Activity Preparation for Chapter 7

Activity/Investigation	Advance Preparation	Time Required	Other Considerations
Find Out: Adding Loads in a Series Circuit (page 124) (TR page 153)	• 1 day before – Check bulbs, batteries, and wires. – Ensure that all bulbs are identical. If more than one type of bulb is available, then group identical bulbs together. – Photocopy any assessment masters you decide to use.	• 40 min	• It is very important that bulbs have the same voltage rating and that each bulb's rating does not exceed the voltage of the source. • Ensure that students know which scale to use on their ammeter or multimeter before beginning this activity.
Find Out: Adding Sources in a Series Circuit (page 125) (TR page 154)	• 1 day before – Check bulbs, batteries, and wires. – Ensure that all bulbs are identical. If more than one type of bulb is available, then group identical bulbs together. – Photocopy any assessment masters you decide to use.	• 40 min	• It is very important that bulbs have the same voltage rating and that each bulb's rating does not exceed the voltage of the source. • Ensure that students know which scale to use on their voltmeter or multimeter before beginning this activity.
Test It! Current in a Parallel Circuit (page 128) (TR page 158)	• 1 day before – Have students write their questions and steps. – Gather supplies. – Photocopy any assessment masters you decide to use.	• 45–60 min	• The length of this activity may vary from class to class. You may want to review planning an investigation, the scientific process, how to ask questions that will yield accurate answers, etc. You may also want to review variables, electric safety, and designing tables.
What's Going On? Circuit Exchange (page 133) (TR page 163)	• 1 day before – Photocopy **BLM 7–2 Circuit Exchange** and **Assessment Master 8 Scientific Communication Rubric**.	• 40 min	• You can use **BLM 7–2 Circuit Exchange** or make your own circuit diagrams.
Test It! Become a Circuits Performer! (page 134) (TR page 164)	• 2 days before – Obtain equipment. • 1 day before: – If using, photocopy **BLM 7–3 Circuits Performer** and any assessment masters you decide to use.	• 60–90 min	• Some students will want to start immediately building a circuit and test it as they go along. Remind students that they can begin building their circuits only after you have approved their plan.

Materials Needed for Chapter 7

Activity/Investigation	Apparatus	Materials	Blackline Masters
Find Out: Adding Loads in a Series Circuit (page 124) (TR page 153)	For each group: • ammeter or multimeter • switch • 3 – 6 V bulbs in holders • 5 wires with alligator clips • 6 V battery in holder		**Optional** Assessment Master 1 Co-operative Group Work Checklist Assessment Master 2 Co-operative Group Work Rubric
Find Out: Adding Sources in a Series Circuit (page 125) (TR page 154)	For each group: • voltmeter or multimeter • switch • 6 V bulb in holder • 5 wires with alligator clips • 3 – 1.5 V batteries in holders		**Optional** Assessment Master 11 Using Tools and Equipment Checklist Assessment Master 12 Using Tools and Equipment Rubric
Test It! Current in a Parallel Circuit (page 128) (TR page 158)	For each group: • ammeter or multimeter • switch • 3 – 6 V bulbs in holder • 6 V battery in holder • 7 wires with alligator clips		**Optional** Assessment Master 7 Scientific Communication Checklist Assessment Master 8 Scientific Communication Rubric Assessment Master 13 Fair Test Checklist Assessment Master 14 Fair Test Rubric
What's Going On? Circuit Exchange (page 133) (TR page 163)			**Recommended** BLM 7–2 Circuit Exchange Assessment Master 8 Scientific Communication Rubric **Optional** Assessment Master 7 Scientific Communication Checklist
Test It! Become a Circuits Performer! (page 134) (TR page 164)	For each group: • batteries • bulbs • buzzers • switches • wires		**Optional** BLM 7–3 Circuits Performer Assessment Master 1 Co-operative Group Work Checklist Assessment Master 2 Co-operative Group Work Rubric Assessment Master 3 Lab Report Checklist Assessment Master 4 Lab Report Rubric Assessment Master 11 Using Tools and Equipment Checklist Assessment Master 12 Using Tools and Equipment Rubric

