STEM CLUBS

NUMBER 1 FOR STEM

STEM ON SCREEN: SUITABLE FOR AGE 11-14

Movie music

STEM Learning activity resources

SUBJECT LINKS

DT, computing, engineering, physics and mathematics.

STEM ON SCREEN: SUITABLE FOR AGE 11-14

Movie music

STEM Learning activity resources

Introduction

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

This programme is part of STEM on Screen, a set of three programmes exploring science, technology, engineering and maths in the movies.

Movie music

Movies are amazing: a good movie can make you laugh, cry or jump in surprise. But how do they do it? The music you are listening to plays a big part.

This programme investigates the design and technology that goes into making movies sound good – from understanding how soundtracks can make you feel a particular emotion, to how cinemas are designed to make your movie experience intense.

Key information

AGE RANGE: 11-14.

SUBJECT LINKS: DT, Computing, Engineering, Physics, Maths.

DURATION: A range of activities from 20 to 60 minutes – 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 student notes.

IMPACT MEASUREMENT: Each set of resources is designed to help evaluate and assess the progress of club based learning on club members. A useful set of assessment tools are available at www.stem.org.uk/stem-clubs

ACHIEVEMENT: students that successfully complete a complete set of activities can be rewarded with the downloadable STEM Clubs Certificate of Achievement. Successfully completing a set of themed activities enables students to enter for a CREST Discovery Award. Further information is available on the STEM Clubs website.

APPROPRIATE VENUES: Club leaders can run most activities in general spaces e.g. classrooms, halls, and outdoor areas. Some activities need to be conducted in labs and workshops – these are marked clearly in the Club leader guide and in the table below.

SAFETY: Each activity includes details about significant health and safety considerations, such as appropriate eye protection, gloves, etc. Club Leaders should ensure that all equipment is handled with care, particularly sharp instruments. Advice and guidelines are available from CLEAPPS and SSERC, or see the STEM Clubs handbook (page 20). We recommend that practical activities are risk assessed before commencing and Club Leaders must follow their employer or organisations policies. Other activities: Visit www.stem.org.uk/resources/stem-clubs/ for a wealth of ideas for STEM-related Clubs.

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FURTHER SUPPORT: The STEM Clubs Best Practice handbook includes comprehensive support for leaders of all STEM-related clubs. It can be found at www.stem.org.uk/stem-clubs/getting-started

Activities

1	**MAKE A DIDDLEY BOW:** students make a simple one-string guitar and explore how stringed instruments make sound.	60 minutes	**Workshop required**
2	**EMOTIONAL REACTIONS:** students will listen to movie music, and observe and measure their different emotional responses. They will discover the real power of movie music.	60 minutes	
3	**SINGING GLASS:** students will make their own glass harmonica, helping them learn about some of the physics behind producing different notes.	50 minutes	
4	**GET IN TUNE:** students use Maths to explore how tuning works and can measure and create simple tuned pipes. Musical notes are all produced by sounds of specific frequencies, and these frequencies can be translated to tube lengths.	60 minutes	**Workshop required**
5	**DESIGNING MOVIE THEATRES:** students create acoustic panels and find out where to place them in the classroom to improve the quality of sound.	40 minutes	**Workshop required**
6	**MUSIC TRICKING OUR EYES:** students investigate if listening to certain types of music affects how people interpret different facial expressions from photos.	30 minutes	
7	**MICRO:BIT BEATBOX:** students can follow a tutorial to create a simple beatbox for creating a rhythm when tapped.	30 minutes	
8	**LOOKING AT SOUNDWAVES:** students make their own non-Newtonian fluid (also known as slime) and place it on a subwoofer in order to take a closer look at soundwaves.	30 minutes	
9	**GET CREST DISCOVERY AWARDS:** By completing all nine activities in this resource pack, your STEM Club members can get a CREST Discovery Award.		

STEM CLUBS

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Movie music

1 Make a diddley bow

Objective

In this activity students make a simple one-string guitar and explore how stringed instruments make sound.

TOPIC LINKS

- Physics: sound waves and frequency
- Design and Technology: making accurate measurements, creating a working prototype

TIME

60 minutes

RESOURCES AND PREPARATION

- 1x music wire or guitar string (100cm long)
- fishing wire can be used as an alternative
- 1x wooden board (90cm long)
- jar
- saw
- nails
- half-round wood rasp
- pencil
- optional: files and sandpaper for shaping the neck

HEALTH AND SAFETY:

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

SUPPORT:

This is a specialist D&T activity that needs to be done in a D&T room. Club leaders are recommended to have the support of a specialist during the activity, or to get training from a specialist and practise with the tools in advance.

DELIVERY

1. Explain how vibrating strings produce sounds. The vibrating body causes the air around it to vibrate. Vibrations in air are called traveling longitudinal waves, which we can hear. Ask students to think about all the different instruments that use strings to make music.
2. What do guitar strings look like when they create sound? They vibrate very quickly. As a guitar string vibrates, it sets surrounding air molecules into vibrational motion. The frequency at which these air molecules vibrate is equal to the frequency of vibration of the guitar string. Show them a famous video that shows misconception of what this looks like, and then an actual piece of footage, using: Science Alert video of slow motion guitar strings.
3. Ask the students what factors might affect the sound created by the guitar (e.g. tightness and thickness of the string, the material the string is made of).
4. Show the video about the 'Sounds of the Nightmare Machine' which proves that sometimes the simplest instruments can be used to create the most interesting sounds.
5. Explain that they will be making their own one-string guitar and will investigate how these instruments can produce notes and melodies. The activity's objective will be for them to use their instrument to create sound effects or part of a soundtrack for a scary movie.

SAFETY NOTE: The board and the glass jar bridge are both under pressure applied by the string. Students should wear face and hand protection when tensioning up the diddley bow.

DIFFERENTIATION IDEAS

Support: Provide the boards and wires at the appropriate lengths and let the students assemble them according to the guidelines. Help struggling students with the tension of the wire.

Challenge: Have the students investigate the effect of string thickness and tension by adding more strings to their instrument.

EXTENSION IDEAS

1. Let students try out what happens when the thickness of the string is increased or decreased. What happens to the pitch? Why?

TIPS

- Students can watch a how-to video (see Useful links).
- Students may want to learn more about the notes or frequencies they are producing through a smartphone tuner app (see Useful links).

