SI Physics - Full Discipline Demo

Resonance

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Physics - Full Discipline Demo
Course	SI Physics - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Match each term with the best description.

- Frequency
- Node
- Rarefaction
- Resonance
- Wave

Description	
A disturbance that transports energy through a medium	1
Point on a medium that has the minimun density of particles	2
Number of vibration cycles per unit of time	3
Amplified sound produced when one object forces another into vibrational motion	4
Point of zero amplitude representing destructive interference	5

Correct answers:

1 Wave 2 Rarefaction 3 Frequency 4 Resonance 5 Node

Identify each statement as true or false.

- A resonance tube is filled with water and closed at both ends.
- Longitudinal waves result in the perpendicular movement of media particles.
- Mechanical waves occur in particulate media.
- Standing waves are produced during resonance.

True	False
1	2

Correct answers:

1 Standing waves are produced during resonance.

Mechanical waves occur in particulate media.

2

Longitudinal waves result in the perpendicular movement of media particles.

A resonance tube is filled with water and closed at both ends.

Exploration

Mechanical waves are produced in media composed of particles and include ____.

- ocean waves
- seismic waves
- sound waves
- All of the above ✔

The velocity of a mechanical wave is the product of its wavelength and _____.

- compression
- frequency ✔
- rarefaction
- All of the above

Resonance only occurs in air, but not liquid or solid media.

- True
- False ✔

A(n) _____ is produced at the water surface as sound travels inside a resonance tube.

- antinode
- node ✔
- transverse wave
- All of the above

Exercise 1

Explain how sound is amplified by a resonance tube.

Sound is produced in a resonance tube when an antinode of a standing resonance wave occurs just above the opening in the tube. The standing waves are the result of the air column vibrating at the same frequency as the tuning fork held near the opening. The sound waves travel from the fork into the air column until reaching the water. The waves are then reflected and encounter waves traveling in the opposite direction, creating standing waves.

The speed of sound in air is influenced by temperature and can be estimated using the equation: v = 331.4 m/s + 0.6(T_c). Calculate the theoretical speed of sound at your

experimental air temperature using this equation. How does this value compare to the speed of sound recorded in Data Table 2? Explain possible sources of error in your results.

V = 331.4 m/s + 0.6(20.0 ^{o}C)

V = 343.4 m/s @ 20 ^{o}C compared to experimental results of 347 m/s.

Possible sources of error include:

- Incorrectly identifying the length of tube where the loudest resonance was produced
- Measurement error of the air column diameter when using the ruler
- Measurement error of ambient temperature when using the thermometer
- Tuning fork variance between the printed frequency and emitted frequency

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The resonance tube used in this experiment produced only one resonance tone. What length of tube would be required to produce a second tone under the same experimental conditions? Explain your answer.

0.68 m

In long tubes, resonance tones occur at λ/4, 3λ/4, and 5λ/4 intervals respectively. The wavelength recorded in the experiment was 0.9028 m. The second resonant tone would be produced at 3λ/4 = 3(0.9028 m) / 4 = 0.6771 m and would require a tube of at least that length.

How would your calculations for the wavelength and speed of sound recorded in Data Table 2 vary if a 512 Hz tuning fork were used? Explain your answer.

The measured wavelength would decrease, but the speed of sound would remain constant. The speed of sound in air is constant for all frequencies. Using the theoretical speed of sound for 20

^{o}C, the wavelength is determined as: λ = v/f = (343.4 m/s) / 512 Hz = 0.671 m.

Data Table 1: Experimental Conditions
(SAMPLE ANSWER BELOW)

Temperature (℃)	Diameter (m)	Frequency (Hz)
20.0	0.019	384

Data Table 2: Resonance Wavelength and Velocity
(SAMPLE ANSWER BELOW)

Trial	Length (m)	Mean Length (m)	λ = 4(L+0.3d) (m)	v = fλ (m/s)
1	0.220	0.220	0.903	347
2	0.218			
3	0.222			

Competency Review

Mechanical waves travel by interacting with particles within the medium.

- True ✔
- False

Longitudinal waves propagate in _____.

- air
- liquids
- solid media
- All of the above ✔

Longitudinal waves are characterized by regions of compression and rarefaction.

- True ✔
- False

The _____ of a longitudinal wave is equal to the distance from one compression to the next compression.

- frequency
- wavelength ✔
- velocity
- All of the above

_____ waves are produced when waves of identical frequencies traveling in opposite directions meet.

- Longitudinal
- Standing ✔
- Transverse
- All of the above

A resonance tube is used to measure resonant frequencies occurring in _____.

- air ✔
- plastic
- water
- All of the above

A resonance tube emits a tone when the _____ of a standing wave occurs at the opening of the tube.

- antinode ✔
- node
- velocity
- All of the above

The _____ should be measured when using a resonance tube.

- ambient temperature
- inside diameter of the tube
- length of the resonating air column
- All of the above ✔

A 500 Hz tuning fork is used to create a single resonant tone at a distance of 0.20 m in a resonance tube with a diameter of 0.01 m. The tone has a wavelength of _____.

- 0.002 m
- 0.81 m ✔
- 1.00 m
- 5.20 m

A 384 Hz tuning fork produces standing waves with a wavelength of 0.90 m inside a resonance tube. The speed of sound at experimental conditions is _____.

- 346.68 m/s ✔
- 384.90 m/s
- 426.67 m/s
- 1382.40 m/s

A sound wave with wavelength $\lambda = 0.068$ m traveling at 340 m/s produces a frequency of _____.

- 0.0002 Hz
- 23.12 Hz
- 1250 Hz
- 5000 Hz ✔

Extension Questions

Seismic resonance is responsible for the damage caused to building by earthquakes. Apply the concepts of wave energy and resonance to explain how earthquakes damage the man-made structures. (SAMPLE ANSWER BELOW)

Earthquakes produce traveling mechanical waves known as seismic waves. These waves propagate by vibrating the ground (solid media), water, and to a lesser degree the air, in areas surrounding the epicenter of the earthquake.Energy from the waves also produces vibrations in buildings. If the frequency of the vibrating ground matches the natural frequency of the building, resonance is produced in the form of standing waves that amplify the vibration to levels that can destroy the structures.