HW#3 Sum07

#1.

Answer in 4 to 5 lines in the space provided for each question:

(a) A tank partially filled with water has a balloon well below the free surface and anchored to the bottom by a string. The tank is accelerated with an acceleration a_x to the right. Which direction the balloon would tilt to and why?

(b) Write important assumptions used in derivation of Bernoulli's equation.

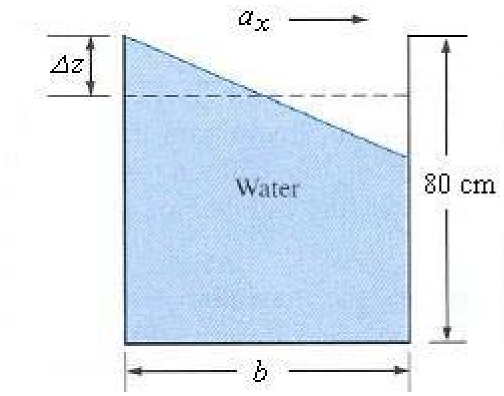
(c) Apart from an airplane wing, give an example based on Bernoulli's principle

(d) Can Bernoulli's relation be applied inside boundary layer? Explain briefly.

(e) Vortex flows are of two types: free vortex and forced vortex. Can we apply Bernoulli equation in vortex flows?

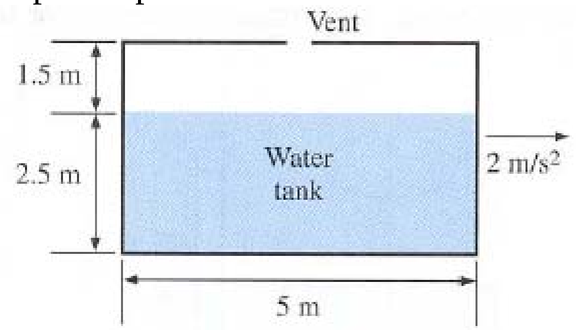
#2.

An 80 cm high fish tank of cross section 2 m × 0.6 m that is initially filled with water is to be transported on the back of a truck. The truck accelerates from 0 to 90 km/h in 10 s. It is desired that no water spill during acceleration. Determine the maximum initial water height in the tank for no spillage. Would you recommend the tank to be aligned with the long or short side parallel to the direction of motion?



#3.

A 5 m long, 4 m high tank contains 2.5 m deep water when not in motion and is open to the atmosphere through a vent in the middle. The tank is now accelerated to to the right on a level surface at 2 m/s^2. Determine the maximum pressure in the tank relative to the atmospheric pressure.



#4.

A 16-cm-diameter open cylinder 27 cm high is full of water. Compute the rigid body rotation rate about its central axis, in rot/min, *(a)* for which one-third of the water will spill out and *(b)* for which the bottom will be barely exposed.

#5.

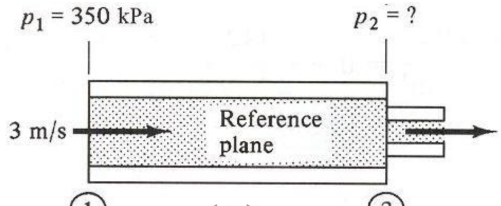
An open 1 m-diameter tank contains water at a depth of 0.7 m at rest. As the tank is rotated about its vertical axis, the center of the fluid surface is depressed. At what angular velocity will the bottom of the tank first be exposed? No water is spilled from the tank.

#6.

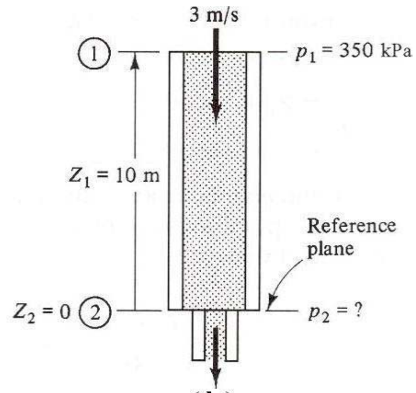
Water (γ = 9810 N/m^3) flows in a pipe. At a section where the inside diameter is 150 mm, the velocity is 3 m/s and the pressure is 350 kPa. At a section located 10 m from the first section, the inside diameter reduces to 75 mm. Calculate the pressure at the second section.

