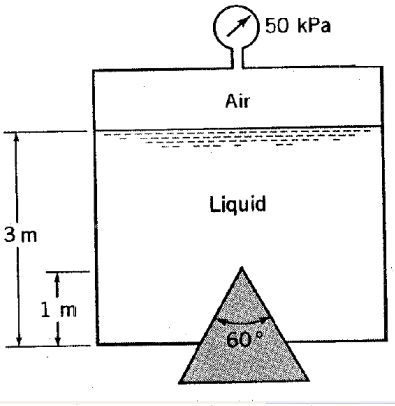
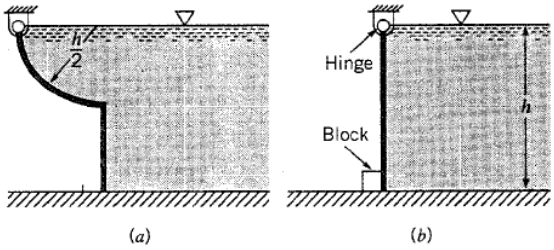
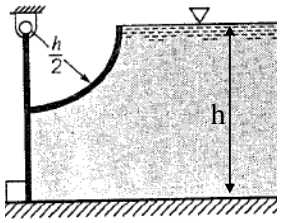
CE 371 HOMEWORK 4

1) A plug in the bottom of a pressurized tank is conical in shape as shown. The air pressure is 50 kPa and the liquid in the tank has a specific weight of 27 kN/m^3. Determine the magnitude, direction and line of action of the force exerted on the curved surface of the cone within the tank due to the 50 kPa pressure and the liquid.

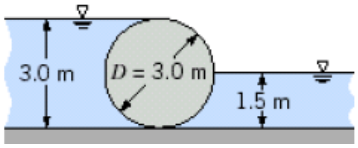


2) Three gates of negligible weight are used to hold back water in a channel of width b as shown in figure. The force of the gate against the block for gate (b) is R. Determine (in terms of R) the force against the blocks for the other two gates.

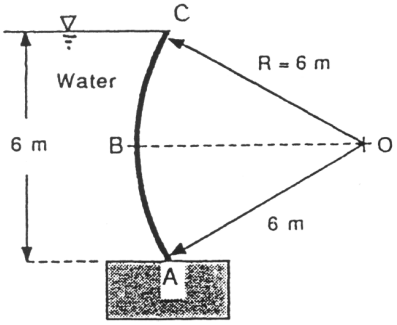




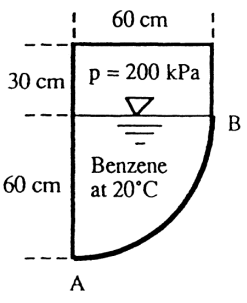
3)A cylindrical weir has a diameter of 3 m and a length of 6 m. Find the magnitude and direction of the resultant force acting on the weir from the weir. γ_{water} = 9810 N/m^3



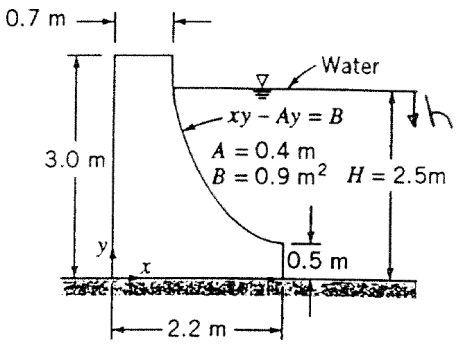
4) Circular-arc *Tainter* gate ABC pivots about point O. For the position shown, determine **(a)** the hydrostatic force on the gate (per meter of width into the paper); and **(b)** its line of action. Does the force pass through point O?
γ_{water} = 9810 N/m^3



