اسئلة محلولة..

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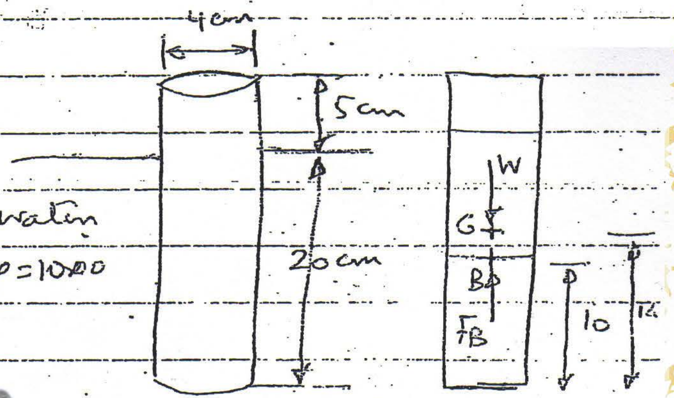
لجنة الميكانيك

Polytechnic

Example:- Fig shows a 4 cm diameter cylinder floating in a basin (حوض) of water, with 5 cm extending above the surface. If the water density is 1000 kg/m³, determine the density of the cylinder.



In the case of equilibrium
The weight of the cylinder is supported by the buoyant force (that acts on the submerged section of the cylinder.

$$F_B = mg = \rho_{cyl}\, g\, \forall_{cyl}$$

$$\rho_{cyl}\, g\, \forall_{cyl} = \rho_{wat}\, g \times \forall_{displ}$$

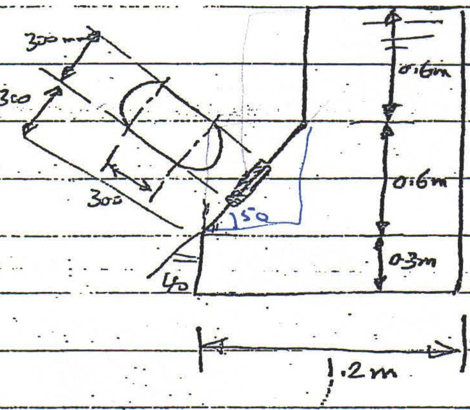
$\forall_{disp}$: the volume of the submerged portion of the cylinder.

$$\rho_{cyl} \frac{\pi}{4}(0.04)^2(0.25)(g) = (1000)(9.81) \times \left(\frac{\pi}{4}\right)(0.04)^2(0.2)$$

$$\rho_{cy} = \frac{200}{0.25} = 800 \text{ kg/m}^3$$

Hydrostatic force on Inclined plane.
(Gates)

Determine the hydrostatic force on the gate and the center of pressure ?!

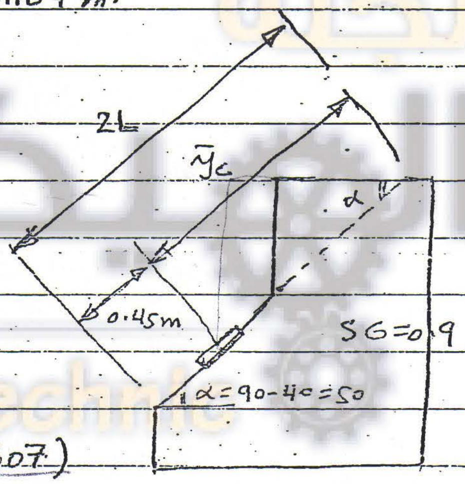


$F_R = \bar{P} A$

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

$2L = \dfrac{0.6+0.6}{\sin 50} = 1.566 \text{ m}.$

$\bar{y}_c = 2L - 0.45 = 1.566 - 0.45 = 1.1164 \text{ m}.$



A = Area of the gate (two semicircles + square)

