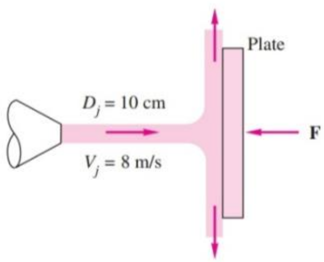
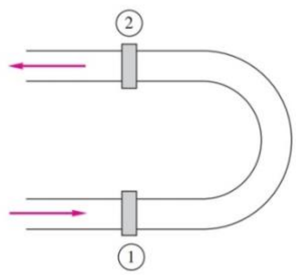
TALLER DE CONSERVACIÓN DE MOMENTUM

P3.40 The water jet in Fig. P3.40 strikes normal to a fixed plate. Neglect gravity and friction, and compute the force F in newtons required to hold the plate fixed.



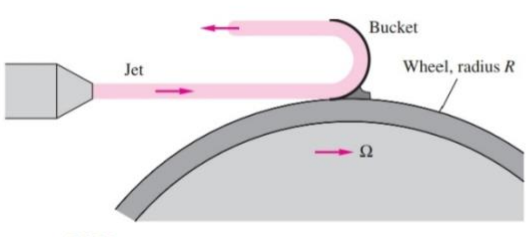
P3.40

P3.43 Water at 20°C flows through a 5-cm-diameter pipe that has a 180° vertical bend, as in Fig. P3.43. The total length of pipe between flanges 1 and 2 is 75 cm. When the weight flow rate is 230 N/s, p_1 = 165 kPa and p_2 = 134 kPa. Neglecting pipe weight, determine the total force that the flanges must withstand for this flow.



P3.43

P3.51 A liquid jet of velocity V_j and area A_j strikes a single 180° bucket on a turbine wheel rotating at angular velocity Ω, as in Fig. P3.51. Derive an expression for the power P delivered to this wheel at this instant as a function of the system parameters. At what angular velocity is the maximum power delivered? How would your analysis differ if there were many, many buckets on the wheel, so that the jet was continually striking at least one bucket?

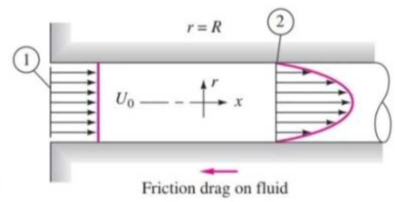


P3.51

P3.53 Consider incompressible flow in the entrance of a circular tube, as in Fig. P3.53. The inlet flow is uniform, $u_1 = U_0$. The flow at section 2 is developed pipe flow. Find the wall drag force F as a function of (p_1, p_2, ρ, U_0, R) if the flow at section 2 is

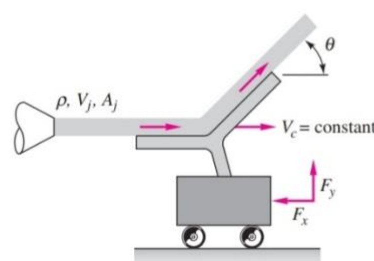
(*a*) Laminar: $u_2 = u_{max}\left(1 - \frac{r^2}{R^2}\right)$

(*b*) Turbulent: $u_2 \approx u_{max}\left(1 - \frac{r}{R}\right)^{1/7}$



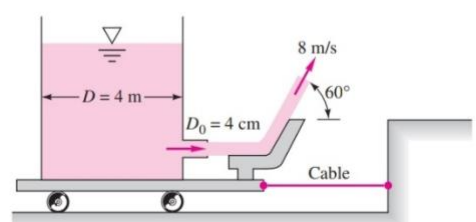
P3.53

P3.55 In Fig. P3.55 the jet strikes a vane that moves to the right at constant velocity V_c on a frictionless cart. Compute (*a*) the force F_x required to restrain the cart and (*b*) the power P delivered to the cart. Also find the cart velocity for which (*c*) the force F_x is a maximum and (*d*) the power P is a maximum.



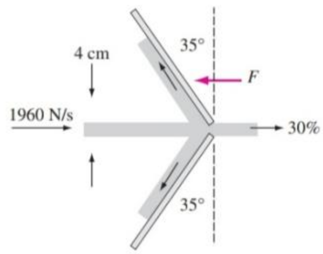
P3.55

P3.58 The water tank in Fig. P3.58 stands on a frictionless cart and feeds a jet of diameter 4 cm and velocity 8 m/s, which is deflected 60° by a vane. Compute the tension in the supporting cable.



P3.58

P3.63 A steady two-dimensional water jet, 4 cm thick with a weight flow rate of 1960 N/s, strikes an angled barrier as in Fig. P3.30. Pressure and water velocity are constant everywhere. Thirty percent of the jet passes through the slot. The rest splits symmetrically along the barrier. Calculate the horizontal force F needed to hold the barrier per unit thickness into the paper.



P3.63

6–25 A reducing elbow in a horizontal pipe is used to deflect water flow by an angle $\theta = 45°$ from the flow direction while accelerating it. The elbow discharges water into the atmosphere. The cross-sectional area of the elbow is 150 cm^2 at the inlet and 25 cm^2 at the exit. The elevation difference between the centers of the exit and the inlet is 40 cm. The mass of the elbow and the water in it is 50 kg. Determine the anchoring force needed to hold the elbow in place. Take the momentum-flux correction factor to be 1.03 at both the inlet and outlet.

