

TAP 307- 5: Resonance of a hacksaw blade

When the driving frequency matches the natural frequency of an oscillator the amplitude of oscillation can rise dramatically. This is resonance. This experiment gets you to measure how the amplitude of an oscillating hacksaw blade changes with the frequency of the driver. The hacksaw blade is linked to the vibration generator by a piece of elastic cord. You will see the blade oscillate but will have to decide how to measure the amplitude of oscillation.

You will need

- ✓ vibration generator
- ✓ signal generator
- ✓ 30 cm hacksaw blade
- ✓ elastic cord
- ✓ slotted base
- ✓ G clamps, 10 cm
- ✓ leads, 4 mm

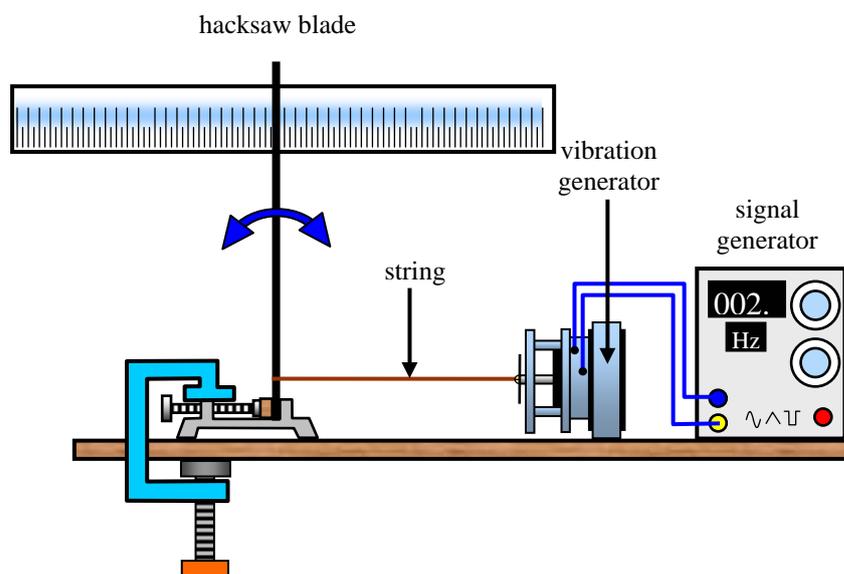
Optional:

- ✓ stroboscope

Be Safe

	<p style="text-align: center;">Safety</p> <p>An oscillating hacksaw blade demands a degree of respect.</p> <p>Students should wear safety goggles and ensure that the device is well clamped.</p> <p>If there is a risk of the blade being used as a weapon, have the teeth ground off by workshop staff.</p>
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Setting up



What to do

Set the variable frequency generator at 1 Hz and measure the amplitude of oscillation. Repeat this at 1 Hz intervals up to 10 Hz. Keep a record of the results – but it is even more vital than usual to plot the results as you go, to see where extra readings are needed to define the curve.

Use the graph plotting package to produce a presentation-quality graph of your results. What do they show you? What happens to the amplitude of the oscillation when the driving frequency matches the natural frequency of the blade?

You have seen

1. That the amplitude of oscillation of the blade increases markedly when the driving frequency matches the natural frequency of the blade.

Practical advice

This quick and effective activity gives a clear example of mechanical resonance. Although we are concerned with a qualitative understanding of resonance, it is worthwhile encouraging students to attempt amplitude measurements as this will lead to more careful observations – they will ‘see’ how sharp the resonance peak is rather than quickly scanning through a range of driving frequencies. There are many ways of measuring the amplitude of oscillation. Three possibilities are: hanging a table-tennis ball by a thread and moving it towards the blade until the ball is seen to be pushed away, or direct measurement with a ruler behind the blade, or chalking the blade and allowing it to rub against a ruler – although this diminishes the amplitude.

The elastic cord forms a loose coupling between the vibration generator and the blade to give a ‘tug’ once an oscillation occurs.

Students could measure the natural frequency of the blade using a stroboscope. The problem with this is that the frequency is about 6 Hz, which is very uncomfortable and best avoided. It is suggested that the teacher or technician measures the frequency before the experiment and marks the value on the blade. A side arm of an inertial balance or ‘wig-wag’ can be used instead of the hacksaw blade if one is available.

Alternative approaches

Students may suggest other resonating systems for exploration.

Social and human context

Resonance effects are widespread. Students could be encouraged to look for readings and articles concerning resonance.

Be safe

Safety	
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External reference

This activity is taken from Advancing Physics chapter 10, 340E