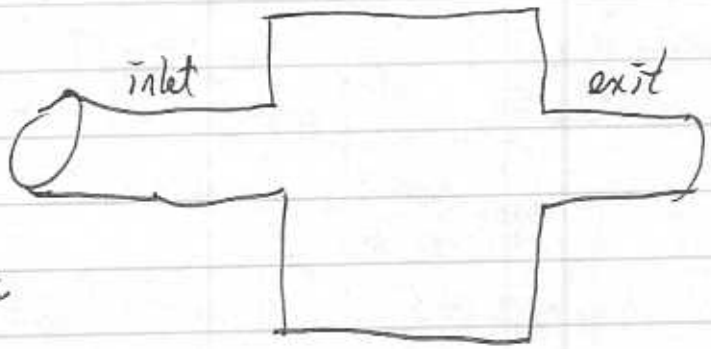
M.S. 4.10 Air, ideal gas



$P_i = 9\,bar$
$T_i = 600K$
$V_i = 40\,m/s$
$A_i = 0.002\,m^2$

$P_e = 2\,bar$
$T_e = 400K$
$V_e = 350\,m/s$

(a) $\dot{m} = ?$ $\quad \dot{m} = \dot{m}_i = \dot{m}_e$

$$\dot{m}_i = \rho_i A_i V_i \qquad \rho = \frac{P}{RT} \qquad R_{air} = 287 \frac{J}{kg \cdot K}$$

$$\rho = \frac{8 \times 10^5 Pa}{\left(287 \frac{J}{kg \cdot k}\right)(600K)}$$

$$\rho = 4.6\ kg/m^3$$

$$\dot{m} = (4.6\ kg/m^3)(.002 m^2)(40\ m/s) = \underline{0.37\ kg/s}$$

(b) $\dot{m}_e = 0.37\ kg/s = \rho_e A_e V_e$

$$\rho_e = \frac{2 \times 10^5 Pa}{\left(287 \frac{J}{kg \cdot k}\right)(400K)} = 1.74\ kg/m^3$$

$$(0.37\ kg/s) = (1.74\ kg/m^3) A_e (350\ m/s) \qquad \boxed{A_e = 6\ cm^2}$$