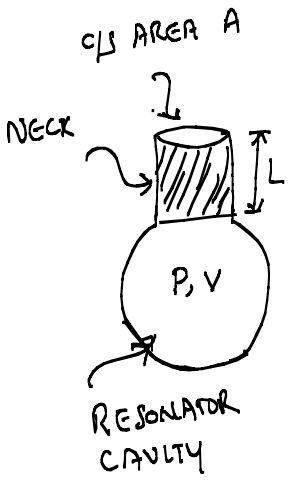
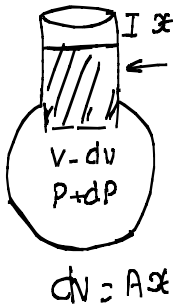
HELMHOLTZ RESONATOR





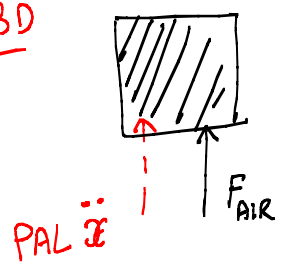
MASS $m = \rho A L$

ADIABATIC IDEAL GAS LAW

$$P V^{\gamma} = \text{CONST}$$

$$\frac{dP}{P} + \gamma \frac{dV}{V} = 0$$

FBD



$$F_{AIR} = -dP\,A = +\frac{\gamma P}{V} A^2 x$$

$$\because\ dP = -\frac{\gamma P}{V} dV = -\frac{\gamma P}{V} A x$$

$$\downarrow \sum_{+ve} F_x > 0 \quad \Rightarrow -\rho A L \ddot{x} - F_{AIR} = 0$$

$$\Rightarrow \rho A L \ddot{x} + \frac{\gamma P}{V} A^2 x = 0$$

$$\Rightarrow \omega_n = \sqrt{\frac{\gamma P A^2}{\rho A L V}} = \sqrt{\frac{\gamma P A}{\rho V L}}$$