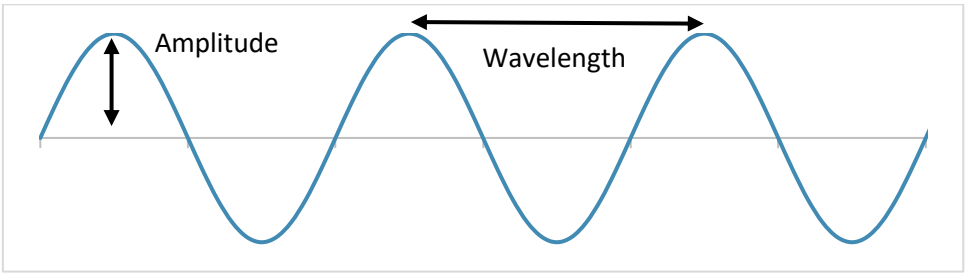
Maths in Music: Workshop 1

Lecture summary.

Mathematicians use different quantities to describe wave. These include:

- **Amplitude** A – maximum displacement of the wave from the equilibrium.
- **Wavelength** λ – the distance between two neighbouring crests.
- **Speed** v – the speed with which the wave propagates through space.
- **Period** T – The time it takes for any point of the wave to move through one full oscillation.
- **Frequency** f – The number of full oscillations any point of the wave completes in 1 second.



The speed can be related to frequency and wavelength using the following mathematical formula:

$$v = \lambda \times f.$$

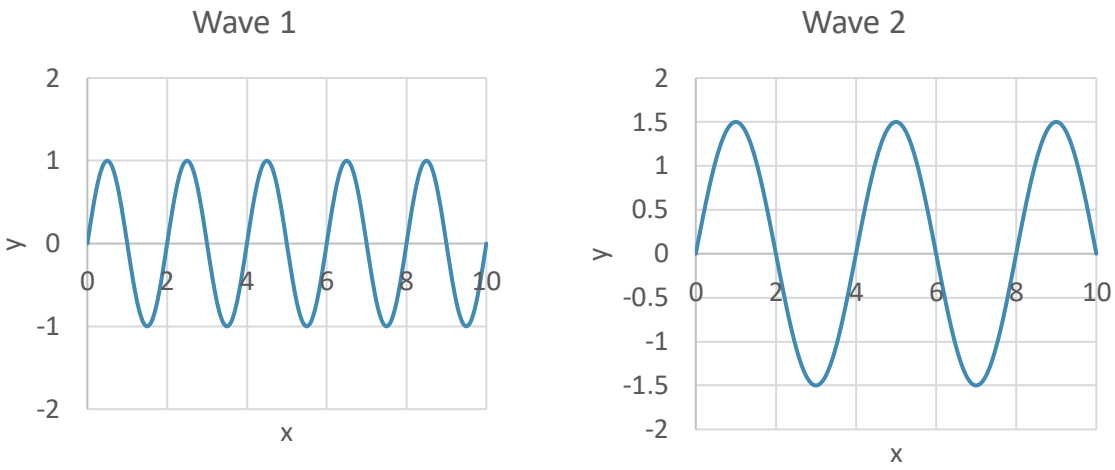
Period and frequency are related by the formula:

$$f = \frac{1}{T}.$$

$sin(x)$ is a wave with a period of 360° and an amplitude of 1. $A\,sin(bx)$ is similar but with the amplitude scaled by A and the wavelength scaled by $\frac{1}{b}$.

Task 1.

The graphs below present two different waves. Try to answer the questions below.



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1. Which wave has a greater amplitude?

2. Which wave has a longer wavelength? What is the wavelength value for each wave?

3. The speed of both waves is the same. Try to use the formula $v = \lambda \times f$ to determine which wave has a higher frequency.

4. We measured that the speed of both waves is $v = 340$ metres per second. Find the frequency of each wave. Compare your answers with other students.

Task 2.

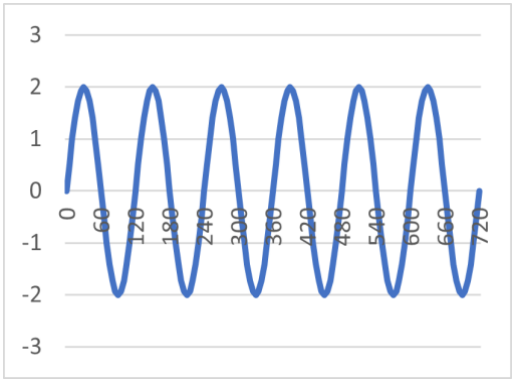
In this activity you will have to interact with the whole group. Take one of the graphs provided by the tutor. Note that each of them presents different waves. Try to line up in the room in the order of increasing frequency.

After you complete this task try to find two things all the graphs have in common.

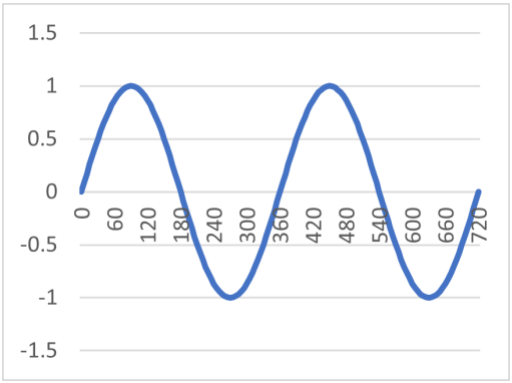
Task 3.

Below are four different sine waves. Match up the equations with the graphs.

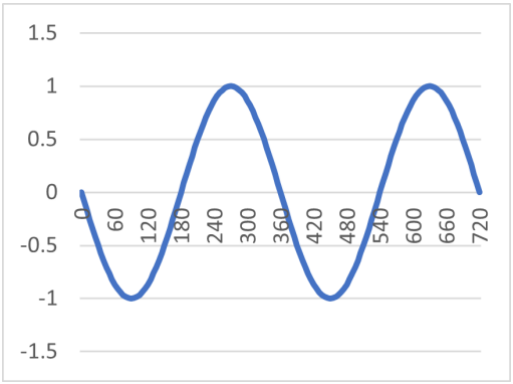
a) $sin(x)$ b) $sin(2x)$ c) $-sin(x)$ d) $2\,sin(3x)$



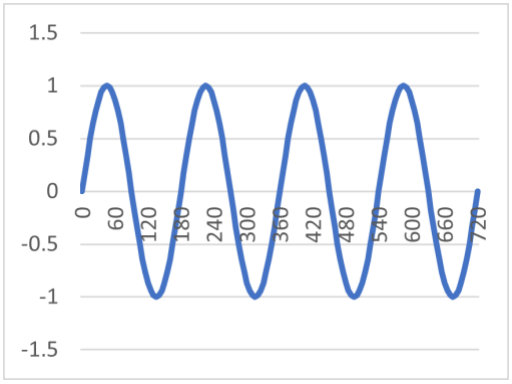
Equation:



Equation:



Equation:



Equation:

Extra challenge!

The amplitude and frequency of waves is analysed using special sea buoys, like the yellow one depicted in the first graph below, which shows the height of the waves in one moment in time. Thanks to the sensors in the buoy, we can measure how its height changes with time, and this information is presented in the second graph. Use both graphs to try and determine the speed of the wave in m/s.