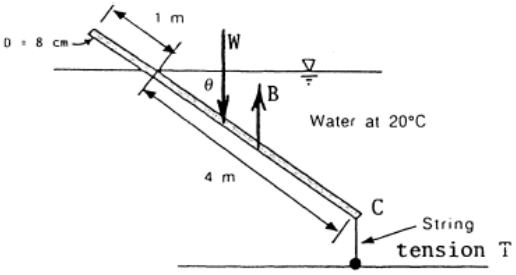
5) The tank in the figure contains benzene and is pressurized to 200 kPa (gage) in the air gap. Determine the vertical hydrostatic force on circular-arc section AB and its line of action.
$\rho_{benzene}$ = 881 kg/m^3



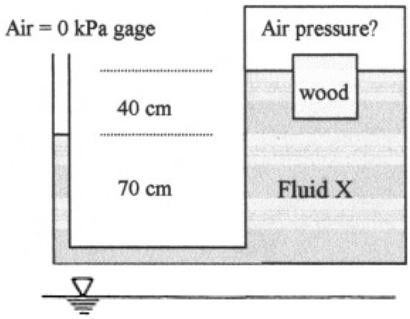
6) A dam is to be constructed across a river using the cross section shown. Assume the dam width is w = 50 m. For water height H = 2.5 m, calculate the magnitude and the line of action vertical force of water on the dam face.



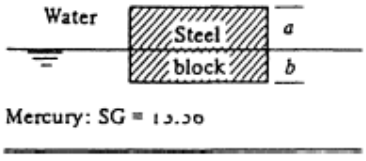
7) The uniform 5-m-long wooden rod in the figure is tied to the bottom by a string. Determine **(a)** the string tension; and **(b)** the specific gravity of the wood.
$\gamma_w = 9810\ N/m^3$



8) A block of wood (SG = 0.6) floats in fluid X in the figure such that 75% of its volume is submerged in fluid X. Estimate the gage pressure of the air in the tank.



9) A uniform block of steel (SG = 7.85) will "float" at a mercury-water interface as in the figure. What is the ratio of the distances *a* and *b* for this condition?
$SG_{mercury} = 13.56$



ANSWERS

1) 127.8 kN directed vertically downward along the cone axis.
2) $F_B = 1.17R$ [for case (a)]; $F_B = 0.875R$ [for case (c)]
3) $F_{res} = 369.9$ kN; $\alpha = 57.5°$
4) $F_{res} = 179.45$ kN; $\alpha = 10.27°$; yes
5) $F_V = 122400$ N/m; acting 29.9 cm to the right of A
6) $F_V = 1.05 \times 10^6$ N acting 1.61 m from the upstream face of the dam
7) a) 39.4 N ; **b)** SG=0.64
8) $p_{air\text{-}gage} = -3139.2\ N/m^2$
9) 0.834

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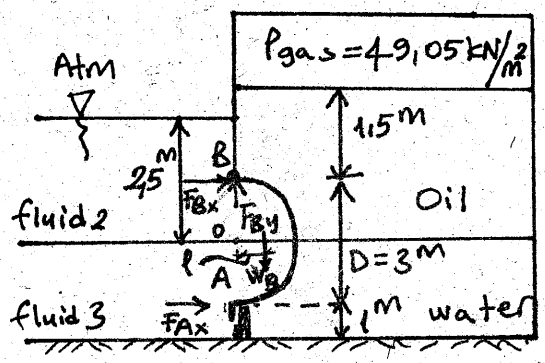
Q1) Find the indicated reaction forces at A and B. The weight of the gate is 10kN and its width is 2 m.