USEFUL LINKS

- Science Alert video of slow motion guitar strings
- YouTube video of how to build a Diddley bow
- The Sounds of the Nightmare Machine
- Smartphone tuning app free example is Tuner - gStrings Free
- Smartphone audio frequency counter app
- Physics of sound, travelling waves

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Movie music

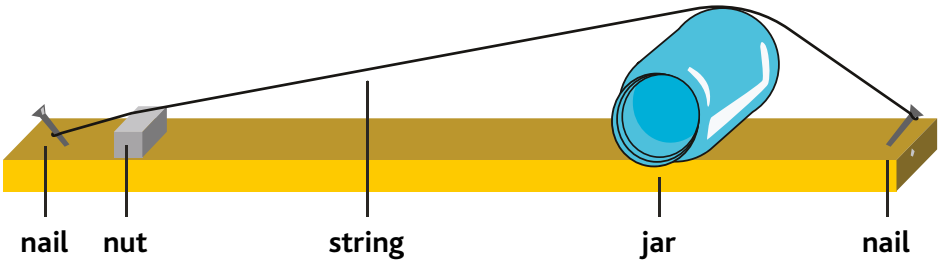
1 Make a diddley bow

Your challenge

Ever listened to a movie soundtrack and thought you'd like to create your own music? Well now you can, by making a one-string diddley bow! Can you use it to make your own sound effects or soundtrack for a scary movie?

Learn about the physics behind sound by making a simple string instrument – the diddley bow.

WHAT YOU NEED TO DO



PHASE 1 – MAKE YOUR DIDDLEY BOW

Materials:

- 1 music wire or guitar string (100 cm long)
- 1 wooden board (90 cm long)
- jar
- saw
- nails
- half-round wood rasp
- pencil
- optional: files and sandpaper for shaping the neck

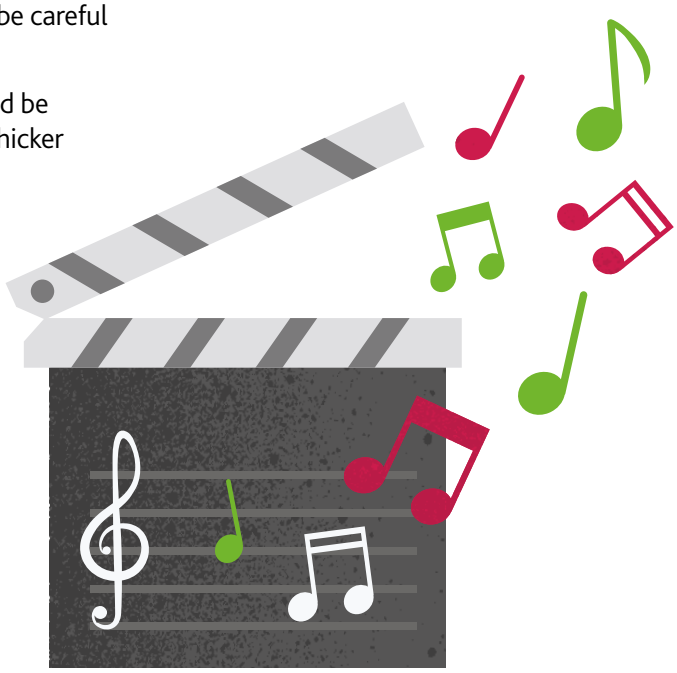
SAFETY:

Please work carefully and sensibly when building, tuning, and playing your instrument. The string applies tension to your board and the glass jar.

1. Collect your materials.
2. Ensure your board is about 10 cm shorter than the length of your wire (cut it if needed).
3. Use your ruler to measure 2.5 cm from the end of your board. Mark this area with your pencil.
4. Hammer a nail into the face of the board at the areas you have marked, angle the nails upward toward the end of the board.
5. Repeat steps 3 and 4 for the other end of the board
6. Wrap one end of the wire around the first nail a couple of times and then around the string itself. Keep the wire close to the board at both ends, and wrap the other end of the wire around the other nail a few turns and then around itself. Cut off the excess on both ends.

7. Slip the jar under the wire at the centre of the instrument, and slide it toward one of the nails, pushing it as far as it will go. When you've pushed it as close as you can to the nail, use a pencil to mark where the jar rests on the board.
8. Remove the jar from under the string.
9. You will now make a shallow groove to let the jar sit in comfortably. Use a half-round wood rasp to rasp out a shallow groove across the board for the bottle to fit into. Check how well your jar fits in the space occasionally until it slips in and does not jiggle around too much. Ask for support from your club leader if necessary.
10. Create the nut at the other end of the wood by taking a small piece of wood and slipping it under the string. Push it as close to the nail as you can. This should put some tension on the string, so be careful with the glass jar!
11. Try playing the string with a stick and a bright sound should be produced. If the sound is too dull, you may need to use a thicker piece of wood to act as your nut.

You have finished your diddley bow!



PHASE 2 – MAKE SOME (CREEPY) MUSIC

1. Now try playing it in different ways: tap the wire, or scratch it. Improvise, and use different objects in different ways to create as many different sounds as possible!
2. Select the ones that sound the 'scariest'.
3. Work by yourself or with others and create a spooky soundtrack for a scary movie.

FUN FACTS

1. The volume of sound is measured in decibels.
2. The frequency of sounds, which is called the pitch (how high or low something sounds) is measured in Hertz, or the vibrations per second. The lowest note on the piano has a frequency of 27.5 Hertz, while the highest note on the piano has a frequency of 4186.01 Hertz.
3. Traditionally, diddley bows used old broom wire as the string – a material which was cheap and easy to get hold of.
4. There are instruments made specifically to create scary sounds as part of the soundtrack in scary movies.
5. What makes a soundtrack scary? A new study has found a connection between horror movie music and the cries of young animals. Researchers believe there are biologically-ingrained reasons why sudden, high-pitched noises and minor chords in music make us nervous.

STEM CLUBS

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Movie music

2 Emotional reactions

Objective

In this activity, students will listen to movie music, and observe and measure their different emotional responses. They will discover the real power of movie music.

