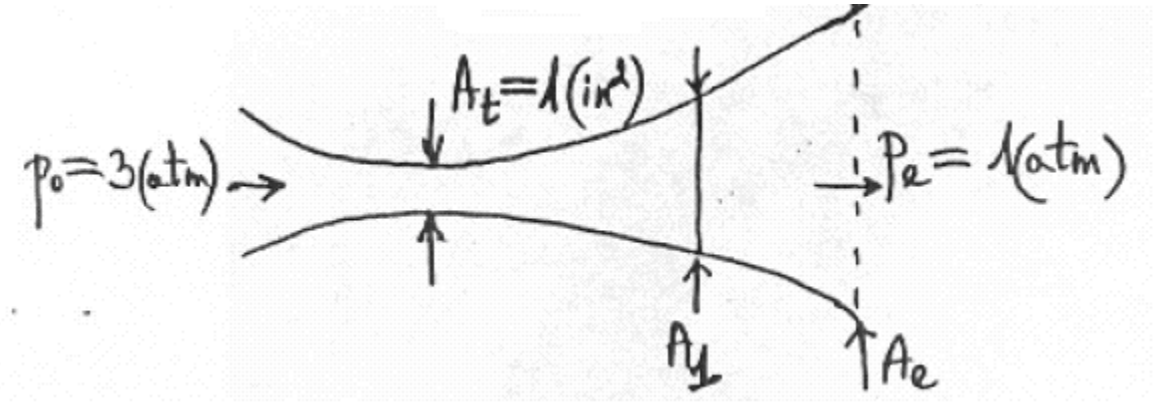
April 19, 2011

MANE – 6650 – 01 Theory of Compressible Flow
Spring Semester 2011
HOMEWORK #5
DUE: May 3, 2011

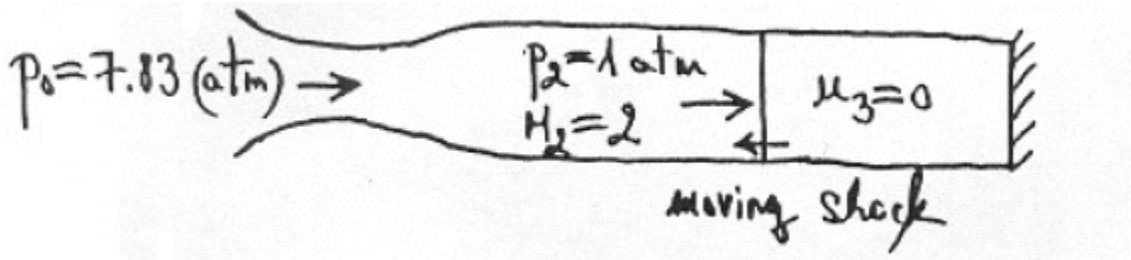
1. Given a converging – diverging nozzle with a ratio of exit cross section area A_e to throat cross section area A_t, $A_e/A_t = 10$. The stagnation pressure at the inlet is $P_o = 3$ (atm). The static pressure along the exit is $P_e = 1$ (atm). Assume a 1-D flow and $A_t = 1(in^2)$.

   i. Is an isentropic flow solution (subsonic or subsonic – supersonic) all along the nozzle possible? Explain.

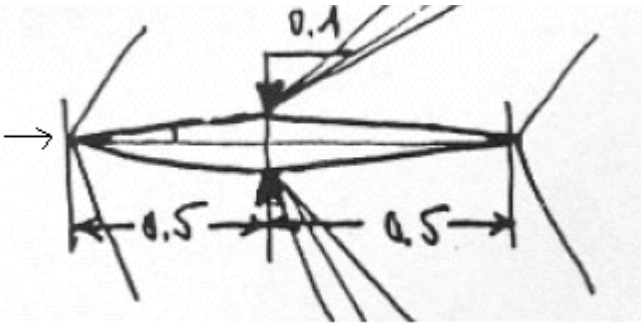
   ii. Find the area of the cross section 1 where a normal shock wave stands in the given flow.



2. A perfect gas ($\gamma = 1.4$) is accelerated in steady flow from stagnation pressure $P_o=7.83$ (atm) and stagnation temperature $T_0 = 300$ K to $P_2 = 1$(atm), then brought to rest by a waving shock (see diagram). Find the pressure P_3 of the stagnant gas behind the shock and shock speed.



3. Solve the pressure distribution over a diamond profile of 10% thickness given at a supersonic flow with $M_\infty = 2.0$ and zero angle of attack ($\alpha = 0^\circ$). Calculate the lift and drag coefficients of the profile.



4. Solve the following shock structure (find M_1, M_2, β_1):