Fluid Mechanics Homework #8

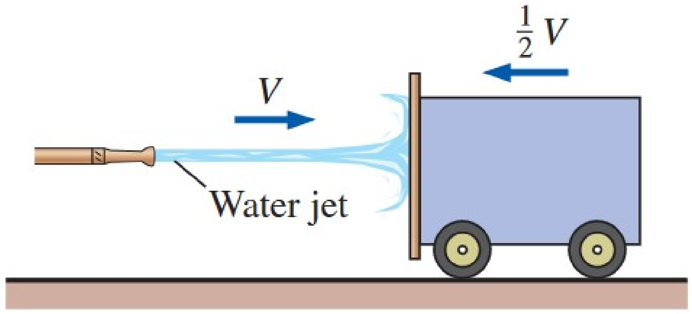
繳交期限：2019/11/20(三) 09:10

共五題，題號為：**6-20,45,52,75,88**

題號的對照書本是 **Yunus A. Cengel and John M. Cimbala "Fluid Mechanics: Fundamentals and Applications 3/e (SI Units) "**

$6-20$
答案以F表示，F為讓平板維持不動所需的力

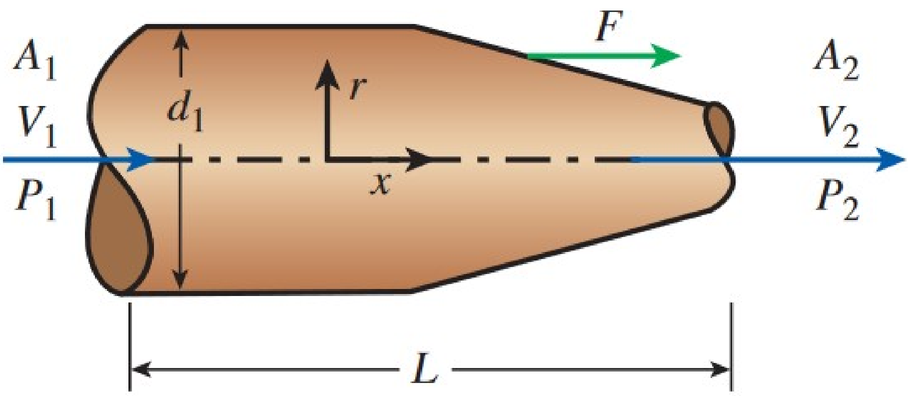
A horizontal water jet of constant velocity V impinges normally on a vertical flat plate and splashes off the sides in the vertical plane. The plate is moving toward the oncoming water jet with velocity $\frac{1}{2}V$. If a force F is required to maintain the plate stationary, how much force is required to move the plate toward the water jet?



- The flow is steady and incompressible.
- The plate is vertical and the jet is normal to plate.
- The pressure on both sides of the plate is atmospheric pressure (and thus its effect cancels out).
- Fiction during motion is negligible.
- There is no acceleration of the plate.
- The water splashes off the sides of the plate in a plane normal to the jet.
- Jet flow is nearly uniform and thus the effect of the momentum-flux correction factor is negligible, β≅ 1