TOPIC LINKS

Biology: neurologic/ physiologic responses

TIME

60 minutes

RESOURCES AND PREPARATION

- a desktop or laptop to show movie clips
- source 4 short movie music clips, keywords:
- suspenseful
- sad
- action, instrumental
- peaceful
- stopwatches
- optional: pulse monitors or data loggers

HEALTH AND SAFETY:

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

DELIVERY

1. Introduce the idea that movie composers have to think about the emotional effect their music has on the viewer. Students should think about what makes a soundtrack sad, happy, exciting or scary (instruments, tempo, etc.).
2. To illustrate how important music is, show them an example of a movie where the 'wrong' soundtrack is used (see Useful links or create your own by muting a movie and playing music over the top). What affect does this have on how they perceive the scene?
3. Music can cause biological responses in the viewer that the viewer might not even be aware of. Ask the students if they can think of any responses they have experienced while watching exciting movies (goose pimples, sweating, increased heart rate, etc.).
4. Hearing music is closely associated with strong emotions. This is because music activates the entire limbic system (the part of the brain responsible for emotion processing). Therefore, music can stimulate an emotional response. How different aspects of music affect us in different ways is what the students will try to investigate (calming effect, or increased heart rate and agitation, goose bumps etc.). See the ScienceDaily article in the Useful links section.
5. This activity will focus on heart rate as it is easy to measure. Describe how our heart rate can reflect emotional state and show how it can be measured as beats per minute.

USEFUL LINKS

- YouTube video of movie clips with the 'wrong' music
- Education article about how music influences the way we experience a film?
- ScienceDaily article: Listening to music lights up the whole brain
- Project: Movies, Moods and Music: How Does Music Influence the Way We Experience a Film?

TIPS

- Choose movie clips that appeal to your class. Find out before the session what kinds of movies students like.
- Let students try out different ways to look at heart rate such as the radial artery at wrist, carotid artery, heart monitor (e.g. smart watch), and stethoscopes. Show the students how data loggers are used and how they allow us to take more accurate measurements.

DIFFERENTIATION IDEAS

Support: Assist students in finding or counting their pulse.

Challenge: Students could find new genres of movie music to investigate. Do these elicit similar emotional responses?

EXTENSION IDEAS

1. Students can investigate how we might use these physiological reactions to music to our advantage. For example, does playing exciting/ exhilarating music during sports enhance a player's results?
2. What patterns can students find when they listen to soundtracks that are supposed to elicit different emotions? Students listen to clips of sad, happy, or action movie scenes to find out if there are particular instruments or other musical tricks that composers tend to use to make the movie scenes more impactful.

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Movie music

2 Emotional reactions

Your challenge

Movies try to suck us in by cleverly using music to fit the scene. Music adds to the visual experience of a movie, and increases the emotions we feel as we watch (and listen). Scary things feel scarier with the right music! Happier things feel happier, too.

How do we feel the effects of music? This can happen in different ways for different people. In this activity, you will investigate if/how music in movies affects your heart rate.

WHAT YOU NEED TO DO

1. To check your pulse at your wrist, place two fingers between the bone and the tendon below the thumb side of your wrist.
2. We measure our heart rates in beats per minute (bpm). In order to find your own heart rate in bpm, you need to find your pulse, start your stopwatch, and count the number of beats for 15 seconds. Multiply this number by 4 to calculate your beats per minute (bpm).
3. Practise measuring your own heart rate – soon you will have to do it quickly and several times in a row. Once you feel confident you know what you are doing, it is time to start the experiment.
4. Measure your heart rate one more time before your club leader starts the first movie clip. Write down your result in the table below in the correct location.
5. Your club leader will start the first movie clip. Halfway through the video, your club leader will signal for you to take another heart rate measurement. Write this down.
6. Once the first clip is over, measure and record your heart rate again.
7. Write down what kind of emotions you think the director and the composer of the movie wanted you to feel during the scene that you have just observed.
8. Repeat step 4–7 with the other three movie clips and complete the table.

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STEM ON SCREEN MOVIE MUSIC EMOTIONAL REACTIONS

Movie clip	Heart rate (bpm)			Emotions you felt
	Before clip	During clip	After clip	
1				
2				
3				
4				

FUN FACTS

1. Movie experts agree on the idea that music adds to the emotional quality of the film.
2. The branch of science studying the neurobiological effects of how music is perceived, learned and performed is called auditory neuroscience. Auditory neuroscientists come from established educational backgrounds, usually with a Ph.D. in neuroscience, neurobiology, cognitive science or psychology.
3. Fast and loud music makes the viewer feel more excited, and slow and soft music calms us down. (Just think about lullabies – they are not usually loud and fast, and now you know why!)
4. Did you know that the music in E.T., Star Wars, and Indiana Jones are all composed by the same person? Just listen to some songs from these three films, and you might be able to recognise that they all actually sound quite similar at times. This makes it difficult to hum the songs in succession. They sound too similar and your brain more easily mixes them up
5. There have been a couple of EXTREME cases of emotional reactions to music in the past. In these cases, people were so moved by the music they were listening to that they suffered seizures. According the scientists who researched this strange phenomenon, it's not the specific tune that caused the seizure, but the emotional reaction to it.

STEM CLUBS

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Movie music

3 Singing glass

Objective

In this activity, students will make their own glass harmonica, helping them learn about some of the physics behind producing different notes.

TOPIC LINKS

- Physics: sound waves and frequencies

TIME

50 minutes

RESOURCES AND PREPARATION

- several wine glasses per group
- water
- food colouring
- pipette
- smartphone tuning app (see Useful links) or electric tuner

HEALTH AND SAFETY:

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

It is recommended to turn this activity into a demo unless the risk assessment clearly indicates the group's ability is appropriate. Extra staff might need to be in place for close supervision.

DELIVERY

1. Explain that the glass harmonica is an instrument made up of a series of glasses containing different amounts of water. The singing tone you can hear as you run your finger over the top is an example of 'acoustic resonance'.
2. Your finger applies changes in the pressure on the rim of the glass that makes the side of the glass move in and out, and this causes the sound. The pattern of movements of the sides of the glass moves the air in the glass, creating a **wave of sound**.
3. The tone of the sound is intrinsic to the glass, and moving your finger faster or slower will affect the volume, but not the pitch. Ask the students how they could change the tone or pitch.
4. If the students do not know the answer, explain that adding water to the cup lowers the pitch of the sound. This happens because the water changes the shape of the glass and makes it heavier. The heavier glass takes more energy to move than the empty glass, and that means that the sound wave is generated more slowly (with a lower frequency). Because frequency is tied to pitch, the pitch produced by the glass goes down as you add more water.

