Activity Preparation for Chapter 6

Activity/Investigation	Advance Preparation	Time Required	Other Considerations
What's Going On? A Human Battery (page 124) (TR page 150)	• 2 to 3 days before – Gather, assemble, and test the equipment. • 1 day before – Photocopy any assessment masters you decide to use. • Day of – Set out materials.	• 45 min	• Students will need DC multimeters or ammeters capable of measuring current in microamperes. • The metal plates must be of good quality since the current produced will be quite low. Science supply stores carry such plates. • Check the plates for sharp edges and remove any sharp edges with a file or sandpaper.
Test It! How to Make a Stronger Battery (page 128) (TR page 155)	• 2 to 3 days before – Gather materials and test equipment. • 1 day before – Photocopy **Assessment Master 1 Narrative Lab Report**, **Master 17 Narrative Lab Report Checklist**, and any other assessment masters you decide to use. • Day of – Prepare an observation table on the chalkboard. – Set out materials.	• 50 min for activity and questions • 20–30 min for narrative lab report	• Science supply stores carry the required metal plates. • To obtain useful results, the metal strips in each battery must be the same size and clean. Use a wire brush to clean the metal. • Sand or file any sharp edges on the metal strips. **Extreme caution:** Lead dust is highly toxic. Do not sand or file lead strips. If necessary, cover sharp edges with small pieces of duct tape or masking tape. • Have students wear protective gloves while handling all metal strips in this activity.
Find Out: No Batteries—No Problem! (page 136) (TR page 160)	• 1 day before – Gather demonstration materials and other materials. – Photocopy **Assessment Master 15 Visual Presentation Checklist**, **Assessment Master 16 Visual Presentation Rubric**, and any other assessment masters you decide to use.	• 45–60 min	• Kinesthetic learners may benefit from building the charging system they designed. • If you decide to have students build charging systems based on their designs, work with them to develop a list of safety precautions.

Materials Needed for Chapter 6

Activity/Investigation	Apparatus	Materials	Blackline Masters
What's Going On? A Human Battery (page 124) (TR page 150)	Per student pair: • hand-size aluminum plate • hand-size copper plate • 2 wires with alligator clips • microampere ammeter • steel wool or eraser • metal file (optional, 1 for teacher)	• water • sandpaper (optional, 1 sheet for teacher)	**Optional** Assessment Master 3 Lab Report Checklist Assessment Master 4 Lab Report Rubric
Test It! How To Make a Stronger Battery (page 128) (TR page 155)	Per student pair: • 3 – 100 mL beakers • labelling pen • microampere ammeter • 2 wires with alligator clips • metal strips (1 each of copper, zinc, aluminum and lead) • wire brush (1 for teacher to clean metal strips) • metal file (optional, 1 for teacher)	Per student pair: • 40 mL vinegar (acetic acid) • 40 mL lemon juice • 40 mL water • sandpaper (optional, 1 sheet for teacher)	**Recommended** Master 1 Narrative Lab Report Assessment Master 17 Narrative Lab Report Checklist **Optional** Assessment Master 6 Scientific Communication Rubric Assessment Master 7 Safety Checklist Assessment Master 8 Safety Rubric
Find Out: No Batteries—No Problem! (page 136) (TR page 160)	• devices with battery-free charging systems, such as shake flashlights Per design team: • coil of wire (optional) • magnet (optional) • capacitor (optional) • additional items for charging systems (optional)	• markers • blank paper • poster paper	**Recommended** Assessment Master 15 Visual Presentation Rubric Assessment Master 16 Visual Presentation Rubric **Optional** Assessment Master 13 Oral Presentation Rubric Assessment Master 14 Oral Presentation Rubric

CHAPTER 6 Batteries and Power

(page 122)

SUGGESTED TIMING	MATERIALS
15 min	• different battery types (e.g., AA, AAA, C, D, button batteries, 9 V, 12 V) • chart paper and markers

Overall Expectations

PEEV.01 – explain the generation, measurement, and conversion of electricity
PEEV.02 – investigate the factors that affect the generation and use of electricity
PEEV.03 – analyse the social, economic, and/or environmental implications of the sources and uses of electrical energy
SIMV.02 – investigate science-related information presented in print and electronic media using appropriate research and reporting skills

Science Background

Alessandro Volta (1745–1827) found a way to generate a voltage by placing different metals in a solution containing salt or acid. His electrochemical cells, or batteries, worked because the metals reacted chemically with the solution, resulting in a flow of electrons—an electric current.

A charged battery is a source of stored, or potential, energy. When a battery is connected into a working circuit, the stored energy is converted to electric energy.

