Speed of sound in air →

The speed of sound depends on the compressibility and inertia of the medium through which they are travelling."

We have a relation

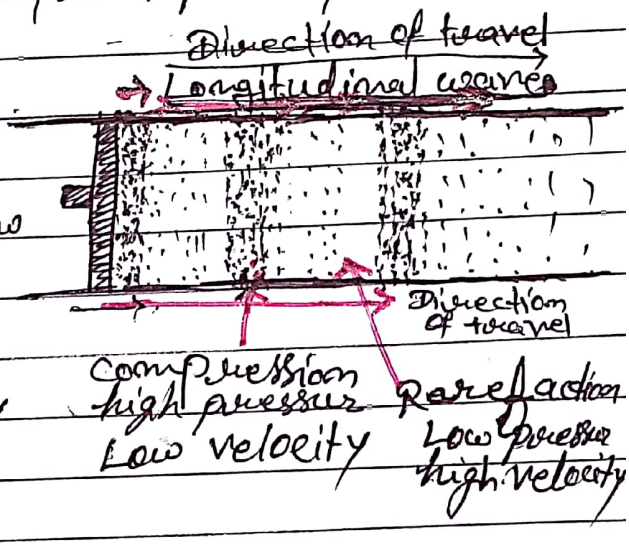
$$V = \sqrt{\frac{E}{\rho}} \quad \text{— (i)}$$ where ρ = density of the medium

and E = Modulus of elasticity

$$E = \frac{\Delta P}{\Delta V/V} \quad \text{— (ii)}$$

Now, Derivation of Newton's formula for speed of Sound →

$$V = \sqrt{\frac{E}{\rho}} \quad \text{— (ii')}$$



For 'E' — We have boyle's law

$$PV = (P + \Delta P)(V - \Delta V)$$

$$PV = P(V - \Delta V) + \Delta P(V - \Delta V)$$

$$PV = PV - P\Delta V + \Delta PV - \Delta P\Delta V$$

Here $\Delta P \Delta V$ is small value, so neglecting it

$$PV = PV - P\Delta V + \Delta PV$$

or, $P\Delta V = \Delta PV$

then $P = \frac{\Delta P}{\Delta V/V}$ so eqn (ii) can be written as

$$\boxed{E = P}$$

Now eqn (i) becomes

$$\boxed{V = \sqrt{\frac{P}{\rho}}}$$

This formula for gives the value 281 m/s but Experimental value in gas is 332 m/s

Newtons formula for the speed of sound
Newtons assumed "the propagation of sound waves through the air" of propagation is isothermal.