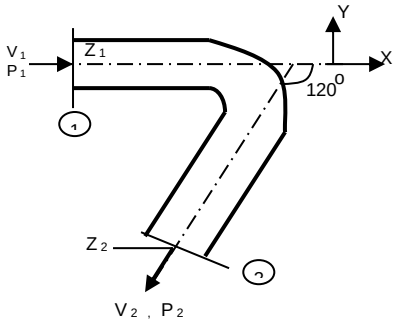
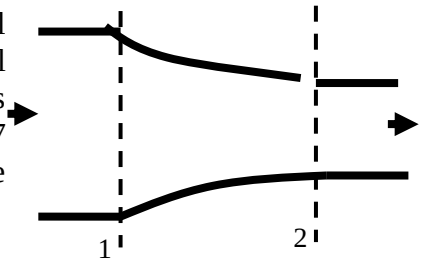
Tutorial Problems on Integral Momentum Balance

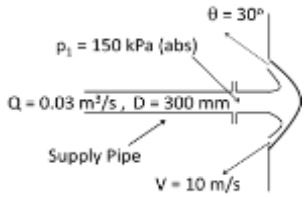
1. The diameter of a pipe bend is 30 cm at inlet and 15 cm at outlet and the flow is turned through 120^0 in a vertical plane. The axis at inlet is horizontal and the centre of the outlet section is 1.5 m below the centre of the inlet section. Total volume of water in the bend is 0.9 m^3. Neglecting 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).



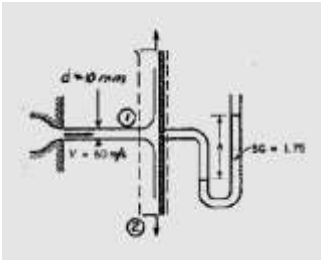
2. The figure represents flow of gasoline (of specific gravity equal to 0.72) through a reducer of weight 25 kg and total volume equal to 0.2 m^3. The velocity at the inlet od diameter equal to 0.4 m is 3 m/s and at the outlet is 12 m/s. The pressure at the inlet is 58.7 kPa (gage) and at the outlet 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 (ρ = 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. Water at 45 ^oC enters a shower head through a circular tube with 15.8 mm inside diameter. The water leaves in 24 streams, each of 1.05 mm diameters. The volume flow rate is 5.67 L/min. Estimate

(i) The minimum water pressure needed at the inlet to the shower head.

(ii) Force needed to hold the shower head onto the end of the circular tube. You may use the value of the contraction coefficient, K, to be equal to 0.5, ρ = 990 kg/m^3. The frictional losses are generally small for such short lengths associated with the shower head.