Sheet 1

1. The density of a certain type of jet fuel is 805 kg/m^3. Determine its specific gravity and specific weight.

2. A liquid is poured into a graduated cylinder is found to weigh 8 N when occupying a volume of 500 ml. Determine its specific weight, density and specific gravity.

3. The information of a can of juice indicates that the can contains 355 ml. the mass of a full can of juice is 0.369 kg while an empty can weighs 0.153 N. Determine the specific weight, density, and specific gravity of the juice. Express you results in SI units.

4. The kinematic viscosity and specific gravity of a liquid are $3.5 * 10^{-4}$ m^2/s and 0.79; respectively. What is the dynamic viscosity of the liquid in SI units?

5. A 0.3 m-diameter cylindrical tank that is 5 m long weighs 551 N and is filled with a liquid having a specific weight of 8.8 N/m^3. Determine the vertical force required to give the tank an upward acceleration of 0.6 m/s^2.

6. A 10 kg block slides down a smooth inclined surface a shown in figure 1. Determine the terminal velocity of the block if the 0.1-mm gap between the block and the surface contains oil having a viscosity of 0.29 N.s/m^2. Assume the velocity distribution in the gap is linear, and the area of the block in contact with the oil is 0.2 m^2.

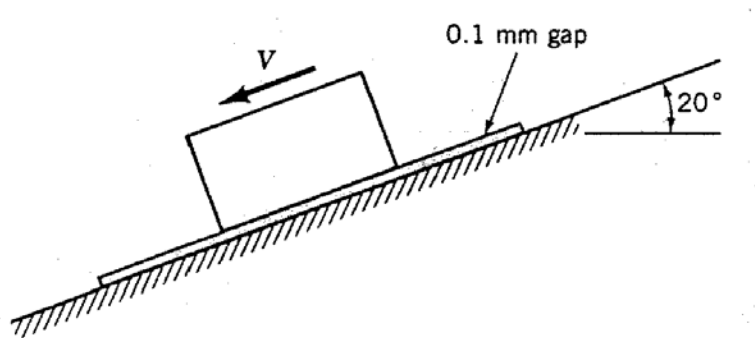

Figure 1

7. A piston having a diameter of 13.9 cm and a length of 24.1 cm slides downward with a velocity V through a vertical pipe. The downward motion is resisted by an oil film between the piston and the pipe wall. The fil thickness is 0.05 mm, and the cylinder weighs 2.22 N. Estimate V if the oil viscosity is 0.766 N.s/m^2. Assume the velocity distribution is linear.

8. A large movable plate is located between two large fixed plates a shown in figure 2. Two Newtonian fluids having the viscosities indicated are contained between the plates. Determine the magnitude and direction of the shearing stresses that act on the fixed walls and when the moving plate has a velocity of 4 m/s. Assume the velocity distribution between the plates is linear.

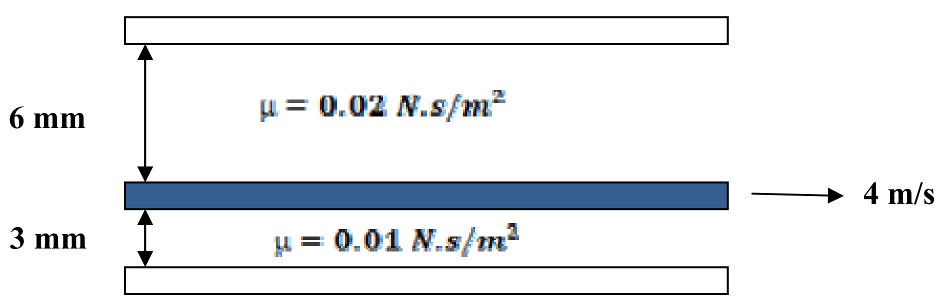

Figure 2

9. Two layers of fluid are dragged along by the motion of an upper plate a shown in figure 3. The bottom plate is stationary. The top fluid puts a shear stress on the upper plate, and the lower fluid puts a shear stress on the bottom plate. Determine the ration between these two shear stresses.

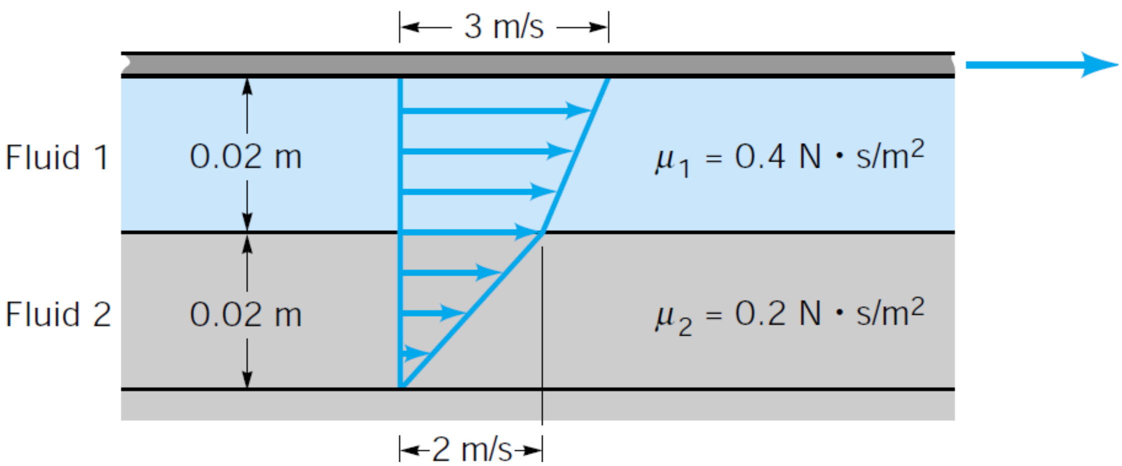

Figure 3

10. A 25 mm diameter plunger is pulled through a cylinder. The lubricant that fills the 0.3 mm gap between the plunger and the cylinder is and oil having a kinematic viscosity of $8*10^{-4}$ m^2/s and a specific gravity of 0.91. Determine the force (P) required to pull the plunger at velocity of 3 m/s. Assume the velocity distribution in the gap is linear.

11. A Newtonian fluid having a specific gravity of 0.92 and a kinematic viscosity of $4*10^{-4}$ m^2/s flows past a fixed surface. Due to the no slip comdition, the velocity at the fixed surface is zero, and the velocity profile near the surface is shown in figure 4. Determine the magnitude and direction of the shearing stress developed on the plate. Express your answer in terms of U and δ, with U and δ expressed in units of meters per seconds and meters; respectively.

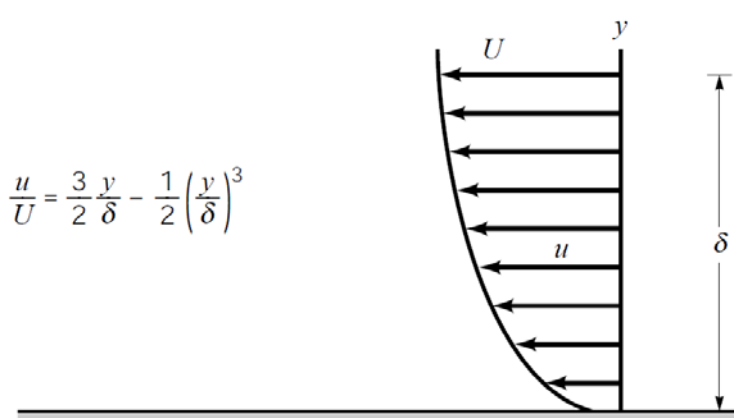

Figure 4

12. Determine the torque required to rotate a 50 mm diameter vertical cylinder a constant angular velocity of 30 rad/s inside a fixed outer cylinder that has a diameter of 50.2 mm. the gap between the cylinders in filled with SAE 10 oil at 20°C. The length of the inner cylinder is 200 mm. Neglect bottom effects and assume the velocity distribution in the gap is linear. If the temperature of the oil increases to 80°C, what will be the percentage change in the torque?