CHAPTER 7 Series and Parallel Circuits (page 122)

SUGGESTED TIMING

10 min

Overall Expectations

PECV.01 – describe the characteristics of electrical circuits
PECV.02 – investigate simple electrical circuits, using safe practices
PECV.03 – analyze the practical uses of electrical circuits and their impact on daily life
SILV.01 – illustrate how science is a part of daily life
SILV.02 – use appropriate scientific skills, tools, and safety procedures to investigate problems
SILV.03 – examine the connections between science and activities in daily life

Activity Planning Notes

Students can appreciate that a circuit can be physically very large (a switch at the front door can control a light at the end of a driveway) or very small (as seen by a battery connected to a flashlight bulb). Reinforce that the switch and the light, regardless of their distance apart, are part of the same circuit if the switch turns the light on or off.

Students might have had experience with three-way switches in their homes where more than one switch controls a light, though they do not know how these things are connected. This opening activity demonstrates that it is useful to be able to connect loads differently, and that many switches can be part of a circuit.

Check Your Understanding Answers (page 122)

1. Answers will vary. For example:

a) easy to light the path from street to door from a single location

b) can turn on one without the other if only one light is needed

c) can turn on porch light from indoors or outdoors

d) can control all lights at once

7.1 Series Circuits: The Only Way to Go (page 123)

SUGGESTED TIMING

30 min
40 min for Find Out: Adding Loads in a Series Circuit
40 min for Find Out: Adding Sources in a Series Circuit

MATERIALS

- circuit components
- juice boxes with extra straws (optional)

BLACKLINE MASTERS

BLM 6–2 Symbols for Circuits
BLM 7–1 Human Series Circuit
OHT B–9 Types of Circuits
Assessment Master 1 Co-operative Group Work Checklist
Assessment Master 2 Co-operative Group Work Rubric
Assessment Master 11 Using Tools and Equipment Checklist
Assessment Master 12 Using Tools and Equipment Rubric

Specific Expectations

PEC1.01 – use scientific terminology during investigations to describe basic electrical concepts and related units of measure
PEC1.04 – use a variety of symbols to represent different components in electrical circuits
PEC2.03 – conduct investigations, using electrical materials, tools, and equipment safely
PEC2.04 – measure and record the current and potential difference in simple circuits through the safe and proper use of an ammeter and a voltmeter
PEC2.06 – communicate plans and results of investigations about electrical circuits, using a variety of oral, written, and graphic formats
SIL2.03 – conduct investigations safely, using appropriate lab equipment

Key Terms Teaching Strategies

Add the new term to the word wall. Ask students to share their prior knowledge of the term "series" (a number of things occurring or placed one after the other). Students might be familiar with television series, book series, and mathematical series. Ask them to predict what a "series circuit" might be.

Reading Icon Answer (page 123)

2. If you open the switch, all three bulbs will turn off.

Activity Planning Notes

The important concept for students to understand is that for a series circuit, all components follow one another. They form part of a continuous chain. If a link of the chain is broken, the circuit is incomplete. You may want to show with a few bulbs that the wire goes from one terminal of the battery, to one end of the bulb holder, then out the other end of the bulb holder. Or use the series circuit visual on **OHT B–9 Types of Circuits**. The goal is to reinforce that a series circuit is a chain.

In series circuits, all loads are connected together in a long chain. Adding more loads increases the resistance of the circuit and decreases the current. If all bulbs in the circuit are identical, the voltage will be divided equally among them. For example, a 6.0 V battery connected to 3 bulbs will provide 2.0 V to each bulb. The brightness of the bulbs goes down as more bulbs are added in series. Current can still flow without the bulbs appearing to glow.

After completing the introduction, have students do the Find Out activities Adding Loads in a Series Circuit and Adding Sources in a Series Circuit.

Then discuss current and voltage in a series circuit. The concepts of current and voltage are difficult to visualize. Bring in some juice boxes and straws and let the students feel the effect of adding straws *end to end* on the amount of juice reaching their mouth. This is a very powerful demonstration. Some students may have seen commercials on television where a child uses a very long straw to reach a glass far away. This demonstration could act as a launching point for discussions on the realism of that commercial.

