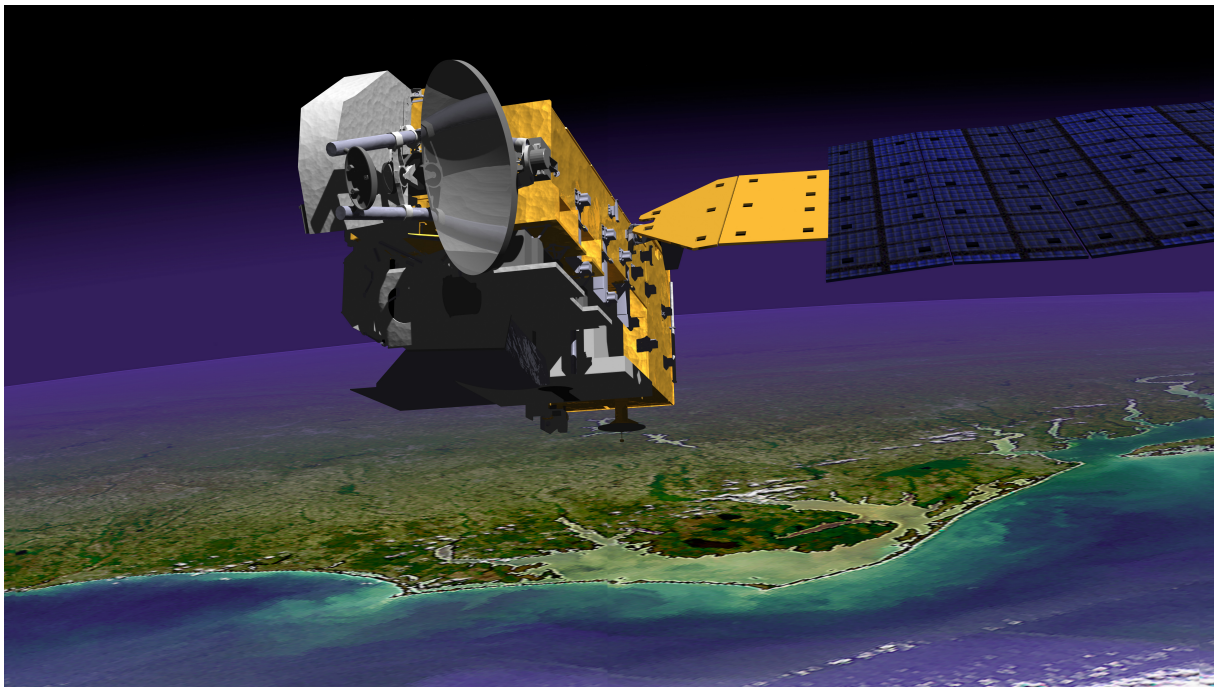
Sensors, Circuits, and Satellites
Lesson 2: Energy Meter



Sensors, Circuit, and Satellites is a collection of classroom lessons created by NASA's Aura mission education and outreach that explore the electromagnetic spectrum and NASA remote sensing instruments using student assembled circuits. These lessons integrate inquiry with active-learning experiences to engage students in the properties of electromagnetic energy and remote sensing. The investigations are sequenced to help the learner construct their knowledge about the electromagnetic spectrum while offering real world examples from NASA.

Credits:
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Lesson 2: Energy Meter

Summary: This lesson introduces students to light as a form of energy, different than sound. The investigation will lead to discovering existence of energy (light) we can't see as an introduction to the broader electromagnetic spectrum.

Student Objective: Students will compare and contrast light is energy and sound waves..

Key Terms: electromagnetic energy, electromagnetic waves

Approximate Time: 30-60 minutes

Materials:

- littleBits™ components: power, light sensor, number bit, wire
    - *ALTERNATE MATERIALS – Light Meter or Lux Meter (cover up any labels or text on device that indicates the meter is measuring 'light')*
- various sources of energy that can be sensed: 1) light energy we can see, such as a flashlight, desk lamp, glow stick; 2) light energy we can't see, such as TV remote control; and 3) non-light sources that are heat and/or sound, such as a radio, hair dryer, or heat from their hands.

