GEEK & CO. SCIENCE!

PROJECT KIT

Ages 8+

GeeKeR SPEAKER LAB

THAMES & KOSMOS

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Safety information

WARNINGS. Only for use by children aged 8 years and older. Instructions for parents or other supervising adults are included and have to be observed. Keep the packaging and instructions as they contain important information. Not suitable for children under 3 years. Choking hazard — small parts may be swallowed or inhaled. Strangulation hazard — long wires may become wrapped around the neck.

Notes on experimenting with batteries

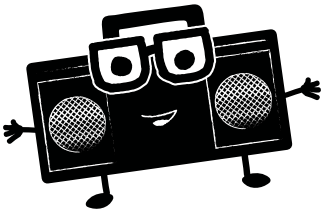
The wires are not to be inserted into socket-outlets. Never perform experiments using household current! The high voltage can be extremely dangerous or fatal!
Two AAA batteries (1.5-volt/LR03) are required, which could not be included in the kit due to their limited shelf life.
Different types of batteries or new and used batteries are not to be mixed.
Do not mix old and new batteries.
Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.
Batteries are to be inserted with the correct polarity. Press them gently into the battery compartment.
Non-rechargeable batteries are not to be recharged. They could explode!
Rechargeable batteries are only to be charged under adult supervision.
Rechargeable batteries are to be removed from the toy before being charged.
Exhausted batteries are to be removed from the toy.
The supply terminals are not to be short-circuited. A short circuit can cause the wires to overheat and the batteries to explode.
Dispose of used batteries in accordance with environmental provisions.
Be sure not to bring batteries into contact with coins, keys, or other metal objects.
Avoid deforming the batteries.
Have an adult check the assembly before you use it so you can be sure it was assembled properly!

Advice for parents and supervising adults

Music is a big part of our lives. It's hard to imagine life without it. And it's nice when we can take our favorite music along with us and listen to it together with our friends. This science project kit was created with that in mind. To help your child use this device safely, read through the instructions together before starting the experiments, discuss the safety information, and help your child with the experiments.

An optional experiment at the end of the manual requires you to help your child find, download, and use a signal generator app for your smartphone or tablet. You may want to also help your child find some supplemental information on the Internet, especially cool video examples of cymatics, or visible sound wave patterns, which you will learn about in this kit.

Have fun listening to the music and performing the experiments!



Notes on disposal of electrical components

None of the electrical or electronic components in this kit should be disposed of in the regular household trash when you have finished using them. Instead, they must be delivered to a collection location for the recycling of electrical and electronic devices. The symbol on the product, instructions for use, or packaging will indicate this. The materials are reusable in accordance with their designation. By reusing or recycling used devices, you are making an important contribution to the protection of the environment. Please consult your local authorities for the appropriate disposal location.

NOTE! *The additionally required items are highlighted in italic script in the individual experiments. Before starting the experiments, carefully read through everything that will be required and make sure to have all the materials ready.*

KIT CONTENTS

1

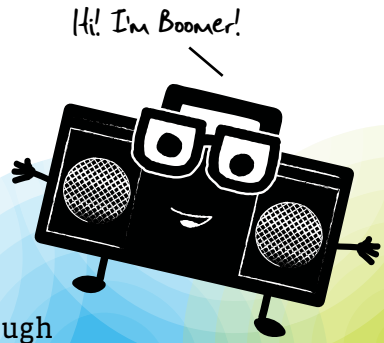
2

3

1 | Vibration speaker
2 | Bag of sand
3 | Plastic tray
4 | Protective film for speaker (on the speaker's adhesive pad)

YOU WILL ALSO NEED: *Two AAA batteries (1.5-volt, type AAA/LR03); small Phillips head (cross-head) screwdriver; audio source such as an MP3 player, cell phone with headphone jack, or sound system; empty box (such as a cereal box); two books or blocks; adhesive tape; signal generator app (optional)*

Hey Audio Geeks!



Are you ready to rock out to some great beats — and learn about the science of sound and how speakers work in the process? The vibration speaker in this kit turns practically any surface into a larger speaker. Stick the speaker onto a variety of surfaces and objects to find out which materials produce the best sound. Experiment to see sound waves ripple through a tray of sand or water. These instructions will show you how to do it. So let's get going!