Hinge at B, $\gamma_{water} = 9810\ N/m^3$

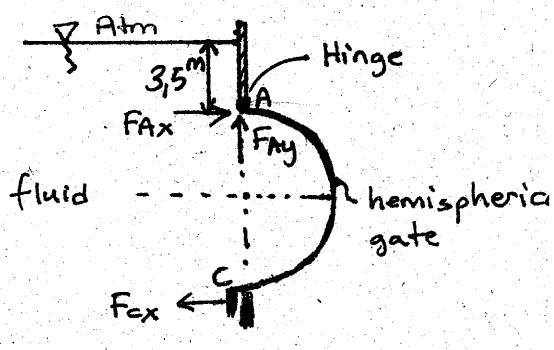
SG of fluid 2 = 0.7, $W_g = 10\ kN$

SG of fluid 3 = 1.6 ($F_{Bx} = 163.83\ kN$

SG of oil = 0.9 $F_{By} = 23.83\ kN$

$P_{gas} = 49.05\ kN/m^2$, $l = 0.75m$ $F_{Ax} = 168.73\ kN$)

Q2) Find the hydrostatic force F and its point of action (CP) on the spherical gate shown in the figure. Also determine the indicated reaction forces at A and C. Neglect the weight of the gate.



$\gamma_{water} = 9810\ N/m^3$ (F = 767.41 kN

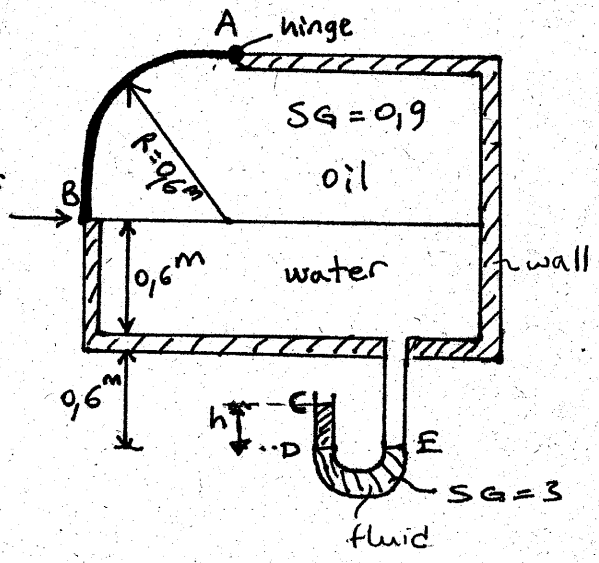
SG of fluid = 1.1 $\alpha = 166.37°$

diameter = 4 m $F_{Ax} = 373.04\ kN\ (\leftarrow)$

$F_{Ay} = 180.80\ kN$

$F_{Cx} = 372.77\ kN$)

Q3) Determine the value of "h" illustrated on the figure for the case where no force is required to hold the gate closed or to open it. The gate freely touches at B. (h=0.49m)



