

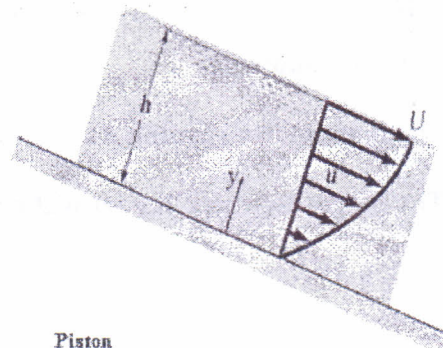


**Answer all the following questions.**

**Question (1)** [5 Marks]

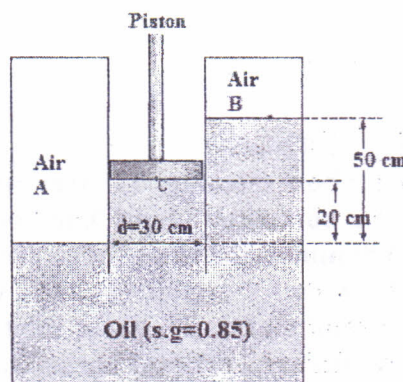
A layer of water flows down an inclined fixed surface with the velocity profile shown in Figure 1. Determine the magnitude of the shearing stress at wall and at  $y = 0.1\text{m}$ . Also, draw the shear stress distribution for this profile. Put  $\mu = 0.001 \text{ Pa}\cdot\text{s}$  and  $h = 0.1$ .

The velocity profile is given by:  $u = 40(y - 5y^2)$



**Question (2)** [4 Marks]

Two chambers with the same fluid at their base are separated by a piston, as shown in Fig. 2. Calculate the gage pressures in chamber B and mass of piston. If the gauge pressure in chamber A is 3500 Pa.

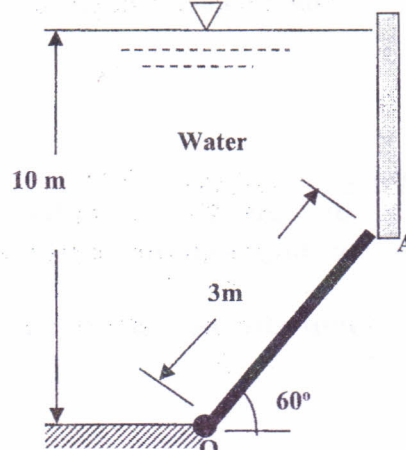


**Question (3)** [8 Marks]

Draw the pressure distribution on the gate OA

(see Fig. 3). Calculate the following:

- the hydrostatic force on the gate (2 m wide) and the location of their line of action.
- the horizontal reaction P exerted by the wall at point A.



**Question (4)** [5 Marks]

Consider a wooden cylinder (sg=0.7) 1 m in diameter and 0.8 m long. Would this cylinder be stable if placed to float with its axis vertical in water?

**Question (5)** [7 Marks]

- Drive the following formula to determine the time to lower the liquid level in a tank of a constant cross section by means of an orifice.

$$t = \frac{2A}{cd \alpha \sqrt{2g}} (\sqrt{H_1} - \sqrt{H_2})$$

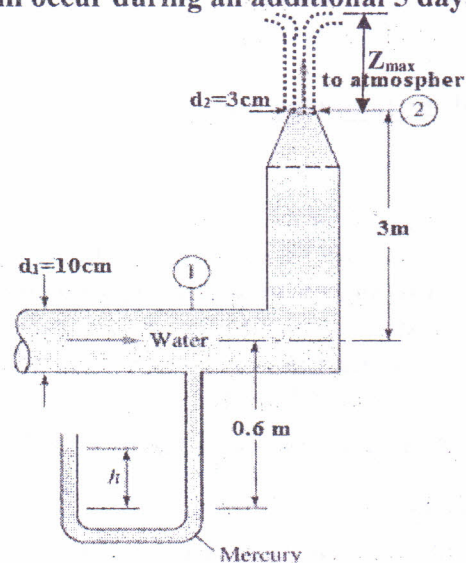
Where:  $A$  is the area of tank,  $a$  is the area of small orifice,  $cd$  is the discharge coefficient,  $H_1$  is the liquid level at time  $t=0$  and  $H_2$  is the liquid level at time  $t$ .

(b) Leakage in the bottom of a storage tank for oil is found to cause the surface level to decrease from 5 m to 4 m in 24 hours. What further drop in level will occur during an additional 5 days?

**Question (6)** [8 Marks]

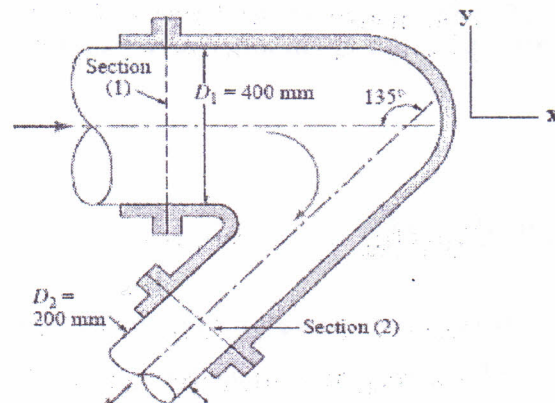
The pipe bend of Fig. 4 has  $d_1=10$  cm and  $d_2=3$  cm. If  $V_1 = 0.6$  m/s and losses are neglected, what is the following:

- The manometer reading  $h$ .
- The height to which the jet will rise  $Z_{max}$ .



**Question (7)** [8 Marks]

A converging elbow (see Fig. 5) turns water through an angle of  $135^\circ$  a horizontal plane. The flow cross sectional diameter is 400 mm at the elbow inlet, section (1), and 200 mm at the elbow outlet, section (2). The volume flow rate of water is  $0.4 \text{ m}^3/\text{s}$  and the elbow inlet pressure is 150 kPa. Calculate the net resultant horizontal force required to hold the elbow in place.



**Question (8)** [8 Marks]

Calculate the pump power for the water piping system shown in Figure 6.

Assume pump efficiency is 75%, and  $f=0.02$ .