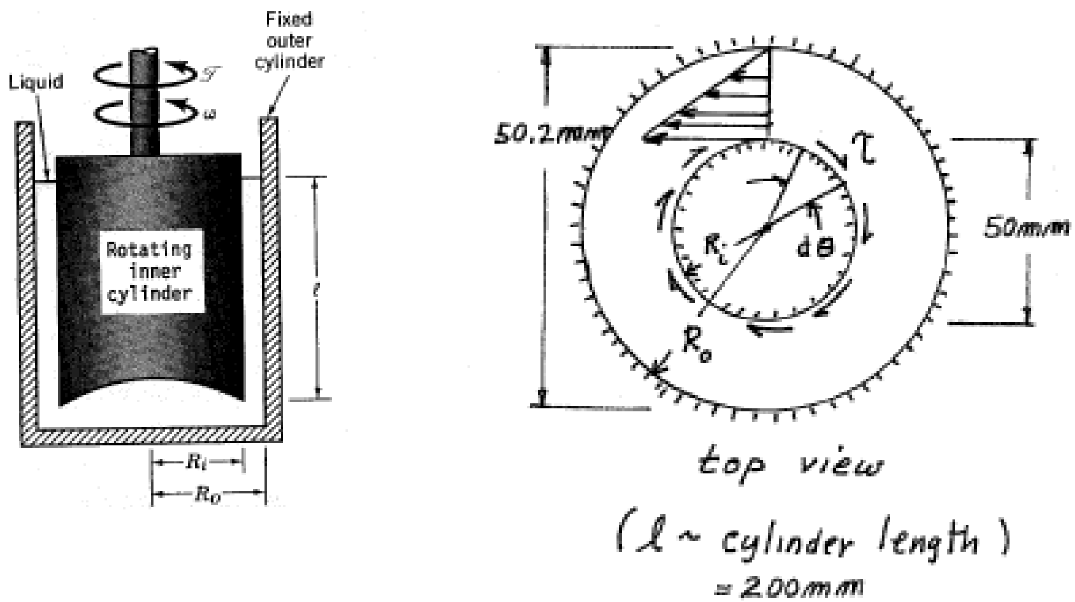

Figure 6

13. A 30.4 cm diameter circular plate is placed over a fixed bottom plate with 3.54 mm gap between the two plates filled with glycerin as shown in figure 7. Determine the torque required to rotate the circular plate slowly at 2 rpm. Assume that the velocity distribution in the gap is linear and that the shear stress on the edge of the rotating plate is negligible.

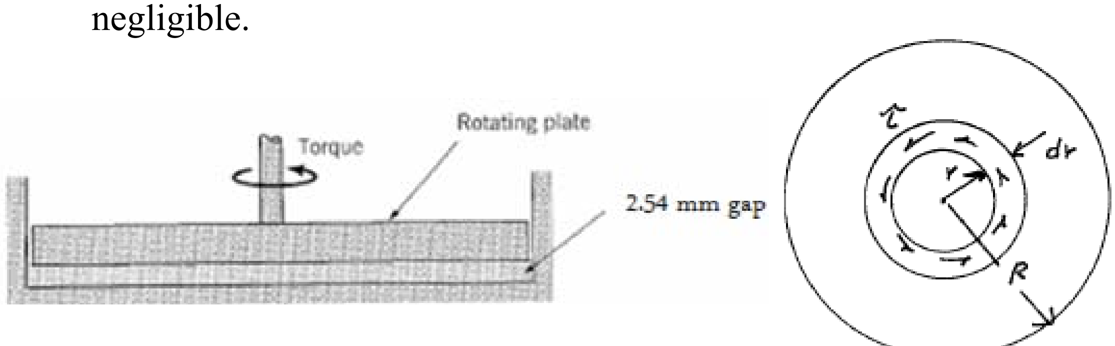

Figure 7

Sheet 2

Part I: *Manometers*

1. A mercury manometer is used to measure the pressure difference in the tewo piplines of figue -11. Fuel oil (specific weight = 6.68 N/m^3) is flowing in A and SAE 30 lube oil (specific weight = 7.18 N/m^3) is flowing in B. An air pocket has become entrapped in the tube oil as iidicated. Determine the pressure in pipe B if the pressure in A is 105.5 KPa.

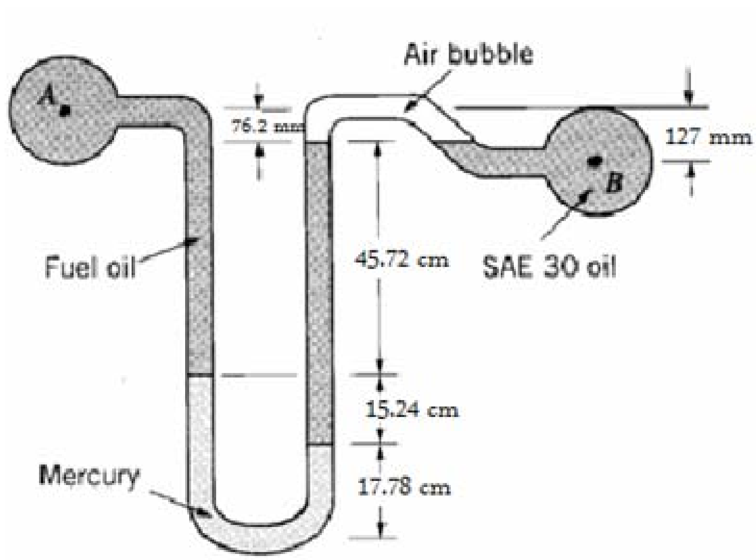

Figure 1-1

2. A closed cylindrical tank filled with water has a hemispherical dome and is connected to an inverted piping system as shown in figure 1-2. The liquid in the top part of the piping system has specific gravity of 0.8 and the remaining parts of the system are filled with water. If the pressure gauge reading at A is 60 kPa, determine (a) the pressure in pipe B, and (b) the pressure head in millimeters mercury at the top of dome (point C).

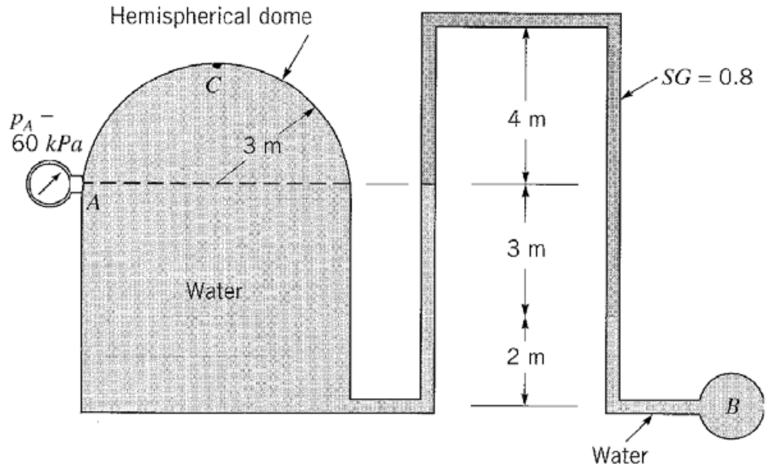

Figure 1-2

3. The mercury manometer of figure 3 indicates a differential reading of 0.3 in when the pressure in pipe A is 30 mm Hg vaccum. Determine the pressure in pipe B.

