ABINGDON SCIENCE PARTNERSHIP

Frequency and wavelength of waves!

Safety!

- Be careful to not snap the ruler - it could leave sharp edges!
- Keep your face well away from the ruler during the investigation.

Apparatus

- A hard surface with an edge.
- A hard ruler (works best if it is plastic or metal)
- A pen/pencil
- Stopwatch (optional)

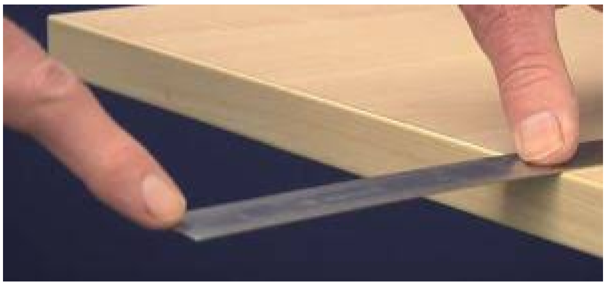
Method

Summary

This experiment uses a ruler to show the relationship between frequency and wavelength. We can also use this setup to show how at a different distance from the pivot, less force is needed.

Steps

- Put the ruler over the edge of the surface and clamp down on the ruler over the table using your hand.



- Use your finger on the end of the ruler to flick the ruler.
- When you let go, the ruler will vibrate. You can vary the distance(wavelength) by moving the ruler so more or less is over the table. Using the table below, you can record your results by saying what happens to the vibrations when you change the length. In the next column, you can say how long the vibrations lasted for, either in relation to the others or in seconds.

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Length of ruler	Frequency generated (high, medium, low)	Time it lasted for (seconds)
¼ of the ruler vibrating		
½ of the ruler vibrating		
¾ of the ruler vibrating		

In the next table down, you can tell us what happens to the pitch of the sound created.

Length of ruler	Pitch created (low pitch, medium or high pitch)
¾ of the ruler vibrating	
½ of the ruler vibrating	
¼ of the ruler vibrating	

In the next part of the experiment, we can look at how the force required to bend the ruler a certain amount, changes with the length of the ruler that is bending. This is a different part of physics called mechanics, but can be looked at in the same experiment. In the table below, record how much relative force you had to put on to the ruler to make a vibration or sound.

Length of ruler	Force applied to the ruler (high, medium, low)
¼ of the ruler vibrating	
½ of the ruler vibrating	
¾ of the ruler vibrating	

Conclusion

What can you say about the three experiments you just did?

Length against frequency of the vibrations - were they slower or faster as length increased?
………………………………………………………………………………………

Length against time the vibrations lasted for - did they last for more or less time as length increased?
………………………………………………………………………………………

Length against pitch of the sound - did the pitch sound higher or lower as length increased?
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Length against force - did you use more or less force a length increased?
………………………………………………………………………………………

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Evaluation

These experiments are based on some simple physics equations that are very important in school and daily life. The first equation is

$$\text{wave speed} = \text{frequency} \times \text{wavelength}$$
$$v = f \times \lambda$$

For these experiments we can assume the wave speed is constant.

This equation shows that the frequency is inversely proportional to the wavelength. Inversely proportional means that, for example, if the wavelength was to get 3 times larger, then the frequency would be 3 times smaller, or 1 third.

The amount of time the waves carry on vibrating is very applicable to real life. The waves with a longer wavelength and lower frequency are not absorbed as well by the air, and therefore last longer. This is the reason it is used for communication, in mobile phones, and radar - they can travel long distances without losing energy. It also doesn't damage humans, as the waves pass right through us. But in a microwave, where the wavelength is shorter and the frequency is higher, this is useful as the energy in the waves need to be absorbed by the food quickly.

Pitch is what we call the frequency of a musical note. If you did the experiment correct, you should see that with a higher frequency there is a higher pitch. This is due to the inverse proportion mentioned earlier, when we shorten the wavelength. The same thing happens when you put your finger down on the string of an instrument with strings, such as a guitar, violin or cello. You shorten the length of string that can vibrate, and this increases the frequency and increases the pitch.

In the final experiment, we looked at length against force. The previous experiments looked at the part of physics looking at waves, but here we are looking at mechanics. You should have found that with a longer distance over the edge of the table, less force was needed. Another experiment you could do is to put a small weight on the end of the ruler(on the table), such as a rubber, and use your finger to see how much force is required to lift up the rubber. You should find the relationship between the length and the force is inversely proportional. When you multiply the (perpendicular) length from the pivot and the force applied, you find the moment. This value is what we call a turning force, but it also represents energy.