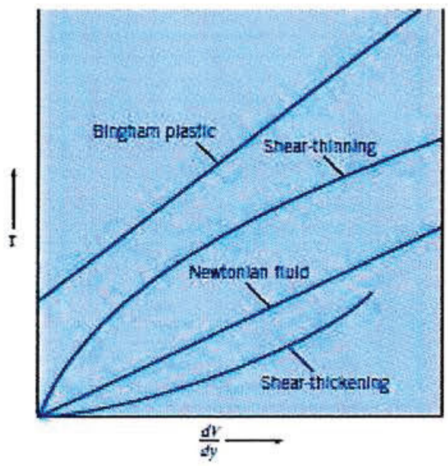
$$= \boxed{1485 * 10^{-3}\ pa}$$

2.39 Consider the ratio μ_{100}/μ_{50} where μ is the viscosity of oxygen and the subscripts 100 and 50 are the temperatures of the oxygen in degrees Fahrenheit. Does this ratio have a value?
(a) Less than 1, (b) equal to 1, or (c) greater than 1?

$$\frac{\mu_{100}}{\mu_{50}} > 1 \qquad \mu_{100} > \mu_{50}$$

* في الغازات
كل ما زادت
درجة الحرارة
تزداد الـ [μ]

$\boxed{c}$ greater than 1



Non Newtonian fluid (Shear-thinning, plastic)

Newtonian fluid (Water,Oil, Air)

Bulk Modulus of Elasticity "Ev"

Is a property that relates changes in pressure to changes in volume.

$$Ev = -\frac{dp}{dv/V} = -\frac{\text{change in pressure}}{\text{fractional change in volume}}$$

حفظ السالب
لأنه الضغط يسبب
تناقص بالحجم

For Example:

$Ev = 2.2 * 10^9$ pa (water)
$Ev = 10^5$ pa (Air)

Compressibility = $\frac{1}{\text{Elasticity}}$.

$$\frac{\text{Compressibility (Air)}}{\text{Compressibility (Water)}} = \frac{2.2*10^9}{10^5} = 2.2 * 10^4$$

*من هنا نستنتج أن الماء "تقريبا" غير قابل للانضغاط .

2.47 An open vat in a food processing plant contains 400 L of water at 20°C and atmospheric pressure. If the water is heated to 80°C, what will be the percentage change in its volume? If the vat has a diameter of 3 m, how much will the water level rise due to this temperature increase? *Hint:* In this case the volume change is due to change in temperature.

$V = 400L$ | $T_2 = 80C^\circ$

$T_1 = 20C$ | $d = 3m$

atm. pressure

$$\boxed{\rho_1 = \frac{P_1}{RT_1}}$$

$$m_1 = \frac{P_1 V_1}{RT_1}$$

$$m_1 = \rho_1 V_1$$

$$m_1 = 998 * (400 * 10^{-3})$$

$$\boxed{m_1 = 399.2 Kg}$$

$m_1 = m_2$

$\rho_1 = \rho_2$

$$V_2 = \frac{m_2}{\rho_2} = \frac{399.2}{1000} = \boxed{0.411 m^3}$$

percentage change in volume

$$\frac{V_2 - V_1}{V_1} = \frac{0.411 - 0.4}{0.4} = 0.0275$$

$$\text{volume } \% = \boxed{2.75 \%}$$

$$V = \pi r^2 h$$

$$\boxed{\begin{array}{l} d = 3m \\ r = 1.5m \end{array}}$$

$$h_{20C^\circ} = \frac{0.4}{\pi r^2} = \frac{0.4}{\pi (1.5)^2} = \boxed{0.0565 m}$$

$$h_{80C^\circ} = \frac{0.411}{\pi (1.5)^2} = \boxed{0.05814 m}$$

$$\Delta h = h_2 - h_1$$

$$= 0.05814 - 0.056$$

$$\Delta h = 1.64 * 10^{-3} m$$

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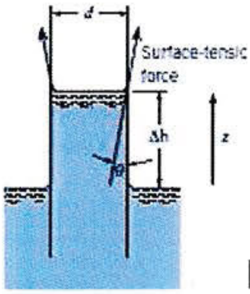
Surface Tension " σ "

Force per unite length

$$\sigma = \frac{F}{L} = \frac{N}{m}$$

Capillary action

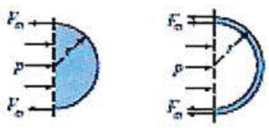
Rise above a static water level at atmospheric pressure show Fig.



IF $\theta < 90$ (Liquid wet surface)

IF $\theta > 90$ (Liquid not wet surface)

$$h = \frac{2\sigma}{\Upsilon r}\cos(\theta)$$



Water Droplet

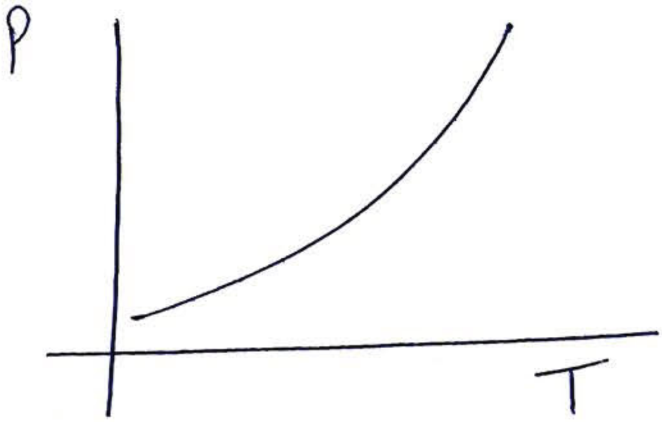
Soap bubble

$P = \frac{4\sigma}{d}$ $P = \frac{8\sigma}{d}$

Vapor Pressure

The pressure at which a liquid will vaporize, or boil, at a given temperature.

الـ **Vapor Pressure** يتكون عندما يتساوى الضغط المحلي ضغط البخار .



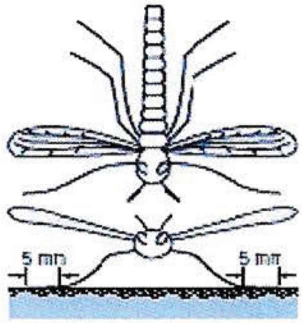
نلاحظ من الشكل التالي

أن قيمة "vapor pressure"

تزداد مع ازدياد درجة الحرارة .

2.50A spherical soap bubble has an inside radius *R*, a filmThickness *t*, and a surface tension. Derive a formula for thepressure within the bubble relative to the outside atmosphericpressure. What is the pressure difference for a bubble with a4 mm radius?
Assume is the same as for pure water.

2.51 A water bug is suspended on the surface of a pond by surfacetension (water does not wet the legs). The bug has six legs,and each leg is in contactwith the water over a length of 5 mm.
What is the maximum mass (in grams) of the bug if it is to avoid Sinking?



2.55 By measuring the capillary rise in a tube, one can calculate the surface tension. The surface tension of water varies linearly with temperature from 0.0756 at 0°C to 0.0589 at 100°C. Size a tube (specify diameter and length) that uses capillary rise of water to measure temperature in the range from 0°C to 100°C. Is this design for a thermometer a good idea?

END OF CHAPTER TWO
Good Luck

CHAPTER THREE: "Fluid Statics"

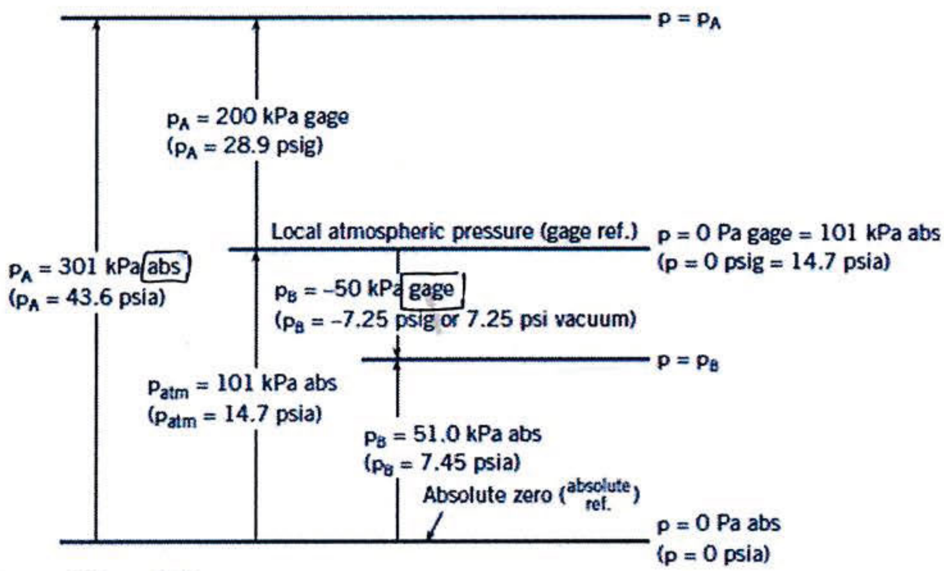
Pressure

Is defined as the ratio of normal force to area at a point.

$$P = \frac{F}{A} = \frac{N}{m^2} = Pa.$$

Types OF Pressure:

Absolute Pressure, Gage Pressure, and Vacuum Pressure.



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

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

$$P_{gage} = - P_{vacume}$$

دائماً عند سطح الـ "atm"

$p = 101$ kpa (abs)

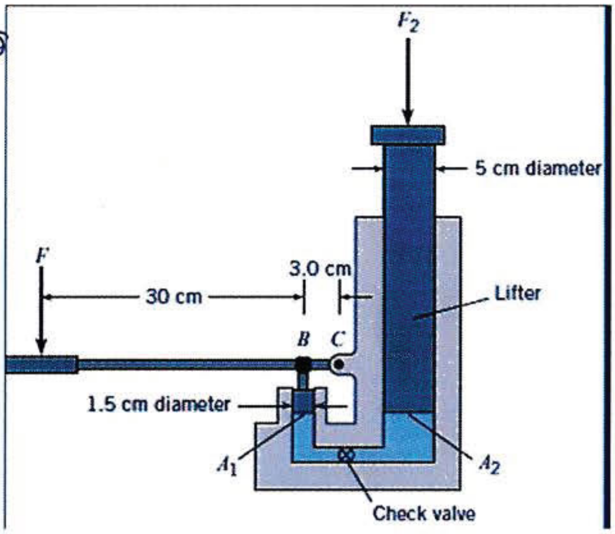
$p = 0$ kpa (gage)

Hydraulic Machines

تستخدم الآله الهيدروليكية مكونات مثل المضخات لنقل القوات والطاقه باستخدام الموائع.
من الأمثـلة على ذلك: أنظمة الكبح , رافعات الشاحنات , أنظمة التحكم بالطائرة .

من مميزات هذا النظام أن أي شخص يستخدم " الـجاك " يمكنه رفع حموله أكبر من ذلك .

EXAMPLE 3.1: A hydraulic jack has the dime
Sons shown. If one exerts a force F of 100 N on the handle of the jack, what load, F_2, can the jack support? Neglect lifter weight.



⊛ أولاً نحسب القوة المؤثرة F_1 (piston)
عن طريق العزوم عند النقطة (C)

$\Sigma M_C = 0$

$-F(33 * 10^{-2}) + F_1(3*10^{-2}) = 0$

(100N)

$\boxed{F_1 = 1100 N}$

⊛ ثانياً نحسب الضغط من القانون :-

$F_1 = P_1 A_1$

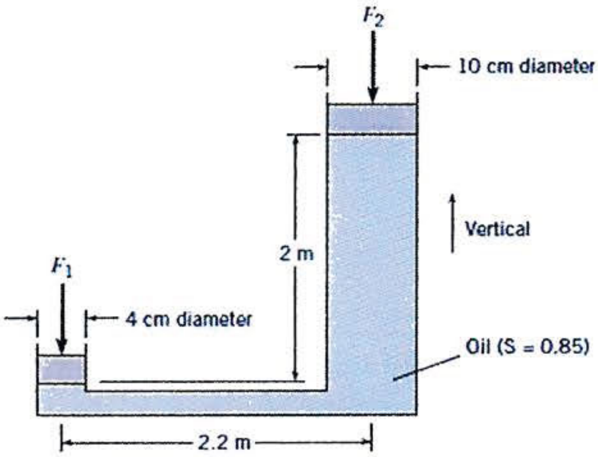
$\frac{F_1}{A_1} = P_1$

$P_1 = \frac{1100}{\frac{\pi}{4}(1.5*10^{-2})^2} = \boxed{6.22 * 10^6 \ pa}$

⊛ ثالثاً نحسب F_2 من القانون :-
علماً بأن $P_1 = P_2$

$F_2 = P_2 A_2 = 6.22*10^6 \left(\frac{\pi}{4}(5*10^{-2})^2\right) = \boxed{12200 N}$

3.13 If a 200 N force $F1$ is applied to the piston with the 4 cm diameter, what is the magnitude of the force $F2$ that can be resisted by the piston with the 10 cm diameter? Neglect the weights of the pistons.



$$F_1 = P_1 \, A_1$$

$$P_1 = \frac{F_1}{A_1} = \frac{200}{\frac{\pi}{4}(0.04)^2} = 159.154 \ KN/m^2$$

From Hydrostatic equation

$$P_2 + \gamma_2 z_2 = P_1 + \gamma_1 z_1$$

$z_1 - z_2$

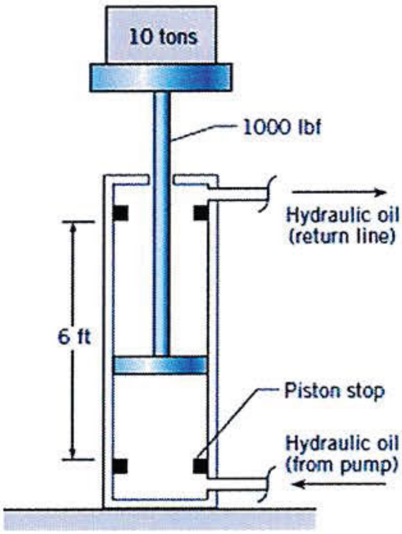
$$P_2 = 159.15 * 10^4 + (9810 * 0.85)(-2)$$

$$P_2 = 142.5 * 10^3 \ KN/m^2 \longrightarrow F_2 = P_2 \, A_2$$

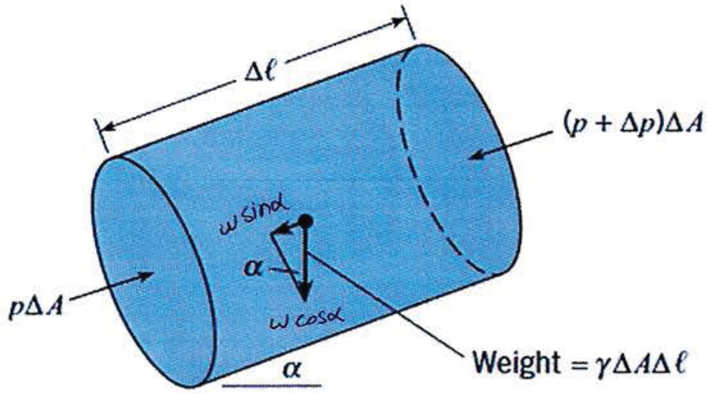
$$= 142.5 * 10^3 \left(\frac{\pi}{4}(0.1)^2\right)$$

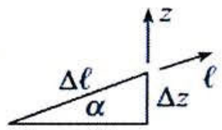
$$F_2 = 1120 \ N$$

3.18 A tank is fitted with a manometer on the side, as shown. The liquid in the bottom of the tank and in the manometer has a specific gravity (S) of 3.0. The depth of this bottom liquid is 20 cm. A 15 cm layer of water lies on top of the bottom liquid. Find the position of the liquid surface in the manometer.



Pressure Variation with Elevation





$$\boxed{\sin\alpha = \frac{\Delta Z}{\Delta L}}$$

$$\Sigma F_L = 0$$

$$P\Delta A - (P+\Delta P)\Delta A - w\sin\alpha = 0$$

$$\cancel{P\Delta A} \cancel{- P\Delta A} - \Delta P\Delta A - w\sin\alpha = 0$$

$$-\Delta P\Delta A - \gamma\Delta A\cancel{\Delta L}\frac{\Delta Z}{\cancel{\Delta L}} = 0$$

$$\boxed{\frac{\partial P}{\partial Z} = -\gamma}$$ → Hydrostatic differential equation.

* من هذه المعادلة نستنتج أن الضغط لا يتغير إلا بتغير الارتفاع.

* إذا زاد الارتفاع قل الضغط والعكس صحيح.

* بعد إجراء عملية التكامل على معادلة "Hydrostatic ----"

$$P + \gamma Z = P = const. \quad \text{(piezometric pressure)}$$

بالقسمة على γ

$$\frac{P}{\gamma} + Z = h = const. \quad \text{(piezometric head)}$$

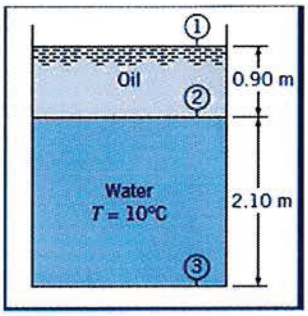
$$P + \gamma z = const$$

where z :- elevation.

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

where h :- piezometric head.

EXAMPLE 3.3: Oil with a specific gravity of 0.80 forms a layer 0.90 m deep in an open tank that is otherwise filled with water. The total depth of water and oil is 3 m. What is the gage pressure at the bottom of the tank?



Oil (S.G = 0.8)

$1 \rightarrow 2$

$$\cancel{P_1} + \gamma_1 z_1 = P_2 + \gamma_2 z_2$$

1atm
0gage

$$(9810*0.8)(3) = P_2 + (9810*0.8)(2.1)$$

$$\boxed{P_2 = 7.0632 \text{ kpa}}$$

$2 \rightarrow 3$

0m

$$P_2 + \gamma_2 z_2 = P_3 + \cancel{\gamma_3 z_3}$$

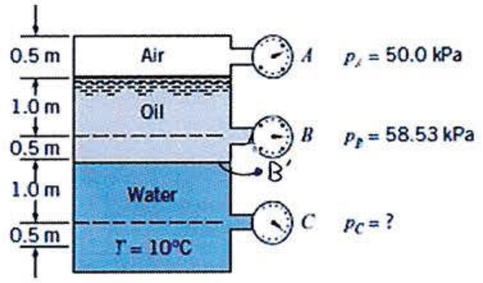
$$7.0632*10^3 + 9810(2.1) = P_3$$

$$\boxed{P_3 = 27.75 \text{ kpa}}$$

* لاحظ: هذا السؤال قمنا بحساب P_2 ثم P_3 لوجود مادتين

لو عكسنا حساب P_3 دون P_2.

3.11 For the closed tank with Bourdon-tube gages tapped into it, what is the specific gravity of the oil and the pressure reading on gage *C*?



S.G ?!

P_c ?!

A → B

$$P_A + \gamma_A z_A = P_B + \gamma_B z_B$$

(أخذنا المرجع B) $50*10^3 + \gamma_{oil}(1) = 58.53*10^3 + 0$

$$\gamma_{oil} = 8530\ N/m^3$$

$$S.G = \frac{\gamma_{oil}}{\gamma_{water}} = 0.869$$

B → B'

$$P_B + \gamma z_B = P_{B'} + \gamma z_{B'}$$

(أخذنا المرجع B') $58.53*10^3 + 8530(0.5) = P_{B'} + 0$

$$P_{B'} = 62.795\ kPa$$

B' → C

$$P_{B'} + \gamma z_{B'} = P_c + \gamma z_c$$

(أخذنا المرجع C) $62.795*10^3 + 9810(1) = P_c + 0$

$$P_c = 72.605\ kPa$$

Pressure Variation in the Atmosphere

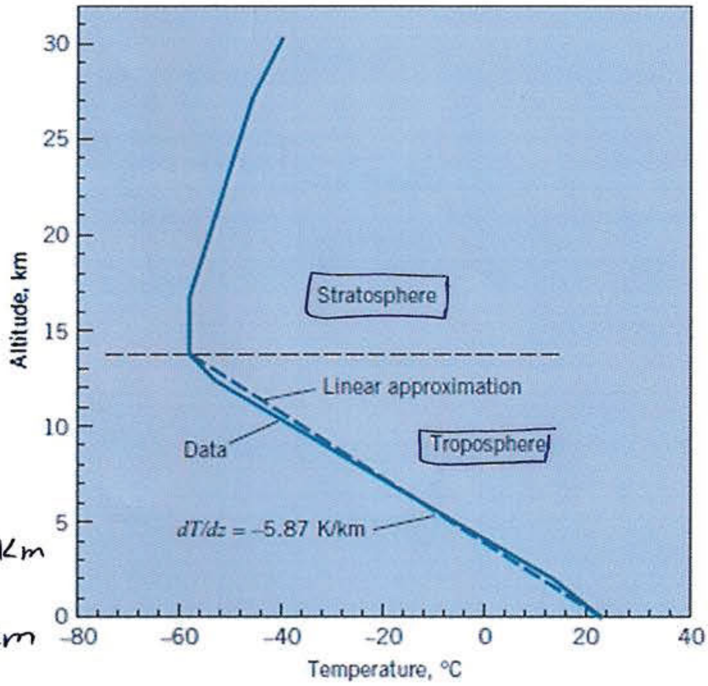
في هذا السكشن سوف نتعلم كيفيه حساب الضغط والكثافه ودرجه الحراره للتطبيقات مثل تصميم الطائرات الشرعية والطائرات و البالونات والصواريخ.

$\alpha = \frac{\partial T}{\partial z}$:- معدل تناقص درجة الحرارة مع الارتفاع

ونلاحظ من الشكل أنه يساوي

[5.87 كلفن لكل ١ كم]

وهو فقط في طبقة التروبوسفير.



Tropossphere 0 Km to 13.7 Km

stratosphere 13.7 Km to 50 Km

The atmospheric pressure variation in the troposphere is:

$$p = p_0\left[\frac{T_0 - \alpha(z - z_0)}{T_0}\right]^{g/\alpha R}$$

$$T = T_0 - \alpha\,(z - z_0)$$

Pressure Variation in the Lower Stratosphere is:

$$p = p_0 e^{-(z-z_0)g/RT}$$

EXAMPLE 3.4: If at sea level the absolute pressure and temperature are 101.3 kPa and 23° C, what is the pressure at an elevation of 2000 m, assuming that standard atmospheric conditions prevail?

$P = 101.3$ kPa $\qquad P|_{@ 2000 m}$?!