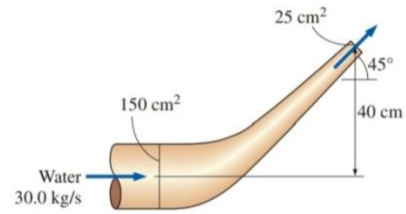
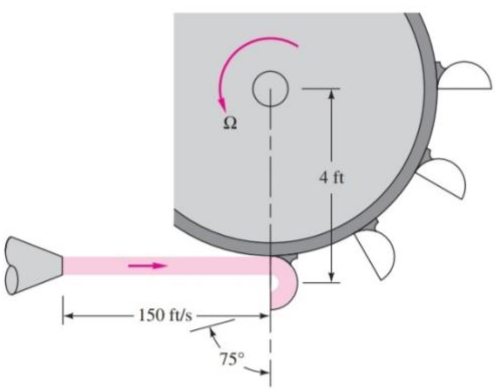


FIGURE P6–25

P3.162 The waterwheel in Fig. P3.162 is being driven at 200 r/min by a 150-ft/s jet of water at 20°C. The jet diameter is 2.5 in. Assuming no losses, what is the horsepower developed by the wheel? For what speed Ω r/min will the horsepower developed be a maximum? Assume that there are many buckets on the waterwheel.



P3.162

6–43 Water enters a centrifugal pump axially at atmospheric pressure at a rate of 0.09 m^3/s and at a velocity of 5 m/s, and leaves in the normal direction along the pump casing, as shown in Fig. P6–43. Determine the force acting on the shaft (which is also the force acting on the bearing of the shaft) in the axial direction.

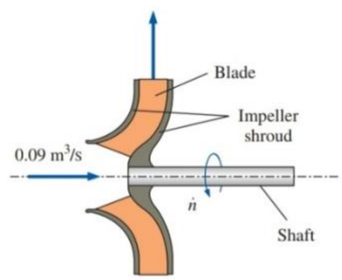


FIGURE P6–43

6–60 Water enters vertically and steadily at a rate of 35 L/s into the sprinkler shown in Fig. P6–60 with unequal arms and unequal discharge areas. The smaller jet has a discharge area of 3 cm^2 and a normal distance of 50 cm from the axis of rotation. The larger jet has a discharge area of 5 cm^2 and a normal distance of 35 cm from the axis of rotation. Disregarding any frictional effects, determine (*a*) the rotational speed of the sprinkler in rpm and (*b*) the torque required to prevent the sprinkler from rotating.

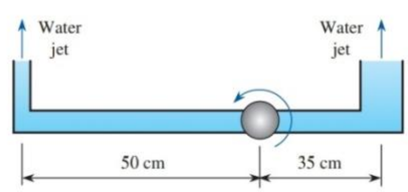


FIGURE P6–60

6–55 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?

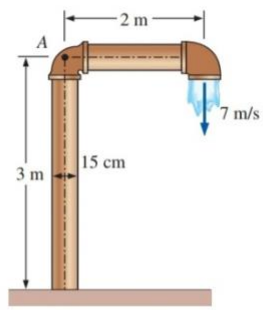


FIGURE P6–55

6–47 An incompressible fluid of density ρ and viscosity μ flows through a curved duct that turns the flow through angle θ. The cross-sectional area also changes. The average velocity, momentum flux correction factor, gage pressure, and area are known at the inlet (1) and outlet (2), as in Fig. P6–47. (*a*) Write an expression for the horizontal force F_x of the fluid on the walls of the duct in terms of the given variables. (*b*) Verify your expression by plugging in the following values: $\theta = 135°$, $\rho = 998.2\ \text{kg/m}^3$, $\mu = 1.003 \times 10^{-3}\ \text{kg/m·s}$, $A_1 = 0.025\ \text{m}^2$, $A_2 = 0.050\ \text{m}^2$, $\beta_1 = 1.01$, $\beta_2 = 1.03$, $V_1 = 6\ \text{m/s}$, $P_{1,\text{gage}} = 78.47\ \text{kPa}$, and $P_{2,\text{gage}} = 65.23\ \text{kPa}$. (*Hint*: You will first need to solve for V_2.) (*c*) At what turning angle is the force maximized? *Answers:* (*b*) $F_x = 5500$ N to the right, (*c*) 180°

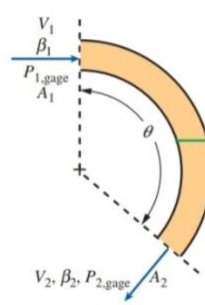


FIGURE P6–47

6–38 An unloaded helicopter of mass 12,000 kg hovers at sea level while it is being loaded. In the unloaded hover mode, the blades rotate at 550 rpm. The horizontal blades above the helicopter cause a 18-m-diameter air mass to move downward at an average velocity proportional to the overhead blade rotational velocity (rpm). A load of 14,000 kg is loaded onto the helicopter, and the helicopter slowly rises. Determine (*a*) the volumetric airflow rate downdraft that the helicopter generates during unloaded hover and the required power input and (*b*) the rpm of the helicopter blades to hover with the 14,000-kg load and the required power input. Take the density of atmospheric air to be 1.18 kg/m³. Assume air approaches the blades from the top through a large area with negligible velocity and air is forced by the blades to move down with a uniform velocity through an imaginary cylinder whose base is the blade span area.

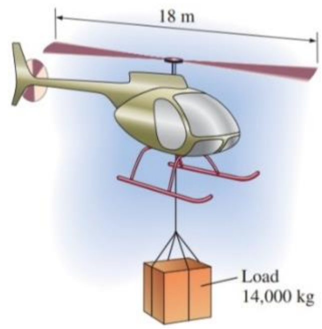


FIGURE P6–38

6–41 The weight of a water tank open to the atmosphere is balanced by a counterweight, as shown in Fig. P6–41. There is a 4-cm hole at the bottom of the tank with a discharge coefficient of 0.90, and water level in the tank is maintained constant at 50 cm by water entering the tank horizontally. Determine how much mass must be added to or removed from the counterweight to maintain balance when the hole at the bottom is opened.

FIGURE P6–41