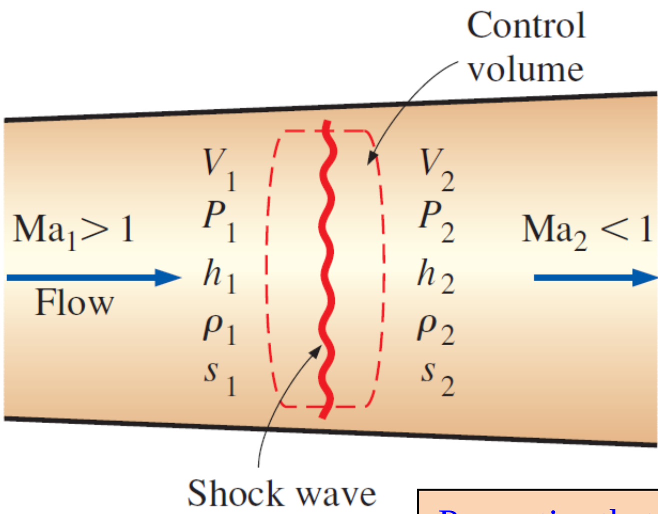
Today, we will:

- Start Chapter 12 – Compressible Flow
- Discuss isentropic compressible flow, converging-diverging ducts

X. INTRODUCTION TO COMPRESSIBLE FLOW (Chapter 12)

A. Introduction

Consider a *stationary* normal shock wave (as in a supersonic wind tunnel)



Properties that ***increase*** across the shock:

- $P_2 > P_1$
- $T_2 > T_1$, thus:
  - $c_2 > c_1$
  - $h_2 > h_1$
- $\rho_2 > \rho_1$
- $s_2 > s_1$
- $A_2^* > A_1^*$

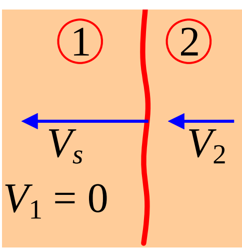
Properties that ***decrease*** across the shock:

- $Ma_2 < Ma_1$
- $P_{02} < P_{01}$
- $\rho_{02} > \rho_{02}$
- $V_2 < V_1$

Properties that ***stay the same*** across the shock:

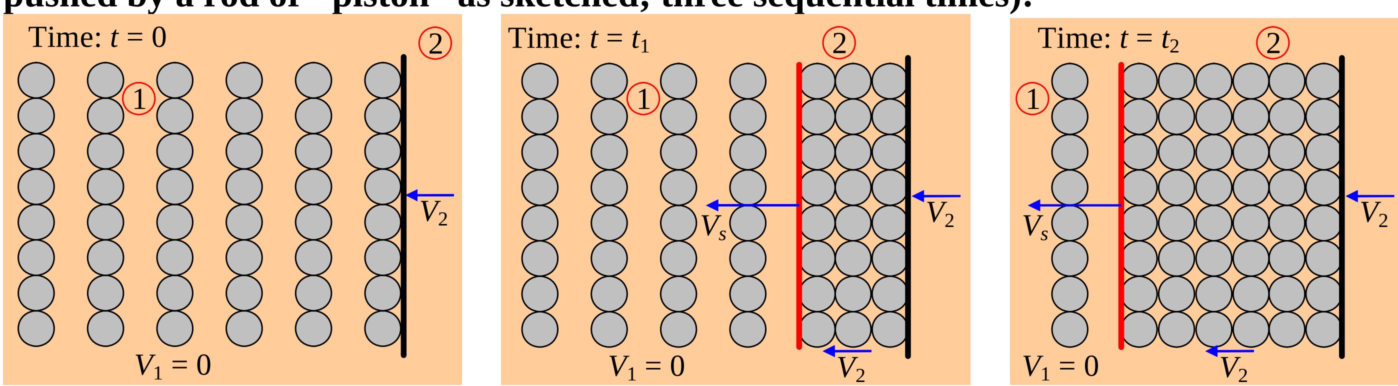
- $T_{02} = T_{01}$
- $h_{02} = h_{01}$

Consider instead a *moving* normal shock wave (as in a blast wave from an explosion)



- The shock is moving into quiescent air (region 1)
- In this frame of reference we define $Ma_1 = V_s/c_1$
- The shock wave travels into region 1 at supersonic speed ($Ma_1 > 1$)
- The air behind the shock (region 2) follows at a slower speed

The "dime analogy" (model the moving shock as rows of dimes that pile up when pushed by a rod or "piston" as sketched; three sequential times):



Comments:

- The vertical red line is analogous to a shock wave: $V_1 = 0$, $V_s > V_2$, $\rho_2 > \rho_1$ (there is sudden increase in density, and the "wave front" of dimes moves faster than the piston).
- The dimes in region 1 don't "know" anything is happening until the shock hits them.
- Similarly in a shock wave in air, the air in region 1 does not "know" anything is happening until the shock wave hits it.