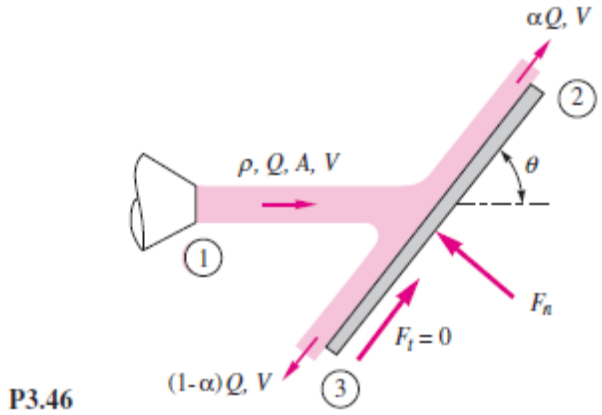
ESO204A: Fluid Mechanics and Rate Processes
TUTORIAL 5 PROBLEMS

August-November 2017

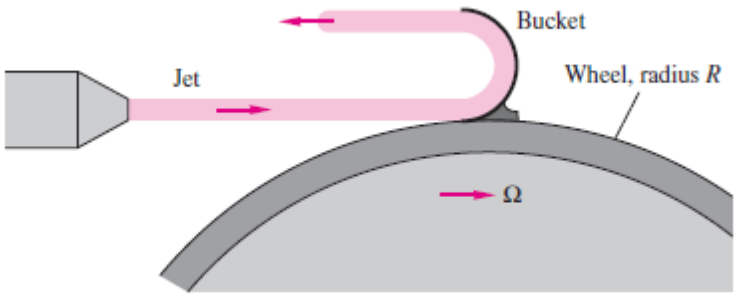
1. Review of Quiz-1 and Tutorial-4

2. When a jet strikes an inclined fixed plate, as in Fig. P3.46, it breaks into two jets at 2 and 3 of equal velocity $V = V_{jet}$ but unequal flows αQ at 2 and (1-α)Q at section 3, α being a fraction. The reason is that for frictionless flow (an approximation) the fluid can exert no tangential force F_t on the plate. The condition $F_t = 0$ enables us to solve for α. Perform this analysis, and find α as a function of the plate angle θ. Why doesn't the answer depend on the properties of the jet?



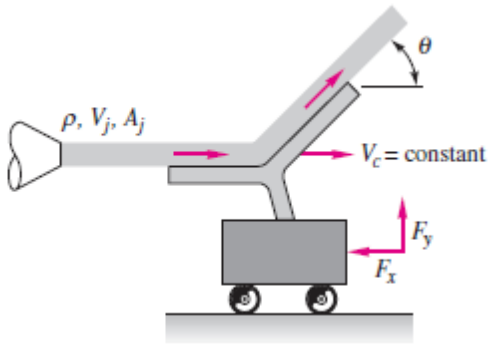
P3.46

3. A liquid jet of velocity V_j and area A_j strikes a single 180° bucket on a turbine wheel rotating at angular velocityΩ, 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?



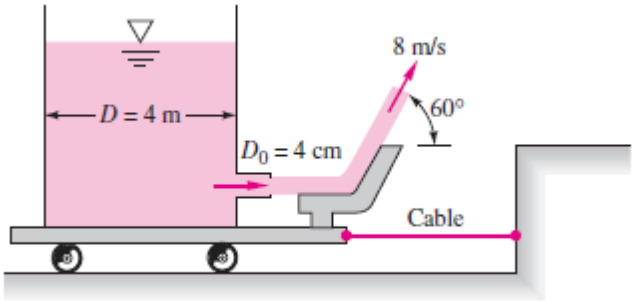
P3.51

4. In Fig. P3.55 a fixed 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 from acceleration 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.



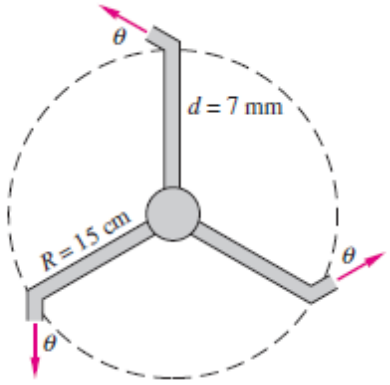
P3.55

5. 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

6. The three-arm lawn sprinkler of Fig. P3.153 receives 20°C water through the center at 2.7 m^3/h. If the collar friction is negligible, what is the steady rotation rate (units of rotations/min) for (*a*) $\theta = 0^\circ$ and (b) $\theta = 40^\circ$?



P3.153