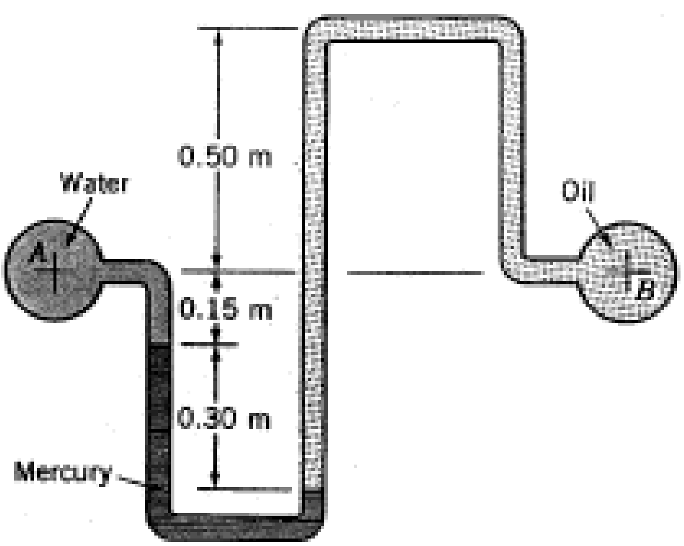

Figure 1-3

4. Determine the angle θ of the inclined tube shown in figure 1-4 if the pressure at A is 689.5 KPa greater than at B.

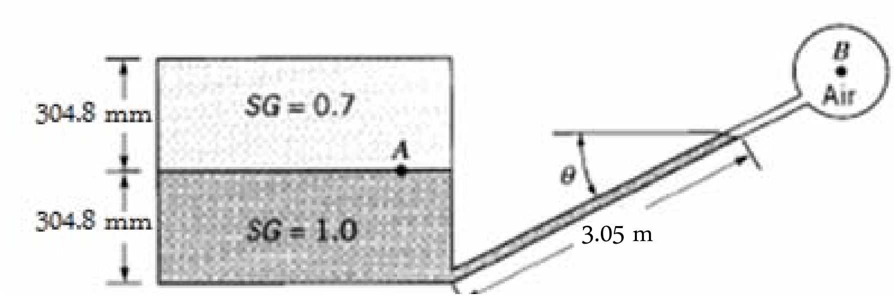

Figure 1-4

5. For the inclined-tube manometer of figure 1-5 the pressure in pipe A is 551.5 KPa. the fluid in both pipes A and B is water and the gauge fluid in the manometer has a specific gravity of 2.6.What is the pressure in pipe B corresponding to the differential reading shown?

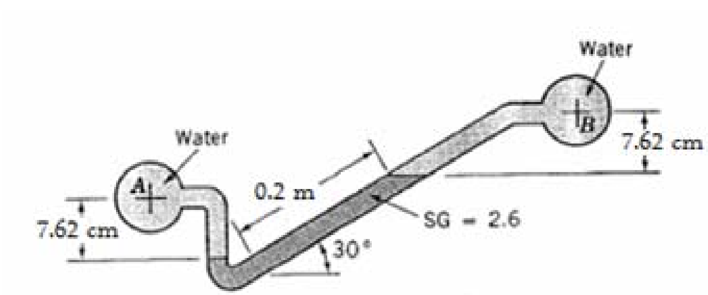

Figure 1-5

6. Determine the change in the elevation of the mercury in the left leg of the manometer of figure 1-6 as a result of an increase in pressure of 344.7 KPa in pipe A while the pressure in pipe B remains constant.

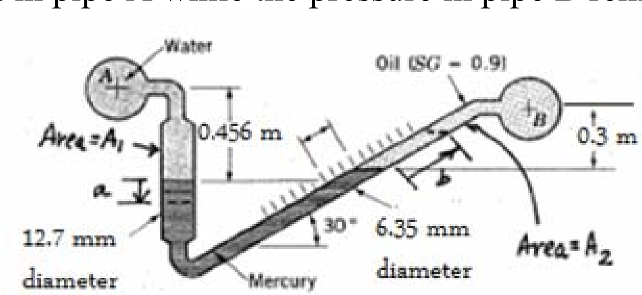

Figure 1-6

7. A U-tube mercury manometer is connected to a closed pressurized tank as illustrated in figure 1-7. If the air pressure is 138 KPa, determine the differential reading, h. The specific weight of the air is negligible.

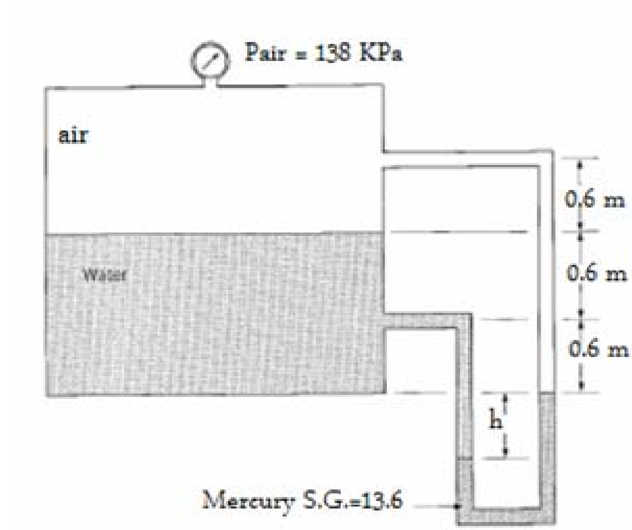

Figure 1-7

Sheet 3

1. A swimming pool is 18 m long and 7 m wide. Determine the location of the resultant force of the water on the vertical end of the pool where the depth is 2.5 m.

2. A vertical triangular gate with water on one side is shown 2-1. Find the total resultant force acting on the gate and locate the center of pressure.

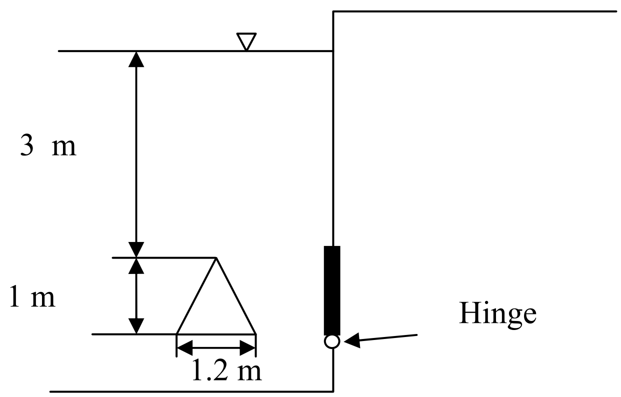

Figure 2-1

3. An inclined rectangular gate with water on one side is shown 2-2. Find the total resultant force acting on the gate and locate the center of pressure.

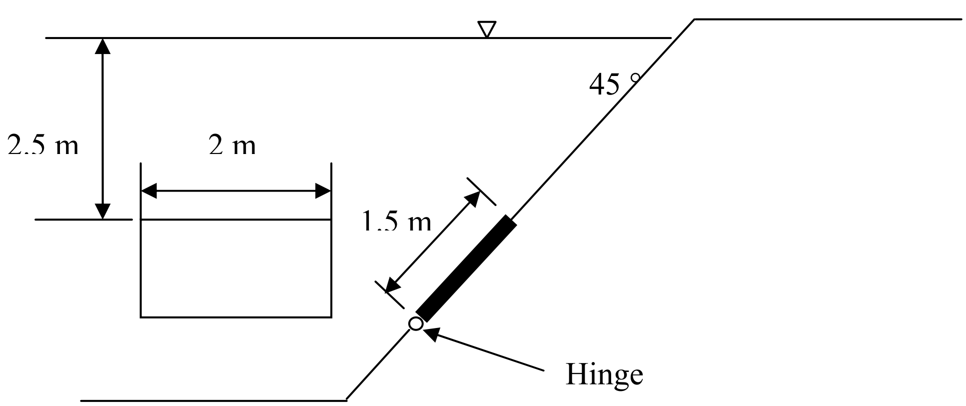

Figure 2-2

4. A rectangular gate having a width of 1.5 m is located in sloping side of a tank as shown in figure 2-3. The gate is hinged along its top edge and is held in position by the force (P). Friction at the hinge and the weight of the gate can be neglected. Determine the required value of (P).

