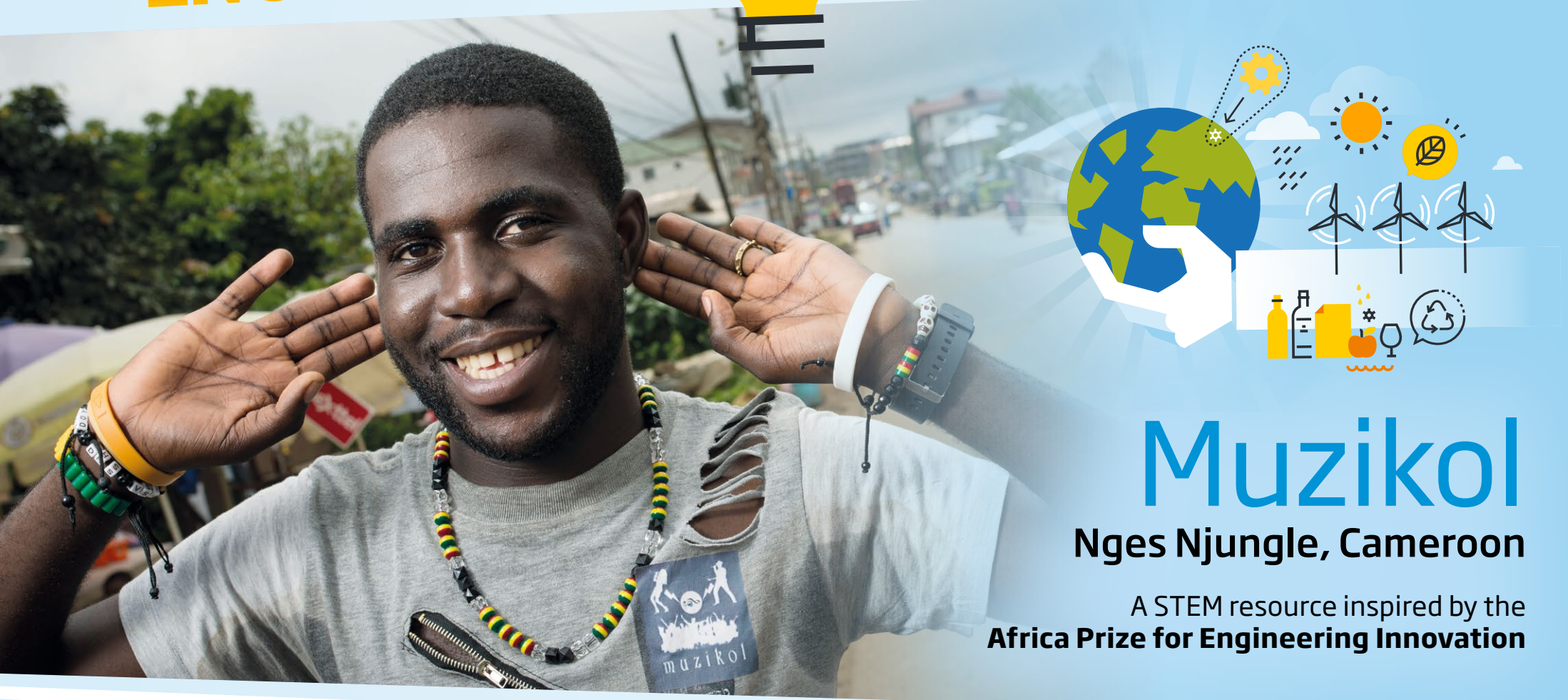
ENGINEERING A BETTER WORLD



Muzikol

Nges Njungle, Cameroon

A STEM resource inspired by the
Africa Prize for Engineering Innovation

ROYAL ACADEMY OF **ENGINEERING**

The Shell Centenary Scholarship Fund

GCRF
Global Challenges Research Fund

ABOUT MUZIKOL

Nges Njungle is a computing engineer from Cameroon.

