ASSIGNMENT No. 3
Hydrostatic Forces on Submerged Surfaces

1. A plane surface of area A is totally immersed in a liquid of mass density (ρ). If this surface is inclined at an angle (ϕ) to the horizontal and its centroid is at a vertical depth ($\bar{h}$) below the free surface. Derive an expression for:
   a) The total hydrostatic force (F) on one side of the surface.
   b) The depth ($h_{c.p.}$) of the center of pressure below the free surface.

2. A vertical triangular gate is holding water on one side as shown in figure. Calculate the total resultant force acting on the gate and locate the centre of pressure for case A and B.

3. The shown gate in figure is rectangular with the dimensions 6.0 m x 5.0 m. Neglecting the weight of the gate, determine the reaction at point **A**

4. A culvert has an inclined circular gate 1.25 m in diameter is shown in the figure. The gate can be rotated about its horizontal axis. Show that the turning moment on the gate is independent of the depth of water if the gate is completely immersed and find the value of this moment.

5. A rectangular gate 6m × 2m is hinged at its base and its upper end is kept in position by a concrete block weighs 5500 kgw, as shown in the figure. Neglecting the weight of the gate, find the level of water when the gate begins to fall. If the height of water increases by 50 cm such that the block is completely immersed, then find the new weight of the block (S.G.=2.42) to keep the gate in position.

6. For the cylindrical tank shown in the figure; find the resultant force exerted by the fluids on the end of the tank and its point of application

7. A structure is attached to the ocean floor. A 2.0 m diameter hatch (Door) is located in an inclined wall and hinged on one edge the way shown in figure. Determine the minimum air pressure P_1 within the container to open the hatch neglecting its weight and friction in the hinge.

8. A gate ABC (0.6 m wide) is horizontally hinged at B and part BC is inclined by 30º, as shown in the figure. Calculate the value of water depth H at which the gate is in equilibrium.

9. The 10 ft long gate shown in the figure is hinged at H. Determine the horizontal force P required to hold the gate in place. Neglect friction and the gate weight.

10. The gate ABC shown in the figure is hinged at its center. Determine the force *F* required to open the gate under each of the following two conditions:
    a) Neglecting the weight of the gate. (Discus without calculation the stability of the gate in this case)
    b) The gate weight is 35 N acting at 1.25 m from the center.

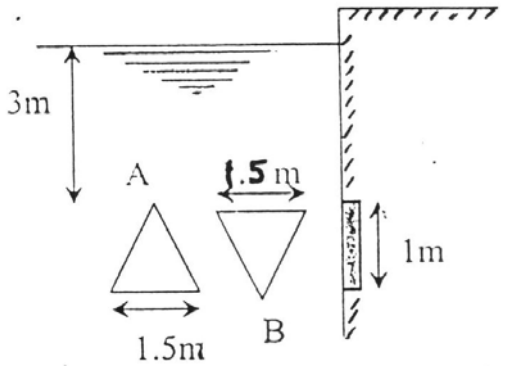
11. Calculate the magnitude, the direction and the location of the resultant force of both the air and jet fuel tank on the quarter cylindrical surface shown in figure. Assume 3.0 m long normal to plane of paper.

12. Determine all the forces acting on the shown circular gate **AB**.

13. For the 1.5 m long tank shown in the attached figure, calculate the following:
    a) The resultant horizontal force on surface ABC and its point of application
    b) The vertical forces on surfaces AB and AC

14. A cylindrical gate 2.0 m in diameter and 1.5 m long weighs 200 kN. Neglecting friction, determine the following:
    a) The reactions at A and B
    b) The resultant fluid pressure and show that it passes through the gate center

15. Determine the vertical force exerted on the semi-cylindrical dome (1.8 m long) when the gage reads 0.58 bar. If the dome was replaced by a hemispherical dome of the same diameter, then recalculate the exerted vertical force.