Discuss how the graphic on page 126 could be altered to show the effects of adding batteries if the bulbs of the flashlights were identical. A possible answer is that more "rays" of light could be added to the graphic to show that the "three-battery" bulb is brighter.

Consider using the following blackline master and overhead transparency in this section:

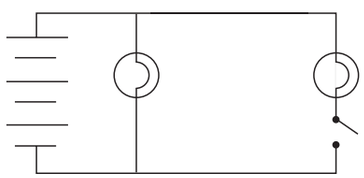
- **BLM 6–2 Symbols for Circuits**
- **OHT B–9 Types of Circuits**

Accommodations

- You may want to cut out large circuit symbols and wires from coloured paper and attach magnetic strips to them. These symbols could be used on the chalkboard for students who are visually impaired or who learn better visually. This will also reinforce that the circuit is made up of many parts and that, in a series circuit, they all follow one another. **BLM 6–2 Symbols for Circuits** may be useful for this purpose.
- ESL and LD Learners could be paired with students who have stronger language skills.

Check Your Understanding Answers (page 123)

3. Diagram should look like the one shown here.



4. If one bulb in this circuit burns out, the circuit opens. No current will flow and both bulbs will be off.

Check Your Understanding Answers (page 126)

1. a) decreases

b) increases

2. No. Adding an extra bulb in series will make the flashlight burn less brightly because current across each load decreases as loads are added in series. (To make a flashlight burn more brightly, add an extra source in series.)

Find Out Activity (page 124)

Adding Loads in a Series Circuit

Purpose

- Students discover the effects of adding loads (bulbs) on the current in a series circuit.

Science Background

The voltage rating (not power rating) of bulbs will tell you if the bulb can be used with a particular power source. Remember that in a series circuit, the voltage of the source gets distributed to the loads. When you use identical bulbs, all bulbs have the same voltage across them in a particular circuit. Since the overall resistance of the circuit increases as more loads are added and the voltage from the source remains the same, the current will decrease as more loads are added.

Students have many misconceptions regarding current. They might explain dimmer bulbs as the loads "eating up" charges. Since there are more loads some students will think that there will be fewer charges to use up, thus a dimmer bulb, which is incorrect. Be careful that misconceptions are not reinforced.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 day before	• Check bulbs, batteries, and wires. • Ensure that all bulbs are identical. If more than one type of bulb is available, then group identical bulbs together. • Photocopy any assessment masters you decide to use.

APPARATUS	MATERIALS
• ammeter or multimeter • switch • 3 – 6 V bulbs in holders • 5 wires with alligator clips • 6 V battery in holder	

Suggested Timing

40 min

Safety Precautions

- Use only one battery.
- Ensure that the ammeter is connected in series.
- Remind students to clean up their work area, put away all equipment, and wash their hands at the end of the activity.

Activity Planning Notes

It is very important that bulbs have the same voltage rating and that each bulb's rating does not exceed the voltage of the source. Bulbs will burn out if their rating is lower than the source. 6 V bulbs have a low resistance (20 ohms to 25 ohms); this will yield values in the range of 80 mA to 240 mA for the current.

Ensure that students know which scale to use on their ammeter or multimeter before beginning this activity. Reinforce that the meter is connected in series so that the current through a load is measured.

Accommodations

- Students can work in groups.
- You might provide a model circuit at your desk for students to check their work against.
- ESL and LD Learners could be paired with students who have stronger language skills.

What to Do Answer (page 124)

5. The current for one bulb may be close to 240 mA and the bulb should be brightly lit. The current for two bulbs may be close to 160 mA and the bulbs will be less brightly lit. The current for three bulbs may be close to 80 mA and the bulbs will be dimly lit.

What Did You Find Out? Answers (page 124)

6. The bulbs become dimmer as more bulbs are added to the series circuit.

7. The current through the circuit decreases as more bulbs are added.

Activity Wrap-up

- Students can write a paragraph describing why they think the bulbs got dimmer. This will allow you to identify students who have a misconception regarding current.
- If students work in groups, you may wish to have them complete **Assessment Master 1 Co-operative Group Work Checklist**.