He is the founder of Muzikol, an online music marketing and social media application designed to meet all the career needs of musicians. The music app deepens relationships between African artists and music lovers and aims to grow the African music market.

Time to think

Muzikol is a music social media app for artists and fans.

- What are some problems associated with social media platforms?
- How might the team at Muzikol prevent these?

THE MUZIKOL MODEL

Muzikol provides the possibility for artists to sell all their artistic services and products.

All services and products can be bought locally using local payment methods or internationally recognised credit cards.

Table showing total number of artists and subscriptions on Muzikol and money made each month from concert ticket merchandise sales.

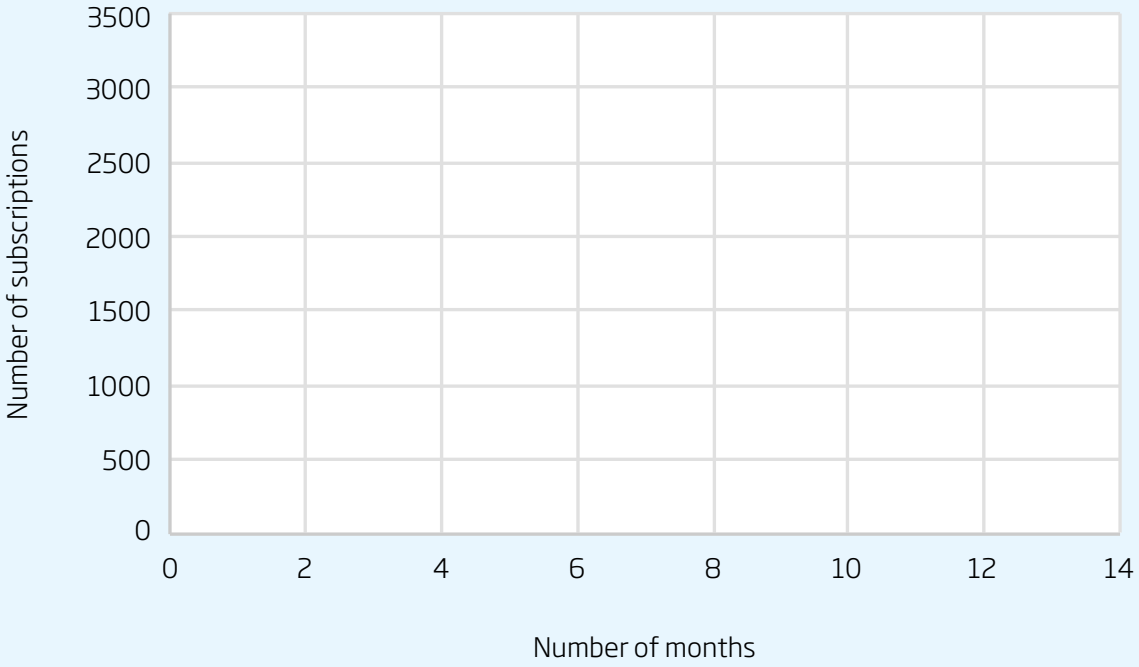
	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
Total number of artists on Muzikol	5	9	22	38	84	166
Total subscriptions (people)	0	111	406	718	992	1297
Concert tickets ($ from each month)	0	50	80	110	140	170
Merchandise sales ($ from each month)	20	45	65	80	100	120

The currency used in Cameroon is the Central African CFA franc (known as a franc). The exchange rate is approximately: $1 ≈ 600 francs

- How much money would they have received in francs after six months from concert tickets sold?
- Muzikol takes 20% of every transaction carried over the app. How much money would they make in dollars and in francs from merchandise sold after the first six months?

The team at Muzikol are trying to use the information from the first six months to predict how their app will grow.

- Plot the information about number of subscriptions on the graph below.
- Can you spot any patterns that might help them predict how many subscriptions they will have for the year?



Stretch and challenge

Create a graph to show the number of artists on the platform. Predict how this might grow over the year. What do you notice?