(a) If the pipe is horizontal

(b) If the pipe is vertical and the flow is downward



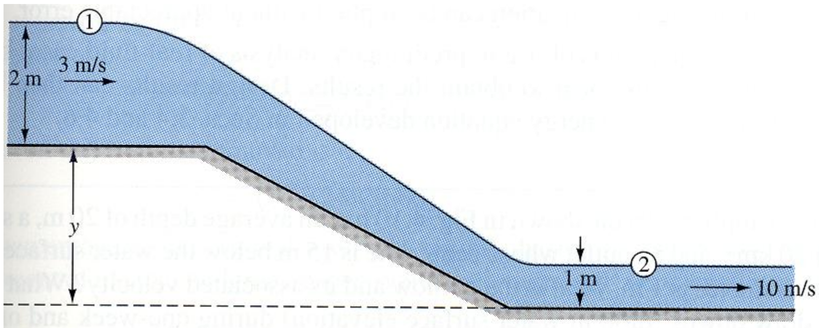
(a)



(b)

#7.

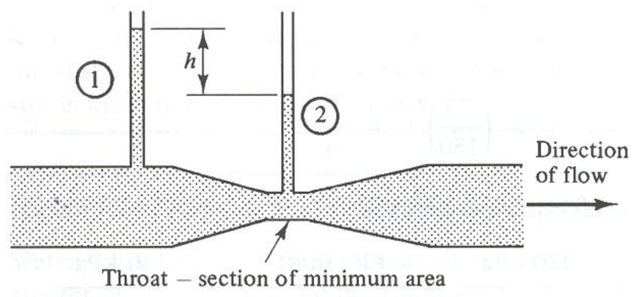
Water is flowing in an open channel at a depth of 2 m and a velocity of 3 m/s. It then flows down a contracting chute into another channel where the depth is 1 m and the velocity is 10 m/s. Assuming a frictionless flow, determine the difference in elevation of the channel floors, *y*.



#8.

The device in the figure is called *venturi meter*, which consists of a converging and diverging conical section of a pipe arranged to give an increase in velocity as the pipe converges, causing a measurable drop in pressure. The diverging section is used to reconvert the increased kinetic energy of the fluid stream into pressure energy at the outlet with minimum losses. Show for this meter with no losses that

$$Q = A_1 \sqrt{\frac{2gh}{\left[(A_1/A_2)^2 - 1\right]}}$$

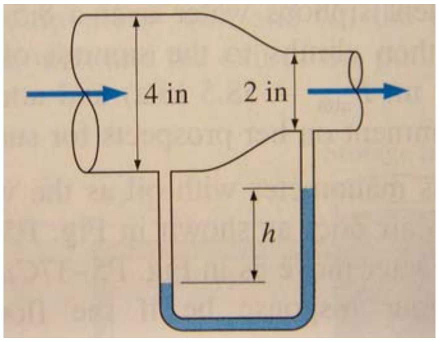


#9.

An airplane is flying at an altitude of 12000 *m*. Determine the gage pressure at the stagnation point on the nose of the plane if the speed of the plane is 200 *km/h*. what would be the gage pressure at a point on the surface of plane where relative speed of wind is 250 *km/h*.

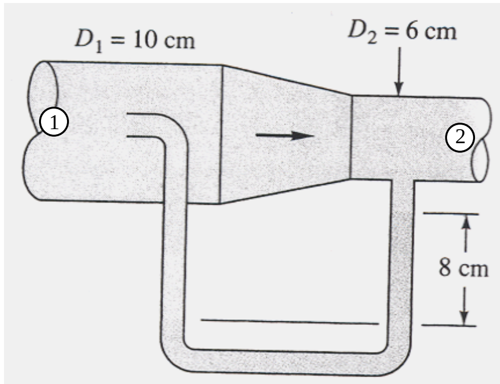
#10.