USEFUL LINKS

- Smartphone tuning app free example is Tuner - gStrings Free
- A YouTube video explaining the physics behind wine glass music

TIPS

- Explain the need to work very carefully during this activity. Wine glasses have very thin sections, which makes them prone to breaking if too much force is used.
- The physics behind sounds: simply put: sound is produced when something vibrates. The vibrating glass (in this activity) causes the air around it to vibrate. Vibrations in air are called travelling longitudinal waves, which we can hear. Use this link for more information regarding the physics behind sound and music.

DIFFERENTIATION IDEAS

Support: Ask students to try tuning with a smaller number of glasses and let them try to play them before attempting to tune their own glass.

Challenge: Ask students to produce a fully tuned 7-glass harmonica.

EXTENSION IDEAS

1. Once the students have a reasonable set of glasses prepared, they can attempt to learn a song other than three blind mice (which is in the activity).

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Movie music

3 Singing glass

Your challenge

In some circumstances, objects will vibrate at a certain frequency and produce sound. This phenomenon is known as 'acoustic resonance'. Singing wine glasses are a well-known example of acoustic resonance. Run a wet finger around the rim of a wine glass, and it will sing. Adding liquid changes the pitch, or the note. Add several glasses together, and you have created a glass harmonica!

Look at the physics behind sound and make a musical instrument!

WHAT YOU NEED TO DO

1. Start with one glass and practise making it sing. The trick here is to make sure your finger is wet, but not too wet. The sound is produced as your finger slips and sticks, and then slips and sticks again (in rapid succession).
2. Once your group can consistently produce the air vibrations that make sound, find out exactly what note you are producing with your glass. Use the electric tuner (or tuning app) to find this.
3. Add a little bit of water to your glass and repeat step 2.
4. Remove some water using the pipette and repeat step 2. Is it possible to get back to that first note? If you remove more, what happens to the pitch?
5. Start your own glass harmonica by gathering three glasses. For your first glass, add water and test the pitch until you get a middle D. (You can use an app to test the pitch.)
6. Repeat step 5, but add a little less water until your tuner tells you you've reached the next note: E.
7. For the third glass, you want to find the note C (this note is lower than the middle D).
8. Colour code your three notes using food colouring and/or write the different notes on the glass.
9. Practise playing 'Three blind mice'.

FUN FACTS

1. The Glass Harmonica was invented by Benjamin Franklin (one of the Founding Fathers of the United States).
2. The Glass Harmonica was such a popular instrument that composers like Mozart and Beethoven wrote musical compositions for it.
3. The instrument lost its popularity during 18th century because some people were saying that listening to the glass harmonica made them feel depressed, affecting their mental health!

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CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Movie music

4 Get in tune

Objective

In this activity students use Maths to explore how tuning works and can measure and create simple tuned pipes. Musical notes are all produced by sounds of specific frequencies, and these frequencies can be translated to tube lengths.

TOPIC LINKS

- Maths: calculate pipe lengths
- Physics: sound waves and frequency
- Design and Technology: making accurate measurements, manufacturing with hand tools

TIME

60 minutes

RESOURCES AND PREPARATION

- 12 mm PVC pipe (60 cm per pan flute)
- Plastic saw
- Ruler
- Cardboard
- Scissors
- Duct tape
- Optional: duct tape in 5–7 colours (depending on the number of pipes, for the different notes)
- Optional: color-coded, pre-made plastic tubes called boomwhackers.

HEALTH AND SAFETY:

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

SUPPORT:

This is a specialist D&T activity that needs to be done in a D&T room. Club leaders are recommended to have the support of a specialist during the activity, or to get training from a specialist and practise in advance.

DELIVERY

1. Explain that musical notes are all produced by sounds of specific frequencies. You can translate those frequencies to tube lengths using the speed of sound.

2. Tell students that they can find out the length of tube they need to produce a given note. In order to produce a given note, you need to insert your measurements (in centimetres) for tube diameter and the frequency of your desired note (in Hertz). The students will need the following formula:

   Length (cm) = (tube diameter in cm/2) + (speed of sound in centimetres per second/(frequency in Hz * 2))

   - the speed of sound is 34300 cm/s
   - in this example, the inner diameter of the tube is 1.3 cm
   - example for a high D note: Length (cm) = (1.3/2) + (34300/(587 * 2)) = 29.9 cm

3. Tell students that they will be making their own instrument, using their knowledge about frequencies. Follow the step-by-step instructions in the student guide.

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STEM CLUBS

NUMBER 1 FOR STEM

DIFFERENTIATION IDEAS

Support: Have the table prepared for the students so they can make the pan flute without needing to do the Maths themselves. If boomwhackers are available, these can be used as examples or to simplify the task.

Challenge: Ask students to fill out the table themselves, letting them calculate the measurements for the different pipes in order to get the right notes. Ask more able students to calculate their own lengths for their wind instrument. For this they will need the values for the frequencies for each of the notes.

EXTENSION IDEAS

1. Let students learn a simple melody by ear and write down the notes.
2. Students could also attempt to make a flute. The calculations can be explained and worked out by students, or this calculator can be used to speed up the process.
3. Ask students to think about wind xylophones. The diameter of these pipes is much larger. Can they do the calculations to figure out how to make a well-tuned wind xylophone? (See the Useful links section for more information.)

TIPS

- It is possible to make a panpipe with different number of pipes.
- Tell students to cut their pipes a little too long rather than a little too short. The top can be filed shorter during tuning.
- HEALTH AND SAFETY: PVC pipes can have sharp edges, especially after being cut. Exercise caution and instruct students to carefully sand edges immediately after cutting.

USEFUL LINKS

- Guide for building panpipes (simple)
- Guide for building panpipes (detailed)
- Calculator to make a pipe flute
- Website explaining how to make a large wind pipe xylophone

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Movie music

4 Get in tune

Your challenge

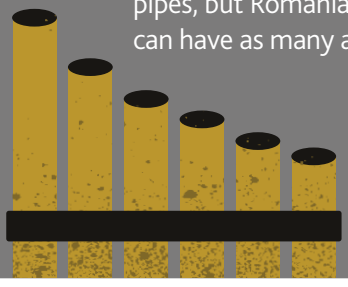
Panpipes are wind instruments that produce a soft, melodious sound that you might have heard as part of the soundtrack in movies before. Many people don't realise that panpipes are one of the few musical instruments you can easily make at home – but will need some maths and physics to get them to sound the way you want!

