STEM CLUBS

NUMBER 1 FOR STEM

A STEM FUTURE: SUITABLE FOR STUDENTS AGED 9-11

# Sounds Amazing!

## STEM Learning activity resources

**SUBJECT LINKS:**

Science, mathematics, design and technology, computing and essential skills.

STEM CLUBS

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A STEM FUTURE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

STEM Learning activity resources

## Introduction

This programme has been created by STEM Learning, the largest provider of STEM education and careers support in the UK. It has been developed in partnership with STEM Club leaders.

## Sounds Amazing!

There's sound and music all around us! This programme has pupils exploring the science of music and sound, creating music and instruments with a range of found objects, and even finding music in unlikely places.

## Digital and Essential Skills

Throughout this booklet, activities highlight skills sets that can be enhanced by taking part. This enables pupils to further develop both digital literacy and competency in desirable key skills. These highlighted skills allow the pupils to focus on specific aspects to achieve notable progression. If other skills better suit your club members on a particular activity, then focus on that skill.

## Key information

**AGE RANGE:** 9–11

**SUBJECT LINKS:** Science, mathematics, design and technology, computing and essential skills.

**DURATION:** activities range from 20 to 60 minutes – approximately 6 hours in total.

**FLEXIBILITY:** Complete the whole programme over a half term or choose individual activities to suit the needs of your Club.

**RESOURCES:** Each activity includes a list of the resources required and a comprehensive set of Club leader and pupil notes in the form of guides.

**ESSENTIAL SKILLS:** Age-appropriate essential skills have been identified which can be enhanced through these activities. Further information about digital and employability skills is available at the end of the booklet.

**IMPACT MEASUREMENT:** Each set of resources is designed to help evaluate and assess the progress of Club members. A free student assessment toolkit can be requested from: STEMclubs@stem.org.uk.

**ACHIEVEMENT:** Pupils can be rewarded for successfully completing activities by downloading free STEM Clubs certificates from https://www.stem.org.uk/stem-clubs/impact-and-recognition/stem-club-certificates. Pupils may be able to use these resources to work towards a CREST Award.

**APPROPRIATE VENUES:** Club leaders can run most activities in general spaces e.g. classrooms, halls, and outdoor areas.

**SAFETY:** Each activity includes details about health and safety considerations. Club Leaders should ensure that equipment is handled with care, particularly sharp instruments. Advice and guidance are available from CLEAPSS and SSERC. We advise that practical activities are risk assessed before commencing and Club Leaders should follow their employer or organisation's policies.

**OTHER ACTIVITIES:** Discover other exciting STEM Club activities: https://www.stem.org.uk/stem-clubs/activity-sets#primary

**STEM CLUB SUPPORT:** Find lots of ideas, support, training and advice at: https://www.stem.org.uk/stem-clubs

## Activities

STEM CLUBS

CLUB LEADER GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 1 Tap it, shake it, automate it

## Objective

In this activity, pupils explore basic circuit building and create a machine that can make music and keep a beat.

### TOPIC LINKS

- Science: electrical circuits, materials
- Design and technology: electronics, materials, methods of making
- Computing: use of technology

### ESSENTIAL SKILLS SUPPORTED

Listening, speaking, teamwork

### TIME

50 minutes

### RESOURCES AND PREPARATION

- Electrical wires with crocodile clips
- Battery and battery holder
- Motor
- Fan/propeller that can be attached to the motor (you can purchase these online, or they could be made from strong card)
- Lolly stick, pencils, straws or chopsticks
- Sticky tape or masking tape
- Chime bars
- Range of percussion instruments
- Cardboard
- Blue or white tack

### HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

Ensure that crocodile clips and wires are in good condition. Ensure batteries are in good condition. Supervise children when they are handling the materials used to make a circuit.

Be sure to explain to the pupils the dangers associated with electricity. Reassure them that the equipment they are working with is not highly dangerous, but that they should still take care to avoid electrical shocks.

### DELIVERY

1. Play a song for pupils and ask them to listen for the background beat. When they think they hear it, they should start clapping along (or tapping the table, etc.). Ask if they know what instrument is being used to create it. (Choose a song where the beat is clearly being played by one instrument.) Explain that in some songs, no one is playing the beat.
2. Ask the pupils if they know why the beat is important. Explain that while beat might be being made by the drummer, bassist, rhythm guitarist etc., all members of the band are playing along with the beat. The beat helps them to play together and make great-sounding music.
3. Explain that pupils will be creating their own instrument by striking the blades of a fan (or using a battery-operated toy) against another object. They will then try to obtain a certain rhythm or tune.

#### Option 1: electrical circuit with fan

1. If you have a circuit making kit, demonstrate/remind pupils how to build a simple circuit using two wires, a cell and a motor. You many also want to attach a switch. Then attach a fan to the motor.
2. As we do not want to damage the fan or object (be it a table, a book or something that might make a rattling noise [like a box of paperclips] or a hollow noise [like an empty tin]), suggest joining something onto one of the fan's blades that will then tap your object. The thing you attach to the blade needs to be soft but firm. What could pupils suggest (e.g. straws, lolly sticks, pipe cleaners, tightly rolled tubes of paper)?
3. Attach these and then fix the motor in place and position the instrument so that it taps your object. Pupils now have their own automatic music maker.
4. Ask pupils to work out the beats per minute.

## TIPS

- sticky tack can be used to hold the motor in place and older batteries will make the fan turn more slowly.
- if the blades of the fan are turning too fast, an easy way to slow them down is by adding more components to the circuit.

## Idea!

**Request a STEM Ambassador to help demonstrate how to build a simple circuit using basic equipment**

### Option 2: battery-operated toy

1. If you don't have circuit-making equipment, you can use a battery-operated toy such as a train or remote-control car and attach a stick or another item that can tap your chosen object(s).
2. Plan out a route for your toy and position your great sounding objects along it, so that they can be tapped as the toy train or car passes by.
3. Encourage pupils to position the objects in a way that creates a regular beat when the toy travels around the track.
4. Ask the pupils to work out the beats per minute. How can they increase or decrease the beats per minute? Pupils could also use chime bars set up to play a well-known tune.

### Results and observations table

| Pupil task | Club leader notes |
|---|---|
| How many beats does your instrument play in 10 seconds? | Leader to tell pupils when to start and stop counting. |
| Multiply your answer by 6 to find out how many beats in a minute. | Multiply by 6. |
| How could you alter your circuit or your toy's route to change the beats per minute? | **More beats per minute:**<br>Electrical circuit – connect a second cell/battery.<br>Loop of track – decrease the length of track by removing a section.<br>**Fewer beats per minute:**<br>Electrical circuit – connect a light bulb in series.<br>Loop of track – increase the length of track by adding in a section. |
| Can you match the number of beats per minute with someone else's instrument? | Write the name of another pupil who has a close bpm. |

## EXTENSION IDEAS

1. Can pupils design an instrument that will pick, pluck or stroke a string when switched on? This could be achieved with a battery-operated or remote-control toy moving backwards and forwards along straight track, pushing and pulling an attached bow. Plucking may work using the same motor-powered fan brushed against guitar strings. Elastic bands around the ends may help to grip the string. Look at the Robot Orchestra in the Useful links section for ideas of how instruments can be played by machines.
2. Combining what has been learnt in this activity with other activities, consider putting on a musical performance for teachers, parents, other pupils or the entire school. Draw together everything that has been learnt and put on a show!

## DIFFERENTIATION IDEAS

**Support:** provide a circuit diagram to help pupils make a complete circuit. They will need to attach their musical extensions to the fan blades prior to placing the fan blade on the motor.

**Challenge:** make a second robot that plays different beats per minute, and have both sound machines play at the same time. Pupils could then create a complex rhythm, similar to a drum machine.

## USEFUL LINKS

**Robot orchestra performance**
https://www.youtube.com/watch?v=23TlCfIw7C0

STUDENT GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 1 Tap it, shake it, automate it!