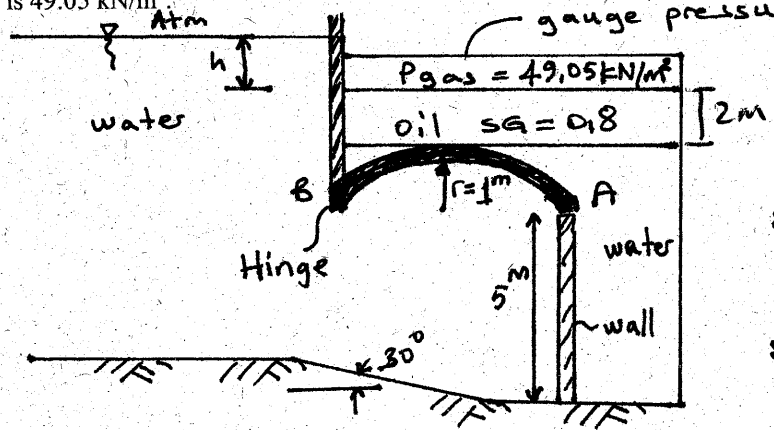
$\gamma_w = 9810\ N/m^3$

gate width = 1.3m

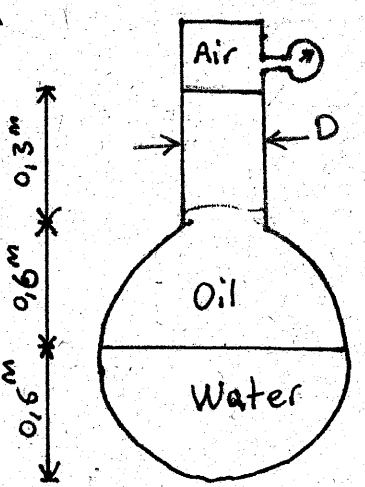
Q4) What should be the value of h so as to keep the hemispherical gate closed ? The gate freely touches the wall at A. Neglect the weight of the gate. The gage pressure P_{gas} is 49.05 kN/m^2.

(h=4.6m)

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



Q5) The cylindirical vessel contains oil, water and air as shown in the figure. The manometer attached measures the air pressure as 25 kN/m^2. Determine the resultant hydrostatic force acting on the curved surface of the vessel.



$P_{air} = 25\ kN/m$

$\gamma_{oil} = 8\ kN/m$

D=20cm

B=1m

Problem 5

(F_V = 15.538 kN ↓)

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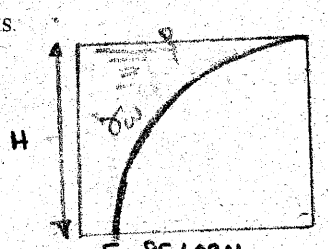
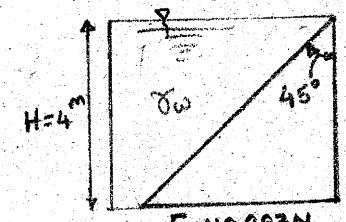
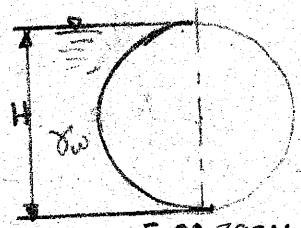
Q1) Three types of water gates is shown in the figure below. Assume each gate is 1 m wide and the depth of the water is H=4m. What is the resultant force of the water pressure exerted on each gate, and what is its line of application, such that the correct moment results.



F= 85.403 N
α= 66.7°



F=110.987 N
y_{cp}=1.33m



B = 1m
H = 4m
γ_{water} = 9810 N/m³

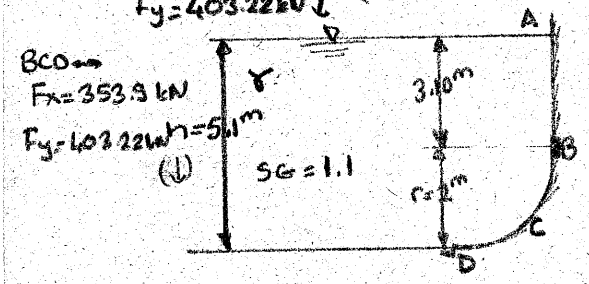
F= 99.792 N
α= 308°

Q2) As shown in figure below, pressure acts on a surface which is made of two sections. The first section of the surface AB is perpendicular to the ground with a height of 3.1m while the second section BCD is a quarter of a cyclinder of radius 2m. The length of the surface perpendicular to the figure's plane is 4m. Determine the horizontal and the vertical components of the resultant force acting on BCD and ABCD for both situations given in Figure (a) and (b).

