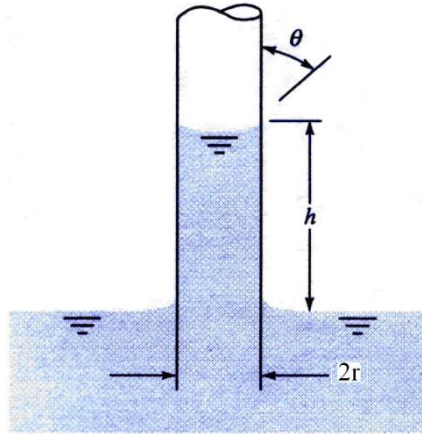
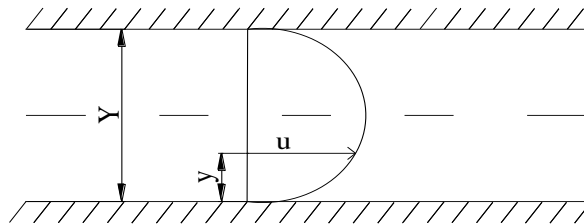


## FLUID MECHANICS

**Problem 1:** Pressures are sometimes determined by measuring the height of a column of liquid in a vertical tube. What diameter of clean glass tubing is required so that the rise of water at 20°C in a tube due to capillary action (as opposed to pressure in the tube) is less than 1.0 mm? (Take surface tension for water as 0.0728 N/m) (Munson and Young, 1998)



**Problem 2:** Consider a water at 20°C flows between two parallel fixed plates.

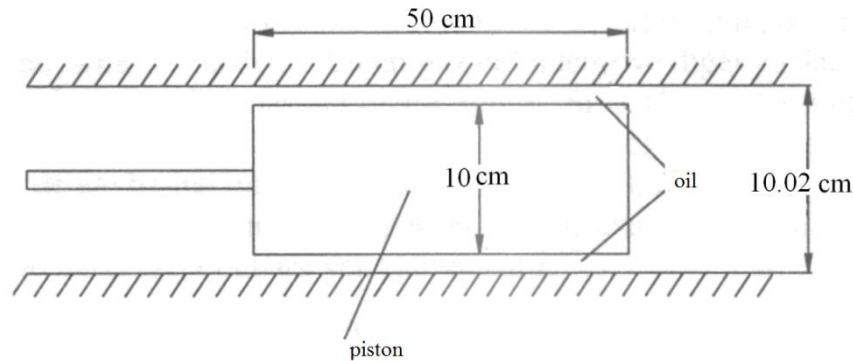


The velocity distribution for the flow is given by  $u=10(0.01y-y^2)$  m/s, where  $y$  is measured in meters from the lower wall. Determine

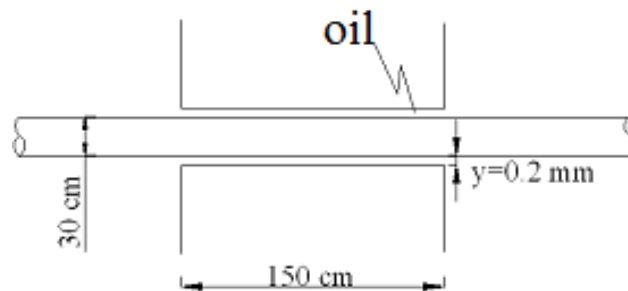
- the distance between the walls,
- the shear stress at the wall,
- the shear stress at a distance of 20 from the wall,
- the location of zero shear stress, and
- the location of maximum velocity. (Yüksel, 2016)

**Problem 3:** A piston 10 cm in diameter and 50 cm in length moves coaxially in a cylinder 10.02 cm in diameter. The space between the piston and the cylinder is filled with oil of kinematic viscosity  $9.25 \times 10^{-5}$  m<sup>2</sup>/s and specific gravity 0.88.

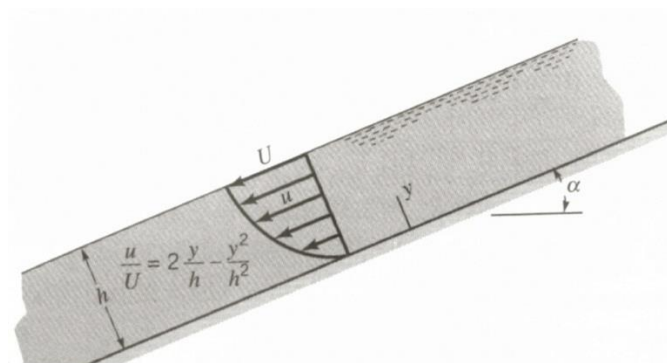
- a) Assuming a linear variation in velocity, determine the force required to move the piston at 0.5 m/s.
- b) Determine the torque necessary to rotate the piston at 1200 rpm assuming.



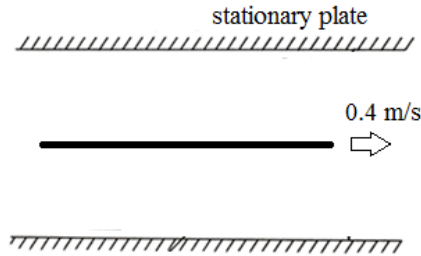
**Problem 4:** A cylinder shaft rotates at 300 rpm between two plates as in the figure. The distance between the shaft and the plates is 0.2 mm, and the filled with oil. And the viscosity of the oil is  $\mu=0.0814 \text{ Ns/m}^2$ . (Assume linear variation in velocity) Determine the torque necessary to rotate the shaft. (Khan, 1987)



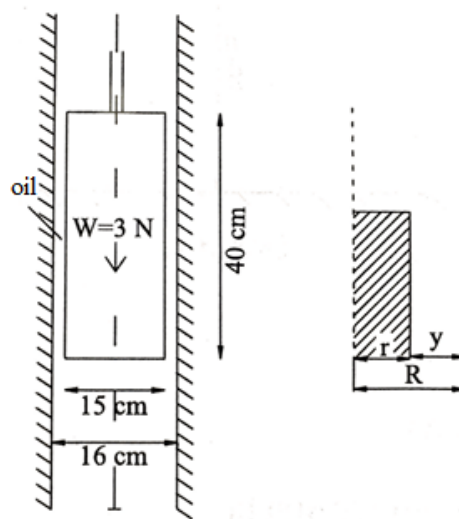
**Problem 5:** A glycerin flows past a thin plate, a thin layer adjacent to the plate surface develops in which the velocity,  $u$ , changes rapidly from zero to the approach velocity,  $U$ , in a distance  $y$ . The velocity profile for this case given as  $u/U = 2y/h - y^2/h^2$ . Determine the velocity at the surface ( $U$ ) for the water depth  $h=7.5\text{mm}$ ,  $\alpha = 20^\circ$ ,  $\gamma_{\text{glycerin}} = 12340 \text{ N/m}^3$ ,  $\mu = 1.49 \text{ Ns/m}^2$  (Munson and Young, 1998).