Find Out Activity (page 125)

Adding Sources in a Series Circuit

Purpose

- Students discover the effects of adding sources in series.

Science Background

The brightness of the bulb will reflect the voltage across it. A bright bulb has a larger voltage across it than one that is dim. The voltage rating (not power rating) of bulbs tells you the amount of voltage the bulbs can handle. Remember that in a series circuit, the voltage of the source gets distributed to the loads. When you use identical bulbs, all bulbs will have the same voltage.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 day before	• Check bulbs, batteries, and wires. • Ensure that all bulbs are identical. If more than one type of bulb is available, then group identical bulbs together.
	• Photocopy any assessment masters you decide to use.

APPARATUS	MATERIALS
• voltmeter or multimeter • switch • 6 V bulb in holder • 5 wires with alligator clips • 3 – 1.5 V batteries in holders	

Suggested Timing

40 min

Safety Precautions

- Do not connect more than three batteries together.
- Remind students to clean up their work area, put away all equipment, and wash their hands at the end of this activity.

Activity Planning Notes

Ensure that all bulbs are identical. If more than one type of bulb is available, then group identical bulbs together. It is very important that bulbs have the same voltage rating and that each bulb's rating does not exceed the voltage of the source. Bulbs will burn out

if their rating is lower than the source. 6.0 V bulbs can have a maximum of 6.0 volts across them.

Check that students know which scale to use on their voltmeter or multimeter before beginning this activity. Demonstrate how the meter should be connected.

You may want to discuss anticipated effects of increasing the number of sources. Students should be able to predict from past experiences that increasing the number of batteries will increase the brightness.

Remind students that only three batteries can be used. Using more than three batteries would likely burn out the bulb (if 6.0 V is exceeded by the sum of the voltages of the batteries).

Accommodations

- Students can work in groups.
- You might provide a model circuit at your desk for students to check their work against.
- ESL and LD Learners could be paired with students who have stronger language skills.

What to Do Answer (page 125)

5. With one battery the voltage should be close to 1.5 V and the bulb will be dimly lit. With two batteries, the voltage should be close to 3.0 V and the bulb will be more brightly lit. With three batteries, the voltage should be close to 4.5 V and the bulb should be brightly lit.

What Did You Find Out? Answers (page 125)

6. The bulb becomes brighter as more sources are added in series.

7. The voltage across the bulb increases as more sources are added in series.

Activity Wrap-up

- Students can write a paragraph about why they think the bulbs got brighter. This will allow you to identify students who have a misconception regarding voltage as well as allow a discussion on safety with power sources and overloaded circuits.
- Students could complete **Assessment Master 11 Using Tools and Equipment Checklist**.

Alternative Activities

- Students could work in groups to model circuits using **BLM 7–1 Human Series Circuit**. After students complete the activity, you may wish to have them draw circuit diagrams for each series they modelled.
- Use some or all of the activities in the following Physics *ActiveFolders*: Electricity.

Technology Links

- Consider using the free OESS software Edison 4 and TINA Pro 6, which are available from your school's OESS representative. Go to **www.mcgrawhill.ca/books/Se9** and follow the links to Free Downloads. Both software packages include a teacher's guide and are consistent with expectations of the LDCC science course.
  - Using Edison Version 4, students can use digitally scanned photorealistic components, a solderless breadboard, virtual instruments, sound and animation to create, test, and safely repair lifelike 3-D circuits and simultaneously see the corresponding circuit schematic. Edison also comes with over 100 experiments and problems that teachers and students can use immediately.
  - Using TINA Pro (Toolkit for Interactive Electronic Network Analysis), students can design analogue, digital, and mixed circuits, and can measure the results using a number of simulated instruments, including an oscilloscope, function generator, and a digital multimeter. TINA also includes unique tools for testing students' knowledge, monitoring progress, and introducing troubleshooting techniques.

Ongoing Assessment

- Use **Assessment Master 2 Co-operative Group Work Rubric** to assess student work during Find Out: Adding Loads in a Series Circuit.
- Use **Assessment Master 12 Using Tools and Equipment Rubric** to assess student work during Find Out: Adding Sources in a Series Circuit.
- Have students write a paragraph explaining why the current decreases through loads in series and why voltage increases across a load when sources are added.

