Problem 332B
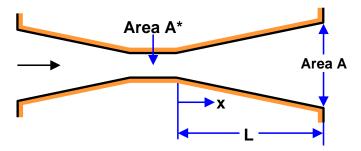
A crude de Laval nozzle with a throat area, A^*, and a diffuser exit area 16 times larger $(A = 16A^*)$ is made using a straight-sided conical diffuser as indicated below:

The nozzle is supplied from an air reservoir $(\gamma = 1.4)$ of pressure, p_0; the external pressure of the air downstream of the diffuser exit is p_E. Find the ratio p_E/p_0 at which a normal shock will form half-way along the diffuser, that is to say at $x/L = 0.5$.