Sound: longitudinal waves and travel time

Student activity • investigation and reasoning

YEAR 10 / LESSON 64 / PHYSICS + SCIENCE (DOUBLE AWARD)

The question

How can two microphones measure the time taken for sound to travel a known distance?

All learners explain sound propagation. The speed-of-sound practical is a Physics-only extension; Double Award learners use the supplied diagram and labelled calculation instead.

Equipment

- Booklet and calculator for all learners
- Physics-only staff setup: two matched microphones, compatible two-channel scope, stands and metre rule

Staff operate the apparatus. Use brief quiet sounds away from ears; stop if uncomfortable and provide a silent trace-analysis route. Secure microphone stands and leads. Never connect a microphone input to mains. No loud bangs, balloons or hearing tests are used.

Course coverage: Shared Physics / Double Award: 3.23; 3.25P practical extension. Sound waves and speed in air.

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. Draw air compressions and rarefactions and show particle oscillation parallel to sound propagation. Explain reflection as the basis of an echo and refraction as a change of direction when sound speed varies.

2. Physics-only extension: staff align two matched microphones with a sound source beyond the first, all on one line. Measure the distance between sensing positions, first near 0.50 m and then near 1.00 m.

3. Staff connect both microphones to a two-channel digital storage oscilloscope with compatible inputs. Produce a brief quiet click or soft clap away from ears and capture both signals in one acquisition.

4. Measure the delay between the same identifiable leading feature on the two traces. Repeat three times at each separation. Convert milliseconds to seconds and calculate speed = separation / delay.

5. Double Award alternative: analyse the supplied model of a 1.00 m path difference and 2.94 ms delay, labelled practice data. Explain why this is one-way travel, unlike an echo’s outward-and-return distance.

6. Compare estimates, discuss triggering, microphone positions and reflected arrivals, and identify the first direct signal. Do not increase volume to compensate for poor sensor settings.

Cleanup

- Switch off and disconnect instruments; return stands and retain traces with measured spacing.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Practice only: 1.00 m / 0.00294 s ≈ 340 m s^{-1}. Actual speed depends on air conditions. Microphone separation equals the path difference only with the source and microphones correctly aligned in order. Sound is longitudinal in air; the oscilloscope trace is a graph, not a picture of transverse air motion.

Separation / m	Repeat	Delay / ms	Speed / m s^{-1}
0.5	1		
0.5	2		
0.5	3		
1	1		
1	2		
1	3		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. How do air particles move relative to propagation?

2. Why align the source and microphones?

3. Convert 2.94 ms to seconds.

4. Find the practice speed.

5. Why is there no factor of two in this direct measurement?

6. What could a late extra pulse represent?