COUNTRY PROFILE

Time to research

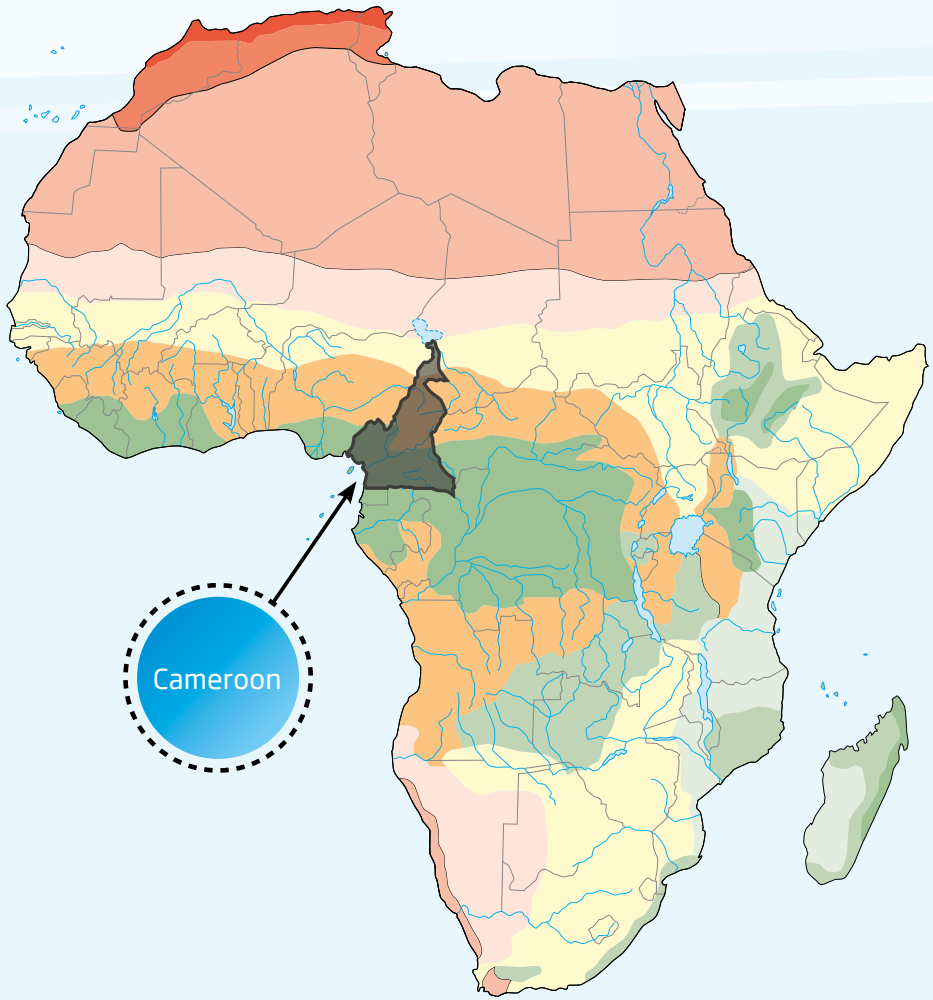
You are an engineer working with a team in Cameroon. In small groups, use a computer, tablet or smartphone to visit the Multicultural kids blog. Search for 'Cameroon' and open the blog page **11 fun facts about Cameroon for Kids**.

You will create a country profile with this information.

- What is the land area of Cameroon?
- What is the population of Cameroon?
- Approximately how many languages are spoken across Cameroon?
- What is the typical climate of Cameroon?
- Name one country that is north of Cameroon, and one each to the east and south.

Why do you think the information you have gathered will be useful?

What other information do you think you could be useful?



SUSTAINABLE DEVELOPMENT GOALS

- Ensure healthy lives and promote well-being for all at all ages.

Time to reflect

After you have completed this challenge, read the quote from Nges below and reflect on how Muzikol works towards Global Goal three.