$6-45$

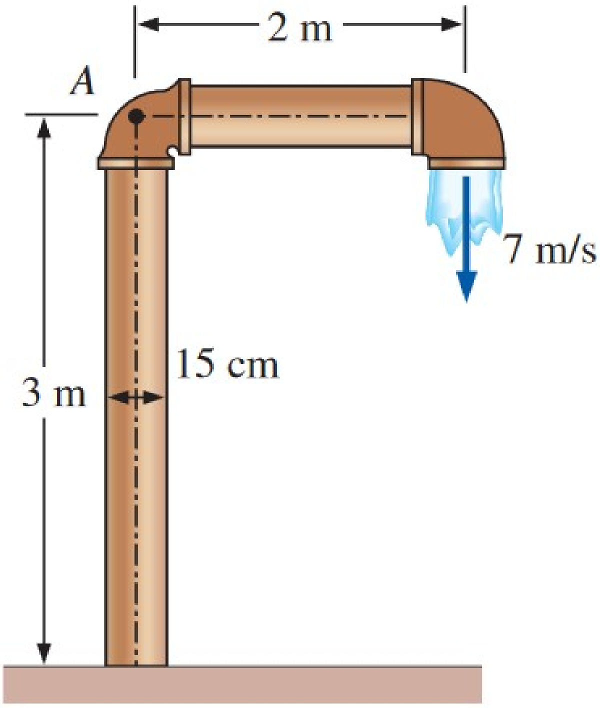
Water of density $\rho = 998.2\ \text{kg/m}^3$ flows through a fireman's nozzle—a converging section of pipe that accelerates the flow. The inlet diameter is $d_1 = 0.100$ m, and the outlet diameter is $d_2 = 0.050$ m. The average velocity, momentum flux correction factor, and gage pressure are known at the inlet (1) and outlet (2), as in Fig. P6–48. (*a*) Write an expression for the horizontal force F_x of the fluid on the walls of the nozzle in terms of the given variables. (*b*) Verify your expression by plugging in the following values: $\beta_1 = 1.03$, $\beta_2 = 1.02$, $V_1 = 4$ m/s, $P_{1,\text{gage}} = 123{,}000$ Pa, and $P_{2,\text{gage}} = 0$ Pa.



- The flow is steady and incompressible.
- The momentum-flux correction factor for each inlet and outlet is given to account for frictional effects and the non-uniformity of the inlet and outlet velocity profiles.

$6-52$

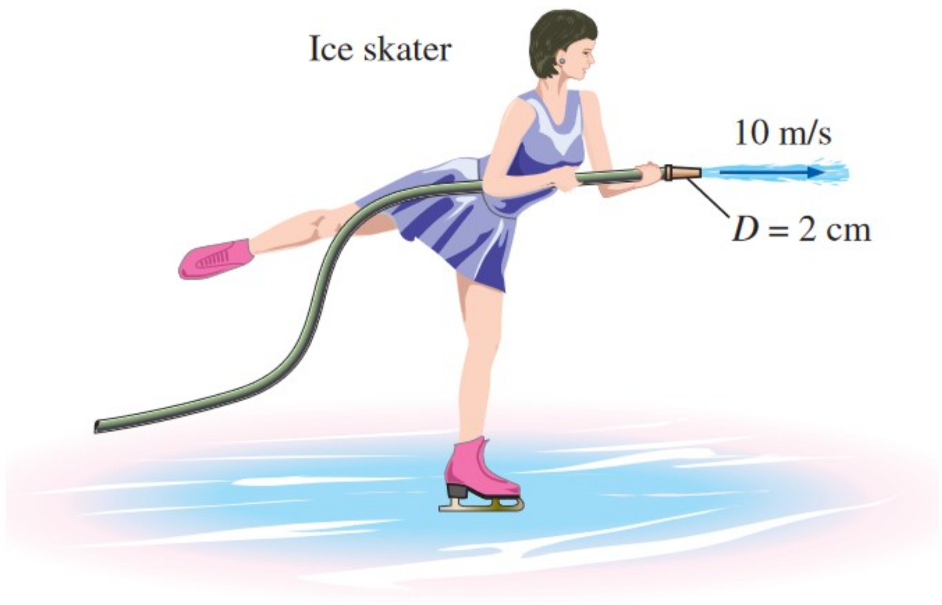
Water is flowing through a 15-cm-diameter pipe that consists of a 3-m-long vertical and 2-m-long horizontal section with a 90° elbow at the exit to force the water to be discharged downward, as shown in Fig. P6–55, in the vertical direction. Water discharges to atmospheric air at a velocity of 7 m/s, and the mass of the pipe section when filled with water is 15 kg per meter length. Determine the moment acting at the intersection of the vertical and horizontal sections of the pipe (point A). What would your answer be if the flow were discharged upward instead of downward?



- The flow is steady and incompressible.
- The water is discharged to the atmosphere, and thus the gage pressure at the outlet is zero.
- Effects of water falling down during upward discharge is disregarded.
- Pipe outlet diameter is small compared to the moment arm, and thus we use average values of radius and velocity at the outlet.