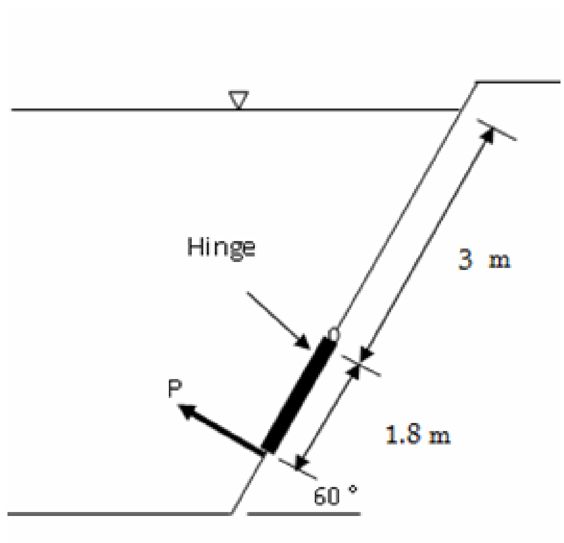

Figure 2-3

5. A gate having the triangular shape shown in figure 2-4 is located in the vertical side of an open tank. The gate is hinged about the horizantal axis AB. The force of the water on the gate creates a moment with respect to the axis AB. Determine the magnitude of the moment.

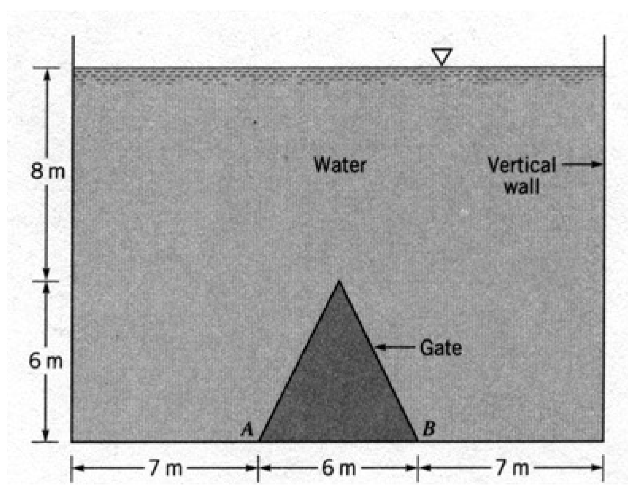

Figure 2-4

6. A homogeneous, 1.2 m wide, 2.4 m long rctangular gate weighing 3.56 KN is held in place by horizantal flexible cable as shown in figure 2-5. Water acts against the gate which is hinged at point A. Friction in the hinge is negligible. Determine the tension in the cable

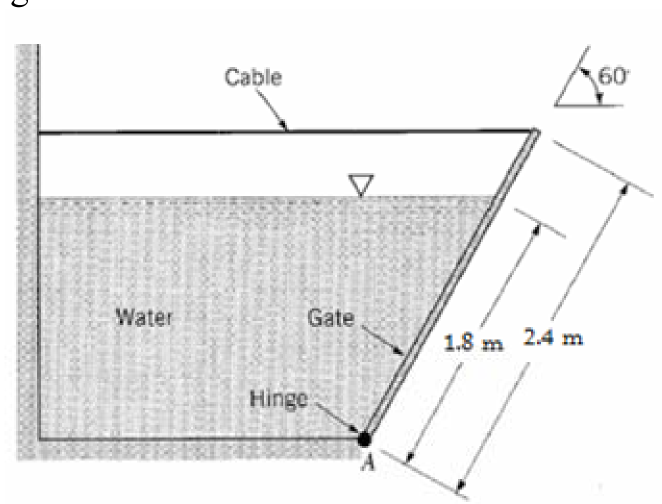

Figure 2-5

7. The rectangular gate CD of figure 2-6 is 1.8 m wide and 2.0 m long. Assuming the material of the gate is to be homogeneous and neglecting friction at the hinge C, determine the weight of the gate necessary to keep it shut untill the water level is 2 m above the hinge.

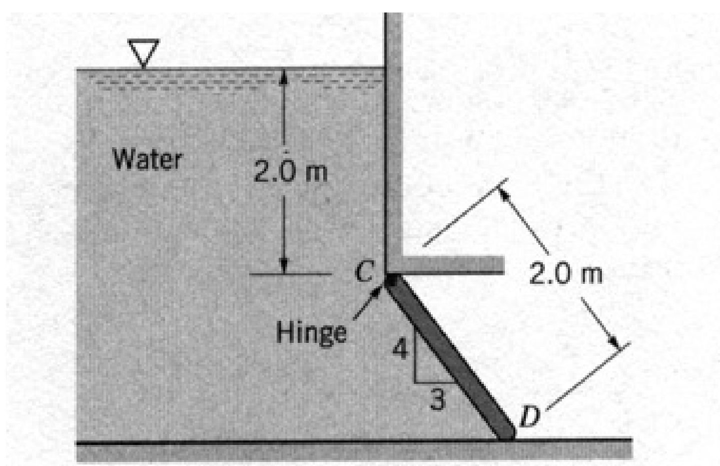

Figure 2-6

8. The rigid gate, *OAB*, of figure 2-7 is hinged at *O* and rests against a rigid support at B. What minimum horizantal force, *P*, is required to hold the gate closed if its width is 3 m. Neglect the weight of the gate and friction at its hinge.

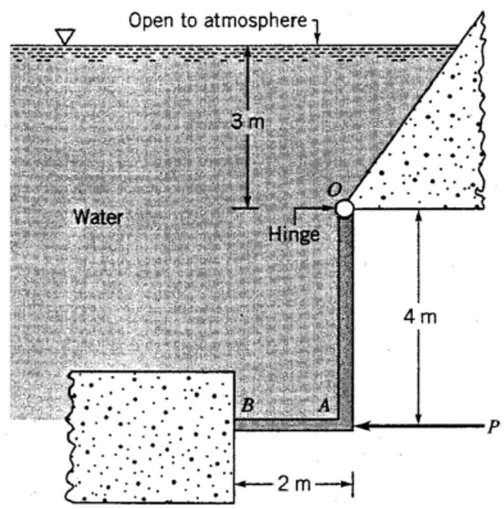

Figure 2-7

9. The massless, 1.2 m wide gate shown in figure 2-8 pivots about the frictionless hinge (*O*). It is held in place by the 8.9 KN counter weight, (*W*). Determine the water depth, (*h*).

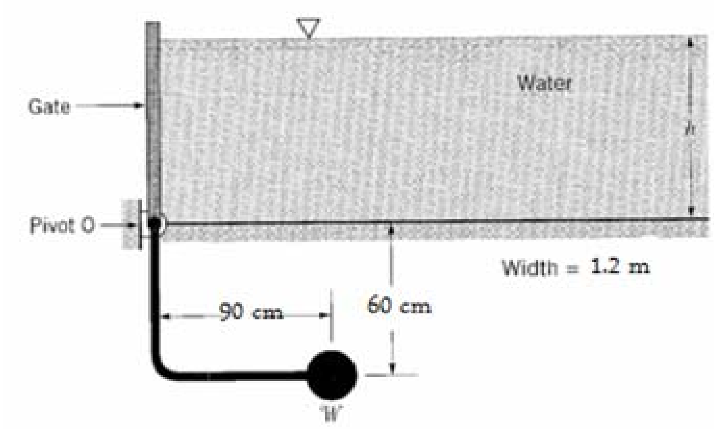

Figure 2-8

10. An open tank has a vertical partition and on one side contains gasoline with density 700 kg/m^3 at depth of 4 m, as shown in figure 2-9. A rectangular gate that is 4 m high and 2 m wide and hinged at one end is located in the partition. Water is slowly added to the empty side of the tank. At what depth, (h) will the gate start to open?