GEEK OUT!

POWERING UP WITH BATTERIES

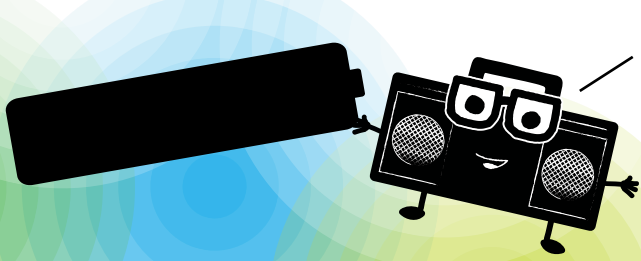
Installing the batteries

You will need:

Vibration speaker, *two AAA batteries (1.5-volt, type LR03), small Phillips head (cross-head) screwdriver*

You will first have to install batteries in the sound booster. It's best to let an adult help you. Open the battery compartment by loosening the small screw on the bottom of the device. Insert two 1.5-volt batteries, type AAA/LR03. The + and – symbols on the batteries and in the compartment show you the correct way to insert them. Finally, put the lid back on the battery compartment and screw it on tight with the small screw.

Now you are ready to rock! Let's get your vibration speaker jammin'.



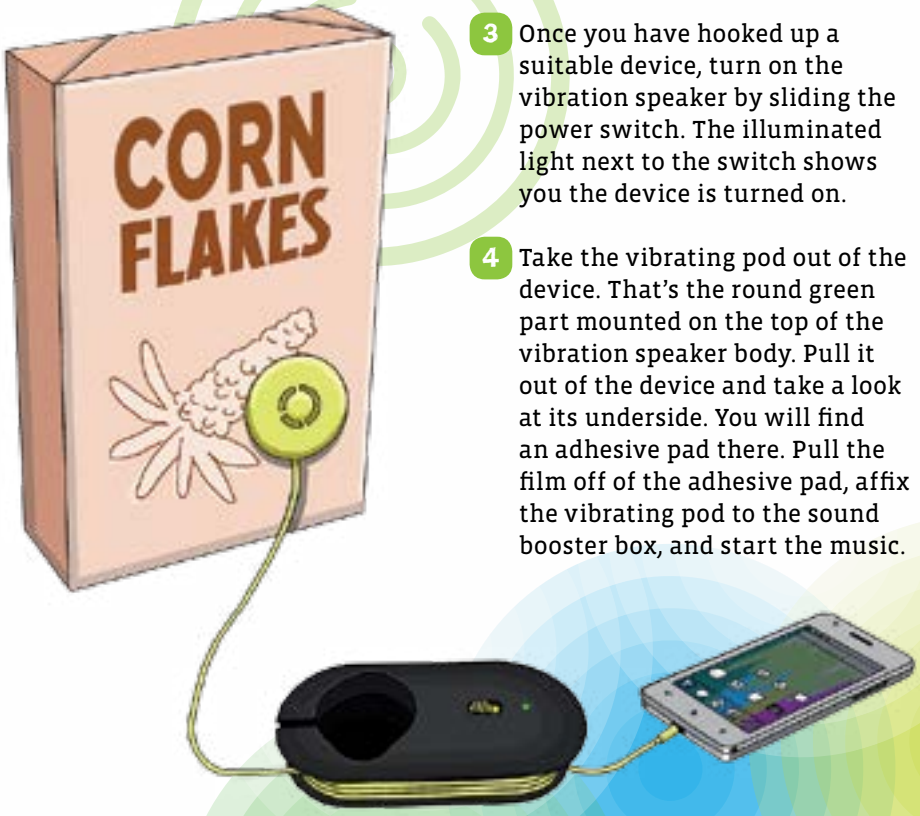
PART 1

USING YOUR GEEKER SPEAKER

How to use the vibration speaker

You will need:

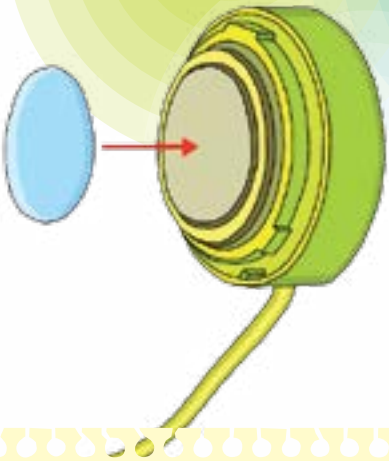
Vibration speaker; *an audio source such as an MP3 player, a cell phone with a headphone jack, or a sound system; empty box (such as a cereal box) to use as a sound booster box*



Here's how:

1. Make sure you have installed the two AAA batteries correctly, and that the batteries are charged.
2. Your vibration speaker has a short wire on the bottom with a 3.5-mm phone jack. This plug will fit in almost any common device that plays music.
3. Once you have hooked up a suitable device, turn on the vibration speaker by sliding the power switch. The illuminated light next to the switch shows you the device is turned on.
4. Take the vibrating pod out of the device. That's the round green part mounted on the top of the vibration speaker body. Pull it out of the device and take a look at its underside. You will find an adhesive pad there. Pull the film off of the adhesive pad, affix the vibrating pod to the sound booster box, and start the music.

5 IMPORTANT!
Do not throw away the protective plastic film that was stuck onto the adhesive pad. It protects the adhesive pad from getting dirty. You can keep using the adhesive pad over and over. If the adhesive pad does get dirty and won't stick well anymore, simply wipe it off with a damp finger. Then it should stick like new again.



Time to make a hypothesis (or educated guess):

What materials and objects do you think will sound the best with the vibration speaker? Write down your initial guesses here, and why you think so.

And below, write down a list of songs you want to experiment playing when the vibration speaker is attached to each of the above materials and objects. Make sure you test each song with each material and object.

PART 2

NEW WAVES: SPEAKER EXPERIMENTS

Experiment 1: Music without a resonating body

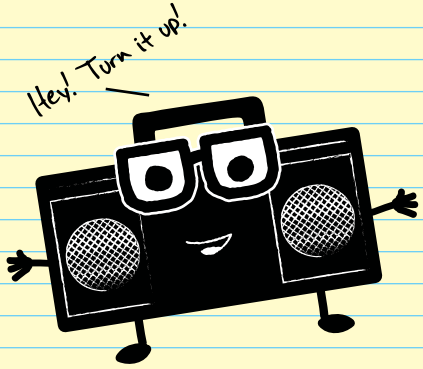
Here's how:

1. Connect the vibration speaker to an audio source and start the music.

2. Remove the vibrating pod from its housing and take a look at it. Can you see the way the speaker membrane vibrates along with the music?

What's happening?

These vibrations are passed along when you attach the speaker to another object. When you do that, the object is acting as a so-called resonating body, or sound box. Without a resonating body, the speaker sounds pretty weak.



Experiment 2: Various materials

You will need:

Vibration speaker, *audio source, a selection of various objects and materials from around your home or classroom*

Here's how:

1. Remove the protective film from the vibrating pod, stick the speaker onto whatever object you have on hand, and start the music. Do you hear how the sound changes?

2. Try this experiment with a variety of different objects and materials. On this page, you can see a few examples of things you can try. But there are really no limits to what your imagination can come up with.

What's happening?

You will hear a different sound depending on the material you use. Metallic objects, for example, don't sound as nice as ones made from wood. The volume will also change as you use different objects. In general, the sound will be louder with hollow objects. But it also matters how well the material vibrates. Record your findings on page 16.

Experiment 3: Making sound visible

You will need:

Vibration speaker, black plastic tray, sand, *audio source, two books or blocks, adhesive tape*

Here's how:

1. Attach the vibration speaker's vibrating pod to the underside of the plastic tray. To keep the experiment tray from sitting on the vibration speaker's wire or resting on the vibrating pod itself, just set it on two equally-thick books or blocks. If the speaker becomes disconnected from the basin, you can also try securing it with some adhesive tape.

2. Cover your work area in newspaper or work in a place where some sand can be spilled and things can get a little bit messy.

3. Pour just a little sand into the tray — not so much that the bottom of the basin would be completely covered if the sand was spread out evenly.

4. Start your music, ideally a song with a lot of bass. If you have done everything right, the sand will move around in the basin and create some cool patterns.