Get in tune and make your own wind instrument.

WHAT YOU NEED TO DO

1. Measure the diameter of your pipes and record this in your table.
2. Calculate the length of the pipes for each of the notes. Use the formula given to you by your club leader. Write all your calculations down in the table.
3. Cut the pipe into the lengths you have calculated. **Tip: it is better to cut your pipe a little bit too long. This way you can fine-tune each pipe in step 4.**
4. Use sandpaper to smooth off the cut edges for each pipe.
5. Cut cardboard into circles with the same width as the PVC pipe. Place the cardboard over one end of each pipe and cover this with duct tape.
6. Test the sound. For this, you could try using a tuner. If necessary, use sandpaper to shorten your pipe carefully.
7. Line the pipes up from small to large and duct tape them together.
8. Blow across the top of each pipe – it's just like blowing on a bottle.

FUN FACTS



1. There aren't a set number of pipes used in panpipes. Many panpipes have either five or eight pipes, but Romanian panpipes can have as many as 20!
2. All flutes produce their sound by vibrating a column of air inside of a tube. This means that what you hear when you play your instrument is not actually the flute, but a vibrating column of air inside of the flute.

Name:

MEASUREMENTS FOR EACH NOTE

Note	Frequency (Hz)	Diameter of pipe (mm)	Length of pipe (mm)	Optional: Colour of pipe
D	587			
E	659			
F	698			
G	784			
A	880			
B	987			
C	1046			

STEM CLUBS

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CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Movie music

5 Designing movie theatres

Objective

In this activity, students create acoustic panels and find out where to place them in the classroom to improve the quality of sound.

TOPIC LINKS

- Design and Technology: making accurate measurements, evaluating success of a prototype
- Physics: sound absorption/ reflection

TIME

40 minutes

RESOURCES AND PREPARATION

Each group will require:

- one art canvas, approximately 4 cm deep (suggested dimensions are 40 x 40 cm)
- convoluted acoustic foam (suggested dimensions are 40 x 40 x 3 cm)
- paper or newspaper backing, to hold the foam in place
- 2x picture hangers (from a hardware or art store)
- scissors
- staple gun (to staple the backing onto the frame)
- hammer (to attach picture hangers)
- hand-held mirror
- nerf gun
- optional: acrylic paint to decorate the canvas (from any art store)
- optional: paint brushes
- optional: sound absorbing fiberglass panels

HEALTH AND SAFETY:

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

Club leaders are recommended to keep the staple gun at a supervised station and provide support or operate the staple gun themselves.

Take care when using a nerf gun, club leaders should refer to CLEAPSS and SERCC guidance.

SUPPORT:

This is a specialist D&T activity. Club leaders are recommended to have the support of a specialist during the activity, or to get training from a specialist and practise in advance.

DELIVERY

1. Ask students to think about how sound bounces of walls: illustrate this with how their voices echo in a tunnel, compared to their voice in a movie theatre.
2. Let them think about the purpose of the sound-absorbing panels that are used along the walls of movie theatres. They are placed strategically to have a dramatic effect. High frequency 'ringing' is killed off, and bass is no longer muddy or booming. All those sound waves that would have bounced off the walls are instead mostly absorbed by the panels, so that the primary wave from the speakers is what you hear most.
3. Use the nerf gun to illustrate how sound hits walls and is reflected in different directions.
4. It is possible to find the strategic locations in a simple trick using a mirror. Try this out with the class. For this you need an assistant and an area which will act as the source of the sound (see video guidelines).
   - ask the assistant to sit in the area where the viewer/listener would be sitting (as a member of the audience in a movie theatre, for example).
   - stand somewhere along the wall between the audience member and the source of the sound (e.g. a speaker).
   - from your location, slide the mirror along the wall until the audience member sees the speaker. This is where the absorption panel should be placed.
5. Show the students how to make their sound panels and allow them to decorate them.
6. At the end of the lesson, let students find the best locations for their collection of panels and try out their own movie theatre.

continued over...

STEM CLUBS

NUMBER 1 FOR STEM

TIPS

- The sound-absorbing fiberglass is denser, so it absorbs more bass than the foam. Choose the material if you would like to add the extension to let students consider the purpose for their panel.

DIFFERENTIATION IDEAS

Support: Help students understand that some materials can absorb sound, reducing the amount that is reflected off objects. This results in a cleaner sound experience, like what they'll find in a cinema.

Challenge: Ask students to create their own frame using cloth and wood.

EXTENSION IDEAS

1. Ask students to consider what they want to use the sound absorber for. In a movie theatre, is it more important to absorb low frequencies or high frequencies? A thicker panel will more effectively absorb a longer wavelength (lower frequency) of sound.
   - for human voices, crowds of people and speech, use 30 mm absorber thickness.
   - for amplified music with bass and drums or cinema surround-sound, use 60 mm absorber thickness (or greater).
2. Planning for the acoustics of an area isn't just important for movie theatres. When the Sage Gateshead was designed, the acoustics of the space were as important as the look and feel of the unusual building. Sage Gateshead looks like one building from the outside, but structurally it is three separate buildings, insulated from each other to prevent noise and vibration travelling between them. The gaps between them can be seen inside. A special 'spongy' concrete mix was used in the construction, with more air capacity to improve the acoustics. These three buildings are enclosed (but not touched) by the now-famous glass and steel shell.

USEFUL LINKS

- Webpage explaining how to make decorative and simple sound absorbers
- YouTube video guidelines on the challenge
- Information on Sage Gateshead

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Movie music

5 Designing movie theatres

Your challenge

Sound reflecting off walls, windows and other hard surfaces can make music sound tinny. Theatres, cinemas or sound stages are designed to use sound absorption products to absorb the unwanted noise. Even vloggers have special equipment in their rooms to make sure their voice is captured by the microphone just right.

Create an acoustic panel to see for yourself how they can be used to improve your movie watching (and listening) experience.

