

## Measurement At Home

### Measuring the speed of sound using toilet rolls



#### How fast does sound travel?

- ❖ Can you measure the speed of sound?
- ❖ If you measure it twice, can you get the same value?
- ❖ NPL uses this technique to measure temperature very accurately

**Estimated time: 20 minutes**

**No experience needed**

#### Instructions

Watch the video ([YouTube ihKYVqkajig](https://www.youtube.com/watch?v=ihKYVqkajig))

1. Place toilet roll on a flat surface with one headphone at the bottom of the tube.
2. Stack two more rolls on top to make a tunnel for the sound and help isolate experimental sound from other noise.
3. Stick some Blue Tack on the cable near the other headphone to make it heavier and keep the cable taut.
4. Search YouTube for '3 kHz test tone' or find similar elsewhere.
5. Whilst playing the sound, carefully lower the second headphone into the tube as far as it will go. Slowly raise the headphone. Listen carefully. At one point the sound should almost disappear. Make tiny adjustments to find the quietest point.
6. Mark the cable at the top of the tube with the pen (or Blue Tack).
7. Move the cable up higher to find the next quietest point, and mark that too.
8. Remove the headphone and measure the distance between the marks in millimetres. This distance is the sound's wavelength.
9. Multiply your frequency by the distance (in mm) divide by 1000 (to convert mm to metres). This is your answer – speed of sound in metres per second.
10. You can check by repeating. You could also try other frequencies which will give different wavelengths, but the calculation should give the same speed. (Try 2 kHz and 4 kHz.)
11. Results received in the NPL webpage by end 17 June may appear in our report which will be on the webpage from 19 June.

**#MeasurementAtHome**

[npl.co.uk/measurement-at-home](https://npl.co.uk/measurement-at-home)

#### Equipment required

3 un-used toilet rolls  
Blue Tack  
in-ear headphones  
smartphone or tablet for YouTube  
ruler or tape measure  
optional pen (non-permanent)

#### Risks

- ❖ For hygiene reasons use unused toilet rolls (need them to be full size anyway)
- ❖ The sounds you play are quite pure and loud if listened to directly, it's best not to put earphones in ear when playing them

#### SI measurement units

- ❖ metre (m) for length
- ❖ second (s) for frequency, actually 1/s which is written as hertz (Hz)

#### Challenge Topics

Measurement Science, Maths, Physics

#### Thoughts, tips and information

- ❖ Do you get the same speed result for different pitched sounds?
- ❖ What happens if you change the type of headphone?
- ❖ Because the speed of light is about a million times faster than that of sound, you can use the time difference between seeing and hearing lightning to indicate distance. Each second represents a distance of about 1/3 km.

Frequency (Hz)	Wavelength (mm)	Speed of sound = frequency x wavelength divide by 1000 (m/s)	Comments

**Adult direction or supervision is required. All experiments are carried out at your own risk.**  
For more experiments, visit [NPL Measurement at Home](https://npl.co.uk/measurement-at-home).