$T = 23 C^\circ$

Sol:

$$P = P_o \left[\frac{T_o - \alpha (z - z_o)}{T_o} \right]^{g/\alpha R}$$

$$T_o = 23 + 273 = \boxed{296 K}$$

$$\alpha = 5.87 * 10^{-3} \ K/m \quad (\text{constant})$$

$$z - z_o = 2000 - 0 = 2000 \ m$$

[sea level z = 0 m]

$$\frac{g}{\alpha R} = \frac{9.81}{5.87 * 10^{-3} (287)} = \boxed{5.823}$$

$$P = 101.3 \left[\frac{296 - 5.87 * 10^{-3} (2000)}{296} \right]^{5.823}$$

$$P = 80 \ kPa \ \ abs.$$

3.51 An airplane is flying at 10 km altitude in a U.S. standard atmosphere. If the internal pressure of the aircraft interior is 100 kPa, what is the outward force on a window? The window is flat and has an elliptical shape with lengths of 300 mm along the major axis and 200 mm along the minor axis.

standard atmosphere

$P_{in} = 100$ Kpa.

elliptical shape

$L_1 = 300$ mm (a)

$L_2 = 200$ mm (b)

F ?!

$$P_{out} = P_o \left[\frac{T_o - \alpha (z - z_o)}{T_o} \right]^{g/\alpha R}$$

$$= 101.3 \left[\frac{296 - 5.87(10-0)}{296} \right]^{\frac{9.81}{5.87 \times 10^{-3} (287)}}$$

$P_{out} = 27.96$ Kpa

$F = \Delta p A \longrightarrow$ Area (elliptical)

$A = \pi a b$

$= \pi (0.3)(0.2)$

$A = 0.18849 \ m^2$

$F = (100 - 27.96)(0.18849)$

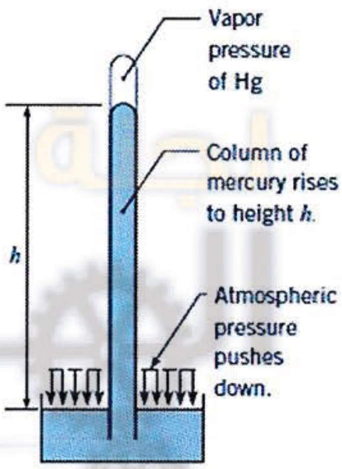
$F = 13.577$ N

Pressure Measurements

يصف هذا السكشن خمسة أجهزة علمية لقياس الضغط:

1- Barometer

وهـي أداة تستخدم لقياس الضغط الجوي .
أكثر الأدوات شيوعاَ هو مقياس الزئبق .
والضغط في الجزء العلوي من البارومتر الزئبقي يكون ضغط بخار الزئبق (وتكون صغيرة جداَ)



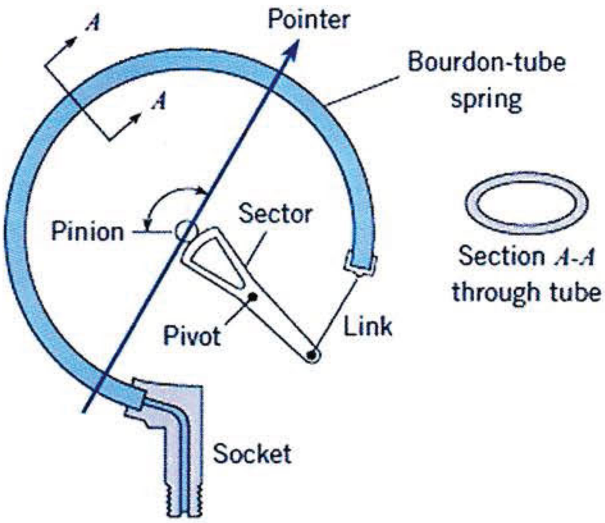
$$p_{atm} = \gamma_{Hg} h + \cancel{p_v} \approx \gamma_{Hg} h$$

2.4*10-6

2- Bourdon-Tube Gage

جهاز من أجهزة قياس الضغط بواسطة الاستشعار عن بعد انحراف أنبوب ملفوف .
وهو أنبوب يحتوي على مقطع عرضي بيضاوي الشكل وانحناء في قوس دائري.

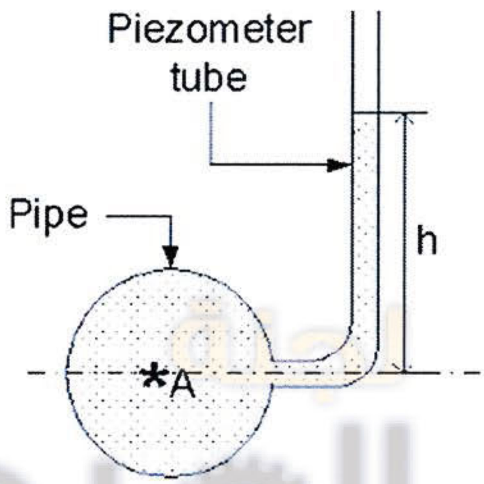
وهو جهاز لقياس ضغط ,
gage and Vacume.

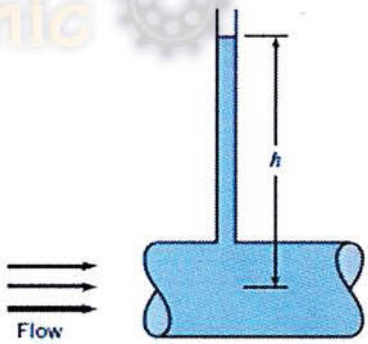


3- Piezometer

وهو أنبوب عمودي عادة يكون شفاف .
من مميزاته : البساطة , لا يحتاج لمعايرة , الدقة العالية .
من سيئاته : لا يمكن بسهولة أن يستخدم لقياس الضغط في الغاز , يقتصر على ضغوط منخفضة.

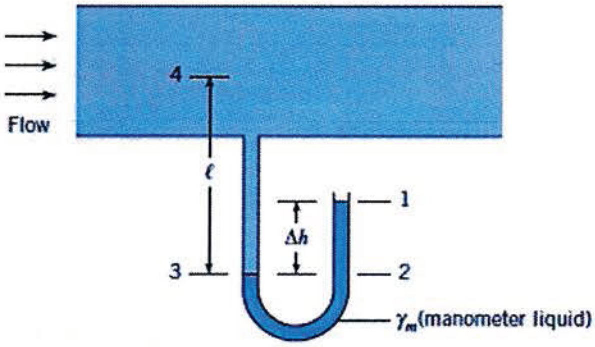
أمثلة عليه :





4- Manometer

هو جهاز لقياس ضغط عن طريق رفع أو خفض عمود من السائل.



U-tube manometer

المانوميتر من أهم أجهزة القياس , وسوف يتم التركيز عليه بشكل كبير .

آليه حل سؤال المانوميتر :

نبدأ من نقطه معلومة الضغط ثم المرور بالسائل حتى الوصول إلى النقطة المراد حساب عندها الضغط .

عند الهبوط إلى الأسفل فإن الضغط يزاداد لذلك نضع إشارة موجبة

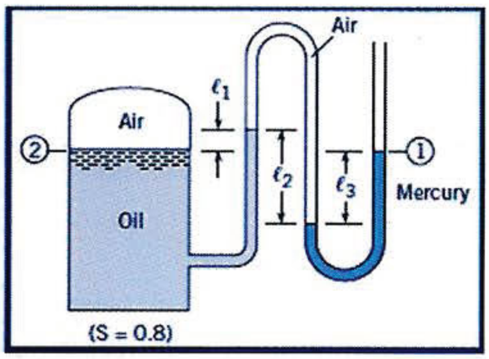
أما عند الصعود فإن الضغط يقل لذلك نضع إشارة سالبه .

EXAMPLE 3.7: What is the pressure of the air in the tank if L_1 40 cm, L_2 100 cm, and L_3 80 cm?

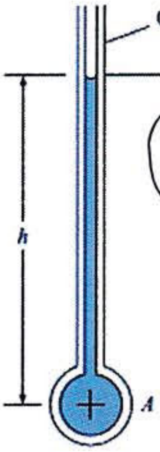
$$\gamma_{mercury} L_3 - \underbrace{\cancel{\gamma_{air} L_2}}_{zero} + \gamma_{oil} L_1 = P_2$$

$$(133)(0.8) + (7850)(0.4) = P_2$$

$$\boxed{P_2 = 110 \text{ Kpa} \quad (gage)}$$



3.32 Considering the effects of surface tension, estimate the gage pressure at the center of pipe *A* for *h* = 100 mm and *T* 20°C.



$P_A = \Delta h \, \gamma$

$\Delta h_1 = \frac{4\sigma}{\gamma d}$ $\quad \Delta h_2 = \frac{P_A}{\gamma}$

from table A.5
$\gamma = 9790 \ N/m^3$
$\sigma = 0.073 \ N/m$

$\Delta h = \Delta h_1 + \Delta h_2$

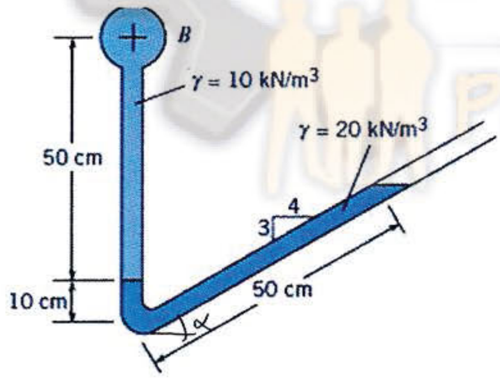
(0.1) من السؤال

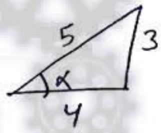
$\Delta h = \frac{4(0.073)}{9790\,(0.5*10^{-3})} + \frac{P_A}{\gamma}$

$\frac{P_A}{\gamma} = 0.1 - \frac{4(0.073)}{9790\,(0.5*10^{-3})}$

$P_A = 0.04034\,(9790) = \boxed{395 \ pa \ gage}$

3.33 What is the pressure at the center of pipe *B*?





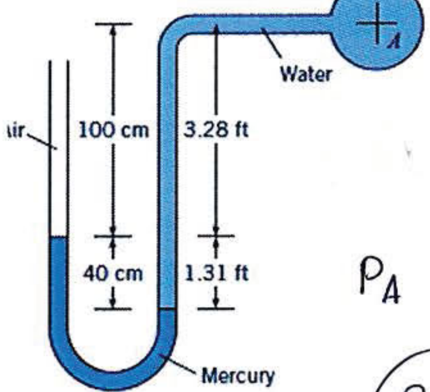
$\sin\alpha = \frac{3}{5} = 0.6$

$\sin\alpha * L = 0.6 * 0.5 = \boxed{0.3 m}$

$P_B + 0.5(10*10^3) + 0.1(20*10^3) - 0.3(20*10^3) = 0$

$P_B = -1 \ kpa \ (gage)$

3.36 Determine the gage pressure at the center of pipe *A* in pounds per square inch and in kilopascals.



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

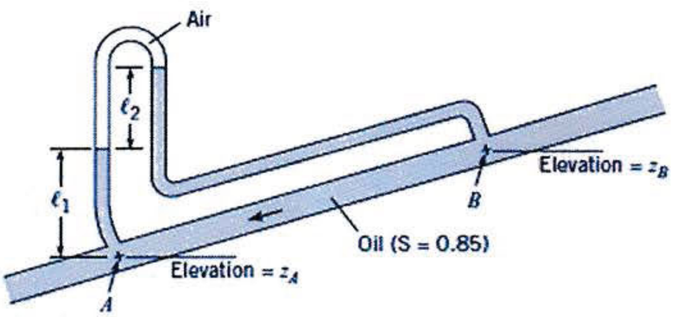
$\gamma_{Mercury} = 1.33 * 10^5\ N/m^3$

$$P_A + (1.4 * 9810) - (0.4 * 1.33 * 10^5) = 0$$

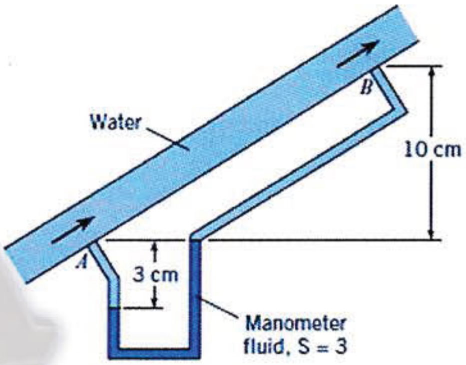
حولناها من ft ← m

$$\boxed{P_A = 39.5\ kPa\ \text{gage}}$$

3.40 Determine (a) the difference in pressure and (b) the difference in piezometric head between points *A* and *B*. The elevations z_A and z_B are 10 m and 11 m, respectively, L_1 1 m, and the manometer deflection L_2 is 50 cm.



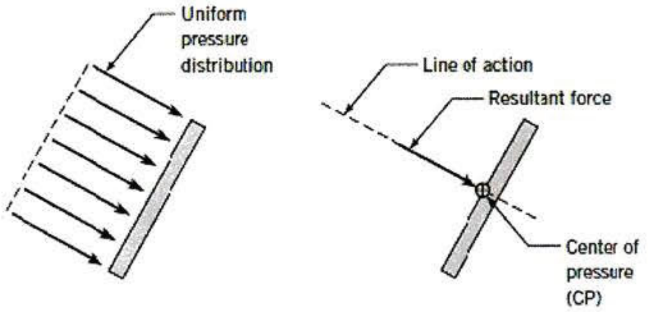
3.44 A manometer is used to measure the pressure difference between points A and B in a pipe as shown. Water flows in the pipe, and the specific gravity of the manometer fluid is 3.0. The distances and manometer deflection are indicated on the figure. Find (a) the pressure differences $p_A - p_B$, and (b) the difference in piezometric pressure, $p_{z,A} - p_{z,B}$. Express both answers in kPa.



Forces on Plane Surfaces (Panels)

في هذا السكشن سوف نقوم بحساب القوة الناتجه عن المائع على البوابات وحساب تأثيرها .

Hydrostatic Pressure Distribution



Magnitude of Resultant Hydrostatic Force

$$F_R = \gamma \bar{h} A$$

γ : specific weight

$\bar{h}$: البعد العمودي عن مركز البوابة والسطح

A : مساحة البوابة

$$\bar{h} = \bar{y} \sin\alpha$$

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

y_{cp} : مكان تأثير القوة

$\bar{y}$: البعد بين مركز البوابة والسطح

I : moment of Inersia.
↳ (statics)

$$\bar{h} \neq y_{cp}$$

إلا إذا كانت البوابة عمودية

EXAMPLE 3.9: Determine the force acting on one side of a concrete form 2.44m high and 1.22 m wide (8 ft by 4 ft) that is used for pouring a basement wall. The specific weight of concrete is 23.6 kN m^3 (150 lbf ft^3).

$F = \bar{p} A$

$\bar{p} = \gamma h$

$= 23.6 * 10^3 \left(\frac{2.44\, m}{2}\right)$

$\bar{p} = 28.79\ kPa$

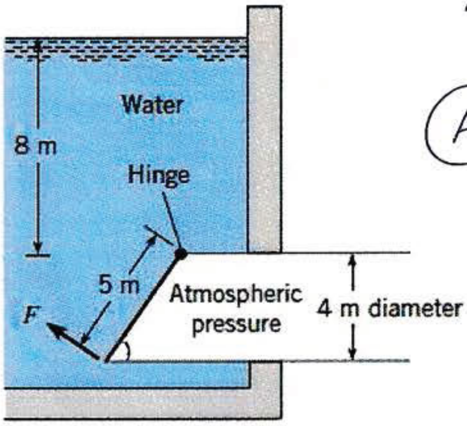
$A = 2.44 * 1.22 = 2.9768\ m^2$

$F = \bar{p} A$

$= 85.702\ kN$

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 F is required to open the gate when water is 8 m deep above the top of the pipe and the pipe is open to the atmosphere on the other side?
Neglect the weight of the gate.

$\boxed{d = 4m}$



$A = \pi a b$

$= \pi (2.5)(2)$

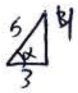
$A = 15.71 m^2$

$F_R = \gamma \bar{h} A$

$= 9810 (15.71) \left(\frac{5}{2} \sin\alpha + 8\right)$

$F_R = 9810 (15.71) \left(\frac{\cancel{5}}{2} * \frac{4}{\cancel{5}} + 8\right)$

$F_R = 1.541 \ MN$



$\sin\alpha = \frac{4}{5}$

$h = \bar{y} \sin\alpha$

$10 = \bar{y} \left(\frac{4}{5}\right)$

$\boxed{\bar{y} = 12.5 \ m}$

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

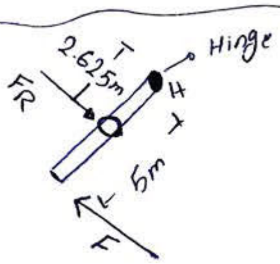
$= 12.5 + \frac{24.54}{(12.5)(15.71)}$

$y_{cp} = 0.125 m$

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

$= \frac{\pi (2.5)^3 (2)}{4}$

$I = 24.54 m^4$



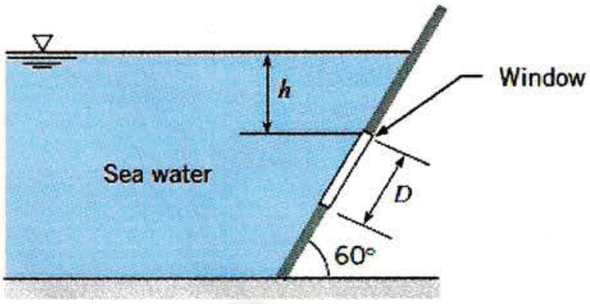
$\Sigma M_H = 0$

$-F(5) + 1.541 (2.625) = 0$

$F = 0.809 \ MN$

3.58 As shown, a round viewing window of diameter $D = 0.8$ m is situated in a large tank of seawater ($S = 1.03$). The top of the window is 1.2 m below the water surface, and the window is angled at 60° with respect to the horizontal. Find the hydrostatic force acting on the window and locate the corresponding CP.

$\rightarrow y_{cp} - \bar{y}$?!



$$\bar{h} = \frac{D}{2} \sin 60 + 1.2$$

$$\bar{h} = 0.4 \sin 60 + 1.2$$

$$\bar{h} = 1.546 \text{ m}$$

$$F_R = \bar{h} \gamma A$$
$$= 1.546 (1.03 * 9810) \left(\frac{\pi}{4} (0.8)^2\right)$$

$$\boxed{F_R = 7.85 \text{ kN}}$$

$$\bar{h} = \bar{y} \sin\alpha$$

$$\bar{y} = \frac{1.546}{\sin 60} = \boxed{1.7858 \text{ m}}$$

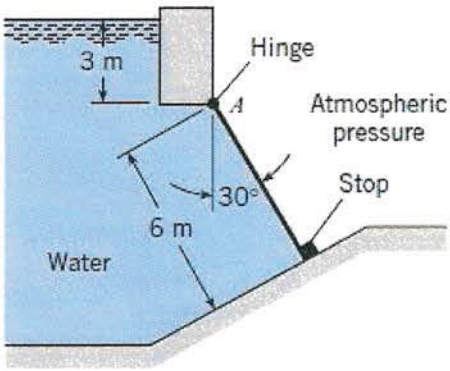
$$y_{cp} - \bar{y} = \frac{I}{\bar{y} A}$$

$$I = \frac{\pi r^4}{4} = \frac{\pi (0.4)^4}{4} = 0.020 \text{ m}^4$$

$$= \frac{0.02}{1.785 \left(\frac{\pi}{4}\right)(0.8)^2}$$

$$y_{cp} - \bar{y} = 0.0224 \text{ m}$$

3.62 The gate shown is rectangular and has dimensions 6 m by 4 m. What is the reaction at point *A*? Neglect the weight of the gate



$A = 6 * 4 = \boxed{24\ m^2}$

$(F_R)_A$?!

$F_R = \gamma \bar{h} A$

$\bar{h} = \frac{6}{2} \sin 30 + 3$

$\bar{h} = 3 \cos 30 + 3$

$\boxed{\bar{h} = 5.6\ m}$

$\bar{h} = \bar{y} \sin\alpha$

$\frac{5.6}{\cos 30} = \bar{y}$

$\bar{y} = 6.46\, m$

$F_R = 5.6\,(9810)\,(24)$

$F_R = 1.31\ MN$

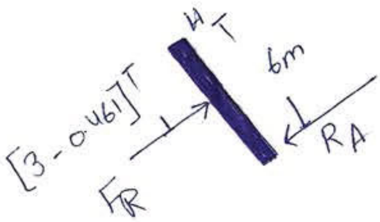
$y_{cp} - \bar{y} = \frac{I}{\bar{y} A}$

$= \frac{\left(\frac{4 * 6^3}{12}\right)}{6.46\,(24)} = 0.461\, m$

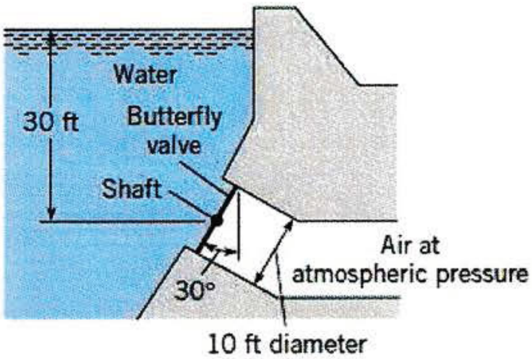
$\Sigma M_H = 0$

$+ \quad 1.31 * 10^6\,(3 - 0.461) + -6 R_A = 0$

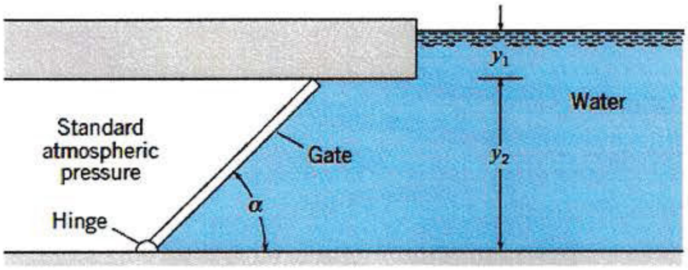
$R_A = 557\ kN$



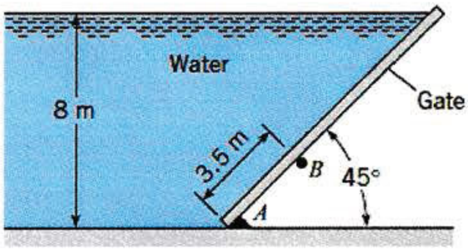
3.65 This 10 ft–diameter butterfly valve is used to control the flow in a 10 ft–diameter outlet pipe in a dam. In the position shown, it is closed. The valve is supported by a horizontal shaft through its center. What torque would have to be applied to the shaft to hold the valve in the position shown?



3.66 For the gate shown, α= 45°, y_1= 1 m, and y_2= 4 m. Will the gate fall or stay in position under the action of the hydrostatic and gravity forces if the gate itself weighs 150 kN and is 1.0 m wide? Assume T= 10°C. Use calculations to justify your answer.

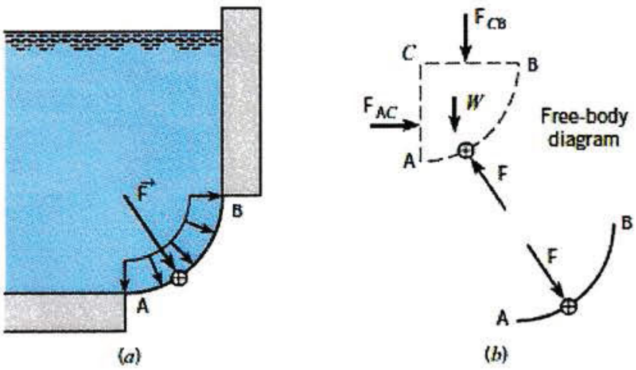


3.70 The plane rectangular gate can pivot about the support at *B*. For the conditions given, is it stable or unstable? Neglect the weight of the gate. Justify your answer with calculations.