WHAT YOU NEED TO DO

Phase 1 – Creating your acoustic panel

1. Gather your materials. If you are using a pre-made canvas frame, measure the dimensions of the inside of the frame: this is where you will need to place the absorbent material.
2. Once you have the measurements from step 1, cut the acoustic foam at these measurements to allow it to fit inside the frame. It should fill the space completely, but not bulge out.
3. Place the foam inside the canvas with the bumpy side facing the painted face of the canvas.
4. Cut off a piece of sturdy paper or newspaper that is large enough to cover the back of the panel, but not hang over the edges. Staple the paper down with a staple gun.

Phase 2 – Placing your acoustic panel

5. Ask one group member to act as the audience while another member takes the hand mirror and stands along the wall between the sound of the music (e.g. a speaker) and the audience.
6. Slide the mirror along the wall until the audience member sees the speaker. This is where the sound waves from the speaker will bounce from the walls and muddle up the sound for the viewer. Place your absorption panel here to improve their movie experience!

Phase 3 – Decorate your acoustic panel

7. Use the art materials to decorate your panel as you like. Your own home cinema will look and sound better than ever!

FUN FACTS

1. The wall coverings, curtains, seats, and audience inside a cinema all absorb sound differently at all frequencies.
2. At the cinema, sit about two-thirds of the way back and in the middle of the room for the best sound experience. That is because audio technicians usually do the sound quality checks for these seats only.
3. In daily life, the impact of unwanted noise can be profound! Poor acoustics in schools and offices can seriously affect concentration and therefore affect results. On top of that, researchers found that long-term exposure to noise at home or at work significantly increases heart attack risk.
4. Global urbanisation will most likely only increase our exposure to unwanted sound, which is why many researchers see the science behind sound absorption as an increasingly important engineering challenge.
5. There are lots of uses for good sound absorbing materials. Designers and architects use them to improve acoustics in sports centres, theatres, restaurants, music studios, hotels and offices.

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Movie music

6 Music tricking our eyes

Objective

In this activity, students investigate if listening to certain types of music affects how people interpret different facial expressions from photos.

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

TOPIC LINKS

- Biology: neurological/ physiological responses

TIME

30 minutes

RESOURCES AND PREPARATION

- computer with sound functionality
- a selection of photos of people with different expressions (these can be found relatively easily using the internet OR students can be given the task to provide their own pictures in advance)
- a selection of 'happy' and 'sad' song excerpts (10–15 seconds). Songs can be reused several times.
- optional: Headphones
- optional: Computer or other device with the selection of songs to be used
- optional: Printed photos (write numbers on the back and provide a key for the researcher)

DELIVERY

1. Ask students if they have ever watched a movie where the music did not match the picture: for example, a happy soundtrack over a sad scene, or the other way round. Usually, such a mismatch makes the scene look silly.
2. Play a sad musical excerpt (approximately 15 seconds). Following the music clip, show a photo of a person with a neutral facial expression and ask students to write down how they think the person in the photo is feeling (e.g. along a scale from very sad to very happy)
3. Repeat this activity, with the same photo, but this time play happy music for 15 seconds before showing them the photo. Discuss the findings – did people notice the photos were the same? Did the music affect their interpretation of it?
4. Introduce the activity they will undertake: to find out if music can affect their classmates' ability to interpret expressions correctly.

TIPS

- **Prepare a presentation (PowerPoint, Prezi, or otherwise) ahead of time where the music excerpts and photos play automatically.**
- **If the students work in groups, it is important to prepare one stack of numbered photos and a playlist with all the music clips. Only the researcher(s) should have the key to the photos and the expressions shown in them.**

DIFFERENTIATION IDEAS

Support:

1. Make it easier for students by letting them write down the emotions they read from pictures without any music first, allowing them to take the time to think (out loud) about what features they look for when determining this.
2. Lead the experiment by playing the music and show the images the same way as in the delivery. All the students are the subjects of this experiment, and the results can be discussed with the whole class or in small groups.

Challenge:

1. Divide the class into groups of 2–3, where there is at least one researcher (showing the photos) and one subject (listening to music and interpreting the expressions). Each group will require the music excerpts and the photos. This challenge does require more preparation and more materials – marked as 'optional' in the resources and preparation section.
2. Students can analyse their results in small groups, interpreting their data and drawing conclusions before sharing this with the class.

EXTENSION IDEAS

1. Students can expand on their research by conducting the experiment outside the classroom. Armed with a selection of songs and photos, they can assess how well people might be influenced by music in this experiment. They bring back their data after one week and analyse their results during a discussion.
2. Students can investigate if music with other emotional themes can influence how people interpret facial expression in a similar way.

USEFUL LINKS

Music affects how we perceive facial expressions

8 surprising ways music affects and benefits our brain

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Movie music

6 Music tricking our eyes

Your challenge

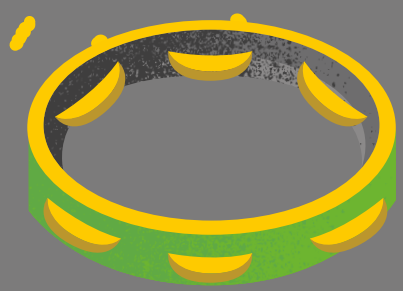
What could a film producer do if she's stuck with a cast of bad actors? Good music could be the answer! Scientists have found that listening to music can trick our brains into interpreting other people's facial expressions differently. Happier music can make us think someone is happier, and sad music makes us think they're sadder. So even if the actors aren't' very good, a good soundtrack could help fool the audience!

Find out just how much our eyes can be tricked by the right kind of music.

WHAT YOU NEED TO DO

1. Your club leader will lead this experiment.
2. You will be listening to short music excerpts that are either happy or sad. Listen carefully, and determine how the music makes you feel. Write this down in your table under 'emotion in the song'.
3. Shortly after listening, you will be shown a photo of a person's face. In the table below, you will need to circle which expression (from very sad to very happy) best describes the person in the photo. Leave the column to the right empty for now.
4. You will continue to listen to different songs and then carefully deciding which expression you can see for several more songs and photos.

FUN FACTS



1. The chills you get when you listen to music is mostly caused by the brain releasing a feel-good hormone known as dopamine while you are expecting the climax of a song. Dopamine is a chemical released by the brain that is connected with the feeling of euphoria, which is also associated with eating!
2. In addition to exercise, music is one of the only activities that stimulates your entire brain.
3. Listening to music while you are exercising is found to have a positive effect. This is because music can release those feel-good hormones in the brain that may boost your mood, dull pain and make you less tired. Next time you go for a run, why not bring along the soundtrack of a particularly exciting movie and see if it helps!