Key Terms Teaching Strategies

Have students complete some or all of the following activities to help them learn and remember the key terms:

- Write definitions for these terms in their Science Log. You may wish to have students keep a glossary at the back of their Science Log.
- Write a paragraph that contains the key terms.

Help students remember the key terms by posting them on a science word wall or electricity bulletin board.

Reading Icon Answer (page 122)

1. A battery converts *chemical* energy to *electric* energy.

Activity Planning Notes

A great way to introduce the chapter is to show students various types of commonly used batteries. Also, having on hand electric devices that employ the various batteries will help illustrate the wide range of uses for batteries in our society.

Use guided questioning to help students complete question 2 on page 122. You may wish to record students' ideas on an overhead transparency or chart paper.

Making Connections Answer (page 122)

2. Answers will vary. Sample answers:

AAA: MP3 player

AA: penlight

C: portable radio

D: large flashlight or battery-powered toy

Flat circular battery: watch

9 volt: guitar tuner

12 volt: large lantern flashlight

6.1 How Does a Battery Work? (page 123)

SUGGESTED TIMING	BLACKLINE MASTERS
30 min 45 min for What's Going On?	Assessment Master 3 Lab Report Checklist Asssessment Master 4 Lab Report Rubric

Specific Expectations

PEE1.01 – describe different methods of generating electricity from other forms of energy
PEE1.03 – determine quantitatively and/or qualitatively the energy and power associated with electrical devices
PEE2.05 – communicate information using appropriate formats for specific purposes and audiences

Science Background

As a battery is used, chemical reactions produce a flow of electricity. When the reactants have been used up, the reactions stop and the battery is considered dead. Rechargeable batteries can be recharged by reversing the chemical reactions, which rebuilds the original reactants. The reactions can be reversed by forcing an electric current through the battery.

Dry batteries, or dry cell batteries, are commonly used in portable electric devices such as flashlights and cellphones. Dry battery rechargers can be plugged into wall outlets.

Wet batteries are typically used in motor vehicles. Lead acid batteries are a common type of wet battery. Like other wet batteries, lead acid batteries must be kept upright so that the corrosive acid they contain does not spill. They can be recharged, but recharging should be carried out in a well-ventilated area since the process can produce explosive hydrogen gas. To jump-start (recharge) a dead car battery, one can use jumper cables to connect the battery in a running car to the dead battery. Electric energy from the running battery produces a chemical reaction that recharges the dead battery.

Key Terms Teaching Strategies

Have students complete some or all of the following activities to help them learn and remember the key terms:

- Write definitions for these terms in their Science Log. You may wish to have students keep a glossary at the back of their Science Log.
- Make annotated drawings to illustrate the key terms.
- Write a paragraph that contains the four key terms.

Help students remember the key terms by posting them on a science word wall.

Reading Icon Answer (page 126)

1. Students should highlight: cellphones, digital cameras, and flashlights.

Reading Icon Answer (page 127)

2. Students should highlight: cars, motor bikes, powerboats, and all-terrain vehicles.

Activity Planning Notes

Read the text on page 123 together as a class before having students answer and then discuss questions 3 and 4.

As a lead-in to the What's Going On? activity, write the following challenge question on the chalkboard: How does a battery work? Students can write their ideas in their Science Log or share them orally with a partner.

After the activity, have students work with a partner to revisit the challenge question about how a battery works. Have students share their ideas in a class discussion.

Read the information on page 126 and 127 together before having students answer and then discuss questions 3 to 6 on page 127.

Accommodations

- Some students have difficulties organizing their thinking and writing concise answers. For question 3 on page 123, suggest they make headings for disposable batteries and rechargeable batteries, and then write a point for each one.
- Pair ESL and LD Learners with students who have stronger language skills.

Check Your Understanding Answer (page 123)

3. Rechargeable batteries can be re-used. Disposable batteries are thrown out when they no longer work.

Making Connections Answer (page 123)

4. Batteries get weak because the chemicals that react to produce a flow of electric current get used up.

Check Your Understanding Answers (page 127)

3. The conductor provides the medium through which electric energy can flow from one terminal to the other.
4. Dry batteries are small, dry, and produce useful amounts of current.
5. The conductor in a *dry battery* is a paste or hard material.

   The conductor in a *wet battery* is a liquid, such as an acid.

Making Connections Answer (page 127)

6. The human battery was a wet battery. Sweat on the skin acts as the liquid found in a wet battery.

What's Going On? Activity (page 124)

A Human Battery

Purpose

- Students gain understanding of the main components of a wet battery by creating various "human" batteries and reporting the results.

Science Background

The three main components of a battery are a negative (–) terminal, conductor, and positive (+) terminal. In the human battery, electric energy flows from the copper plate (negative terminal) to the aluminum plate (positive terminal). Sweat from the hands reacts chemically with the metal plates, causing electrons to flow from the copper plate to the hand touching it, and from the other hand to the aluminum plate. The body fluids serve as an electrolyte that conducts electrons between the copper and aluminum plates.

