89. (a) This is similar to the situation treated in Sample Problem 15-8, and we refer to some of its steps (and notation). Combining Eq. 15-35 and Eq. 15-36 in a manner very similar to that shown in the textbook, we find

$$R = A_1 A_2 \sqrt{\frac{2\Delta p}{\rho \left(A_1^2 - A_2^2\right)}} \ .$$

for the flow rate expressed in terms of the pressure difference and the cross-sectional areas. Note that this reduces to Eq. 15-38 for the case $A_2 = A_1/2$ treated in the Sample Problem. Note that $\Delta p = p_1 - p_2 = -7.2 \times 10^3$ Pa and $A_1^2 - A_2^2 = -8.66 \times 10^{-3}$ m^4, so that the square root is well defined. Therefore, we obtain $R = 0.0776$ m^3/s.

(b) The mass rate of flow is $\rho R = 68.9$ kg/s.