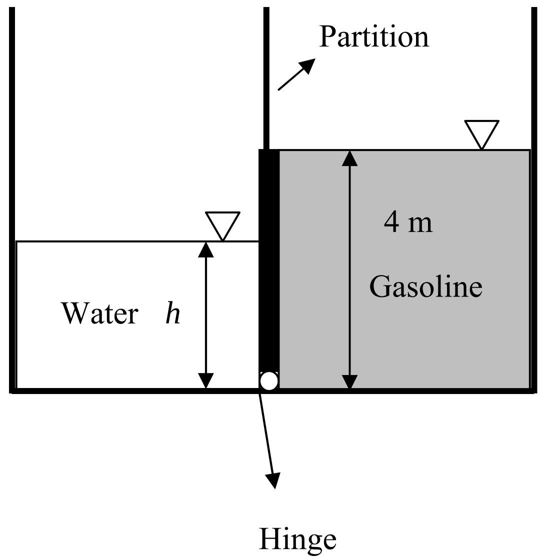

Figure 2-9

11. The 6 m-long gate of figure 2-10 is a quarter circle and is hinged at H. Determine the horizantal force, P, required to hold the gate in place. Neglect friction at the hinge and the weight of the gate.

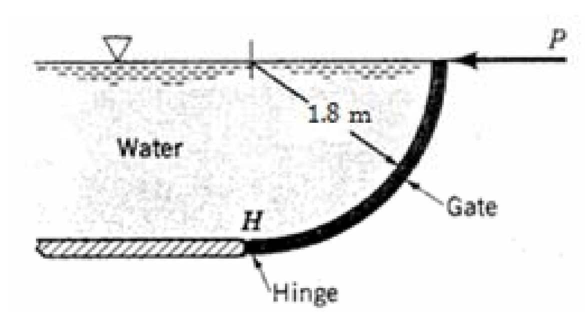

Figure 2-10

12. A gate in the form of a partial cylinder surface (called a Tainter gate) holds back water on top of a dam as shown in figure 2-11. The radius of the surface is 6.7 m, and its length is 11 m. The gate can pivot about point *A*, and the pivot point is 3 m above the seat, *C*. Determine the magnitude and resultant water force on the gate. Will the resultant pass through the pivot? Explain.

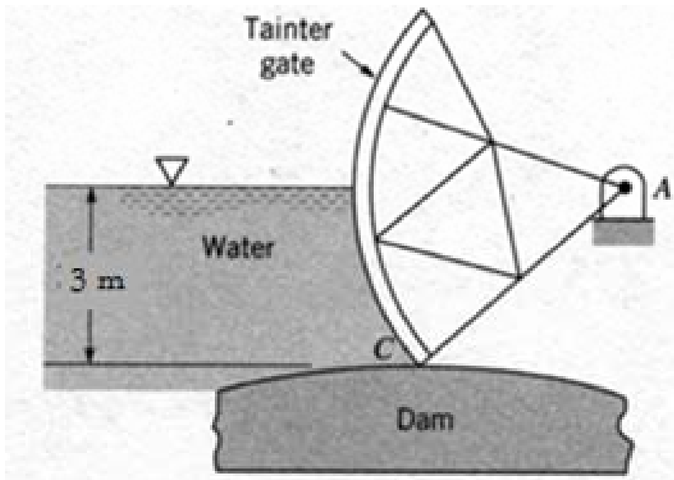

Figure 2-11

Sheet 4

Bernoulli Theorem & Continuity Equation

1. Water flows from a garden hose nozzle with a velocity of 15 m/s. What is the maximum height that it can reach above the nozzle?

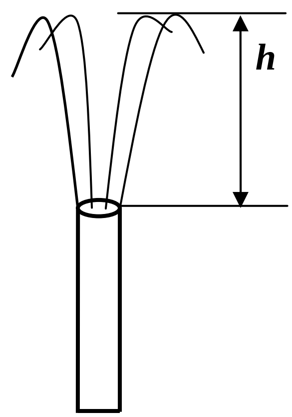

Figure 1

2. Water flowing from the 20 mm diameter outlet as shown in figure 2. Determine the flow rate.

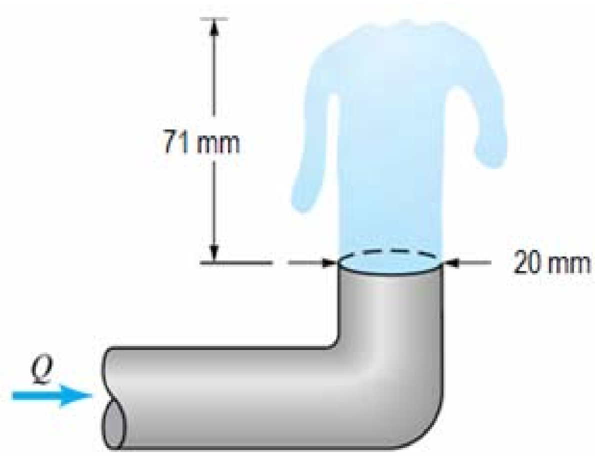

Figure 2

Dr. Kamal Abd El-Aziz

3. Water flows without viscous effects from the nozzle shown in figure 3. Determine the flow rate and the height, h, to which the water can flow.

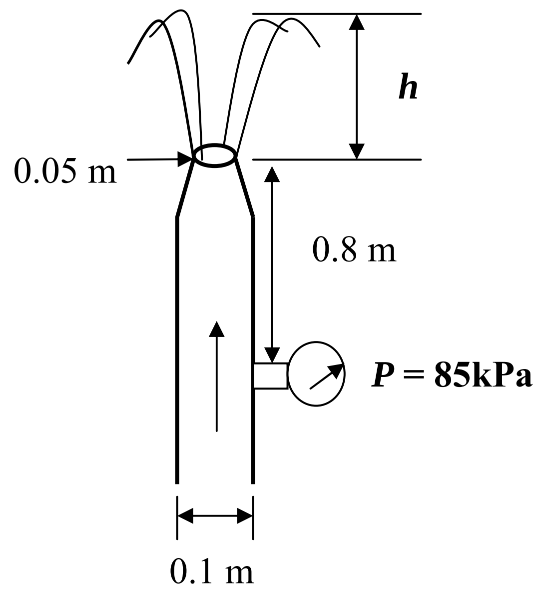

Figure 3

4. Water flows steadily through the large tanks as shown in figure 4. Determine the water depth h_A.

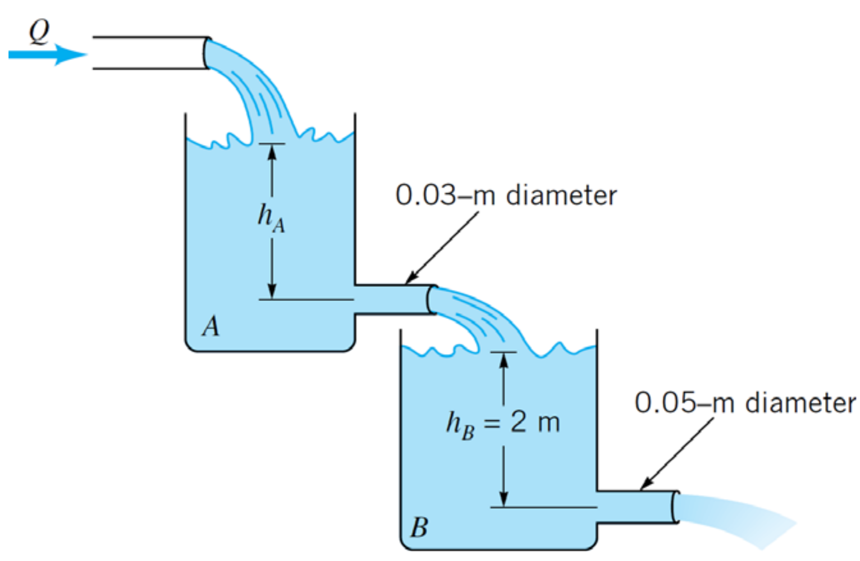

Figure 4

5. What pressure P_1 is needed to produce a flow rate of 0.00254 m^3/s from the tank shown in figure 5?

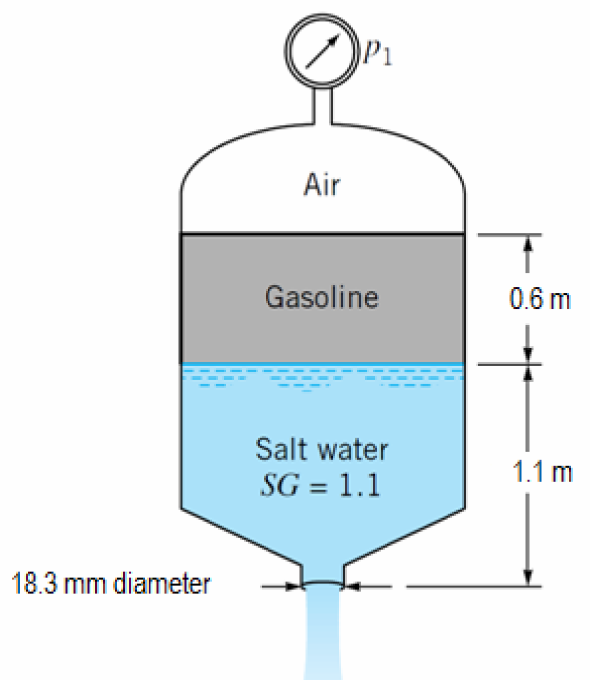

Figure 5

6. The vent on the tank shown in figure 6 is closed and the tank is pressurized to increase the flow rate. What pressure P_1 is needed to produce twice the flow rate of that when the vent is open?

