NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
ACTIVITY : 50 MINS

Digging into Lithium

Building on their knowledge from the lesson *The Circle of Stuff*, students engage with a variety of resources to apply the ideas of linear and circular economies to mobile devices that are powered by lithium-ion batteries. They investigate the uses and impacts of lithium in order to make an evidence-based claim about its continued use.

GRADES

6 - 8

SUBJECTS

Biology, Ecology, Chemistry, Earth Science, Geology, Social Studies, Economics

CONTENTS

1 PDF

OVERVIEW

Building on their knowledge from the lesson *The Circle of Stuff*, students engage with a variety of resources to apply the ideas of linear and circular economies to mobile devices that are powered by lithium-ion batteries. They investigate the uses and impacts of lithium in order to make an evidence-based claim about its continued use.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/digging-lithium/

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DIRECTIONS

***Closing the Loop: Towards a Circular Economy* unit driving question**: How can we make our economy more circular, and why does it matter?

***The Secret Lives of Batteries* lesson driving question**: What are the steps and benefits of recycling lithium-ion batteries?

1. **Elicit students' prior knowledge about, and experiences with, electronic devices that use lithium-ion batteries.**

- Display an image of different types of common electronic devices, such as smartphones, tablets, and laptops. Note that for the purposes of this activity, students can consider any electronic device with a rechargeable lithium-ion battery, such as some electric toothbrushes, smart speakers, e-bikes, electronic and hybrid vehicles.
- Prompt the class to consider their own use of these devices: *Raise your hand if you or your family have electronic devices of some kind at home.*
    - Depending on your class' socioeconomic characteristics, you may decide to ask more specific questions, such as: *How many of you have your own smartphone, tablet, or laptop? How many devices do you have in your household altogether?*
- Ask: *How long do these devices usually last?* (Possible responses: A few months to a year; Several years; A decade or more.)
- Ask: *What happens to this device when you can no longer use it?* (Possible responses: I throw it away; I keep it in a drawer; I give it to a younger sibling, relative, or friend; I recycle it. If students respond this way, ask them how and where they found out about this.)

2. **Share surprising facts and statistics to help students understand their use of mobile devices specifically, in the context of the linear global economy.**

- Segue to mobile devices specifically rather than the broader focus on electronic devices in Step 1. Explain that millions of devices are thrown out every year in the United States. Ask: *What kinds of problems could this lead to? Consider everything you have learned about the linear economy so far in previous activities.* (Possible responses:

- There might be materials in those devices that could be recycled into new devices.
- It will take up space in landfills.
- If there are toxic chemicals in any of the devices, they could leach out of the landfills and contaminate soil and water. Non-toxic chemicals could also interact to produce toxic interactions.
- Manufacturers will have to keep mining for new raw materials instead of recycling the materials they have already extracted.
- Many of the materials are non-renewable, and we could run out.
- There are risks to human safety when we throw out lithium-ion batteries that power the devices.)

- Ask: *What might be some possible solutions to these problems?* (Possible responses: We could collect devices to be recycled to make the economy more circular; We could pass a law requiring manufacturers to make their devices more recyclable and to educate consumers about ways to recycle their old devices.)
- Distribute the handout *A World of Minerals in Your Mobile Device*. With a partner, have students consider the following questions while they read, prompting them to connect back to the big ideas from the previous lesson, *The Circle of Stuff*:

    - As described on the first page of the handout, mobile devices contain many different kinds of minerals. What problems might this cause? What solutions can you think of?

        - Key ideas to emphasize:

            - Since minerals are non-renewable, landfilling mobile devices containing all these minerals could lead to a shortage. Based on what we learned in the previous lesson, solutions include: increasing recycling rates for mobile devices, limiting our use of mobile devices, and redesigning them to use different, renewable materials.

    - As shown on the map on the second page of the handout, the minerals in mobile devices come from countries all around the world. What problems might this cause? What solutions can you think of?