7.2 On Parallel Tracks (page 127)

SUGGESTED TIMING	MATERIALS	BLACKLINE MASTERS
30 min 45–60 min for Test It!	• coloured pencils • juice box and straws (optional)	BLM 6–2 Symbols for Circuits OHT B–9 Types of Circuits OHT B–10 Compare Circuits Assessment Master 3 Lab Report Checklist Assessment Master 4 Lab Report Rubric Assessment Master 7 Scientific Communication Checklist Assessment Master 8 Scientific Communication Rubric Assessment Master 13 Fair Test Checklist Assessment Master 14 Fair Test Rubric

Specific Expectations

PEC1.01 – use scientific terminology during investigations to describe basic electrical concepts and related units of measure
PEC1.04 – use a variety of symbols to represent different components in electrical circuits
PEC2.03 – conduct investigations, using electrical materials, tools and equipment safely
PEC2.04 – measure and record the current and potential difference in simple circuits through the safe and proper use of an ammeter and a voltmeter
PEC2.05 – extract and interpret information from instructions and manuals for circuits and electrical devices
SIL1.01 – describe how the procedures, skills, and tools employed in different areas of science are also evident in daily life
SIL2.04 – observe and record data, using a variety of formats, including the use of SI units, where appropriate
SIL2.05 – assess data to make inferences and conclusions and to answer questions and refine procedures

Key Terms Teaching Strategies

Add the new term to the word wall. Ask students what other meanings they know for "parallel" and how those meanings are different from the use of the word in "parallel circuit." From math, students may be familiar with parallel lines. Discuss how the sample parallel circuit is similar to parallel lines in that each load on the circuit has its own set of wires.

Reading Icon Answer (page 127)

3. One bulb will turn off.

Activity Planning Notes

You may wish to use the parallel circuit diagram on **OHT B–9 Types of Circuits** as you discuss page 127 to emphasize that there is more than one path for the current to flow through. Point out that the set of "roads" are one-way streets. Cars in the analogy cannot move back along their paths.

Students can draw the paths that the current can take using different coloured pencils directly on the graphic of page 127.

In parallel circuits, the loads are connected together side by side. Each load receives some current; thus if one bulb burns out, the others will stay lit. Adding more loads decreases the apparent resistance of the circuit. Identical bulbs should be equally bright in a parallel circuit.

You might use a juice box and straw analogy again. Increasing the number of straws (placed side by side into the juice box) will allow more juice to leave the container in a given time.

After completing the introduction to this section, have students do Test It! Current in a Parallel Circuit.

Then go on to Adding Loads in Parallel on page 130. You may wish to use **OHT B–10 Compare Circuits** for introducing and discussing the chart on page 131.

Note: The Science and Literacy Link on page 131, question 3 h) should read as follows:
"As more loads are added, current through the circuit *increases*." This was incorrect in the first printing and was corrected for all subsequent printings. If you are using the first printing, please instruct students to make this correction in their student resource before beginning this exercise.

Consider using the following blackline master and overhead transparencies in this section:

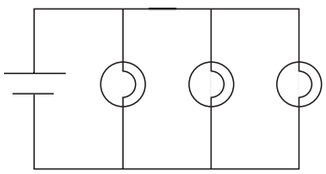
- **BLM 6–2 Symbols for Circuits**
- **OHT B–9 Types of Circuits**
- **OHT B–10 Compare Circuits**

Accommodations

- You may want to cut out large circuit symbols and wires from coloured paper and attach magnetic strips to them. These symbols could be used on the chalkboard for students who are visually impaired or who learn better visually. This will also reinforce that the circuit is made up of many parts, and that in this case the parts all follow one another. **BLM 6–2 Symbols for Circuits** may be useful for this purpose.
- ESL and LD Learners could be paired with students who have stronger language skills.

Check Your Understanding Answers (page 127)

4. a) Student drawing should look like the diagram shown here.



b) There are three complete pathways for electric current to follow in this circuit.

