Conductivity Experiment

with micro:bit

Apply the scientific method to experiment with conductivity! Code a micro:bit and learn about simple circuitry.

AGE

Grades 6-9

OBJECTIVES

Lesson objectives:

- Understand and apply a science experiment to investigate conductivity.
- Collect data and draw conclusions from evidence.
- Appreciate how coding is a skill that can help you solve problems.

Curricular content:

- Curricular competencies from Science and ADST across many grade levels.
- Subject content:
  - Science 7: electricity
  - Science 9: circuits

MATERIALS

Per group of 2-3 students

- Micro:bit with micro-USB cable
- 2 alligator clips
- Computer device with internet access
- Miscellaneous materials of varying conductivity to test
- Writing supplies to record observations and data

TROUBLESHOOTING TIPS

SAFETY NOTES

- On the micro:bit, don't connect 3V to GND
  - This makes a complete circuit, which can overheat and damage micro:bit components
- The maximum voltage with the micro:bit is 3V. The voltage from a wall outlet is much higher, above 100V. It's safe to experiment but the low-voltage micro:bit, but remind students that they should not repeat this experiment with wall outlets.

Other troubleshooting tips

- Familiarize yourself beforehand with connecting the micro:bit to your particular computer devices. See instructions at microbit.org/start
- Ensure all connections are secure. Alligator clips are less likely to move around if they are clipped onto the micro:bit pins perpendicularly through the holes rather than parallel with the board.
- If the code isn't working, try downloading it again. Code has to be downloaded after every change.
- Double check that the pin numbers in the code correspond to the alligator clips.
- Check that you are using the appropriate digital or analog block.

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ACTIVITY OUTLINE

Overview and Suggested Timeline:

Introduction	10 minutes
Activity 1	20 minutes
Activity 2	15minutes
Activity 3	15 minutes
Reflection and Wrap-Up	10 minutes

Introduction

Introduce electrical conductivity and circuits.

- Amount of time will depend on your group – you can use this activity to introduce these concepts or to refresh.

Introduce the micro:bit and its components

- The micro:bit pins (gold-coloured bottom of the micro:bit) allow us to create some electrical circuits through the micro:bit
- Pins can "read" (input), or "write" (output) a current through a circuit
- To complete the circuit, we also connect to either 3V (if reading), or GND (ground) (if writing)
- The micro:bit measures ("reads") the current at the pin. A material that easily allows for a flow of electrons will have a higher current, and one that resists the flow of electrons will have a lower current.
- Show how to use the micro:bit coding platform.

Activity 1: Which materials conduct a current?

Goal: code the micro:bit to show a different symbol when the circuit is turned on or off

Find the following blocks of code:

- Pins:
  - Digital read pin [P0]
    - This is a variable (oval) that holds a different number, depending on the reading from the pin.
    - Computers communicate with binary signals, expressed as 1s and 0s (for an electrical signal turned on or off).
- Logic:
  - If <true> then / else
    - For the micro:bit to do something different depending on a reading, it has to have different options based on the status of a condition. An if/else statement (a conditional) in coding says what condition to check for and what to do. Think of it like a sequential flowchart.
  - < 0 = 0 >
    - This hexagon-shaped block represents the condition that the micro:bit will be checking.
    - Make sure to NOT use the hexagon with quotation marks. That one expects to use a string of characters, not a number.
- Basic:
  - Forever
    - This clamp-shaped block is an event. In this case, we want the micro:bit to always be checking the current.
  - Show icon OR show leds (x2)

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    - As a result of the condition being met or not, we want the micro:bit to light up the screen of 25 red LEDs in a different pattern

Fit the code together.

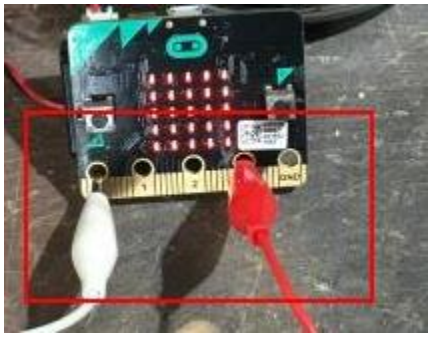
- What blocks should go where? The shape will give you a hint.
- Think about what you want the micro:bit to do. Read through your code.