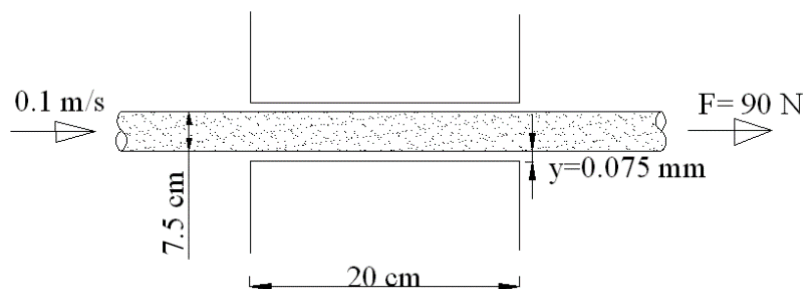
**Problem 6:** As shown in Figure, 30 cm width and 60 cm length plate is slipped with 0.4 m/s velocity. Determine the force required to move the plate. The bottom and upper plates are stationary. Middle plate is located 0.5 cm and 1 cm far away from upper and bottom plates, respectively. (Yüksel, 2016)



**Problem 7:** A circular cylinder slides inside a vertical pipe. The slope between the cylinder and the pipe is lubricated with an oil film. The velocity profile for this oil film given as  $U = -320r + 2000r^2$  (m/s). Determine the dynamic viscosity for the oil? (Weight of the cylinder is 3N) (Yüksel, 2016)



**Problem 8:** A 7.5 cm diameter shaft moves at 0.1 m/s constant velocity between two plates as in the figure. The distance between the shaft and the plates is 0.075 mm and filled with a fluid. If 90 N force is needed to move this shaft determines the viscosity of the fluid between the shaft and the plates. (Assume linear variation in velocity) (Streeter, 1966)



## FLUID STATICS

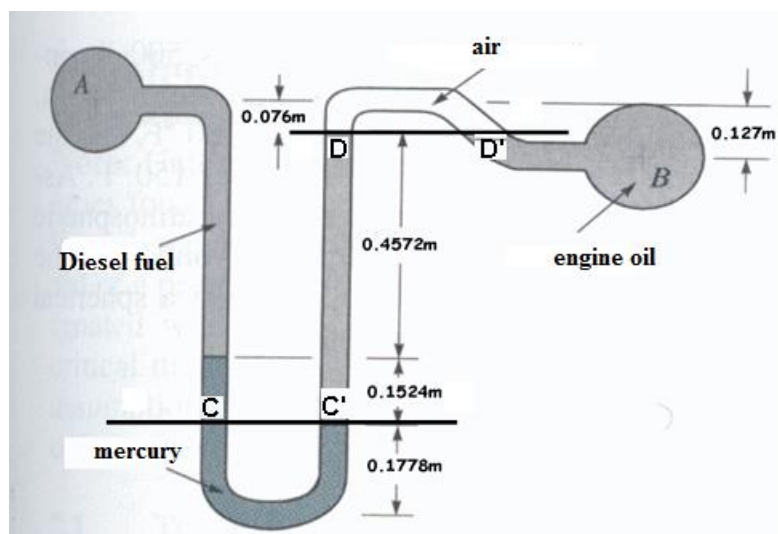
**Problem 1:** Convert a pressure 50kPa to water column, mercury column and carbon-tetra-chloride column.

$$(\gamma_{\text{water}} = 9.81 \text{ kN/m}^3, \gamma_{\text{carbon-tetra-chloride}} = 15.6 \text{ kN/m}^3, \gamma_{\text{mercury}} = 133 \text{ kN/m}^3)$$

**Problem 2:** A closed container filled with glycerin to a depth of 3.048m and rest of it is air. If the pressure in the container caused by air is  $41.37 \text{ kN/m}^2$ . Determine the pressure at the bottom of the container? ( $\gamma_{\text{glycerin}} = 12.348 \text{ kN/m}^3$ ) (Munson and Young, 1998)

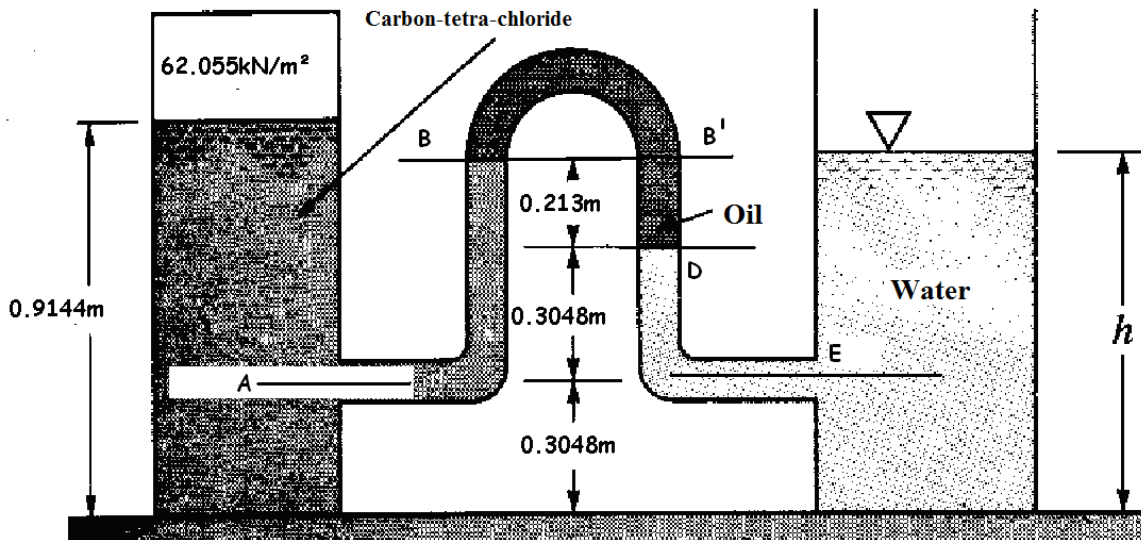
**Problem 3:** Bourdon gage is attached to a pump and the gage reads  $28.728 \text{ kN/m}^2$  suction (vacuum) pressure. What is the absolute air pressure in the tank? Assume standard atmospheric pressure of  $101.356 \text{ kN/m}^2$ . (Munson and Young, 1998)