Check Your Understanding Answers (page 130)

1. a) increases

b) remains the same

2. No. Adding an extra source in parallel will not make the bulb burn more brightly because the voltage across each load remains the same. (To make the flashlight burn more brightly, add an extra source in series.)

Comparing Circuits Answers (page 131)

3. a) series

b) parallel

c) parallel

d) parallel

e) series

f) series

g) series

h) parallel (Point h) should read: "As more loads are added, current through the circuit *increases*.")

4. Student table should be similar to the one shown here. The objective is to place similar sentences side by side to facilitate comparison between series and parallel circuits.

Series Circuit	Parallel Circuit
Electric current has only one path to follow.	Electric current has more than one path to follow.
As more sources are added, voltage across each load increases.	As more sources are added, voltage across each load stays the same.
If the circuit is opened at one point, current stops flowing in the whole circuit.	If the circuit is opened at one point, current still flows through other parts of the circuit.
As more loads are added, current through the circuit decreases.	As more loads are added, current through the circuit increases.

Test It! Activity (page 128)

Current in a Parallel Circuit

Purpose

- Students design a procedure that answers their question. The question should relate to the effect of adding loads in a parallel circuit.

Science Background

As loads are added to the circuit, each individual bulb should glow as brightly as the other bulbs in the circuit. Since each path that the current can take has only one bulb where the energy conversion can take place, each bulb will have the same amount of energy given to it. Since each bulb has the same amount of energy, it will glow with the same brightness as the other bulbs (assuming identical bulbs).

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 day before	• Have students write their questions and steps. • Gather supplies. • Photocopy any assessment masters you decide to use.

APPARATUS	MATERIALS
• ammeter or multimeter • switch • 3 – 6 V bulbs in holder • 6 V battery in holder • 7 wires with alligator clips	

Suggested Timing

45–60 min

Safety Precautions

- Remind students to be careful not to "short" the circuit by connecting the ends of the battery to a wire.
- Do not connect more than one battery.
- Ensure that the ammeter is connected in series.
- Remind students to clean up their work area, put away all equipment, and wash their hands after this investigation.

Activity Planning Notes

The length of this activity may vary from class to class. You may want to review planning an investigation, the scientific process, and how to ask questions that will yield accurate answers. You may also want to review variables, electric safety, and designing tables. The basic set-up of this activity allows it to be tailored to the needs of your class.

Readings on your ammeter will range from 480 mA to 720 mA (for one 6.0 V battery and three 25 ohms bulbs).

Ensure that the ammeters are always connected in series and that students know which scale to use.

Accommodations

- Symbol cutouts such as those from **BLM 6–2 Symbols for Circuits** could be used so that students can plan out the activity and review each step before obtaining the real equipment. Students could then demonstrate their investigation to you before doing the lab.
- Students should work in pairs for this investigation.

Test It! Answers (pages 128–129)

1. Sample question:
What happens to current in a circuit when you add loads in parallel?

2. Materials list should include the following:
ammeter or multimeter
switch
3 (or more) 6 V bulbs in holders
6 V battery in holder
7 (or more) wires with alligator clips

4. Sample answer:
Step 1: Obtain all materials.
Step 2: Text: Assemble the circuit shown in the diagram. Close switch and measure current. Record current and brightness of bulb (bright/dim/dimmer). Circuit diagram: Simple series circuit diagram consisting of a battery, switch, bulb, and ammeter.
Step 3: Text: Connect a second bulb in parallel, close switch, measure current, and record brightness of bulbs. Circuit diagram: one bulb added in parallel to circuit of step 2.
Step 4: Text: Connect a third bulb in parallel, close switch, measure current, and record brightness of bulbs. Circuit diagram: One bulb added in parallel to circuit of step 3.

5. Answers will vary. Students may answer that they have followed all safety procedures (checked equipment, removed jewellery, worked in a clean area, connected loads in order, faced all batteries the same way, and kept switches off), did not short out the battery, and did not attempt any unauthorized investigations. They might also answer that they did not fool around or disturb others, and that they stayed focussed on their tasks.