5. Experiment with different songs and different volume levels.

Experiment 4: Making sound visible in water

You will need:

Setup from Experiment 3

Here's how:

1. Try the "Making sound visible" experiment with water. It also produces some very interesting visual effects, even though it looks totally different. You can also try a combination of sand and water. You may be able to think of other materials to try with this experiment as well.

What's happening?

Sound vibrations travel through air. They also travel through liquids, like water, and through solids. The medium through which sound travels greatly affects the way the vibrations move, and thus the way we perceive the sound.

It may seem weird to you that sound can travel through liquids and solids, but as long as there are particles that can vibrate, there can be sound. Think of all the particles in a solid table, for example, as being connected together with tiny springs in between each particle. When you push one particle, the energy is transmitted through the spring to the next particle, and so on. In fact, the less compressible a material is, the faster sound travels through it! Sound travels four times faster in water than air, and 15 times faster in iron than air.

Bonus Experiment: Frequency patterns

You will need:

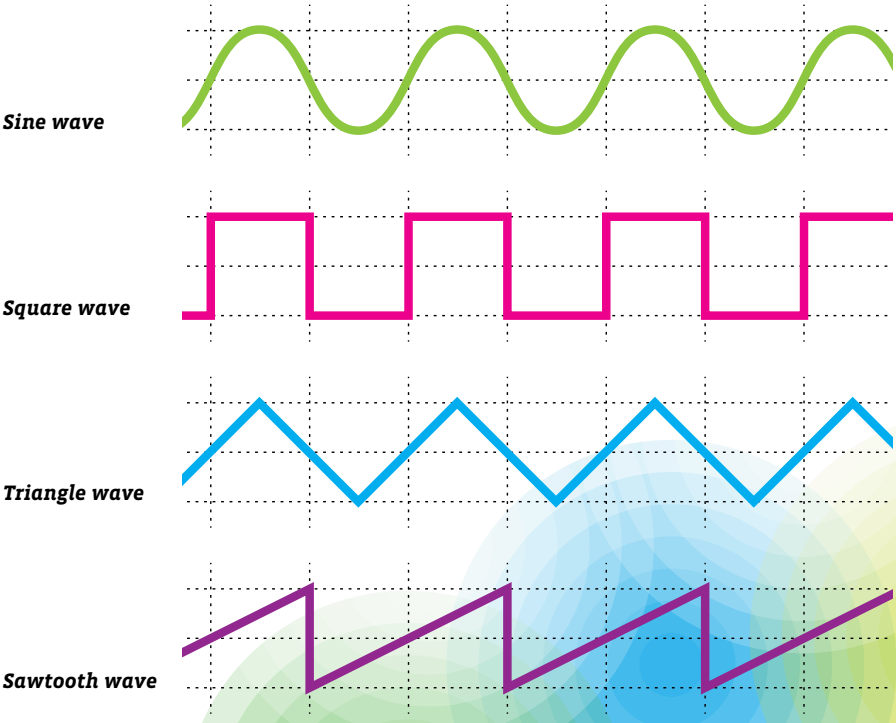
Setup from Experiment 3, *smartphone or tablet, signal generator app (have an adult help you with this)*

Here's how:

1. Have an adult help you find and download a signal generator app onto your smartphone or tablet. Search for "signal generator" or "tone generator." There are many free and paid apps available.

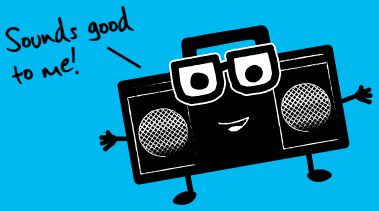
2. With a signal generator app, you can produce much more consistent sound patterns than with music. Use the same experiment setup as in the "Making sound visible" experiment.

3. Simply connect your smartphone or tablet to the vibration speaker, start the app, and push the app's "on" button. You can use the controls to adjust the volume and frequency. You can also try adjusting the frequency very precisely by inputting numbers. Can you find a frequency at which the grains of sand or drops of water will start to dance in interesting patterns?



GEEK OUT!

WHAT IS SOUND?