**Problem 4:** The U-tube manometer is also widely used to measure the difference in pressure between two containers or two points in a given system. As an example a manometer connected between containers A and B is shown in Figure. Pipe A is filled with the diesel fuel has a specific gravity  $\gamma_{\text{diesel fuel}} = 8.326 \text{ kN/m}^3$  and pipe B filled with engine oil has a specific gravity  $\gamma_{\text{engine oil}} = 8.955 \text{ kN/m}^3$ . If the pressure in pipe A is  $105.49 \text{ kN/m}^2$ . Determine the pressure at B. ( $\gamma_{\text{mercury}} = 133 \text{ kN/m}^3$ ) (Munson and Young, 1998)

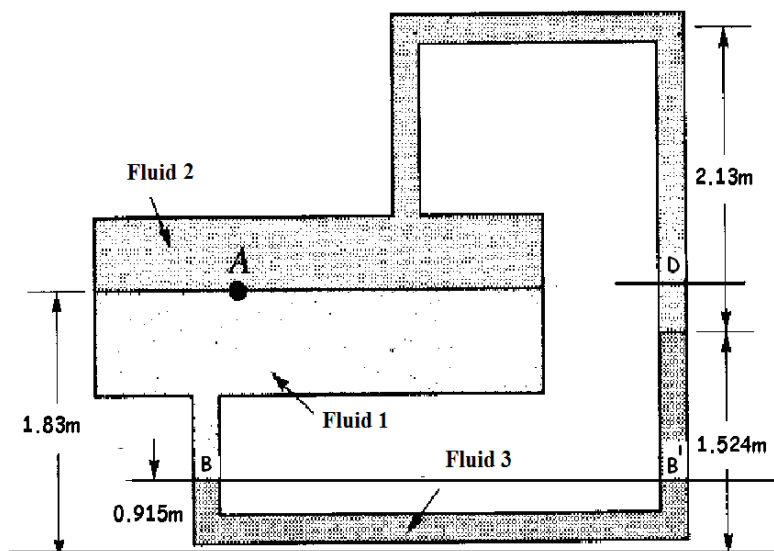


**Problem 5:** Two reservoir system filled with different type of fluid is shown in Figure. If the closed reservoir which filled with carbon-tetra-chloride is under  $62.055 \text{ kN/m}^2$  pressure.

Determine water level (h) in tank filled with water. ( $\gamma_{\text{carbon-tetra-chloride}} = 15.6 \text{ kN/m}^3$ ,  $\gamma_{\text{oil}} = 0.8 \times 9.81 = 7.848 \text{ kN/m}^3$ ) (Munson and Young, 1998)

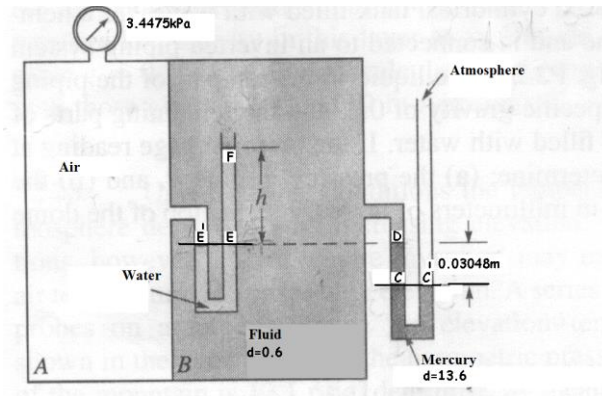


**Problem 6:** A manometer is connected to a closed tank filled with three different type of fluid as illustrated in Figure. Determine the density for the third fluid ( $d_3$ ). The specific weight of the air is negligible. ( $\gamma_1 = 9.803 \text{ kN/m}^3$ ,  $\rho_2 = 0.825 \text{ t/m}^3$ ) (Munson and Young, 1998)

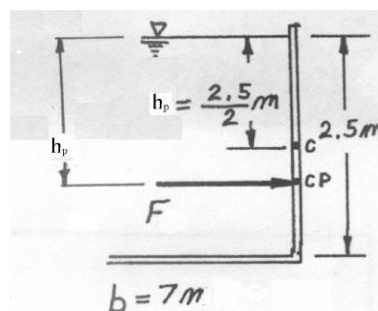


**Problem 7:** Compartments A and B of the tank shown in Figure are closed and filled with air and a liquid with a density equal to 0.6. Determine the manometer reading, h, if the

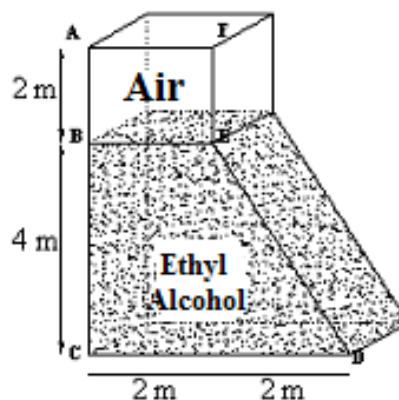
barometric (atmospheric) pressure is 101.25 kPa and the pressure gage reads 3.4475kPa. The effect of the weight of the air is negligible. (Munson and Young, 1998)



**Problem 8:** 18m long and 7m width of a swimming pool contains water to a depth of 2.5m as shown in Figure. Determine the magnitude and location of hydrostatic force. (Munson and Young, 1998)

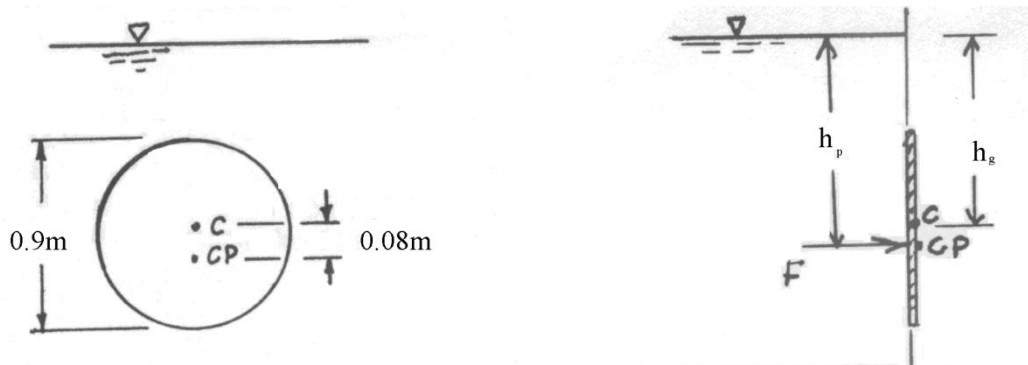


**Problem 9:** 7m long closed tank shown in the figure contains ethyl alcohol and air. The manometer shows a 40 kPa pressure at the air. Find the hydrostatic pressure force acting on the tank surfaces indicated as ABCDEF.  $\gamma_{\text{ethyl}} = 7.74 \text{ kN/m}^3$  (Munson and Young, 1998)