$= \frac{\pi}{4} D^2 + D^2$

$= D^2 \left[\frac{\pi}{4} + 1\right] =$

$= 0.1607 \text{ m}^2$

SG = 0.9

$\therefore F_R = (9810)(0.9)(1.1164)(\sin 50)(0.1607)$

$\boxed{F_R = 1213.3 \text{ N}}$

$y_{cp} = \bar{y}_c + \dfrac{I_{xx}}{\bar{y}_c A}$

I = 2nd moment of area of the gate

$= \frac{\pi}{4} R^4 + \frac{1}{12} D^4$

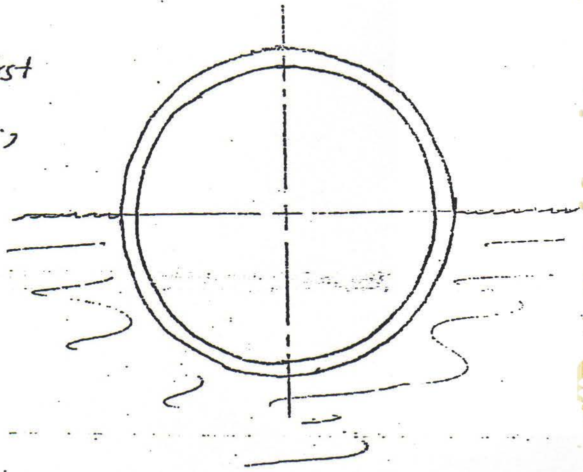
$= D^4 \left[\frac{\pi}{64} + \frac{1}{12}\right] = 1.0726 \times 10^{-3} \text{ m}^4$

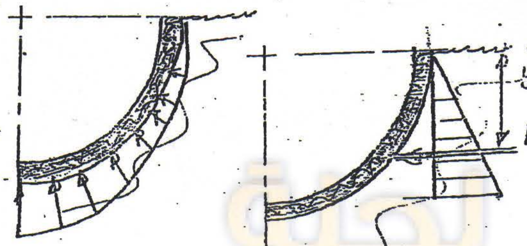
$y_{cp} = 1.1164 + \dfrac{1.0726 \times 10^{-3}}{(1.1164)(0.1607)}$

$\boxed{y_{cp} = 1.122 \text{ m}}$

Example:

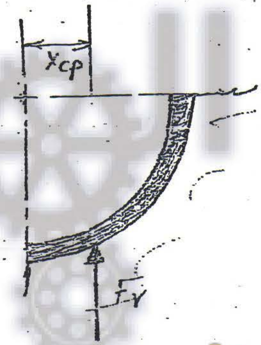
When the culvert described in the first example was installed and still empty, it was buried halfway in mud. Determine the forces acting on half the submerged portion, assuming that the mud has a density equal to that of water.





$$F_H = \gamma h_v A_V$$
$$= (9810)(0.5)(2.5\times 1)$$
$$= 12.3 \text{ kN}$$

$$y_{cp} = \bar{y}_v + \frac{I_v}{\bar{y}_v A}$$
$$= 0.5 + \frac{(\frac{1}{12})(2.5)(1)^3}{(0.5)(2.5\times 1)} = 0.667 \text{ m}$$ below the free surface.

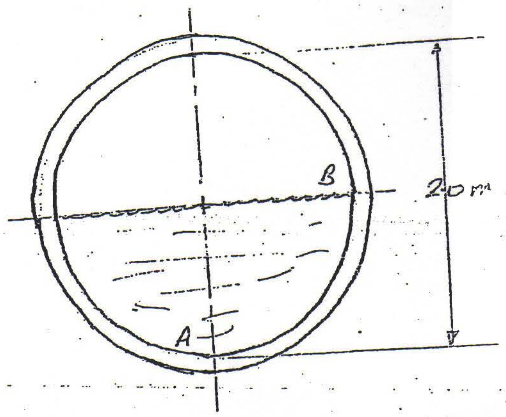


F_V = weight of the fluid above surface (imaginary)

$$= \gamma \forall = (9810)(\frac{\pi}{4}(1)^2(2.5))$$
$$= 19.25 \text{ kN}$$

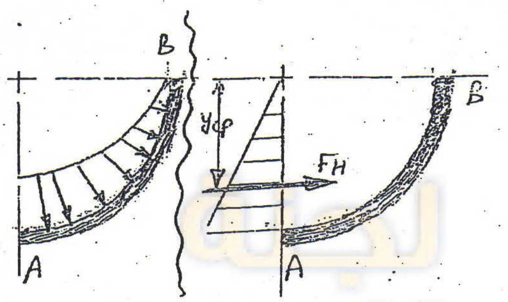
$$X_{cp} = \frac{4R}{3\pi} = \frac{(4)(1)}{(3)(\pi)} = 0.42 \text{ m from the CL}$$

Example A concrete culvert that contains water is 2 m in diameter. Determine the force exerted on the portion labeled A-B in the fig. if the culvert is filled halfway. Determine also the location of the forces. Culvert length (into the paper) from joint to joint is 2.5 m.

