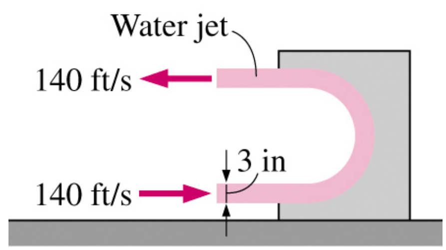
10.303 & 14.301 Fluid Mechanics

Homework Assignment #9 Fall 2006

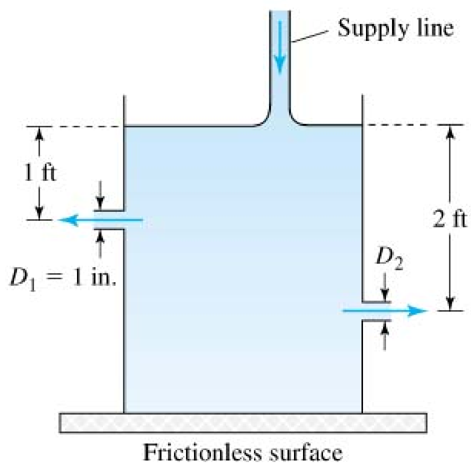
The Linear Momentum Equation

1. A 3 inch diameter horizontal water jet having a velocity of 140 ft/s strikes a curved plate which deflects the stream by 180^o at the same speed. Ignoring friction losses, determine the force required to hold the plate in place against the water stream.

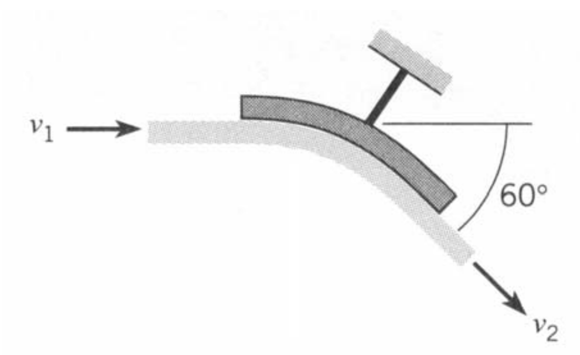


2. The tank shown is resting on a frictionless surface. The volume flow rate through the supply line is adjusted so that the water level in the tank remains constant. The water surface and the exit nozzles are open to the atmosphere.

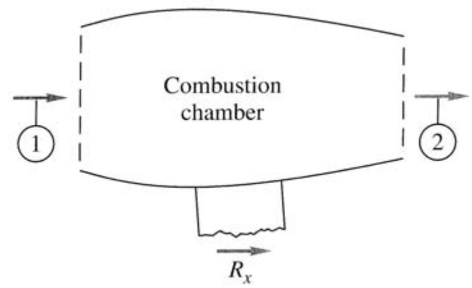
With the information given in the diagram (neglecting losses in the fluid), determine the diameter D_2 needed so that the tank remains motionless. Explain the logic used in your analysis!



3. A water jet is deflected 60^o by a stationary vane as shown. The incoming jet has a speed of 100 ft/s and a diameter of 1 inch. Ignoring the influence of gravity, find the force needed to hold the vane in place. Specify both the x-directed and y-directed components of the force.

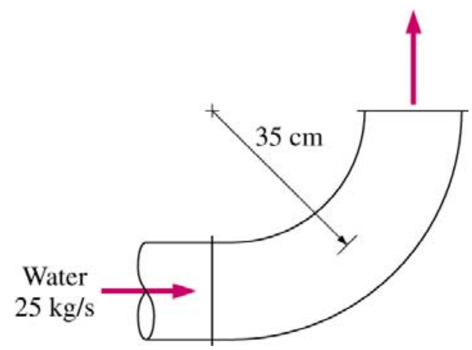


4. A turbojet with a 1 m diameter inlet is being tested in a facility capable of simulating high altitude conditions where the atmospheric pressure is 55 kPa absolute and the temperature is 267 K. The gas constant for air is 287 J/kg-K. The velocity at the inlet is measured to be 100 m/s. The conditions at the exit of the chamber include an exit diameter of 0.75 m, an exit temperature of 800 K, and an exit pressure that is the same as the local atmospheric pressure (55 kPa absolute).



For these test conditions, compute the horizontal reaction force R_x needed to hold the engine fixed. This is equal to the thrust developed by the turbojet.

5. A 90° elbow is used to direct water flow at a rate of 25 kg/s from a horizontal pipe in an upward direction. The diameter of the elbow is 10 cm and the elevation difference between the centers of the exit and the inlet of the elbow is 35 cm. The elbow discharges water into the atmosphere, and thus the pressure at the exit is the local atmospheric pressure.



Assuming that the weight of the elbow and the water in the elbow are negligible, determine the gage pressure at the center of the inlet of the elbow and the anchoring force needed to hold the elbow in place. Specify both the x-directed and y-directed components of the force. Take $\beta = 1.03$ for your calculations involving the momentum flux at both the inlet and outlet of the elbow.