        - Key ideas to emphasize:

            - Since minerals must be mined, the environmental and social impacts of mining (such as habitat destruction, water pollution, soil erosion, geopolitical conflict, inhumane working conditions, child labor, and more) of our mobile devices extend all around the world and have disproportionate impacts on developing countries. Based on

what we learned in the previous lesson, solutions include: increasing recycling rates for mobile devices so that materials can be recycled instead of extracting raw materials, limiting our use of mobile devices, and redesigning them to use different, renewable materials.

- Lead a brief class discussion to elicit students' responses and ideas, emphasizing the concepts listed above that follow from the previous lesson. Consider documenting the problems and solutions identified by students in a visible location, to ground their learning for the rest of the lesson and unit.

3. **Facilitate a jigsaw activity using multimedia resources for students to research the uses and environmental impacts of lithium, a key material in mobile devices.**

- Tell the class that, even though there are many minerals used in mobile devices with many impacts, this unit will focus on one mineral in particular: lithium, which is used in lithium-ion batteries. Show the video *Lithium 101* (3:14) to introduce the element and its properties.
- Divide your class into five groups of two to five students. Assign each group a number from one to five in order to jigsaw the resources below.
    - Explain that each group will learn more about lithium through one or more resources. Some of the resources are images, some are videos, and some are text. In the next activity, students from each of the five jigsaw groups will share what they learned with students from other groups.
    - Distribute the *Digging into Lithium* handout with the following questions for all groups to answer. Each student needs to record their answers so that they can share with classmates from other groups in the following activity. Preview the questions before students engage with their resources, so that they know what to focus on:
        - Share three new interesting facts you learned about lithium.
        - Do your resources portray lithium in a positive, negative, or neutral way? Explain. (For groups with more than one resource, answer this question for each resource separately.)
        - Based on your resource(s) and what you have learned about circular economies, what do you recommend?
            - A. Continue using lithium as we currently do.

        - B. Continue using lithium, but move towards a more circular economy by recycling used lithium-ion batteries.
            - C. Stop using lithium altogether.
    - Identify two pieces of evidence that support your claim in Question 3. For each piece of evidence, describe your reasoning.
- Assign the following resources to each group:
    - Group 1:
        - *Energy 101: Electric Vehicles* (video, 2:49)
        - *Lithium Ion Batteries: Why They Explode* (video, 3:15)
        - *Here's Where the Juice That Powers Batteries Comes From* (video, first 5:17 of 6:11)
    - Group 2:
        - *Photos: Bolivia Seeks Electric Car Future in Salt Flats*(images, plus 1,444 words in captions)
    - Group 3:
        - *The Common Uses of Lithium-Ion Batteries* (text, 1,254 words)
    - Group 4:
        - *Lithium—For Harnessing Renewable Energy* (text, 1,491 words)
    - Group 5:
        - *Batteries, Recycling and the Environment* (video, 13:28)
- Have students store their completed handouts in an accessible place so they can complete the jigsaw and share their findings in the next activity, *The Second Lives of Batteries*.

4. **Lead students in brainstorming about the target audience for their final product.**

- If needed, remind students about the details for the final product for the unit project: a video challenge for students to create and share on social media. The aim of the challenge

will be to encourage the target audience to take part in the circular economy by recycling used electronics such as cell phones, also known as electronic waste, or e-waste.
- Organize students into project groups of three or four, with whom they will collaborate to create their video challenges (see Tips).
- Prompt groups to brainstorm about the target audience for their video challenge by considering the following questions:

    - Who would benefit from hearing about what they have learned about the circular economy and lithium-ion batteries?
    - Who needs to be involved in helping to make change?
    - Who will hear about and share the video challenge on social media, promoting the message and action steps identified in the video challenge?
    - Whose participation will help ensure that use and disposal of lithium-ion batteries will be more circular than linear?

- Within their project groups, students should come to consensus about the target audience for their video challenge. They can do so through discussion, ranking, or voting.

Tip

Step 1: Sharing information about personal or familial access to mobile devices may be awkward for some students. This discussion may reveal socioeconomic disparities among your students, which they may or may not already be aware of. Be prepared to navigate this topic with your students should the need arise.