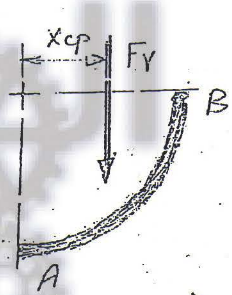


① The horizontal force

$$F_H = \gamma \bar{h}_v A_v$$
$$= (9810)\left(\tfrac{1}{2}\right)(1)(2.5)$$
$$= 12.3 \text{ kN}$$



$$y_{cp} = \bar{y}_v + \frac{I_v}{\bar{y}_v A}$$
$$= (0.5) + \frac{\left(\frac{1}{12}\right)(2.5)(1)^3}{(0.5)(2.5)}$$
$$= 0.667 \text{ m below the surface.}$$

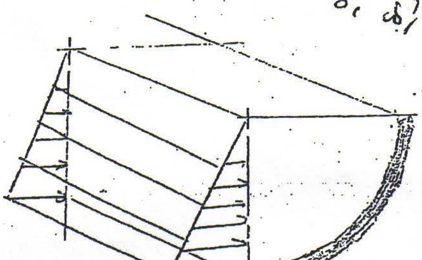


② F_v = weight of the fluid above AB

$$F_v = (9810)\left(\frac{\pi}{4}(1)^2(2.5)\right)$$
$$= 19.25 \text{ kN}$$

centroid $\frac{4R}{3\pi}$

The line of action of this vertical component passes through the centroid of the quarter circle at a distance into the page of 1.25 m.

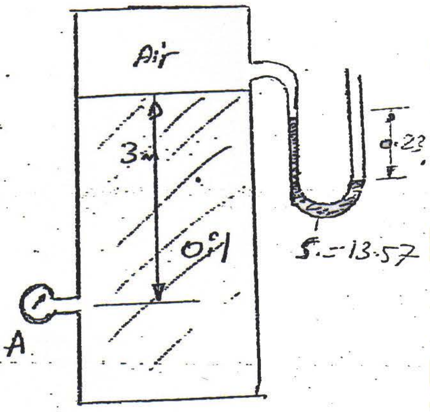


$$X_{cp} = \frac{4R}{3\pi} = \frac{(4)(1)}{3\pi} = 0.42 \text{ m from the center line.}$$

Ahmad Abu Arabuh 2010/2011

Chapter 3

The tank in the figure contains oil of relative density 0,750. Determine the reading of gage A in Pa.?



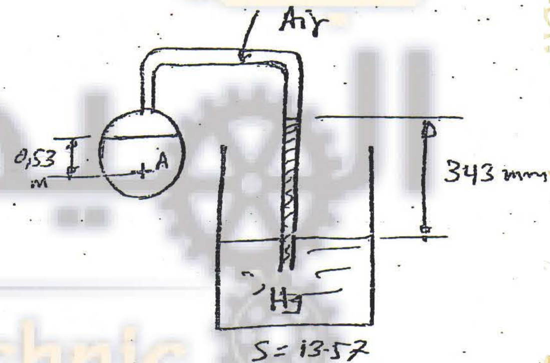
$$P_A - \gamma_{oil}(3) + \gamma_{Hg}(0,23) = 0.0$$

$$P_A = 3\gamma_{oil} - \gamma_{Hg}(0,23)$$

$$= (3)(0,75)(9810) - (0,23)(13.57)(9810)$$

$$= -8545.5 \text{ Pa}$$

Point A is 0,53 m below the surface of the liquid, S.G=1.25, in the vessel. What is the pressure at A in bar gage if the mercury rises 343 mm in the tube?