Name:

Song number	Emotion in the song	Photo number	Expression* (according to subject) *Circle one	Intended expression
1		1	Very sad Sad Neutral Happy Very happy	
2		2	Very sad Sad Neutral Happy Very happy	
3		3	Very sad Sad Neutral Happy Very happy	
4		4	Very sad Sad Neutral Happy Very happy	
5		5	Very sad Sad Neutral Happy Very happy	
6		6	Very sad Sad Neutral Happy Very happy	
7		7	Very sad Sad Neutral Happy Very happy	
8		8	Very sad Sad Neutral Happy Very happy	

STEM CLUBS

NUMBER 1 FOR STEM

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Movie music

7 Micro:bit beatbox

Objective

In this activity, students can follow a tutorial to create a simple beatbox that makes a rhythm when tapped.

TOPIC LINKS

Computing: programming

TIME

30 minutes

RESOURCES AND PREPARATION

- computer with internet access
- bbc Micro:bit

HEALTH AND SAFETY:

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

SUPPORT:

This is a specialist computing activity. Club leaders are recommended to have the support of a specialist during the activity, or to get training from a specialist and practise in advance.

DELIVERY

1. Introduce the topic of percussion and its role in music (it leads the tempo).
2. Students may enjoy watching beatboxers showing their skills. (This slow motion video of a beatboxer is an interesting start.)
3. Tell the students they will become beatboxers in this activity, not with their mouths but by coding their Micro:bit.

TIPS

- Familiarise students with the Micro:bit coding editor before starting this activity.
- There are a lot of pages with extra help to be found on the Micro:bit website.
- Run this activity online in the emulator mode.

DIFFERENTIATION IDEAS

Support: Go over the coding with the students step by step. If they have never programmed before, show them how to drag and drop and how to navigate through the different categories.

Challenge: Explain the goals for the activity and (part of) the script. Advanced students may enjoy working through the problem through trial and error and by searching for ways on the internet.

EXTENSION IDEAS

1. Use the light beatbox Micro:bit challenge to expand on this activity. The students can use the BBC Micro:bit website.
2. Once students have mastered online programming, challenge them to programme the Micro:bit, you will need crocodile clips to make the connections.

USEFUL LINKS

Link that this activity is based on

Micro:bit generation of music tones

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Movie music

7 Micro:bit beatbox

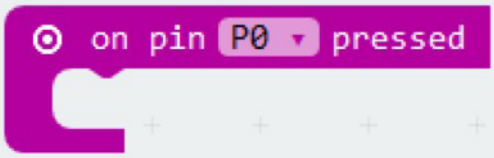
Your challenge

Rhythm in music is characterized by a repeating sequence of beats. The tempo of a song is the measure of time given to a beat or rhythm. Have you ever tried to beatbox? This is when you use your voice to mimic complex sounds of percussion instruments, usually at a very high tempo.

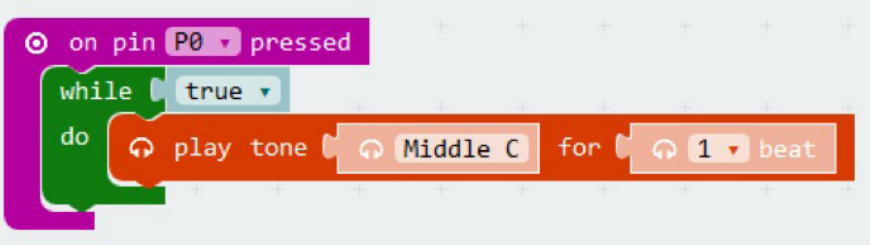
Learn how to make a beatbox using code and investigate some different tempos!

WHAT YOU NEED TO DO

1. Go to the BBC Micro:bit website: www.microbit.org
2. Click on "I've got my Micro:bit, what do I need to get started? Get started".
3. Scroll down to the "easy peasy" section and click "Let's code".
4. Under JavaScript Blocks Editor click "let's code"
5. You will see the board where you will select 'blocks' that linked together, create a code or a program giving the Micro:bit instructions as to what to do. All the blocks you will need are organised in different categories ('Basic', 'Input', 'Music', 'Led' etc.). Your screen will automatically load up an '**on start**' block and a '**forever**' block. Neither of these blocks are necessary for now.
6. From the 'Input' tab on the left, click and drag the '**on pin pressed**' block and place it in the workspace.



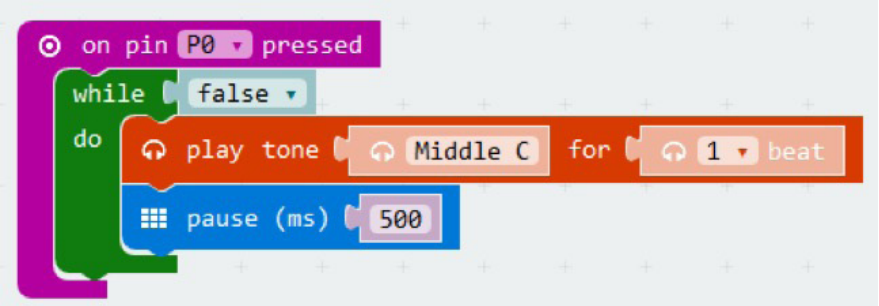
7. Now we need to select the blocks that we want to act when pin P0 is pressed. Select the '**while ... do**' block from the '**Loops**' tab. Make sure you switch the blue box to '**true**'.
8. Next, go the '**Music**' category and select the '**play tone ... for**' block. You can decide on the note you want to start with. The image below has selected C.



continued over...

9. Check if your code works so far by pressing the P0 button on the virtual Micro:bit. Play around with the length of time the note plays, and see how it sounds after running the new code.

10. In order to change the amount of time between each note, so you can add a pause. Go to the '**Basic**' category in the tab and select the '**pause**' block. The pause in the example is quite long – try different numbers and see what the results are.



11. It is possible the change the tempo by selecting the '**on button A pressed, do**' block from the '**Input**' tab.

12. Drag the '**change tempo by**' block from the '**Music**' category into the first block and you should get this:

You have made a very simple beatbox!