Disciplinary core ideas

- MS-PS4-1 Waves and Their Applications in Technologies for Information Transfer: Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.
- MS-PS4-2 Waves and Their Applications in Technologies for Information Transfer: Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Crosscutting concept:

- Structure and Function: Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.
- Patterns Graphs and charts can be used to identify patterns in data. (MS-PS4-1)

Set-up:

- Divide students into small groups and provide the energy sources (see materials section) on each group table for students to test. Teacher needs to provide both examples and non-examples of energy sources that use light.
- Assemble "Energy Meter" circuit using the littleBits™ components: power + light sensor + number bit. Do not tell students the name of the circuit yet. (TIP: Use a small piece of masking tape to cover up the words "light sensor" on the bit. Make sure the bit is set to "light" and not "dark.")

Engage: Ask students "What does this circuit do?" (hold-up the circuit so that students can see the number changing on the Number Bit) "How can we find out what this circuit does?" Chart student ideas without confirming or denying any idea. Possible questions: Can you make the number change on the display? How are you doing that? Why is the number changing?

Explore: Invite students to work in groups. They should start by putting together circuit: power + light sensor + number bit assembly. Ask students to use the circuits to explore energy sources at their table and record data reading on data sheet provided. You may also want to invite students to walk around the classroom to test their energy meter on other things. Give students ten minutes or so to explore materials at their tables and in the classroom. Circulate through the room asking students to explain what they think is happening. What is the highest number you can get? What is the lowest number?

Teacher note: As students are walking around, they may always have some kind of a reading from their circuit because the lights in the classroom are on. You may wish to dim the lights in the classroom as part of this investigation.

Explain: Have the students come back together as a whole group and share their results. What do they think their circuit is sensing? What is the source of the information it is sensing? Students should participate with their data sheets filled out and in front of them and should use the data as evidence of claims they are making from the patterns in their recorded data. The teacher can also chart the data and the claims and evidence to help the discussion. It is also important at this time to start pointing out the difference in the readings. They may conclude that the energy meter is measuring light. But what about the remote control or the IR led? What evidence do students have to support their ideas and explanations?

Use the infrared light sources as a segue to introducing light we can't see. The visible portion of the spectrum is just a small part of a larger electromagnetic spectrum.

Introduce EM energy spectrum – light we can't see. We know that light is energy that energy travels in waves. You cannot see these waves like you can see ocean waves, but you can see their energy as visible light. The infrared remote control is light energy also, but it is not light we can see with our eyes. It is called infrared light.

Explore: We interact with the electromagnetic energy everyday. Match the following everyday items to this chart of the Electromagnetic Spectrum (EMS). (Print and use the EMS Cards, EMS Answer Key also available).

Explain: What do you notice that is different about longer and shorter wavelengths of light? What do you notice about the energy of longer versus shorter wavelength? How do we use these waves differently? Use data from your data table, and from the electromagnetic spectrum chart as evidence for your explanation.

Evaluate:

A) If you have already done Lesson 1: Wave Generator, refresh student's knowledge of compression waves and vibrations moving through the liquid in the spoon. How do you think light waves are different?

B) If you did not share the demonstration in lesson 1, then recall prior knowledge about compression waves. Waves in the ocean are compression waves, they are energy moving through water. Sound waves are also compression waves and travel through the compression of air molecules. How do you think light waves are different?

Have students compare the EMS card sort chart to a chart of sound frequencies and record differences and similarities between sound and light waves. Use the Comparing Sound and Light Waves worksheet, with same on the left and different on the right to compare light and sound waves.