Forces on Curved Surfaces

يوضح هذا السكشن كيفية حساب القوى على السطوح التي لها انحناء. هذه النتائج تعتبر مهمة لتصميم مكونات مثل الدبابات وأنابيب، والبوابات المقوسة.



$$\boxed{F_h = \gamma \bar{h}_v A_v}$$

F_h : القوة الأفقية

h_v : البعد العمودي

A_v : مساحة البوابة

$$\boxed{F_v = \gamma \forall}$$

F_v : القوة العمودية

$\forall$: الحجم

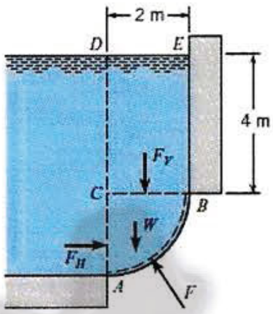
$$\boxed{y_{cp} = \bar{y}_v + \frac{I_v}{\bar{y}_v A_v}}$$

UOLOADED BY AHMAD JUNDI

$$F_R = \sqrt{F_y^2 + F_x^2}$$

$$= \sqrt{(109.3)^2 + (98.1)^2} = 146.9\,KN$$

EXAMPLE 3.11: Surface *AB* is a circular arc with a radius of 2 m and a width of 1 m into the paper. The distance *EB* is 4 m. The fluid above surface *AB* is water, and atmospheric pressure prevails on the free surface of the water and on the bottom side of surface *AB*. Find the magnitude and line of action of the hydrostatic force acting on surface *AB*.



① $F_h = \gamma h_v A_v = F_x$

$= 9810 (4 + 1)(2 * 1)$

$F_h = 98.1\,KN$

③ $F_V = \gamma V$

$= 9810 * (4 * 2 * 1)$

$F_V = 78.5\,KN$

$W = \gamma V_{ABC}$

$= 9810 (\frac{\pi}{4} r^2)(\text{width})$

$= 9810 (\frac{\pi}{4} (2)^2)(1)$

$\boxed{W = 30.8\,KN}$

$F_y = F_V + W = 78.5 + 30.8 = \boxed{109.3\,KN}$

④ $X_{cp} F_y = F_V y_{cp} + W y_{cp}$

$X_{cp} = \frac{F_V y_{cp} + W y_{cp}}{109.3}$

$X_{cp} = \frac{F_V y_{cp} + W y_{cp}}{109.3}$

$X_{cp} = \frac{78.5(1) + 30.8(y_{cp})}{109.3}$ → centroid $= \frac{4r}{3\pi}$ $= \boxed{0.849m}$

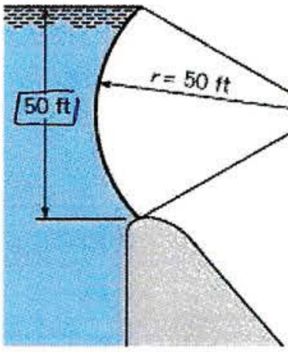
$X_{cp} = 0.957m$

② $y_{cp} - \bar{y} = \frac{\bar{I}}{\bar{y} A}$ ⇒ $y_{cp} = 5 + \frac{\frac{1 * 2^3}{12}}{5(2*1)}$

$y_{cp} = 5.067\,m$

(Horizontal)

3.76 Determine the hydrostatic force acting on the radial gate if the gate is $\boxed{40\text{ ft}}$ long (normal to the page). Show the line of action of the hydrostatic force acting on the gate.



$\gamma = 9810\ N/m^3 = 62.4\ Ib/ft^3$

$F_h = F_x = \bar{h}\gamma A$

$= 25\ (62.4)(40)(50)$

$\boxed{F_x = 3.12\ M\ Ib}$

$F_V = \gamma \forall$

$\forall = \left[\frac{60}{360}\pi * (50)^2 - 25 * 50\cos 30\right] * 4$

$\boxed{\forall = 9600\ ft^3}$

$F_V = F_y = 62.4\ (9600)$

$\boxed{F_y = 0.565\ M\ Ib}$

$F_R = \sqrt{(F_x)^2 + (F_y)^2}$

Buoyancy

يصف هذا السكشن كيفية حساب قوة الطفو على الجسم.
ويعرف قانون الطفو بأنه القوة الصاعدة التي يتم إنتاجها على الهيئة التي كليا أو جزئيا المغمورة في السائل.

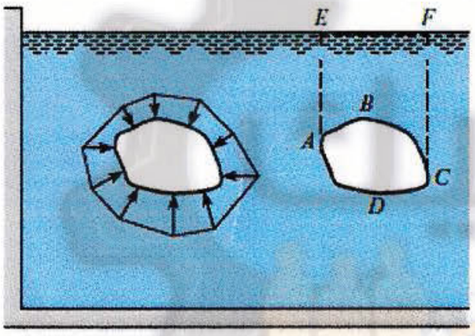
من الأمثلة علـى ذلك السفن السطحية، نقل الرواسب في الأنهار، والأسماك الهجرة.

The Buoyant Force Equation

$$F_{\text{up}} = \gamma(\forall_b + \forall_a)$$

$\forall_b$ :: volume of body.

$\forall_a$ :: volume of Liquid bove the body



نلاحظ من الشكل السابق أن الجسم مغمور كليآ في السائل ، كما نلاحظ أن الجسم يتعرض لضغط ليرتفع إلى الأعلى.

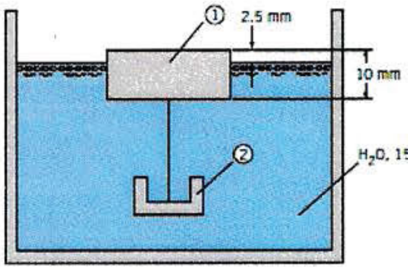
$$F_{\text{Down}} = \gamma \forall_a$$

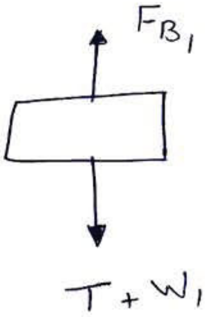
$$F_{total} = F_{up} - F_{down}$$

$$= \gamma \forall_b \cancel{+\gamma \forall_a} - \cancel{\gamma \forall_a} = \boxed{\gamma \forall_b}$$

UOLOADED BY AHMAD JUNDI

EXAMPLE 3.12: A metal part (object 2) is hanging by a thin cord from a floating wood block (object 1). The wood block has a specific gravity S_1 0.3 and dimensions of 50 * 50 * 10 mm. The metal part has a volume of 6600 mm^3. Find the mass m_2 of the metal part and the tension T in the cord.





$\Sigma F_y = 0$

$F_{B_1} = T + W_1$

$\gamma \forall_b = T + W_1$

$F_{B_1} = 9810\,(50 * 50 * 7.5)(10^{-9})$

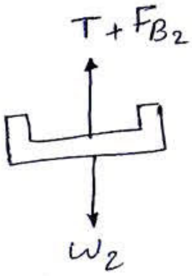
$F_{B_1} = 0.184\ N$

$W_1 = \gamma S_1 \forall_1$

$W_1 = 9810\,(0.3)(50 * 50 * 10)(10^{-9})$

$W_1 = 0.0735\ N$

$T = 0.184 - 0.0735 = \boxed{0.11\ N}$



$F_{B_2} = \gamma \forall_2 = 9810\,(6600)(10^{-9})$

$F_{B_2} = 0.0647\ N$

$T + F_{B_2} = W_2$

$W_2 = 0.11 + 0.0644$

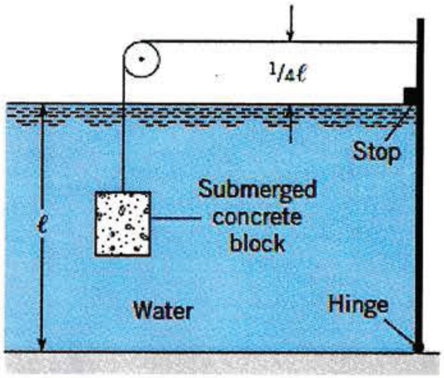
$W_2 = 0.1744\ N$

$m = \dfrac{W_2}{g}$

$= 0.177\ kg$

$m = 17.7\ g$

3.93 Determine the minimum volume of concrete (Y = 23.6 kN m3) needed to keep the gate (1 m wide) in a closed position, with L= 2 m. Note the hinge at the bottom of the gate.



نهاية شابتر "3" من مادة الفلويد

← هذا التلخيص لا يكفي لدراسة المادة ، يرجى الرجوع إلى الكتاب والإطلاع على البروبلمز .

← هنالك عدد من الأسئلة الغير محلولة في الدوسية .

حلهم لحالك :p.

← أرقام بروبلمز مهمة على شابتر "3" من الطبعة التاسعة :-

10 , 11 , 13 , 17 , 18 , 21 , 24 , 25

30 , 34 , 39 , 40 , 47 , 42 , 64

"مهم جداً"

65 , 70 , 77 , 74 , 82 , 87 , 93

بالتوفيق للجميع

سامر مامن

=> Fluid Mechanics

ع كما تكلمنا عن مادة الفلويد الفرست

Fluid
- rest
  - solid
  - Liquid + Gas — First
- motion
  - solid
  - Liquid + Gas — Second + Final

* chapter four "Flowing Fluids and pressure Variation"

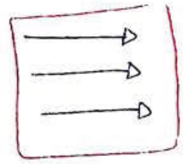
4.1 : Discriptions of Fluid Motion

Flow
- uniform $\frac{\partial V}{\partial s} = 0$ "منتظم"
  لاتتغير السرعة بالنسبة للمسافة
- non uniform $\frac{\partial V}{\partial s} \neq 0$ "غير منتظم"
  تتغير السرعة بالنسبة للمسافة

flow
- steady $\frac{\partial V}{\partial t} = 0$ "لايتأثر بالزمن"
- un_steady $\frac{\partial V}{\partial t} \neq 0$ "يتأثر بالزمن"

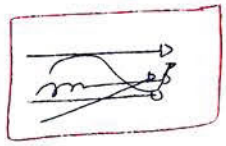
⇒ flow in pipe :

① Laminar $Re < 2000$



② Transition $2000 < Re < 3000$

③ Turbulent $Re > 3000$



4:2 : Acceleration

$$a = \left[\underbrace{v \frac{\partial v}{\partial s}}_{\text{Convective acceleration}} + \underbrace{\frac{\partial v}{\partial t}}_{\text{Local acceleration}} \right] + \underbrace{\frac{v^2}{r}}_{\text{Centripetal acceleration}}$$

→ if the flow is uniform → $\left[\frac{\partial v}{\partial s} = 0.0 \right]$

→ if the flow is steady → $\left[\frac{\partial v}{\partial t} = 0.0 \right]$

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

$$a_y = u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} + w \frac{\partial v}{\partial z} + \frac{\partial v}{\partial t}$$

$$a_z = u \frac{\partial w}{\partial x} + v \frac{\partial w}{\partial y} + w \frac{\partial w}{\partial z} + \frac{\partial w}{\partial t}$$

⇒ Example : for acceleration flow , the velocity for fluid is given by :

$$v = (3xy^2 - 4xt)\,\hat{i} + (2x^2y - 5t)\,\hat{j}$$

Det. acceleration @ $x=1$, $y=1$ and $t=2s$.

sol:

$u = 3xy^2 - 4xt$

$u = 3(1)(1) - 4(1)(2)$

$= \boxed{-5}$

$v = 2x^2y - 5t$

$= 2(1)(1) - 5(2)$

$= 2 - 10$

$= \boxed{-8}$

$\frac{du}{dx} = 3y^2 - 4t$

$= 3(1) - 4(2)$

$\boxed{-5}$

$\frac{dv}{dx} = 4xy - 0$

$= 4(1)(1)$

$= \boxed{4}$

$\frac{du}{dy} = 6xy - 0$

$= 6(1)(1)$

$= \boxed{6}$

$\frac{dv}{dy} = 2x^2 - 0$

$= \boxed{2}$

$\frac{du}{dt} = 0 - 4x$

$= \boxed{-4}$

$\frac{dv}{dt} = 0 - 5$

$= \boxed{-5}$

$$a_x = u\frac{\partial u}{dx} + v\frac{\partial u}{dy} + \cancel{w\frac{\partial u}{\partial z}}^{\text{zero}} + \frac{\partial u}{\partial t}$$

$= -5(-5) + -8(6) + -4 = \boxed{-27\,m/s^2}$ ✓

$$a_y = u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} + \cancel{w\frac{\partial v}{\partial z}}_{\text{zero}} + \frac{\partial v}{\partial t}$$

$= -5(4) + -8(2) - 5 = \boxed{-41\,m/s^2}$ ✓

⇐ ممكن نكتب معادلة التسارع بهذه الصيغة :-

$$\vec{a} = \left(V \frac{\partial V}{\partial s} + \frac{\partial V}{\partial t} \right) e_t + \left(\frac{V^2}{r} \right) e_n$$

*problem 4.17 the velocity along apath Line as given by $V[m/s] = S^2 t^{1/2}$ where "S" in meter and "t" in seconds, the radius is (0.5 m), evaluate the acceleration along and Normal to the path @ [S = 2m] and [t = 0.5 s]

سؤال من أسئلة السنوات

Sol:

$$a = \left[V \frac{\partial V}{\partial s} + \frac{\partial V}{\partial t} \right] e_t + \left[\frac{V^2}{r} \right] e_n$$

$$V = (2)^2 (0.5)^{0.5} = \boxed{2.828 \ m/s}$$

$$\frac{\partial V}{\partial s} = 2S t^{1/2} = 2(2)(0.5)^{0.5} = \boxed{2.828 \ m/s^2}$$

$$\frac{\partial V}{\partial t} = \frac{1}{2} S^2 t^{-1/2} = \frac{1}{2}(4)(0.5)^{-0.5} = \boxed{2.838 \ m/s^2}$$

$$a = \left[2.828 \, (2.828) + 2.828 \right] e_t + \left[\frac{(2.828)^2}{0.5} \right] e_n$$

$$\boxed{a = 10.8 \ e_t + 16 \ e_n}$$

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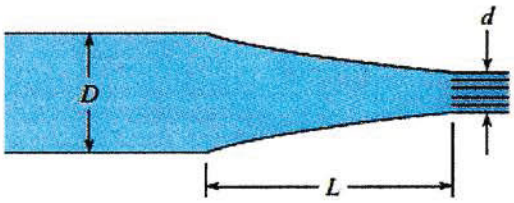
4.20 The nozzle in the figure is shaped such that the velocity of flow varies linearly from the base of the nozzle to its tip. Assuming quasi–one-dimensional flow, what is the convective acceleration midway between the base and the tip if the velocity is 1 ft s at the base and 4 ft s at the tip? Nozzle length is 18 inches.



$V_{base} = 1$ ft

$V_{tip} = 4$ ft.

$L = 18$ in

يجب بداية أن نوحد الوحدات .

يا إما نحول ال ft لل in أو العكس .

ولتحويل ال in لل ft

نستخدم المعادلة التالية

1 ft = 12 in

L = 18 in

$L = 1.5$ ft

$$\frac{\partial V}{\partial s} = \frac{V_{tip} - V_{base}}{L} = \frac{4-1}{1.5} = \boxed{2\ s^{-1}}$$

Velocit @ midway $\quad v = \frac{4+1}{2} = 2.5$ ft/s

acceleration @ midway

$$a = V \frac{\partial V}{\partial s}$$

$$= 2.5(2)$$

$$a = 5\ /s^2$$

UOLOADED BY AHMAD JUNDI

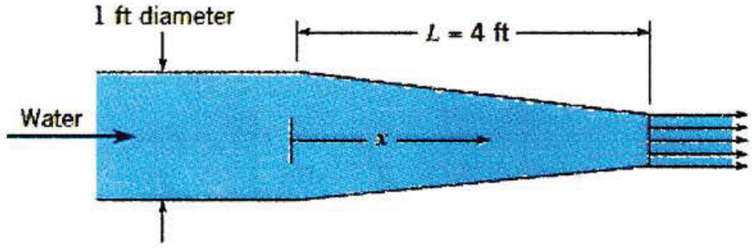
4.24 The velocity of water flow in the nozzle shown is given by the following expression:

$$V = 2t/(1-0.5x/L)^2,$$

where V = velocity in feet per second, t = time in seconds, x = distance along the nozzle, and L = length of nozzle = 4 ft. When $x = 0.5L$ and $t = 3$ s, what is the local acceleration along the centerline? What is the convective acceleration? Assume quasi-one-dimensional flow prevails.

local (a) = $\frac{\partial V}{\partial t}$

convection (a) $= V\frac{\partial V}{\partial s}$



① Local acceleration $= \frac{\partial V}{\partial t}$

$$= \frac{\partial\left[\frac{2t}{(1-0.5\frac{x}{L})^2}\right]}{\partial t}$$

$$= \frac{2t}{(1-0.5\frac{x}{L})^2} = \frac{2}{\left(1-0.5*0.5\frac{L}{L}\right)^2}$$

$$\boxed{a_l = 3.55\ ft/s^2}$$

② convection acceleration

$a_c = V\frac{\partial V}{\partial x}$ $\quad V = \frac{2t}{(1-0.5x/L)^2} = \frac{2(3)}{\left(1-0.5*0.5\frac{(4)}{4}\right)^2}$

$$V = 10.66\ ft/s$$

⇒

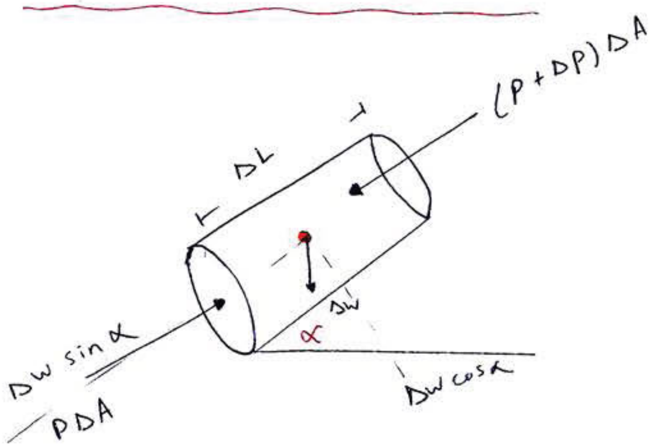
$$a_c = V \frac{\partial V}{\partial x}$$

$$= 10.66 \frac{\partial \left[\frac{2t}{(1-0.5\frac{x}{L})^2}\right]}{\partial x}$$

$$= 10.66 \ (3.55)$$

$$a_c = 37.84 \ ft/s^2$$

⇒ 4.3 : Euler's Equation



$$\Sigma F_L = m a_L$$

$$F_p + F_g = m a_t$$

$$m = \rho \Delta A \Delta L$$

$$F_p = P\Delta A - (P + \Delta P)\Delta A = -\Delta P \Delta A$$

$$F_g = -\Delta W = -\Delta W \sin\alpha$$

$$-\Delta P \Delta A - \gamma \Delta L \Delta A \frac{\Delta Z}{\Delta L} = \rho \Delta L \Delta A a_t$$

$$-\frac{\Delta P}{\Delta L} - \gamma \frac{\Delta Z}{\Delta L} = \rho a_t$$

$$\frac{\partial}{\partial L}(P + \gamma Z) = -\rho a_L$$

where :: L → elevation

$P + \gamma Z$ → pizometric pressure.

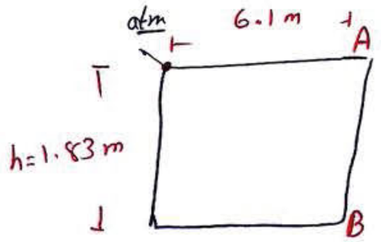
ρ → dinsity

a_L → acceleration.

⇒ Example 4.1 : the tank on a trailer truck is filled completely with gasoline, which has spacific weight 6.6 KN/m³. The truck is decelerationg at a rate of 3.05 m/s².

(a) if the tank on the trailer is 6.1 m Long and if the pressure at the top rear end of the tank is atmospheric, what is the pressure at the top front.?

(b) if the tank is 1.83 m high, what is maximum pressure in the tank?



Sol: (a)

$$\frac{\partial}{\partial L}(P+\gamma z) = -\rho a_L$$

$$\frac{\partial P}{\partial L} + \underbrace{\cancel{\frac{\gamma \partial z}{\partial L}}}_{zero} = -\rho a_L$$

$$\frac{P_A - P_{atm}}{L} = -\frac{\gamma}{g} a_L$$

$$P_A = +\frac{6.6 * 10^3}{9.81} * (6.1)(3.05)$$

$$P_A = 12.5178 \text{ Kpa}$$

(b)

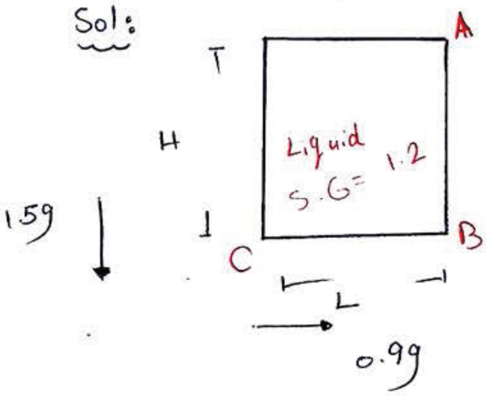
$$P_B + \gamma z_B = P_A + \gamma z_A$$

$$P_B = P_A - \gamma(z_A + z_B)$$

$$P_B = 24.6 \text{ Kpa}$$

⇒ problem 4:37 The closed tank shown, which is full of Liquid, is acceleration downward at 1.5g and to the right at 0.9g. Here L = 1m, H = 5m and the spacific gravity of the Liquid is 1.2. Determine $P_C - P_A$ and $P_B - P_A$?!

Sol:



$P_B - P_A$

$$\frac{\partial}{\partial L}(P + \gamma z) = -\rho a_L$$

$$\frac{\partial P}{\partial L} + \gamma \frac{\partial z}{\partial L} = -\rho a_L \qquad \boxed{-1}$$

$S.G = \frac{\gamma_{fluid}}{\gamma_{water}}$

$$\frac{P_B - P_A}{5} - 1(9810 * 1.2) = -1000(1.2)(1.5g)$$

$$P_B - P_A = 5\left[-1000(1.2)(1.5 * 9.81) + (9810 * 1.2)\right]$$

$$\boxed{P_B - P_A = -29430 \ Pa}$$

$P_C - P_B$

$$\frac{\partial}{\partial L}(P + \gamma z) = -\rho a_L$$

$$\frac{\partial P}{\partial L} + \gamma \cancel{\frac{\partial z}{\partial L}}^{zero} = -\rho a_L$$

بعكس اتجاه التسارع

$$\frac{P_C - P_B}{1} = -1000(1.2)(-0.9 * 9.81)$$

$$\boxed{P_C - P_B = 10594.8 \ Pa}$$

$$P_C - P_A = (P_C - P_B) + (P_B - P_A)$$

$$= 10594.8 - 29430$$

$$= \boxed{-18835.2 \ pa}$$

=) 4:4 :- pressure Distribution in Rotating flows

$$-\frac{d}{dr}(p + \gamma z) = \rho a_r$$

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

$$-\frac{d}{dr}(p+\gamma z) = -\rho\frac{V^2}{r}$$

$\rightarrow$ $V = \omega r$

$$\frac{d}{dr}(p+\gamma z) = \rho r \omega^2$$

$$p + \gamma z = \rho \frac{r^2 \omega^2}{2} + \text{const.}$$

$$p + \gamma z - \rho \frac{\omega^2 r^2}{2} = C.$$

=) pressure Variation in rotating flow..