Fast finishers:

13. Using the guidelines above, add to your code so that a different note will play when you press the P1 and P2 pin.

14. Add the option to press button B. Every time you press it, the tempo should slow down.

FUN FACTS

1. Beatboxers use their mouth, lips, tongue and voice to generate sounds that one might never expect to come from the human body. Scientists have gone so far as to put a beatboxing man in a scanner to find out exactly how they can create these strange sounds.

STEM CLUBS

NUMBER 1 FOR STEM

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Movie music

8 Looking at soundwaves

Objective

In this activity, students make their own non-Newtonian fluid (also known as slime) and place it on a subwoofer in order to take a closer look at soundwaves.

TOPIC LINKS

Physics: observe the effects of vibration on substances

TIME

30 minutes

RESOURCES AND PREPARATION

- cornstarch
- jar
- subwoofer
- food colouring (various colours)
- cling film
- water (optional: use tonic water to make fluorescent slime using a black light)
- optional: Black light

Before the students arrive, prepare one or more subwoofer stations by covering them in cling film and setting them up so they can play different songs (check the tips for one song worth preparing).

HEALTH AND SAFETY:

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

DELIVERY

1. Ask the students which senses are stimulated when we listen to music. Have they ever noticed that loud, deep sounds can be felt as vibrations?
2. Describe the basics behind how sound waves are created and how we interpret them as sound. Then explain what resonance is, and how we can feel vibrations of sound.
3. Divide the class in groups of 2–3 and introduce the activity.

DIFFERENTIATION IDEAS

Support: Assist students with measuring out the correct quantities to make the slime.

Challenge: Students could search for a tone generator on the internet and change the frequencies played on the subwoofer. Challenge them to find out which frequencies work best to make the slime jump.

TIPS

- This is a messy practical. Wear eye protection, lab coats (especially when adding food colouring) and prepare plenty of paper towels for the clean-up.
- If there is only one subwoofer available, this task can be turned into a demonstration where small groups observe the slime in turn to observe the effect of different frequencies while the rest of the class creates their own slime. Alternatively, students take it in turns to test across 2–3 pieces of music, and compare which had the biggest effect.
- This activity works well with very long sound waves (heavy bass sounds). It is worth experimenting with music suggested by the class, but this YouTube video should work very well to make the slime dance.
- If available, make the slime with tonic water and turn off lights in the room. With a black light, the tonic water should make the slime glow in the dark.

EXTENSION IDEAS

1. Look into more experiments that explore soundwaves. Show this video (warning: loud audio) and let the students investigate how to recreate it (this guide shows how it could be made).

USEFUL LINKS

- Website that illustrates what the dancing slime should look like
- Mythbusters did an episode on the brown note which is related to this topic of feeling sound waves. This clip shows the intensity of the sound vibrations being felt

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Movie music

8 Looking at soundwaves

Your challenge

Imagine sitting in the movie theatre during an action-packed scene. Explosions are going off on screen, accompanied by loud music. In a situation like this, you may have noticed a strange sensation where you can actually feel the sound. This vibrating feeling is caused by the long sound waves from the cinema's sound system. Let's take a closer look at these sound waves, with the help of some non-Newtonian fluid.

Make your own gooey non-Newtonian liquid and visualise sound vibrations, proving that it is possible to feel sound.

WHAT YOU NEED TO DO

1. Start by mixing together two parts cornstarch with one part water. For this, pour some water (or tonic water) into your jar, and slowly add the starch a little bit at the time while stirring the mixture.
2. Stop adding starch once it is possible (but getting very difficult) to stir. You should notice that the more force you apply to your mixture, the more the liquid acts like a solid: you have made your non-Newtonian liquid.
3. Your club leader should have a prepared subwoofer covered with cling film for your group or for the class. Place the non-Newtonian liquid on the subwoofer and observe what happens.

CONSIDER THE FOLLOWING QUESTIONS:

1. How does the sound from the subwoofer move through your slime?
2. What happens to the slime as the sound waves get longer (more bass-y)?
3. What happens to the slime as the sound waves get shorter (more high-pitched)?
4. When does the slime dance the most?
5. Are the patterns the same for different notes? Why do you think this is?
6. When you squash the slime in your hands, it becomes a solid. When you relax, it becomes a liquid again. Can you explain why the slime goes back and forth from liquid to solid while on the subwoofer?

FUN FACTS

1. Low frequency sounds have longer wavelengths, and produce bass-like sounds. These bass sounds match the vibrations of the human body, and when that happens, your whole body seems to vibrate. We call this phenomenon 'resonance'.
2. Resonance is also what allows some people to break glasses with just their voice: the high-pitched (short wavelength) sound vibrations resonate with the glass, making it vibrate so much that it breaks.
3. The 'brown note', also known as the disco dump, is a subsonic frequency around 9 Hertz (Hz) that supposedly rocks so hard, it causes people to lose control of their bowels. However, this myth has been busted by famous Myth Busters Adam Savage and Jamie Hyneman. All of the brown-note frequencies failed to stir the Myth Buster's bowels, busting the myth – and preserving Adam's dignity.

Worksheet

Notes

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Movie music

9 Get CREST Discovery Awards

By completing all nine activities in this resource pack, your STEM Club members can get a CREST Discovery Award.

ABOUT CREST

CREST is a scheme that inspires young people to think and behave like scientists and engineers. It is student-led, flexible and trusted. 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 DISCOVERY AWARDS

It's easy to get your members' Discovery Awards, simply:

1. Sign-up for a free account - https://my.crestawards.org/
2. Have each member complete a CREST Awards Discovery Passport
3. Create a project eg. "How do they make movies", "Movie music" or "Witchcraft and wizardry"
4. Upload names
5. Upload two or three passports and any accompanying work
6. Assess individuals, have they:
   a. Completed around five hours of work on the project?
   b. Participated fully in the project?
   c. Reflected on their learning?
7. Type in your delivery and payment details.

TAKING THEIR WORK FURTHER

If members want to take activities further, they can work towards a CREST Bronze or Silver Award.

CREST Bronze Awards require around ten hours of enquiry, project-based work, and Silver Awards require thirty hours of work at GCSE or equivalent standard. Using one of the activities for inspiration, they choose a question or topic to investigate.

Guidance on how to run CREST Bronze and Silver Award projects is available on the CREST Awards website www.crestawards.org.

Notes

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**