Solution: This is a 'numerical' version of the "analytical" body-drag Prob. 3.44. The student still must make a CV analysis similar to Prob. P3.44 of this Manual. The wake is exactly the same shape, so the result from Prob. 3.44 holds here also:

$$F_{drag} = \frac{1}{3}\rho U_o^2 Lb = \frac{1}{3}(998)(4)^2(0.8)(1.0) \approx \mathbf{4260\ N} \quad \textit{Ans.}$$

The drag coefficient is easily calculated from the above result: **C_D = 2/3**. *Ans.*

3.73 A pump in a tank of water directs a jet at 45 ft/s and 200 gal/min against a vane, as shown in the figure. Compute the force F to hold the cart stationary if the jet follows (a) path A; or (b) path B. The tank holds 550 gallons of water at this instant.

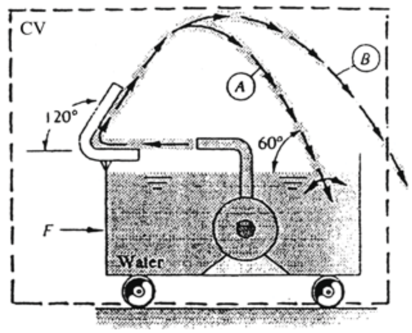

Fig. P3.73

Solution: The CV encloses the tank and passes through jet B.
(a) For jet path **A**, *no momentum flux crosses the CV*, therefore **F = 0** *Ans.* (a)
(b) For jet path B, there *is* momentum flux, so the *x*-momentum relation yields:

$$\sum F_x = F = \dot{m}_{out} u_{out} = \dot{m}_{jet} u_B$$

Now we don't really *know* u_B exactly, but we make the reasonable assumption that the jet trajectory is *frictionless* and maintains its horizontal velocity component, that is, $u_B \approx V_{jet}\cos 60°$. Thus we can estimate

$$F = \dot{m}u_B = \left(1.94\ \frac{slug}{ft^3}\right)\left(\frac{200}{448.8}\ \frac{ft^3}{s}\right)(45\cos 60°) \approx \mathbf{19.5\ lbf} \quad \textit{Ans.}\text{ (b)}$$

3.74 Water at 20°C flows down a vertical 6-cm-diameter tube at 300 gal/min, as in the figure. The flow then turns horizontally and exits through a 90° radial duct segment 1 cm thick, as shown. If the radial outflow is uniform and steady, estimate the forces (F_x, F_y, F_z) required to support this system against fluid momentum changes.