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Rubber Band Bass Guitar

What you'll need:

A rubber band. If you have different shapes and sizes, even better!

What to do:

In this activity you'll be listening to sounds by putting your finger in your ear. Wash your hands before doing this and remember never to force your finger (or any other object) into your ear.

1. Take your rubber band. Stretch it between the index finger and thumb of one hand.
2. Gently put your index finger in your ear. Don't push hard, but make sure there's a seal, as if you were trying to block out a loud noise.
3. Twang the band with the index finger of your other hand. You should hear loud sounds like a bass guitar.
4. Change how much the band is stretched by moving your fingers closer together or farther apart. Stretching the band increases the tension in the band. Can you adjust the band so that you can play two different notes on the two halves of the band?
5. Take your finger out of your ear, but keep twanging the band. How does the sound change?
6. Once you've got the hang of it, see if you can play any famous basslines, like Seven Nation Army or Another One Bites the Dust.

Things you could ask:

- *What makes the sound and how does it get into your ear?*

- *How does the sound change when you stretch the rubber band more or less?*

What's going on?

A sound is made when something vibrates. Take your rubber band, stretch it out and give it a twang. You can even see these vibrations! The vibrating band makes the air nearby vibrate, and the vibrations spread out in all directions. If your ear is nearby, you will hear the sound as the vibrations make your eardrum and the bones in your ear vibrate as well.

In our rubber band bass guitar, the vibrations travel through your finger to your ear. Sounds travel better through solids like your finger than through gases like the air. This is because the molecules in a solid are so much closer together than in a gas so it is easier for the vibrations to be passed along. As soon as you take your finger out of your ear, there is a gap of air so the sound gets quieter.

You can change the pitch to create your basslines as you stretch and release the band. The more you stretch the band, the more tension it is under and the faster it vibrates up and down. The number of vibrations every second is called the frequency and this tells you exactly how high or low the note is. A guitarist does the same thing when tuning their guitar by turning the fiddly things on the neck of the guitar to stretch or relax the string.

What next?

Investigate together and discover how the sound changes when you use:

- A thicker or thinner band
- A longer or shorter band (You can shorten a long band by tying a knot in it)
- Knowing what you do about vibrations, can you predict what will happen?

Did you know?

The study of sound itself is called acoustics. This is also the name for non-electronic music – so your rubber band bass experiment is both!

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Waterproof Hanky

What you'll need:

- A glass or transparent cup
- A plate, one with a raised edge works nicely
- Water
- Fabric handkerchief (or any type of cloth really). Don't use a paper hanky, it won't work!

What to do:

In this activity you'll be tipping glasses of water upside down and there will probably be some spillages along the way. We recommend trying the trick outside, in a bathroom or at the very least over a bowl! You should definitely practise the motion a couple of times before trying it with a person.

1. Push the centre of the hanky into the glass, so that the edges are hanging over the outside of the rim of the glass.
2. Pour water into the glass, through the loose hanky. Make sure that the rest of your family can see the water pouring easily through the hanky into the glass. Keep pouring the water until the glass is roughly half full.
3. Pull the corners of the hanky so that the material is taut over the top of the glass. Hold the glass and hanky so that the material stays tightly stretched over the opening.
4. Place the plate on the top of the glass and tip it all upside down, being careful to keep the hanky pulled tight.
5. Choose the member of your family most likely to forgive you if this goes wrong and you soak them…
6. Hold the upside-down glass and plate combo above their head, making sure that the glass is vertical and the hanky is tight. Remove the plate and... voila! The water stays inside the glass.

What to talk about:

- With no hanky, what force makes the water fall out of the glass?
- Have you ever seen a bug walk on water?

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What's going on?

There are three main forces that have an effect when we turn our glass of water upside down. Gravity pulls down on the water, and is the force that makes the water pour out of a glass.

There are also upward forces on the water due to both air pressure, which pushes on everything around us all the time (in this case the air will be pushing up through the mouth of the glass) and surface tension, which tries to hold the water together across the mouth of the glass.

Surface tension is what gives water an elastic-like skin at the surface. This elastic skin has real effects – it's what pulls water into droplets like you might see on a spider's web early in the morning, it's what holds up water strider bugs walking across ponds and it's what lets you overfill a glass before it spills.