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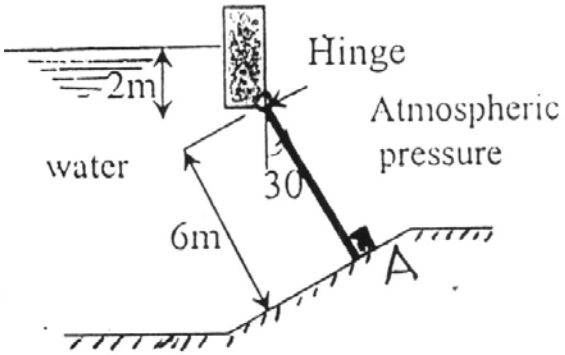

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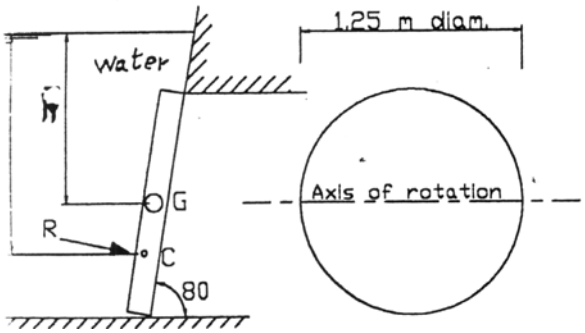

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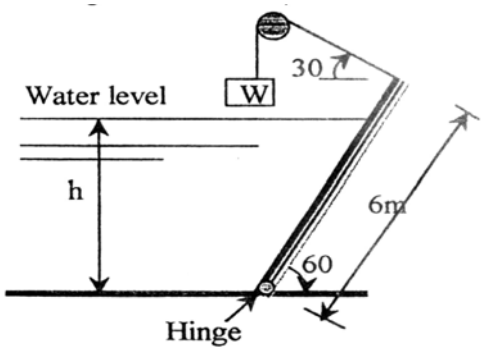

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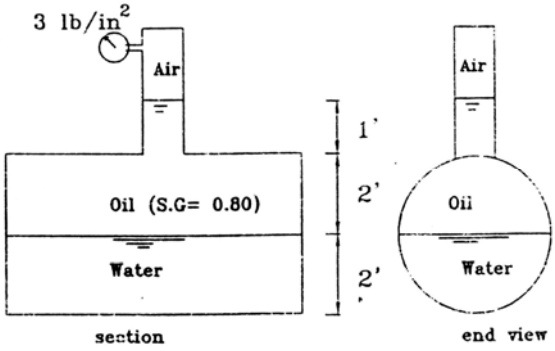

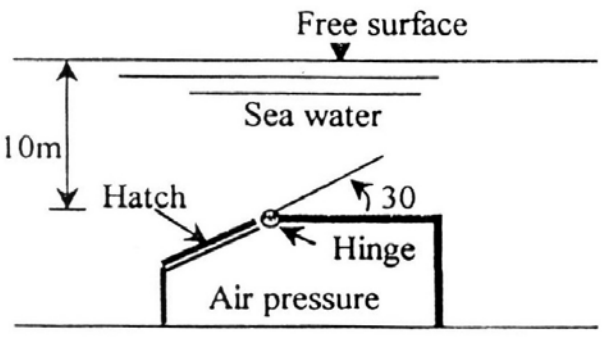

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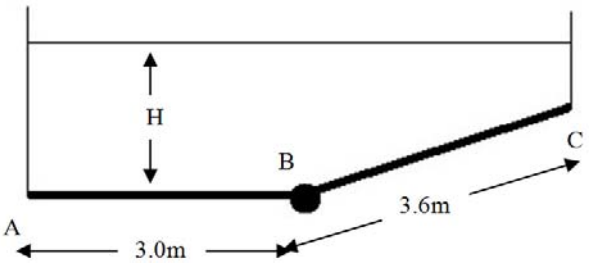

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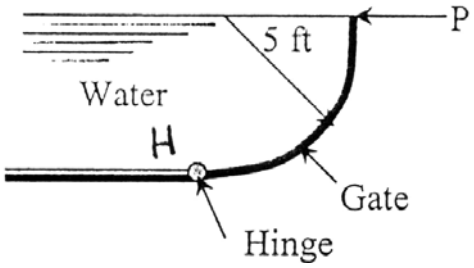