Actions that increase the rate of chemical reactions between the hands and the plates will increase the amount of current that flows through the human battery. However, the human body resists the flow of electric current, so when two people join hands to make a human battery, the current is especially weak.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
• 2 to 3 days before	• Gather, assemble, and test the equipment.
• 1 day before	• Photocopy any assessment masters you decide to use.
• Day of	• Set out materials.

APPARATUS	MATERIALS
Per pair: • hand-size aluminum plate • hand-size copper plate • 2 wires with alligator clips • microampere ammeter • steel wool or eraser • metal file (optional, 1 for teacher)	• water • sandpaper (optional, 1 sheet for teacher)

Suggested Timing

- 45 min

Safety Precautions

- Most commercially ordered metal plates from science supply stores do not have sharp edges. Nevertheless, you should check the plates and remove any sharp edges with a file or sand paper.
- Remind students to be careful not to cut themselves on the edges of the metal plates.
- Remind students to clean up their work area and put away all equipment after the activity.

Activity Planning Notes

Students will need DC multimeters or ammeters capable of measuring current in microamperes. The metal plates must be of good quality since the current produced will be quite low. Science supply stores carry such plates. The copper and aluminum plates work well for this activity, but you may wish to expand the test to include other metals. Zinc plates can be substituted for copper plates.

Let students know how their work will be assessed. You might provide each student with a copy of **Assessment Master 3 Lab Report Checklist**.

Demonstrate how to use the equipment. Students may need to set the ammeters or multimeters to measure current in microamperes. The black (negative) lead must be connected to the copper plate. The red or white (positive) lead must be connected to the aluminum plate. Be sure that the plates are not grounded to a metal surface. Students should work on a non-metallic surface, such as a wooden or synthetic lab bench.

Have students work in pairs to complete the activity.

Accommodations

- Students with physical disabilities could be teamed with those without disabilities, and use their partner's results to answer the questions.
- Encourage shy or less confident students to get involved by having lab partners switch roles after recording one set of results.

What's Going On? Activity Answers (page 125)

The answers will vary according to the quality of the metal plates; typical results are recorded below.

Step	Current (microamperes)
Step 2. No hands on the plates	0
Step 3. One hand on each plate	2–4
Step 4. After cleaning the plates	4–9
Step 5. Pressing hard on the plates	4–11
Step 6. Wet hands on the plates	5–12
Step 7. Holding hands and touching the plates	0–2

8. a) Students should find that when they placed their hands on the plates, a low electric current registered on the ammeter or multimeter.

b) There was a chemical reaction between the hands and the metal plates, which produced an electric current. (Note that students likely won't know this. They might infer that their hands or bodies had an effect that enabled a weak electrical current to flow from one metal plate, through their bodies, and to the other metal plate. Accept all reasonable answers.)

9. a) Students should draw an arrow from the negative terminal (copper plate) to the positive terminal (aluminum plate) to show the flow of electric energy.

b) The copper plate was the negative terminal of the human battery.

10. Students should find that cleaning the plates (Step 4), pressing hard on the plates (Step 5), and wetting their hands (Step 6) increased the chemical reactions occurring in the human battery, resulting in a higher current. Students should find that holding a partner's hands and touching the plates (Step 7) decreased the chemical reactions occurring in the human battery, resulting in a lower current. Students should circle the correct answers in the table.

Activity Wrap-up

- Take up the results with the class and discuss why electric current began to flow when someone touched the two metal plates. Ask students to suggest why some steps increased the chemical reactions producing electric current, while others decreased the reactions.
- Discuss the fact that the amount of electric current produced by a human battery would be insufficient to power any electric device. To make this point, have a student hook up an ammeter or multimeter to a 1.5 V battery and record the current, which will be far greater than that of the human battery.

Ongoing Assessment

- Use **Assessment Master 4 Lab Report Rubric** to assess student work during the What's Going On? activity.
- Use student answers to questions 3 to 6 on page 127 to assess how well they understand concepts about batteries.

Technology Links

- For information on how batteries work, go to **www.mcgrawhill.ca/books/Se10** and follow the links to How a Battery Works.

Alternative Activity

- Have students build a lemon battery by pushing a copper strip and a zinc strip into opposite ends of a lemon. Each metal strip should be wired to a voltmeter to read the voltage across the battery. The battery will work best if the lemon is gently crushed to allow the juices to flow within the fruit.

