(c) Assume $\rho = \rho_o = \rho_{tire}$, for how would we know ρ_{exit} if we didn't use compressible-flow theory? Then the incompressible Bernoulli relation predicts

$$\rho_o = \frac{p_o}{RT_o} = \frac{169120}{287(303)} = 1.945\ \frac{kg}{m^3}$$

$$V_{e,inc} \approx \sqrt{\frac{2\Delta p}{\rho_o}} = \sqrt{\frac{2(169120-100000)}{1.945}} \approx \mathbf{267}\ \frac{\mathbf{m}}{\mathbf{s}} \quad \textit{Ans.}\text{ (c)}$$

This is **8% lower** than the "exact" estimate in part (a).

9.43 Air flows isentropically through a duct with T_o = 300°C. At two sections with identical areas of 25 cm^2, the pressures are p_1 = 120 kPa and p_2 = 60 kPa. Determine (a) the mass flow; (b) the throat area, and (c) Ma_2.

Solution: If the areas are the same and the pressures *different*, than section (1) must be subsonic and section (2) supersonic. In other words, we need to find where

$$\frac{p_1/p_o}{p_2/p_o} = \frac{120}{60} = 2.0 \quad \text{for the same } A_1/A^* = A_2/A^* \text{—search Table B.1 (isentropic)}$$

$$\text{After laborious but straightforward iteration, } Ma_1 = 0.729, \quad \mathbf{Ma_2 \approx 1.32} \quad \textit{Ans.}\text{ (c)}$$

$$A/A^* = 1.075 \text{ for both sections, } A^* = 25/1.075 = \mathbf{23.3\ cm^2} \quad \textit{Ans.}\text{ (b)}$$

With critical area and stagnation conditions known, we may compute the mass flow:

$$p_o = 120[1+0.2(0.729)^2]^{3.5} \approx 171 \text{ kPa} \quad \text{and} \quad T_o = 300+273 = 573 \text{ K}$$

$$\dot{m} = 0.6847 p_o A^*/[RT_o]^{1/2} = 0.6847(171000)(0.00233)/[287(573)]^{1/2}$$

$$\dot{m} \approx \mathbf{0.671}\ \frac{\mathbf{kg}}{\mathbf{s}} \quad \textit{Ans.}\text{ (a)}$$

9.44 In Prob. 3.34 we knew nothing about compressible flow at the time so merely assumed exit conditions p_2 and T_2 and computed V_2 as an application of the continuity equation. Suppose