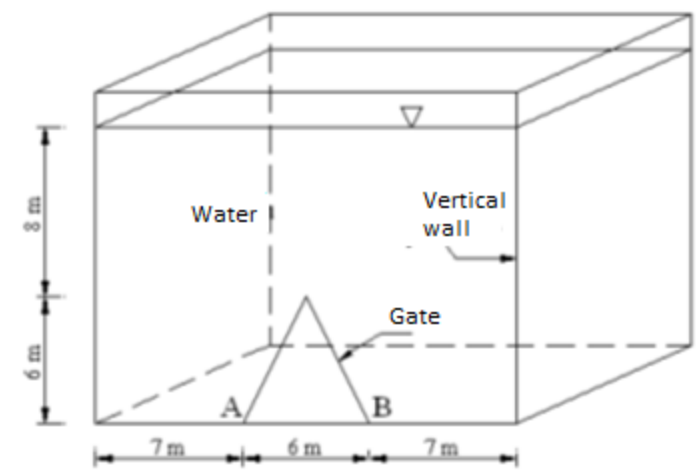


**Problem 10:** A circular plate having the shape of 0.9m diameter shown in Figure is located in the vertical side of an open tank containing fuel. If the force due to the fuel acting on the plate

is located at 0.08m below the centre of gravity (C) of the plate determine the water depth  $h_g$  (Munson and Young, 1998)



**Problem 11:** A gate having the triangular shape shown in Figure is located in the vertical side of an open tank. The gate is hinged about the horizontal axis AB. The force of the water on the gate creates a moment with respect to the axis AB. Determine the magnitude of this moment. (Munson and Young, 1998)

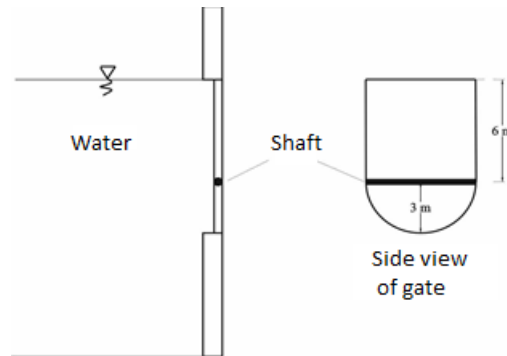


**Problem 12:** A gate having the shape shown in Figure is located in the vertical side of an open tank containing water. The gate is mounted on a horizontal shaft.

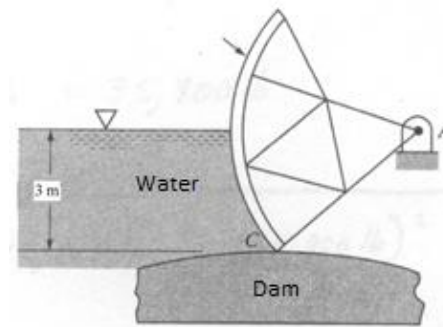
- When the water level is at the top of the gate, determine the magnitude of the fluid force on the rectangular portion of the gate above the shaft and the magnitude of the fluid force on the semicircular portion of the gate below the shaft.
- For this same fluid depth determine the moment of the force acting on the semicircular portion of the gate with respect to an axis which coincides with the shaft. (Munson and Young, 1998)

$$\left( h_p = \frac{I_G \times \sin^2 \theta}{h_G \times A} + h_G \right)$$

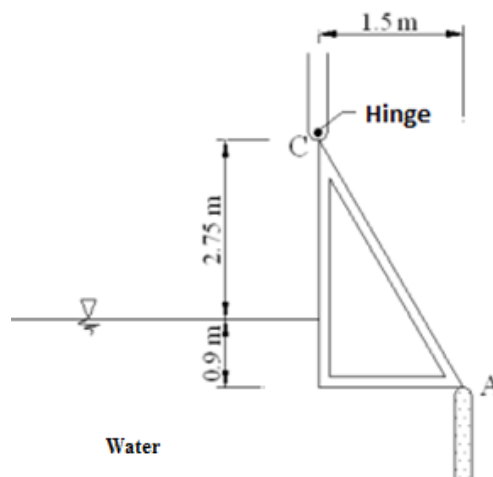
$$(I_{\text{semicircle}} = 0.1098 \times r^4 ; h_{G,\text{semicircle}} = 4r/3\pi)$$



**Problem 13:** A gate in the form of a partial cylindrical surface holds back water on top of a dam as shown in Figure. 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. Determine the magnitude of the resultant water force on the gate. Will the resultant pass through the pivot? Explain. (Munson and Young, 1998)

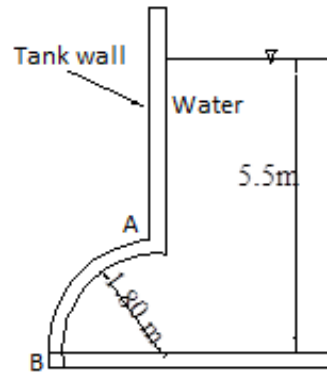


**Problem 14:** The 1.2 m wide gate hinged from C point is shown in the Figure. The weight of the gate is 80 kN, determine the reaction force at A point. (Munson and Young, 1998)

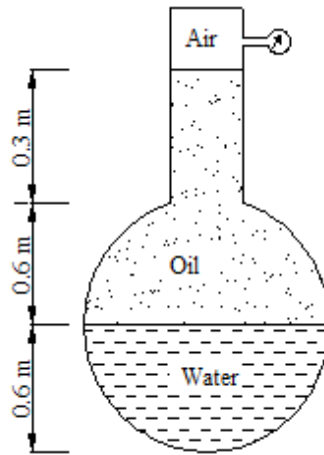




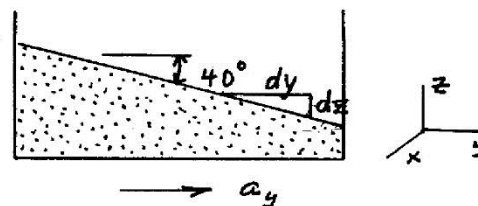
**Problem 15:** The 1.2 m perpendicular depth tank wall is shown in the Figure. Determine the magnitude of the horizontal and vertical components of the force of the water on AB surface. (Munson and Young, 1998)



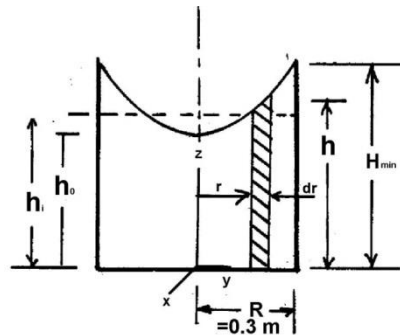
**Problem 16:** The cylindrical body cylindrical body shown in the figure contains oil, water and air. The manometer shows a  $25\text{ kN/m}^2$  pressure at the air. Find the hydrostatic pressure force acting on the surfaces on the cylinder.  $\gamma_{\text{oil}}=8\text{ kN/m}^3$ . (Yüksel, 2016).