6.2 Battery Power (page 128)

SUGGESTED TIMING	MATERIALS	BLACKLINE MASTERS
30–40 min including the Science and Media Link 45–50 min for Test It!	• 2 – 1.5 V batteries • battery holder • 3.0 V light bulb in a light bulb holder • electric motor • electric switch • craft stick	Assessment Master 1 Narrative Lab Report Assessment Master 6 Scientific Communication Rubric Assessment Master 7 Safety Checklist Assessment Master 8 Safety Rubric Assessment Master 17 Narrative Lab Report Checklist

Specific Expectations

PEE1.01 – describe different methods of generating electricity from other forms of energy
PEE1.02 – define and describe electrical concepts and their units
PEE1.03 – determine quantitatively and/or qualitatively the energy and power associated with electrical devices
PEE2.01 – locate and select information from various sources to identify factors affecting generation and use of electricity
PEE2.02 – design and build an electrical device, using lab equipment and materials safely
PEE2.03 – modify the electrical device they built to increase the amount of electrical energy it produces
PEE2.04 – determine and record the electrical energy and power of electrical devices
PEE2.05 – communicate information using appropriate formats for specific purposes and audiences
SIM2.02 – research science-related information from a variety of electronic and other sources
SIM2.03 – interpret research data, including analysis for accuracy and bias as appropriate, using a range of strategies for reading for information

Science Background

The voltage supplied by sources connected in series is additive. On page 128, the flashlight on the left has three batteries in series. If each battery were to supply 1.5 V, the total voltage supplied by the batteries would be 4.5 V. The light from this flashlight will therefore be brighter than the light from the flashlight with batteries in parallel.

The total voltage supplied by the batteries in parallel would be only 1.5 V. However, the batteries in parallel would contribute less to the total current, and therefore would last longer than the batteries in series.

Key Terms Teaching Strategies

Have students complete some or all of the following activities to help them learn and remember the key term:

- Write a definition for the term in their Science Log. You may wish to have students keep a glossary at the back of their Science Log.
- Write a sentence that contains the key term.

Help students remember the key term by posting it on a science word wall.

Reading Icon Answers (page 128)

1. **a)** Students should write high voltage under the flashlight with batteries connected in series.

   b) Students should write high current under the flashlight with batteries connected in parallel.

Activity Planning Notes

On the chalkboard, write focus questions such as "What is battery power?" and "What is the difference between connecting batteries in series and connecting batteries in parallel?"

Demonstrate connecting batteries in series and connecting batteries in parallel. Connect two batteries in parallel in a battery holder in order to power a light bulb. Ask a volunteer to turn off the overhead lights and another volunteer to turn on the switch in the electric circuit. Ask students to observe the brightness of the light produced. Then, repeat the test connecting two batteries in series. Students should see that connecting the batteries in series results in a brighter light than connecting the same batteries in parallel. Record the results on the chalkboard and have students record the results in their Science Logs.

Repeat the demonstration with a small motor. Tape a craft stick to the motor shaft so that it is easier to see the motor spin. Connect the motor to batteries connected in parallel and then to batteries connected in series. The motor will spin faster when the batteries are connected in series. Caution: Keep your hands away from the spinning craft stick.

Have students complete and then discuss question 1 on page 128. Point out the 9 V battery at the top of the page and remind students that to make a higher voltage battery, many small batteries (electrochemical cells) are connected in series.

In the Test It! activity, students explore how a battery's composition affects its strength, or the amount of current it produces.

As a class, read the information about capacity on page 132. Have students look once more at the visuals of flashlights on page 128. Ask students which flashlight batteries will last longer: the batteries in series or the batteries in parallel? Explain that even a high capacity battery can be drained quickly if it is used to power a device that draws a high current.

Have students read the Science and Media Link on page 132. Use prompts to help students interpret the information on the graph. Have them answer and then discuss the questions on page 133.

Have students rethink their answers to the opening focus questions on battery power and make summary statements that they share with the class.

Accommodations

- Kinesthetic learners may benefit from testing the difference between connecting batteries in parallel and in series for themselves after watching the demonstration.
- Make a point of pronouncing the name of each different battery type on page 132.
- Pair ESL and LD Learners with students who have stronger language skills. Partners can take turns reading the Science and Media Link aloud and work together to complete the questions.

Check Your Understanding Answer (page 132)

1. stored energy in a battery in ampere-hours (Ah) or milliampere-hours (mAh)

Check Your Understanding Answers (page 133)

2. **a)** nickel-metal hydride or nickel-cadmium batteries

   b) Answers may vary. Sample answer:
   - Both batteries perform well in high-drain devices, such as MP3 players.
   - Both batteries are rechargeable. Some students may know that nickel-metal hydride batteries are more environmentally responsible than nickel-cadmium batteries.