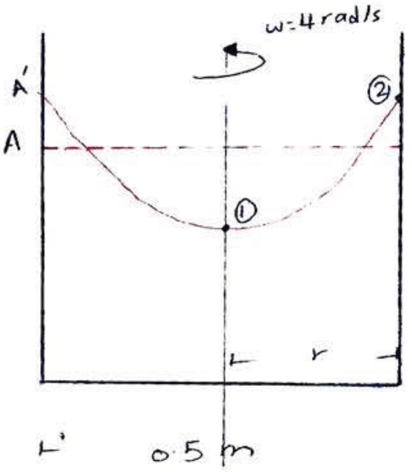
oR

$$\frac{p}{\gamma} + z - \frac{\omega^2 r^2}{2g} = C.$$

⇒ Example 4.4 | A clyindrical tank of Liquid shown in the figure is rotating as a solid body at a rate 4 rad/s. the tank diamter 0.5 m. The Line AA depicts the Liquid surface before rotation, and the Line AA' shows the surface profil after rotation has been estalished.

Find the elevation differance between the Liquid at the center and the well during rotation.

sol:



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

atm, zero $(r_1 = 0)$, atm

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

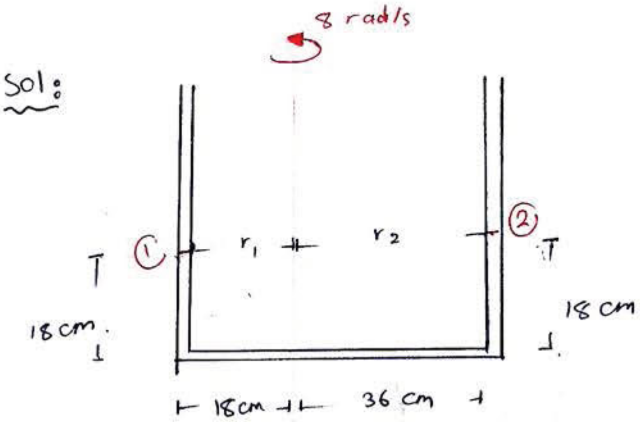
$$z_2 - z_1 = \frac{w^2 r_2^2}{2g}$$

$$z_2 - z_1 = \frac{(4)^2 (0.25)^2}{2(9.81)}$$

$$\boxed{z_2 - z_1 = 0.051 \text{ m}}$$

=) Example 4.5 when the U-tube is not rotated, the water stands in the tube as shown. if the tube is rotated about the eccentric axis at a rate of 0.8 rad/s, what are the new levels of water in the tube?

Sol:



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

atm atm

$$z_1 - \frac{\omega^2 r_1^2}{2g} = z_2 - \frac{\omega^2 r_2^2}{2g}$$

$$z_2 - z_1 = \frac{\omega^2}{2g}(r_2^2 - r_1^2)$$

$$z_2 - z_1 = \frac{(8)^2}{2(9.81)}(0.36^2 - 0.18^2)$$

$$\boxed{z_2 - z_1 = 0.3171 \text{ m}}$$

$z_2 + z_1 = 0.36$ m → as a shown

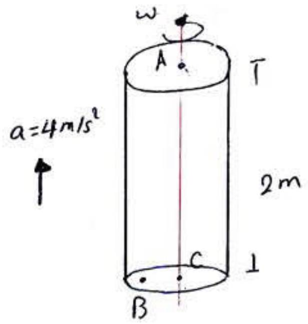
$2z_2 = 0.6770$

$$\boxed{z_2 = 0.3385 \text{ m}}$$

$$\boxed{z_1 = 0.0214 \text{ m}}$$

* problem 4.44 A closed tank of (Liquid $\underline{\underline{S=1.2}}$) is rotated about a vertical axis, and at the same time entire tank is acceleration upward at $4\,m/s^2$. if the rate of rotation is $\underline{\underline{10}}$ rad/s, what is the differance in pressure between A and B ?

point B is the bottom of the tank at the radius of $\underline{\underline{0.5}}$ m from the axis rotation, and point A is the top on the axis of rotation.



$P_A - P_B$?!

$$P_A - P_B = (P_A - P_C) + (P_C - P_B)$$

$P_A - P_C$

$$\frac{\partial}{\partial L}(P + \gamma Z) = -\rho a_L$$

$$\frac{\partial P}{\partial L} + \gamma \cancel{\frac{\partial Z}{\partial L}}^{1} = -\rho(4)$$

$$\frac{P_A - P_C}{2} = -1000(1.2)(4) - 9810(1.2)$$

$$\boxed{P_A - P_C = -33144\ Pa}$$

$P_C - P_B$:

$$\frac{P_C}{\gamma} + \cancel{Z_C}^{zero} - \cancel{\frac{\omega^2 r_C^2}{2g}}^{zero} = \frac{P_B}{\gamma} + \cancel{Z_B}^{zero} - \frac{\omega^2 r_B^2}{2g}$$

$$P_C - P_B = -\frac{\rho \omega^2 r_B^2}{2} = -\frac{1000(1.2)(10)^2(0.5)^2}{2} = \boxed{-15000\ Pa}$$

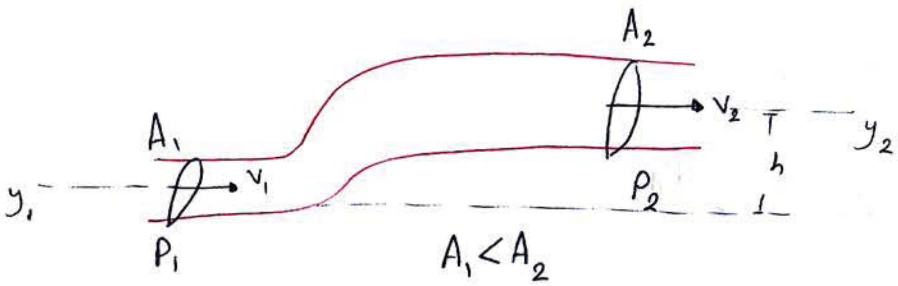
$$P_A - P_B = (P_A - P_c) + (P_c - P_B)$$

$$= -15000 - 33144$$

$$= -48144 \ Pa$$

⇒ 4.5 ⇒ The Bernoulli Equation Along a streamLine

ضغط الغاز المتحرك يقل إذا زادت السرعة



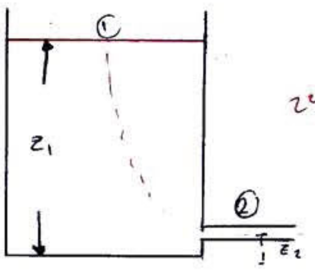
1. steady-Flow
2. Incompressible flow
3. Irrotantional flow
4. no-heat transfer

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2$$

pressure head — Velocity head — elevation head.

⇒ Example 4.7 | An open the tank is filled with water and drains through a port at abottom of the tank. the elevation of the water in the tank is 10 m above the drain. The drain port is at atmospheric pressure. Find the velocity of the Lequid in the drain port?

Sol :



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

$$z_1 - z_2 = \frac{V_2^2}{2g}$$

$$10\,(2)\,(9.81) = V_2^2$$

$$\boxed{V_2 = 14.007 \text{ m/s}}$$

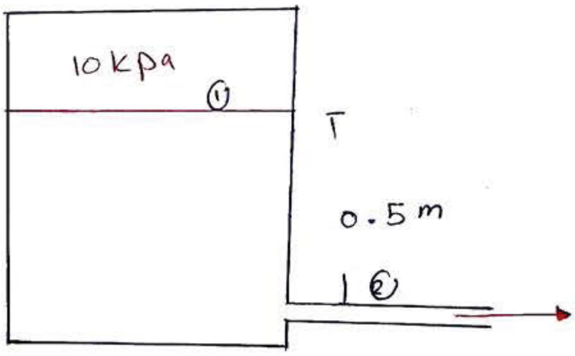
=> problem 4.60 | A pressure of 10 kpa, gage is applied to the surface of water in an closed tank.

The distance from the water surface to outlet is 0.5 m. The Temp. of the water is 20 C°.

Find the velocity (m/s) of water at the outlet.

The speed of the water surface is much Less than the water speed at the outlet.

Sol:



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

$$\frac{10 \times 10^3}{9810} + (z_1 - z_2) = \frac{V_2^2}{2(9.81)}$$

$$V_2 = 5.4598 \text{ m/s}$$

① stagnation point

↳ (Some times calls a total head tube)

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

$$V_0^2 = \frac{2}{\rho}(P_1 - P_0)$$

$$V_0 = \sqrt{2gL}$$

② pitot statics tube

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

$$V_2 = \left[\frac{2}{\rho}(P_{z,1} - P_{z,2})\right]^{1/2}$$

$$\boxed{V = \sqrt{\frac{2\Delta P}{\rho}}}$$

→ pitot static tube equ.

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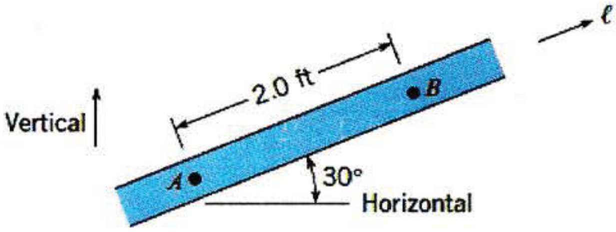
4.35 A liquid with a specific weight of 100 lbf/ft^3 is in the conduit. This is a special kind of liquid that has zero viscosity. The pressures at points *A* and *B* are 170 psf and 100 psf, respectively.
Which one (or more) of the following conclusions can one draw with certainty? (a) The velocity is in the positive Ldirection. (b) The velocity is in the negative _ direction. (c) The acceleration is in the positive L direction. (d) The acceleration is in the negative L direction.



$\gamma = 100 \ lbf/ft^3$

$P_A = 170$ psf

$P_B = 100$ psf

using Euler's equation :

$$-\frac{\partial}{\partial L}(P + \gamma z) = +\rho a_L$$

$$-\frac{\partial P}{\partial L} - \frac{\gamma \partial z}{\partial L} = \rho a_L$$

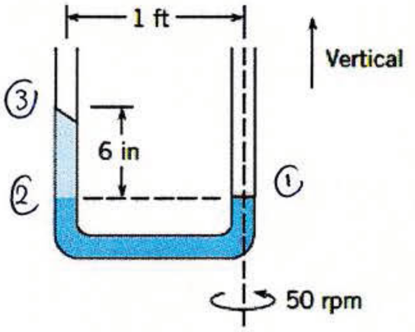
$$-\frac{(P_B - P_A)}{L} - 100(\sin 30) = \rho a_L$$

$$-\frac{(100 - 170)}{L} - 50 = \rho a_L$$

$$\left(\frac{70}{2} - 50\right)\rho = a_L \rightarrow \boxed{a_L = -\text{Number}}$$

d

4.47 A U-tube is rotated at 50 rev min about one leg. The fluid at the bottom of the U-tube has a specific gravity of 3.0. The distance between the two legs of the U-tube is 1 ft. A 6 in. height of another fluid is in the outer leg of the U-tube. Both legs are open to the atmosphere. Calculate the specific gravity of the other fluid.



$S.G = 3.$

$\omega = 50 \text{ rev/min}$

$= \frac{50}{60}(2\pi)$

$\boxed{\omega = 5.24 \text{ rad/s}}$

$1 \text{ ft} \rightarrow 12 \text{ in}$

$? \rightarrow 6 \text{ in}$

$\boxed{6in = 0.5 \text{ ft}}$

$$\cancel{P_1}^{\text{0 gage}} + \cancel{\gamma z_1} - \cancel{\frac{\rho r_1^2 \omega_1^2}{2}}^{\text{zero}} = P_2 + \cancel{\gamma z_2} - \rho \frac{r_2^2 \omega_2^2}{2} \quad (z_1 = z_2)$$

$$P_2 = \frac{\rho r_2^2 \omega^2}{2} = \frac{\overset{S.G.}{3}(1.94)(1)^2(5.24)^2}{2}$$

$\boxed{P_2 = 79.8 \text{ psfg}}$

between 2, 3.

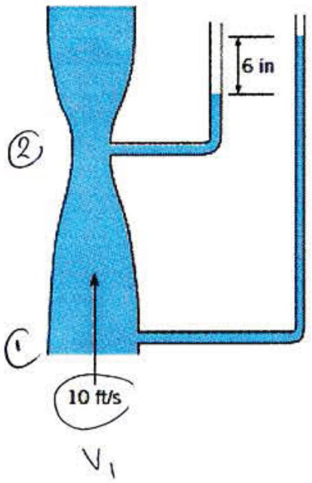
$$P_2 + \gamma_2 z_2 = \cancel{P_3}^{0.0} + \gamma_3 z_3$$

$79.8 = \gamma(z_3 - z_2)$

$\boxed{\gamma = 159.6 \text{ lbf/ft}^3}$

$$S = \frac{\gamma_{fluid}}{\gamma_{water}} = \frac{159.6}{62.4} = \boxed{2.56}$$

4.61 Water flows through a vertical contraction (venturi) section. Piezometers are attached to the upstream pipe and minimum area section as shown. The velocity in the pipe is 10 ft/s. The difference in elevation between the two water levels in the piezometers is 6 inches. The water temperature is 68 °F. What is the velocity (ft s) at the minimum area?



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

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

$$\frac{\rho V_2^2}{2g} = \frac{\rho V_1^2}{2g} + \underbrace{(P_1 + \gamma z_1) + (P_2 + \gamma z_2)}_{\text{piezometric equ.} = \gamma \Delta h}$$

1 ft → 12 in

? → 6

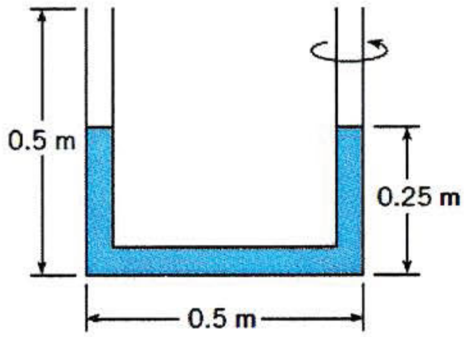
$\boxed{z = 0.5\ ft}$ $\boxed{= 20cm}$

$\boxed{V_1 = 10\ ft/s}$ $\boxed{= 4\ m/s}$

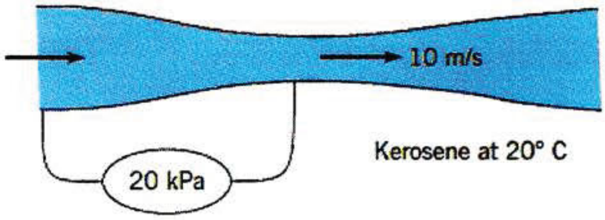
$$\frac{1000\, V_2^2}{2} = \frac{1000\,(4)^2}{2} + [9810 * 0.2]$$

$$V_2 = 4.45\ m/s$$

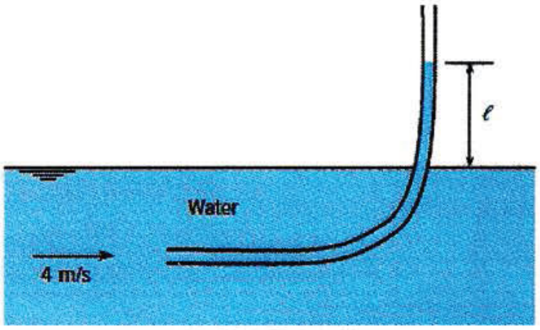
4.45 A U-tube is rotated about one leg, as shown. Before being rotated the liquid in the tube fills 0.25 m of each leg. The length of the base of the U-tube is 0.5 m, and each leg is 0.5 m long. What would be the maximum rotation rate (in rad s) to ensure that no liquid is expelled from the outer leg?



4.62 Kerosene at 20oC flows through a contraction section as shown. A pressure gage connected between the upstream pipe and throat section shows a pressure difference of 20 kPa. The gasoline velocity in the throat section is 10 m s. What is the velocity (m/ s) in the upstream pipe?

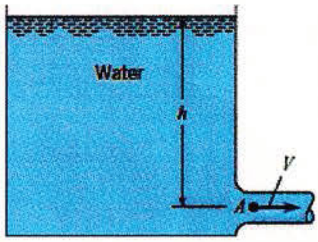


4.64 A glass tube is inserted into a flowing stream of water with one opening directed upstream and the other end vertical. If the water velocity is 4 m s, how high will the water rise in the vertical leg relative to the level of the water surface of the stream?



4.95 The velocity in the outlet pipe from this reservoir is 16 ft s and h =15 ft Because of the rounded entrance to the pipe, the flow is assumed to be irrotational. Under these conditions, what is the pressure at A?

4.96 The velocity in the outlet pipe from this reservoir is 6 m s and h =15 ft Because of the rounded entrance to the pipe, the flow is assumed to be irrotational. Under these conditions, what is the pressure at A?



End of chapter four

Good Luck ^u^

* هذا التلخيص لا يكفي لدراسة المادة ..

عليك بالرجوع إلى أسئلة البروبلمز

أرقام أسئلة بروبلمز مهمة في شابتر "4" ^_^

19, 20, 24, 31, 32, 33, 35, 36, 37

41, 42, 44, 45, 46, 47, 52, 59, 61

62, 63, 72, 73, 95, 99, 98 ..

مع العلم أن هذه الأرقام من الطبعة التاسعة.

بالتوفيق ^_^

⇒ chapter Five :

"Control volume Approach and Continuity Equation"

5.1 : Rate of flow

volume flow rate ⟶ $Q = \int v\,dA = \bar{V} A$

$\bar{V}$: Average velocity.

A : Area.

mass flow rate ⟶ $\dot{m} = \int_A \rho v\,dA$

$\dot{m} = \rho \int_A v\,dA$

$\dot{m} = \rho V A$

$\boxed{\dot{m} = \rho Q}$

$Q = VA$

⇒ Example 5.1 | Air that has a mass density of 1.24 kg/m³ flows in a pipe with diameter of 30 cm at mass rate of flow of 3 kg/s . what are mean velocity and discharge in the pipe ?!

Sol :

$Q = \frac{\dot{m}}{\rho} = \frac{3}{1.24} = \boxed{2.4193 \ m^3/s}$

$Q = VA$

$\hookrightarrow V = \frac{Q}{A} = \frac{2.4193}{(\frac{\pi}{4})(0.3)^2} = \boxed{34.226 \ m/s}$

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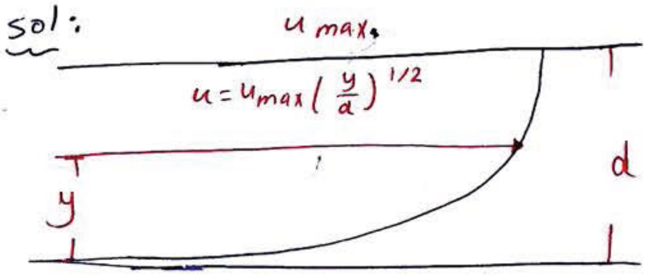
⇒ Example 5.3 The water velocity in the channel shown in the accompanying figure has a distribution across the vertical section equal to $\frac{u}{u_{max}} = \left(\frac{y}{d}\right)^{1/2}$. what is the discharge in the channel if the water is 2m deep (d = 2m). the Channel is 5m wide, and the maximum velocity is 3m/s?

sol:



$$Q = \int_0^d u \, dA$$

$$5 = \frac{dA}{dy}$$

$$Q = \int_0^2 u_{max} \left(\frac{y}{d}\right)^{1/2} dA$$

$$\boxed{5\,dy = dA}$$

$$Q = \frac{5\,u_{max}}{d^{1/2}} \int_0^2 y^{1/2} \, dy$$

$$Q = \frac{5*3}{2^{1/2}} \left(\frac{2}{3} y^{3/2}\right) \Big]_0^2$$

$$Q = 20 \ m^3/s$$

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⇒ problem 5.16 | Air enters this squar duct at section 1 with the velocity distribution as shown.

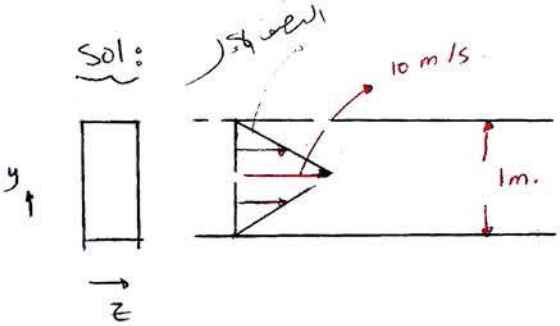
Note that the velocity varies in the y direction only (for a given value of y, the velocity is the same for all values of z)

a) what is the volume rate of flow ?

b) what is the mean velocity in the duct ?

c) what is the mass of flow rate ? ($\rho = 1.2\ kg/m^3$)

Sol:



$V = ay + b$

$U_{max} = 10$ @ $y = 0.5m$

$V = 0$ @ $y = 0\ m$

$10 = a(0.5) + b$

$\boxed{a = 20}$

$0 = 0 + b \longrightarrow \boxed{b = 0}$

$V = 20y$ ...

$A = y * 1$

$\boxed{dA = dy}$

ⓐ $Q = \int V\, dA = \int_0^{0.5} 20\, y\, dy$

$Q = \frac{20\, y^2}{2} \Big]_0^{0.5} = \boxed{2.5\ m^3/s}$

للنصف الأول.

$Q = 2 * 2.5 = \boxed{5\ m^3/s}$

(b) $V_{mean} = \bar{V} = \frac{Q}{A} = \frac{5}{(1*1)} = 5\ m/s$

(c) $\dot{m} = \rho Q = 1.2(5) = 6\ Kg/s$

5.2 : Control Voluem

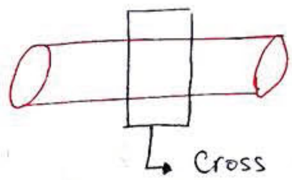
⇒ Intensive property : any property that is independent of the amount of matter present.

خاصية لاتعتمد على الكتلة.

⇒ Extensive property : any property that is dependent of the amount of metter present.

خاصية تعتمد على الكتلة.

⇒ Control volume and Control surface



Cross section Area.

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

→ if flow steady "$\frac{d}{dt}\int_{C.V}\rho\, dv$" equal zero.

→ $\int_{C.S}\rho\, V dA = \sum \dot{m}_{out} - \sum \dot{m}_{in} = 0.0$

⇒ Reynolds transport theorem :-

$$\frac{dB_{sys}}{dt} = \frac{d}{dt}\int_{C.V} b\rho\, d\forall + \int_{C.S} b\rho V\, dA$$

$b = \frac{m}{m} = 1$

$B = m$

B :- any extensive property.

b :- the corresponding intensive property.

$$\Rightarrow \frac{d}{dt}\int_{C.V} \rho\, d\forall + \int_{C.S} \rho V\, dA = 0$$

$$\boxed{\frac{d}{dt} m_{CV} + \sum \dot{m}_{out} - \sum \dot{m}_{in} = 0}$$

↳ the countinuty equ.

where $\frac{d}{dt} m_{CV} > 0.0 \longrightarrow \sum \dot{m}_{in} > \sum \dot{m}_{out}$

" filling "

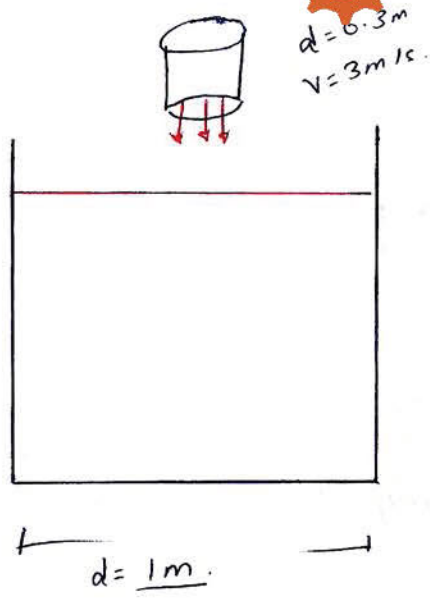
$\frac{d}{dt} m_{CV} = 0 \longrightarrow \sum \dot{m}_{in} = \sum \dot{m}_{out}$

" stead state "

$\frac{d}{dt} m_{CV} > 0 \longrightarrow \sum \dot{m}_{out} > \sum \dot{m}_{in}$

" emptying "

=) example



$\frac{dh}{dt}$?!