Start from point A

$$P_A - 0,53\,\gamma_{1.25} + 0,343\,\gamma_{Hg} = 0.0$$

$$P_A = 0,53\,\gamma_{1.25} - 0,343\,\gamma_{Hg}$$

$$= (0,53)(1.25)(9810) - 0,343(13.57)(9810)$$

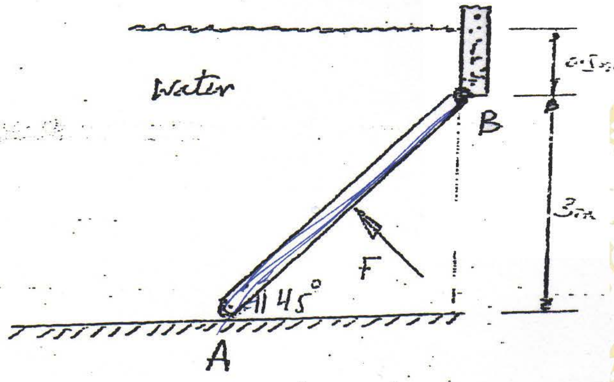
$$= -39162 \text{ Pa}$$

$$\boxed{P_A = -0,3916 \text{ bar}}$$

Aiman Abu Arabih 2010/2011

Ch. 3 Hydrostatic force on inclined plane.

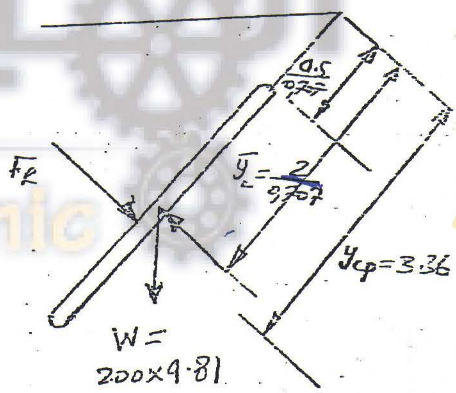
A 200-kg, 5m wide rectangular gate shown in the fig is hinged at B and leans against the floor at A making an angle of 45° with the horizontal. The gate is to be opened from its lower edge by applying a normal force at its center. Determine the minimum force F required to open the water gate.



$$F_R = \gamma \bar{h}_c A = \gamma \bar{y}_c \sin 45\, A$$

$$= (9810)\left(0{,}5 + \frac{3}{2}\right)\left[\frac{3}{\sin 45}\right][5]$$

$$= 416266\ \text{N.}$$



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

$$= \frac{2}{0{,}707} + \frac{\left(\frac{1}{12}\right)(5)\left(\frac{3}{0{,}707}\right)^3}{\left(\frac{2}{0{,}707}\right)(5)\left(\frac{3}{0{,}707}\right)}$$

$$= 0{,}53\ \text{m} + 2.83 = 3.36\ \text{m.}$$

$$\Sigma M_B = 0.0$$

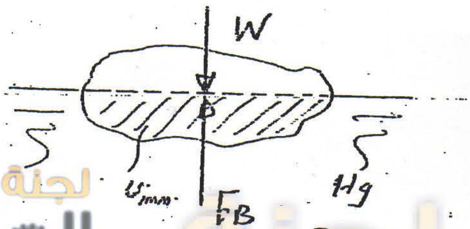
$$-F\left(\frac{1.5}{0{,}707}\right) + F_R\left(\frac{1.5}{0{,}707} + 0{,}53\right) + (200)(9.81)(1.5) = 0.0$$

$$\boxed{F = 521.64\ \text{kN.}}$$

Chap. 3 Buoyancy and flotation

Example: What fraction of the volume of a solid piece of metal of density 7250 kg/m³ floats above the surface of a container of mercury of specific gravity 13.57??

Weight of the body = Buoyant force



S.G = 13.57

$$mg = \gamma_{Hg} \forall_{displaced}$$

$$(\rho g \forall)_{metal} = (\rho g)_{Hg} \forall_{disp}$$

$$\frac{\forall_{disp}}{\forall_{tot}} = \frac{(\rho g)_{met}}{(\rho g)_{Hg}} = \frac{7250}{13570} = 0{,}534$$