3. **a)** rechargeable alkaline batteries

   b) Answers may vary. Sample answer:
   - low cost
   - rechargeable

Making Connections Answers (page 133)

4. **a)** Answers may include: MP3 players, cellphones, portable gaming devices, or calculators.

   b) Answers may vary. Look for three features such as:
   - cost
   - performance
   - impact on the environment (whether they are rechargeable or disposable and whether or not they contain dangerous chemicals)

Test It! Activity (page 128)

How to Make a Stronger Battery

Purpose

- Students test how using different materials affect a battery's strength.
- Students write a narrative lab report.

Science Background

A battery brings two reactive metals and an electrolyte into close proximity. In general, the greater the reactivity differences between two metals, the greater the electric current. Here is a reactivity series for some common metals, listed from greatest to least reactivity: potassium, sodium, calcium, magnesium, aluminum, zinc, iron, tin, lead, copper, silver, and gold.

Based on the reactivity series, one might predict that the copper/aluminum combination would produce the greatest electric current of the three metal plate combinations tested. However, the aluminum plate is covered by a strong and stable oxide barrier. As a result, the copper/zinc combination will produce the highest electric current, followed by the copper/lead combination, and then the copper/aluminum combination.

The stronger the battery acid (conductor or electrolyte), the stronger the chemical reaction between the two metals in the battery, and thus the stronger the current produced in amperes. Since vinegar is more acidic than lemon juice, the vinegar battery will produce the higher current. The lemon juice battery will produce a higher current than the water battery, since tap water is close to neutral (contains low concentrations of ions compared with vinegar and lemon juice).

Copper/zinc batteries are among the most common types of dry batteries that are commercially available. Copper/lead dry batteries are no longer made because their disposal presents environmental concerns.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
2 to 3 days before	• Gather materials and test equipment.
1 day before	• Photocopy **Assessment Master 1 Narrative Lab Report**, **Master 17 Narrative Lab Report Checklist**, and any other assessment masters you decide to use.
Day of	• Prepare an observation table on the chalkboard. • Set out materials.

APPARATUS	MATERIALS
Per student pair: • 3 – 100 mL beakers • labelling pen • microampere ammeter • 2 wires with alligator clips • metal strips (1 each of copper, zinc, aluminum and lead) • wire brush (1 for teacher to clean metal strips) • metal file (optional, 1 for teacher)	Per student pair: • 40 mL vinegar (acetic acid) • 40 mL lemon juice • 40 mL water • sandpaper (optional, 1 sheet for teacher)

Suggested Timing

50 min for activity and questions; 20–30 min for narrative lab report

Safety Precautions

- Check the metal strips for sharp edges. File or sand any sharp edges. **Extreme caution:** Lead dust is highly toxic. Do not sand or file lead strips. If necessary, cover sharp edges with small pieces of duct tape or masking tape. Have students wear protective gloves while handling all metal strips in this activity.
- Advise students to be careful when handling the metal strips so they do not cut themselves.
- Ensure that students wear safety glasses and gloves while completing the activity.
- Review eye wash procedures with students. If anyone gets liquid in the eye, the eye should be washed with clean water for 15 min.
- Do not use glacial acetic acid for the activity; household vinegar is sufficient.
- Remind students to clean up the work area and wash their hands thoroughly at the end of the investigation.

Activity Planning Notes

To obtain useful results, the metal strips in each battery must be the same size and clean. Sand or file any sharp edges on the metal strips. **Extreme caution:** Do not sand or file lead strips. See Safety Precautions.

Introduce the activity and demonstrate how to use the equipment as you review the procedure with the class. Review all safety precautions and procedures. You may wish to reinforce the importance of safety in the lab by providing students with **Assessment Master 7 Safety Checklis**t, and review the criteria.

Have students work in pairs to complete the activity. As you circulate, remind students to record their observations in the table on page 130. Also check that students have properly connected the ammeters or multimeters to the metal strips.

When students are ready to clean up their work area, have them return all used liquids to you for appropriate disposal (as appropriate to your Board).

Accommodations

- Pair students with physical disabilities with those who can help set up the lab equipment.

- Have students who have difficulty writing discuss the narrative lab report orally.
- Encourage struggling readers and writers to read their narrative lab reports out loud to a partner to check for grammatical errors.

Test It! Activity Answers (page 130)

9. The results will vary according to the condition of the metal strips and the acidity and ionic strength of the liquids used. Sample results are provided.

Metal Terminals	Current (microamperes)		
	Vinegar	Lemon Juice	Water
copper/zinc	5	4	0
copper/aluminum	2	1	0
copper/lead	3	2	0

10. Answers will vary depending on predictions. Note that predictions should not be assessed as right or wrong. Encourage students instead to focus on the reasons for making their prediction and how the results they obtained supported or did not support their prediction.