Sol :

$$\frac{d}{dt}\int_{C.V} \rho \, d\forall + \cancel{\sum \dot{m}_{out}} - \sum \dot{m}_{in} = 0$$

$$V = Ah$$

$$\frac{d}{dt}\int_{C.V} A\rho \, dh + \sum \dot{m}_{in} = 0$$

$$\boxed{\dot{m} = \rho Q}$$

$$\frac{dh}{dt}\rho A = \sum \dot{m}_{in}$$

$$\frac{dh}{dt}\cancel{\rho} = \frac{\cancel{\rho} Q}{A} = \frac{Q}{A_{tank}}$$

$$Q = VA$$
$$= \frac{\pi}{4}(0.3)^2(3)$$
$$= 0.21205 \ m^3/s$$

$$A_{tank} = \frac{\pi}{4}(1)^2$$
$$= \boxed{0.785 \ m^2}$$

$$\boxed{\frac{dh}{dt} = 0.2699}$$

⇒ Continuity Equation for flow in a pipe :

$$\cancel{\frac{d}{dt}\int_{C.V} \rho \, d\forall} + \Sigma \dot{m}_{out} - \Sigma \dot{m}_{in} = 0$$

zero

becase the system steady !!

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

$$\cancel{\rho_{out}} A_{out} V_{out} = \cancel{\rho_{in}} A_{in} V_{in}$$

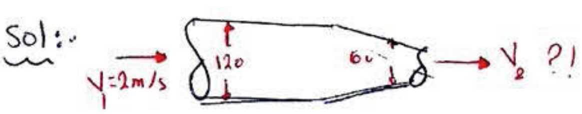
$$A_{out} V_{out} = A_{in} V_{in}$$

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

⇒ Example 5.8

A 20 cm pipe is in series with a 60 cm pipe. The speed of the water in the 120 pipe 2 m/s. what is the water speed in the 60 cm pip?

Sol :



$$Q_1 = Q_2$$

$$V_1 A_1 = V_2 A_2$$

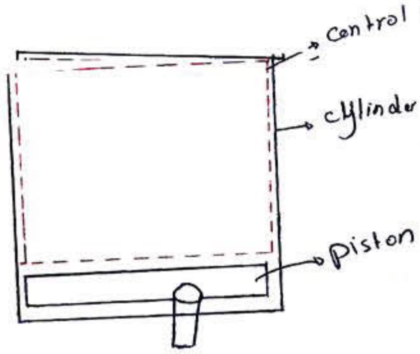
$$\frac{2 \left(\frac{\pi}{4}\right)(120 * 10^{-2})^2}{\left(\frac{\pi}{4}\right)(60 * 10^{-2})^2} = V_2$$

$$V_2 = 2 * 4 = \boxed{8 \ m/s}$$

* من هنا نستنتج ان السرعة أكبر عند القطر الأصغر !!

=> problem 5.38 | The piston in the cylinder is moving up. Assume that the control volume is the volume inside the cylinder above the piston (the control volume changes in size as the piston moves). A gaseous mixture exists in the control volume. For the given condition indicate which of the flowing statement are true.

sol:-



a) $\sum_{c.s} \rho V \cdot A$ is equal zero.

b) $\frac{d}{dt} \int_{c.v} \rho d\forall$ is equal zero

c) The mass density of the gas in the control volume is increasing with time.

d) The temp of the gas in the control volume is increasing with time

e) The flow inside the control volume is unsteady.

ⓐ True, there is no flow entering or leaving.

ⓑ True, the mass in the control volume is not change with time.

ⓒ True, the mass const.

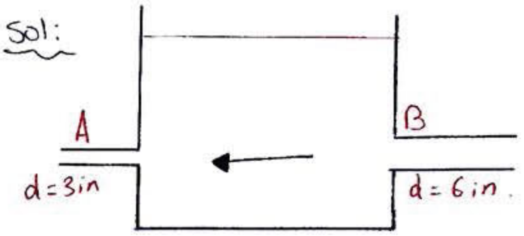
ⓓ True, the piston is moving rapidly, there is no time for heat transfer so temp. must increase.

ⓔ True, due to piston motion the velocity of the gases in the cylinder will be changing with time.

=> problem 5.44, Both pistons are moving to the left, but piston A has a speed twice as great as that of piston B. Then the water level in the tank is

✓(a) rising (b) not moving up or down (c) failng ?!

Sol:



$$\boxed{V_A = 2V_B}$$

$$\frac{\partial}{\partial t}\int_{C.V}\rho\, d\forall + \int_{C.S}\rho v\, dA = 0.$$

$$\frac{\partial}{\partial t}\int_{C.V}\rho\, dV = \Sigma \dot{m}_{in} - \Sigma \dot{m}_{out} \qquad \boxed{\dot{m} = \rho V A}$$

$$\cancel{\rho}\frac{\partial}{\partial t}\int dV = \cancel{\rho}\left(V_{in}A_{in} - V_{out}A_{out}\right) \qquad \boxed{V_A = 2V_B}$$

$$Q_{in} = V_{in}A_{in}$$

$$Q_{in} = V_B\left(\frac{\pi}{4}\right)(6)^2$$

$$\boxed{Q_{in} = 28.27\, V_B}$$

$$Q_{out} = V_{out}A_{out}$$

$$= 2V_B\left(\frac{\pi}{4}\right)(3)^2$$

$$\boxed{Q_{out} = 14.13\, V_B}$$

$$\frac{\partial V}{\partial t} = 28.27\, V_B - 14.13\, V_B$$

$$\frac{\partial V}{\partial t} = 14.14\, V_B \rightsquigarrow V = Ah$$

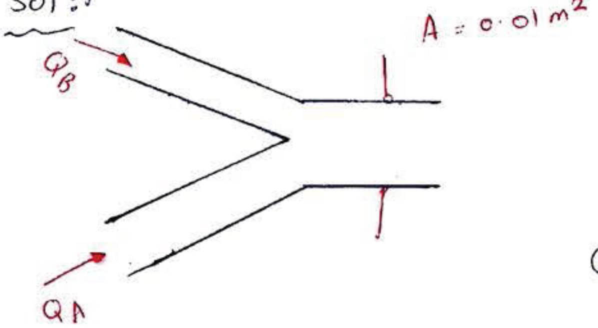
$$A\frac{\partial h}{\partial t} = 14.14\, V_B$$

$$\frac{\partial h}{\partial t} = \boxed{\frac{14.14\, V_B}{A}} \longrightarrow > 0.0$$

So its "Rising"

=) problem 5.46 | Two streams discharge into a pipe as shown. The flows are incompressible. The volume flow rate of stream A into the pipe is given by $Q_A = 0.02t\ m^3/s$ and that stream B by $Q_B = 0.008t^2\ m^3/s$ where t is seconds. The exit area of the pipe is $0.01\ m^2$. Find the velocity and acceleration of the flow at the exit at $t = 1s$.

Sol:



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

$$Q_A + Q_B = Q_{out}$$

$$Q_A + Q_B = V_{out} A_{out}$$

$$V_{out} = \frac{Q_A + Q_B}{A_{out}}$$

$$V_{out} = \frac{0.02 + 0.008t^2}{0.01}$$

$$V_{out}\Big|_{at\ t=1s} = \frac{0.02t + 0.008t^2}{0.01}$$

$$V_{out} = 2.8\ m/s$$

$$a_{exit}\Big|_{at\ t=1s} = \frac{\partial V}{\partial t} + \cancel{V\frac{\partial V}{\partial s}} \quad 0.0$$

$$= 2t + 0.8t^2$$

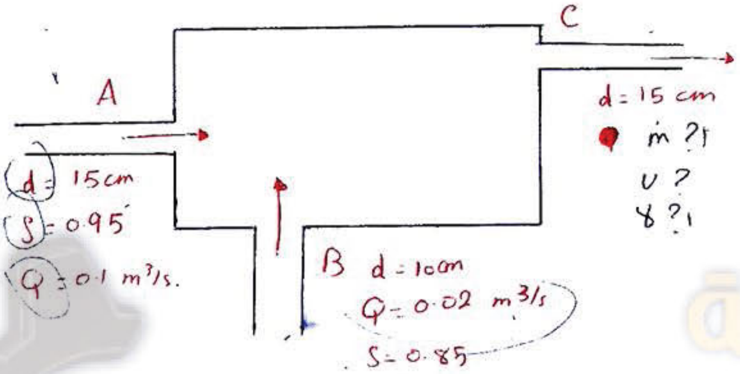
$$= 2 + 1.6t$$

$$= 2 + 1.6$$

$$= 3.6\ m/s^2$$

=) problem 5.66) Assuming that complete mixing occurs between the two in flows befor the mixing the discharges from the pipe at C , find the mass rate of flow , velocity and the specific gravity of the mixture in the pipe at C?

Sol:



$$\Sigma Q_{in} = \Sigma Q_{out}$$

$$Q_A + Q_B = Q_C \longrightarrow Q_C = 0.1 + 0.02 = \boxed{0.12 \ m^3/s}$$

$$Q_c = V_c A_c$$

$$0.12 = V_c \left(\frac{\pi}{4}\right)(0.15)^2$$

② $$\boxed{V_c = 6.79 \ m/s}$$

$$\dot{m}_C = \rho Q_c$$

③ $$\rho_c = \frac{112}{0.12} = 933.33 \ kg/m^3$$

$$\dot{m}_A + \dot{m}_B = \dot{m}_C$$

$$\rho Q_A + \rho Q_B = \dot{m}_C$$

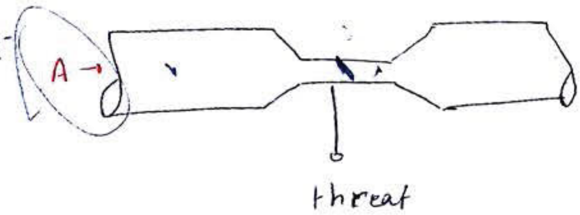
$$(0.95)(1000)(0.1) + (0.85)(1000)(0.02) = \dot{m}_C$$

① $$\dot{m}_C = 112 \ kg/s$$

* example : when gage "A" indicates 100 kPa gage, and $d = 40$ cm, and threat dimeter = 10 cm, and $P = 1.27$ kPa (absolute) what is the Discharg ?!

سؤال مناقشة السنوات

Sol :-



$P_A = 100$ kPa "gage"

$P_{th} = 1.27$ kPa "absolute"

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

$P_{th} = 1.27$ kPa "abs"

$P_A = 200$ kPa "abs"

$Q_A = Q_{th}$

$A V_A = A V_{th}$

$\cancel{\left(\frac{\pi}{4}\right)}(0.4)^2 V_A = \cancel{\left(\frac{\pi}{4}\right)}(0.1)^2 V_{th}$

$\boxed{16 V_A = V_{th}}$

$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + \cancel{Z_A} = \frac{P_{th}}{\gamma} + \frac{V_{th}^2}{2g} + \cancel{Z_{th}}$$

$$\frac{200\times10^3}{9810} + \frac{V_A^2}{2(9.81)} = \frac{1.27\times10^3}{9810} + \frac{V_{th}^2}{2(9.81)}$$

$V_{th} = 16 V_A$

$$\frac{200\times10^3}{9810} + \frac{V_A^2}{19.62} = \frac{1.27\times10^3}{9810} + \frac{256 V_A^2}{19.62}$$

$$\frac{198.73\times10^3}{9810} = \frac{255 V_A^2}{19.62} \longrightarrow V_A = 1.248 \text{ m/s}$$

$Q = V_A A_A$

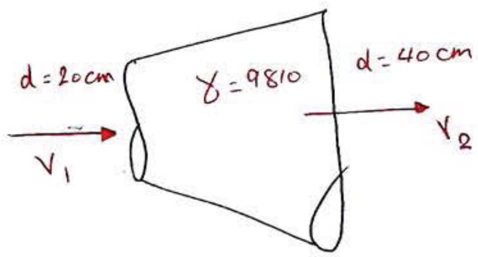
$= 1.248 \left(\frac{\pi}{4}\right)(0.4)^2$

#

$Q = 1.568 \text{ m}^3/\text{s}$

(12)

=) example | in the figure shown, find the range of ΔP if the discharge $[0.01 \leq Q \leq 0.1]$



$Q_{in} = V_{in} A_{in}$

Sol:- for $Q = 0.01$

$$V_1 = \frac{Q_1}{A_1} = \frac{0.01}{\frac{\pi}{4}(0.2)^2} = 0.3183 \ m/s$$

$$V_2 = \frac{Q_2}{A_2} = \frac{0.01}{\frac{\pi}{4}(0.4)^2} = 0.07957 \ m/s.$$

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + \cancel{Z_1}^{0.0} = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + \cancel{Z_2}^{0.0}$$

$$\frac{P_1}{9810} + \frac{(0.3183)^2}{2(9.81)} = \frac{P_2}{9810} + \frac{(0.07957)^2}{2(9.81)}$$

$$\boxed{\Delta P = 47.521 \ Pa}$$

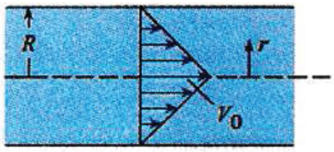
for $Q = 0.1$

نفس الفرع السابق

5.12 The hypothetical velocity distribution in a circular duct is

$$\frac{v}{V_0} = 1 - \frac{r}{R}$$

where r is the radial location in the duct, R is the duct radius, and V_0 is the velocity on the axis. Find the ratio of the mean velocity to the velocity on the axis.



$\frac{\bar{V}}{V_0}$?!

$$Q = \int V \, dA$$

$$A = \pi r^2$$
$$\boxed{dA = 2\pi r \, dr}$$

$$Q = \int_0^R V_0 \left(1 - \frac{r}{R}\right) 2\pi r \, dr$$

$$Q = V_0 (2\pi) \int_0^R \left[r - \frac{r^2}{R} \right] dr$$

$$Q = V_0 (2\pi) \left[\frac{r^2}{2} - \frac{r^3}{3R} \right]_0^R$$

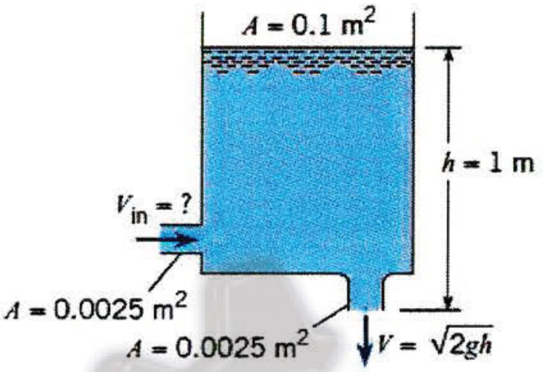
$$Q = 2\pi V_0 \left[\frac{R^2}{2} - \frac{R^3}{3\cancel{R}} \right] = 2\pi V_0 \left[\frac{R^2}{2} - \frac{R^2}{3} \right]$$

$$Q = \frac{2}{6} \pi V_0 \left[R^2 \right]$$

$$\bar{V} = \frac{Q}{A} = \frac{\frac{2}{6} \cancel{\pi} V_0 \cancel{R^2}}{\cancel{\pi} \cancel{R^2}} = \frac{2}{6} V_0 \implies \frac{\bar{V}}{V_0} = \frac{\frac{2}{6} \cancel{V_0}}{\cancel{V_0}}$$

$$\frac{\bar{V}}{V_0} = \frac{1}{3}$$

5.49 A tank has a hole in the bottom with a cross-sectional area of 0.0025 m2 and an inlet line on the side with a cross-sectional area of 0.0025 m2, as shown. The cross-sectional area of the tank is 0.1 m^2. The velocity of the liquid flowing out the bottom hole is $V = (2gh)^{0.5}$, where h is the height of the water surface in the tank above the outlet. At a certain time the surface level in the tank is 1 m and rising at the rate of 0.1 cm/ s. The liquid is incompressible. Find the velocity of the liquid through the inlet.



$\boxed{V = Ah}$

$\boxed{dV = A\,dh}$

$$\frac{d}{dt}\int_{C.V} \rho\, d\forall + \sum \dot m_{out} - \sum \dot m_{in} = 0$$

$$\frac{d}{dt}\int \rho A\,dh + \rho Q_{out} - \rho Q_{in} = 0$$

$$\frac{dh}{dt}\cancel{\rho} A + \cancel{\rho} Q_{out} - \cancel{\rho} Q_{in} = 0$$

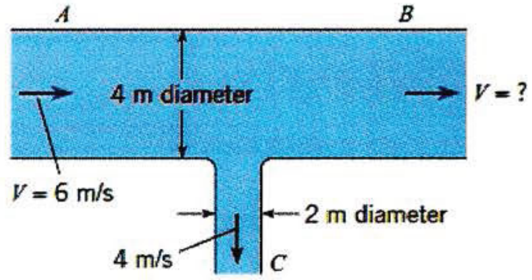
$\sqrt{2gh} = \sqrt{2*9.81*1}$

$\boxed{v = 4.42\ m/s}$

$$(0.1)*10^{-2}(0.1) = V_{in}(0.0025) - V_{out}(0.0025)$$

$$V_{in} = 4.46\ m/s$$

5.58 What is the velocity of the flow of water in leg *B* of the tee shown in the figure?



Continuity equation :

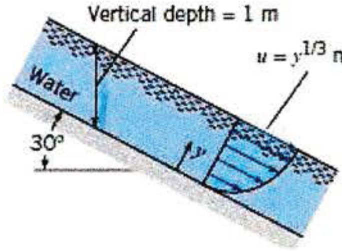
$$Q_{in} = Q_{out}$$

$$V_A A_A = V_B A_B + V_C A_C$$

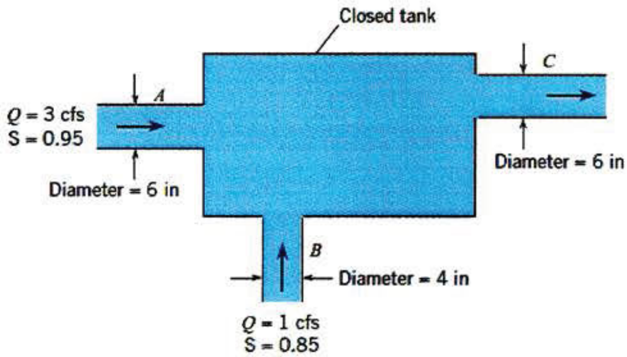
$$6\left(\frac{\pi}{4}(4)^2\right) = V_B\left(\frac{\pi}{4}(4)^2\right) + 4\left(\frac{\pi}{4}(2)^2\right)$$

$$V_B = 5 \text{ m/s}$$

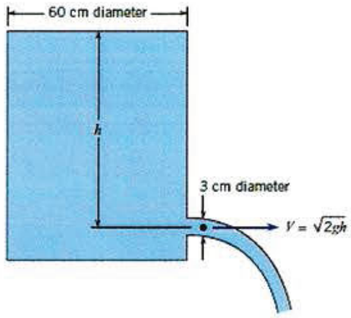
5.18 The rectangular channel shown is 1.5 m wide. What is the discharge in the channel?



5.66 Assuming that complete mixing occurs between the two inflows before the mixture discharges from the pipe at *C*, find the mass rate of flow, the velocity, and the specific gravity of the mixture in the pipe at *C*



5.74 How long will it take the water surface in the tank shown to drop from h= 3 m to h= 50 cm?



END of chapter Five

Good luck ^^

Chapter six Momentem of principle

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

$$\Sigma F_x = \frac{d}{dt}\int_{C.V} \rho \bar{V} \, d\forall + \Sigma \dot{m}_{out} V_{out} - \Sigma \dot{m}_{in} V_{in}$$

$$\Sigma F_y = \frac{d}{dt}\int_{C.V} \rho \bar{V} \, d\forall + \Sigma \dot{m}_{out} V_{out} - \Sigma \dot{m}_{in} V_{in}$$

$$\Sigma F_z = \frac{d}{dt}\int_{C.V} \rho \bar{V} \, d\forall + \Sigma \dot{m}_{out} V_{out} - \Sigma \dot{m}_{in} V_{in}$$

= خطوات حل سؤال الـ Momentem

١) نرسم شكلين، احد للقوى (F.D) وواحد للزخم (M.D)

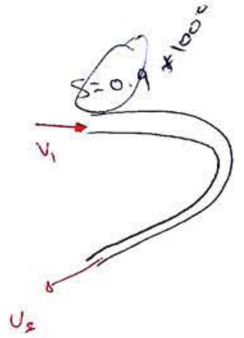
٢) نحل الوزن وردة الفعل على الشكل الأول (F.D).

٣) نحدد السرعات الداخلة والخارجة والدفعة الكتلية على الشكل الثاني (M.D).

٤) نستخدم قوانين الزخم كما موجود في أعلاه.

problem 6.20 Determine the external reaction in the x and y direction needed to hold fixed vane, which turns oil jet in a horizontal plane. Here $V_1 = 18\,m/s$, $U_2 = 17\,m/s$ and $Q = 0.15\,m^3/s$

Sol:



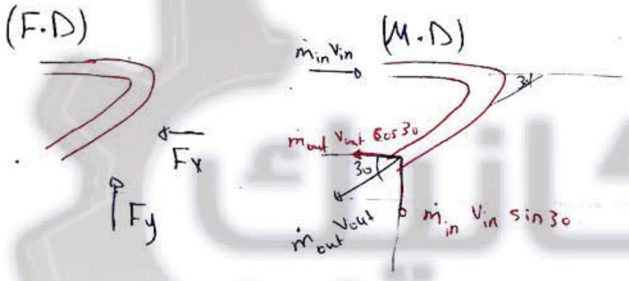
$Q_{in} = Q_{out}$

$V_1 A_1 = V_2 A_2$

$\dot{m} = \rho Q$

$= 0.9(1000)(0.15)$

$= 135\,kg/s$



$$\Sigma F_x = \cancel{\frac{d}{dt}\int_{C.V} \rho\, V\, dV} + \Sigma \dot{m}_{out} V_{out} - \Sigma \dot{m}_{in} V_{in}$$

0.0 (steady)

$$-F_x = -135(17)(\cos 30) - 135(18)$$

$$\boxed{F_x = 4.417\ KN}$$

$$F_y = \Sigma \dot{m}_{out} V_{out} \cancel{- \Sigma \dot{m}_{in} V_{in}}$$

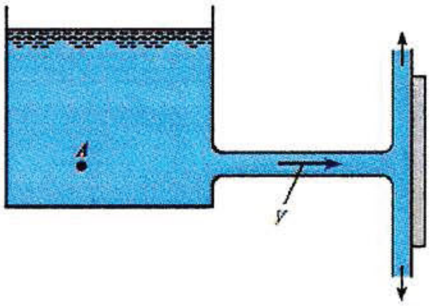
0.0

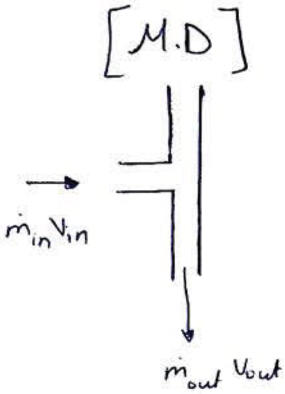
$$F_y = -135(17)(\sin 30) = \boxed{-1.1475\ KN \quad \text{عكس الاتجاه المفروض}}$$

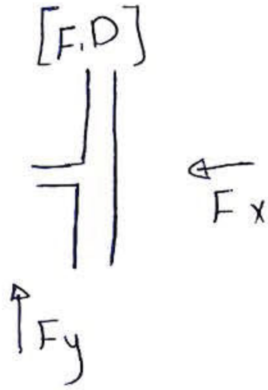
6.10 A horizontal water jet at 70°F impinges on a verticalperpendicular plate. The discharge is 2 cfs. If the external force required to hold the plate in place is 200 lbf, what is the velocity of the water?