7. Student data table should look like the following.

Circuit	Current	Observations of Bulb Brightness
Circuit with one bulb		
Circuit with two bulbs in parallel	Current should increase as more bulbs are added in parallel.	Bulbs should be equally bright in all circuits.
Circuit with three bulbs in parallel	Current should increase as more bulbs are added in parallel.	Bulbs should be equally bright in all circuits.

8. Students should conclude that current in a circuit increases as loads are added in parallel.

9. Factors that stay the same are the source, the conductors, and the type of bulb used.

10. The only factor to change during the test is the number of bulbs in the circuit.

11. Students should be able to explain whether or not their test was fair. For example:
It was a fair test because it measured the effect of a change in a single factor.

Activity Wrap-up

- This is an excellent opportunity to emphasize the scientific method, planning, and communication of results. You may want to have students review Scientific Method on page 7 of the student resource as part of the discussion.
- Students can complete **Assessment Master 13 Fair Test Checklist**.
- Students can write a paragraph describing how they used the scientific method in this activity. You may wish to review the scientific processes described on page 7 and have students use some of those terms in their paragraphs. Students could complete **Assessment Master 7 Scientific Communication Checklist** while they write their paragraphs.

Ongoing Assessment

- Consider using the following assessment masters to assess students in the Test It! investigation.
  - Use **Assessment Master 8 Scientific Communication Rubric** to help assess students' paragraphs.
  - Use **Assessment Master 14 Fair Test Rubric** to assess students' understanding of fair tests.

Technology Links

- Consider using the free OESS software Edison 4 and TINA Pro 6. Go to **www.mcgrawhill.ca/books/Se9** and follow the links to Free Downloads.
- For on-line tutorials on series and parallel circuits, go to **www.mcgrawhill.ca/books/Se9** and follow the links to Electric Circuits Tutorials.

Alternative Activities

- Students could plan an imaginary investigation similar to the one demonstrated in the graphic at the top of page 130. They could write up the steps of the investigation following **Assessment Master 3 Lab Report Checklist**. You can assess their plans using **Assessment Master 4 Lab Report Rubric**.
- Use some or all of the activities in the following Physics *ActiveFolders*: Electricity.

7.3 Combination Circuits (page 132)

SUGGESTED TIMING

25 min
40 min for What's Going On?
60–90 min for Test It!

MATERIALS

- battery
- 3 identical bulbs
- 3 switches
- 8 wires

BLACKLINE MASTERS

BLM 6–2 Symbols for Circuits
BLM 7–2 Circuit Exchange
BLM 7–3 Circuits Performer
BLM 7–4 Parallel Circuit
OHT B–11 Combination Circuit
Assessment Master 1 Co-operative Group Work Checklist
Assessment Master 2 Co-operative Group Work Rubric
Assessment Master 3 Lab Report Checklist
Assessment Master 4 Lab Report Rubric
Assessment Master 7 Scientific Communication Checklist
Assessment Master 8 Scientific Communication Rubric
Assessment Master 11 Using Tools and Equipment Checklist
Assessment Master 12 Using Tools and Equipment Rubric

Specific Expectations

PEC1.01 – use scientific terminology during investigations to describe basic electrical concepts and related units of measure
PEC1.02 – demonstrate an understanding that electrical energy can be converted into other forms of usable energy within electrical circuits
PEC1.03 – identify how household and workplace electrical devices operate by converting energy to another form
PEC1.04 – use a variety of symbols to represent different components in electrical circuits
PEC2.01 – formulate scientific questions about circuits and create a simple plan to carry out an investigation, including safety procedures
PEC2.02 – design, build, and test an electrical circuit to investigate the chosen question, using appropriate safety procedures
PEC2.03 – conduct investigations, using electrical materials, tools, and equipment safely
PEC2.04 – measure and record the current and potential difference in simple circuits through the safe and proper use of an ammeter and a voltmeter
PEC2.05 – extract and interpret information from instructions and manuals for circuits and electrical devices
PEC2.06 – communicate plans and results of investigations about electrical circuits, using a variety of oral, written, and graphic formats
SIL2.05 – assess data to make inferences and conclusions and to answer questions and refine procedures
SIL3.03 – demonstrate an understanding of how problem-solving and decision-making activities in the workplace use scientific process skills

Key Terms Teaching Strategies

Add the new term to the word wall. Students may have used a combination lock and have eaten a fast-food "combo" (short form of "combination"). Use these experiences to get across the idea that a combination means that two or more things are brought together. Have students predict the meaning of "combination circuit."

