Sound frequency and oscilloscope traces

Student activity • investigation and reasoning

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The question

How can an oscilloscope trace distinguish pitch from amplitude?

Observe brief quiet tones and use a microphone trace to calculate frequency. This is not a hearing-range test.

Equipment

- Staff signal generator, small speaker, microphone and compatible oscilloscope
- Booklet and calculator

Use short, quiet tones and stop if anyone is uncomfortable. Keep speakers away from ears; no headphones, high-volume tests or sweeps to hearing limits. Offer silent trace analysis. Staff make all electrical connections using compatible low-voltage equipment.

Course coverage: Physics only: 3.24P, 3.26P–3.29P. Frequency, pitch, amplitude and loudness.

Plan, model or apparatus sketch

Draw a labelled wave, ray or apparatus diagram appropriate to this activity.

Method and reasoning

Read the whole sequence before starting

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1. Staff connect a low-voltage signal generator to a suitable small loudspeaker. A separate microphone feeds a compatible oscilloscope input. Begin at low volume with a short tone near 500 Hz.

2. Record the time-base scale. Measure the time across five complete cycles from a captured microphone trace, then divide by five for the period and calculate f = 1/T.

3. Repeat at about 250 Hz and 1000 Hz, keeping sounds brief and comfortable. Repeat one capture at each frequency and compare the calculated values with the generator setting.

4. At fixed frequency, staff make a small amplitude change. Keep microphone position and gain fixed and compare vertical trace amplitude, distinguishing it from the horizontal period.

5. Explain the relation of pitch to frequency and loudness to amplitude under comparable conditions. Do not treat microphone voltage as a calibrated sound-level measurement.

6. State the approximate textbook human hearing range of 20 Hz to 20 kHz and its variation. Do not test individuals at range limits; anyone may complete the task silently using captured traces.

Cleanup

- Switch off sound promptly, disconnect equipment and retain trace measurements.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Practice trace: five cycles occupy 10.0 ms, so T = 2.00 ms and f = 500 Hz. A microphone trace is voltage against time; its sine-like shape does not mean sound in air is transverse. The hearing range is approximate, not a diagnostic standard for any pupil.

Setting / repeat	5 cycles / ms	Period / ms	Frequency / Hz
250 Hz / 1			
250 Hz / 2			
500 Hz / 1			
500 Hz / 2			
1000 Hz / 1			
1000 Hz / 2			

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Why time five cycles?

2. Find T for five cycles in 10.0 ms.

3. Find f for that trace.

4. What mainly determines pitch?

5. What happens to trace amplitude when sound amplitude increases at fixed gain?

6. Does this activity measure a pupil’s hearing range?