## Your challenge

**Do you enjoy making music? Ever wanted to play more than one instrument at a time? Well, then this is the STEM session for you! Today, you are going to learn how to create a simple robot that can tap out a beat while you sing along or play another instrument. Your automated instrument will hold the beat steady, so you will be able to stay in time.**

**YOUR TASK** Plan and build a machine that can keep a beat (or maybe even play music)!

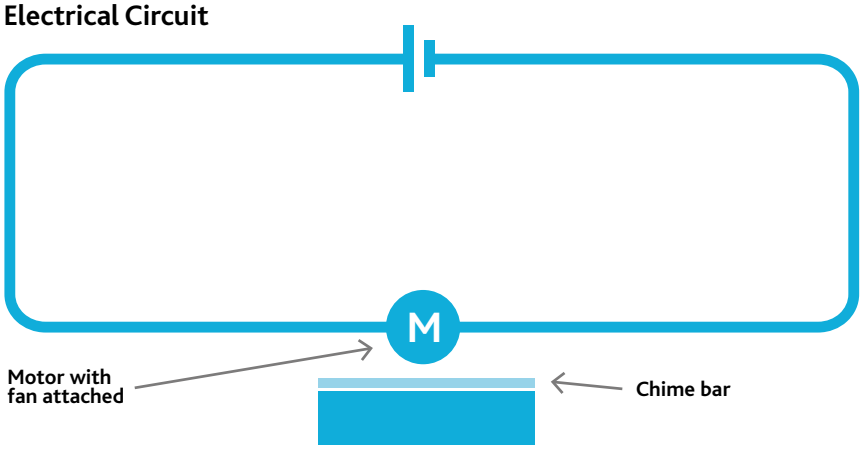
### WHAT YOU NEED TO DO

1. Find an object that can be tapped to make a great sound. Perhaps a jar filled with something that rattles, or an empty tin that makes a nice hollow sound when you tap it? Try out different objects to see what has the best sound. Using this, you're going to create a machine that can keep a beat.

**If you have circuit equipment:**

2. Gather together your circuit equipment and begin to create a circuit that includes a spinning fan. Can you think of all the components you will need to make the circuit?
3. Connect the two wires, the cell and the motor. You could also add a switch.
4. If needed, attach something to the fan that will gently tap your object(s). Test to see if tapping your chosen object with this makes a great sound. You may decide that you want to change your object so that when it gets tapped, it makes a better sound. Then attach the fan to the motor.

**Electrical Circuit**




5. Fix the motor in place and place your object(s) so that it gets tapped as the fan spins. You now have your own automatic music maker!
6. Can you work out the beats per minute? How could you increase or decrease the beats per minute? As an extra challenge, you could try to set up chime bars to play a well-known tune.

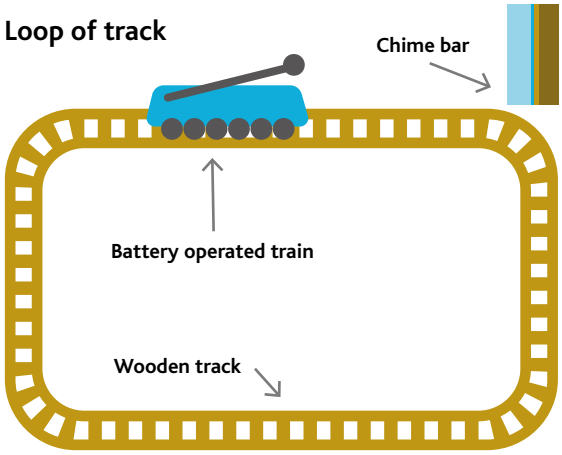
STUDENT GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 1 Tap it, shake it, automate it!

### If you have a battery-operated toy:

7. Create a route for your toy to travel around.
8. Attach something long and thin to the toy train/ car. This will be used to tap the objects as the toy passes by. Check to make sure that the objects make a good sound when they get hit. If they don't make an interesting sound, you may choose to change your objects.
9. Position your objects along the route so that they can be tapped as the toy train or car passes by.




10. See if you can position the objects so that you create a regular beat.
11. Can you work out the beats per minute? How could you increase or decrease the beats per minute? As an extra challenge, you could try to set up chime bars to play a well-known tune.

### RESULTS AND OBSERVATIONS

How many beats does your instrument play in 10 seconds?

Multiply your answer by 6 to find out how many beats your instrument plays in a minute.

How could you alter your circuit or your toy's route to change the beats per minute?

Can you match the number of beats per minute with someone else's instrument?

### FUN FACTS

1. A one-man band is one person wearing and playing many instruments at the same time. There is a Pixar short animation called 'One Man Band'.
2. The term 'one-man band' can also be used to describe a gifted musician who can play many different instruments. Recording artists who have played and recorded all their own music include Dave Grohl from the rock band Foo Fighters, as well as singer-songwriters KT Tunstall and Ed Sheeran.

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CLUB LEADER GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 2 Bin beats!

## Objective

In this activity, pupils take apart an existing item and reassemble it to create a musical instrument.

### TOPIC LINKS

- Science: understanding how forces and movement will act on equipment to produce sound
- Design and technology: joining different materials together
- Computing: use of technology

### ESSENTIAL SKILLS SUPPORTED

Creativity, teamwork, aiming high

Internet research, online videos, use of digital recording

### TIME

50 minutes

### RESOURCES AND PREPARATION

- Variety of found or recycled materials, ideally objects that contain many component parts, e.g. an old filing cabinet, computer, chairs
- Screwdrivers to take old equipment apart
- Work gloves, safety goggles
- Newspaper
- Sticky tape, split pins, stapler, paperclips, hot glue-gun
- Marbles
- Marble run (optional)

### HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

Ensure that pupils are closely supervised when using screwdrivers. Model how to hold equipment and screwdrivers safely. Provide work gloves to add extra grip if required.

Pupils must wear safety goggles and gloves when taking apart their items. Ensure that pupils are supervised closely and that any hazardous materials (sharp electrical instruments, sharp metal, splintered wood etc.) are immediately confiscated.

Check old equipment prior to allowing pupils to handle it and check for sharp edges. Ensure any old equipment has batteries removed and mechanical parts disabled before allowing pupils to handle it.

Make pupils aware of the dangers associated with taking apart old objects. Explain that there could be sharp objects inside electrical equipment and that splintered wood can be dangerous.

### DELIVERY

1. Watch an excerpt from the musical 'Stomp' (see useful links.) Note that this group uses everyday objects to create rhythmical sound, which we recognise as music.
2. Explain to pupils that they are going to create their own instruments by repurposing other objects. Good starting materials include an old filing cabinet, old computer, chairs, old printer or any piece of machinery or furniture made of many smaller parts. Perhaps ask pupils if they have anything at home that their parents would be happy to donate for this activity.

   **Make it clear that the pupils are not to destroy or dismantle anything in the classroom. Only objects that have been specifically donated for this activity should be taken apart.**
3. Provide pupils with screwdrivers of different sizes, wire cutters and small hammers to start taking apart the objects.
4. Encourage pupils to start thinking about the design for their instrument. If they come across an object that they really want to use, encourage them to change their design to incorporate that object. If they find that their design is too complicated and that they don't have the resources they need to make it, encourage them to change their design to something more appropriate. Explain that this is all part of the design process.

## TIPS

- Encourage pupils to support each other to join the materials back together in creative ways.
- Encourage the children to come forward with anything they think is dangerous while dismantling the objects.

## Idea!

**Invite a STEM Ambassador who works in sound engineering to run a talk.**

5. As the pupils start to consider what instruments they will create, encourage them to use every piece of equipment available. For example, if pupils make an instrument that rattles, they could use extra pieces from circuit boards, or screws inside another object to create this sound.
6. Can the pupils take apart the larger or less familiar objects and use their parts in different ways? For example:

- stretch fabric across a frame to create an instrument that can be drummed, or pieces of elastic across a frame to create an instrument that can be plucked
- use the smaller parts of an object to create an instrument that rattles. Put them inside an empty container, or make a container using the equipment you have. If there are no suitable small parts, you could add dry rice or lentils
- create a marble run using pipes, rolled up paper and whatever you can find. Drop the marble through and listen to the sounds created on the different surfaces

7. Once the instrument has been created, pupils need to play a repeated sound pattern or rhythm.
8. Listen to the instruments that have been created. Pupils should be encouraged to suggest how others' instruments could be improved, particularly if they are using unfamiliar objects.

## Incorporating Digital Skills

**Encourage the pupils to use the internet to find other acts that use rhythm within their routine.**

### EXTENSION IDEAS

1. Use a handheld digital device to record and playback the sound you create.
2. Combining what has been learnt in this activity with other activities, consider putting on a musical performance for teachers, parents, other pupils or the entire school. Draw together everything that has been learnt and put on a show!

### DIFFERENTIATION IDEAS

**Support:** use a marble run and ask pupils to build a track that a marble can roll down. Ask them to create a track where the ball will make four drops at equal time intervals, keeping a steady beat. This may seem simple at first, but due to acceleration, the drops cannot be evenly spaced! Galileo first discovered this using ramps and bells.

**Challenge:** how can pupils alter the pitch of their instrument? How must they alter the design? Remember that a higher pitch is produced by shorter soundwaves (smaller vibrations), so shorter pipes will produce higher-pitched sounds. Longer or larger containers of air will produce low-pitched sounds.

## USEFUL LINKS

**Stomp Video 1 – Bins**
https://www.youtube.com/watch?v=Zu15Ou-jKM0

**Stomp Video 2 - Brooms**
https://www.youtube.com/watch?v=tZ7aYQtIldg

**Stomp Video 3 – Match boxes**
https://www.youtube.com/watch?v=93t6bCnAvk4

STUDENT GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 2 Bin beats!

