5.13   Two rivers merge to form a larger river as shown in Fig. P5.13. At a location downstream from the junction (before the two streams completely merge), the nonuniform velocity profile is as shown. Determine the value of V.
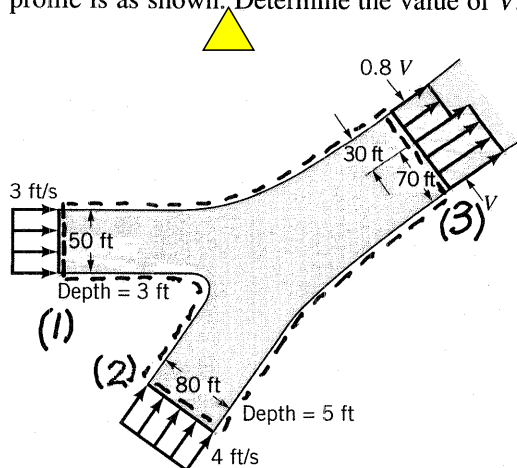

FIGURE P5.13

Use the control volume shown within broken lines in the sketch above. We note that $\dot{m} = \rho A V$ and from the conservation of mass principle we get

$$\dot{m}_1 + \dot{m}_2 = \dot{m}_3 = \dot{m}_{0.8V} + \dot{m}_V$$

Thus

$$\rho A_1 V_1 + \rho A_2 V_2 = \rho A_{0.8V} \, 0.8 V + \rho A_V V$$

and

$$V = \frac{A_1 V_1 + A_2 V_2}{A_{0.8V}(0.8) + A_V} = \frac{(50ft)(3ft)\left(3\frac{ft}{s}\right) + (80ft)(5ft)\left(4\frac{ft}{s}\right)}{(30ft)(6ft)(0.8) + (70ft)(6ft)}$$

$$V = \underline{\underline{3.63}} \, \frac{ft}{s}$$