Test the code virtually

- Test out your code on the virtual micro:bit by toggling the pin from 0 to 1. Does it behave as expected?
- Do you need to change anything in your code? What happens if you change the number in the comparison condition block? What about changing P0 to say something else?

Test some materials

- First: discuss which materials are safe to test with an electrical current and which are not.
    - Avoid other electronic devices
    - Don't get the micro:bit wet, but getting the alligator clips wet is ok
    - With the low-voltage micro:bit, testing humans is generally safe but should be avoided if the human has embedded electronics (pacemaker, hearing aid etc).
        - You can discuss principles of ethics in scientific research here if you want
- Download code onto the micro:bit. Attach alligator clips to P0 and 3V as shown in the picture below. Walk around the room with the micro:bit, testing different things.
- Record your results.



Activity 2: Comparing conductivity

Goal: Code the micro:bit to display the read current as a range.

- The digital read only tells us if the circuit is on or off, but some of the materials you tested might be mildly conductive. Our tool from activity 1 doesn't let us distinguish between different levels of conductivity.

Code:

- Except for the forever event block, delete the Activity 1 code.
- Basic:
    - Show number
        - This will cause whatever number is in this block to scroll across the micro:bit screen
- Pins
    - Analog read pin P0
        - Like digital read, this is a variable that contains a changeable number. Instead of reading a 1 or 0 (on or off), this converts the current read into a scale of 0 (no current) to 1023 (equivalent of digital read 1).

Fit the code together.

- What blocks should go where? The shape will give you a hint.

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- Think about what you want the micro:bit to do. Read through your code.

Test out your code on the virtual micro:bit by clicking on the pin.

- Does it behave as expected? Do you need to change anything in your code?

Download code onto the micro:bit.

- Test the same materials from activity 1.
- Record your results.

Any surprises? What was the lowest number you read? Why do you think the micro:bit is always reading a small current?

Activity 3: Science experiment

Goal: use the micro:bit as a data collection tool for an experiment

Discuss the steps of the experimental scientific method. Why do scientists follow this process?

- Pick a new material to test.
- Make a prediction.
  - Do you think this will be a conductor? Why or why not?
- Controls:
  - From your previously tested materials, choose 2 to be your controls. You want one that is high conductivity, and one that is low. You are going to compare these to the new material.
  - What is the purpose of comparing the thing you're testing to something that you already know? What could you conclude about your experiment if you get unexpected results from one of your controls?
- Using your micro:bit set up, take several measurements (~5) from each material (negative control, positive control, new material).
  - Why do we use multiple samples, instead of just measuring each thing once?
- Record your results.
- Based on those measurements, would you conclude that the new material is conductive or not? Why or why not?
- What new questions do you have after your experiment? How would you investigate them?

Optional Extensions

- Research what properties of a substance affect the conductivity. Can you manipulate some of the materials you tested to change their conductivity?
- Research how the human body uses electric signals. What is special about the cells that do this?

REFLECTION QUESTIONS

- What did you learn about the conductivity of different materials through your experiment?
- How did your results compare with your initial hypothesis?
- Why is it important to use controls and take multiple measurements in an experiment?
- What challenges did you face during the experiment, and how did you address them?
- What is a benefit to learning to code, and how did coding help us to run a scientific experiment?