The sound that we hear is nothing other than compressed air pushing against the inner parts of our ears. For example, when we snap our fingers, this action compresses, or pushes together, the air at the location impacted by our fingers. The air particles are condensed for a moment and then expand again. This vibration, or fluctuation in pressure, passes on to the surrounding air particles, which in turn pass it on to the air particles next to them. In this way, the vibration spreads out like waves in all directions. The particles themselves do not necessarily move very far — rather the vibration travels through the medium, from particle to particle.

If we could see this, it would look something like the **waves** that are created when you toss a rock into the water, only in three dimensions instead of two. The vibration speaker transfers sound waves to other objects and gets them to start vibrating.

By the way, vibrations can travel through all sorts of media: solids, liquids, and gases. We can hear sound under water because sound vibrations spread out very easily in water. In outer space, on the other hand, we wouldn't hear anything at all, because there is no medium such as air or water through which the sound can spread out. There is simply nothing to vibrate in space.

Sound vibrations travel through materials like waves in a pool of water.

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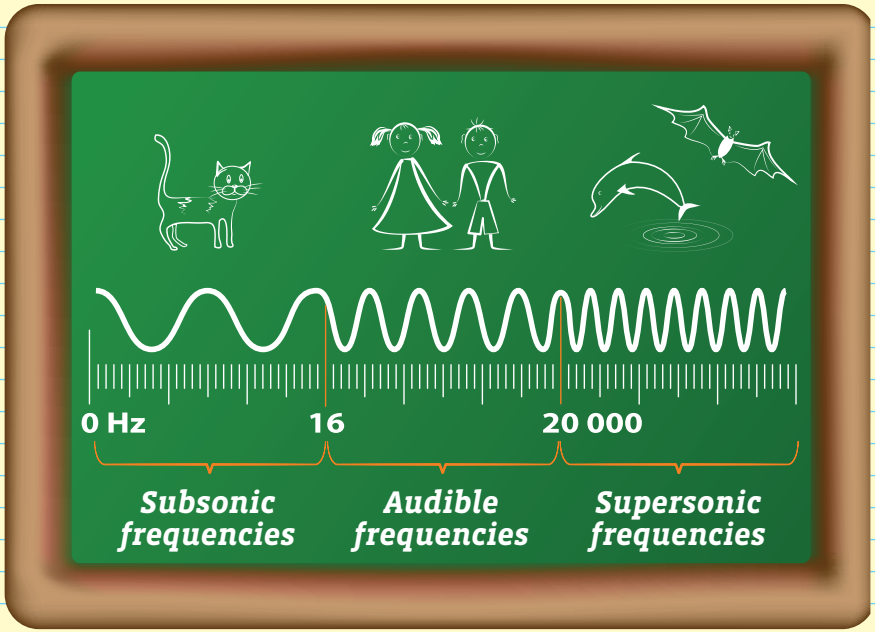
GOOD VIBRATIONS: SOUND FREQUENCIES

Sound is indicated in **frequencies.** The frequency indicates how many waves there are per second at a particular spot. As mentioned on the previous page, a sound wave in this sense can be thought of as a change from most compressed state to least compressed state and back again. The number of times this happens in a particular time, or **period,** is the frequency.

The unit for frequency is the **hertz.** One wave per second equals 1 hertz.



Humans can perceive frequencies between 16 and 20,000 hertz. Some animals can hear lower frequencies and others can hear higher ones.