### Your challenge

**Have you ever found yourself tapping a glass with a spoon or drumming the table? If you have, you'll be glad that 'Bin beats' is here! It's a STEM Club activity where you create music using everything around you!**

**YOUR TASK** **Create a musical instrument of your choice and design.**

### WHAT YOU NEED TO DO

1. Consider how to create your own musical instrument.
2. Your STEM leader will provide a piece of furniture or an old piece of electrical equipment for your group to use.
3. Take it apart carefully using the tools provided. Be careful of any sharp edges that may get revealed while taking the object apart. You are now going to use these pieces to create your very own instrument.
4. Consider:
   - will your instrument be something you tap
   - will your instrument be something you pluck
   - will your instrument be something you hit
   - will your instrument use objects that move through other objects? For example, a marble that rolls through different pipes
   - how will you join the pieces of your instrument together
5. Once you have made your instrument, play it with the group.
6. After playing your instrument, evaluate it. Use the Evaluation table to help you.

### FUN FACTS

1. Musical instruments that are played by striking them with a hand or stick, or by shaking them, are called percussion instruments. Drums, cymbals, xylophones, gongs, bells, rattles and tambourines are all percussion instruments.
2. Stomp is a famous performance group who create complex percussion rhythms using everyday objects. They have been touring the world for 24 years!
3. You can use percussion techniques on your body to create musical sounds. These can include stomping your feet, patting your thighs and face with your hands, and clapping and snapping your fingers. You can change the pitch of the sounds created by changing the curve of your hand.

STUDENT GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 2 Bin beats!

### PLANNING

Use this section to write down some of your thoughts and plan out how you will make your instrument.

| | |
|---|---|
| I plan to make an instrument that looks like this. | The instrument will be played like this. |
| This piece will be the main body of my instrument. | I will use these pieces for….<br>(rattling, plucking, joining, decoration) |

### EVALUATION

Use this section to evaluate your newly-made instrument.

| | |
|---|---|
| My finished instrument looks like this. | Did you adapt your original design or not? |
| Describe the sound of your instrument.<br>Does your instrument sound as you expected? | If you did this activity again, what would you do differently? |

### THINGS TO THINK ABOUT

1. Can you alter the pitch of your instrument?

CLUB LEADER GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 3 Ch-ch-check it out!

## Objective

In this activity, pupils record themselves speaking or singing using a microphone. They will then use electronic equipment to sample or mix the recordings. Pupils will create a sound pattern using their recorded voice.

**HEALTH AND SAFETY:**

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

Ensure pupils use electronic equipment safely. Microphones should not be placed in the mouth. You may wish to use anti-bacterial wipes to clean microphones between use by different pupils.

**TOPIC LINKS**

- Computing: using an app to record and play back voice tracks; using an app to segment the recording and recombine it
- Mathematics: counting beats

**ESSENTIAL SKILLS SUPPORTED**

Creativity, problem solving, aiming high

Using sound layering app

**TIME**

45 minutes

**RESOURCES AND PREPARATION**

- Tablet/computer that has an in-built microphone, with an app for recording and manipulating vocals. GarageBand is complicated, but excellent. Toc and Roll is paid for, but inexpensive, and has the capabilities required
- Easi-speak microphones can record and play back sound. The recording quality is fairly poor, but you may like the fuzzy sound – it sounds already remixed
- Novation Launchpad midi mixer (optional)

**DELIVERY**

1. Ask the pupils if they know about beatboxing. If they don't, explain to them that beatboxing is a skill that some people have where they can make an array of unusual and interesting sounds with their mouths and throats. Beatboxers often make repetitive, rhythmic sounds that other singers could sing or rap over the top of. If the pupils are still unsure about beatboxing, then show them a short video (link below).
2. Explain to the pupils that they are going to record their own sounds, voices, words or singing and use software to remix it.
3. Remixing is a term used by musicians to describe the technique of adding other layers of sound onto a piece of music, or altering the original recording, for example by making the pitch different or the speed (tempo) faster.
4. Demonstrate using the remixing software, so the pupils know how to record and play back their voices, and then get them started! If the group is stuck for ideas about what to record, suggest onomatopoeic words, such as 'boom' or 'whizz', or suggest stretching the sounds in words, like 'razzamatazz'.
5. Sound technology: Ask pupils to record multiple beatbox-esque phrases, using an app like Novation Launchpad or GarageBand. They should assign each 4-beat phrase a separate button. They can now begin to experiment with timing and layering the different samples they have created, in order to play them together and create a song.

**TIPS**

- You may want to give groups specific words, moods or seasons to inspire and guide their work. For example, relaxation, spooky at Halloween or light and breezy in summertime.

## EXTENSION IDEAS

1. Have a go at beatboxing! After all, the human voice is the most amazing instrument there is. What range of sounds can your voice produce? Record these to create 4-beat vocal loops.
2. Add the vocal loop to sounds that have been recorded during other sessions.
3. Use a decibel meter (lots of apps available) to measure how quiet or loud different sounds are. Investigate pitch relative to decibels – are higher-pitched sounds quieter? Find out using recorded vocal sounds played back at the same volume.
4. Combining what has been learnt in this activity with other activities, consider putting on a musical performance for teachers, parents, other pupils, or the entire school. Draw together everything that has been learnt and put on a show!

## DIFFERENTIATION IDEAS

**Support:** use a voice-changing app like Voice Changer plus. You may wish to pair pupils to support each other while using the software, having a pupil who is more familiar with the software supporting a pupil who is less familiar.

**Challenge:** use the Novation Launchpad midi mixer. The launchpad deck is a grid of buttons, and an extension to the app. Once pupils are familiar with the app, they will be able to move on to this kit. Think of the Launchpad as a book, with each button down the side turning to a different page of sounds. Initially, stick with page 1, as 64 sounds and sound loops will be enough! Using a computer with the Ableton software program, the Launchpad can have each button assigned with a sound and a light colour. When the program is completed, upload it to the Launchpad which can then be disconnected from the computer. The Launchpad can then be 'played' and will produce a sound and light show!

## Idea!

**Request a STEM Ambassador who builds software to run a discussion on how the programmes work.**

## USEFUL LINKS

- **TED talk and demonstration on beatboxing and how the mouth and throat make the sounds**
  https://www.youtube.com/watch?v=LqdFL0u2HLY
- **KT Tunstall using live looping**
  https://www.youtube.com/watch?v=FGT0A2Hz-uk
- **Learn how to make beat box sounds:**
  https://www.youtube.com/watch?v=B6-45rswo0o

STUDENT GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 3 Ch-ch-check it out!

### Your challenge

**Today you're going to discover the capabilities of the world's most incredible instrument – the human voice! You're going to find out about beatboxing, the sounds that certain humans can make with their mouths and the techniques beatboxers use. World-class beatboxers need to start somewhere, and you can start today!**

**YOUR TASK** **Using special software, you will learn how you can play around with sound, alter your voice and make a song using only the sounds made by your mouth.**

### WHAT YOU NEED TO DO

1. Decide on a word or sound you would like to record. Use the software to experiment and play with this sound.
2. Once you feel comfortable using the software, consider recording new sounds. Now that you know how the software works, you might have some good ideas about how to use it to make interesting sounds and beats.
3. You should record a 'loop' of sound – that is a 4-beat section of music that can be played on repeat. Once you've done this, try to layer a different 4-beat loop on top of the first, making a more complex sound pattern.
4. You can create your 4-beat sound loops in different ways:

- you could record a single word, and use the app suggested by your Club leader to make this into 4-beats by stuttering, repeating or stretching the word
- you could record a repeated phrase for 4 beats
- you could record a sound made through a voice changer machine or app and stretch this over four beats

### THINGS TO THINK ABOUT

1. How does altering the pitch of a word affect the length of a word?

### FUN FACTS

1. The average human can make over 500 distinct sounds, but when you start to include changes in pitch and volume, the number of different sounds is almost infinite!
2. Beatboxing is a type of 'vocal percussion' and started with people mimicking the sound of drum machines.
3. Ed Sheeran uses live looping to play his music. Many people watching him perform at Glastonbury 2017 were confused and thought he was using a backing track. In fact, he played 4 beats, recorded them at the same time, and then replayed this loop continuously. It allowed him to play something different, creating a richer depth of sound.

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CLUB LEADER GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 4 What's that sound?

## Objective

In this activity, pupils will demonstrate how circuits in battery-operated toys can be altered. This is known as 'circuit bending'. Pupils will see how programmable toys can have their sounds altered.

### TOPIC LINKS

- Physics: soundwaves
- Electronics: adding electrical wire to alter the sound output
- Computing: use of technology

### ESSENTIAL SKILLS SUPPORTED

Listening, teamwork, problem solving

### TIME

30 minutes

### RESOURCES AND PREPARATION

- Old battery-operated toys (donated or available cheaply from charity shops)
- A selection of screwdrivers
- Crocodile clips
- Batteries (check the size the toy requires)
- A variety of resistors, potentiometers, and switches (optional)

### Idea!

**Invite a STEM Ambassador to talk about how they work with electronics in their role.**

### HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

It is important to stress to the group to only take apart battery-operated toys of 9V or less, and always under adult supervision.

