**School band**

Some students have formed a band.

They played their first concert at the end of last term.

The students in the sound-crew are talking about the music.

**Wiktoria:** All the different notes reach the back of the room at the same time.

**Xavier:** You hear the drums just before the other music because they are so loud.

**Yasmin:** The high notes are the sharpest because they reach you first.

**Zara:** The best sound is closest to the stage, before the different notes mix together.

**To answer**

1. Who is right about the music?
   * *Explain your answer*
2. Who is wrong about the music?
   * *What would you say to help them understand?*

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| Cards for  **School band** |  |
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*Physics > Big idea PSL: Sound, light and waves > Topic PSL4: Waves > Key concept PSL4.2: A wave model of sound*

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| **Diagnostic question** |
| **School band** |

**Overview**

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| Learning focus: | As a sound wave (longitudinal wave) travels it transfers energy, as particles of the medium through which it travels are successively made to vibrate forwards and backwards along the direction in which the wave travels. |
| Observable learning outcome: | Compare the speed of sound waves that have a different frequency or loudness to each other and are moving through a common medium. |
| Question type: | Talking heads |
| Key words: | Wave, longitudinal wave, amplitude, frequency |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic question:

* Diagnostic question: Faster sound waves

**What does the research say?**

The speed of a sound wave depends on the properties of the medium it is passing through. It is independent of the wave’s frequency or the size of disturbance (amplitude). In a study of 15- to 16-year-old science students (n=243), Caleon and Subramaniam (2010) found that a third of students thought sound waves travel faster when the sound is louder. A common reason given was that louder waves have more energy. Whilst louder waves do have more energy, amplitude does not affect the speed of a sound wave in normal conditions.

About a third of students the same study and nearly a third of university students enrolled onto a university physics course (n=92) believed higher pitched sounds travel faster (Caleon and Subramaniam, 2010; Tongchai et al., 2011). This is perhaps because of the experience that when cars approach at a higher speed the sound that the car makes has a higher pitch, due to the Doppler Effect. In this situation, the sound is not travelling through the air more quickly, instead it is the movement of the car that changes the frequency of sound – and it can only do this because the sound is travelling at a constant speed.

**Ways to use this question**

This task is intended for discussion in pairs or small groups. It can be done as a pencil and paper exercise or projected onto a screen.

Students should read the statements and follow the instructions on either the worksheet or the PowerPoint. Listening in to the conversations of each group will often give you insights into how your students are thinking. Each member of a group should be able to report back to the class.

Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in the each group. For example, you may choose to select a student with strong prior knowledge as the scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

NB in any class, small group discussions typically improve over time and a persistence with this strategy is often very successful in the medium to long term.

**Expected answers**

1. Wiktoria is correct, because sound waves travel at the same speed (through the same medium) no matter what their amplitude or frequency.
2. Xavier, Yasmin and Zara are all wrong. The sound of the drums and the high notes travel at the same speed as every other note. The different notes do not mix together because they travel at the same speed therefore they always reach the listener in the same order.

The differences in how we perceive sounds are partly due to the structure of the ear, which detects certain frequencies with more sensitivity than others, and partly due to the acoustics of the room. Echoes mean that sounds may reach the ear having travelled *different distances*.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: singer: <https://pixabay.com/vectors/singing-music-sound-entertainment-311578/>, drummer: <https://pixabay.com/vectors/girl-drummer-drum-set-musician-309632/>, singer and guitarist: <https://pixabay.com/illustrations/musicians-emotions-concert-ac-dc-1428749/>.

**References**

Caleon, I. and Subramaniam, R. (2010). Development and Application of a Three-Tier Diagnostic Test to Assess Secondary Students' Understanding of Waves. *International Journal of Science Education,* 32:7**,** 939-961.

Tongchai, A., et al. (2011). Consistency of students' conceptions of wave propogation: Findings from a conceptual survey in mechanical waves. *Physical Review Special Topics Physics Education Research,* 7(2)**,** 11.