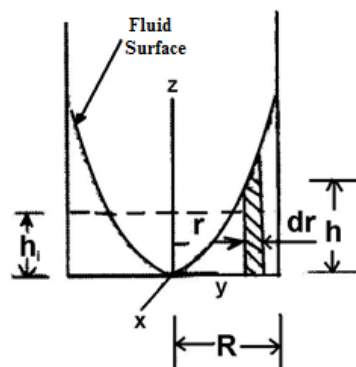
**Problem 17:** Determine the  $a$  acceleration, when the open tank is accelerated horizontally with  $40^\circ$  angle as shown in Figure. (Munson and Young, 1998).



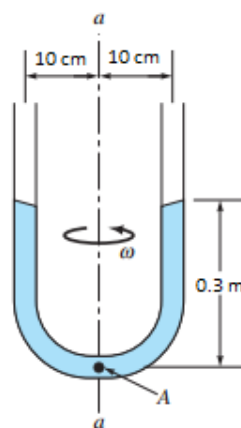
**Problem 18:** The 0.6 m diameter and 0.9 m water depth open tank is shown in Figure. When the tank rotates around the vertical axis with 160 rpm, determine the minimum water depth of side wall not to be spilled from the tank. (Munson and Young, 1998).



**Problem 19:** An open 1-m-diameter tank contains water at a depth of 0.7 m when at rest (Figure a). As the tank is rotated about its vertical axis the center of the fluid surface is depressed. At what angular velocity will the bottom of the tank first be exposed? No water is spilled from the tank. (Munson and Young, 1998).

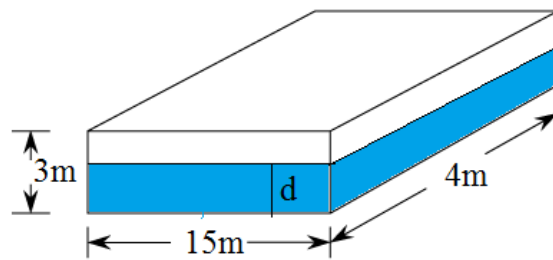


**Problem 20:** The U-tube of figure is partially filled with water and rotates around the axis a-a. (Figure b). Determine the angular velocity that will cause the water to start to vaporize at the bottom of the tube. (Point A) ( $P_{b, \text{water}} = -101.55 \text{ kN/m}^2$ ) (Munson and Young, 1998)



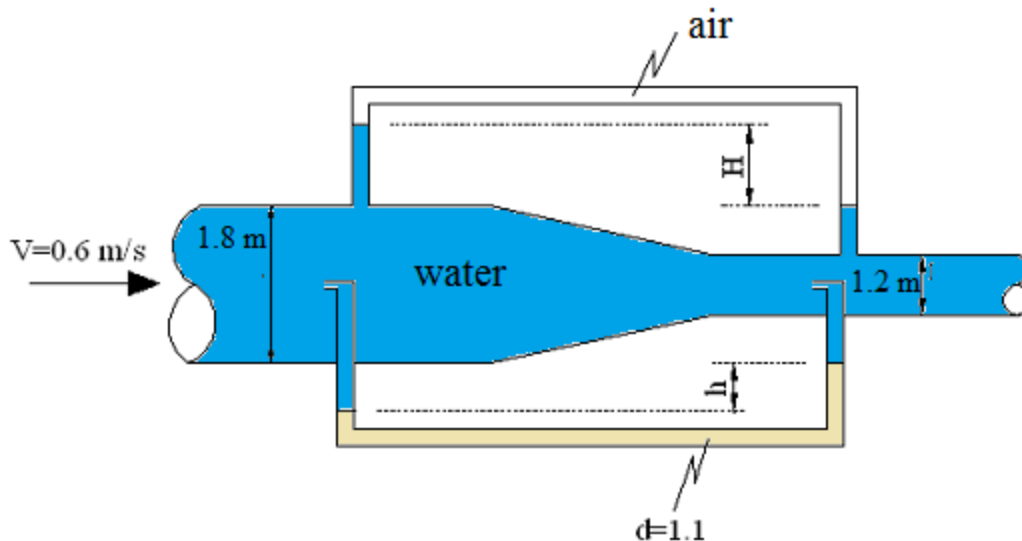
**Problem 21:** A barge (seen in Figure) measuring 15m by 4m and 3m deep, has  $900\text{kg/m}^3$  density. It carries a load of 150kN. The barge floats in sea water with a density of  $1.090\text{ kg/m}^3$ .

- Find the barge's sinking depth.
- Find its metacentric height and determine the stability of barge if it moves sideways with  $6^\circ$  angular tilt.
- Find the change in moment of the buoyancy force.

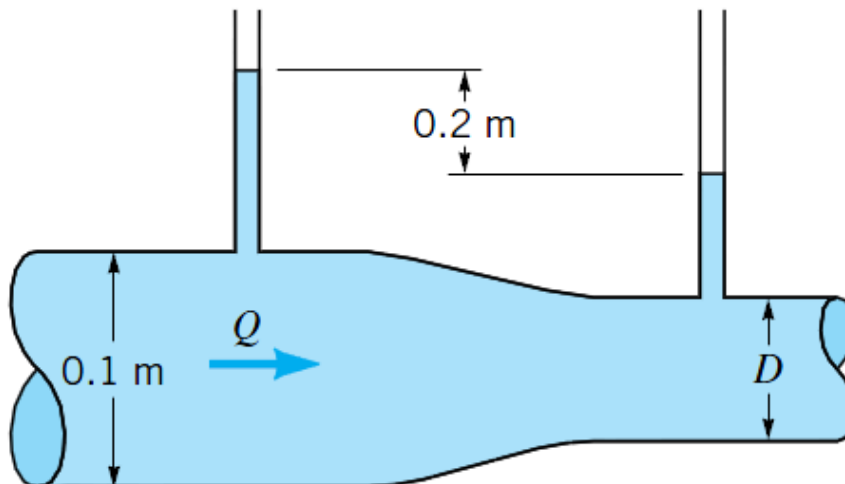


## FLUID DYNAMICS

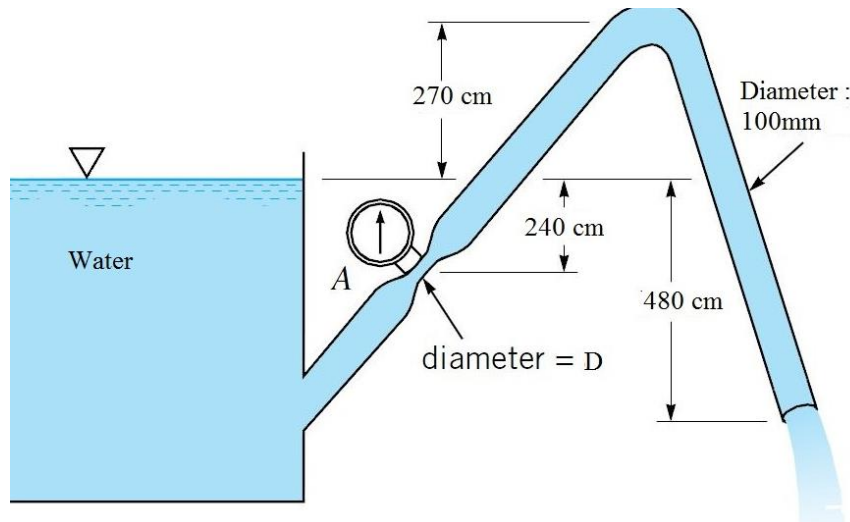
**Problem 1:** Water flows through a pipe reducer as is shown in Figure. Determine the manometer reading,  $H$  and  $h$  in meter. (Munson and Young, 1998)