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

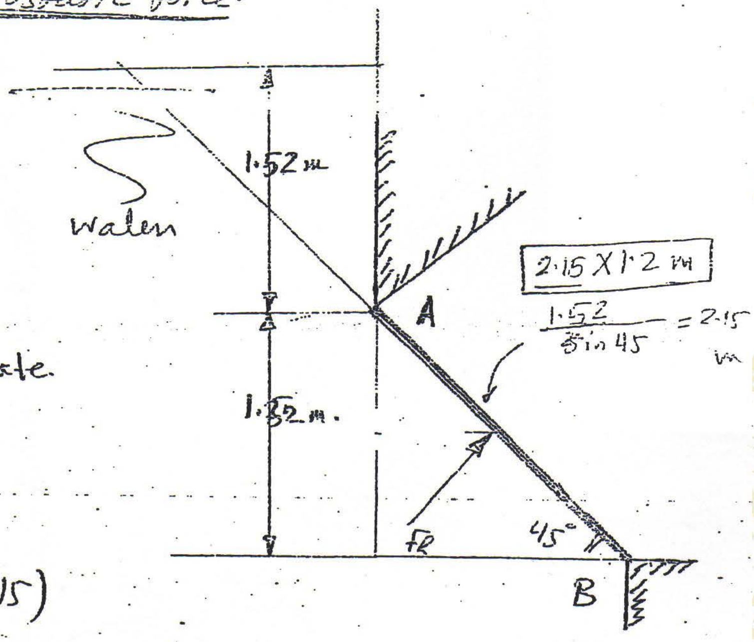
$$\frac{13.57 \times 9810}{9.81 \; (g)} = \rho$$

The fraction of the volume above the mercury = 1 − 0,534

= 0.466

Ch. 3 Hydrostatic force.

Example In fig. the gate AB is hinged at B and is 1.2 m wide. What vertical force, applied at the center of gravity of the 20 kN gate, will keep in equilibrium?



$F_R = \gamma h_c \cdot A$

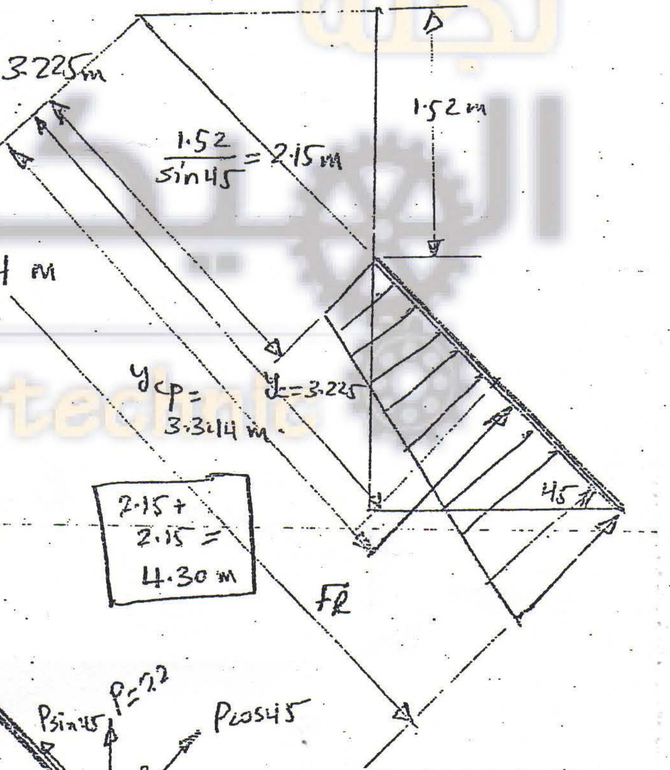
$= (9810)\left(1.52 + \frac{1.52}{2}\right)(1.2)(2.15)$

$F_R = 57.71$ kN

$\bar{y}_{cp} = \frac{h_c}{\sin 45} = \frac{\left(1.52 + \frac{1.52}{2}\right)}{0.707} = 3.225$ m

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

$= 3.225 + \frac{\left(\frac{1}{12}\right)(1.2)(2.15)^3}{(3.225)(1.2)(2.15)} = 3.344$ m