Pupils should be warned of the dangers of misusing screwdrivers and should be supervised at all times when using screwdrivers.

Many electrical components have small metal wires sticking out at the ends. Ensure the pupils handle these with extra care. You may wish to demonstrate how to handle these first.

Explain to the pupils the dangers of working with circuits and impress upon them the need to be careful and sensible when working with electricity, electrical components, crocodile clips and circuits in general.

### NOTES ON RESOURCES

- resistors alter how quickly electricity flows around certain parts of the circuit. As this is changed, the output (sound) is altered. It cannot be altered again once fixed in place
- a potentiometer is a variable resistor – more like a volume control knob – which allows the voltage to be varied. As the output in this instance is sound, this will produce 'slide' type sounds, where the pitch can be altered from low to high and high to low
- switches allow the current to be switched on or off instantly

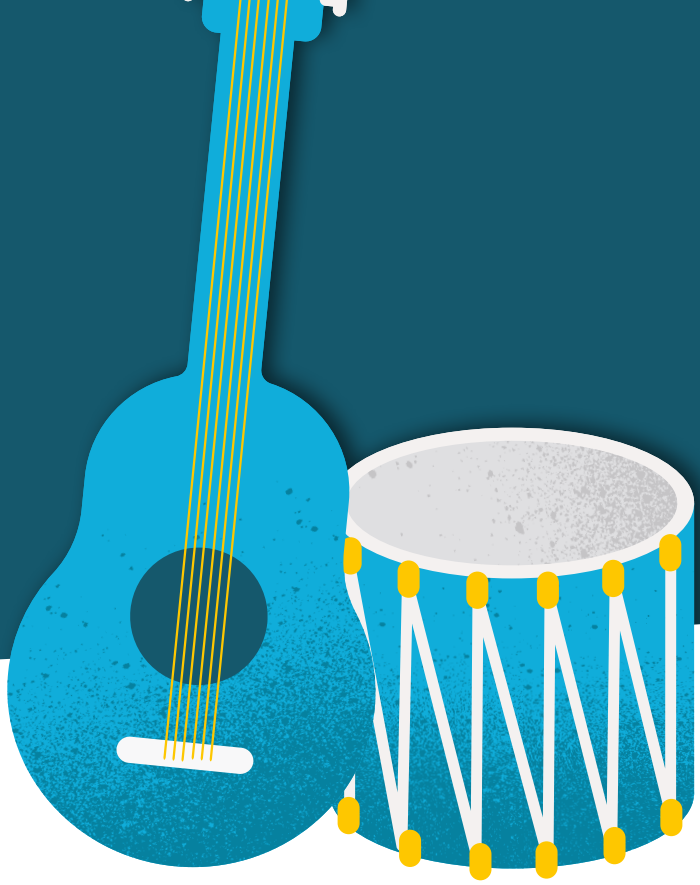
### DELIVERY

**Note:** there are different ways to run this activity.

**Option 1:** you can attach switches, resistors and potentiometers to a breadboard. You can then test the different switches.

**Option 2:** for an even more accessible option, simply use crocodile clips to connect to the circuit board.

This session may be mostly demonstration, depending on how many battery-operated toys you are able to acquire.



## TIPS

- check that the screws on the back allow the back to be removed easily. Sometimes toys use screws made from very soft metal, and you may need to pry the back off using a flathead screwdriver.
- older toys are better for circuit bending as they have separate components, compared to newer toys which hold much of their sound-producing properties within microprocessors.

## Incorporating Digital Skills

**Use digital photography to record the disassembly of the toys.**

1. Use a familiar child's toy to make a variety of unusual sounds. This could be anything from a VTech speaking toy to an electronic keyboard.
2. Remove the back of the toy to expose the circuit board and wires.
3. Make sure the printed circuit board (PCB) is the correct way up. You should be able to see the silver traces of solder holding the capacitors and resistors in place. If you cannot see this side, unscrew the PCB and turn it over.
4. Place new batteries into the toy and turn it on.
5. Hold down a key or press a button to make it play a tune/make a sound. Explain that this is the un-bent version or the circuit.
6. You are now going to start 'circuit bending' to alter the sound.
7. Time for experimentation! Run the wires or crocodile clips across the silver solder parts of the PCB to find which part alters the sound. The process of testing should be systematic and methodical. Hold one crocodile clip against a joint of solder, and use the other end to touch other solder joints. Make sure there is a constant sound playing, so that you can hear any alterations in the output. Once you find a position that makes a suitably pleasing sound, draw a diagram so you remember which points produced that sound, or take a photograph. You've now bent the circuit!

## DIFFERENTIATION IDEAS

**Support:** have some toys with their backs already removed, and one end of the wire already clipped in place, ready for pupils to start exploring the circuit board and sound alteration.

**Challenge:** use a more complicated toy with a printed circuit board, or try to make specific sounds using circuit bending.

## EXTENSION IDEAS

1. Use the sounds created to make your own music by recording the individual sounds and then playing them back.
2. Combining what has been learnt in this activity with other activities, consider putting on a musical performance for teachers, parents, other pupils or the entire school. Draw together everything that has been learnt and put on a show!

STUDENT GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 4 What's that sound?

### Your challenge

**Have you ever wanted to change the sounds that your toys make? Toys that play music or make sounds are great, but sometimes they can be really boring. You are going to have a go at changing sounds.**

**YOUR TASK** **In this session, you will find out how you can alter the sounds that your toys make, then use them to make your own music!**

### WHAT YOU NEED TO DO

1. Make sure you watch carefully during the demonstration of 'circuit bending' as it involves fiddly electronic devices.
2. As every battery-operated toy is different, you will need to work carefully and slowly to identify the different parts of your specific toy.
3. Take the batteries out of the battery compartment.
4. Remove the back of the toy to expose the printed circuit board and wires.
5. Make sure the circuit board is green side up – you should be able to see little silver soldering iron blobs, and the circuit map will be silver too. If the circuit board is face down and you can see resistors and capacitors, carefully unscrew the circuit board and turn it over.
6. Put new batteries back into the toy.
7. Press a button to make the toy play music or make a sound.
8. Use a wire with crocodile clips at the end to touch different soldering blobs. This part is trial and error as each toy is built differently. At some point, you will discover how to change the sound your toy makes!

**SAFETY FIRST!** Circuit bending is fairly safe, as long as you only ever use a battery-operated toy that uses a battery with 9 volts or less. Ask your Club leader to check your toy to make sure that it is safe to circuit bend. NEVER try to bend the circuit of any toy that has a plug attached.

### FUN FACTS

1. Known as 'The father' of circuit bending, Reed Ghazala stumbled across circuit-bending in the mid 1960's and has been experimenting with it ever since.
2. The first electrical organ was developed by Thaddeus Cahill in 1897 and used tonewheels to generate sounds as electrical signals. This was the first electric sound synthesiser.
3. Steve Aoki is a world-famous DJ who has circuit bent many toys and used their sounds in his music.

# Sounds Amazing!

## 4 What's that sound?

### OBSERVATIONS AND RESULTS:

Describe the sound the electronic toy makes before circuit bending.

Draw the printed circuit board here. Use colours that match the colours you can see. Include as much detail as you can.

Draw a line to show which blobs of silver solder you have tried to connect with crocodile clip ends. Test each different pair of silver solder blobs and record the sound made.

Describe the sound the electronic toy makes after successfully bending the circuit.

STEM CLUBS

CLUB LEADER GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 5 Surprising sounds

## Objective

In this activity, pupils learn how to create a simple 'talker' for someone with speech or speaking difficulties. They will use Makey Makey to programme a piece of card to talk. They can also extend this to explore how other objects can be used to make music.

### HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

Ensure extra care when handling electrical components. Wires may have sharp ends. Ensure batteries are in good working condition before using.

### TOPIC LINKS

- Design and technology: creating a second purpose for an object
- Computing: use of technology

### ESSENTIAL SKILLS SUPPORTED

Problem solving, creativity, staying positive

Using a Makey Makey Micro Controller and Scratch.