$Q = 2\,cfs = \boxed{0.05\ m^3/s}$

$F = 200\ lbf = 900\ N.$







$$\sum F_x = \cancel{\sum \dot{m}_{out} V_{out}}^{\,0.0} - \sum \dot{m}_{in} V_{in}$$

$$-F_x = -\,50\,(V)$$

$$\frac{900}{50} = \boxed{18\ m/s}$$

$\dot{m} = \rho Q$

$\dot{m} = 1000\,(0.05)$

$\boxed{\dot{m} = 50\ kg/s}$

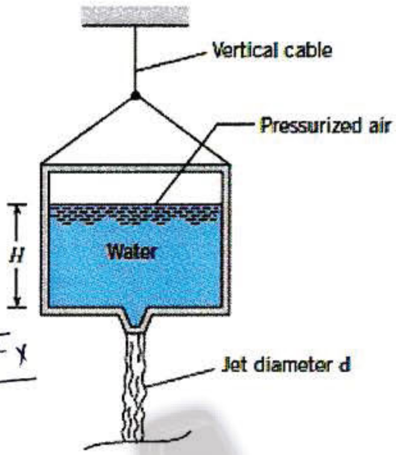
عِلماً أنو الجواب طلع موجب معناتو فرضنا صحيح

لو طلع سالب فقط تكتب

"عكس الاتجاه المفروض" ^_^

UOLOADED BY AHMAD JUNDI

6.15 A tank of water (15° C) with a total weight of 200 N (water plus the container) is suspended by a vertical cable. Pressurized air drives a water jet (d= 12 mm) out the bottom of the tank such that the tension in the vertical cable is 10 N. If H =425 mm, find the required air pressure in units of atmospheres (gage). Assume the flow of water is irrotational.



$\omega = 200\ N.$

$d = 12\ mm$

$F = 10\ N.$

P_{gage} ?!

F_x

F_y

$$\Sigma F_y = \Sigma \dot{m}_{out} v_{out} - \cancel{\Sigma \dot{m}_{in} v_{in}}^{\,0.0}$$

$$-10 + \underbrace{200}_{\boxed{\omega}} = \rho Q V_2$$

$$\frac{\pi}{4}(12\times10^{-3})^2 = 0.113\times10^{-3}\ m^2$$

$$+190 = 1000\, A V_2^2$$

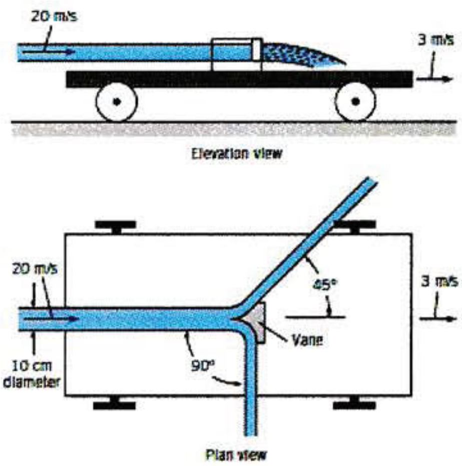
$$v_2 = 41\ m/s$$

$$\frac{P_1}{\gamma} + z_1 + \frac{v^2}{2g} = \cancel{\frac{P_2}{\gamma}}^{\,0\ gage} + z_2 + \cancel{\frac{V_2^2}{2g}}^{\,zero\ (tank}$$

$$\frac{P_1}{\gamma} = (z_2 - z_1) + \frac{v_2^2}{2g} = -(425\times10^{-3}) + \frac{41^2}{2(9.81)}$$

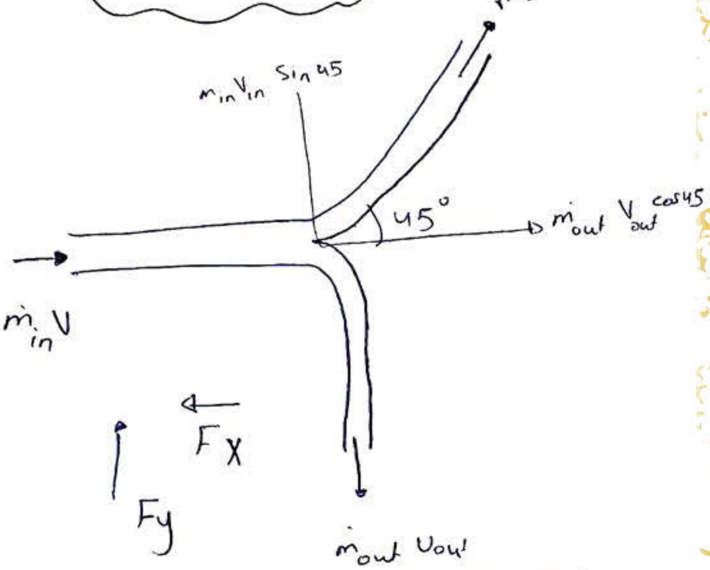
$$P_1 = 8.255\ atm$$

6.30 A vane on this moving cart deflects a 10 cm water jet as shown. The initial speed of the water in the jet is 20 m s, and the cart moves at a speed of 3 m/s. If the vane splits the jet so that half goes one way and half the other, what force is exerted on the vane by the jet?



$V = 20 - 3$

$V = 17\,m/s$



$\Sigma F_x = \Sigma \dot{m}_{out} U - \Sigma \dot{m}_{in} U_{in}$

$-F_x = 17(133.5)\left[-1 + \frac{\cos 45}{2}\right]$

$\boxed{F_x = -1470\,N}$

عكس الاتجاه المفروض

$\dot{m}_{in} = \dot{m}_{out} = \rho A V$

$= 1000(17)\left(\frac{\pi}{4}\right)(0.1)^2$

$\dot{m} = 133.5\,kg/s$

$F_y = \Sigma \dot{m}_{out} U_{out} - \cancel{\Sigma \dot{m}_{in} V_{in}}^{\,0.0}$

$F_y = \frac{\dot{m}}{2} V(\cos 45 - 1)$

$= \frac{133.5}{2} * 17 * (0.707 - 1) = \boxed{-332\,N}$

عكس الاتجاه المفروض

$Q = 1\ m^3/s$

$P_1 = 70\ kPa \quad z_1 = 30\ m$

$P_2 = 60\ kPa \quad z_2 = 31\ m$

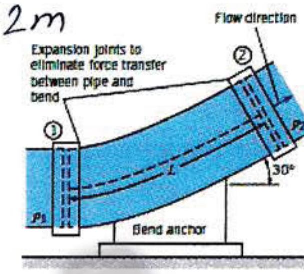
$L = 1.2\ m$

$\omega = 1400\ N$

$D = 60\ cm$

6.44 This 30° vertical bend in a pipe with a 2 ft diameter carries water at a rate of 31.4 cfs. If the pressure p_1 is ~~10~~ psi at the lower end of the bend, where the elevation is 100 ft, and p_2 is 8.5 psi at the upper end, where the elevation is 103 ft, what will be the vertical component of force that must be exerted by the "anchor" on the bend to hold it in position? The bend itself weighs 300 lb, and the length L is ~~4 ft~~.

1.2m



$P_2 A_2$

$V = \frac{Q}{A} = \frac{1}{\frac{\pi}{4}(0.6)^2} = 3.53\ m/s$

$P_1 A_1$

$F_y \quad F_x$

$$\Sigma F_x = \Sigma \dot{m}_{out} v_{out} - \Sigma \dot{m}_{in} v_{in}$$

$$-F_x + P_1 A_1 - P_2 A_2 \cos 30 = \rho Q \left[3.53 \cos 30 - 3.53 \right]$$

$$-F_x = 60 \times 10^3 \left(\frac{\pi}{4}(0.6)^2\right) \cos 30 - 70 \times 10^3 \left(\frac{\pi}{4}(0.6)^2\right) + 1000 \left[3.53 \cos 30 - 3.53\right]$$

$$F_x = 49.986\ kN$$

$$\Sigma F_y = \Sigma \dot{m}_{out} v_{out} - \cancel{\Sigma \dot{m}_{in} v_{in}}^{\,0}$$

$$F_y - W_{water} - W_{Bend} - P_2 A_2 \sin 30 = \rho Q V \sin 30$$

$$F_y - \gamma V - 1400 - 60 \times 10^3 \left(\frac{\pi}{4}(0.6)^2\right) \sin 30 = 1000\,(3.53) \sin 30$$

$$F_y - 9810 \left(\overset{L}{1.2} \overset{A}{\left(\frac{\pi}{4}(0.6)^2\right)}\right) - 1400 - 60 \times 10^3 \left(\frac{\pi}{4}(0.6)^2\right) \sin 30 = 3.53\,(1000) \sin 30$$

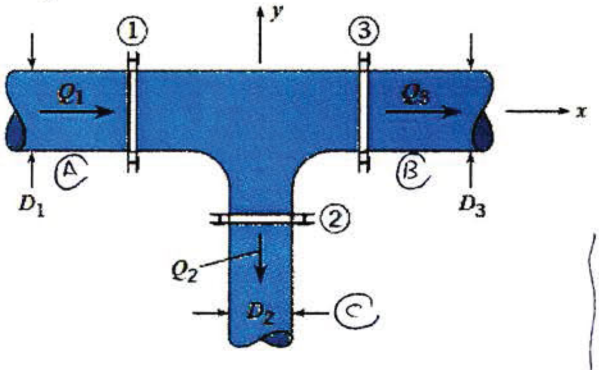
$$F_y = 14.97\ kN$$

6.55 For this horizontal T through which water ($\rho = 1000 \text{ kg/m}^3$) is flowing, the following data are given: $Q_1 = 0.25 \text{ m}^3/\text{s}$, $Q_2 = 0.10 \text{ m}^3/\text{s}$, $p_1 = 100 \text{ kPa}$, $p_2 = 70 \text{ kPa}$, $p_3 = 80 \text{ kPa}$, $D_1 = 15 \text{ cm}$, $D_2 = 7 \text{ cm}$, and $D_3 = 15 \text{ cm}$. For these conditions, what external force in the *x-y* plane (through the bolts or other supporting devices) is needed to hold the T in place?

F_x , F_y ?!

$Q_{in} = Q_{out}$

$Q_A = Q_B + Q_C$



$0.25 = 0.1 + Q_3$

$Q_3 = 0.15 \text{ m}^3/\text{s}$

$\Sigma F_x = \Sigma \dot{m}_{out} v_{out} - \Sigma \dot{m}_{in} V_{in}$

$F_x + P_1 A_1 - P_3 A_3 = \dot{m}_3 V_3 - \dot{m}_1 V_1$

$F_x = \rho Q_3 V_3 - \rho Q_1 V_1 + P_3 A_3 - P_1 A_1$

$F_x = 1000(0.15)(8.49) - 1000(0.25)(14.15) + 80 \times 10^3 \left(\frac{\pi}{4}(0.15)^2\right) - 100 \times 10^3 \left(\frac{\pi}{4}(0.15)^2\right)$

$\boxed{F_x = -2617 \text{ N}}$

$V_1 = \dfrac{Q_1}{\frac{\pi}{4}(d_1^2)} = \dfrac{0.25}{\frac{\pi}{4}(0.15)^2}$

$\boxed{V_1 = 14.15 \text{ m/s}}$

$V_2 = \dfrac{Q_2}{\frac{\pi}{4}(d_2)^2} = \dfrac{0.1}{\frac{\pi}{4}(0.07)^2}$

$\boxed{V_2 = 25.98 \text{ m/s}}$

$V_3 = \dfrac{Q_3}{\frac{\pi}{4}(d_3)^2} = \dfrac{0.15}{\frac{\pi}{4}(0.15)^2}$

$\boxed{V_3 = 8.49 \text{ m/s}}$

$$F_y + P_2 A_2 = \sum \dot{m}_{out} V_{out} - \cancel{\sum \dot{m}_{in} V_{in}}$$

$$0$$

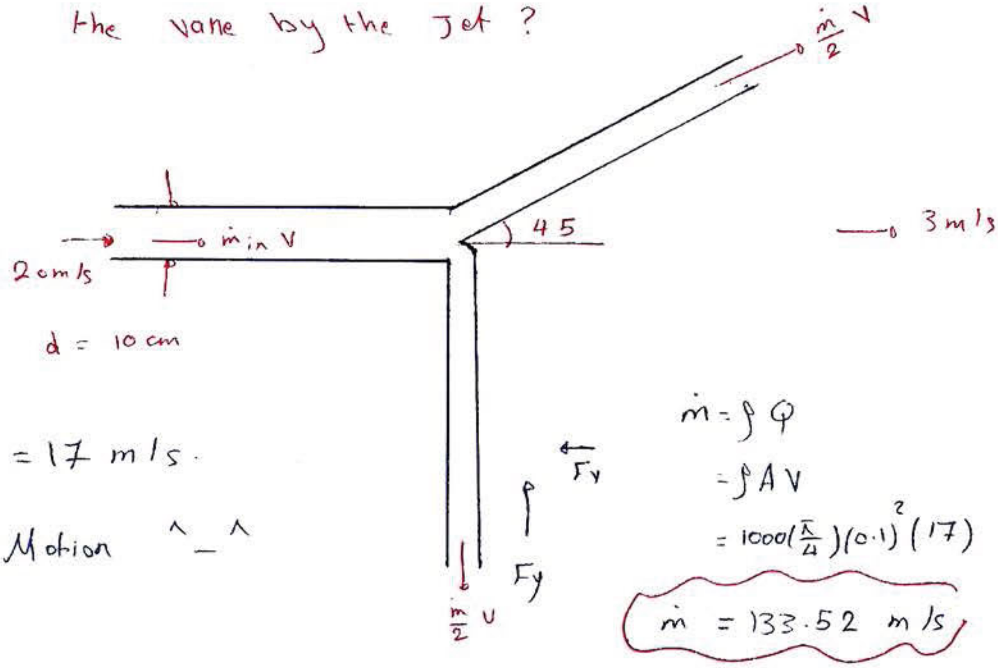
$$F_y = \rho Q_2 V_2 - P_2 A_2$$

$$F_y = 70 \times 10^3 (0.1)(25.98) - 70 \times 10^3 \left(\frac{\pi}{4}(0.07)^2\right)$$

$$F_y = -2867 \, N$$

⇒ problem 6.70 A vane on this moving cart deflects a 10cm water jet has a shown. The initial speed of the water in the jet is 20 m/s, and the cart moves at a speed of 3m/s. If the fane splits the jet so that half goes on way and half the other, what forces is exerted on the vane by the jet?

Sol:-



$U = 20 - 3 = 17\ m/s$.

Relative Motion ^_^

$\dot m = \rho Q$

$= \rho A V$

$= 1000(\frac{\pi}{4})(0.1)^2(17)$

$\dot m = 133.52\ m/s$

$F_x = \Sigma \dot m_{out} V_{out} - \Sigma \dot m_{in} V_{in}$

$= \frac{\dot m}{2} V \cos 45 - \dot m V$

$= \frac{133.52}{2}(17)(\cos 45) - 133.52(17) = \boxed{1470\ N}$

عكس باتجاه المفروض

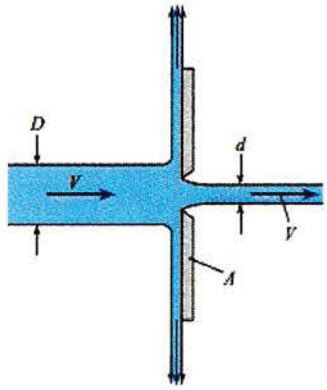
$F_y = \Sigma \dot m_{out} V_{out} - \Sigma \dot m_{in} V_{in}$

$F_y = \left[\frac{\dot m}{2} V \sin 45 - \frac{\dot m}{2} V\right] - 0 = \frac{133.55}{2}(17)\left[\sin 45 + 1\right]$

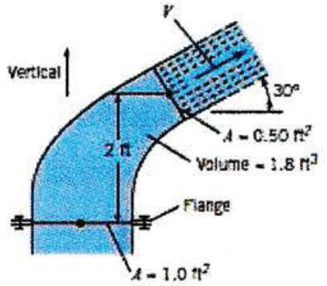
$F_y = -332 N$

عكس باتجاه المفروض

6.26 Plate *A* is 50 cm in diameter and has a sharp-edged orifice at its center. A water jet (at 10° C) strikes the plate concentrically with a speed of 30 m s. What external force is needed to hold the plate in place if the jet issuing from the orifice also has a speed of 30 m s? The diameters of the jets are $D = 5$ cm and $d = 2$ cm.



6.46 This nozzle bends the flow from vertically upward to 30° with the horizontal and discharges water ($\gamma = 62.4$ lbf /ft^3) at a speed of $V=$ 130 ft s. The volume within the nozzle itself is 1.8 ft^3, and the weight of the nozzle is 100 lbf. For these conditions, what *vertical* force must be applied to the nozzle at the flange to hold it in place?



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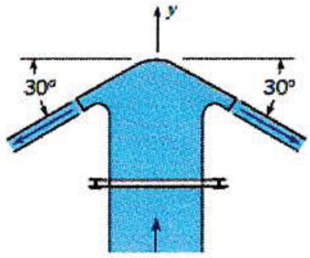
6.69 This spray head discharges water at a rate of 4 ft^3 /s. Assuming irrotational flow and an efflux speed of 65 ft s in the free jet, determine what force acting through the bolts of the flange is needed to keep the spray head on the 6 in. pipe. Neglect gravitational forces



END of CHAPTER Six

Good Luck

* chapter seven. "The Energy Equation"

تكلمنا في مادة الفيرست عن المائع في حالة السكون، ثم في مادة السكند انتقلنا إلى دراسة المائع في حالة الحركة.

وفي مادة الفاينل سوف نتكلم أيضاً عن المائع في حالة الحركة.

قانون الثرموداينمكس الأول :-

$$E = K.E + p.E + u$$

where $E \rightarrow$ Energy.

$K.E \rightarrow$ Kinatic energy.

$p.E \rightarrow$ potential energy.

$u \rightarrow$ resulting energy for atoms.

$$E = Q - w .$$

$$\frac{dE}{dt} = \dot{Q} - \dot{w} .$$

where $Q \rightarrow$ Heat transfer.

$w \rightarrow$ work.

$\frac{dE}{dt} \rightarrow$ the rate of change for energy.

$\dot{Q} \rightarrow$ the rate of heat transfer.

$\dot{w} \rightarrow$ the rate of work.

⇒ Energy Equation (General form).

$$\dot{Q} - \dot{W} = \frac{dE}{dt}$$

من هذه المعادلة يوجد اشتقاق طويل

⋮

$$\frac{P_1}{\gamma} + \alpha_1 \frac{\bar{V}_1^2}{2g} + z_1 + h_p = \frac{P_2}{\gamma} + \alpha_2 \frac{\bar{V}_2^2}{2g} + h_t + h_L$$

where α_1, α_2 ⟶ Kinetic energy correction factor.

if the system uniform flow.

↳ $\alpha_1 = \alpha_2 = 1$.

if the system nonuniform flow.

↳ $\alpha_1 > 1$, $\alpha_2 > 1$.

h_p ⟶ head added by pumps.

h_t ⟶ head extracted by turbines.

h_L ⟶ head Loss due to Viscous effects.

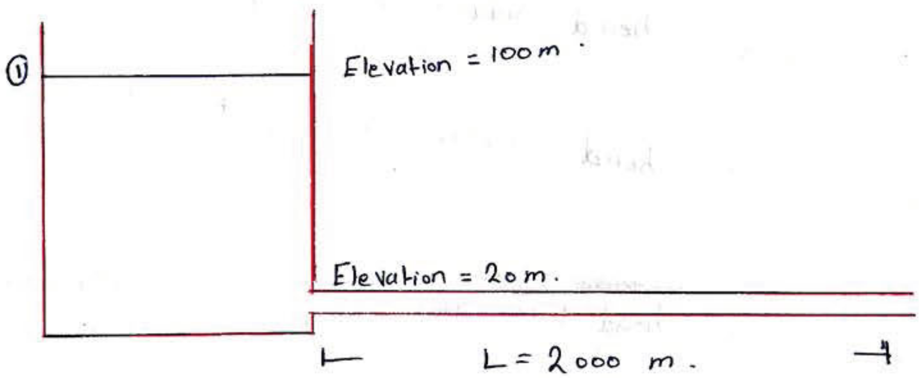
⇒ Example 7.2

A horizontal pipe carries cooling water at 10C°. for a thermal power plant from a reservoir as shown. The head loss in the pipe is

$$h_L = \frac{0.02\,(L/D)\,V^2}{2g}.$$

where L is the Length of the pipe from the reservoir to the point in question, V is the mean velocity in the pipe, and D is the diameter of the pipe. if the pipe diameter is 20 cm and the rate of flow is 0.06 m^3/s, what is the pressure in the pipe at L = 2000 m. Assume $\alpha_2 = 1$.

sol:



using Energy Equation :

$Q = VA$

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

1 atm = 0 gage

0 (tank)

0 pump لا يوجد في النظام

0 turbines لا يوجد في النظام

$$Z_1 = \frac{P_2}{\gamma} + \frac{\alpha_2 V_2^2}{2g} + Z_2 + h_L$$

$Z_1 = 100 m.$

$$U_2 = \frac{Q}{A} = \frac{0.06}{\frac{\pi}{4}(0.2)^2} = \boxed{1.910 \ m/s}$$

$Z_2 = 20 m.$

$$h_L = \frac{0.02 (L/D) V^2}{2g} = \frac{0.02 (2000/0.2)(1.910)^2}{2(9.81)}$$

$$= \boxed{37.2 \ m}$$

$$\Rightarrow 100 = \frac{P_2}{9810} + \frac{1(1.910)^2}{2(9.81)} + 20 + 37.2$$

$$\boxed{P_2 = 418 \ Kpa}$$ #

=> Energy Equation : pipe Flow.

$$\dot{m} = \rho A \bar{V} = \int_A \rho V \, dA$$

$$\vdots$$

$$\alpha = \frac{1}{A} \int_A \left(\frac{V}{\bar{V}}\right)^3 dA$$

→ Kinetic-energy correction factor.

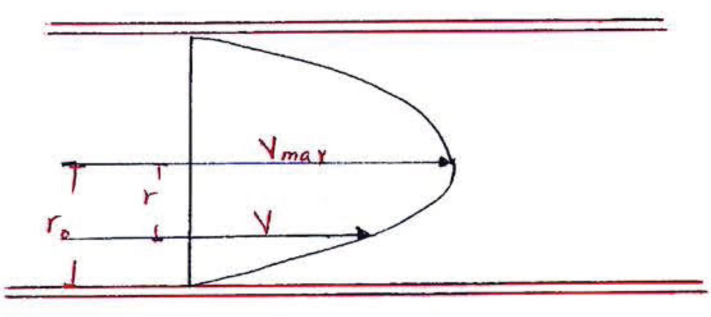
Example 7.1 The velocity distribution for Laminar flow in a pipe is given by the equation:-

مهم جداً

$$V = V_{max} \left[1 - \left(\frac{r}{r_o}\right)^2 \right]$$

Here r_o is the radius of the pipe and r is the radial distance from the center.