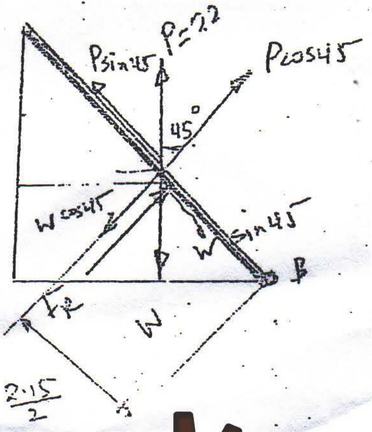


$\sum M_B = 0.0$

$(-57.71)(4.3 - 3.344) - P\cos 45\left(\frac{2.15}{2}\right)$

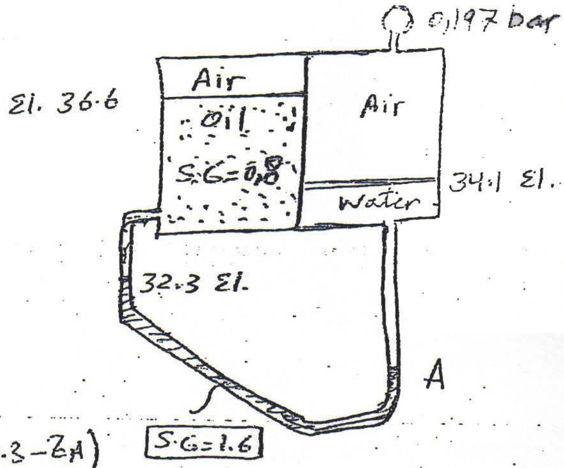
$+ (20)\cos 45\left(\frac{2.15}{2}\right) = 0.0$

$P = -52.6$ kN



Chapter 3

\# In the left hand tank in the figure, the air pressure is −229 mm Hg. Determine the elevation of the gage liquid in the right hand column at A.



Starting From the air in the left side tank

$$P_{Air} + \gamma_{oil}[36.6-32.3] + \gamma_{1.6}(32.3-Z_A) - \gamma_{H_2O}(34.1-Z_A) = P_{Air}\ (\text{right side})$$

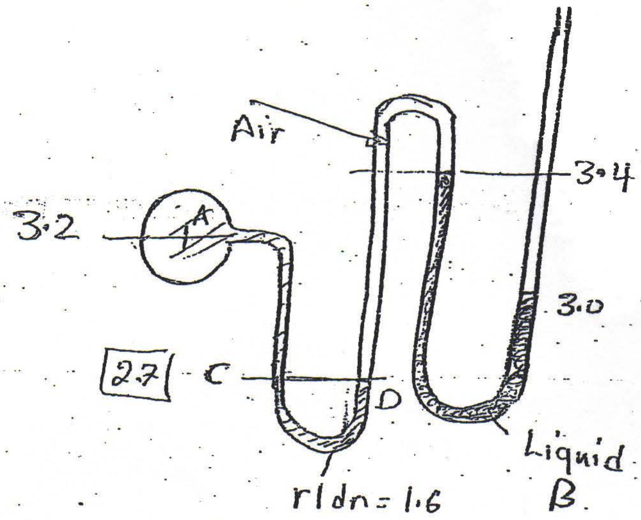
$$(-0.229)(13.6)(9810) + (0.8)(9810)(4.3) + (1.6)(9810)(32.3-Z_A) - 9810[34.1-Z_A] = 0.197\times10^5$$

$$-30552 + 33746 + 506981 - 15696Z_A - 334521 + 9810Z_A = 0.197\times10^5$$

$$5886Z_A = 155954$$

$$\boxed{Z_A = 26.5\ m}$$

For a gage pressure at A of −11000 Pa. find the relative density of the gage Liquid B



$$P_A + (1.6)(9810)(3.2-2.7) - (1.22)(9.81)(3.4-2.7) + (\gamma_B)(3.4-3.0) = 0.0$$

$$0.4\,\gamma_B = 11000 + (1.2)(9.81)(0.7) - (1.6)(9810)(0.5)$$

$$0.4\,\gamma_B = 3160$$

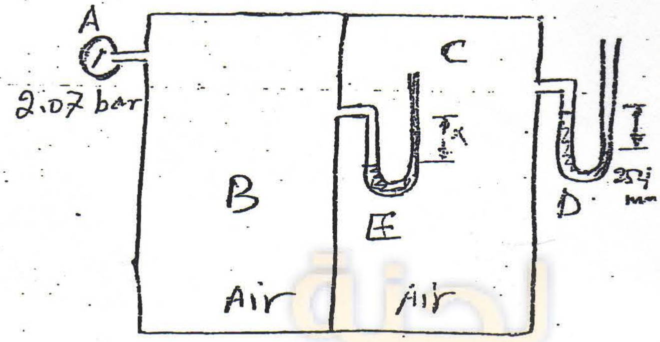
$$\gamma_B = 7901 \ N/m^3$$

$$S.G_B = \frac{\gamma_B}{\gamma_{H_2O}} = 0.805$$

Aiman Anb Anabuh 2010 - 2011

Chapter 3

The compartments B and C are closed and filled with air. The barometer reads 1 bar. When the gages A and D read as indicated, what should be the value of x for gage E (mercury in each U-tube gage)