### TIME

50 minutes

### RESOURCES AND PREPARATION

- Makey Makey (see https://www.rapidonline.com/makey-makey-inventors-kit-73-5500?gclid=EAIaIQobChMIl6Xtm_3c2wIVChgbCh2FHQPLEAAYASAAEgKrBPD_BwE), also available from other UK retailers.
- Crocodile clips and electrical wire of different lengths
- Access to computers
- Graphite pencils

For an alternative activity:

- Batteries and battery holders
- Buzzers (Rapid Electronics sell a range of buzzers.)
- Contact switches/push switches
- Twister mat, toys, cushions, other everyday objects
- Velcro dots or stickers

### DELIVERY

1. Ask pupils to think about verbal communication. If a person has difficulty with this, they sometimes use a machine to talk for them. These machines are programmed with words so that when certain buttons are pressed, the machine talks. Tell pupils that they will be creating their own machine that could help someone communicate.
2. Makey Makey uses everyday objects that conduct electricity (even very low amounts) to make machines that make sounds. Makey Makey can be used in lots of different ways, so allow the children to explore the technology and discover new ways to use it to help people with speaking difficulties.
3. Visit the Makey Makey website for a full set of instructions (including trouble shooting guide) for how to use the kit, you can also download the educator guide http//makeymakey.com/how-to/classic/

   The site has links to suggested apps, to use with the Makey Makey: https://makeymakey.com/apps/

   Remember you can use any app or programme with Makey Makey, providing it uses a keyboard or mouse.
4. The maximum number of keys that can be programmed is 18, so pupils will need to think carefully about what words or phrases would be most useful to help someone communicate. They should then record themselves saying their chosen words or phrases. We suggest limiting the pupils to six phrases to begin with.
5. They should then plan and design their machine, create the buttons and attach the crocodile clips so that specific buttons link to specific words or phrases.

   **Tip** - This can be done quite simply by drawing the machine on card using graphite pencils and attaching the clips to the edge of the drawing. Support pupils by reminding them to draw their buttons in a position that can easily be attached to the clip. If you have more time, pupils could make the machine using recycled boxes or other materials.

## TIPS

- Whatever acts as the 'buttons' will need to be a conductor. Pupils could try out a variety of different materials to see which are the most effective while still being user friendly.
- Watch the video for great Makey Makey music ideas https://www.youtube.com/watch?v=wkPt9MYqDW0

6. We suggest using Scratch to record the voices or sounds as it will easily link to specific keys on the keyboard.

   **a)** create a new programme and select the Scripts tab.

   **b)** click the Events menu and select 'when space key presssed', select one of the following keys: WASDFGHJ and Space

   **c)** click on the Sound menu and select 'play sound meow', join it to the script 'when space key pressed'. Click the drop down menu in 'play sound meow' and select record. Record the word or phrase and create a name for the recording to identify it.

   **d)** repeat until all words and phrases have been recorded.

   **e)** test the phrases on the keyboard, the Sounds Tab will allow pupils to edit the phrases.

7. Tell groups to ask each other questions to test out how well they're able to communicate with their boards. They can then evaluate and adjust their designs as needed.

## Idea!

**Request a STEM Ambassador to talk about how they use coding in their job.**

If you don't have access to a Makey Makey, you can use the following alternative:

1. Tell pupils that they will be creating a totally different sort of instrument today. They are going to attach sound-makers (buzzers of different pitches) to everyday objects. This may benefit people who have mobility difficulties and would otherwise have trouble using certain objects or instruments.

- for example, by adding buzzers to a game of Twister, people who are visually impaired would know that they have their hand or foot on the correct colour once they have heard a certain sound from the mat
- ask the pupils if they can think of other ways this technology could be used to help people who are impaired in some way

2. Begin by adding sensors to a chair to test it out.
3. Create a simple circuit using a push switch, and position the switch on the seat of the chair. It could be placed under a cushion. Attach the buzzer and battery to the side of the chair. Get a volunteer sit down to test that the buzzer works.
4. If you have a Twister mat, set pupils the task of adding as many buzzers as possible. Using the mat will allow pupils some workspace. Finish the session by playing the game Twister, now with an added dimension! Assign the buzzers to different colours, so each colour only has buzzers of the same pitch.

### DIFFERENTIATION IDEAS

**Support:** ask pupils to create the electrical circuit and pass it to another child to attach.

**Challenge:** ask pupils to think of other kinds of switches that could be used. For example, solar switches could make the buzzer sound when covered. These could be used on the handle of an object, for example a fairy wand or the handlebars of a tricycle (instead of the bell).

### EXTENSION IDEAS

1. If you have Makey Makey, use it to create a musical instrument out of everyday objects. For example, attach clips to a Twister mat and play pitched notes, transforming Twister into an array-like keyboard.
2. Combining what has been learnt in this activity with other activities, consider putting on a musical performance for teachers, parents, other pupils or the entire school. Draw together everything that has been learnt and put on a show!

STUDENT GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 5 Surprising Sounds

### Your challenge

**If a person has difficulty with verbal communication, they sometimes use a machine that talks for them. These machines are programmed with words so that when the buttons are pressed, the machine talks. You are going to investigate this.**

**YOUR TASK**

**Create your own machine that could help someone communicate.**

**WHAT YOU NEED TO DO**

1. You're going to use a Makey Makey to create a machine that makes sounds. Your Club leader will give you some wire and crocodile clips with which to do this.
2. Which words or phrases would be most useful for someone who can't communicate verbally? Think carefully – each wire can only be used for one word or phrase, so you need to make each one count! Think about what words or phrases are the most useful in everyday life, and what words or phrases you would absolutely need in an emergency.
3. Use the table below to write down some of your thoughts. Once you've put down some ideas, share your ideas with some other people in your class. Ask them if they have any ideas about how to improve your suggestions. Ask to see what they have written down, as this might help you to come up with new, better ideas.
4. Revise the words and phrases you are going to get your machine to say.

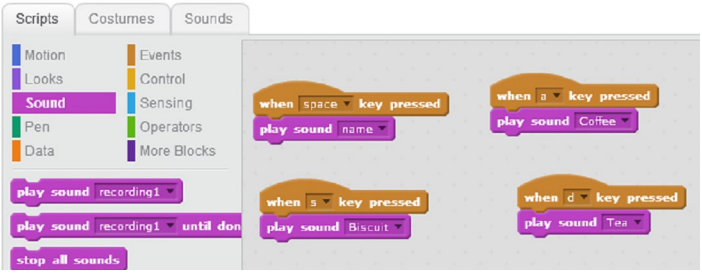
| Clip button | Word or phrase it will say |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |

# Sounds Amazing!

## 5 Surprising Sounds

5 Record yourself saying your chosen words and phrases.

6 You will use Scratch to record six phrases or sounds.




**a)** select the Scripts tab.

**b)** click the Events menu and select 'when space key pressed', choose one of these keys from the drop down menu: WASDFGHJ and Space

**c)** click on the Sound menu and select 'play sound meow', join it to the script 'when space key pressed'. Click the drop down menu in 'play sound meow' and select record. Record the word or phrase and create a name for the recording to identify it.

**d)** repeat until all six phrases have been recorded.

**e)** test the phrases on the keyboard, you can edit the phrases in the Sounds tab.

7 Plan and design your machine. What would make the best buttons? Why? How will you arrange the buttons? How will the arrangement of buttons make the machine easier to use?

**My electronic talker design** (remember to position the buttons where they can easily be attached to the clips)

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# Sounds Amazing!

## 5 Surprising Sounds

8. Draw or build your machine. Create the buttons and attach the crocodile clips so that they play the right word or phrase when pressed.

9. Put it to the test. Ask other pupils to have a conversation with you, but you can only respond with your machine. How well are you able to communicate? Are there any changes you would make?

10. Use the space below to evaluate your machine. Think about what you might do differently if you did this activity again. If you had more time and more equipment, how would you make your machine better? Was there anything that you liked about someone else's machine?

**Evaluation:**

## FUN FACTS

1. The loudness of a sound is measured in decibels (db). Sounds above 85db can be harmful to humans. Everyday speech is around 55db, busy city traffic is about 85db, while an ambulance siren can be as loud as 125db!
2. Most animals have better hearing than humans. One of the best examples of an animal with good hearing is the bat, whose hearing is so good that it doesn't even need its eyes to hunt for prey. But moths are said to have even better hearing - this may be so that they can avoid becoming bat food!

CLUB LEADER GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 6 Scaling up and down

## Objective

In this activity, pupils will explore creating high and low pitches using containers and water. They will correctly pitch their instruments using an app for support. They can then play different tunes!

**HEALTH AND SAFETY:**

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

If using glass containers, ensure they are handled with extra care, as they may be slippery if water is spilled. Ensure the working area is dry before allowing children to use electronic equipment.

**TOPIC LINKS**

- Design and Technology: created a pitched instrument using various containers
- Computing: use of technology

**ESSENTIAL SKILLS SUPPORTED**

Listening, speaking, problem solving
Use of software apps, digital recording

**TIME**

50 minutes

**RESOURCES AND PREPARATION**

- Various plastic and glass containers
- Boomwhackers and octavator caps (optional)
- Heavy duty tape
- Water
- Different colours of food colouring
- Funnel
- Jugs
- Measuring cylinders
- Drumsticks or plastic beaters
- Tablet or mobile phone with a pitch app

**DELIVERY**

### Option 1: if you have Boomwhackers and octavator caps

1. Seal the Boomwhackers using the octavator caps and make them watertight using heavy duty tape around each cap.
2. Use the pitch app to find out the pitch of the empty Boomwhacker, by tapping it and watching the app.
3. Now add water to the Boomwhacker tube. Add a fixed amount each time, for example 200ml, then tap the Boomwhacker again and use the app to see if the pitch has changed. Use the funnels and measuring cylinders to add water as carefully and accurately as possible.
4. How does the pitch change once water has been added? Does it go up or down?