Find the kinetic-energy correction factor α.



$dA = 2\pi r \, dr$

Sol:

$$\alpha = \frac{1}{A}\left[\int_A \left(\frac{V}{\bar{V}}\right)^3 dA\right]$$

$$\bar{V} = \frac{1}{A}\int_A V\, dA \qquad = \frac{1}{\pi r_o^2}\left[\int_0^{r_o} V_{max}\left(1-\frac{r^2}{r_o^2}\right) 2\pi r\, dr\right]$$

$$= \frac{2V_{max}}{r_o^2}\left[\int_0^{r_o}\left(1-\frac{r^2}{r_o^2}\right) r\, dr\right]$$

$$= \frac{2V_{max}}{r_o^2}\left[\frac{r^2}{2} - \frac{r^4}{4r_o^2}\Big|_0^{r_o}\right]$$

$$= \frac{2V_{max}}{r_o^2}\left[\frac{r_o^2}{2} + \frac{r_o^2}{4}\right]$$

$$= \frac{\cancel{2}V_{max}}{r_o^2}\left[\frac{1\cancel{8}\, r_o^2}{\cancel{4}\; 2}\right]$$

$$\boxed{\bar{V} = \frac{V_{max}}{2}}$$

$$\Rightarrow \alpha = \frac{1}{A}\left[\int_A \left(\frac{V}{\bar{V}}\right)^3 dA\right]$$

$$\alpha = \frac{1}{\pi r_o^2 \bar{V}^3}\left[\int_0^{r_o} V^3 * 2\pi r\, dr\right]$$

$$\alpha = \frac{1}{\pi r_0^2 (V_{max}/2)^3}\left[\int_0^{r_0}\left[V_{max}\left(1-\frac{r^2}{r_0^2}\right)\right]^3 * 2\pi r \; dr\right]$$

من نص السؤال

$$\alpha = \frac{(2)^3 (2\pi)}{\pi r_0^2 \cancel{(V_{max})^3}}\left[\int_0^{r_0} \underbrace{\cancel{(V_{max})^3}}_{\text{constant.}} \left[1-\frac{r^2}{r_0^2}\right]^3 * r \; dr\right]$$

$$= \frac{16}{r_0^2}\left[\int_0^{r_0}\left(1-\frac{r^2}{r_0^2}\right)^3 r \, dr\right.$$

كالكولاس

كملوها لحالكم

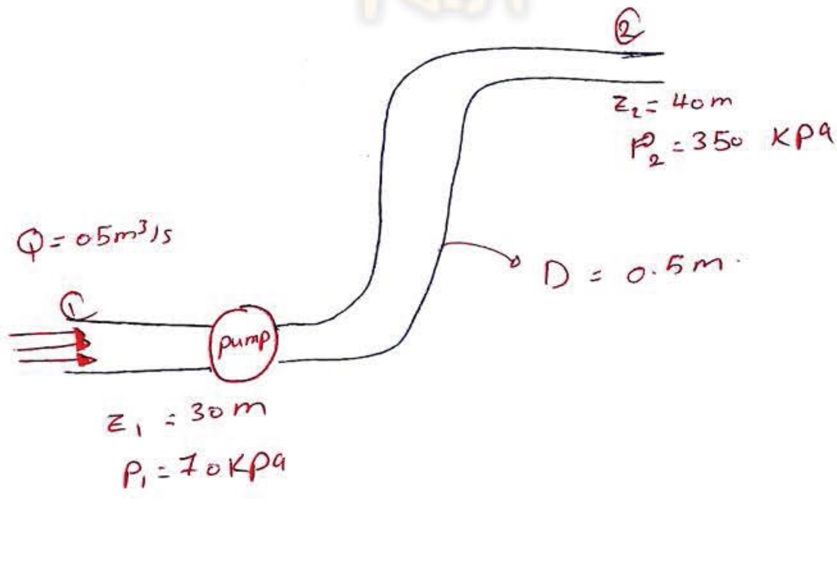
=> power Equation.

$$\boxed{\begin{aligned} \dot{W}_p &= \gamma Q h_p = \dot{m} g h_p \\ \dot{W}_t &= \gamma Q h_t = \dot{m} g h_t \end{aligned}}$$

$$\eta = \frac{P_{output}}{P_{input}}$$

=> Example 7.3

A pipe 50 cm in diameter carries water (10°C) at a rate of 0.5 m³/s. A pump in the pipe is used to move the water from an elevation of 30 m to 40 m. The pressure at section 1 is 70 kPa gage and the pressure at section 2 is 350 kPa gage. What power in kilowatts and in horsepower must be supplied to the flow by the pump? Assume $h_L = 3$ m of water and $\alpha_1 = \alpha_2 = 1$.



sol:- using Energy Equation

$$\frac{P_1}{\gamma} + \cancel{\frac{\alpha_1 V_1^2}{2g}}^{0} + z_1 + h_p = \frac{P_2}{\gamma} + \cancel{\frac{\alpha_2 V_2^2}{2g}}^{0} + z_2 + \cancel{h_t}^{0} + h_L$$

$$\frac{70*10^3}{9810} + 30 + h_p = \frac{350*10^3}{9810} + 40 + 3$$

$$\boxed{h_p = 41.5 \ m}$$

$$P = Q h_p \gamma$$

$$= 0.5 * 41.5 * 9810$$

$$\boxed{P = 204 \ KW}$$

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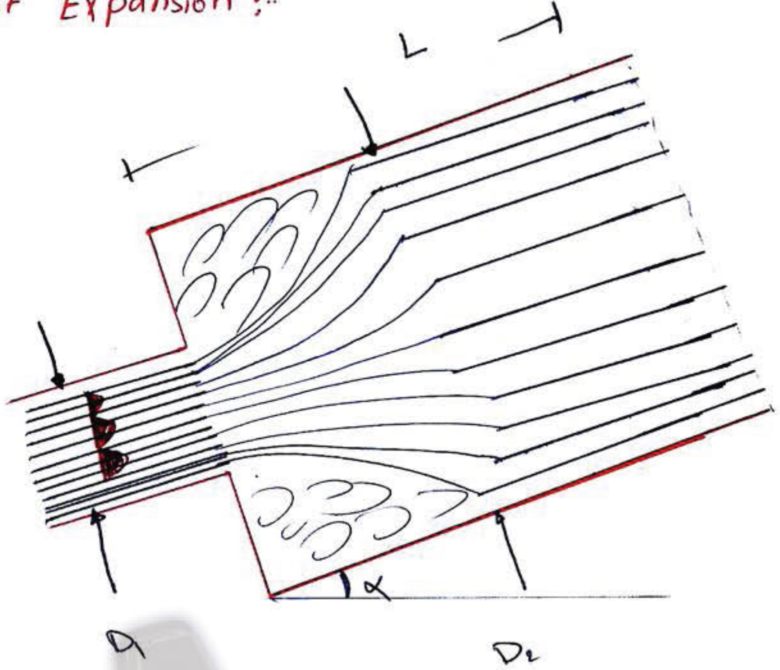
⇒ Arupt Expansion :-



في حالة التوسع المفاجئ تكون h_L :-

$$h_L = \frac{(V_1 - V_2)^2}{2g}$$

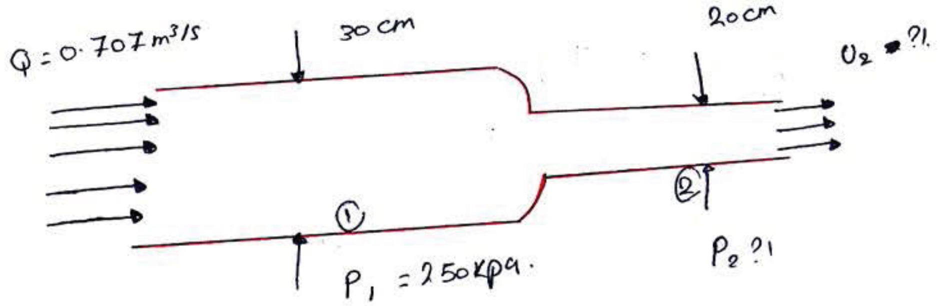
⇒ Forces on Transition.

To Find Forces on transition in pipe , Apply the momentum equation in combination with the energy equation.

"ch. 6" ^_^

⇒ Example 7.5 A pipe 30 cm in diameter carries water (10 c°, 250 Kpa) rate of 0.707 m^3/s. The pipe contracts to a diameter of 20 cm. The head Loss through the contraction is given by :- $h_L = 0.1 \frac{V_2^2}{2g}$

where V_2 is the velocity in the 20 cm pipe. what horizontal force is required to hold the transition in place? Assum $\alpha_1 = \alpha_2 = 1$.



sol:- using Energy Equation

$$\frac{P_1}{\gamma} + \alpha_1 \frac{V_1^2}{2g} + \cancel{Z_1}^{0} + \cancel{h_p}^{0} = \frac{P_2}{\gamma} + \alpha_2 \frac{V_2^2}{2g} + \cancel{Z_2}^{0} + \cancel{h_t}^{0} + h_L$$

$$V_1 = \frac{Q}{A_1} = \frac{0.707}{\frac{\pi}{4}(0.3)^2} = 10 \text{ m/s}.$$

$$V_2 = \frac{Q}{A_2} = \frac{0.707}{\frac{\pi}{4}(0.2)^2} = 22.5 \text{ m/s}.$$

$$h_L = \frac{0.1\ (22.5)^2}{2(9.81)} = \boxed{2.58\ m}$$

$$\frac{P_1}{\gamma} + \frac{\alpha_1\ (10)^2}{2(9.81)} = \frac{P_2}{\gamma} + \frac{\alpha_2\ (22.5)^2}{2(9.81)} + 0\ 2.58.$$

$$\boxed{P_2 = 21.6\ Kpa}$$

$$F_x = \Sigma \dot{m}_{out}\ v_{out} - \Sigma \dot{m}_{in}\ v_{in}$$

$$P_1 A_1 - P_2 A_2 + F_x = \rho Q (V_{out} - V_{in})$$

$$F_x = 1000\ (0.707)(22.5 - 10) + 21.6 \times 10^3 \left(\frac{\pi}{4}\right)(20 \times 10^{-2})^2 - 250 \times 10^3 \left(\frac{\pi}{4}\right)(30 \times 10^{-2})^2$$

$$\boxed{F_x = -8.16\ KN}$$

applied in the negative x direction.

⇒ Hydraulic and Energy Grade Lines "مهم جدا"

$$EGL = \frac{\alpha V^2}{2g} + \frac{P}{\gamma} + Z = [\text{total head}]$$

$$HGL = \frac{P}{\gamma} + Z = [\text{piezometric head}]$$

* نصائح لرسم [HGLs] and [EGLs] :

① في الخزان يكون ال HGL و EGL متطابقان مع بعض.

② المضخة تؤدي إلى ارتفاع خط ال HGL و EGL بزاوية 90°.

③ التوربين تؤدي إلى انخفاض خط ال HGL و EGL بزاوية 90 .

④ إذا كان نصف القطر ثابت ، فإن المساحة بين ال HGL و EGL تبقى ثابتة .

⑤ إذا نقص نصف القطر تزداد المساحة بين ال HGL و EGL .

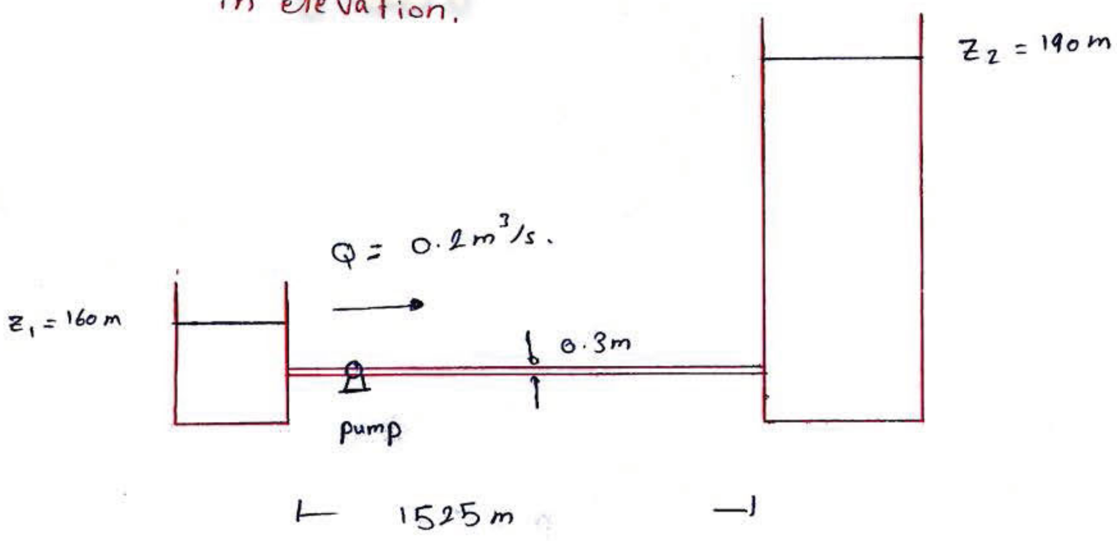
⑥ حد ال HGL أدنى من EGL بمقدار $\left(\frac{\alpha V^2}{2g}\right)$.

⑦ كل ما كان ميل الخط أكبر يكون نصف القطر أقل .

*Example 7.6 A pump draws water (10°C) from a reservoir where the water-surface elevation is a 160 m, and Forces the water through a pipe 1525 m Long and 0.3 m in diameter. This pipe then discharge the water into a reservoir with water-surface elevation of a 190 m. The flow rate is 0.2 m^3/s and head Loss in the pipe is given by

$$h_L = 0.01\left(\frac{L}{D}\right)\left(\frac{V^2}{2g}\right)$$

Determine the head supplied by the pump (h_p) and the power supplied to the flow, and draw the HGL and EGL for the system.
Assume that the pipe is horizontal and is 155 m in elevation.



Sol:-

$$h_L = 0.01\left(\frac{L}{D}\right)\left(\frac{V^2}{2g}\right) \qquad \Rightarrow V = \frac{Q}{A} = \frac{0.2}{\frac{\pi}{4}(0.3)^2}$$

$$\boxed{V = 2.829 \text{ m/s}}$$

$$\boxed{h_L = 20.74 \text{ m}}$$

using Energy Equation to find [hp]

$$\cancel{\frac{P_1}{\gamma}} + \cancel{\frac{\alpha_1 V_1^2}{2g}} + z_1 + h_p = \cancel{\frac{P_2}{\gamma}} + \cancel{\frac{\alpha_2 V_2^2}{2g}} + z_2 + \cancel{h_t} + h_L$$

$$h_p = (z_2 - z_1) + h_L$$

$$= (190 - 160) + 20.74$$

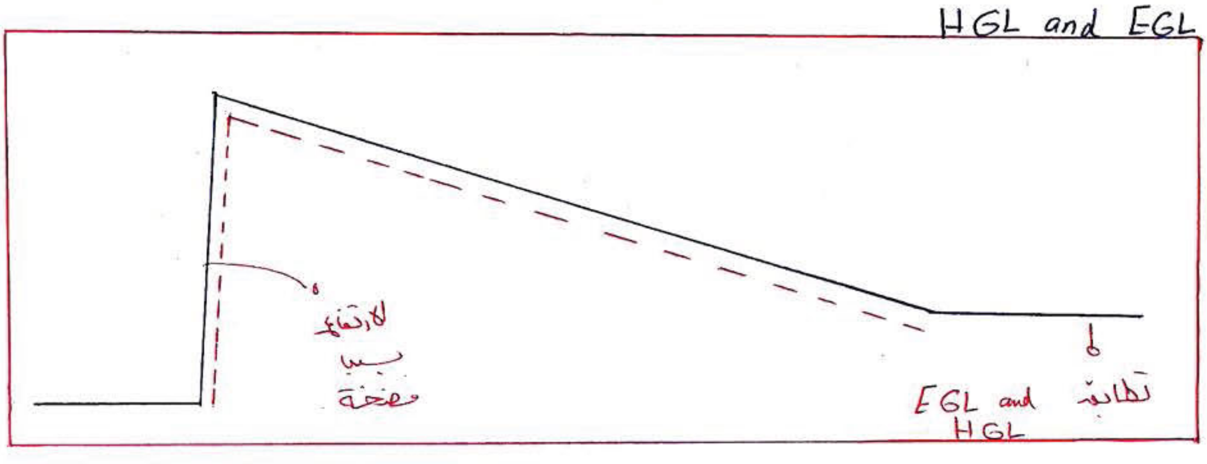
$$\boxed{h_p = 50.74 \text{ m}}$$

$$\dot{W} = \gamma Q h_p = 9810(0.2)(50.74)$$

$$= 99551.88 \text{ W}$$

$$\boxed{\dot{W}_p = 99.55 \text{ KW}}$$

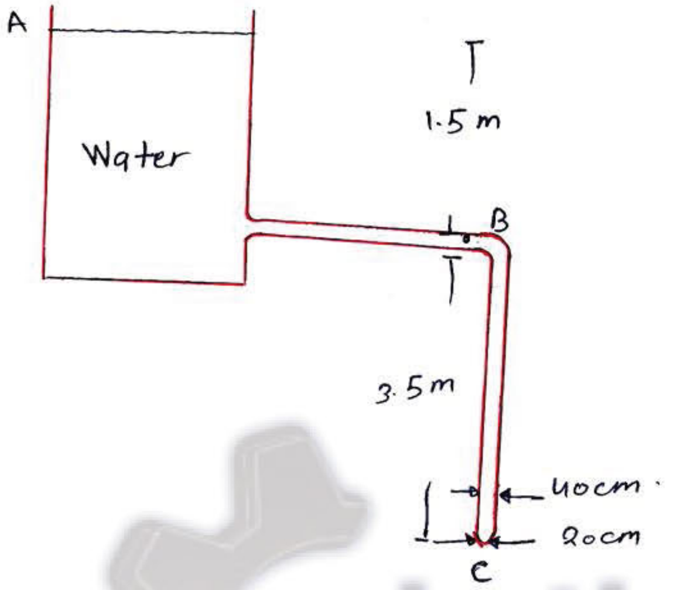
HGL and EGL



بسبب وجود تنك.

*problem 7.21 | Determine the discharge in the pipe and the pressure at point B , Neglect head Losses.

Assume $\alpha = 1$ at all location.



sol :-

$$\cancel{\frac{P_A}{\gamma}} + z_A + \cancel{\frac{\alpha V_A^2}{2g}} + \cancel{h_p} = \cancel{\frac{P_C}{\gamma}} + \cancel{z_C} + \frac{\alpha V_C^2}{2g} + \cancel{h_t} + \cancel{h_f}$$

(tank)

$$5 = \frac{V_C^2}{2(9.81)}$$

$$\boxed{V_C = 9.9 \ m/s}$$

$$Q = V A$$

$$= 9.9 \left(\frac{\pi}{4}\right)(0.2)^2$$

$$\boxed{Q = 0.311 \ m^3/s}$$

$$Q_B = Q_c$$

$$V_B A_B = V_c A_c$$

$$V_B = V_c \frac{A_c}{A_B}$$

$$= 9.9 \frac{(\frac{\pi}{4})(0.2)^2}{\frac{\pi}{4}(0.4)^2}$$

$$\boxed{V_B = 2.475 \ m/s}$$

$$\cancel{\frac{P_A}{\gamma}} + Z_A + \cancel{\frac{\alpha V_A^2}{2g}} + \cancel{h_p} = \frac{P_B}{\gamma} + Z_B + \frac{\alpha_B V_B^2}{2g} + \cancel{h_t} + \cancel{h_f}$$

0 0 0 0 0

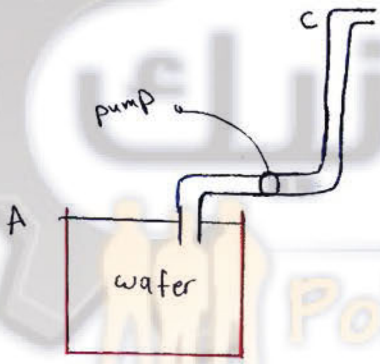
$$5 = \frac{P_B}{\gamma} + 3.5 + \frac{(1)(2.475)^2}{2(9.81)}$$

$$\boxed{P_B = 86.4 \ kPa}$$

*problem 7.45 | A pump draws water (20C°) through a 20 cm suction pipe and discharges it through a 10 cm pipe in which the velocity is 3 m/s.

The 10 cm pipe discharge horizontally into air at point C. To what height h above the water surface at A can the water be raised if 35 KW is delivered to the pump?

Assume that the pump operates at 60% efficiency and that the head loss in the pipe between A and C is equal $\frac{2V_c^2}{2g}$. Assume $\alpha = 1$.



Sol:- using Energy Equation.

$$\cancel{\frac{P_A}{\gamma}} + \cancel{\frac{\alpha_1 V_A^2}{2g}} + \cancel{Z_A} + h_p = \cancel{\frac{P_C}{\gamma}} + \frac{\alpha_1 V_c^2}{2g} + Z_c + \cancel{h_t} + h_f$$

0 0 0 0 0

$$h_p = \frac{V_c^2}{2g} + h + \frac{2V_c^2}{2g}$$

$$h_p = h + \frac{3V_c^2}{2g}$$

$V_c = 3 m/s.$

$$Q = VA$$
$$= 3\left(\frac{\pi}{4}\right)(0.1)^2$$

$$\boxed{Q = 0.0235 \ m^3/s}$$

$$P = \frac{\gamma Q h_p}{\eta}$$

$\eta \rightarrow \frac{P_{output}}{P_{input}}$

$$h_p = \frac{P\eta}{\gamma Q} = \frac{35 * 10^3 * 60 * 10^{-2}}{9810(0.0235)}$$

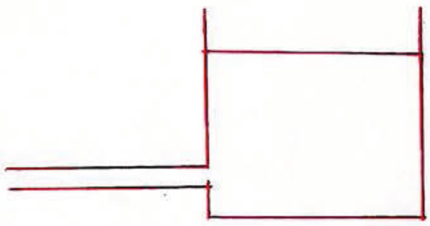
$$\boxed{h_p = 91.09 \ m}$$

$$h_p = h + \frac{3V_c^2}{2g}$$

$$91.09 = h + \frac{3(3)^2}{2(9.81)}$$

$$\boxed{h = 89.713 \ m}$$

*problem 7.57 | what is the head loss at the outlet of the pipe that discharge water into the reservoir at a rate of $0.5\ m^3/s$ if the diameter of the pipe is 50cm.



Sol :- $h_L = \frac{V^2}{2g} = \boxed{0.33\ m}$

$V = \frac{Q}{A} = \frac{0.5}{\frac{\pi}{4}(0.5)^2} = \boxed{2.55\ m/s}$

* أرقام بروبلمز مهمة ع شابتر 7 من الطبعة العاشرة :-

7 , 12 , 28 , 30 , 35 , 39 , 43 , 49 , 51 , 55 , 60

71 , 90 , 73 , 84 , 87 , 82 , 79 , 54.

* ارقام بروبلمز مهمة ع شابتر 7 من الطبعة التاسعة :-

5 , 7 , 9 , 10 , 11 , 12 , 18 , 21 , 24 , 25 , 30

45 , 50 , 52 , 53 , 64 , 71 , 72 , 77 , 80 , 51.