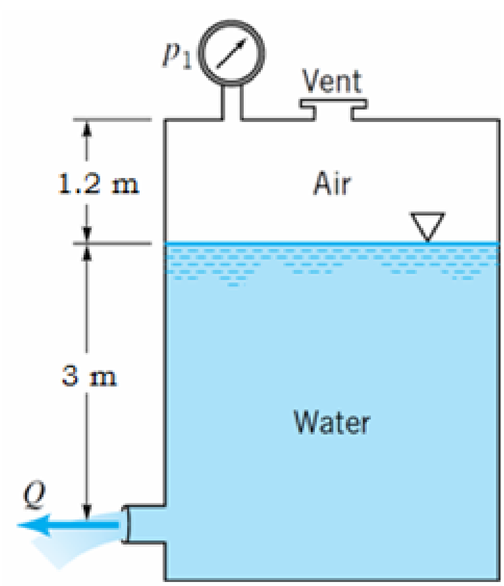

Figure 6

Dr. Kamal Abd El-Aziz

7. A large open tank contains a layer of oil floating on water as shown in figure 7. The flow is inviscid. Determine:
   a. The height, h, to which the water will rise.
   b. The water velocity in the pipe.
   c. The pressure in the horizantal pipe.

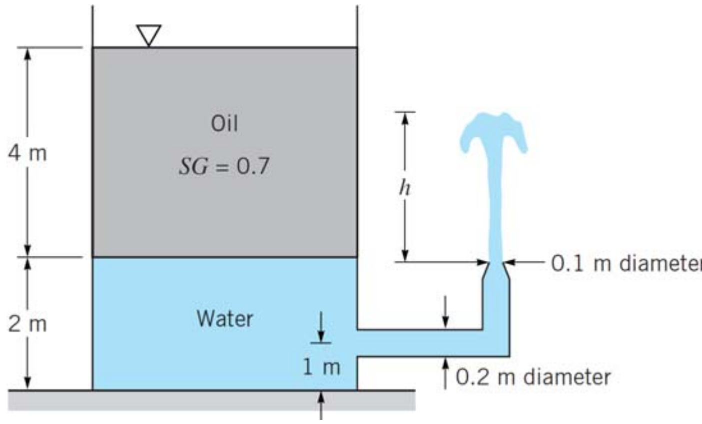

Figure 7

8. Water flows from the faucet on the first floor of building shown in figure 8 with a maximum velocity of 6.1 m/s. For steady flow, determine the maximum water velocity from the basement faucet and from the faucet on the second floor. Assume each floor is 3.6 m tall.

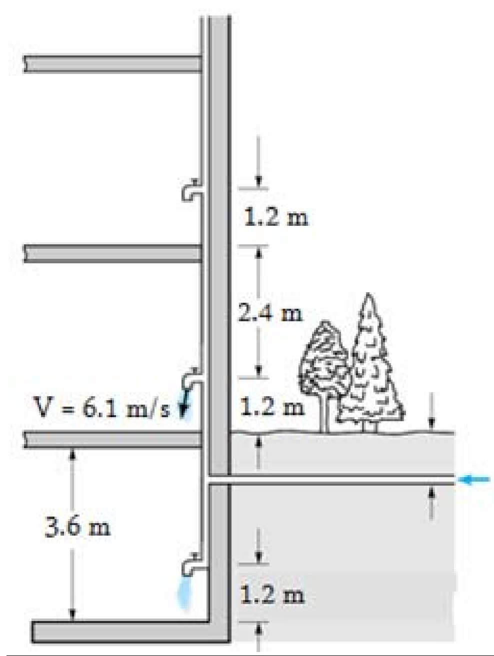

Figure 8

9. Streams of water from two tanks impinge upon each other as shown in figure 9. If viscous effects are negligible and point (A) is a stagnation point, determine the height (h).

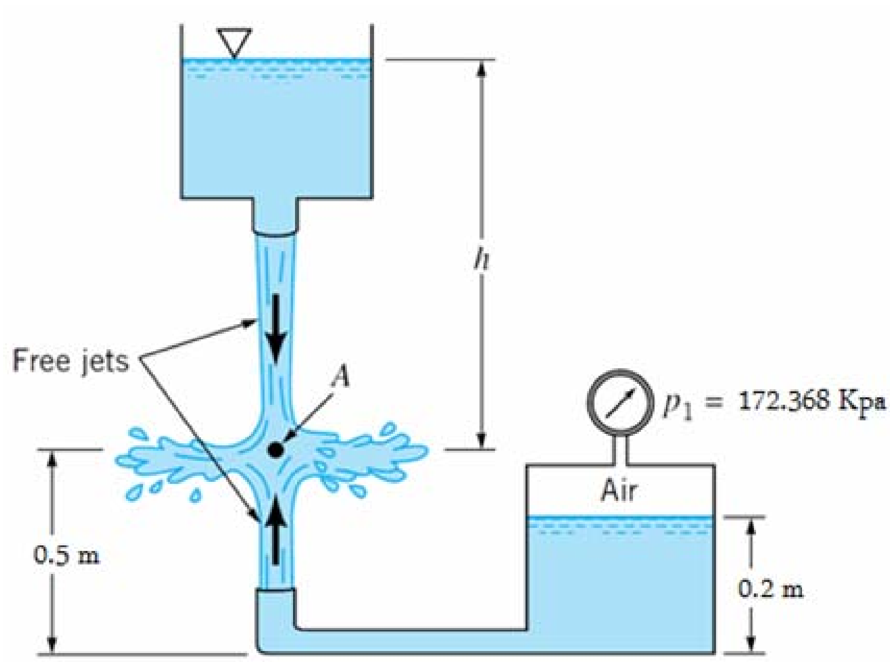

Figure 9

10. Water flows through the branching pipe shown in figure 10. If the viscous effects are negligible, determine the pressure at section (2) and the pressure at section (3).

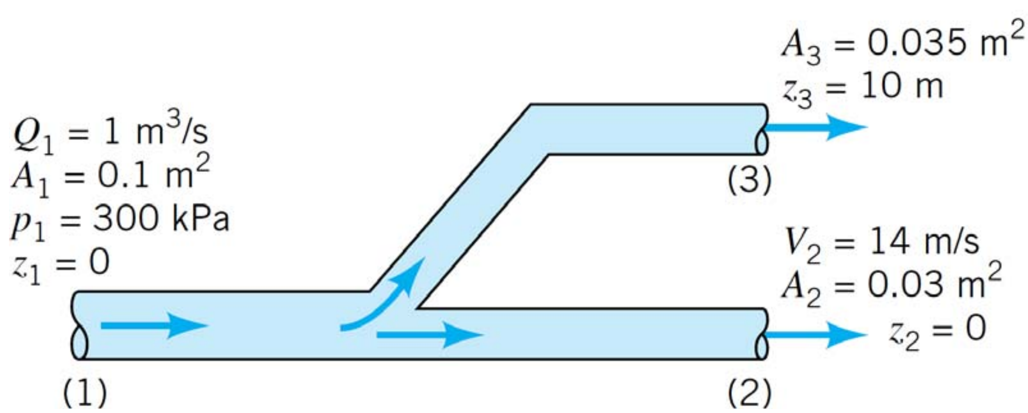

Figure 10

Sheet 5

Flow Measurements

1. Water flows through a Venturi meter as shown in figure (1). The Venturi meter has a 10.16 cm diameter throat and is installed in a horizontal 30.48 cm diameter pipeline. Determine the discharge coefficient of the Venturi meter if the discharge in determined to be 0.06 m^3/s.