(The pitch should go down because as more water is added, the vibrations produced by the plastic become slower and slower, producing lower pitched sounds.)

5. Encourage pupils to use funnels and measuring cylinders to make reasoned decisions about how much water to add to each Boomwhacker.
6. Now ask pupils to create three notes that sit next to each other on a scale. For example, C, D, E.
7. Start by adding water to one of the Boomwhackers and use the pitch app to determine the note. Pupils can then use this to inform creating the notes either side.
8. Once they have created three notes, they can play 'Hot Cross Buns':

E, D, C
E, D, C
CCCC, DDDD
E, D, C

## TIPS

- You may wish to conduct this activity outside (unless you are using glass containers).
- Glass produces a clear sound, similar to a metal xylophone, while thin plastic containers are unlikely to produce a clear sound.

## Incorporating Digital Skills

**Record and playback compositions, can you make a recognisable piece of music with the recordings?**

**Option 2: using a range of containers, including plastic, ceramic or glass (glass works best) and jugs of water.**

1. Allow time for pupils to explore the tonal quality of water in the different containers, so they know what sounds the best. The tone produced needs to be clear enough for the app to measure, if you choose to use the app.
2. Gather the group together and discuss any generalisations they have made. For example, tonal quality produced. Ask "What happens to the pitch when water is added?" The note produced when the container is tapped is lower than without the water.
3. Why does this happen? When the container is tapped, it vibrates to produce a sound. The water causes the vibrations to slow down. As more water is added, the vibrations produced become slower and slower, producing lower pitched sounds.
4. Encourage pupils to use funnels and measuring cylinders to make reasoned decisions about how much water to add to each container.
5. Now ask pupils to create three notes that sit next to each other on a scale. For example, C, D, E or A, B, C.
6. Start by adding water to one of the containers and use the pitch app to determine the note. Pupils can then use this to inform creating the notes either side.
7. Once they have created three notes, they can play 'Hot Cross Buns':

E, D, C
E, D, C
CCCC, DDDD
E, D, C

## Idea!

**Request a STEM Ambassador who works in creative digital arts to talk to students.**

### EXTENSION IDEAS

1. Pupils continue to add further notes to their scale so they can play complex (but well known) tunes. For example, the start of 'Jingle Bells' and 'Happy Birthday' both require 4 notes. C, D, E, F

### DIFFERENTIATION IDEAS

**Support:** provide identical containers so pupils are able to limit what is changed.

**Challenge:** ask pupils to blow across the top of the bottle to make the note. What happens to the pitch of the three bottles? Can the pupils explain?

(The air vibrates rather than the glass, producing a different pitch. When there is water in the bottle, there is less air, producing a note with a higher pitch. This is the same bottle that produces a low note when tapped!)

## USEFUL LINKS

**Harry Potter theme tune played on a glass harp – The glass vibrates to produce the sound**
https://www.youtube.com/watch?v=7hOar8dXNbA

**Examples of glass harps**
http://thekidshouldseethis.com/tagged/glass-harp

STUDENT GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 6 Scaling up and down

### Your challenge

**Have you ever blown into a bottle and heard a musical note? You can actually use this same idea make your own musical instrument!**

**YOUR TASK**

**Create your own water 'harp' and use it to play a song.**

### WHAT YOU NEED TO DO

**If you have Boomwhackers**

1. Seal the Boomwhackers with the caps and heavy duty tape.
2. Using the pitch app, tap the empty Boomwhacker to find out the pitch.
3. Now carefully add water to the Boomwhacker tube. Tap the Boomwhacker again and use the app to see if the pitch has changed.
4. How does the pitch change once water has been added? Does it go up or down?

**If you have containers made of different materials**

1. Test out your containers to find the one that makes the best sound. You want to find something that could make a good musical instrument!
2. Use the pitch app and tap an empty container to find out the pitch.
3. Now carefully add water and test the pitch again.
4. How does the pitch change once water has been added? Does it go up or down?

### NEXT STEPS

5. Now you need to find a C note. Add or remove some water from your Boomwhacker or container until you find a C note.
6. Do this two more times to get a D and an E note.
7. You now have the notes you need to play 'Hot Cross Buns.' Follow the notes below:

E, D, C
E, D, C
CCCC, DDDD
E, D, C

### THINGS TO THINK ABOUT

1. Does adding water make the pitch higher or lower?
2. Can you play any other songs with your three notes? What if you add more?
3. Write down the notes for any other songs you can create. Can the other groups follow them?

STUDENT GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 6 Scaling up and down

**Notes**

## FUN FACTS

1. The first glass harp was called an ‘armonica’ by Benjamin Franklin in 1761. ‘Armonica’ means harmony in Italian.
2. There is an instrument called the ‘Hydrodaktulopsychicharmonica’. The name comes from a collection of Greek words. They mean something like "harmonica to produce music for the soul by fingers dipped in water" (hydro- for "water", daktul- for "finger", psych- for "soul").
3. The glass harmonica was thought to be a dangerous instrument in the 18th Century – causing ‘dark moods’ in people who listened or played the instrument for too long!

CLUB LEADER GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 7 Louder is better - amplify it!

## Objective

In this activity, pupils explore how sound travels. They will use balloons to create their own amplifiers.

### TOPIC LINKS

- Science: sound waves
- Design and technology: creating a second purpose for an object
- Computing: use of technology

### ESSENTIAL SKILLS SUPPORTED

Listening, team working

Use of decibel meter app

### TIME

20 minutes

### RESOURCES AND PREPARATION

- Balloons
- Other inflatable objects, for example arm bands, inflatable rings, or swimming aids
- A radio, speaker or tablet or mobile phone or similar for children to use
- Decibel meter app

### Idea!

**Ask a STEM Ambassador to support setting up the experiment and to talk about how they experiment in their job.**

### HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

Be careful not to over expose pupils to sustained loud noises.

Be careful not to over-inflate the balloons or other inflatables that you are using. Explain to the pupils the dangers associated with doing so.

### DELIVERY

1. Show children a picture of inflatable speakers and pose the question 'How do inflatable speakers work?'
2. Ask the pupils if they could make a similar speaker using other objects. Do they have any ideas they want to share with the class? What if they used a balloon instead? Would it amplify the sound?
3. Investigate holding a balloon next to a volunteer's ear and try tapping it lightly. Compare this to tapping the same rhythm on your hand using one finger.
4. Which was louder? Can they explain why they think that happened?

(Tapping on the balloon was louder because air molecules become compressed inside a balloon. As the air molecules are compressed and closer together inside a balloon, they are able to pass vibrations between themselves more easily, which means that sound waves pass through the air in a balloon more efficiently than through normal air.)

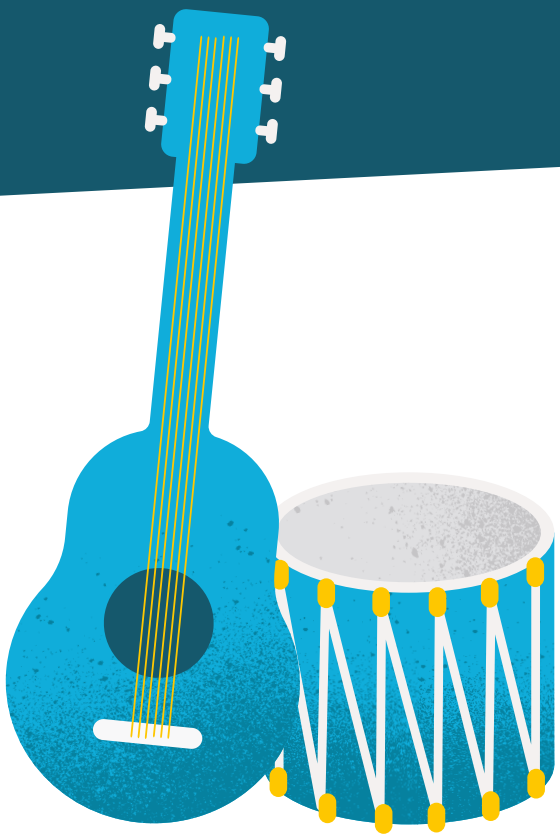
5. Continue to investigate if a balloon will amplify music played through an iPod. Play the same piece of music at the same volume in the air and again with the speaker pressed into the balloon. Measure the sound output using a decibel meter.

