1. In some wind tunnels the test section is perforated to suck out fluid and provide a thin viscous boundary layer. The test section wall in the figure contains 1200 holes of 5mm diameter each per square meter of wall area. The suction velocity through each hole is \( V_r = 8 \text{ m/s} \), and the test-section entrance velocity is \( V_1 = 35 \text{ m/s} \). Assuming incompressible steady flow of air at 20C, compute (a) \( V_0 \), (b) \( V_2 \), and (c) \( V_f \), in m/s.

![Figure 1:](image1)

2. A small lawn sprinkler is shown in the sketch below. At an inlet gage pressure of 20 kPa, the total volume flow rate of water through the sprinkler is 7.5 liters per minute and it rotates at 30 rpm. The diameter of each jet is 4 mm. Calculate the jet speed relative to each sprinkler nozzle. Evaluate the friction torque at the sprinkler pivot.

![Figure 2:](image2)

3. When a uniform stream flows past an immersed cylinder of radius \( L \), a broad low-velocity wake is created downstream, idealized as a V-shape in the figure. Pressures \( p_1 \) and \( p_2 \) are approximately equal. If the flow is two-dimensional and incompressible, with width \( b \) into the paper, derive a formula for the drag force \( F \) on the cylinder. Rewrite your result in the form of a dimensionless drag coefficient based on body length \( C_D = F/(\rho U^2 b L) \).
4. Water is flowing through a 12cm diameter pipe that consists of a 3m long vertical and 2m long horizontal section with a 90\degree elbow at the exit to force the water to be discharged downward, as shown in figure, in the vertical direction. Water discharges to atmospheric air at a velocity of 4m/s, and the mass of the pipe section when filled with water is 15kg 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?

5. The cart shown rolls with negligible resistance along a horizontal track. It is to be accelerated from rest by a liquid jet that strikes the curved vane at the front of the cart and is then deflected into the tank. The initial mass of the tank is $M_0$. Use mass and momentum conservation to show that at any instant the mass of the vehicle and liquid contents is $M = M_0V/(V - U)$. Obtain a general expression for $U/V$ as a function of time.
6. Water flows through the pipe contraction shown in Fig. 6. For the given 0.2\text{m} difference in manometer level, determine the flowrate as a function of the diameter of the small pipe, $D$. 