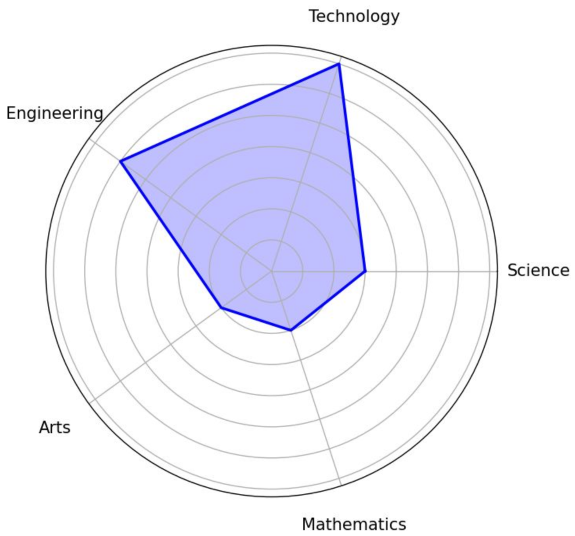
Academia de inventores
POWERED BY EDELVIVES

Curricular



CARBON MICROPHONE

Duration	Age	Difficulty
45 min	11-12	Medium
#SOUND #ELECTRICITY #ENGINEERING		

DESCRIPTION

This hands-on activity invites students to explore the science behind how sound is transmitted by building a basic carbon microphone using recycled materials. Working in teams, students will discover how sound waves are transformed into electrical signals and then back into sound — a principle at the core of many communication technologies. Through this process, they will gain insight into key concepts such as electrical resistance, mechanical and electrical oscillations, and electromagnetism. The project not only fosters scientific curiosity and technical skills but also encourages teamwork and iterative design thinking, in a creative learning setting.

KEY COMPETENCES (EU)

- Mathematical competence and competence in science, technology, and engineering (STEM)
- Personal, social and learning to learn competence
- Citizenship competence
- Entrepreneurship competence

ACTIVITY OBJECTIVES

- **Understanding sound-to-electricity conversion**: Students will construct a functioning carbon microphone and explain, using a diagram or oral presentation, how sound waves are converted into electrical signals.
- **Applying physical science concepts**: Students will identify and describe how changes in resistance affect sound transmission in their prototype and use relevant vocabulary (e.g., "electrical resistance," "oscillation," "conduction") to explain the concept.
- **Developing scientific method skills**: Encourage students to build, test, and iteratively improve a prototype through experimentation and reflection.
- **Promoting teamwork and problem-solving**: Foster collaborative roles within groups to build communication, leadership, and critical thinking skills.
- **Encouraging innovation and creativity**: Inspire students to creatively repurpose materials and improve their microphone design through testing and troubleshooting.

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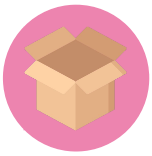
MATERIALS

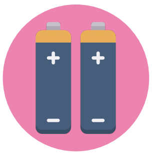


4 small cardboard boxes (1 per group)

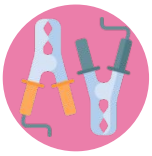
4 speakers (electric component)

4 thin metal pieces (in the examples we use screws but it works better with thinner materials)

one 2mm graphite lead per group



one 9V battery per group



3 alligator cables per group

- Provided by students
- Provided by the teacher/institution
- Downloadable Elements

PREVIOUS PREPARATION

- Build and test a working demo in advance.
- Pre-cut all sharp or hazardous components (razor blades, wires, etc.).
- Form four student groups of five participants.
- Lay out all materials at each group's workstation before the activity begins.
- Review safety protocols with students.
- Assign rotating group roles: technician, recorder, tester, safety monitor, etc.

CONTEXTUALIZATION AND ADAPTATION

Communication is one of the pillars of human development. But have you ever wondered how early telephones worked?

In this activity, students will recreate a primitive form of telephone using a **carbon microphone built from recycled materials**. This hands-on project reveals how sound can travel not only through air but also via electric current — the foundation of microphones, speakers, and mobile phones.
By exploring the science behind early **sound transmission**, students will understand essential concepts like **electrical resistance, mechanical and electrical oscillation, and electromagnetism**.