Teacher note: Make sure to help student make the connection to the similarities and differences in the characteristics between light and sound. Both light and sound are energy, and both travel in waves. Sound waves have different frequencies that result in sounds of different pitches. Sound waves do not travel far as their energy is dissipated easily. Sound waves are compression waves and can only travel through matter, thus there is no sound in space. Light is an electromagnetic wave, which means it doesn't require matter to travel like sound waves do. Light waves can travel a much greater distance, and consist of varying electric and magnetic fields. Longer waves or sound are lower tones and longer waves of light are lower energy (and vice versa).

Extension, possible research activity/project:

A) Choose one of the many kinds of waves (except for visible light) pictured on the electromagnetic spectrum, and research how it is used by NASA scientists and what kind of discoveries have been made using that specific wavelength of light.
B) What have you learned about light energy? Write a paragraph or two explaining what you have learned and using data from your recording data sheet to back up your ideas with evidence. What new questions do you have? Be prepared to share your ideas.

Group: _____

Data Recording Sheet for Energy Meter

Energy Source	Description of action	Number Reading

Claim: We think that our circuit is _____

_____

Our evidence for that is_____

_____

_____

_____

_____

_____

How could you test this?

_____

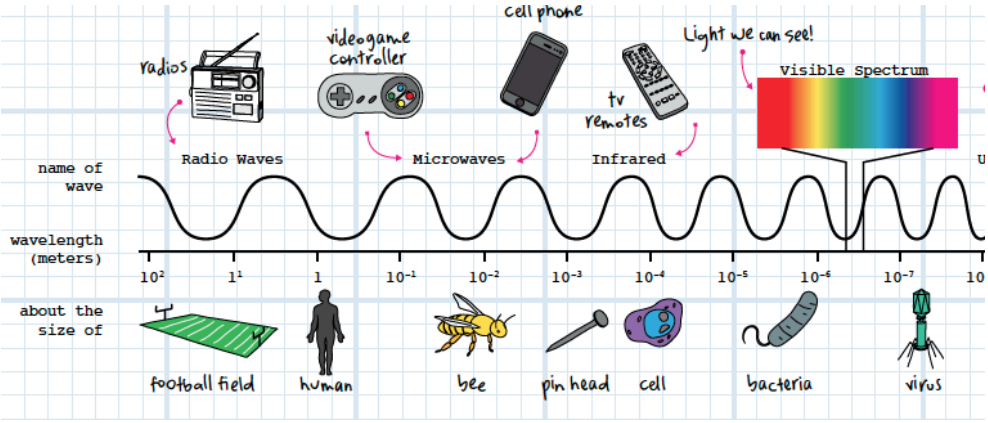
_____

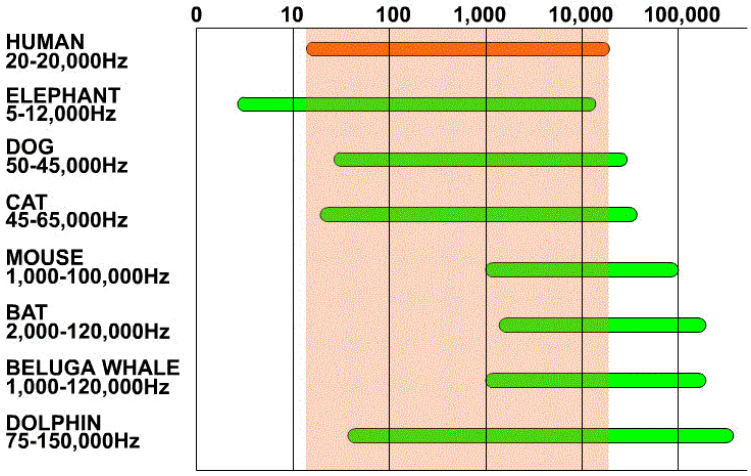
_____

_____

Name: _____

Comparing Sound and Light Waves





SAME	DIFFERENT