"*We believe that music is food for the soul. A sense of communal identity is found and shared in music. The way we act is reflected in the music we listen. Therefore, our music is our heritage and our culture.*"

I HEAR YOU

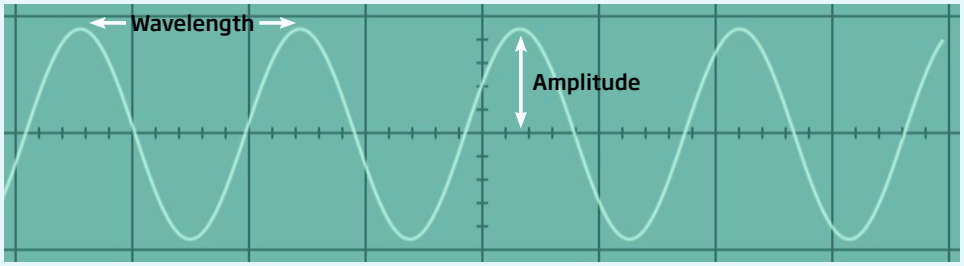
Sound and music play a large part in many of our lives.

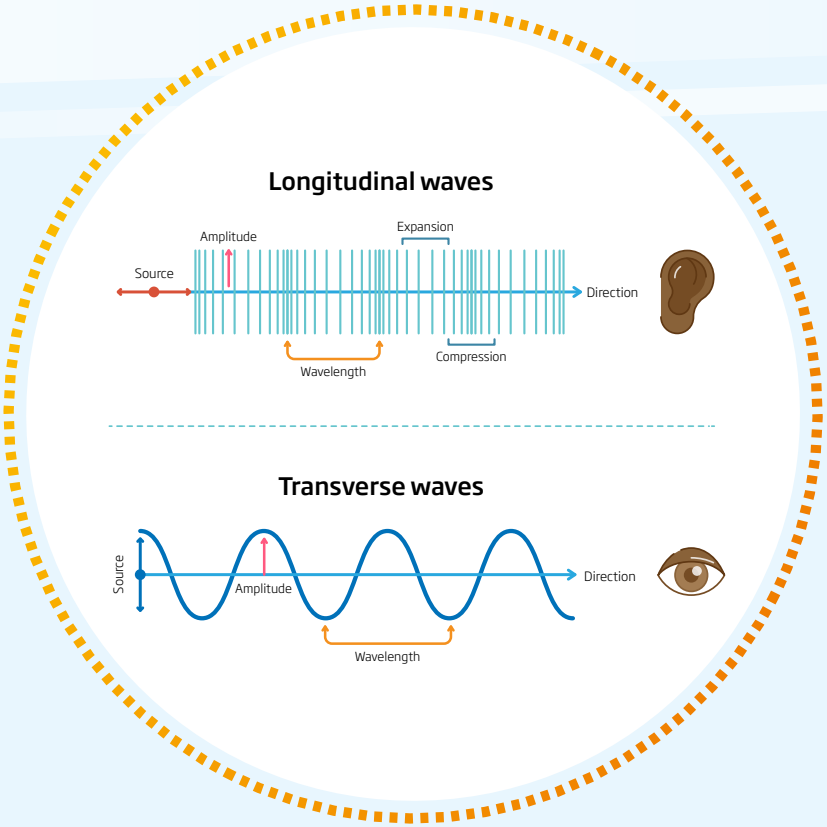
Sound is a form of **energy**. It is produced by a vibration and it travels as a longitudinal wave.

If a sound wave is moving from left to right through air, then the particles of air will move left and right as the energy of the sound wave passes through it. Vibrating air molecules cause the human eardrum to vibrate, which the brain interprets as sound.

Sound waves can be represented as transversal waveforms and we can use this to show the pitch and volume of noise. The greater the **amplitude** of a wavelength, the louder the noise. The higher the **frequency** of wavelengths, the higher the pitch.

Hertz is the measurement used for the frequency of sound waves.