This trick makes use of the fact that the strength of surface tension depends on the size of the hole; the smaller the hole, the stronger the surface tension. Without a hanky, the hole is large and the surface tension is nowhere near strong enough keep the water together. The upward forces aren't big enough to balance the downward force of gravity and so the water pours out (and as the water moves out of the way, air pressure makes the air rush into the glass to replace the water).

A hanky is made of a material that's woven together and has tiny holes. Putting one across the mouth of the glass makes the hole through which water is trying to get through much smaller and so the surface tension much stronger. There is a strong stretchy skin across each hole. The surface tension, combined with the push due to air pressure is large enough to balance the force of gravity so that the water stays inside the glass – and you stay friends with your family.

What next?

If you want to investigate further with your family, you can put the strength of surface tension to the test (do this bit over a sink, not over somebody's head!)

- Almost fill a glass with water and put Clingfilm over the mouth. Turn it upside down like you did with the hanky. Of course nothing happens… Clingfilm is waterproof!

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- Can your family predict what will happen if you keep it upside down and prick small holes in the Clingfilm with a pin?
- How many small holes can they make without the water escaping?
- How big can you make the hole before water starts to drip through?

Now that you've found out about surface tension, gravity and air pressure, can you work out what's going on?

Did you know?

The surface tension of water is pretty strong, but it's the element mercury that has the highest surface tension.

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Shrinking Coin

What you'll need:

- 1x 10c coin (or 1p)
- 1x €2coin (or 2p)
- piece of paper (approx 10cm x 10cm)
- pencil
- scissors

What to do:

1. Lay your small coin in the centre of the piece of paper. Trace around it using the pencil.
2. Cut out the centre of the circle so that you're left with a piece of paper with a hole in the centre.
3. Demonstrate that the small coin slips easily through the hole.
4. Challenge your family to get the larger coin through the hole – WITHOUT ripping the paper or altering it in any way. Give them some time to try (it might be a nice idea for each person joining in to have their own coin and piece of holey paper).
5. Show them how it can "really" be done:

Take the piece of paper and bend it in half. Hold the paper so that the bend is at the bottom. Drop the big coin between the sides of the paper into the centre of the hole.

Grasp the paper between finger and thumb near the bend, on either side of the coin. Slide your fingers upwards around the coin. Allow the paper to buckle around the coin – you don't want to keep it tight all the way around.

The coin should now slip through the hole! A top tip for you here though – try to use fresh sheets of paper with each experiment, as the folds you make might give them a clue…

What to talk about:

- *What happens when you fold your paper? Is it still totally flat?*
- *Try naming some different 2D and 3D shapes.*

What's going on?

This is definitely a challenge and to solve it your family will have to put their problem solving skills to the test. The answer isn't obvious, so how can you help them along the way?

Firstly, work out exactly what the problem is. So set up the trick – first with the 1p and then 2p piece (or equivalent). See if they can pinpoint exactly why it won't work.

- For our coins it is pretty simple, the 2p coin is too big for the hole!

Now that you know exactly what is stopping the coin, ask your family if there is anything that they can change?

- We can't change the coin, but we can change the paper – ripping it is against the rules but is there anything else they can try?
- Folding it in half turns the round hole on our flat (2D) piece of paper into a slit across the bottom of our folded (3D) one. Of course our problem is still there: the points on either side of our coin are still too close together for it to fit through the slit.

Finally, don't be afraid to be creative! Because we have folded the paper we can now pull these two points apart very gently and the paper will bend to allow the slit to get wider and not tear. The coin slips through, almost like it has shrunk.

Physics is all about understanding our world, and as we solve problems like our shrinking coin we find out a little something more about how our Universe works – and it can be fun too! Who doesn't like to find out how a trick works?

What next?

This is a really nice experiment to try out first with the youngest member of your family. Once they have worked it out, you can put them in charge of the puzzle and they can challenge everyone else with the mystery of the amazing shrinking coin!

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Did you know?

There are more dimensions than just the three you are familiar with. Time is sometimes thought of as the 4th dimension.