**Tip** – make sure the decibel meter is the same distance away during each test. This will ensure that the loudness test is fair.

6. Continue to investigate the balloon amplification phenomenon using a range of other inflatables or hollow objects such as crisp tubes.

### TIPS

- **Have a variety of different shaped balloons and other objects for pupils to use.**



7. The results will vary depending on how much something is inflated (the air pressure), and the material it is made from (for example, the rubber of the balloon is better at passing on vibrations than slippery plastic). Remember, bigger inflatables aren't always better at passing on sound vibrations!
8. Finally, ask pupils to design a balloon speaker as a product for sale, and create the packaging and box for it. Pupils could even create and film a short advert.

## EXTENSION IDEAS

1. Find out more about our noisy lives. Research information about decibels to find out what levels would be safe for babies, children and adults respectively. Where would be the noisiest place to live on the planet and why? Where would the quietest place be?
2. Find out about how sounds were amplified before advanced technology existed. Research the whispering gallery at St Paul's Cathedral and the sound mirrors that were used before radar was invented.
3. Combining what has been learnt in this activity with other activities, consider putting on a musical performance for teachers, parents, other pupils or the entire school. Draw together everything that has been learnt and put on a show!
4. Place a coin in a balloon, then inflate it and tie the end. When the balloon is moved in a circular motion, the coin will travel around the inside surface. Use a decibel or sound meter to measure the loudness of the sounds made by different coins. Are curved-edged coins or straight-edged coins louder? (Straight-edged coins are louder, as they rapidly 'bump' around the balloons inner surface, causing the balloon's skin to vibrate more, making a louder noise!)

## DIFFERENTIATION IDEAS

**Support:** limit the activity to exploring how differently sized balloons alter the amplifying effect they have. Do not use other inflatables. You could even have just three pre-determined balloon sizes to investigate.

**Challenge:** provide a range of objects for pupils to explore, without giving too much guidance. Allow them time to experiment and draw their own conclusions about what makes the best amplifiers.

## USEFUL LINKS

**How the whispering gallery at St Paul's Cathedral works**
https://londonist.com/2016/05/how-does-the-whispering-gallery-at-st-paul-s-actually-work

**About acoustic mirrors in Kent**
http://www.andrewgrantham.co.uk/soundmirrors/locations/denge/

**Coins in balloons – video**
https://www.youtube.com/watch?v=aAMW_3kWUhE

STUDENT GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 7 Louder is better - amplify it!

### Your challenge

**Did you know inflatables aren't just for swimming? They can amplify sounds too. Today you will learn about the science behind inflatable amplification using balloons, arm bands and any other inflatables you have.**

**YOUR TASK** Create your own inflatable speakers!

### WHAT YOU NEED TO DO

1. Blow up a balloon (or other inflatable).
2. Get into pairs. Try lightly tapping your finger against the palm of your other hand, behind your partner's head. By tapping behind their head, they can't see if you are moving or not, so they can't cheat!
3. Repeat the tap, using the same pressure, but this time tapping on a balloon.
4. Which was easier for your partner to hear? Which tapping made a louder sound? Do you know what was happening inside the balloon to amplify the sound (make it louder)?
5. Now investigate different balloons and objects to find out which one makes the best inflatable speaker.
6. Imagine you were going to sell your inflatable speakers – they could be the next big thing! Create attractive packaging for your inflatable speakers and some instructions for use. Make sure you include information about the best air pressure, size and material for using inflatables to amplify sounds.

### THINGS TO THINK ABOUT

1. Do you have any ideas about why certain objects amplify sound better than others?
2. What would make other people want to buy your speaker?

### FUN FACTS

1. Sound above 140db can cause pain to human ears. Conversation is around 70db, a chainsaw is 110db, a rock concert is 140db, while a rocket engine is 180db!
2. Covering your ears with your hands can reduce the decibel level by up to 25db, so if you're really stuck, this does work!

STUDENT GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 7 Louder is better - amplify it!

**My speaker design**

CLUB LEADER GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 8 Sensational soundwaves

## Objective

In this activity, pupils visualise soundwaves in order to understand how sound travels. They will then consider the best shape for a theatre or cinema.

### TOPIC LINKS

- Science: sound waves
- Computing: use of technology

### ESSENTIAL SKILLS SUPPORTED

Teamwork, leadership, speaking

Use of digital devices and software apps

### TIME

20 minutes

### RESOURCES AND PREPARATION

- Variety of plastic containers
- Plastic sheet
- Cling film
- Paint
- Uncooked rice or birdseeds
- Drum and drumsticks
- Corn flour and food colouring
- Large speaker
- iPad or tablet
- Slinky (optional)

### Idea!

**Invite a STEM Ambassador to support the demonstration of all the students have learnt in this resource.**

### HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

Ensure to properly cover the work areas (including pupils) with protection. Ensure pupils are not exposed to sustained loud sounds for a long time.

### DELIVERY

1. Ask the pupils what sound waves look like. What shape and direction do they travel in? When is it important to think about how sound travels? What kinds of places or buildings might find it important to think about how sound travels?

2. Begin by visualising a soundwave. Choose your preferred level of mess:

a. **Not too messy:** place uncooked rice grains in the centre of a drum. Gently tap the drum skin and watch the rice grains jump. Do they all jump at the same time? Film the grains jumping using a tablet and watch the footage back in slow motion to see how the rice moves. If you are able to do this outside, you could use birdseed. If you do this, you can observe the movement of soundwaves and feed the birds at the same time!

b. **Slightly messier:** place a speaker on its side, remove the front frill to expose the speaker bowl and cover it with cling film. Put some paint in a plastic dish (use plastic containers of different shapes to support the questions about how some buildings use information about sound waves to inform their architecture) and then place the plastic dish on top of the speaker. Play some loud music through the speaker to see how the paint reacts. Also try white paint with a drop of a different colour paint in the middle to see how the two colours mix.

c. **The messiest:** repeat the speaker preparation, but this time put a slime mixture (cornflour and water) directly into the cling film-covered speaker bowl – do not use a plastic container. Turn the music up high and watch the results! The cornflour mixture should jump around as though it were alive! This is because corn flour and water mixes together to form a solution that is known as a non-Newtonian fluid. Non-Newtonian fluids act like normal fluids most of the time, but when they interact with strong vibrations or other physical forces, they stiffen up and act more like solids. This is what causes the corn flour and water mixture to dance around in the speaker bowl when loud music is played through the speaker.

## TIPS

- Lay plastic sheeting out covering everything in sight before starting the messy speaker part of the session! Music with lots of bass works best, as sound waves of lower pitches are the result of longer sound waves. Longer sound waves have a greater impact on the non-Newtonian fluid, which results in more impressive movements.

## Incorporating Digital Skills

**Use a mobile phone, digital camera or tablet to video record the experiment. Use a software app to slow down the footage.**

3. Pupils should now understand the idea that soundwaves radiate outwards. They should also understand that sound waves travel like ripples through a slinky.

   **Tip** – If you want to try this out, get a slinky and have two pupils hold an end each a couple of metres apart. Ask one pupil to push their hand forwards and backwards once quickly. This will create a ripple of compression that moves through the stretched-out slinky. This is how sound waves move.

4. The pupils should also understand that, because sound travels as a vibration that is passed between air molecules, sound cannot travel in a vacuum. Sound needs a medium through which travel – whether that be air, water or a solid material. In the vacuum of space, it's really true that no one can hear you scream! (People in space ships and space suits can hear things, however, as air molecules are pumped inside to allow the astronauts to breathe!)

5. Ask pupils to think about the buildings where it is important that sound travels well (e.g. cinemas, concert halls or theatres). Can they find examples of buildings or structures from history that have a circular shape in order to facilitate better acoustics (e.g. amphitheatres)?

6. What about modern cinemas? Are they still circular? Why not? (Most modern cinemas and theatres are not due to space constraints, but they usually use surround sound speakers to get around this problem!)

### DIFFERENTIATION IDEAS

**Support:** have a slinky to model how soundwaves move. They travel away from the sound source, but vibrate side to side rather than up and down like waves on the ocean.

**Challenge:** ask pupils to design their own optimised cinema based on what they've observed.

### EXTENSION IDEAS

1. Investigate how sound cannot travel in a vacuum, using an electronic toy inside a vacuum jar. Use a vacuum cleaner to remove the air and the sound will grow faint. Depending how much air you manage to remove, it may even go silent! Allow air to seep back into the bag and listen for the sound as it grows louder.

2. Combining what has been learnt in this activity with other activities, consider putting on a musical performance for teachers, parents, other pupils or the entire school. Draw together everything that has been learnt and put on a show!