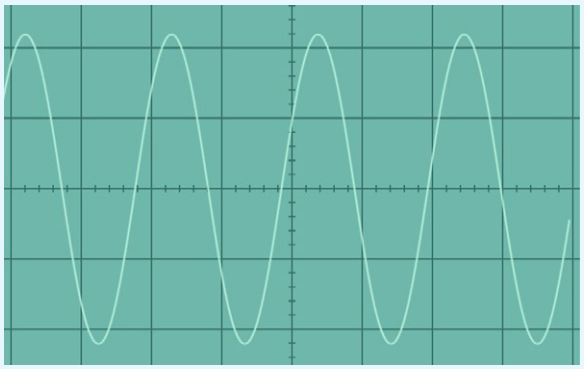


Comparing sound waves

In your groups, describe or demonstrate what each of the waves might sound like.

Explain the differences between the waves and how this effects the sound produced.

1



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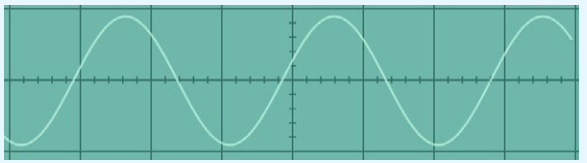

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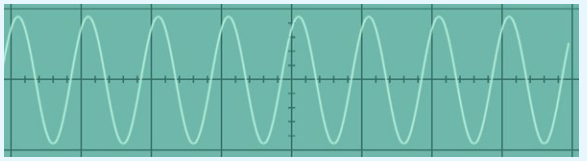


CYMATICS

Cymatics is the connection between sound, vibrations and physical reality. It is the study of wave phenomena.

Using a smartphone, laptop, tablet or computer search for 'Cymatics science vs. music - Nigel Stanford' on YouTube.

In your groups, discuss what you think this video shows us about sound waves.

Teacher note

Background information and more videos about each of the experiments shown and how they were filmed is available at nigelstandform.com/Cymatics/. This is an interesting read and you may wish to look at some of the individual sound experiments in more detail.

Feel the vibes

All over the world there are people with varying levels of hearing loss, from mild to profound deafness. You and/or others in your class might use a hearing aid or know someone who does.

Many deaf people play musical instruments and take part in musical activities every day. Musicians with hearing loss often use the vibration of their instrument, or the surface that it is connected to, to help them feel the sound that they create. Deaf people can use the vibrations caused by musical sounds to help them 'listen' to music.

Something as simple as a balloon can be used at music events to feel the vibrations created by musicians.

Time to research

Find out about famous deaf musicians or composers. How did they progress in their career?

Try it yourself - balloon speakers!

- Blow up a latex balloon to approximately half full. If you can, don't tie up the end so that you can reuse the same balloon for further investigation.
- Hold the balloon up to your ear and ask a friend to tap the balloon on the other side.
- Repeat but blow the balloon up so that it is slightly larger.

What do you notice?

But why?

Hopefully you noticed that the tapping sound is **amplified** as you filled the balloon with more air. The air molecules are compressed inside the latex skin of the balloon, and as you increase the size of the balloon, you increase the number of compressed air molecules.

The compressed air molecules act as a better conductor of sound waves than the less compressed air molecules around you.