سامحونا ع قلة الأمثلة في التلخيص

لا تنسوني :)

بالتوفيق

⇒ chapter ten : "Flow in Conduits"

$$Re = \frac{\rho V D}{\mu} = \frac{VD}{\nu} = \frac{4Q}{\pi D \nu} = \frac{4\dot{m}}{\pi D \mu}.$$

$Re < 2000$ "Laminar"

$3000 > Re > 2000$ "Transition"

$Re > 3000$ "Turbulent"

* Entrance Length :-

For Laminar → $L_e = 0.05 D\, Re$

For Turbulant → $L_e = 50 D$

* Head Loss

major

$$h_f = f \frac{L}{D} \frac{V^2}{2g}$$

f ?!
- $f = \frac{64}{Re}$ (Laminar)
- using mody chart (turblent).

هذا النوع يحدث بسبب الإحتكاك

minor

$$h_f = \frac{KV^2}{2g}$$

K :- from table.

هذا النوع يحدث بسبب وجود الأكواع .

*Example 10.1 | Consider fluid flowing a roud tube of Length 1 m and diameter 5 mm. Classify the flow as Laminar or turbulent and calculate the entrance Length (a) Air (50C°) with a speed of 12 m/s.
(b) Water (15C°) with a mass flow rate of 8 kg/s.

Sol:. (a) Air

$$Re = \frac{VD}{\nu} = \frac{12(5*10^{-3})}{1.79*10^{-5}} = \boxed{3350}$$

Re 2000

ν ↓ From table A.3

$$L_e = 50D$$
$$= 50(5*10^{-3}) = \boxed{0.25\ m}$$

(b) Water

$$Re = \frac{4\dot{m}}{\pi D\mu} = \frac{4(8)}{\pi(5*10^{-3})(1.14*10^{-3})} = \boxed{1787}$$

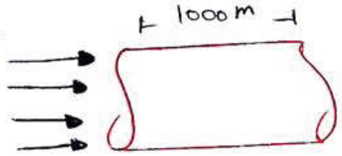
μ From table A.5.

Re < 2000

"Turbulant"

$$L_e = 0.05\ D\ Re$$
$$= 0.05(5*10^{-3})(1787) = \boxed{0.4467\ m}$$

Ex:-



$K_s = 0.12\ mm.$

$Q = 0.05\ m^3/s.$

$D = 0.2\ m.$

h_f ?!

$$h_f = f \frac{L}{D} \frac{U^2}{2g}$$

$$\frac{Q}{A} = \frac{0.05}{\frac{\pi}{4}(0.2)^2} = 1.59\ m/s.$$

$$Re = \frac{VD}{\nu} = \frac{1.59\,(0.2)}{10^{-6}} = 318000.$$

$\hookrightarrow$ $Re > 3000$
"Turbulent"

في حالة الـ Turbulent يجب علينا استخدام مودي شارت

من مخطط $[f]$

أو ممكن نستخدم هذا القانون

$$f = \frac{0.25}{\left[\log_{10}\left(\frac{K_s}{3.7D} + \frac{5.74}{Re^{0.9}}\right)\right]^2}$$

$$f = 0.0325.$$

$$h_f = f \frac{L}{D} \frac{U^2}{2g}$$

$$= 0.0325 \frac{(1000)}{(0.2)} \frac{(1.59)^2}{2(9.81)} = \boxed{20.94\ m}$$

*Example 10.2 | Oil (S= 0.85) with a kinematic viscosity is 6×10^{-4} m^2/s flows in a 15cm pipe at a rate of 0.020 m^3/s.

what is the head loss per 100 m Length pip?

Sol:-

$$h_f = f \frac{L}{D} \frac{v^2}{2g}$$

$$\frac{Q}{A} = \frac{0.02}{\frac{\pi}{4}(0.15)^2} = \boxed{1.13 \text{ m/s}}$$

$$Re = \frac{VD}{\nu} = \frac{1.13\,(0.15)}{6*10^{-4}}$$

$$= \boxed{282.5}$$

Re < 2000.

$$f = \frac{64}{Re} = \boxed{0.226}$$

$$h_f = 0.226 \frac{(100)}{(0.15)} \frac{(1.13)^2}{(2*9.81)} = \boxed{9.829 \text{ m}}$$

* ملاحظة :
الكتاب حل ع قانون ثاني وهو

$$\boxed{h_f = \frac{32\mu L V}{\gamma D^2}}$$

وهذا القانون لايطبق الا ع حالة ال Laminar

*** Example 10.4** The head Loss per Kilomter of 20cm asphated cast iron pipe is 12.2m.
what is the flow rate of water through the pipe ?

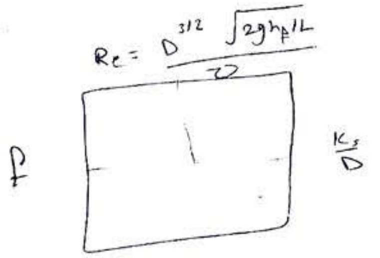
$$Re = \frac{D^{3/2}\sqrt{2 g h_f / L}}{\nu}$$

$$= \frac{(0.2)^{3/2}\sqrt{2(9.81)(12.2/1000)}}{10^{-6}}$$

$$= \boxed{4.38 * 10^{4}} \longrightarrow Re > 3000 \text{ (turbulent)}$$

$$\frac{K_s}{D} = \frac{0.00012}{0.2} = \boxed{0.0006}$$

مودي شارت



$$f = 0.019$$

$$h_f = f \frac{L}{D} \frac{V^2}{2g}$$

$$\frac{12.2}{1000} = \frac{0.019}{0.2} \frac{V^2}{2(9.81)} \longrightarrow \boxed{V = 1.6 \ m/s}$$

$$Q = VA$$
$$= 1.6\left(\frac{\pi}{4}\right)(0.2)^2 = \boxed{0.05 \ m^3/s}$$

* problem 10.79 (من الطبعة العاشرة 8)

مهم جداً "جداً"

The pressure at a water main is 350 Kpa gage. what size of pipe is needed to carry water from the main at a rate of 0.025 m^3/s to a factory is 160 m from the main? Assume the galvanized-steel pipe is to be used and that the pressure required at the factory is 70 kpa gage at a point 8 m above the main connection.

Sol:- using Energy Equation

$$\frac{P_1}{\gamma} + \cancel{\frac{\alpha_1 V_1^2}{2g}}^{0} + z_1 + \cancel{h_p}^{0} = \frac{P_2}{\gamma} + \cancel{\frac{\alpha_2 V_2^2}{2g}}^{0} + z_2 + \cancel{h_t}^{0} + h_L$$

$$\frac{350*10^3}{9810} = \frac{70*10^3}{9810} + 8 + h_L$$

$$\boxed{h_L = 20.542 \text{ m}}$$

$$h_f = f \frac{L}{D} \frac{V^2}{2g} \longrightarrow Q^2/A^2$$

∴ هذه الحالة يوجد لدينا مجهولين

f, D ?!

^_^ في هذه الحالة نقوم بفرض قيمة (f)

Assume $f = 0.02$.

$$h_f = f \frac{L}{D} \frac{Q^2}{2A^2 g}$$

$$20.5 = 0.02 \frac{(160)}{D} * \frac{(0.025)^2}{2(\frac{\pi}{4} D^2)^2 g}$$

$$20.5 = \frac{0.02 (160)}{D} * \frac{(0.025)^2 16}{2\pi^2 D^4 g}$$

$$D = \left[\frac{8 (0.02)(160)(0.025)^2}{20.5 (\pi^2)(9.81)}\right]^{1/5}$$

$$\boxed{D = 0.095 \text{ m}}$$

$$\frac{K_s}{D} = \frac{0.15}{(0.095)*10^3} = \boxed{0.001566}$$

From table 10.4

$$Re = \frac{4Q}{\pi D \nu} = \frac{4(0.025)}{\pi(0.095)(1.31*10^{-6})} = 255773.3115$$

From table A.5.

Re >3000

"Turbulent"

flow is Turbulent

→ mody chart

→ $f = \dfrac{0.25}{\left[\log_{10}\left(\dfrac{K_s}{3.7D} + \dfrac{5.74}{Re^{0.9}}\right)\right]^2}$

$$\boxed{f = 0.0231}$$

0.02 احنا فرضناها

فرجع نفوض مرة ثانية f الجديدة في القانون

الأول

$h_f = f \dfrac{L}{D} \dfrac{V^2}{2g} \rightarrow \boxed{Q^2/A^2}$

$$\boxed{D = 0.098 \ m}$$

$\dfrac{K_s}{D} = \dfrac{0.15}{0.098(10^3)} = \boxed{0.00153}$

$f = \dfrac{0.25}{\left[\log_{10}\left(\dfrac{K_s}{3.7D} + \dfrac{5.7}{Re^{0.9}}\right)\right]^2} = \boxed{0.0228}$

* منضل نجرب مش نثبت قيمة f.

$$h_f = f \frac{L}{D} \frac{U^2}{2g}$$

$$D = 0.098\,m$$

$$\frac{K_s}{D} = 1.52 \times 10^{-3}$$

$$f = \frac{0.25}{\left[\log_{10}\left(\frac{K_s}{3.7D} + \frac{5.74}{Re^{0.9}}\right)\right]^2}$$

$$\boxed{f = 0.0228}$$ وأخيراً ثبت

$$D = 0.098\,m$$ #

* ملاحظة :-

يمكننا في الامتحان يحدد لك كم محاولة للتخفيف .

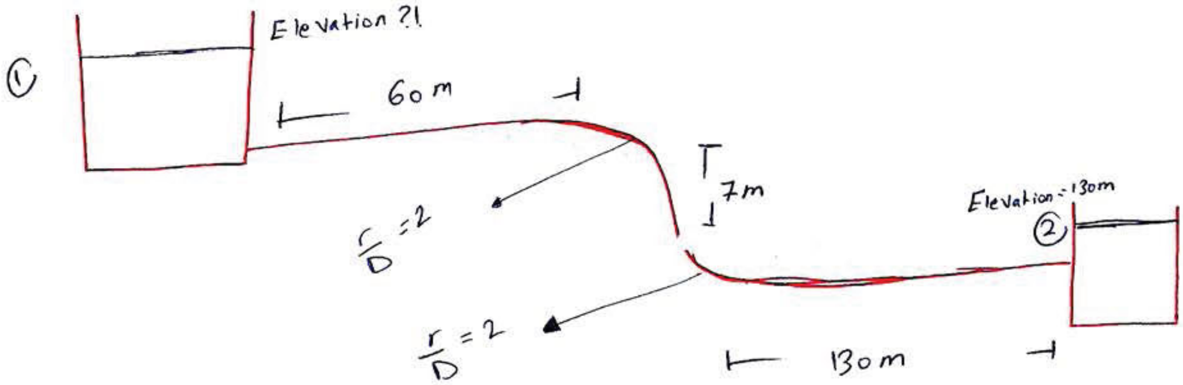
* افترض ثلاث قيم لفرض f

- $f = 0.015$.
- $f = 0.020$.
- $f = 0.025$.

هذا السؤال مهم جداً !!.

بالتوفيق

*** Example 10.7** if oil ($\nu = 4 \times 10^{-5}\ m^2/s$, $S = 0.9$) flows from the upper to Lower reservoir at rate of $0.028\ m^3/s$ in the 15 cm smooth pipe, what is the elevation of the oil surface in the upper reservoir?



sol:- $\frac{r}{D} \rightarrow$ ادري الانا لتعرف قيمة $\boxed{K}$ from table 10.5.

$$\cancel{\frac{P_1}{\gamma}}^{0} + \cancel{\frac{\alpha_1 V_1^2}{2g}}^{0} + z_1 + \cancel{h_p}^{0} = \cancel{\frac{P_2}{\gamma}}^{0} + \cancel{\frac{\alpha_2 V_2^2}{2g}}^{0} + z_2 + \cancel{h_t}^{0} + h_f$$

$$z_1 = z_2 + h_f$$

$$Z_1 = Z_2 + h_f$$

major

$$h_f = f \frac{L}{D} \frac{V^2}{2g}$$

$$Re = \frac{VD}{\nu} = \frac{1.58\,(0.15)}{4\times10^{-5}} = \boxed{5.93\times10^{3}}$$

$\hookrightarrow Re > 3000$

$$V = \frac{Q}{A} = \frac{0.028}{\frac{\pi}{4}(0.15)^2} = \boxed{1.58\ m/s}$$

$$f = \frac{0.25}{\left[\log_{10}\left(\frac{Ks}{3.7D} + \frac{5.74}{Re^{0.9}}\right)\right]^2} = \boxed{0.036}$$

$$h_f = 0.036\ \frac{(130+7+60)}{(0.15)}\ \frac{(1.58)^2}{2(9.81)}$$

$$= \boxed{6.01579\ m}$$

m nor

$K_e = 0.5$

$K_E = 1$

$K_b = 0.19$

$$h_f = \frac{V^2}{2g}\left(1 + 2(0.19) + 0.5\right)$$

$$h_f = \frac{(1.58)^2}{(2\times9.81)}\left(1 + 2(0.19) + 0.5\right)$$

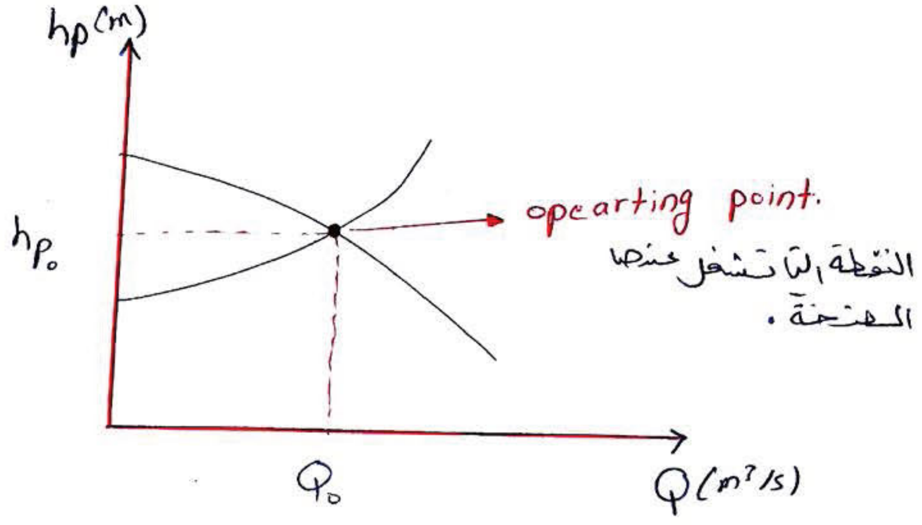
$$\boxed{h_f = 0.239\ m}$$

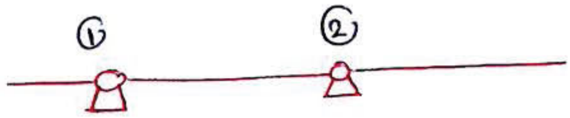
$$Z_1 = 130 + (6.01579 + 0.239)$$

$$Z_1 = 136.252\ m$$

*characteristic curve :

*أهم موضوع ع مادة الفلويد.

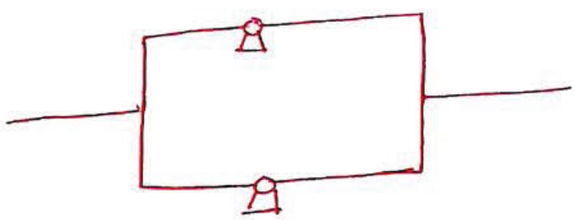




2 pump in serise.

$$\boxed{Q_{const} = Q_1 = Q_2}$$

$$\boxed{hp = hp_1 + hp_2}$$



2 pump in parallel.

$$\boxed{hp_{const.} = hp_1 = hp_2}$$

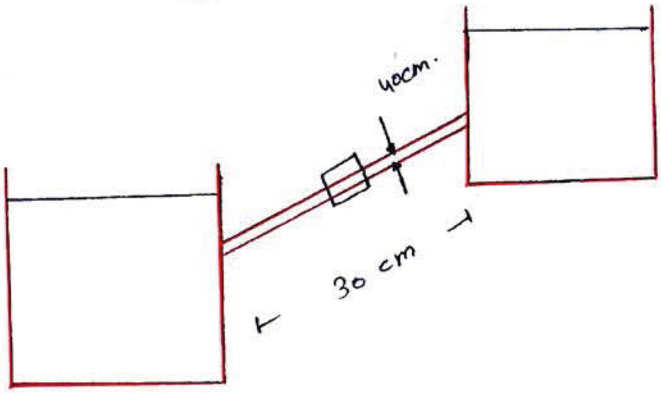
$$\boxed{Q = Q_1 + Q_2}$$

*Example

سؤال من الأسئلة الفاينل [عشرين علامة]

Two reservers are concted by a 30 m Long, asphalt Lind, cast Iron pipline 40 cm in diameter.

The minor Losses include the entrance, exit and a gate value :



The elevation differnce two reasivoirs is 10 m and the water temp. is 10C°, Determine the head and discharge using :-

① one pump.
② two pump in serise.
③ two pump in parallel.

Q(m^3/s)	hp(m)
0	30
100	29.5
200	28
300	25
400	19
500	4

Sol:

in serise

Q(m^3/s)	hp (m)
0	60
100	59
200	56
300	50
400	38
500	8

in parallel

Q(m^3/s)	hp(m)
0	30
200	29.5
400	28
600	25
800	19
1000	4

ـ في حالـــــه التوالي نثبت قيمة [Q] ونضاعف قيمة [hp]

ـ في حالـــــه التوازي نثبت قيمة [hp] ونضاعف قيمة [Q]

* في هذا السؤالـــــ رح يطلع عنا 4 كيرفات :

① curve system (Energy Equation)

(Data) ② one pump.

(Data) ③ two pump in serise.

(Data) ④ two pum in parallel

using Energy Equation.

$$\cancel{\frac{P_1}{\gamma}}^{0} + \cancel{\frac{\alpha_1 V_1^2}{2g}}^{0} + z_1 + h_p = \cancel{\frac{P_2}{\gamma}}^{0} + \cancel{\frac{\alpha_2 V_2^2}{2g}}^{0} + z_2 + \cancel{h_t}^{0} + h_f$$

$$h_p = (z_2 - z_1) + \underbrace{h_f}_{\text{major} \quad \text{minor}}$$

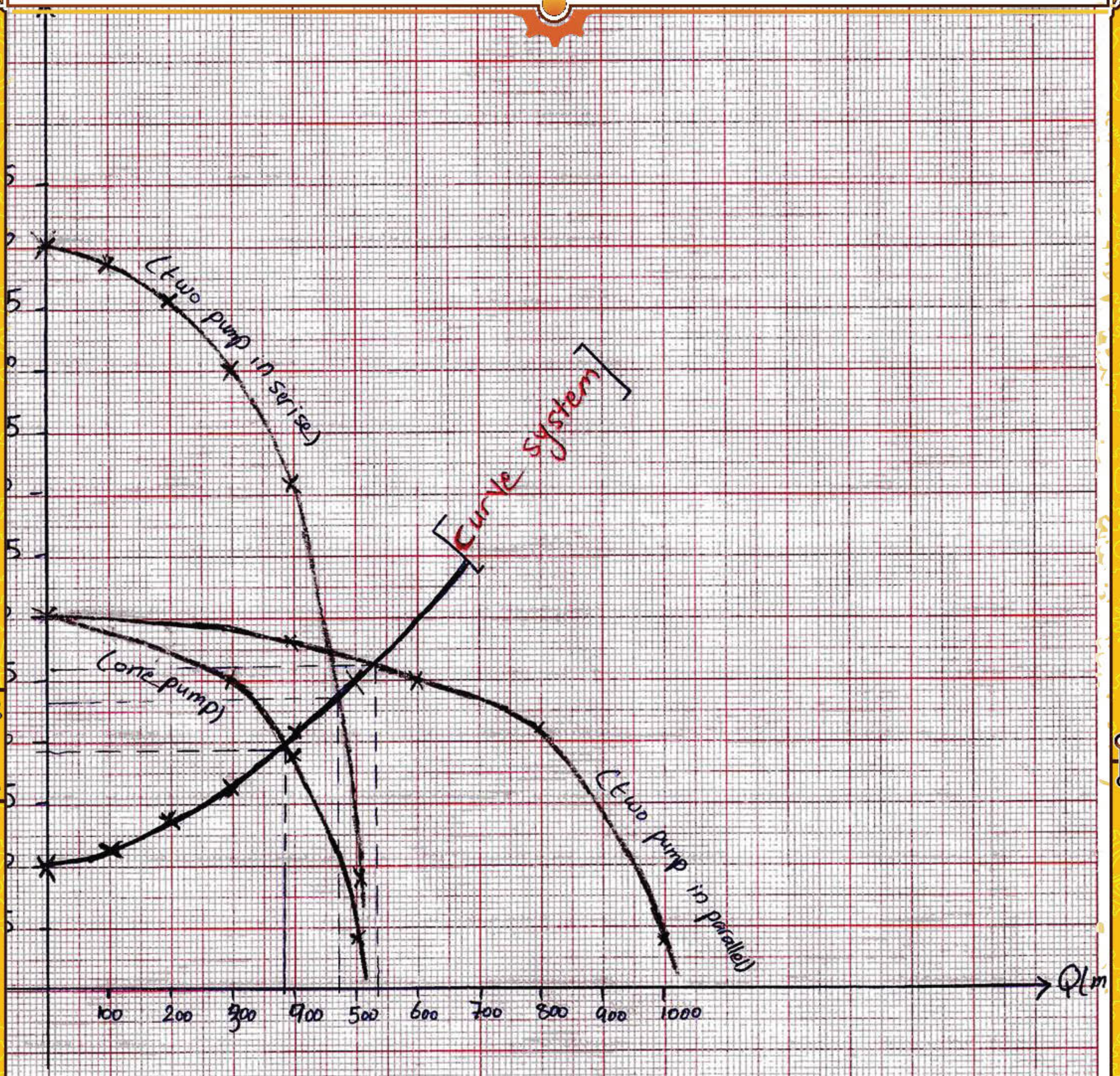
$$h_p = 10 + \left(f\frac{L}{D} + \Sigma K\right)\frac{V_1^2}{2g} \longrightarrow Q^2/A^2$$

$$h_p = 10 + \left(f\frac{(0.3)}{(0.4)} + K_{in} + K_e + K_v\right)\frac{V^2}{2g}$$

$$h_p = 10 + \left(f\frac{(3)}{(4)} + \underbrace{(0.5 + 1 + 0.2)}_{\text{from table 10.5. 10.4.}}\right)\frac{Q^2}{2(9.81)\left(\frac{\pi}{4}(0.4)^2\right)^2}$$

$$h_p = 10 + \left[2.42\, f + 5.48\right]Q^2$$

$Q\ (m^3/s)$	$V\ (m/s)$ $\boxed{(Q/A)}$	Re $\boxed{(VD/\nu)}$	f $\boxed{\frac{0.25}{\left[\log_{10}\left(\frac{K_s}{D(3.7)} + \frac{5.74}{Re^{0.9}}\right)\right]^2}}$	$h_p\ (m)$
0	0	0	0	10
100	0.796	2.43×10^5	0.0149	11.66
200	1.59	4.85×10^5	0.0149	13.74
300	2.39	7.3×10^5	0.0149	16.66
400	3.18	9.71×10^5	0.0149	20.4
500	3.98	1.215×10^5	0.0149	25



كل ما كانت دقة الرسم عالية كانت الأجوبة أصح