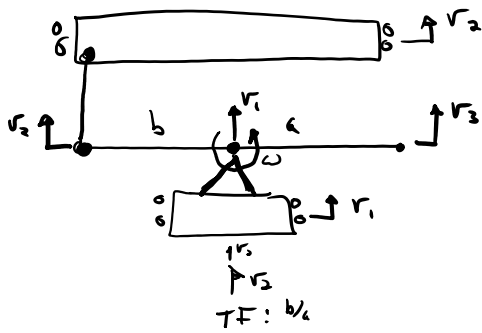


- Lab 3 due today
- Lab 4 posted tomorrow due Nov 27<sup>th</sup>
- HW 7 due Monday
- Choose Lab 4 & 5 partners by Friday

## HW 4.16

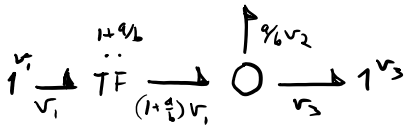


$$v_2 = v_1 - \omega b \Rightarrow \frac{v_1 - v_2}{b} = \omega$$

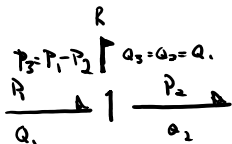
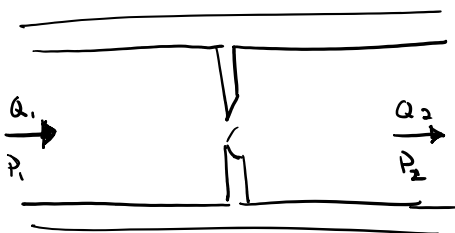
$$v_3 = v_1 + \omega a$$

$$v_3 = v_1 + \frac{a}{b} (v_1 - v_2)$$

$$v_3 = \left(1 + \frac{a}{b}\right) v_1 - \frac{a}{b} v_2$$



Sharp edge circular orifice



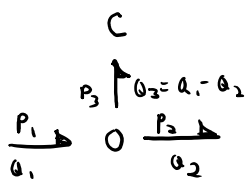
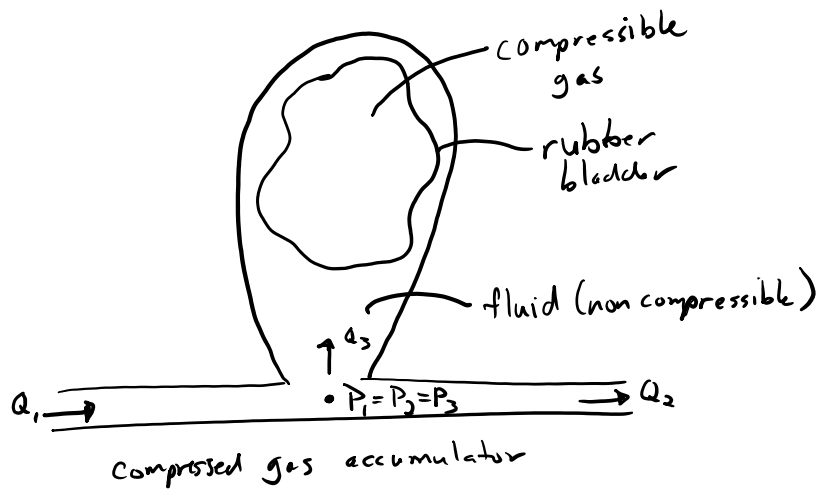
$$P_3 = \frac{\rho Q_3 |Q_3|}{2 C_d^2 A_3^2}$$

discharge coeff.  
 $\approx 0.61$   
 but can vary

if opening is a valve

$$P_3 = \frac{\rho Q_3 |Q_3|}{2 C_d^2(x) A_0^2(x)}$$

x: valve opening diameter



$$P_3 = \frac{P_0 V_0^\gamma}{(V_0 - V_3)^\gamma}$$

$P_0, V_0$ : initial pressure & volume

$P, V$ : instantaneous pressure, volume

$\gamma$ : specific heat ratio

## Steps for hydraulic systems (analogous to electrical)

1. Show positive directions for fluid flows and pressure drops.
2. For each distinct pressure establish a O-Junction and attach elements that act on absolute pressures. Include a O-Junction for atmospheric pressure (if needed).
3. Insert R-, C-, and I- elements between appropriate O-Junctions using 1 junctions for pressure drops.
4. Eliminate O-Junctions for atmospheric pressure if gage pressure is desired.
5. simplify (optional)

# Examples Helmholtz Oscillator

mass + spring, inductor + capacitor - fluid equivalent