Step 3: The resources for each group have been arranged roughly in order of reading level. Group 1's resources consist entirely of short videos (less than six minutes each). Group 2's resources are photographs with more information in captions. Groups 3 and 4 are both assigned high-level texts with over 1,000 words each. Group 5 has a long video with advanced concepts. Keep this in mind when assigning students to jigsaw groups and encourage students to focus on the most important parts of each resource that will help them to answer the questions on the *Digging into Lithium* handout, rather than understanding every detail.

Step 3: As a cooperative learning strategy, a jigsaw increases student engagement by making each group member responsible for explaining what they learned. Watch a video from *Cult of Pedagogy* about best practices for structuring a jigsaw, see a jigsaw in action in a real classroom via *Ambitious Science Teaching*, or read more about the benefits of the jigsaw strategy at *TeachHub.com*.

Step 4: Project groups could be the same groups that students worked with in Step 3 while conducting research, or differ to provide them opportunities to collaborate with other peers. Alternately, groups could be formed after the next activity, *The Second Lives of Batteries*, so that groups have representative diversity of perspectives on lithium use.

Step 4: Depending on time constraints, this step may be completed after Step 1 of the next activity, *The Second Lives of Batteries*. The brainstorm could also be started individually as part of the *Digging into Lithium* handout, with students sharing their ideas with their project groups in the next activity.

Modification

Step 2: Consider using the story and resources at *Fairphone* as an example solution: a cell phone that has been redesigned to use responsibly sourced materials and includes a takeback initiative to recycle the components.

Step 2: An alternative wrap-up to this step would be to have students use the *An X-Ray of the Global Economy* infographic to identify which parts might be relevant to the production, use, and disposal of electronic devices.

Informal Assessment

Students' responses in class discussions and on their *Digging into Lithium* handouts demonstrate their ability to identify the uses and impacts of lithium.

Extending the Learning

Consider building on the ideas in this activity to highlight how the distribution of valuable mineral resources can lead to geopolitical conflict. A relevant example comes from Bolivia, the poorest country in South America and home to at least a quarter of the world's lithium. Bolivian president Evo Morales, a socialist and the first ever democratically-elected indigenous president of Bolivia, had repeatedly promised that the profits from the extraction of lithium would benefit the Bolivian people first and foremost. These comments may have made international mining companies less likely to invest their technology and expertise in Bolivia, knowing they would be unlikely to make large profits. Then, on November 10, 2019, Morales was violently overthrown; Morales claimed that his stance towards lithium played a role in the coup. Another example is mining for cobalt (another key material in lithium-ion batteries) in the Democratic Republic of Congo. The extraction process has been shown to involve children labor and unsafe working conditions for all involved. A recent lawsuit names global tech companies (including Apple, Google, Tesla and Microsoft) as having knowledge about the possibility of child labor used to extract the cobalt for their products. These complex geopolitical issues may be a compelling line of research for students with an interest in international relations, colonialism, capitalism, and indigenous rights.

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology

- Chemistry

Earth Science

- Geology

Social Studies

- Economics

Learning Objectives

Students will:

- Identify the minerals and resources used in mobile devices.
- Propose problems associated with and solutions for landfilling mobile devices.
- Determine how a circular economy for lithium-ion batteries can minimize their negative impacts.

- Support a claim about lithium with evidence and reasoning.

Teaching Approach

- Project-based learning

Teaching Methods

- Discussions
- Jigsaw
- Reading

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information Literacy
    - Information, Communications, and Technology Literacy
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Critical Thinking and Problem Solving
  - Life and Career Skills
    - Leadership and Responsibility
    - Productivity and Accountability
- 21st Century Themes
  - Environmental Literacy
  - Global Awareness
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Evaluating
  - Understanding
- Geographic Skills

    - Acquiring Geographic Information
    - Analyzing Geographic Information
    - Answering Geographic Questions
- Science and Engineering Practices
    - Constructing explanations (for science) and designing solutions (for engineering)
    - Engaging in argument from evidence
    - Obtaining, evaluating, and communicating information