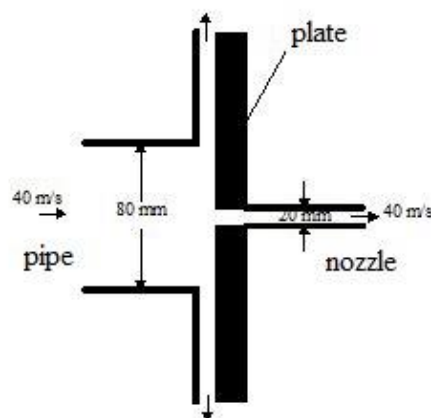
**Problem 2:** Water flows through the pipe contraction shown in Figure.. For the given 0.2-m difference in the manometer level, determine the flowrate as a function of the diameter of the small pipe,  $D$  (Munson and Young, 1998).



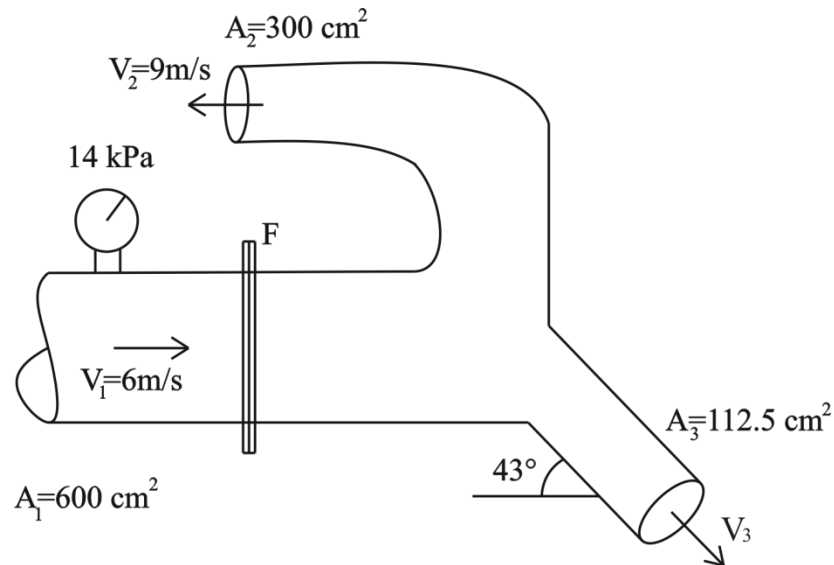
**Problem 3:** Water flows steadily from a large open tank and discharges into the atmosphere through a 100mm diameter pipe as shown in Figure. Determine the diameter,  $D$ , in the narrowed section of the pipe at A if the pressure gages at A and B indicate the same pressure. (Munson and Young, 1998)



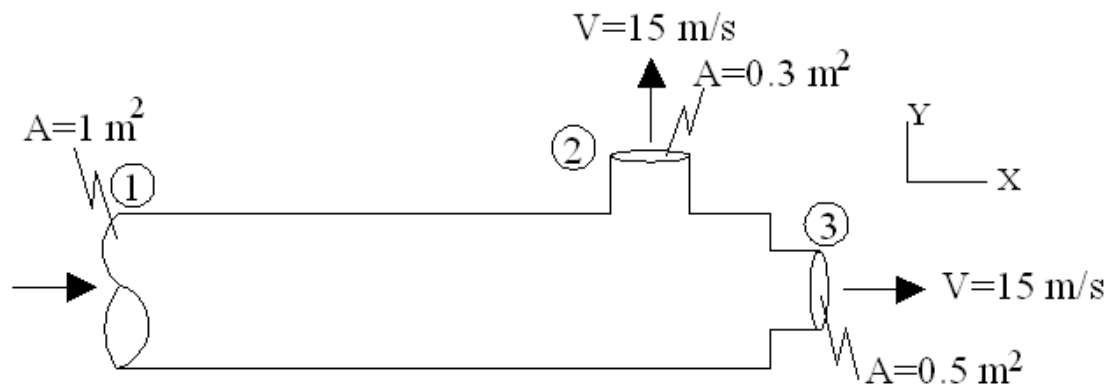
**Problem 4:** Air flows from a 80mm diameter pipe shown in Figure as a free jet and strikes a flat plate and flows out from a 20mm diameter nozzle with the same velocity. The flow geometry shown is symmetrical. Determine the force on the plate.  $\rho_{\text{air}} = 1.225 \text{ kg/m}^3$  (Munson and Young, 1998)



**Problem 5:** Water flows through the horizontal branching pipe (pipe 2 - 3) shown in Figure. If a viscous effect of water is negligible, determine force (F) at the plate in axis-x. ( $g=10\text{m/s}^2$ ) (Munson and Young, 1998)

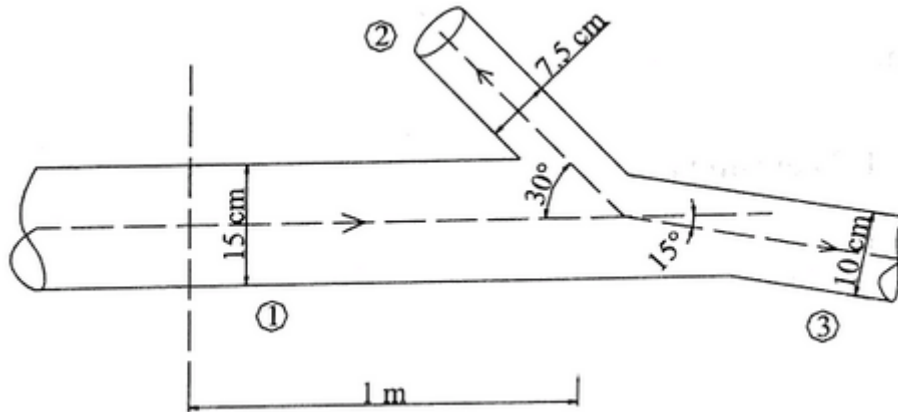


**Problem 6:** Water flows as two free jets from the tee attached to the pipe shown in Figure. The exit speed is 15 m/s. If viscous effects and gravity are negligible, determine the x and y components of the force that the pipe exerts on the tee. (Munson and Young, 1998)