11. Students should find that the copper/zinc combination produced the greatest current.

12. Students should find that the vinegar and lemon juice produced more current than water. The vinegar will likely produce more current than lemon juice, unless students used concentrated lemon juice.

13. Sample answer:

- Change the type of metals used for the terminals.
- Change the liquid.

14. Yes. Sample answer: The chemical reactions would eventually stop because the chemicals (metal and acid) would eventually be used up.

Activity Wrap-up

- Have students complete and then discuss questions 10 to 14 on page 130. You may wish to have students share their results in a table on the chalkboard.
- Discuss the reasons for variations among different pairs' results. Some factors that might have affected the results include: the condition or cleanliness of the metal strips, the strength of the acids used (if not all pairs used the same sources or if the lemon juice was not thoroughly mixed), and how the ammeter was connected.
- Have students complete narrative lab reports in class or as homework. Provide students with a copy of **Assessment Master 17 Narrative Lab Report Checklist** (as a guide) and **Master 1 Narrative Lab Report** if they need more space. Encourage students to work with their lab partners, but remind them to write the report in their own words.

Alternative Activities

- Have students test how using various salt concentrations affects the strength of batteries. The saltiest water will be the best conductor of electricity and produce the greatest current.
- Have students research the best battery to use in an electric device they choose.

Technology Links

- For detailed descriptions of different types of batteries go to **www.mcgrawhill.ca/books/Se10** and follow the links to Battery Types.
- For a graph that shows power drain in alkaline batteries, go to **www.mcgrawhill.ca/books/Se10** and follow the links to Alkaline Drain Chart.

Ongoing Assessment

- Use **Assessment Master 8 Safety Rubric** to assess students' safety practices during the Test It! activity.
- Assess students' narrative lab reports in the Test It! activity.
- Use student answers to the Science and Media Link as a formative assessment of how well they understand features of batteries and making battery choices appropriate for the intended purpose.

6.3 Batteries—With or Without Them? (page 134)

SUGGESTED TIMING	MATERIALS	BLACKLINE MASTERS
25–30 min 45–60 min for Find Out	• examples of batteries (e.g., alkaline, button cell, lithium, nickel-cadmium, nickel-hydride) • battery-free (shake) flashlight	BLM 6–1 Researching Batteries Assessment Master 13 Oral Presentation Checklist Assessment Master 14 Oral Presentation Rubric Assessment Master 15 Visual Presentation Checklist Assessment Master 16 Visual Presentation Rubric

Specific Expectations

PEE1.01 – describe different methods of generating electricity from other forms of energy
PEE2.02 – design and build an electrical device, using lab equipment and materials safely
PEE2.05 – communicate information using appropriate formats for specific purposes and audiences
PEE3.01 – compare technologies used for generating electrical energy, including their social, economic, or environmental implications
SIM2.02 – research science-related information from a variety of electronic and other sources
SIM2.03 – interpret research data, including analysis for accuracy and bias as appropriate, using a range of strategies for reading for information

Science Background

Some batteries contain heavy metals, such as cadmium and mercury. When heavy metals get into an ecosystem, they can accumulate in living organisms and biomagnify from one trophic level to the next. Heavy metals can cause severe neurological damage and other health problems.

One reason to recycle certain batteries is to keep heavy metals from getting into the environment. Another reason to recycle lithium batteries, nickel-cadmium batteries, and nickel-metal hydride batteries is to re-use the elements that went into making the batteries.

In 1996, the United States passed a law banning the use of mercury in most batteries, and Canadian battery manufacturers have voluntarily followed the U.S. regulations. Although some batteries are considered safe to put in the trash, they add to landfill.

A battery-free, or shake, flashlight contains a coil of wire that moves in a magnetic field and generates electric energy. The electric energy is stored in a capacitor, which is then used to power a low voltage LED. Another battery-free portable electric device that students might be familiar with is a bicycle lamp, which also uses a capacitor.

Key Terms Teaching Strategies

Have students complete some or all of the following activities to help them learn and remember the key term:

- Write definitions for the term in their Science Log. You may wish to have students keep a glossary at the back of their Science Log.
- Write a paragraph that contains the key term in this section.

Help students remember the key term by posting it on a science word wall.

Reading Icon Answer (page 134)

1. Students should highlight four disadvantages:

- It is more expensive to use batteries than to use energy from an electric outlet.
- Producing batteries requires valuable resources and energy.
- Some batteries contain toxic chemicals that can harm the environment.
- Batteries that can be safely thrown out add to landfill.

Reading Icon Answer (page 136)

1. Students should circle: magnet, wire coil, and capacitor.

Activity Planning Notes

If possible, collect an example of each type of battery featured on the chart of battery types on page 134. Use the batteries and an overhead transparency of the chart to highlight the class discussion. Invite students to share the types of batteries they are using in electric devices (e.g., watches, MP3 players) that they have with them.

