5.61

5.61 Water discharges into the atmosphere through the device shown in Fig. P5.61. Determine the x component of force at the flange required to hold the device in place. Neglect the effect of gravity and friction.

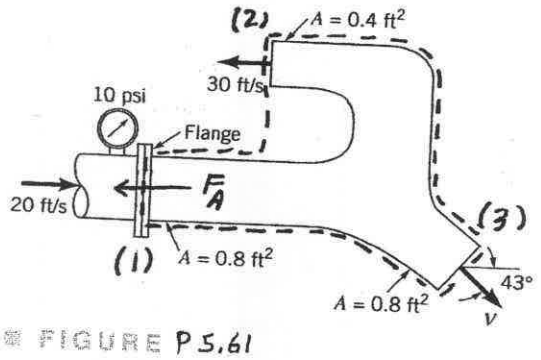

FIGURE P5.61

To calculate the x-direction anchoring force required to hold the device in place, the x-direction component of the linear momentum equation is used on the contents of the control volume shown in the sketch to obtain:

$$-V_1\rho V_1 A_1 - V_2\rho V_2 A_2 + V_3\cos 43^\circ \rho V_3 A_3 = -F_A + p_1 A_1 \qquad (1)$$

To determine V_3, the conservation of mass equation is used to obtain:

$$Q_1 = Q_2 + Q_3$$

or

$$V_1 A_1 = V_2 A_2 + V_3 A_3$$

and $$\left(20\ \frac{ft}{s}\right)(0.8\ ft^2) = \left(30\ \frac{ft}{s}\right)(0.4\ ft^2) + V_3\,(0.8\ ft^2)$$

so $$V_3 = 5\ \frac{ft}{s}$$

Then from Eq. 1 we get

$$-\frac{\left(20\ \frac{ft}{s}\right)\left(1.94\ \frac{slugs}{ft^3}\right)\left(20\ \frac{ft}{s}\right)(0.8\ ft^2)}{\left(1\ \frac{slug.ft}{lb.s^2}\right)} - \frac{\left(30\ \frac{ft}{s}\right)\left(1.94\ \frac{slugs}{ft^3}\right)\left(30\ \frac{ft}{s}\right)(0.4\ ft^2)}{\left(1\ \frac{slug.ft}{lb.s^2}\right)}$$

$$+\frac{\left(5\ \frac{ft}{s}\right)(\cos 43^\circ)\left(1.94\ \frac{slugs}{ft^3}\right)\left(5\ \frac{ft}{s}\right)(0.8\ ft^2)}{\left(1\ \frac{slug.ft}{lb.s^2}\right)} = -F_A + \left(10\ \frac{lb}{in^2}\right)\left(144\ \frac{in^2}{ft^2}\right)(0.8\ ft^2)$$

or

$F_A = \underline{2440}$ lb to the left as shown in the sketch