Start from compartment B

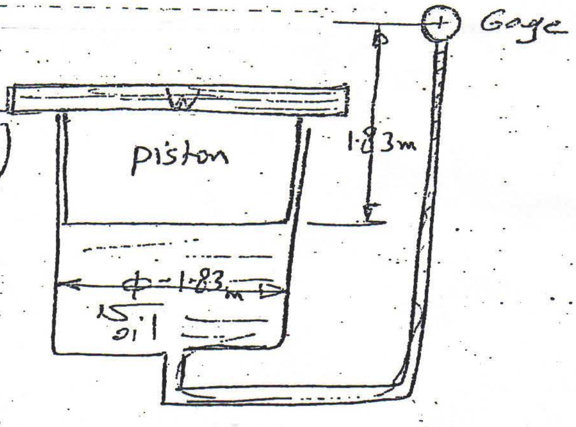
$$P_A - x\gamma_{Hg} + 0.254\,\gamma_{Hg} = 0$$

$$x = \frac{P_A + 0.254\,\gamma_{Hg}}{\gamma_{Hg}}$$

$$= \frac{207\times10^3 + (0.254)(13.57)(9810)}{(13.57)(9810)}$$

$$\boxed{x = 1.81\ m}$$

The cylinder and tubing shown in the fig contain oil, S.G=0.902. For a gage reading of 2.15 bar, what is the total weight of piston and weight W?