This challenge invites them to think like inventors, reuse everyday materials, and reflect on how communication technologies have evolved — from Alexander Graham Bell's early prototypes to smart assistants and modern wireless tech.

When you talk, your voice creates sound waves—tiny movements in the air. A microphone changes those sound waves into electrical signals. Inside the carbon microphone, the sound pushes on materials (like a pencil or piece of metal), which changes the electrical resistance. This creates a signal that travels as electricity and can later turn back into sound through a speaker. That's how we send voices through phones or computers!

Sound wave → vibration → resistance change → electric signal → speaker sound

Reflection

Today, we use microphones in many places—your phone, your computer, even in smart assistants like Alexa or Google Home. These devices use built-in microphones to hear your voice and respond by using the internet to process your request.

Ask students: 🗣️ "Have you ever talked to Alexa or Siri? What do you think happens between your voice and the answer you hear back?"

Encourage a short group brainstorm!

Watch video 📽️

Great Inventors: Hedy Lamarr

Could you live without Wifi? Have you ever used a smart assistant like Alexa? Guess what - the amazing technology behind wifi, bluetooth, and gps was the brainchild of hollywood actrice turned visionary inventor – Hedy Lamarr. The 1940s Lamar was a huge movie star, and people called her the most beautiful woman in the world. But she wasn't just a pretty face, she invented things like an improved traffic light that we still use today. During the second world war Lamar wanted to help – she knew that the US navy controlled torpedos using radio signals, but the signals were easy to hack. So she co-invented a method of sending secure radio messages using frequency hopping technology, which sent the same radio signal but from multiple sources and was impossible to jam. Thanks to her innovation, wireless microphones and smart devices can send audio signals more securely and clearly without interference. Her invention made it possible for microphones to be wireless, mobile, and smarter—key features in devices like phones, headsets, and Alexa.

Engineers like her transform sound into electricity—now it's your turn to invent something amazing!

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ACTIVITY

STEP 1: Introduce the Concept

💬 *"What do you think happens when you talk into a phone?"*
💬 *"How does your voice travel to the other side?"*

Briefly explain how a microphone converts sound waves into electrical signals.

Show a video (e.g., about Hedy Lamarr or sound-to-electricity) to inspire and connect the activity to real-world applications.

Watch video 📽️

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Optional classroom activity: How communication tech has evolved 💡

Students can be prompted to ask how microphones and phones worked years ago:

"Interview someone about how they used phones or microphones 20 years ago and compare the technology."

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Watch video 📽️

Learn about Margaret Watts Hughes, a remarkable 19th-century Welsh singer and inventor who discovered a fascinating way to make sound visible. She created a device called the Eidophone, which used her voice to form beautiful, swirling patterns in powders and liquids. These patterns showed how sound vibrations could move physical matter, making her one of the early pioneers in exploring the relationship between sound and science.

Watch this short video: The Eidophone – Voice Figures – Margaret Watts Hughes

Activity idea: After watching, ask students: "What do you think your voice would look like if we could see it like Margaret did?" Encourage them to draw, paint, or build their own visual interpretations of sound!

You can also try a mini Eidophone experiment in class using a stretched balloon over a cup, a bit of salt or sugar, and a loud sound to see vibrations in action

STEP 2: Organize teams and assign roles:

Form small groups and assign roles (encourage all students to take on a variety of roles and especially leadership roles for girls):
• Technician – handles tools and assembly
• Wire Manager – connects and arranges wires
• Speaker – tests the microphone by talking
• Listener – checks speaker output

🔁 Roles can (and should!) be rotated throughout the activity.
Everyone should get a chance to try each role and contribute.

💡 Tip: Use a working demo to show how the final setup might look!

Note for the teacher 📝

Encourage creative experimentation during construction. It's okay if the microphones don't work perfectly the first time – the goal is to improve iteratively.