Have students work in pairs to complete the questions on page 135 before taking them up in a class discussion.

Introduce the information on page 136 by bringing in a battery-free flashlight and demonstrate how to use it. Ensure that students know the purpose of a capacitor before they move on the Find Out activity that follows.

Accommodations

- Pair ESL and LD Learners with students who have stronger language skills. Partners can take turns reading the information on pages 134 and 136 aloud.

Check Your Understanding Answers (page 135)

2. alkaline, zinc-carbon, zinc-chloride, nickel-metal hydride

3. lithium, nickel-cadmium, nickel-metal hydride

Making Connections Answer (page 135)

4. Answers will vary. Students should give a reason for each essential item and an alternative for each non-essential item. Students may say that some devices, such as a cellphone, flashlight, and radio are essential in case of an emergency or that the digital camera and portable computer are essential depending on the purpose of the trip. Alternatives to some of the electric devices used for entertainment might be reading, playing board games or card games, singing and playing acoustic instruments, or working on crossword puzzles or word searches.

Check Your Understanding Answer (page 136)

2. A capacitor *stores* electric energy.

Find Out Activity (page 136)

No Batteries—No Problem!

Purpose

- Students design a battery-free charging system that could be used to power their favourite electric device.
- Students present their designs to the class.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 day before	• Gather demonstration materials and other materials. • Photocopy **Assessment Master 15 Visual Presentation Checklist**, **Assessment Master 16 Visual Presentation Rubric**, and any other assessment masters you decide to use.

APPARATUS	MATERIALS
• devices with battery-free charging systems, such as shake flashlights Per design team: • coil of wire (optional) • magnet (optional) • capacitor (optional) • additional items for charging systems (optional)	• markers • blank paper • poster paper

Suggested Timing

45–60 min

Safety Precautions

- If you decide to have students build charging systems based on their designs, work with them to develop a list of safety precautions.

Activity Planning Notes

Begin the activity by asking students what they would do if there were no batteries.

Provide examples of devices that use battery-free charging systems, such as the shake flashlight, flashlights and radios with hand-crank generators, and battery-free bicycle lights. Remind students many battery-free charging systems produce only small amounts of electric current—enough to power an LED, but not an MP3 player, for example. Students will have to consider the amount of power an electric device takes in order to design an appropriate charging system for it.

Present the design challenge. You may wish to have students work individually or in pairs. Provide students with **Assessment Master 15 Visual Presentation Checklist** and review the criteria for the poster. You may wish to provide students with **Assessment Master 16 Visual Presentation Rubric** so that they are aware of the expectations.

Students should complete questions 1 to 3 on page 137 before working on the design criteria. Remind them to review their design criteria as they sketch the charging system. Circulate and provide feedback as students work on their designs.

Provide time for students to prepare their posters.

Accommodations

- Some students may require assistance with planning the design. Pair students with complementary skills.
- Pair students with visual impairments or those who have difficulty drawing with other students who can help them.
- Kinesthetic learners may benefit from building the charging system they have designed, assuming appropriate safety precautions are observed.

Find Out Activity Answers (page 137)

1. Students can name any electric device.
2. coil of wire, magnet, capacitor
3. The system will probably have to be powered by motion. Students should be able to integrate activities like biking, skateboarding, walking, running, or jumping for the charging system design. Some students might otherwise suggest a charging system based on solar power, which would use solar panels but would not need a magnet and wire coil.
4. Students will have different solutions for meeting the design criteria.
   - In order for the charging system to work without the user stopping to shake it, an everyday activity must result in the movement of the coil of wire around or along the magnet.
   - To hide the charging system, it could be stored in a fanny pack or somewhere on a bicycle.
   - The system could be made waterproof by keeping it in a plastic sleeve.
   - To make the system durable, it could be encased in firm plastic or other durable material.
5. Sketches will vary and need be limited only by the creativity of the student.

Activity Wrap-up

- Before students present their posters to the class, coach them about how to make an effective oral presentation. Provide students with **Assessment Master 13 Oral Presentation Checklist** and review the criteria. After each presentation, invite students to ask the presenter(s) pertinent questions.
- You might have students assess their own performance using **Assessment Master 13 Oral Presentation Checklist**.

Alternative Activities

- Have students research battery types and battery care using **BLM 6–1 Researching Batteries**. The activity includes an analysis of information for accuracy and bias. In advance, find some appropriate web sites. The Technology Links on this page has a suggestion for a web site.
- Have students make a visual presentation that features alternatives to battery-powered devices. If so, review the criteria using **Assessment Master 15 Visual Presentation Checklist**.