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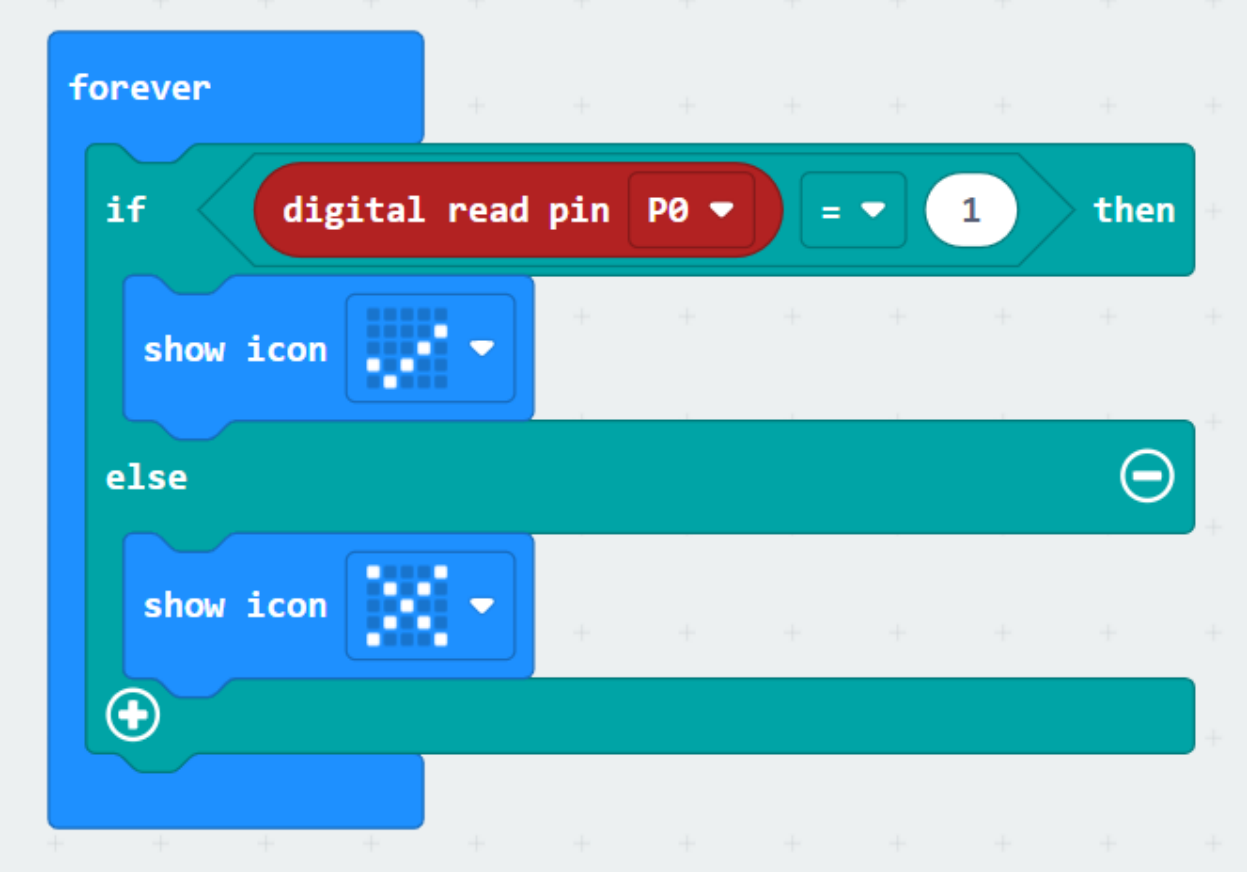
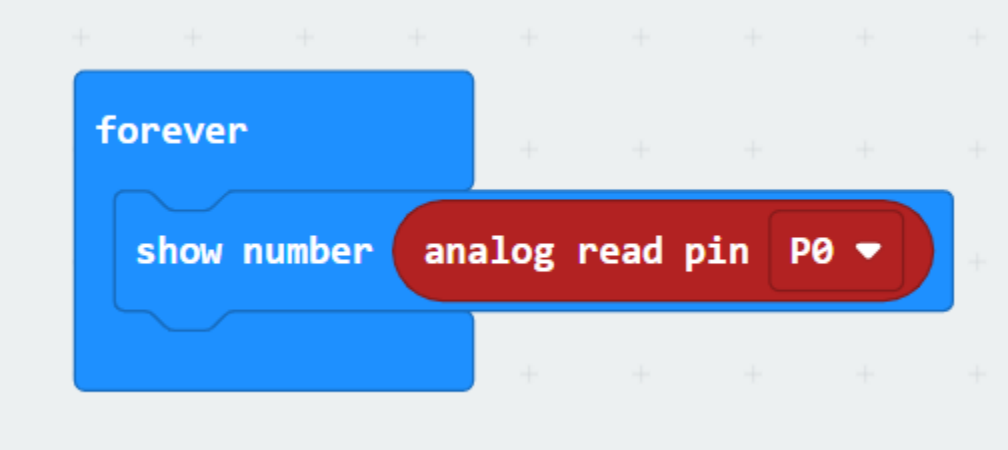
SAMPLE SOLUTIONS





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