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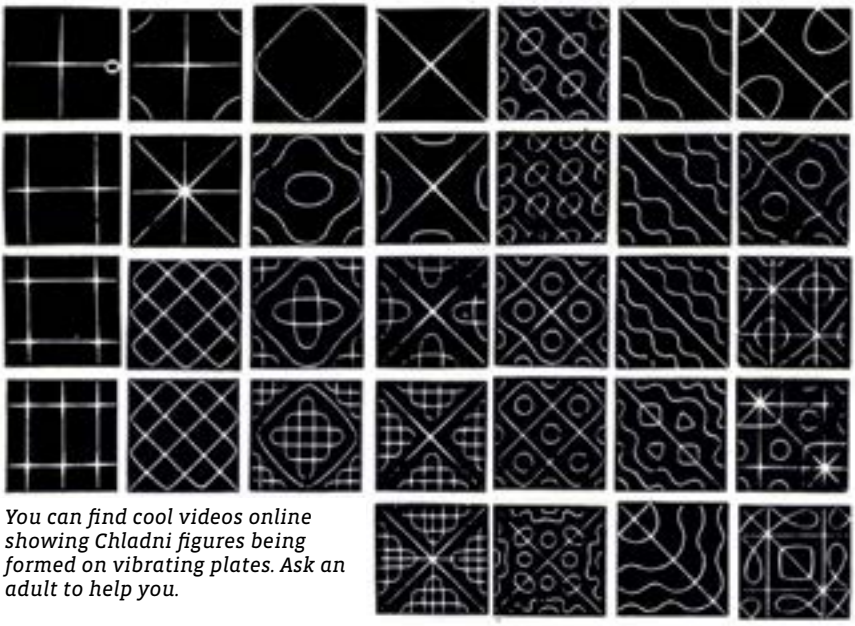
SEEING SOUND WAVES: CYMATICS

Cymatics is the study of techniques for making sounds and sound waves visible. A pioneer of cymatics was the German physicist and musician Ernst Chladni (1756 – 1827). He would draw his violin bow over a thin metal plate to make it start vibrating. When he sprinkled sand on the plate as he made it vibrate, complex patterns would form that would differ depending on the frequency of the vibrations. He recorded these patterns in his book *Die Akustik* ("Acoustics"). Today, these patterns are known as **Chladni figures.**

Ernst Chladni



You can find cool videos online showing Chladni figures being formed on vibrating plates. Ask an adult to help you.

GEEK OUT!

SPEAKER SCIENCE

There are many types of **speakers**. What all speakers have in common is that they convert fluctuations in current into sound vibrations.

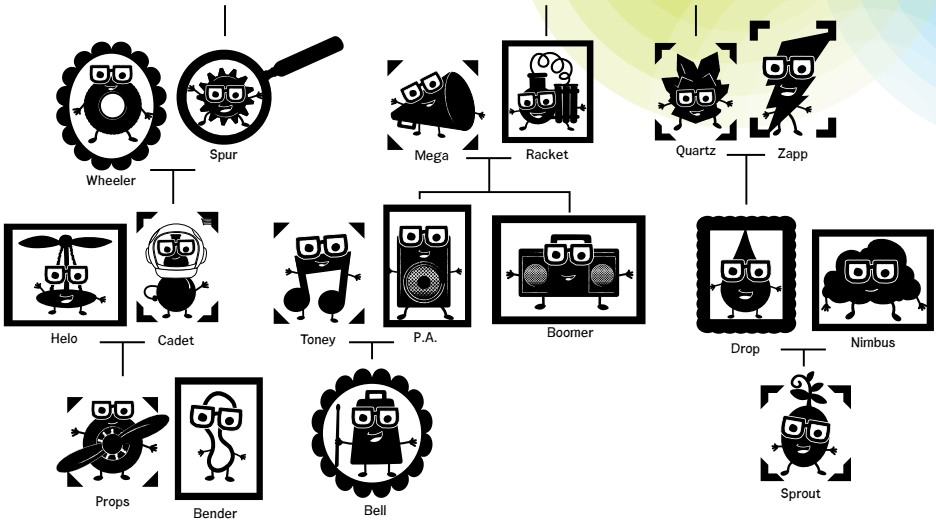
Speakers can be built in many different ways. But all have a large, flexible membrane to set the greatest possible quantity of air into vibration.

Simple speakers use the **piezoelectric effect** for this: Certain materials become elastically deformed under the influence of current fluctuations, rising and falling in rhythm with the fluctuations and thereby creating sound vibrations in the air.

Better speakers, by contrast, have a movable suspended coil made of fine wire, with the coil positioned near a strong magnet and connected to the membrane. When current flows through the coil, the coil itself becomes magnetic. As this current fluctuates, the magnetism rapidly changes in strength and direction, so the coil is attracted one moment by the external magnet and repelled the next. It is these movements that are transferred through the membrane to the air. Ears interpret the vibrations in the air as sound.

What surfaces and materials produce the best sound with your vibration speaker? Record your findings here...

MEET THE NEXT-GEN GEEKERS!



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