## USEFUL LINKS

Video demonstrating how to use a slinky to emulate the movement of sound waves
https://www.youtube.com/watch?v=Bcqp6t4ybxU

STUDENT GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 8 Sensational soundwaves

## Your challenge

**Learn what a sound wave looks like through some messy investigations! Then think about how this applies to real life. You might discover that people use information about sound waves to decide how buildings and other structures should be built.**

**YOUR TASK** Watch how soundwaves travel then design your own cinema!

### WHAT YOU NEED TO DO

1. Help the Club leader to mess-proof the area you will be working in with plastic sheeting. Then help the Club leader to prepare the demonstration.
2. Watch the demonstration to find out how soundwaves travel. You could even record the demonstration and then play it back in slow motion to learn more about how sound waves travel.
3. Use the space below to describe what you saw. Based on what you saw, can you draw a sound wave? Think about the way that sound waves move and the direction they move in. Discuss your ideas with other pupils if you are stuck. You can even ask your Club leader for help.

**Describe what you learnt from the demonstration about how sound waves travel:**

## FUN FACTS

1. The largest cinema complex is in Madrid, Spain and has 25 screens. Between them, 9,200 people can be seated!
2. One of the first amphitheatres to be built was by the Romans in Pompeii, Italy, around 70 BCE.
3. In 1883, a volcano on the Indonesian island of Krakatoa erupted. It was one of the largest eruptions that the world has ever seen. The sound created by the explosive eruption was so loud that the sound waves created by it travelled around the entire Earth… four times! People 3,000 miles away could hear the explosion!

# Sounds Amazing!

## 8 Sensational soundwaves

4 Can you think of any buildings where it would be very important for sound to travel well? What shape are these buildings? Have these types of buildings stayed the same shape throughout history?

**The best room shape for soundwaves to travel in is...**

**The types of buildings with this shape include:**

**Design a cinema. Think about where the speakers and seats should be placed for the best experience.**

5 Try recording other things that vibrate or make sound, then watch the videos in slow motion. You might learn even more about how sound waves move! Try recording a wave through a slinky (ask you Club leader to help you), the strings on a guitar being plucked, a tuning fork after it's been hit, and anything else you can think of!

CLUB LEADER GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 10 Get CREST SuperStar Awards

**By completing 8 activities in this resource pack, your STEM club members could get a CREST SuperStar Award.**

### ABOUT CREST

CREST is a scheme that inspires young people to take on the role of scientists and engineers. CREST helps young people become independent and reflective learners. With no set timetable, projects can start whenever you want, and take as long as you need.

### HOW TO GET YOUR CREST SUPERSTAR AWARD

1. Learn more about CREST Awards by visiting https://www.crestawards.org/ or contact the CREST team on crest@britishscienceassociation.org for advice and support.
2. Sign-up for a free account - https://apply.crestawards.org/
3. Select 8 activities from this pack and deliver them. The CREST Primary Getting Started guide has all the details!
   Download it from: https://primarylibrary.crestawards.org/getting-started-guide-primary/62140323
4. Have each student complete a CREST SuperStar Passport to monitor their progress
5. Log in to your CREST account to submit the student project, pay the entry fee and request certificates and iron-on badges. These will be posted to your delivery address.

### TAKING THEIR WORK FURTHER

If members want to take activities further, they can work towards a CREST Discovery Award. CREST Discovery Awards require around 5h of work and offer an introduction to real project work and give students the freedom to run their own investigations. They can be completed in one day, with students working together in self-managed groups. Select one or two activities that have open investigation potential and encourage extended research and scientific investigation. Projects should be made suitable for CREST Discovery Days. The CREST Discovery Getting Started guide has all the details!
Download it from: https://discoverylibrary.crestawards.org/getting-started-guide-discovery/62140325

CLUB LEADER GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 9 The Skills Builder Framework

Skills Builder FRAMEWORK

### The Activities and Employability Skills

Each activity within this resource pack has identified the essential employability skills it supports and develops in students.

These skills have been mapped to the essential skills identified by the Skills Builder Framework, which breaks down eight essential skills into 16 teachable and measurable steps. Club leaders and teachers can use the activities to promote good practice and enhance each student's individual learning curve. Helping to promote transferable skills key to their education and future employment.

### ABOUT THE SKILLS BUILDER PARTNERSHIP

The Skills Builder Partnership brings together educators, employers and skills-building organisations around a common approach to building eight essential skills. Their programmes include training and resources, supporting schools and colleges to embed a rigorous approach to building skills and achieve the Gatsby Benchmarks. As an individual teacher or Club leader, you can freely access a suite of online teaching tools and resources, designed by their team of teachers to build essential skills. The suite includes learning activities, supporting videos, classroom resources, assessment tools and the Skills Builder Framework, which you can use in STEM clubs and classroom teaching.

### THE SKILLS BUILDER FRAMEWORK

The Skills Builder Framework breaks down eight essential skills into 16 teachable and measurable steps, providing a common set of expectations and a roadmap for progression. Step 0 is for the least experienced learners and Step 15 represents a highly skilled adult. The Framework can be used by teachers and Club leaders to talk to students about their skill strengths and areas for development and is a useful tool for framing conversations about careers and employability. Focusing student learning through the Framework, enables students to recognise their own essential skill levels and work to master them over time. The Framework can provide a language for students to articulate this progress to helping to develop employability skills and prepare students for future careers.

Skills Builder also provide multiple online assessment tools, including a student self-assessment, student-by-student teacher assessment and class- level formative assessment through the Skills Builder Hub. This means that programmes can be differentiated and focused to meet individual needs.

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## 9 The Skills Builder Framework


### EIGHT ESSENTIAL SKILLS

The eight essential skills broadly break down into four domains we know both teachers and employers value.

#### Communication

1. Listening – ability to listen and understand information.
2. Speaking - vocal communication of information or ideas.

#### Creative Problem solving

3. Problem Solving – ability to find a solution to a complex situation or challenge.
4. Creativity – use of imagination and the generation of new ideas.

#### Self-Management

5. Staying Positive – ability to use tactics to overcome setbacks and achieve goals.
6. Aiming High – ability to set clear, tangible goals and devise a robust route to achieving them.

#### Inter-personal

7. Leadership – supporting, encouraging and motivating others to achieve a shared goal.
8. Teamwork – working cooperatively with others towards achieving a shared goal.

You can find out more about essential skills and the Framework on the Skills Builder website, https://www.skillsbuilder.org/framework and you can access resources on the Skills Builder Hub https://www.skillsbuilder.org/hub

You can find additional support and information on careers and employability skills on the STEM Learning Careers pages, https://www.stem.org.uk/ stem-careers. You can also download the free Skills Builder toolkit from the STEM Learning website https://www.stem.org.uk/rxfum6

CLUB LEADER GUIDE: SUITABLE FOR AGE 9-11

# Sounds Amazing!

## 9 Digital Skills

### UNDERSTANDING DIGITAL SKILLS

Digital Skills are the product of digital literacy that we are all emersed in, especially within educational settings. The rapid use of digital technologies over the last 10-15 years have impacted the way we live our lives within a modern technological society.

Within this STEM Club activity, they are vast opportunities to utilize Digital Skills, which will have been taught already within the schools curricula. It's important that the use of digital skills is not meant to replace traditional methods; but enhance and further develop your students STEM learning future.

Digital skills can be grouped, recognised and celebrated.

| Cross Curricula Baseline Digital Skills | Computing curriculum baseline digital literacy | Computing curriculum specific skill | D&T/Engineering specific digital skills | Science specific digital skills | Maths specific digital skills |
|---|---|---|---|---|---|
| Communication tools | Safe technology use | Digital media | Digital design (CAD) | Modelling and simulation | Modelling |
| Presentation | Evaluative skills | Programming | Programmable embedded systems | Sensor-enabled data collection | Data analysis / data science |
| Word processing and DTP | Moral, ethical and lawful behaviour | Applied knowledge of systems and networks | Digital manufacturing (CAM) | Data analysis, inference and communication | Calculation |
| Data handling | | Modelling and simulation | | Digitally enabled explanation | Graphing |
| Devices, tools and applications | | Software development | | | Dynamic geometry |
| Productivity and task management | | Data manipulation | | | |
| | | Cyber security | | | |

### EXAMPLES OF USE

When conducting experiments, recording results in Excel makes it easier to present those results in a graph. This is a good example of Cross Curricula Baseline Digital Skills. Within a design and making opportunity, it would be fantastic to develop this design using 3D Computer Aided Design (CAD) and outputting on Computer Assisted manufacturing (CAM) and Rapid Prototyping (RP) such as 3D Printing. This is obviously D&T/Engineering specific digital skills.

Within the guides opportunities are signposted, these aren't the extensive list. You may find alternative Digital Skill provision. Remember you know your pupils and what equipment and skillsets staff are equipped with. This could be a great opportunity to investigate staff CPD.

STEM CLUBS

NUMBER 1 FOR STEM

# STEM Clubs Programme, led by STEM Learning

Achieving world-leading STEM education for all young people across the UK.

For more information on the programmes and publications available from STEM Learning, visit our website **www.stem.org.uk**