SEEING SOUND

Time to experiment

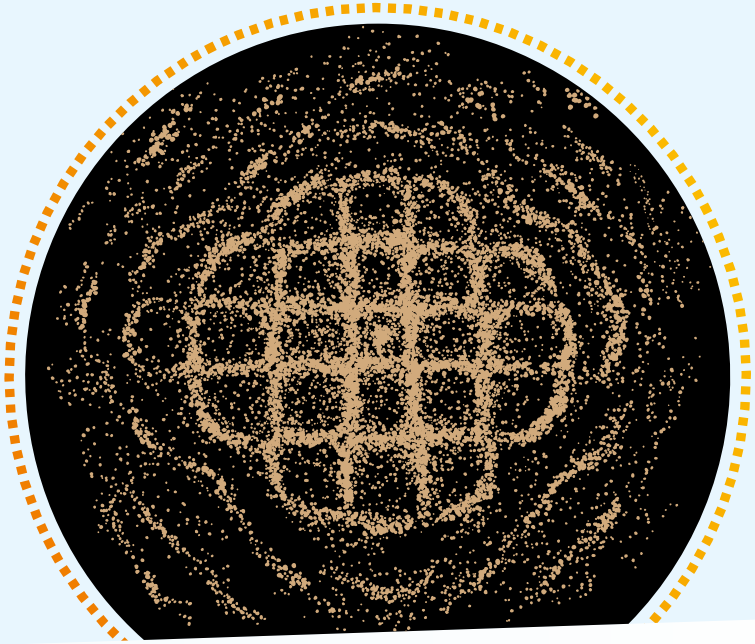
In the video on page six, you will have seen a famous experiment that makes sound waves visible on metal plates. The experiment was made famous by an 18th century scientist and musician, Ernst Chladni and the experiment is now called **Chladni Plates**.

As the surface vibrates, the salt also vibrates and moves around the surface until it reaches the points that are not vibrating and comes to rest in these positions creating different patterns depending on the pitch of the sound. These are known as **nodal positions** or **points of no displacement**.

Create your own Chladni Plates

Materials needed

- Plastic jar, Pringles tube or similar (can you find something to recycle?)
- Dark coloured balloon (recycle old balloons if you can)
- Masking tape
- Scalpel (speak to your teacher about helping with this) or scissors depending on what container you are using
- Something to play music (using your phone or voice would work)
- Salt



STEP 1

Take the container you are using and use scissors or a scalpel to cut a hole in the bottom side.

This is where you will project sound through the jar.

You will need to decide on the size of this hole depending on how you will project sound through the jar.

We suggest you use a phone, project your voice through a tube or you could try the DEXT buzzers.

STEP 2

Cut a balloon open so that you are able to cover the lid of your plastic jar with it.

Make sure the balloon is on tightly to create a flat, taut surface.

A rubber band maybe helpful.

STEP 3

You will need to create a barrier around the top edge of the jar.

We have used masking tape to do this.

Wrap the strip of tape around the jar so that the tape attaches firmly to the rim of the jar.

STEP 4

Spread a (very!) thin layer of salt on top of the balloon surface.

STEP 5

Use your phone (or your voice) to project sound through your container.

If you are using your phone, then there are online tone generators such as or apps such as www.tmsoft.com/tone-generator/.

Ensure your jar is completely flat to get the best effect.

You will need to maintain a sound that is the same pitch for a long period of time to see the effects.

Teachers note

If you have access to a container with a larger surface area, and a speaker you could use them to make the patterns more distinct.

This experiment is an introduction into cymatics and Chladni's Plate experiment. After your pupils have had a go at this, show them this video (search 'Amazing Resonance Experiment' on YouTube) that clearly illustrates what happens on a metal plate as you change the frequency/pitch of sound.

More information and ideas for further exploration can be found at http://sciencenetlinks.com/lessons/making-sound-waves-visible-exploring-chladni-plates/

Time to experiment

- What happens if you increase/decrease the frequency?
- What happens to the pattern if you play a song that has multiple frequencies?
- Why do you think this happens?

Use the boxes below to draw images of some of the patterns that formed and any other observations you made.

Pattern/observation 1
Pitch:

Pattern/observation 2
Pitch:

Pattern/observation 3
Pitch:

Pattern/observation 4
Pitch:

Pattern/observation 5
Pitch:

Teacher note

Check out our resource from Engineering in the movies: good vibrations for more practical activities about sound waves.

Students
Tell us what you think of this resource!

Take our short survey for a chance **to win £500** of robotics/coding equipment for your school.

Scan this QR code on your phone or go to http://stemresources.raeng.org.uk/student-survey/

MATHS AND MUZIK

Dance and movement plays a big part in Cameroonian musical culture.