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STEP 3: Build the Carbon Microphone Prototype

Prepare the graphite lead

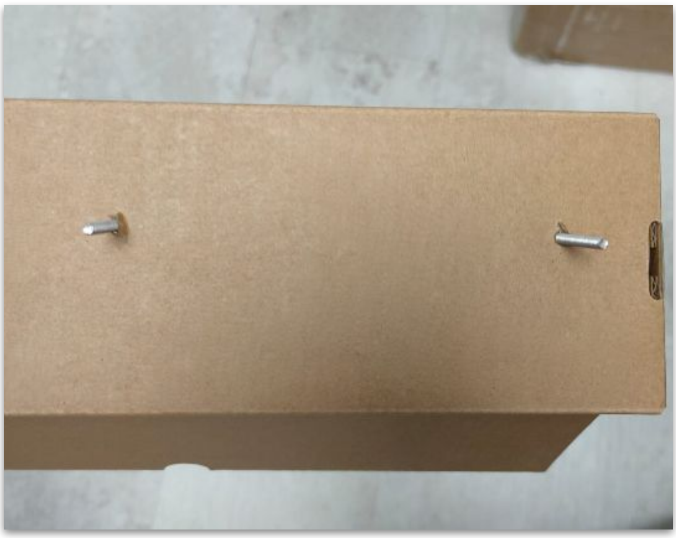
• Measure the length of the graphite lead with a ruler and record that measurement.

• The graphite lead is what is going to vibrate and let us close our circuit at the end. It's important not to be rough on it because it might break:

Build the microphone housing

• Take a small cardboard box.

• On the bottom of the box, cut two narrow slits separated by the same length as the measurement you did before of the graphite lead, just wide enough to fit your metal strips (In this example, we then inserted screws in the slits made; however, using lighter and narrower objects will improve the experiment, as they make it easier to generate vibrations).



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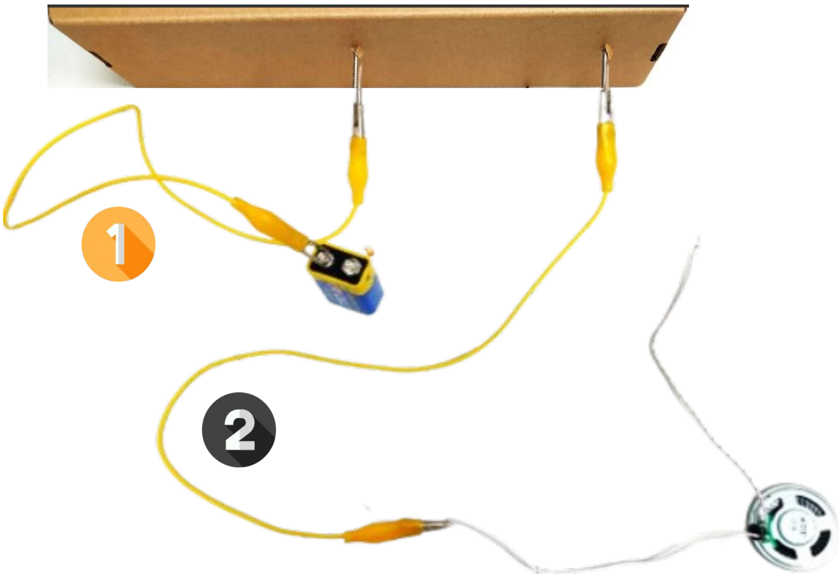
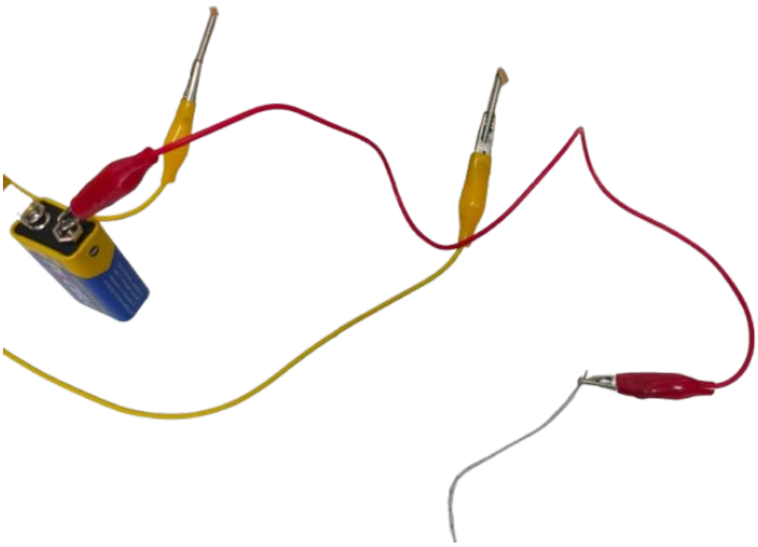
Attach the Wires to the Metal Contacts

• Next, we will work on the outside of the box. First, connect one alligator clip to one of the metallic strips and then to the **POSITIVE** terminal of the battery, this arrangement is marked as '1' in the diagram below.