National Standards, Principles, and Practices

NATIONAL GEOGRAPHY STANDARDS

• **Standard 11:**
The patterns and networks of economic interdependence on Earth's surface
• **Standard 14:**
How human actions modify the physical environment
• **Standard 16:**
The changes that occur in the meaning, use, distribution, and importance of resources

NATIONAL SCIENCE EDUCATION STANDARDS

• **DCI ESS3.A::**
Natural Resources: Humans depend on Earth’s land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 5:**
Energy and matter: Flows, cycles, and conservation
• **MS-ESS3: Earth and Human Activity:**
MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment
• **Science and Engineering Practice 4:**
Analyzing and interpreting data
• **Science and Engineering Practice 6:**
Constructing explanations and designing solutions

• **Science and Engineering Practice 7:**
Engaging in argument from evidence
• **Science and Engineering Practice 8:**
Obtaining, evaluating, and communicating information

Preparation

What You'll Need

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per pair, Projector

PHYSICAL SPACE

- Classroom

GROUPING

- Jigsaw grouping
- Large-group instruction
- Small-group work

ACCESSIBILITY NOTES

For the partner reading in Step 2 and jigsaw activity in Step 3, consider strategically grouping students who have challenges with reading and comprehension to ensure they can work successfully with peers to make sense of the resources.

BACKGROUND & VOCABULARY

Background Information

Even if students do not have their own mobile device, smartphones and tablets are a ubiquitous technology across United States households. Focusing on mobile devices is an ideal way to bring alive the concept of a circular economy and connect to students' everyday lives and experiences, which has the potential to increase their classroom engagement and

motivation. Additionally, given that only 13 percent of smartphones are recycled annually in the United States, there is a demonstrated need for the smartphone industry (and consumer behavior) to move towards being more circular and less linear.

Lithium-ion batteries are incredibly efficient and relatively inexpensive, leading to the powering of many modern devices, ranging from smartphones to electric toothbrushes to electric vehicles. This decreases our global reliance on fossil fuels, helping to combat climate change. The lithium industry also creates jobs and income for people in developing nations. In line with the key principles of a circular economy, lithium-ion batteries are able to be recycled, so that the source materials can be recovered and used in new batteries.

As highlighted in this activity, lithium-ion batteries also cause problems. Lithium is a non-renewable mineral resource, and mining for it has negative environmental and social impacts on the local environment and communities. Energy, which currently comes from fossil fuels, is used to extract, process, and transport lithium. Improper lithium battery disposal can be dangerous, leading to fires.

In all, lithium-ion batteries are a key, and appropriately complex, example to demonstrate the utility of a circular economy and need for an advocacy campaign to promote recycling, which students are compelled to create throughout this unit.

Prior Knowledge

["Circular versus linear economy","Environmental impacts of mining and landfills","Renewable versus non-renewable resources"]

Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition

Term	Part of Speech	Definition
circular economy	*noun*	a system of production that extends the lifespan of consumer goods by maximizing reusing and recycling, and minimizing throwing things away.
extraction	*noun*	process by which natural resources are extracted and removed from the earth.
linear economy	*noun*	system where raw materials are collected and transformed into products, which are eventually discarded as waste.
lithium	*noun*	chemical element with the symbol Li; the lightest metal known, often used in lithium-ion batteries.
lithium-ion battery	*noun*	lightweight, high-density rechargeable battery commonly used for electronics.
nonrenewable resource	*noun*	natural resource that exists in a limited supply.
recycle	*verb*	to clean or process in order to make suitable for reuse.
renewable resource	*noun*	resource that can replenish itself at a similar rate to its use by people.

For Further Exploration

Articles & Profiles

- Electronics Notes: Lithium Ion Battery Advantages and Disadvantages
- How Stuff Works: How Lithium-Ion Batteries Work
- This mineral is powering today's technology - at what price?

Images

- EPA: The Secret Life of a Smart Phone

Video

- Story of Stuff: The Story of Electronics