# Sound Waves

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What are sound waves?

- Oscilations of pressure.
- Oscilating molecules "Displacement amplitude" $\rightarrow$ "$A$" (Typically very tiny... microsopic)
  Instead we used "Pressure Amplitude"

$$P_{max} = BkA$$

Where $B$ is the bulk modulus, K is the wave number $k\lambda = 2\pi$, and $A$ is the displacement amplitude.

$$\begin{array}{rcr} A & \rightarrow & \text{very small} \\ B & \rightarrow & \text{very large} \\ P_{max} & \rightarrow & \text{reasonable} \end{array}$$

String waves?

$$v = \sqrt{\frac{\text{tension}}{\mu \quad \leftarrow \quad \text{linear density}}}$$

$$\text{Power} = \frac{1}{2}\mu v w^2 A^2$$

In general...

**Definition 0.1.**

$$\boxed{v = \sqrt{\frac{\text{"elastic factor"}}{\text{"intertial factor"}}}}$$

Back to sound waves, let's start with an idealized example. A air tube.

$$\begin{aligned} \text{mass} &= \text{density} \cdot \text{volume} \\ m &= \rho \cdot S \cdot vt \\ \text{momentum} &= \text{mass} \cdot \text{veloctiy} \\ &= \rho S v t \cdot v_y \end{aligned}$$

Pressure in a medium...

$$\begin{aligned} P =& - B\frac{\Delta V}{V} \\ =& B\frac{Sv_y t}{Svt} \\ =& B\frac{v_y}{v} \end{aligned}$$

$$\begin{aligned} \text{Force} =& P \cdot S \\ F =& B\frac{v_y}{v} \cdot S \end{aligned}$$

$$\begin{aligned} \text{Impluse} =& F \cdot t \\ =& B\frac{v_y}{v} \cdot S \cdot t \\ \rho Svt \cdot v_y =& B\frac{v_y}{v} \cdot S \cdot t \end{aligned}$$

**Definition 0.2.**

$$\boxed{\rho v = B \quad v = \sqrt{\frac{B}{\rho}}}$$

What are the units for all of these values though?

| | | | |
|---|---|---|---|
| Density? | SI Unit | | $\frac{kg}{m^3}$ |
| B? | SI Unit | Pascal | $\frac{N}{m^2}$ |