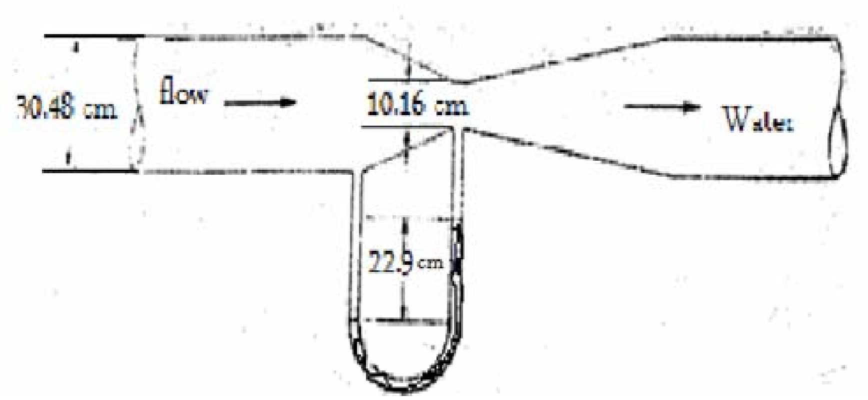

Figure 1

2. A Venturi meter having a throat diameter of 150 mm is installed in a horizontal 300 mm diameter water main, as shown in figure (2). The coefficient of discharge of Venturi meter is 0.982. Determine the difference in level of the mercury columns of the differential manometer attached to the Venturi meter if the discharge is 0.142 m^3/s.

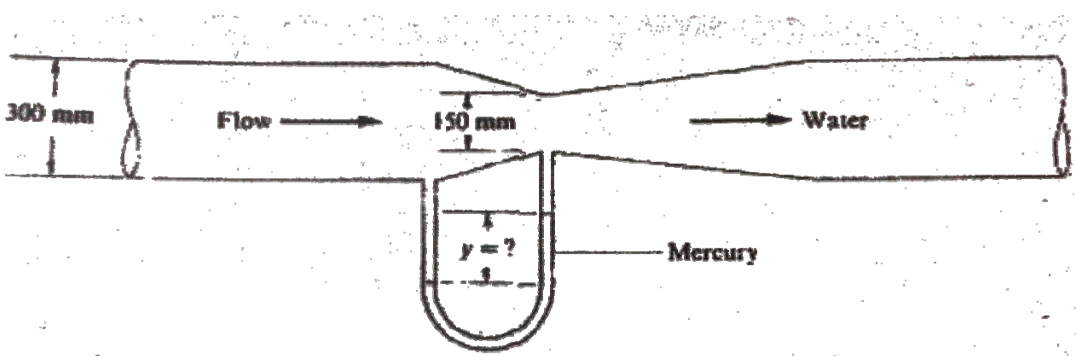

Figure 2

3. Kerosene (SG = 0.85) flows through the venturi meter shown in figure (3) with flowrates between 0.005 and 0.050 m^3/s. determine the range in pressure difference, $p_1 - p_2$ needed to measure these flowrates.

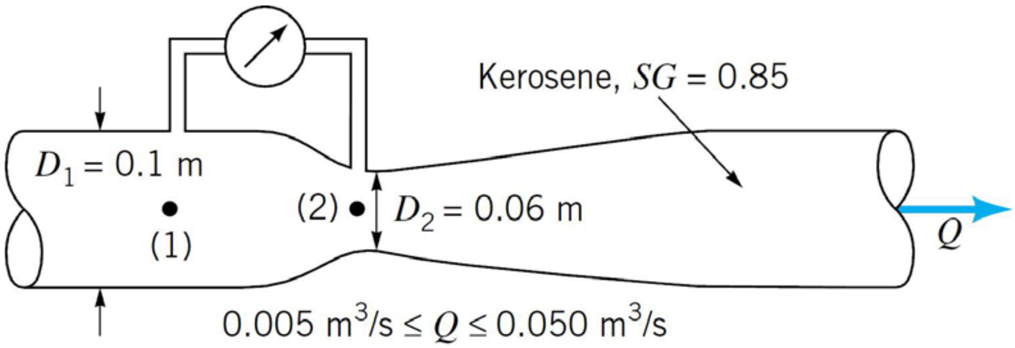

Figure 3

4. Oil flows through a pipe as shown in figure (4). The coefficient of discharge for the orifice is 0.63. Determine the discharge of oil in the pipe.

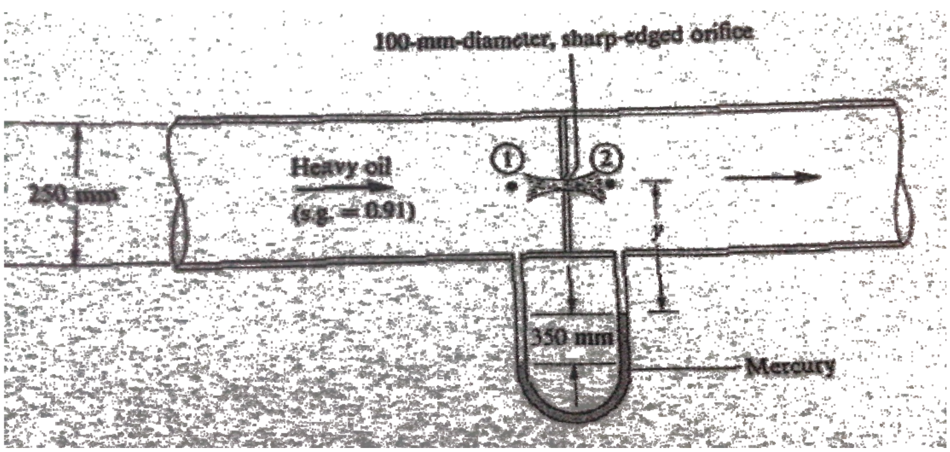

Figure 4

5. Water flows through the orifice meter shown in figure (5) at a rate of $0.0028 \ m^3/s$. If $d = 3.048$ cm, determine the value h.

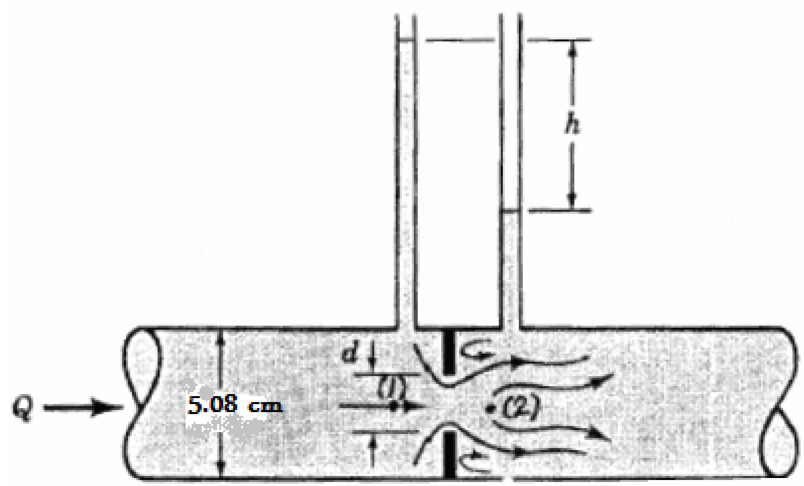

Figure 5

6. Water flows from a large tank through an orifice and discharges to the atmosphere, as shown in figure (6). The coefficient of velocity and contraction is 0.96 and 0.62, respectively. Determine the diameter and actual velocity in the jet. Also determine discharge from the orifice.

