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http://www.acoustics.salford.ac.uk/schools

TEACHERS LESSON PLAN: Lesson Two – Wave Equation

This lesson plan accompanies the WHITEBOARD version of the site, and can perhaps be used as a 'script' to accompany the lesson. The guide script is shown in italics.

AIM: to know that sound travels at different speeds through different materials

1) WAVE EQUATION
In this lesson you will learn how speed, frequency and wavelength are linked.
You will find out how the speed of sound varies depending on what it is travelling through.
You will also learn how to use the WAVE EQUATION.

2) RECAP – SOUND WAVES
Speed is measured by how many meters the wave travels in one second.
Frequency is the number of times the waveform passes a point per second.
Wavelength is the distance between matching points on a wave.

3) SPEED FREQUENCY WAVELENGTH
From lesson 1 you learnt that if the ball is moved quicker the wavelength is reduced when the speed of the wave stays the same.
Talk them through the animation at this point.

As frequency increases wavelength decreases when speed is constant.
What equation would link these together?
Talk them through the pen animation at this point.

4) WAVE EQUATION
The speed, frequency and wavelength of a wave are linked by the following equation:

Speed = Frequency x Wavelength

Speed is measured in m/s, frequency in Hz, and wavelength in m

Now you could show them how to use the sliders to change the frequency and wavelength and see the change in speed.

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5) WAVE EQUATION – IN USE
This sound wave has a wavelength of 0.5m and a frequency of 300Hz. What speed is the wave travelling at?

You could either work through this with the class, or ask them to put their hand up if they know the answer

ANSWER = 150 m/s

6) SOUND TRANSMISSION

At this point you could recap the particle model (kinetic theory at A-level). Ask them what they remember about this – hopefully they come up with the answers! You could maybe ask them to draw pictures on the board. This should take around 5 minutes.

Ask them to think about how sound waves are transmitted – BY PARTICLES VIBRATING. Animation at this point to show vibrating particles.
If particles are close together, they are able to pass on vibration to next particle more easily. **Therefore sounds travel fastest in solids** (they usually presume gas, which is why its good to remind them of particle model)

SOLIDS – in a solid the particles are close together. The vibration passes from one particle to the next easily. A sound wave therefore travels quickly through solids.
GAS – in a gas the particles are further apart. The vibration passes from one particle to the next less easily. A sound wave therefore travels slowly through gas.

7) WAVE EQUATION

Use wave equation again with different materials (water, air, steel) – could link to refraction = Frequency remains the same, but if the speed changes the wavelength must change.

Here are a couple of questions that use the wave equation for you to try:

> *A sound wave travels through a liquid with a wavelength of 1.5m and a frequency of 300Hz. What speed is the wave travelling at?*
>
> *Now the sound is travelling through a solid, what will happen to the speed?*
> *a sound wave travels through a solid with a wavelength of 2.1m and a frequency of 300Hz. What speed is the wave travelling at?*

8) WAVE EQUATION
The wave equation is (read this out)
This can be shown with the following triangle.

So the three equations are: (read the equations out)

Here is a question that uses one of the rearranged wave equations.

A sound wave has a speed of 340m/s and a frequency of 2kHz. What is the wavelength of the wave?

SUMMARY

*The **Wave Equation** is: **Speed** (v) = **Frequency** (f) x **Wavelength** (λ)*

*Waves travel **quickly** through **solids***

*Waves travel **slowly** through **gas***

*The **Wave Equation** can be rearranged into:*

$f = v / \lambda$

$\lambda = v / f$