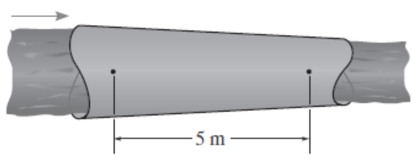
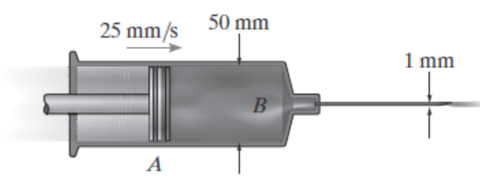
Assignment Sheet in Fluid Mechanics*
Applications of Bernoulli Equation

1. Water flows through a 5 m long horizontal pipe. Determine the average decrease in pressure along a horizontal streamline so that the water has an acceleration of 0.3 m/s^2. [1.5 kPa]

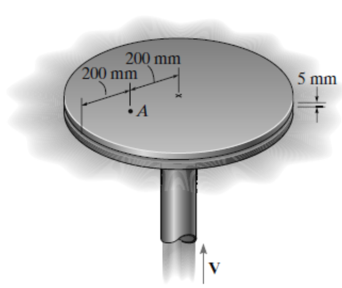


2. A plunger (A) moves inside a syringe (B) with a velocity of 25 mm/s. If the fluid inside the syringe has a density of $\rho_s = 1060\ \text{kg/m}^3$, determine the pressure developed inside the syringe at B.

[2070 kPa]



3. A fountain is produced by water that flows up the tube at $Q = 0.08\ \text{m}^3/\text{s}$ and then radially through two cylindrical plates before exiting to the atmosphere. Determine the velocity and pressure of the water at point A. [−60.788 kPa (gauge)]



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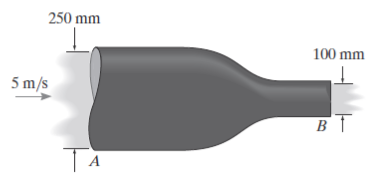
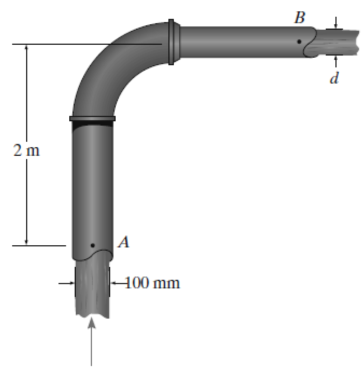
4. Air enters into a nozzle at A at a temperature of 30° C at 5 m/s and then exits to the atmosphere at B, where the temperature is 0° C. Determine the pressure at A. [91.711 kPa (abs)]

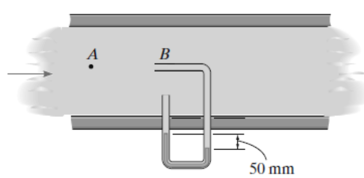


5. Water flows up through the vertical pipe such that when it is at A, it is subjected to a pressure of 150 kPa and has a velocity of 3 m/s. Determine the pressure and its velocity at B. Take $d = 75$ mm.

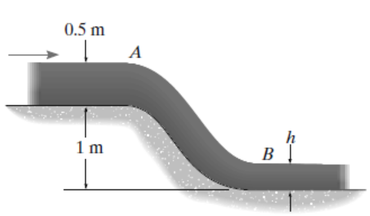
[120.675 kPa; 5.33 m/s]



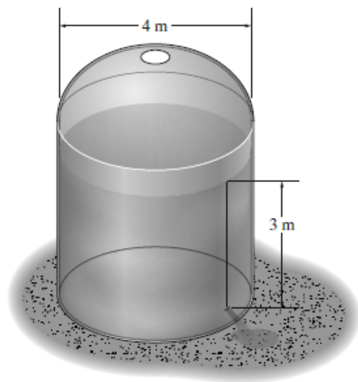
6. Carbon dioxide at 20° C flows past the Pitot tube B such that the mercury within the manometer is displaced 50 mm as shown. Determine the mass flow if the duct has a cross-sectional area of 0.18 m^2. Take $\rho_{CO_2}(20°C) = 1.84$ kg/m^3 and $\rho_{Hg} = 13550$ kg/m^3. [28.15 kg/s]