Technology Links

- For a news release about a recall of toys using mercury batteries, go to **www.mcgrawhill.ca/books/Se10** and follow the links to Mercury-Battery Toys.
- For information about the Rechargeable Battery Recycling Corporation (RBRC) and its Call2Recycle™ program, which helps people recycle used rechargeable batteries, go to **www.mcgrawhill.ca/books/Se10** and follow the links to Recycle.
- For information about a battery-free charging system, go to **www.mcgrawhill.ca/books/Se10** and follow the links to Who Needs Batteries?
- For information about battery types and battery care, go to **www.mcgrawhill.ca/books/Se10** and follow the links to Battery.

Ongoing Assessment

- Use student answers to questions 2 and 3 on page 135 to assess their understanding of proper disposal of batteries.
- Use **Assessment Master 16 Visual Presentation Rubric** to assess the posters made for the Find Out activity.
- Use **Assessment Master 14 Oral Presentation Rubric** to assess students' oral presentations for the Find Out activity.

Chapter 6 Review (page 138)

SUGGESTED TIMING

75 min to complete and take up the review, and then assign the Practice Test

BLACKLINE MASTERS

Master 5 Certificate
Master 6 List of Skills
BLM 6–2 Chapter 6 Practice Test
BLM 6–3 Chapter 6 Test
BLM 6–4 BLM Answers

Accommodations

- Allow students to make a chapter summary page of the key ideas/skills from the chapter. The back of the student resource provides space to do this. Alternatively, you might develop a chapter summary as an entire class.
- If students have difficulty with a particular review question, use the Review Guide to identify the section they need to review.
- Arrange students in study groups to complete the Chapter Review.
- **BLM 6–2 Chapter 6 Practice Test** can be customized to produce extra reinforcement questions.

Summative Assessment

- Have students complete **BLM 6–3 Chapter 6 Test** to assess individual skills.
- You may wish to develop **Master 5 Certificate** to show students what they have learned during this chapter. Cut and paste the related skills from **Master 6 List of Skills**.

Using the Chapter Review

Depending on your class, students should be able to work through the review at their own pace. In order to have success with the Chapter Review, some students may need to do it in chunks, by completing several questions and then taking them up before continuing. This process will prevent students from completing many questions incorrectly.

Once the review is completed and taken up, assign **BLM 6–2 Chapter 6 Practice Test** for students to answer individually. They may wish to use their completed review to help them.

Review Guide

Question	Section(s)	Refer to
1	6.1	How Does a Battery Work? (page 123)
2	Chapter Opener	Batteries and Power (page 122)
3	6.1	How Does a Battery Work? (page 123)
4	Chapter Opener	Batteries and Power (page 122)
5	6.1	Wet Batteries (page 127)
6	6.2	Capacity (page 132)
7	6.1	Dry Batteries (page 126)
8	6.3	Can We Be Battery Free? (page 136)
9	6.1	Dry Batteries (page 126)
10	6.2	Battery Power and Test It! How to Make a Stronger Battery (page 128)
11	6.2	Science and Media Link (page 132)
12 to 13	6.2	Battery Power (page 128)
14 to 15	6.3	Batteries—With or Without Them? (page 134)
16	6.1	Wet Batteries (page 127)
17	6.3	Batteries—With or Without Them? (page 134)

Chapter 6 Review Answers (pages 138–139)

1. **d)** disposable
2. **e)** battery
3. **a)** rechargeable
4. **i)** portable
5. **b)** wet battery
6. **f)** capacity
7. **c)** dry battery
8. **h)** capacitor
9. **a)** positive terminal

   b) conductor paste

   c) negative terminal
10. • change the liquid conductor to a stronger acid
    • change the metal terminals

    Some students may say: line up small batteries in series to provide higher voltage.
11. **a)** rechargeable

    b) Answers may vary. Sample answer:

    • can be used repeatedly, which offsets the initial cost and reduces waste entering a landfill
    • nickel-metal hydride and nickel-cadmium batteries perform well in high-drain devices
12. Mercury is toxic. When mercury-containing batteries break down, they release mercury into the environment.
13. **a)** flashlight with batteries placed end to end

    b) The batteries are arranged in series, which produces more current than batteries arranged in parallel.

    c) flashlight with batteries placed end to end (in series)

    d) This flashlight draws more current, so it will use up the energy stored in the batteries sooner.
14. **a)** rechargeable
15. **b)** take them to a recycling centre
16. **a)** wet battery
17. Look for one of the following disadvantages:

    • more expensive to use batteries than to use electric energy from an outlet
    • making batteries uses energy and valuable resources
    • some batteries contain toxic chemicals
    • batteries that are disposed of in trash add to landfill