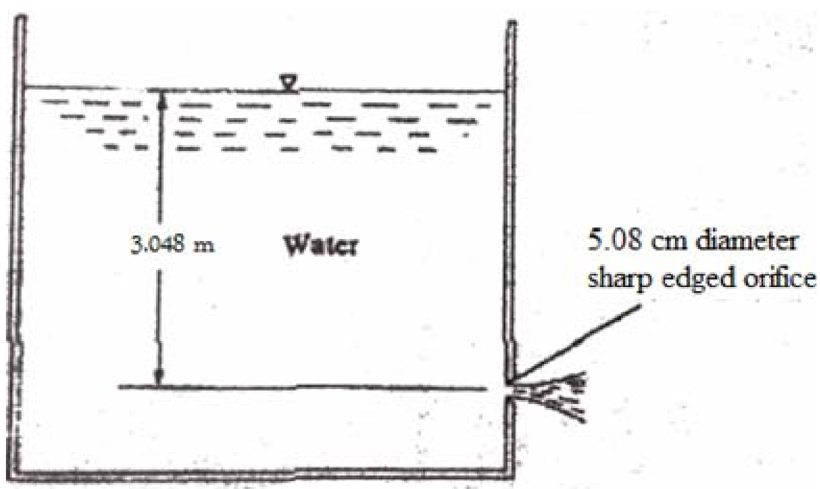

Figure 6

7. Determine the flowrate through the submerged orifice, shown in figure (7) if the discharge coefficient is 0.68.

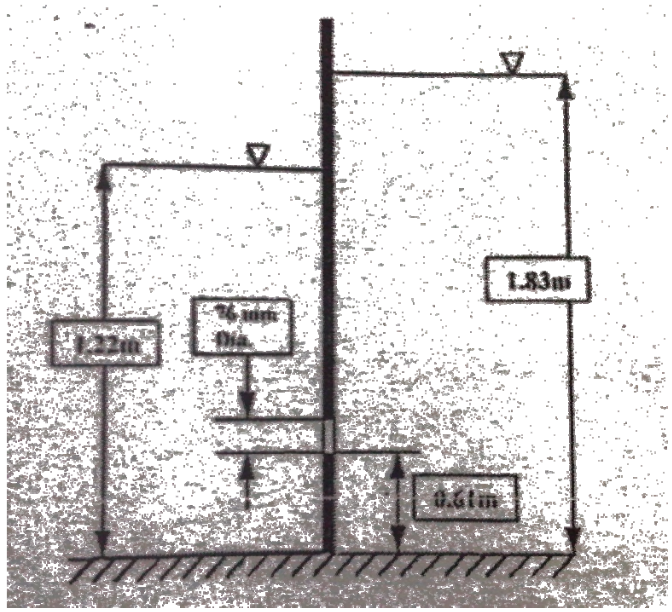

Figure 7

Sheet 6

Flow in Pipes

1. Water flow in constant diameter pipe with the following conditions measured:
At section (a): p_a = 223.39 KPa and z_a = 17.3 m.
At section (b): p_b = 204.774 KPa and z_a = 20.8 m.
Is the flow from (a) to (b) or from (b) to (a)? Explain.

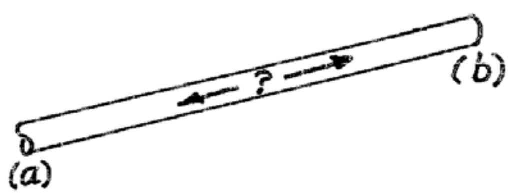

Figure 1

2. Repeat Problem (1) if the specific gravity of the fluid is 0.5.

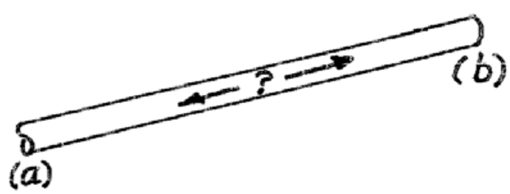

Figure 2

3. Oil (specific weight = 8900 N/m3, viscosity = 0.1 N.s/m2) flows through a horizontal 23 mm diameter tube as shown in figure 3. A differential tube manometer is used to measure the pressure drop along the tube. Determine the range of values for h for laminar flow.

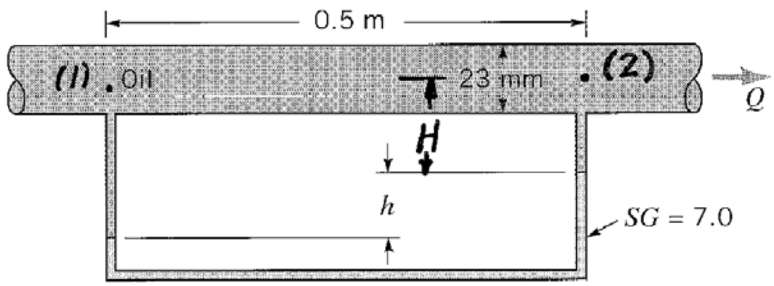

Figure 3

4. During a heavy rainstorm, water from a parking lot completely fills an 45.72 cm diameter, smooth, concrete storm sewer. If the flow rate is 0.2831 m^3/s, determine the pressure drop in a 30.48 m horizontal section of the pipe. Repeat the problem if there is a 60.96 cm change in elevation of the pipe per 30.48 m of its length.

5. Water flows at a rate of 0.01416 m^3/s from tank A to tank Through a horizontal 7.62 cm diameter cast iron pipe of length 60.96 m. if minor losses are neglected, determine the difference in elevation of the free surfaces of the tanks.

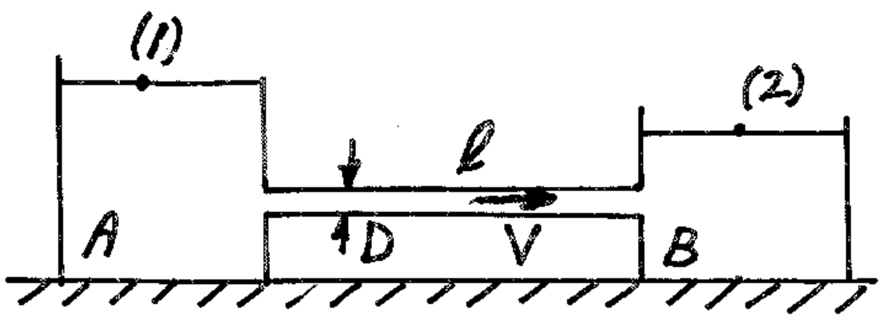

Figure 4

6. The pump shown in figure 5 adds 25 kW to the water and causes a flowrate of 0.04 m^3/s. Determine the flowrate expected if the pump is removed from the system. Assume f = 0.016 for both cases and neglect minor losses.

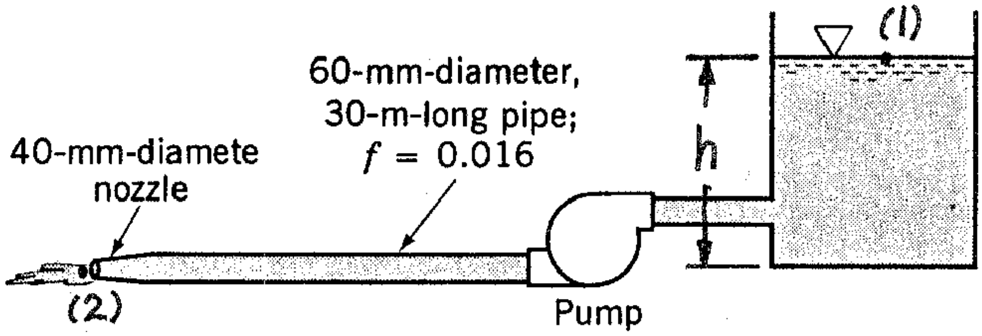

Figure 5