PROBLEM 5.39

GIVEN Plate hit with water. Fig. P 5.39 Neglect gravity. Frictionless plate.

FIND Force F to hold plate stationary.

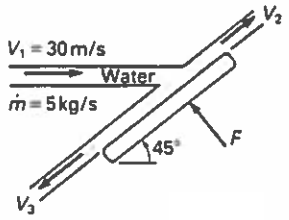
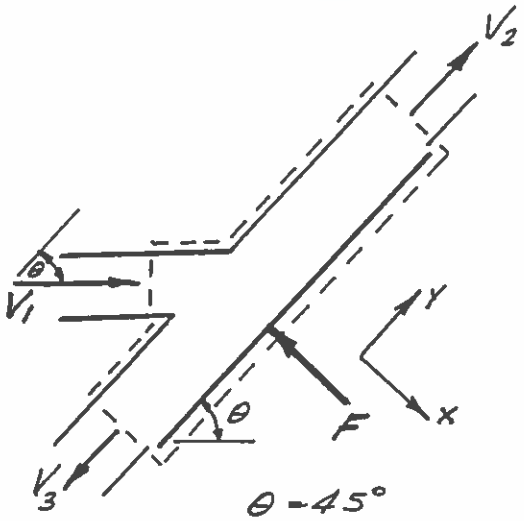


FIG. P. 5.39

SOLUTION Assume steady flow and apply the linear momentum equation in the x-direction to the control volume shown. F is the force on the plate.



$$\dot{M}_{x,out} - \dot{M}_{x,in} = \Sigma F_x$$

where

$$\dot{M}_{x,out} = 0,$$

$$\dot{M}_{x,in} = \rho A_1 V_1 (V_1 \sin\theta),$$

and

$$\Sigma F_x = -F.$$

The x-direction linear momentum equation is then

$$0 - \rho A_1 V_1^2 \sin\theta = -F \quad \text{or} \quad F = \rho A V_1^2 \sin\theta$$

$$= \dot{m} V_1 \sin\theta.$$

The numerical values give

$$F = \left(5 \frac{kg}{s}\right)\left(30 \frac{m}{s}\right) \sin 45° \left(\frac{N \cdot s^2}{kg \cdot m}\right)$$

$$\boxed{F = 106 \text{ N.}}$$