Using Code to Build a Simple Conductivity Tester

Author: Lloyd Godson

This resource was developed as a result of participation in CSIRO's teacher professional learning program, Educator on Board.

Using code to build a simple conductivity tester

One of the most common instruments used in oceanographic research on RV *Investigator* is a CTD rosette system (see picture below). This instrument, made up of a set of small probes attached to a water bottle rosette system, is deployed off the starboard side of the ship using a crane and lowered vertically through the water column with a winch. Each deployment of the CTD is called a cast.

Figure 1 The CTD rosette system being prepared for a cast. Credit: Godson, 2019

The CTDs electronic probes measure **Conductivity** (salinity), Temperature, and Depth (pressure) at set time intervals. The water sampler collects discrete samples for later analysis in the vessel's lab. Data from a CTD cast is then used to create water column profiles to show differences between various marine locations or depths. Although you can't see it from the surface, oceans are not one continuous type of water from surface to seafloor. Rather, there are chemical and physical fluctuations of parameters that change due to geographical location, seafloor features, weather patterns, depth and current systems.

Build your own conductivity tester

Some materials do an excellent job of conducting electricity through them, while others do not. Materials that allow the electrons to flow easily through them due to their atomic structure are called conductors. Materials that do not easily allow electrons to flow through them are called insulators. The following table shows some common conductors and insulators.

Conductor	Insulator
Water	Glass
Copper	Air
Aluminium	Plastic

Since water is an excellent conductor, engineers have to design and use specialised coatings to protect or insulate electronic equipment from short circuiting while working underwater from RV *Investigator*. The goal of this lesson is to:

- Create a tool to test conductivity of different materials.
- Explore how electrically conductive or insulative different materials are using your tester.
- Apply previous knowledge to find conductive materials and make informed predictions.
- Recognise how the MaKey MaKey can interact as a computer interface.

Resources required

- Power Supply
- Light bulb / buzzer
- MaKey MaKey board and USB cable
- MaKey MaKey Piano Program
- Alligator Clips
- Beakers or cups
- salt
- Computer / laptop
- Objects to test (fruit, paper clip, paper, pencil, cups of distilled, tap and salt water, food, clay, copper tape, aluminium foil, plants, magnets, anything!)

Procedure

1. Construct a simple circuit using the light bulb or buzzer, power supply and alligator clips as shown below, leaving two ends of the alligator clips unattached.

2. Check if the circuit is working by touching the two unattached ends of the alligator clips together. If working correctly, the bulb will light. If not, double-check the connections around the circuit to make sure everything is secure.

How to Test a Material's Conductivity using a simple circuit

3. Place the object between the two open ends of the alligator clips. If the material is a conductor, electrons will flow through the object, complete the circuit and the light will turn on. If the material is an insulator, electrons won't pass easily through the particles within the object interrupting the flow, and the lightbulb will remain off.

4. Complete the table below recording your results for each material tested. Make a hypothesis as to whether each material will be a conductor (C) or insulator (I) and check your hypothesis for each material.

Challenge 1: Use copper tape or aluminium foil to construct part of your circuit.

Material	Hypothesis: Conductor (C) or Insulator (I)	Conductor	Insulator

How to Test a Material's Conductivity using a MaKey MaKey

1. Connect one end of the USB cable to the MaKey MaKey and plug the other end into your laptop or computer.
2. Your computer may ask you to install drivers or do other setup. This is unnecessary, click cancel or close the window.
3. Connect the first alligator clip (any colour) to the Earth section of the MaKey MaKey board.
4. Attach a second alligator clip to the space bar on the MaKey MaKey board.
5. Insert or attach the opposite end of this alligator clip to the objects you want to test for conductivity (e.g., banana, paper clip, paper, pencil).
6. In your Internet browser, launch this MaKey MaKey Conductivity tester: https://scratch.mit.edu/projects/86384956/
7. Decide which object you're going to test first. Make a prediction about whether it's going to be conductive or not. Write down your predictions in the table.
8. While holding the grounded (connected to Earth) alligator clip in one hand, touch one of your objects with the other hand to see if it makes a sound.
9. If yes, then that object is conductive and electricity is passing through it. If not, try something else.

Challenge 2: Have students code their own MaKey MaKey Conductivity Tester using Scratch

How to Test a Material's Conductivity using the MaKey MaKey Piano Program

1. Connect one end of the USB cable to the MaKey MaKey and plug the other end into your laptop or computer.
2. Your computer may ask you to install drivers or do other setup. This is unnecessary, click cancel or close the window.
3. Connect the first alligator clip (any colour) to the Earth section of the MaKey MaKey board.
4. Next, attach three or four additional alligator clips to the arrows, space, and click sections on the Makey Makey board.
5. Insert or attach the opposite end of these alligator clips to the objects you want to test for conductivity (e.g., banana, paper clip, paper, pencil).
6. In your Internet browser, launch the MaKey MaKey Piano Program.
7. Decide which object you're going to test first. Make a prediction about whether it's going to be conductive or not. Write down your predictions in the table.
8. While holding the grounded (connected to Earth) alligator clip in one hand, touch one of your objects with the other hand to see if it makes the piano play.
9. If yes, then that object is conductive and electricity is passing through it. If not, try something else.

Challenge 3: Include other people in testing, making a circuit. Hold hands to make the circuit bigger!

Challenge 4: Draw a thick line with a pencil and test its conductivity. Try wetting the paper, and see if the circuit can still be closed.
Challenge 5: Fill three cups with water - one with distilled water and the other with regular tap water. Place one of the wires connected to an arrow in each cup of water. Grabbing the grounded

wire, touch the water in the cup filled with tap water to control the corresponding key on the on-screen piano. Then, while still holding the grounded wire, try touching the water in the distilled cup. Finally, while still holding the grounded wire, try touching the water in the saltwater cup.

Reflection Questions

Discuss your experiment and observations. Which objects were able to play the piano and which weren't?

What similarities do you observe between materials that are conductors?

What similarities do you observe between materials that are insulators?

If you rearrange the same materials in a circuit, does the arrangement impact whether or not the circuit works?

The power supply and light bulb were not touching. How do you know electricity flowed between them? Give an example as evidence.

Challenge 6: Ask students to devise a way of testing how electrically conductive or insulative different materials are!

Reference:

SCRATCH. 2015. Makey Makey conductivity test. Available at: https://scratch.mit.edu/projects/86384956/