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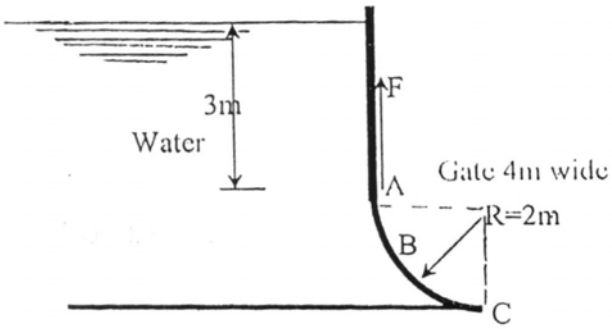
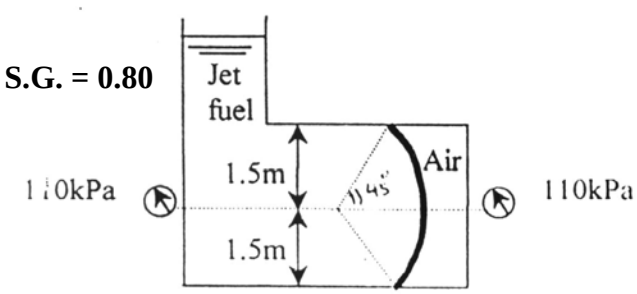
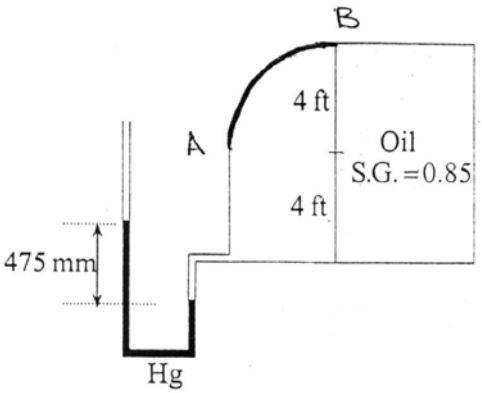


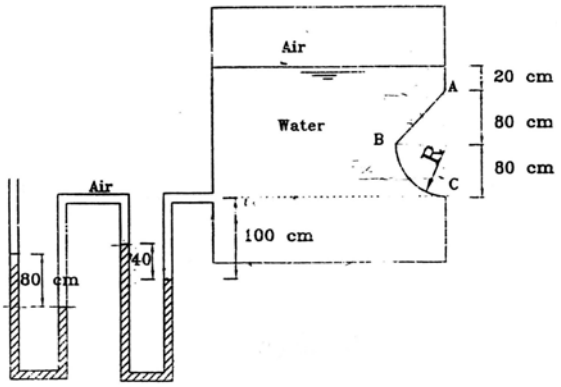
Problem (9)



Problem 10

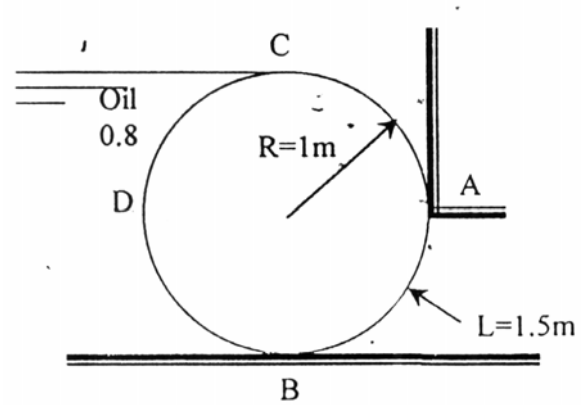
Problem 11

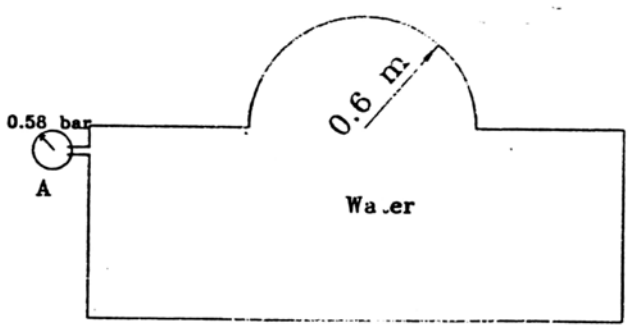




Problem 12

Problem 13





Problem 14

Problem 15