(a)

ABCD → F_x = 561.3 kN
F_y = 403.22 kN ↓

BCD →
F_x = 353.9 kN
F_y = 403.22 kN

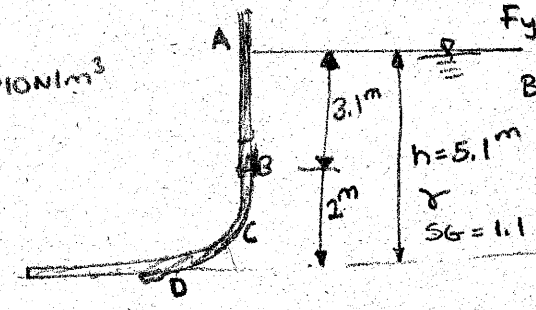


γ_{water} = 9810 N/m³
B = 4m

(b)

ABCD → F_x = 561.3 kN
F_y = 403.22 kN ↑

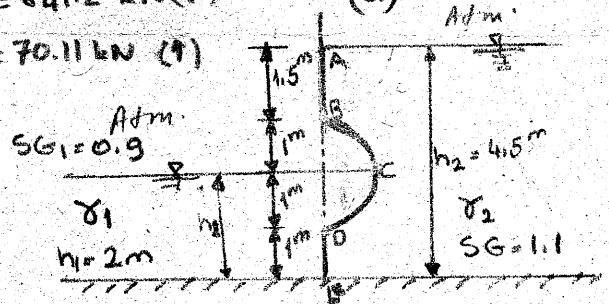
BCD → F_x = 353.9 kN
F_y = 403.22 kN



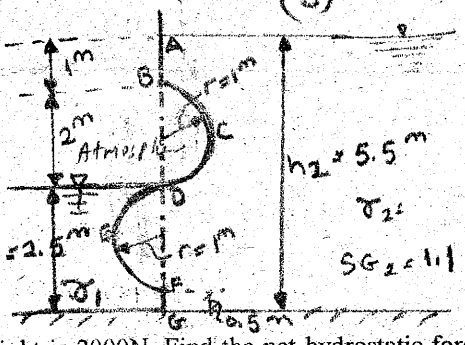
Q3) Determine the horizontal and the vertical components of the resultant force acting on the surfaces ABCDE and ABCDEFG, shown in figure (a) and (b) below, respectively. The width of the gates is 7m.

(a)

F_x = 641.2 kN (←)
F_y = 70.11 kN (↑)

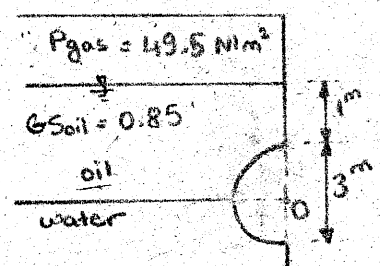


(b)



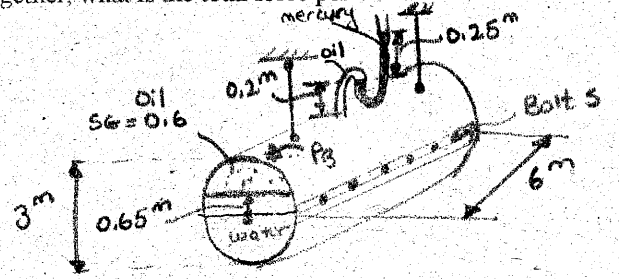
γ_1 , γ_2
SG_1 = 0.9
SG_2 = 1.1
γ_{water} = 9810 N/m³
B = 7m
F_x = 949.4 kN (←)
F_y = 97.08 kN (↑)

Q4) Width of the semi-cylindirical gate is 2.5m and its weight is 2000N. Find the net hydrostatic force acting on the gate and the angle, the net force is making with the horizontal.



γ_{water} = 9810 N/m³
F_x = 156714.8 N (→)
F_y = 84678.5 N
α = 28.4°

Q5) A large conduit supported from above conducts water and oil under pressure, as shown in figure below. It is made of two semicylindrical sections bolted together and weighing 4kN/m each. If, in a 6m length of the conduit, 100 bolts clamp the two sections together, what is the total force per bolt to hold the section together with a total force of 6kN between the flanges to prevent leakage.



$SG_{mercury}$ = 13.6
SG_{oil} = 0.6
γ_{water} = 9810 N/m³

F_{bolt} = 10.64 kN