Water flows through a horizontal pipe at a rate of 1 *gal/s*. The pipe consists of two sections of diameters 4 *in* and 2 *in* with a smooth reducing section. The pressure difference between the two pipe sections is measured by a mercury manometer. Neglecting the frictional effects, determine the differential height of mercury between the two pipe sections



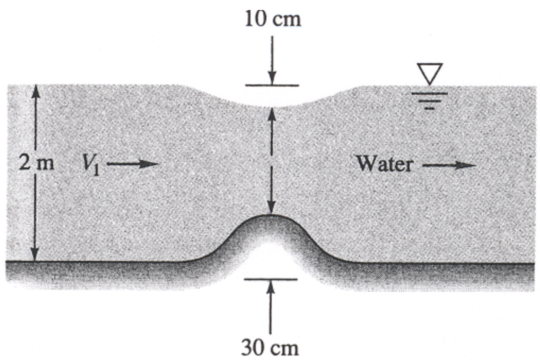
#11.

In Fig. given the flowing fluid is CO_2. Neglecting losses, if the total pressure at 1, $p_{01,}$ is 170 kPa and the manometer fluid is Meriam red oil (SG = 0.827), estimate *(a)* p_2 and *(b)* the gas flow rate in m^3/h.



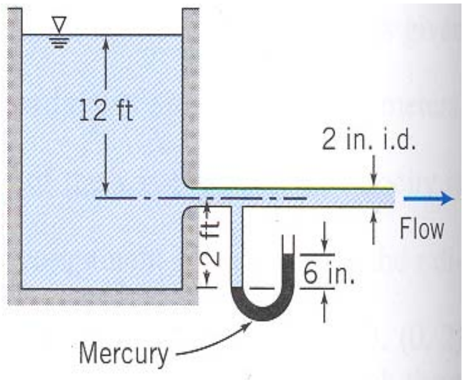
#12

If the approach velocity is not too high, a hump in the bottom of a water channel causes a dip Δh in the water level, which can serve as a flow measurement. If, as shown in the Fig., Δh = 10 cm when the bump is 30 cm high, what is the volume flow Q_1 per unit width, assuming no losses? In general, is Δh proportional to Q_1?

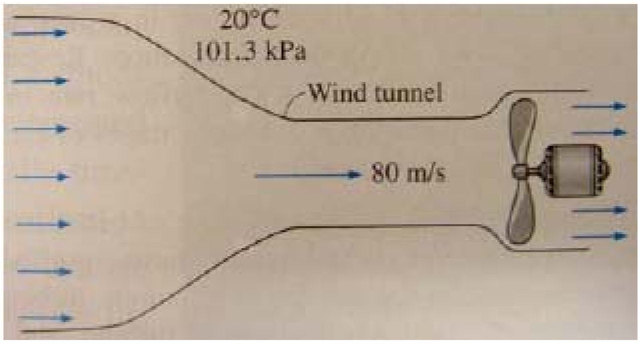


#13

Water flows from a very large tank through a 2 in. diameter tube. The dark liquid in the manometer is mercury. Estimate the velocity in the pipe and the rate of discharge form the tank



#14
A wind tunnel draws atmospheric air at 20°C and 101.3 *kPa* by a large fan located near the exit of the tunnel. In the air velocity in the tunnel is 80 *m/s*, determine the pressure in the tunnel.



#15

The incompressible flow form of Bernoulli's relation is accurate only for Mach numbers less than 0.3. At higher speeds, variable density must be accounted for. The most common assumption for compressible fluid is *isentropic flow of an ideal gas*. Show that the compressible isentropic Bernoulli relation can be written as:

$$C_p T + \frac{1}{2} V^2 + gz = const$$

#16

Consider an airfoil in a flow of air, where far ahead of the airfoil (the free stream), the pressure, velocity and density are 2116 lb/ft^2, 500 mi/h and 0.002377 slug/ft^3 respectively. At a given point *A* on the airfoil, the pressure is 1497 lb/ft^2. What is the velocity at point *A*? Assume isentropic flow and $c_p =$ 6006 ft-lb/(slug)(°R).