CONCEPT: SPEED OF LONGITUDINAL WAVES IN FLUIDS AND SOLIDS

● Just like transverse waves, the **speed** of longitudinal waves depends *only* on the properties of the **medium:**

TRANSVERSE

$$v_{string} = \sqrt{\frac{F_T}{\mu}} = \lambda f$$

LONGITUDINAL

For **FLUIDS:**

$$v_{long.} = \sqrt{\frac{\quad}{\quad}} = \lambda f$$

β = bulk modulus of fluid

ρ = density of fluid

In **SOLIDS:**

$$v_{long.} = \sqrt{\frac{\quad}{\quad}} = \lambda f$$

Y = Young's modulus of solid/rod material

ρ = density of solid

EXAMPLE**:** In a liquid of density 1200 kg/m^3, longitudinal waves with a frequency of 400Hz have a wavelength of 8m**.** Calculate the bulk modulus of the liquid**.**

EXAMPLE**:** You strike a 60.0-m-long brass at one end**.** How long does it take for a person on the other end of the rod to hear the sound? The Young's Modulus of brass is 9×10^{10} Pa and the density is 8600 kg/m^3**.**

PROBLEM: A metal bar has a length of 1.5m and a density of 6400 kg/m³. Sound waves take 3.9×10^{-4}s to travel along the length of the bar. What is the Young's modulus for this metal?

A) 2,311 Pa
B) 9.47×10^{10} Pa
C) 2.46×10^{7} Pa
D) 3.744 Pa

WAVES	
$v = \lambda f$	(all waves)
$v = \sqrt{\frac{F_T}{\mu}}$	(for *strings only*)
$v = \sqrt{\frac{\beta}{\rho}}$	(long. waves in liquids)
$v = \sqrt{\frac{Y}{\rho}}$	(long. waves in solids)

PROBLEM: In a container, 32 g of oxygen occupies 0.0224 m³. If the speed of sound in this container is 317 m/s, what is the bulk modulus for oxygen gas?

A) 1.44×10^{8} Pa
B) 453 Pa
C) 1.44×10^{5} Pa
D) 7.03×10^{4} Pa

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