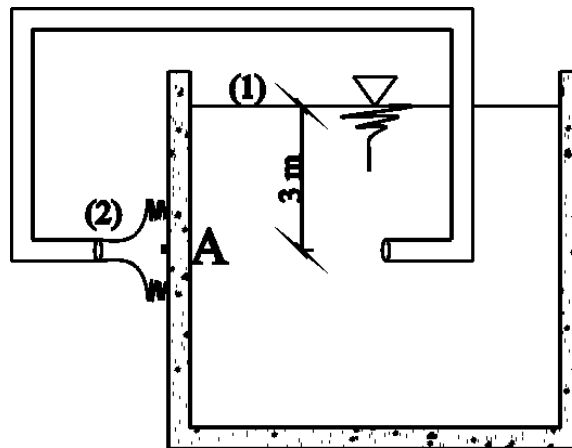


**Problem 7:** Water flows in a branched pipe system with given directions as seen in Figure. Water flows velocity is 12m/s in pipe (2) which is opened to the atm at the end of the pipe. Velocity is 9 m/s for pipe 3.

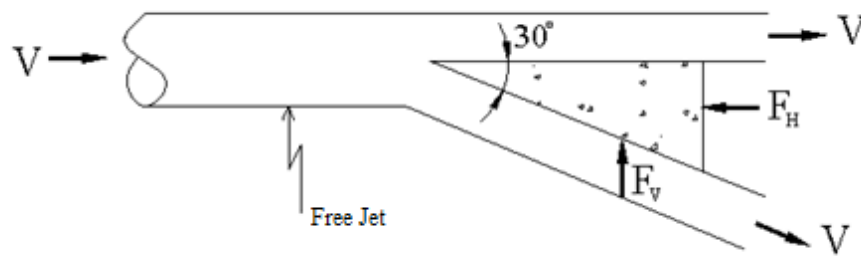
- Find the magnitude and direction of the flow force on the junction section.
- Calculate the normal and shear stress for on pipe (1). Find the bending moment at 1m behind the junction point for this pipe. (Yüksel, 2016).



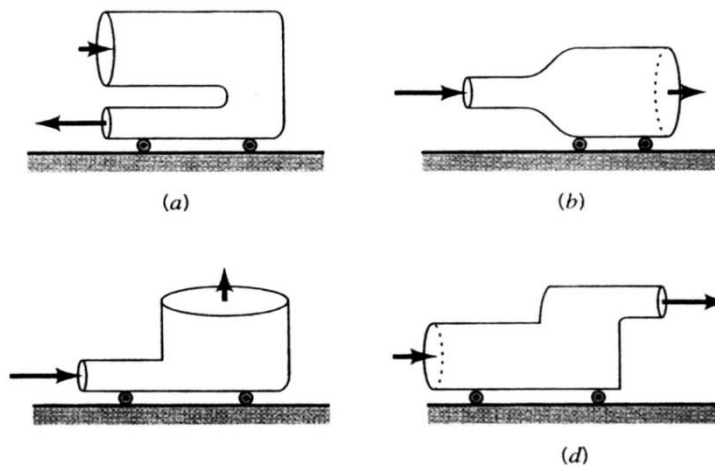
**Problem 8:** Water siphon in open tank is shown in Figure. Determine the flowrate involved and the pressure at the stagnation point (A). (Munson and Young, 1998).



**Problem 9:** A free jet of fluid strikes a wedge as shown in Fig. Of the total flow, a portion is deflected the remainder is not deflected. The horizontal and vertical components of force needed to hold the wedge stationary are and respectively. Gravity is negligible, and the fluid speed remains constant. Determine the force ratio,  $F_H/F_V$ ? (Munson and Young, 1998).

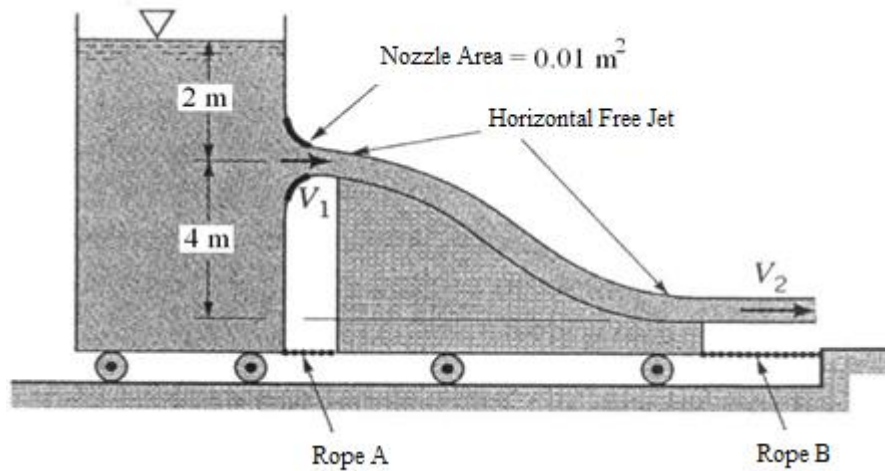


**Problem 10:** The four devices shown in Fig. rest on frictionless wheels, are restricted to move in the  $x$  direction only and are initially held stationary. The pressure at the inlets and outlets of each is atmospheric, and the flow is incompressible. The contents of each device is not known. When released, which devices will move to the right and which to the left? Explain (Munson and Young, 1998).

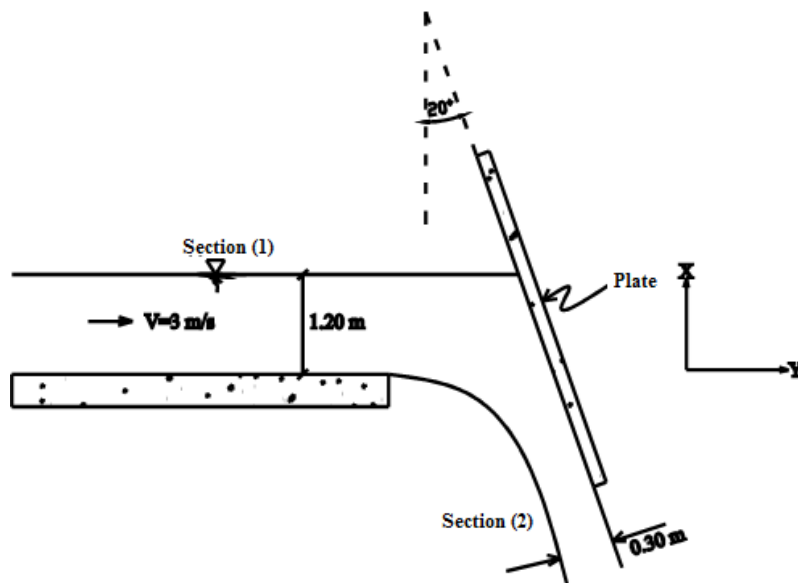


**Problem 11:** Water flows steadily from a tank mounted on a cart as shown in Fig. After the water jet leaves the nozzle of the tank, it falls and strikes a vane attached to another cart. The cart's wheels are frictionless, and fluid is inviscid. **(a)** Determine the speed of the water leaving the tank,  $V_1$ , and water speed leaving cart,  $V_2$ . **(b)** Determine the tension in rope A. **(c)** Determine the tension in rope B. (Munson and Young, 1998).