$$P_{gage} + 1.83\,\gamma_{oil} = P_{piston}$$

$$P_{pist} = 215\times10^3 + (1.83)(0.902)(9810)$$

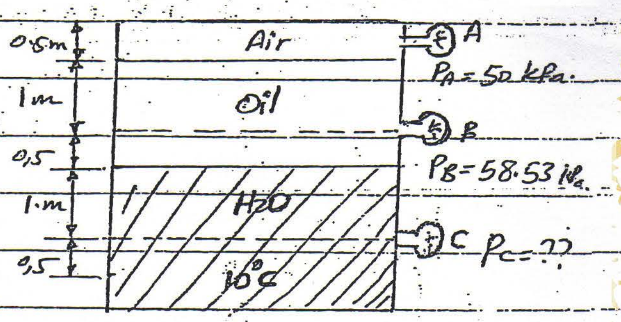
$$= 231193\ Pa.$$

$$P_{pist} = \frac{W + W_p}{\text{Area piston}}$$

$$W + W_p = (231193)\left(\frac{\pi}{4}\right)(1.83)^2$$

$$= 608088\ N \Leftarrow$$

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



$$P_B = P_A + (1.0)\,\gamma_{oil}$$

$$\gamma_{oil} = \frac{P_B - P_A}{1.0} = 8.53\ kN/m^3$$

$$SG_{oil} = \frac{\gamma_{oil}}{\gamma_{water}} = \frac{8.53}{9.81} = 0.8695$$

$$P_C = P_B + 2.5\,\gamma_{oil} + (1.0)\,\gamma_{H_2O}$$

$$= 58.53 \times 10^3 + (0.5)(8530) + (9810)(1)$$

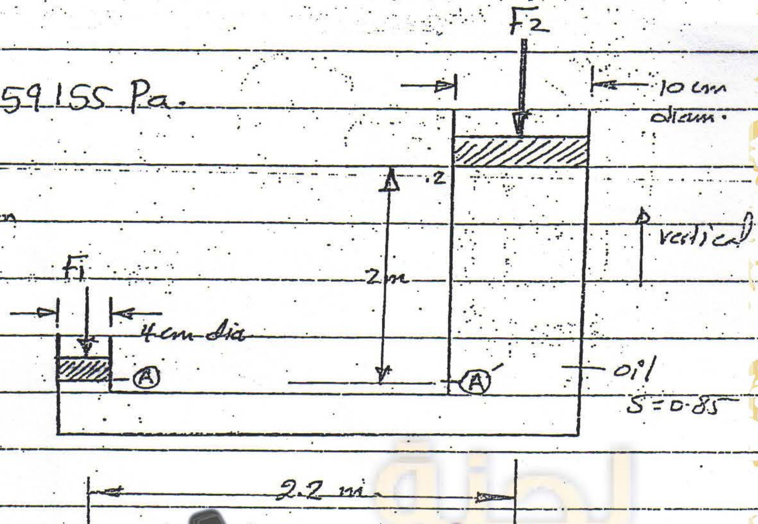
$$= 72605\ Pa$$

$$= 72.605\ kPa$$

2010 / 2011

3.13 (9) If a 200 N force F_1 is applied to the piston with the 4 cm diameter, what is the magnitude of the force F_2 that can be resisted.

يقاوم



$P_A = \frac{F_1}{A_1} = \frac{200}{(\frac{\pi}{4})(0.04)^2} = 159155 \text{ Pa}$

$P_A = P_{A'}$ the same elevation and same fluid.

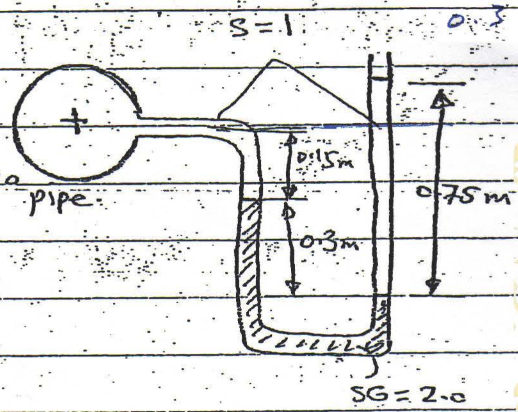
$P_{A'} = P_2 + \gamma_{oil} h$

$P_2 = P_{A'} - \gamma_{oil}(2)$
$= 159155 - (2)(0.85)(9810)$
$= 142478 \text{ Pa}$

$P_2 = \frac{F_2}{A_2} \Rightarrow F_2 = P_2 A_2 = (142478)(\frac{\pi}{4})(0.1)^2$
$= 1119 \text{ N}$

Eng Analiah Alradi 2010/2011 اعداد الم...

3.30 Is the gage pressure at the center of the pipe (a) negative (b) zero, or (c) positive? neglect surface tension effects and state your rationale



$P_{pipe} + (0.15)\, SG_1 \gamma_{H_2O} + (0.30)\, SG_2 \gamma_{H_2O} - 0.75\, SG_1 \gamma_{H_2O} = 0$

$P_{pipe} = (-0.15)(1)(9810) - (0.3)(2)(9810) + 0.75\,(1)\,(9810)$

$= 9810\,[-0.15 - 0.6 + 0.75]$

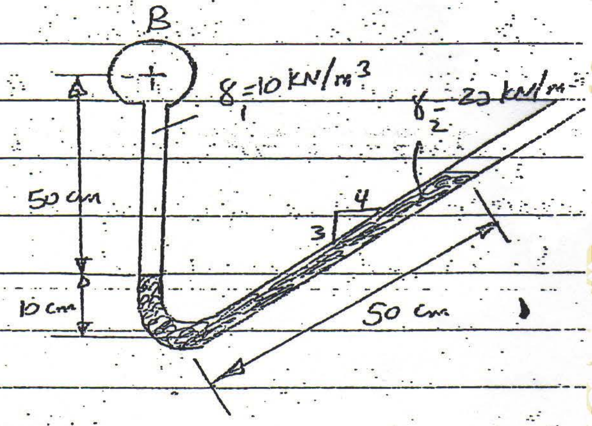
$= \text{Zero}$

∴ The gage pressure @ the center of the pipe equal zero (b)

Aiman Ahmad Ans 2010 - 2011

3:33 What is the pressure at the center of pipe B?

(9)



$$P_B + \gamma_1(0.5) + \gamma_2(0.1) - \gamma_2(0.5 * \tfrac{3}{5}) = 0$$

$$P_B = (-0.5)(10*10^3) + (0.3-0.1)(20\times10^3)$$

$= -1000\ Pa$ gage pressure.

Ahmad Abu Arabiyya 2010/2011