• After that, connect another alligator clip to the **POSITIVE** terminal of the speaker. You can identify this terminal by a '+' sign, either on the cable (if present) or on the back of the speaker itself. This arrangement is marked as '2 in the diagram below.



Then, connect another alligator cable from the **NEGATIVE** terminal of the battery to the **NEGATIVE** terminal of the speaker. This connection is illustrated with the red cable in the picture below.



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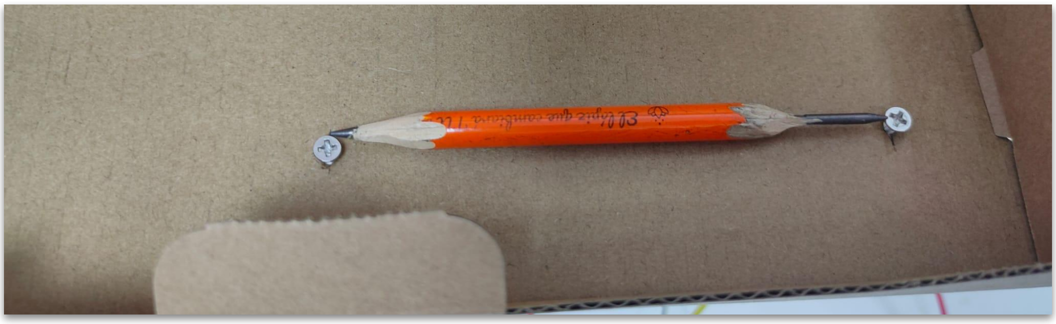
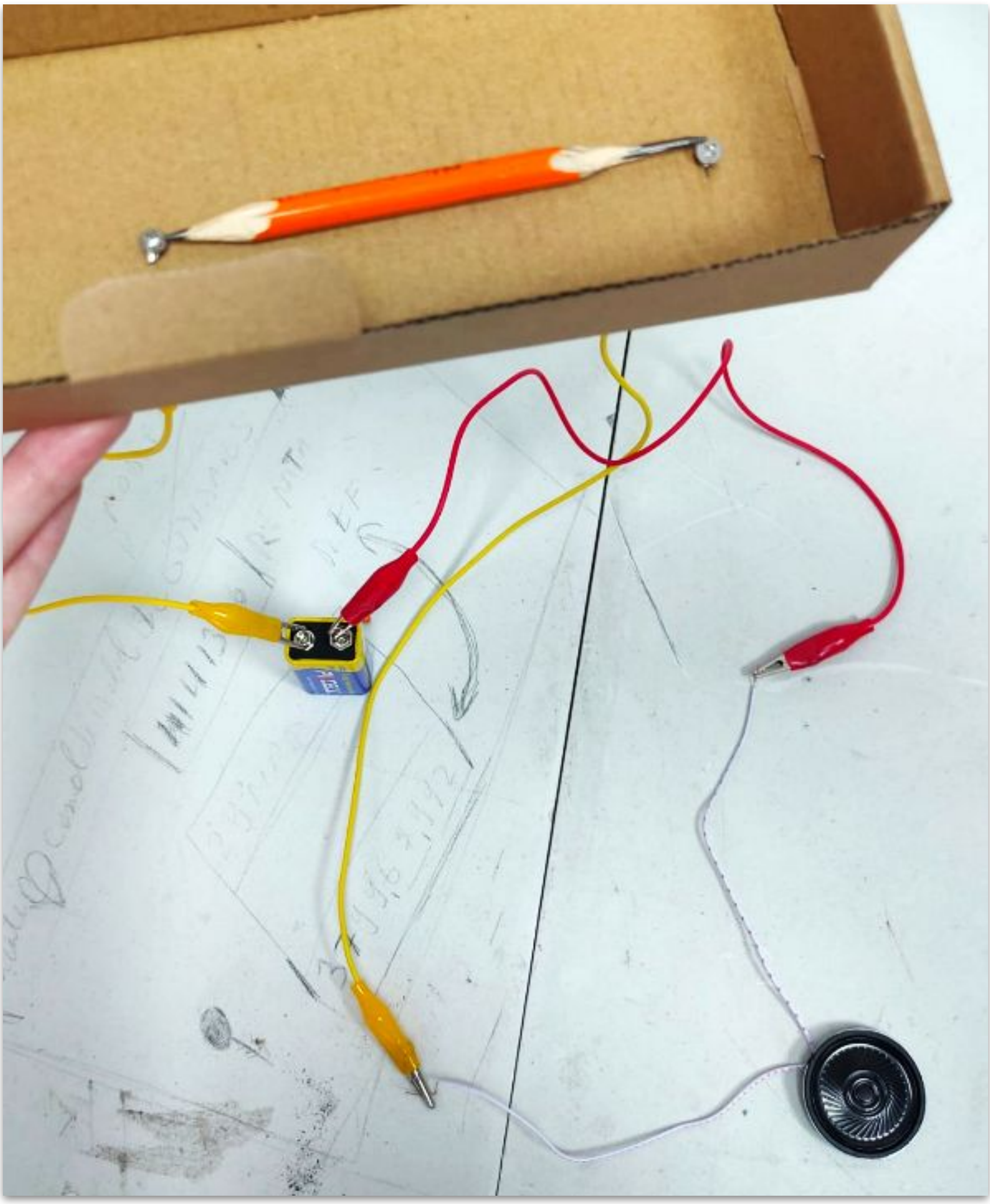
Close the circuit