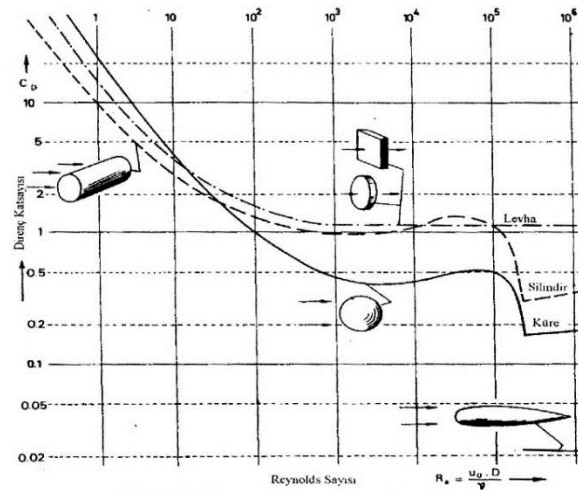




**Problem 12:** Water flows from a two-dimensional open channel and is diverted by an inclined plate as illustrated in Fig. When the velocity at section (1) is 3 m/s, what horizontal force (per unit width) is required to hold the plate in position? At section (1) the pressure distribution is hydrostatic, and the fluid acts as a free jet at section (2). Neglect the friction. (Munson and Young, 1998).

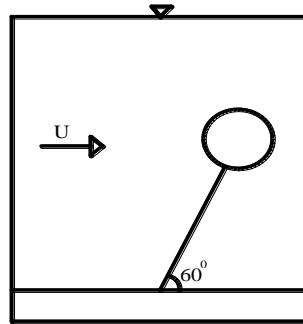


**Problem 13:** The 2 m length and 25 cm thickness plate is located in  $15^\circ\text{C}$  water along its length. Average water velocity is 5 m/s, determine the resistance force of plate. (Khan, 1987).



Şekil 4.45 Direnç katsayısı (Van Rijn, 1990)

**Problem 14:** Specific gravity of the 0.051 m diameter sphere is 2042 N/m<sup>3</sup>. The sphere is tied up with cable at the bottom of river. The resistant force coefficient is 0.5 and determine the river velocity. Neglect cable resistance and weight. (Munson and Young, 1998)



**Problem 15:** The 12 N weight kite has the 0.8 m<sup>2</sup> surface area. When the wind velocity is 8.6 m/s, the tension of kite rope is 35 N. The rope is 45° angle with horizontal. Specific gravity of air is 1.18 kg/m<sup>3</sup>. Calculate the resistance force coefficient and drag force coefficient. (Hamill, 1995).

## FLUID KINEMATICS

**Problem 1:** The velocity field of a flow is given by

$$\mathbf{V} = 3yz^2\hat{i} + xz\hat{j} + y\hat{k}$$

where  $x$ ,  $y$ , and  $z$  are in meter. Determine expressions for the local and convective components of acceleration. (Munson B.R., Young D.F., Okiishi T.H., 1998)

**Problem 2:** The three components of velocity in an incompressible flow field are given by

$$u = x^2y \quad v = 4y^3z \quad w = 2z$$

Prove that this is a case of a possible steady incompressible flow field or not. (Munson B.R., Young D.F., Okiishi T.H., 1998)

**Problem 3 :** For the incompressible fluid flow field the velocity components are given by (m/s)

$$u = t \times y \quad v = \frac{z(x-2)^2}{t+1} \quad w = x y$$

- Determine if this flow steady or unsteady?
- Determine if this flow uniform or ununiform?
- Determine if this flow one two or three dimensional?
- Determine if this flow irrotational or rotational?
- Find the local acceleration components at axis- $x$  and convective acceleration components at axis- $y$  at point  $A(x,y,z,t)=A(0,1,1,4)$   $B(x,y,z,t)=B(2,2,1,0)$  for the same flow field.

## POTENTIAL FLOW

**Problem 1:** Velocity components in two dimensional velocity fields are given below. Determine that these functions satisfies the requirements for the continuity and the potential flow (irrotational flow). (Pao, 1961).

a)  $u = Cx, v = -Cy$

b)  $u = -\frac{Cx}{y}, v = C \ln xy$

c)  $u = x + y, v = x - y$

d)  $u = Ax^2 - Bxy, v = -2Axy + \frac{1}{2}By^2$

**Problem 2:** Determine that streamline functions below are possible in irrotational flow field. (Pao, 1961).

a)  $\psi = Ax + By^2$

b)  $\psi = Ax^2y^2$

c)  $\psi = A \sin xy$

d)  $\psi = A \ln(x/y)$

**Problem 3:** Evaluate the u, v velocity potential components for velocity potential below and determine that satisfy or not the continuity equation. (Pao, 1961).

a)  $\phi = x + y$

b)  $\phi = x^2 + y^2$

c)  $\phi = \sin x + \sin y$

d)  $\phi = \ln(x + y)$

**Problem 4:** The velocity potentials in two dimensional flow are given below. Determine the streamline functions for these flows. (Pao, 1961).

a)  $\phi = x + y$

b)  $\phi = x^2 + y^2$

## DIMENSION ANALYSIS

**Problem 1:** Obtain an expression for pressure gradient in a circular pipeline, of effective roughness,  $k$ , conveying an incompressible fluid of density,  $\rho$ , dynamic viscosity,  $\mu$ , at a mean velocity,  $V$ , as a function of non-dimensional groups. (Yüksel, 2005).

**Problem 2:** The small orifice discharge  $Q$  depends on a orifice area,  $A$ , orifice head,  $H$ , and gravity. Determine the expression of discharge equation.(Hamill, 1995).

**Problem 3:** Determine the resistance force expression of the  $D$  diameter sphere is placed in the  $\mu$ , dynamic viscosity,  $\rho$  specific gravity,  $V$  average velocity fluid.(Hamill, 1995).