

Sound, echoes, ultrasound and hearing

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Lab answers

Model answers use the sample data. Your values depend on the temperature and the distance to the wall, but they should lie between 320 m/s and 350 m/s. When you discuss errors, mention reaction time, wind and the uncertainty in the distance.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** IGCSE 3.4

Question 1 Mean time

Mean = $(7.4 + 7.2 + 7.3 + 7.1 + 7.5) / 5 = 36.5 / 5 = \mathbf{7.3 \text{ s}}$.

Question 2 Time for one interval

$7.3 / 20 = \mathbf{0.365 \text{ s}}$. It is the time for the sound to travel to the wall and back, a distance of 2 d.

Question 3 Speed of sound

$v = 2 d / t = 2 \times 60.0 / 0.365 = 120 / 0.365 = 328.8 \approx \mathbf{330 \text{ m/s}}$.

Question 4 Comparing

$(343 - 328.8) / 343 \times 100 = \mathbf{4.1 \%}$ lower. The result is close to 330 m/s used in school problems.

Question 5 Why 20 intervals

Human reaction time is about 0.2 s. Timing one interval of 0.365 s would give an error of more than 50 %. Over 20 intervals the same 0.2 s is only about 2.7 % of 7.3 s, so **the result is much more reliable**.

Question 6 Uncertainty

Uncertainty $\approx$ half the range = $(7.5 - 7.1) / 2 = 0.2 \text{ s}$. $0.2 / 7.3 \times 100 = \mathbf{2.7 \%}$.

Question 7 Effect of conditions

On a hotter day the air particles move faster, so sound travels faster and the measured time is shorter. Wind carries the sound with or against it, which changes the apparent speed in each direction and introduces **an error**.

Question 8 Improvement

Use a longer distance (for example 100 m) so the interval is longer relative to timing errors, repeat on different days, and **use a microphone and a data logger** instead of a stopwatch.