• Place the graphite lead inside the box so that it lies between the two slits, with the graphite ends positioned just under the slits (In the photos, we used a wooden pencil, but for safety and easier handling, we recommend using the graphite lead directly).





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Test the Microphone
• One student should speak clearly and closely into the graphite lead.
• Another student should listen to the speaker for sound.
• You may hear a faint but audible voice — if so, your microphone works!
• If not, check all connections and try reversing battery polarity or replacing the battery.
• Also, try moving a little bit the graphite with out fingers, making a short circuit, you may be able to hear through the speaker when connections are made.

STEP 4: Iterate and improve — just like real engineers!

1. Talk into microphone. Can your teammate hear you?
2. Try swapping battery wires – does polarity affect results?
3. Push pencil further / pull back – does sound improve?

Common issues:
- Loose wire? Tighten or tape it
- Weak sound? Try a fresh battery
- No sound? Check graphite contact or try another pencil

Retest and record changes.

STEP 5: Reflect and Connect

📢 Share your design and explain:
• How did you make it work?
• What did you change to improve it?
• What scientific concepts you observed (e.g., resistance, oscillation)
• Where do we see this tech in real life? (e.g., phones, hearing aids, smart assistants)

Debate in groups 🗣️

Design a version of your microphone adapted for someone who cannot speak loudly

Challenge: "How might you help someone who speaks very quietly?"

Could you:
- Use more sensitive materials?
- Add a funnel or cone to collect sound better?
- Connect to a sound amplifier? Encourage creativity in engineering for accessibility!

If you want to support this further, consider printing or projecting examples of assistive communication tech, like voice amplifiers or hearing aids.

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Optional activities 💡

Create a mini-poster, infographic, or video explaining:

- How your microphone works
- Scientific principles behind it
- Modifications and improvements made
- Real-world applications of the tech

Research and draw a communication method from another culture and compare it to your microphone

CONCLUSION AND SHARING

Each group shares how their microphone worked and what they learned.

Facilitate a discussion around:
• What worked? What didn't? Why?
• What could be improved in their design?
• How does this relate to modern technology like mobile phones, hearing aids, or smart assistants?
• How would you redesign your microphone to be wearable or used with a smartphone

💡 Classroom activity:
Ask: "Where else do we see sound transformed into electrical signals today?"
Prompt reflection on technology, accessibility, and innovation (e.g., how microphones impact communication for disabled people or underserved areas)

Don't forget to take a photo of your experience and share it with us!

LinkedIn Instagram X

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