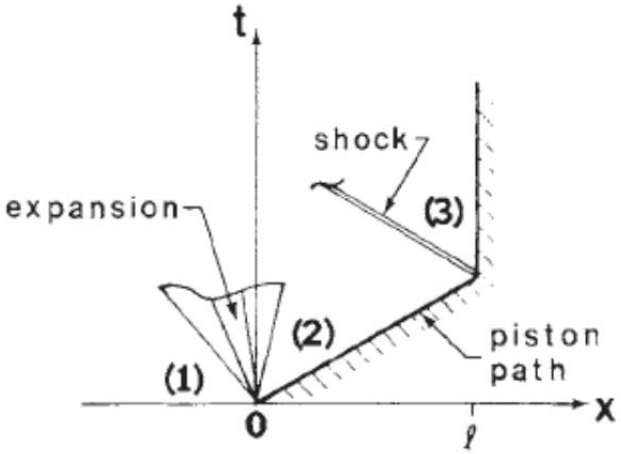
HW (Unsteady Wave Motion)

Due: Final Exam (Late HW's won't be accepted)

1- A piston is impulsively withdrawn from 300 K argon gas at a speed of 150 m/s. An unsteady expansion wave is generated as shown in the sketch. After traveling a distance *f*, the piston is impulsively stopped, thereby generating an unsteady normal shock wave. Determine P_3/P_1.

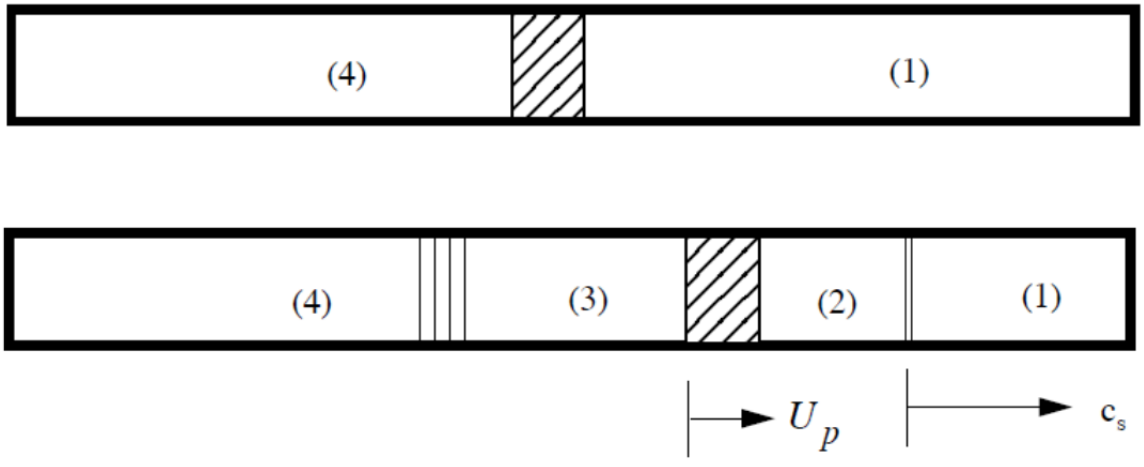


2- We normally think of the shock tube as a device that can be used to study relatively strong shock waves. But shock tubes have also been used to study weak shocks relevant to the sonic boom problem. Suppose the shock tube is used to generate weak shock waves with $P_2/P_1=1+\varepsilon$. Show that for small the relationship between and is approximated by:

$$P_4/P_1=1+A\varepsilon$$

How does A depend on the properties of the gases in regions 1 and 4? Use the exact theory to determine the strength of a shock wave generated in an air-air shock tube operated at $P_2/P_1=1.2$. Compare with the approximate result.

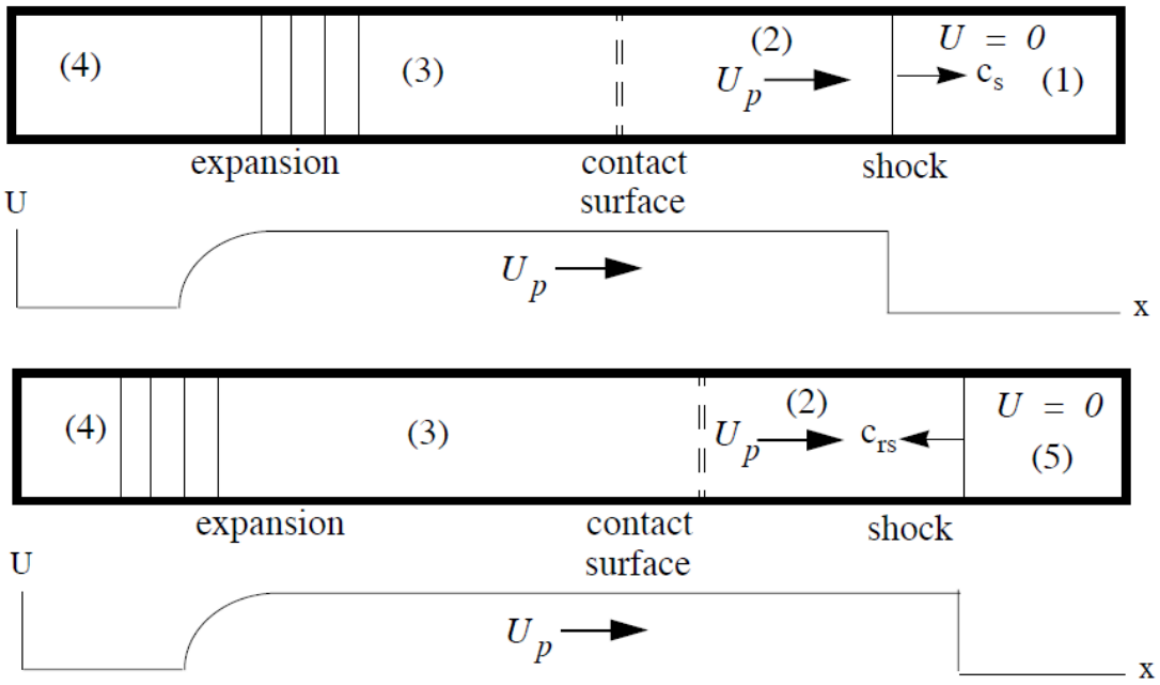
3- A moveable piston sits in the middle of a long tube filled with Air at one atmosphere and 300º K. At time zero the piston is moved impulsively to the right at U_p = 200 m/s.



1) What is the pressure on the right face of the piston (region 2)?

2) What is the pressure on the left face of the piston (region 3)?

4- The figure below shows a shock wave reflecting from the end wall of a shock tube. The reflected shock moves to the left at a constant speed into the gas that was compressed by the incident shock. The gas behind the reflected shock, labeled region (5), is at rest and at a substantially higher temperature and pressure than it was in state (1) before the arrival of the incident shock.



a) Suppose the gas in the driver and test sections is Helium at an initial temperature of 300°K prior to opening the diaphragm. The Mach number of the incident shock wave is 3. Determine the Mach number of the reflected shock.

b) Determine T_5/T_1

5.

A plane shock front in air with pressure ratio $P_2/P_1 = 1.2$ is reflected from a parallel rigid wall. Find the pressure behind the reflected shock:

(*a*) From linear (acoustic) theory

(*b*) From nonlinear (shock) theory

Answer (*a*) $1.4000P_1$; (*b*) $1.4334P_1$