Get into groups of up to six and create a routine that is inspired by the factors of the number 6.

What about the factors of 12? 24? 36? Square numbers? Prime numbers? Can you think of other ideas for this challenge?

Use a clip from the famous Cameroonian song – **Soul Makossa by Many Dibango** for your routine.

Teachers note: Take a look at this video of a school group 'Maths dance: Triangular squares https://www.youtube.com/watch?v=0m4j8Nt2JWQ' for ideas on what this activity might look like.

Clap to the beat

Timing in music is extremely important, especially when you are playing as a group. All members of a band or orchestra keep a consistent beat.

Find a partner, and both start the same rhythm:

Clap, clap, tap, clap, clap, tap, clap, clap, tap...

- What will you be doing on the 15th beat? 20th beat? 99th beat? 100th beat?
- Can you predict what you will be doing for any beat?

Now try this sequence:

Click, clap, clap, tap, click, clap, clap, tap, click, clap, clap, tap...

- What will you be doing on the 15th beat? 20th beat? 99th beat? 100th beat?
- Write rules to show what you will be doing for any beat.

Now you and your partner will start two different sequences, but start at the same time and try and keep a steady rhythm going.

Person A:
tap, clap, clap, tap, clap, clap, tap, clap, clap...

Person B:
clap, tap, clap, tap, clap, tap, clap, tap, clap, tap...

- On which beat will you both tap at the same time?
- When is the next?
- Write a rule to show when you will clap at the same time at any stage of the rhythm.
- Carry out this same activity with the first two sequences provided.

Stretch and challenge

Can you and your partner investigate and prepare two musical sequences like those used in the challenge above to share with the rest of the group?

Get creative with your sequence! What happens if you use more than two sounds? Experiment with changing the order of the sounds in your sequence. But remember you must be able to explain how your sequences will work together in the end!

MAKING MUSIC

Electronics skills

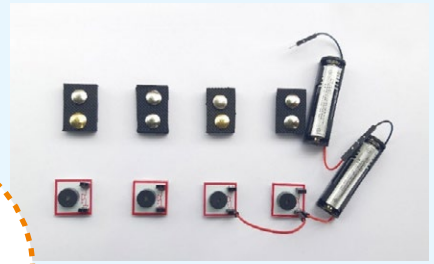
- Series and parallel connections of components
- Creating different types of switches

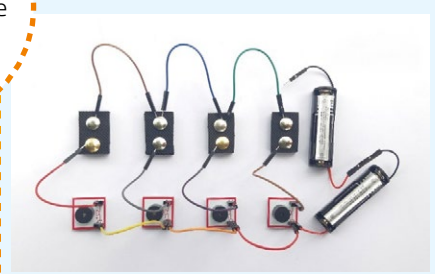
A huge amount of the music we listen to all over the world is made electronically.

You will use your DEXT science set to build your own electronic musical instrument.

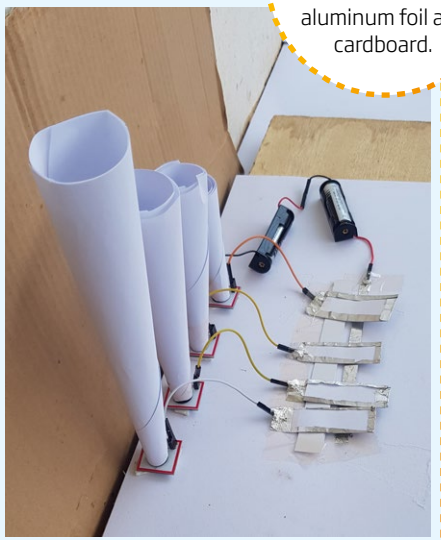
Materials needed

- DEXT science set
- Extra buzzers
- Scissors and glue
- Corrugated cardboard
- Soft cardboard
- Aluminum foil or drawing pins (to make the switches)





The touch switches in these images have been made using drawing pins.



