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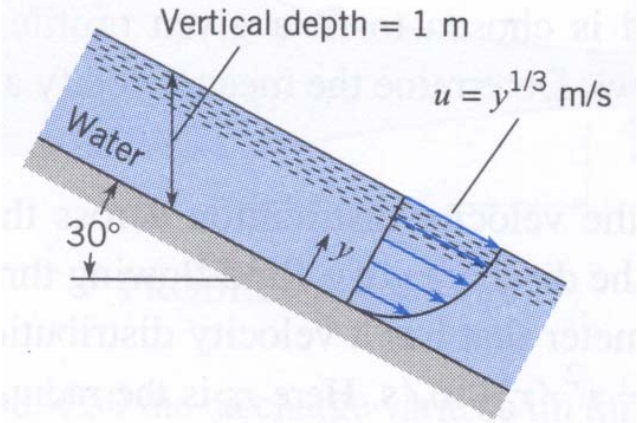
1. The rectangular channel shown is 2m wide.

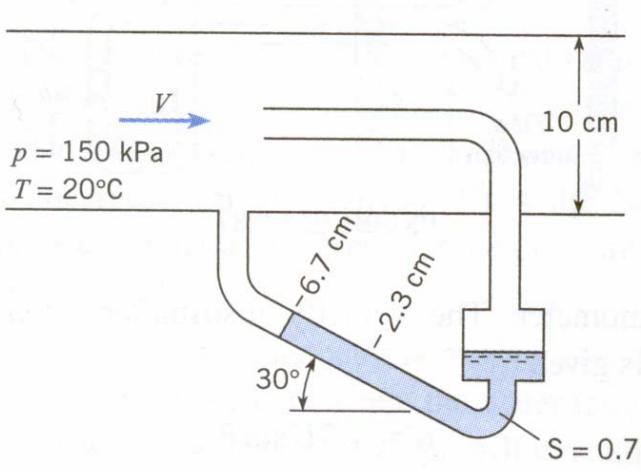
(Viscosity for water $\mu = 1.00 \times 10^{-3} N \cdot s/m^2$)

(a) What is the discharge in the channel?

(b) Calculate the shear stress at y=0.433m by assuming the flow is laminar?



2. The apparatus shown in the figure is used to measure the velocity of air at the center of a duct having a 10-cm diameter. A tube mounted at the center of the duct has a 2-mm diameter and is attached to one leg of a slant-tube manometer. A pressure tap in the wall of the duct is connected to the other end of the slant-tube manometer. The well of the slant-tube manometer is sufficiently large that the elevation of the fluid in it does not change significantly when fluid moves up the leg of the manometer. The air in the duct is at a temperature of 20°C, and the pressure is 150kPa. The manometer liquid has a specific gravity of 0.7, and the slope of the leg is 30°. When there is no flow in the duct, the liquid surface in the manometer lies at 2.3cm on the slanted scale. When there is flow in the duct, the liquid moves up to 6.7cm on the slanted scale. Find the velocity of the air in the duct. Assuming uniform velocity profile in the duct, calculate the rate of flow of the air. (Gas constant $R = 287\ J/kg \cdot K$)



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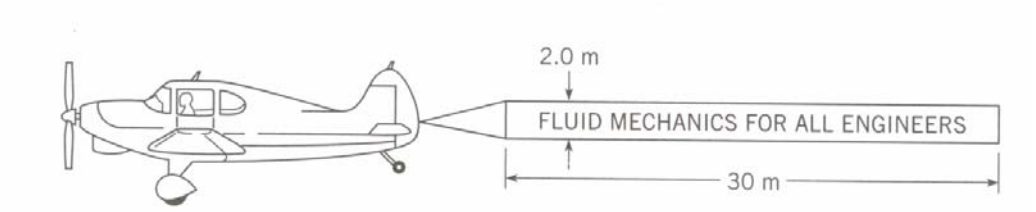
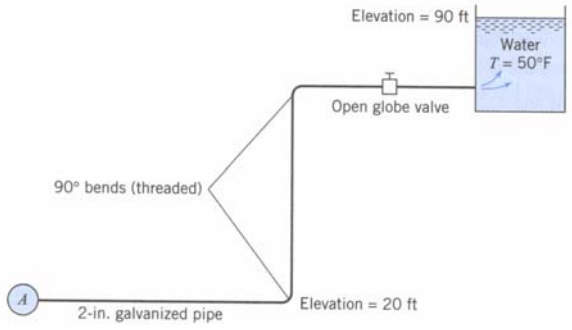
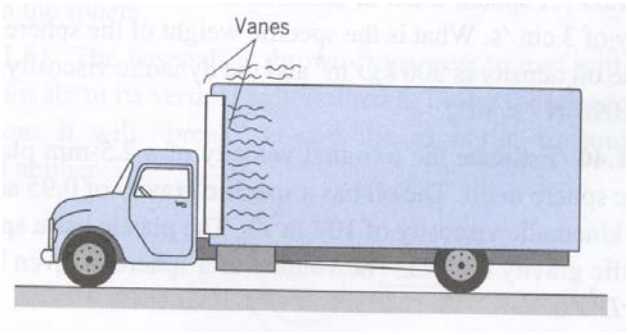
3. Estimate the power required to pull the sign shown if it is towed at 30m/s and if it is assumed the sign has the same resistance characteristics as a flat plate. Assume standard atmospheric pressure and a temperature of 10°C.



4. Points A and B are 1km apart along a 15-cm new steel pipe (wrought iron, steel). Point B is 20m higher than A. Crude oil (S=0.82, $\mu = 10^{-2} N \cdot s/m^2$) is flowing from A to B with a flow rate of 0.03m^3/s.
(a) Check the flow is laminar or turbulent.
(b) What pressure must be maintained at point A if the pressure at point B is to be 250kPa?

5. The steel pipe (galvanized iron) shown carries water from the main pipe A (velocity in the main pipe is zero) to the reservoir and is 2 in. in diameter and 240ft long. What must be the pressure in pipe A to provide a flow of 50gpm? (1gpm = 0.002228ft^3/s)





6. One way to reduce the drag of a blunt object is to install vanes to suppress the amount of separation. Such a procedure was used on model trucks in a wind-tunnel study by Kirsh and Bettes (18). For tests on a van-type truck, they noted that without vanes the C_D was 0.78. However, when vanes were installed around the top and side leading edges of the truck body (see the figure), a 25% reduction in C_D was achieved. For a truck with a projected area of 8.36m^2, what reduction in drag force will be effected by installation of the vanes when the truck travels at 100km/h? Assume standard atmospheric pressure and a temperature of 20°C.