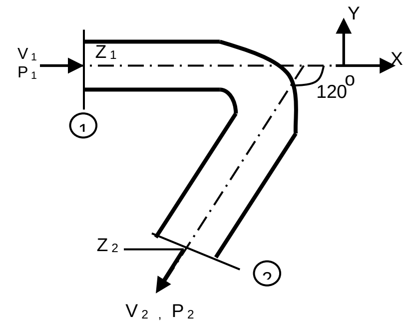
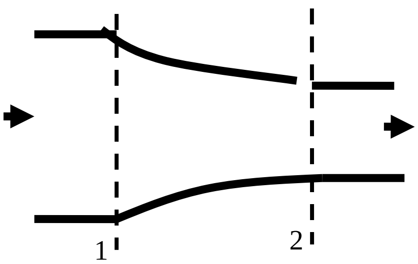
Tutorial Problems on Integral Momentum Balance and Bernoulli Equation

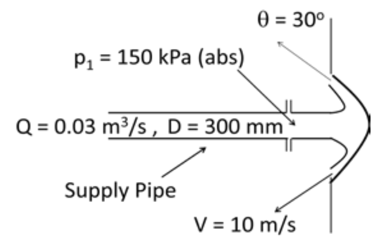
1. The diameter of a pipe bend is 30 cm at inlet and 15 cm at outlet and the flow is turned through 120^0 in a vertical plane. The axis at inlet is horizontal and the centre of the outlet section is 1.5 m below the centre of the inlet section. Total volume of water in the bend is 0.9 m^3. Neglecting friction, calculate the magnitude and direction of the force exerted in the bend by water flowing through it at 250 L/s and when the inlet pressure is 0.15 N/mm^2 (Note that the pressure at the inlet is absolute pressure and the outlet is not open to the atmosphere).



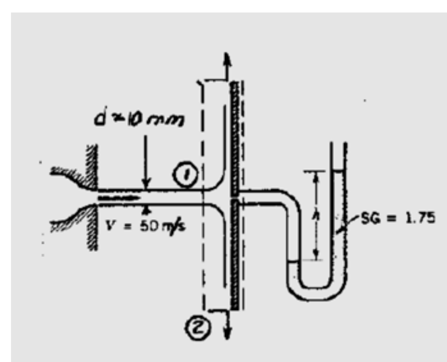
2. The figure represents flow of gasoline (of specific gravity equal to 0.72) through a reducer of weight 25 kg and total volume equal to 0.2 m^3. The velocity at the inlet od diameter equal to 0.4 m is 3 m/s and at the outlet is 12 m/s. The pressure at the inlet is 58.7 kPa (gage) and at the outlet is 109 kPa (absolute). Calculate the force needed to hold the reducer in place.



3. A conical spray head is shown in the figure. The fluid is water and the exit stream is uniform along the entire inner surface of the spray head. Evaluate (a) the thickness of the water film along the spray head, when the radius of the spray head is 400 mm, and (b) the axial force exerted by the spray head on the connecting supply pipe.

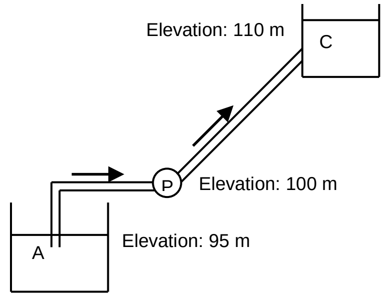


4. A horizontal, axi-symmetric jet of air ($\rho = 1.23$ Kg/m^3) with a diameter of 10 mm strikes the centre of a vertical disk of 200 mm diameter. The jet speed is 50 m/s at the nozzle exit. There is a small hole at the centre of the disk, where the air jet strikes and a manometer with a manometric liquid of specific gravity equal to 1.75. Calculate (i) the deflection, h, of the manometer and (ii) the force exerted by the jet on the disk.

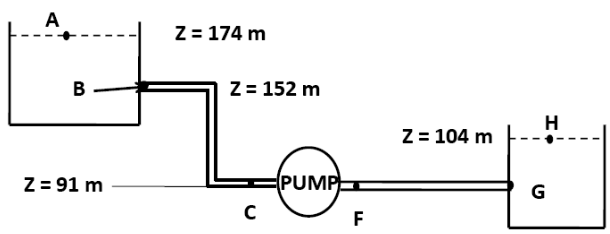


5. For the pumping set-up shown, estimate the power required and the pressure at the suction side of the pump to pump water from A to C at a rate of 0.02 m^3/s. Assume there are no bends in the pipeline. You can take the atmospheric pressure head to be equal to 10.0 m. The specifications of the pipes are as follows:

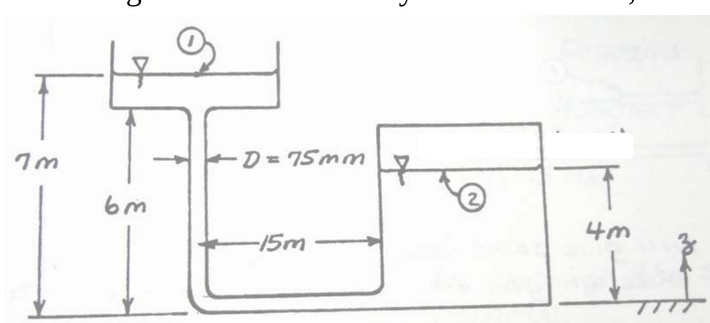
Pipe	Diameter	length	f
AP	15 cm	20m	0.02
PC	12 cm	300 m	0.02



6. Water (kinematic viscosity = 1.0 x 10^{-6} m^2/s) is pumped from a reservoir at the rate of 1310 L/s and is being sent to another large tank. The path of water through the pipe is marked as BCFG with the pump being located between C and F. From B to C, the system consists of a square-edged entrance, 760 m of pipe, three gate valves, four 45° elbows (Le/D = 20) and two 90° elbows. Gage pressure at C is 197 kPa. The system between F and G contains 760 m of pipe, two gate valves (Le/D = 8) and four 90° elbows (Le/D = 30). All the pipes are made of cast iron (ε = 0.26 mm) and of 508 mm diameter. Calculate the average velocity of water in the pipe, the gage pressure at F, the power input to the pump (of efficiency 80%) and the wall shear stress in section FG.



7. The adjoining figure shows two reservoirs containing water connected by a constant area, galvanized iron pipe (cannot be assumed as a smooth pipe) that has one right angle bend. The surface pressure at the upper reservoir (1 in figure) is atmospheric whereas the pressure (absolute) at the lower reservoir (s in figure) surface is 171.3 KPa. The pipe diameter is 75 mm. Assume that the only significant losses occur in the pipe and the bend. Determine the <u>direction</u> and <u>magnitude</u> of the volume flow rate of water (ρ = 999 kg/m^3, kinematic viscosity = 1.1 x 10^{-6} m^2/s). Take L_e/D for the bend to be equal to 12.



8. In the given figure, pipe AB is 600 m long, of 180 mm diameter, with f = 0.035; pipe BC (upper) is 500 m long, of 120 mm diameter, with f = 0.025; pipe BC (lower) is 400 m long, of 160 mm diameter, with f = 0.030. The elevations are: reservoir water surface = 150 m, A = 100m, B = 60m, C = 50 m, D = 20 m. Neglecting velocity heads and minor losses (a) compute the flow in each pipe and (b) determine the pressures at B and C. Comment on the practicality of this system.