The touch switches in this image have been made using aluminum foil and cardboard.

Building your circuit

Using the images above as a guide and what you learned from working through the DEXT Science Set workbook, build a circuit that has four buzzers, four switches and two batteries.

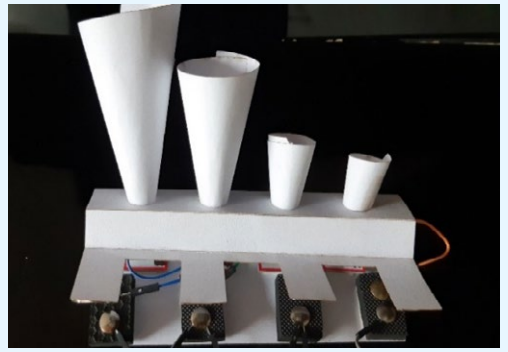
You will be building a circuit where the switches are **touch sensitive**.

Changing sounds

We can change the sound the buzzers make by using cones to change the direction in which the soundwaves are concentrated.

Using your circuit, have a go at building an instrument that will produce four different sounds.

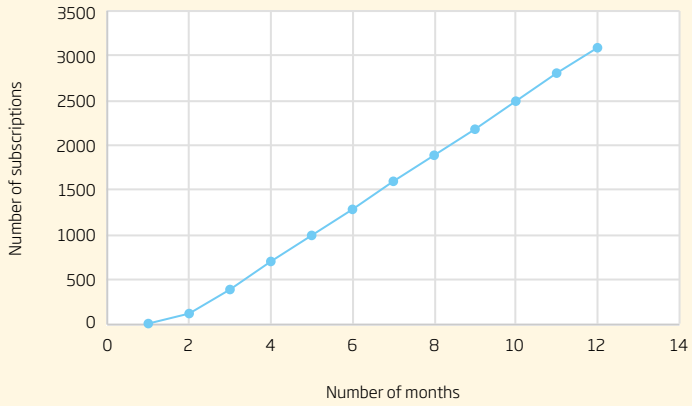
In pairs or groups, create a sequence like you did in the *Maths and Muzik* section of this resource, using your new instrument as well as your clapping, clicking, tapping and anything else you want to make a funky tune.



SOLUTIONS

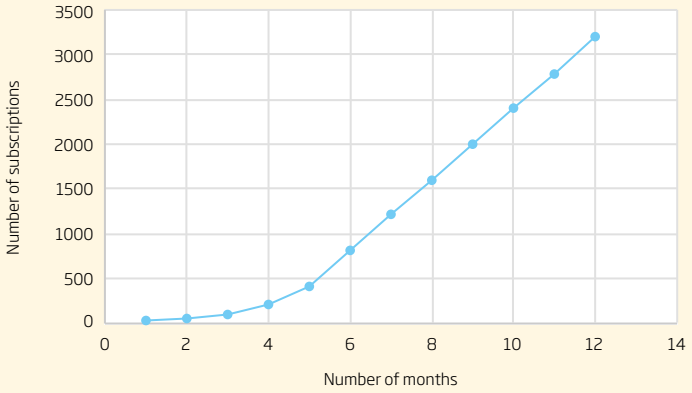
Answers – The Muzikol Model

- Concert ticket sales after 6 months = $550.
  550 x 600 = 330,000 francs
- Merchandise sold after 6 months = $430
  $430 x 0.2 = $86
  86 x 600 = 51,600 francs
  Muzikol team made $86 ≈ 51,600 francs
- Graph to show number of subscriptions



Subscriptions are increasing by approximately 300 each month.

- Stretch and challenge



Number of artists on platform is approximately doubling each month.

Answers – Maths and Muzik

Sequence one

- 15th beat – tap, 20th beat – clap, 99th beat – tap, 100th beat – clap
- Tap on any multiple of 3.

Sequence two

- 15th beat – click, 20th beat – tap, 99th beat – clap, 100th beat – tap
- Tap on any multiple of 4.

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