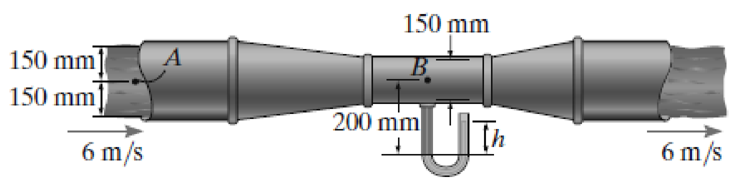
7. Water flows at 3 m/s at A along the rectangular channel that has a width of 1.5 m. If the depth at A is 0.5 m, determine the depth at B. [0.260 m]



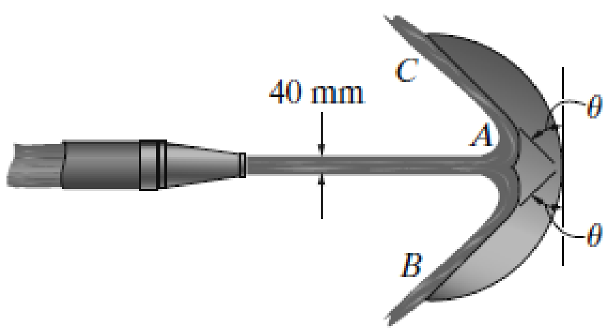
8. The open cylindrical tank is filled with linseed oil. A crack having a length of 50 mm and average height of 2 mm occurs near the base of the tank. How many litres of oil will slowly drain from the tank in 8 hours? Take $\rho = 940$ kg/m^3. [18.9×10^3 litres]



9. Water flows through the pipe at A with a speed of 6 m/s and at a pressure of 280 kPa. Determine the velocity of the water at B and the difference in elevation h of the mercury in the manometer. [$V_B = 24.0$ m/s; $h = 90$ mm]

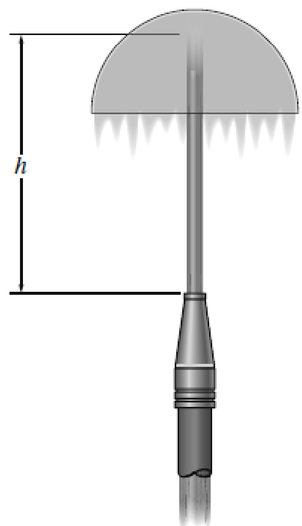


10. The nozzle has a diameter of 40 mm. If it discharges water with a speed of of 20 m/s against a fixed blade, determine the horizontal force exerted by the water on the blade. The blade divides the water evenly at an angle of $\theta = 45°$. [858 N]

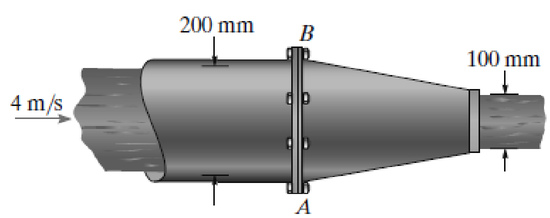


11. The hemispherical bowl of mass m is held in equilibrium by the vertical jet of water discharged through a nozzle of diameter d. If the volumetric flow is Q, determine the height h at which the bowl is suspended. The water density is ρ.

$$\left[h = \frac{8Q^2}{\pi^2 d^4 g} - \frac{m^2 g}{8\rho^2 Q^2}\right]$$



12. Water flows through the 200 mm diameter pipe at 4 m/s. It it exits into the atmosphere through the nozzle, determine the resultant force the bolts must develop at the connection AB to hold the nozzle onto the pipe. [2.26 kN]



13. The velocity field over a stationary circular cylinder, of radius a, is given by

$$\mathbf{V} = U\left[1 - \left(\frac{a}{r}\right)^2\right]\cos\theta\,\hat{\mathbf{e}}_r - U\left[1 + \left(\frac{a}{r}\right)^2\right]\sin\theta\,\hat{\mathbf{e}}_\theta.$$

Check that the conditions for applying the Bernoulli equation (not along a streamline) are valid (assume the density, ρ is constant). If the freestream pressure is p_∞, obtain an expression for the pressure distribution along the streamline forming the cylinder surface, $r = a$. If density is not assumed to be constant, is $\nabla \cdot \mathbf{V}$ still equal to zero? $\left[p = p_\infty + \frac{1}{2}\rho U^2\left(1 - 4\sin^2\theta\right)\right]$