$6-75$

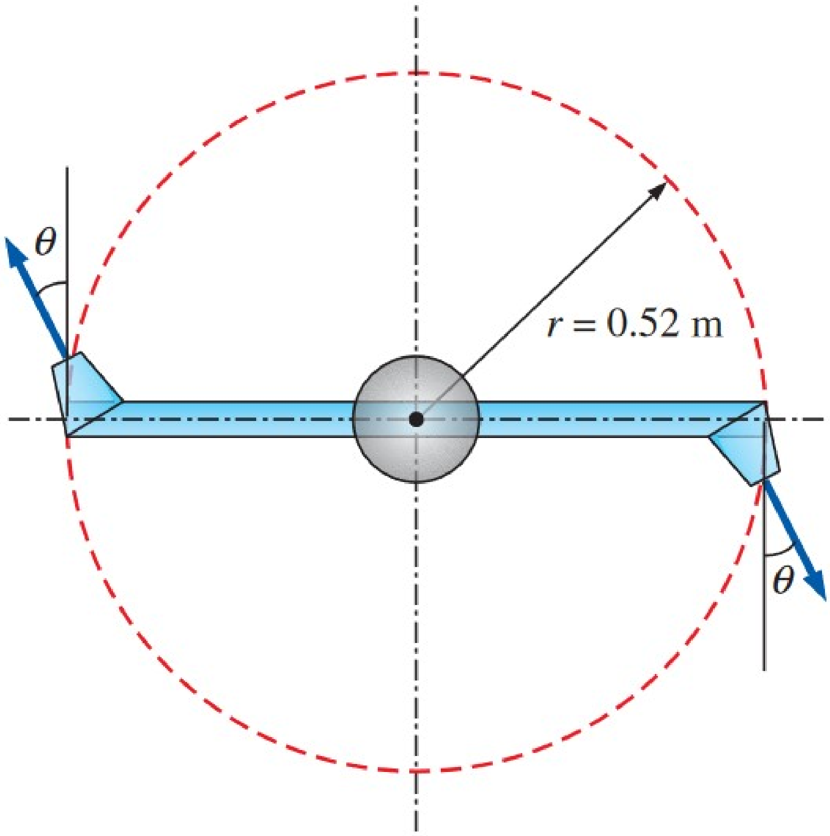
A 60-kg ice skater is standing on ice with ice skates (negligible friction). She is holding a flexible hose (essentially weightless) that directs a 2-cm-diameter stream of water horizontally parallel to her skates. The water velocity at the hose outlet is 10 m/s relative to the skater. If she is initially standing still, determine (*a*) the velocity of the skater and the distance she travels in 5 s and (*b*) how long it will take to move 5 m and the velocity at that moment.



- Friction between the skates and ice is negligible.
- The flow of water is steady and one-dimensional (but the motion of skater is unsteady).
- The ice skating arena is level, and the water jet is discharged horizontally.
- The mass of the hose and the water in it is negligible.
- The skater is standing still initially at t = 0.
- Jet flow is nearly uniform and thus the momentum-flux correction factor can be taken to be unity, β≅ 1.

6 – 88

Water enters a two-armed lawn sprinkler along the vertical axis at a rate of 75 L/s, and leaves the sprinkler nozzles as 2-cm diameter jets at an angle of θ from the tangential direction, as shown in Fig. P6–92. The length of each sprinkler arm is 0.52 m. Disregarding any frictional effects, determine the rate of rotation $\dot{n}$ of the sprinkler in rev/min for (*a*) $\theta = 0°$, (*b*) $\theta = 30°$, and (*c*) $\theta = 60°$.



- The flow is uniform and cyclically steady (i.e., steady from a frame of reference rotating with the sprinkler head).
- The water is discharged to the atmosphere, and thus the gage pressure at the nozzle outlet is zero.
- Frictional effects and air drag of rotating components are neglected.
- The nozzle diameter is small compared to the moment arm, and thus we use average values of radius and velocity at the outlet.