Reading Icon Answers (page 132)

1. Switch 3
2. Switch 2
3. Switch 1
4. Bulb 3
5. Bulb 2 goes out and Bulb 3 stays lit.
6. Bulbs 1 and 2 stay lit.
7. You could connect an ammeter anywhere before the switch or immediately after the switch but before the branch. An ammeter can also be connected after the current has exited the two branches before reaching the battery.

Accommodations

- ESL and LD Learners could be paired with students who have stronger language skills.
- Visually impaired students may require preferred seating close to the demonstration area.
- For students who need extra practice, use **OHT B–13 Circuit Diagram**, ask the following questions, and discuss each answer:
  - What will happen when both switches are closed? (All bulbs will light up.)
  - What will happen when Switch 1 is closed and Switch 2 is open? (Only Bulb 2 and Bulb 3 will light.)
  - What will happen when Switch 1 is open and Switch 2 is closed? (No bulbs will light.)
  - What will happen if both switches are closed and Bulb 3 is burned out? (Only Bulb 1 will light.)

Activity Planning Notes

Use an interactive lecture demonstration such as the following to approach this section:

- First build the circuit shown on page 132 and go through a checklist with the class to see that all components work. (Is the circuit complete? Is the switch closed? Are all the wires properly connected?).
- Next discuss and take up the questions on page 132 one by one. Each student must make a prediction and commit to an answer by writing it down.
- Students can share their answer with a partner. If answers differ, they can try to convince each other that one solution is better than the other.
- After a minute of discussion between partners, provide the answer using your circuit to demonstrate. Then explain or have students explain why the answer is correct.
- Go on to the next question.

After completing the introduction to this section, students can do the What's Going On? activity and the Test It! investigation.

Consider using the following overhead transparency:

- **OHT B–11 Combination Circuit**

What's Going On? Activity (page 133)

Circuit Exchange

Purpose

- Students practise their questioning skills and discover advantages and disadvantages of combination circuits.

Science Background

The brightness of the bulbs will vary in this activity (as seen if you build and demonstrate the circuit shown on page 132). Identical bulbs in the same branch will have equal brightness, while other branches with other bulbs (or a different number of bulbs) may have a different brightness. The brightest bulb will be the single bulb in a branch since it has the greatest potential difference across it. Switches near the battery will disconnect the entire circuit while switches in a branch will disconnect that branch.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
1 day before	• Photocopy **BLM 7–2 Circuit Exchange** and **Assessment Master 8 Scientific Communication Rubric**.

Suggested Timing

40 min

Activity Planning Notes

You can use **BLM 7–2 Circuit Exchange** or make your own circuit diagrams. Keep the circuit diagrams as simple as possible. Varying the location of the switch is an easy way to differentiate circuits. Three or four bulbs should be sufficient for students to demonstrate the expectations.

Accommodations

- ESL and LD Learners could be paired with students who have stronger language skills.

What Did You Find Out? Answers (page 133)

5. Answers may include the following:
- Series circuits enable more than one device to be controlled by the same switch.
- Series circuits enable a single device to be controlled by more than one switch.
- Connecting sources in series provides a way to increase voltage across loads in a circuit.

6. Answers may include the following:
- Parallel circuits let devices work independently of one another.
- Parallel circuits let more than one device work from the same source.
- Connecting sources in parallel provides a way to make battery-operated devices last longer.

Activity Wrap-up

- This section lends itself to consolidating the knowledge gained so far regarding series and parallel circuits. Use the answers to questions 5 and 6 as launching points for a discussion about the advantages and disadvantages of parallel and series circuits.
- Students could complete **Assessment Master 7 Scientific Communication Checklist**.

Alternative Activity

- You may wish to have students build their circuits to verify their answers. If so, be sure to first review all the safety precautions for working with circuits. The amount of equipment available will dictate the number of bulbs in the circuits. As long as the bulb holders do not have an internal fault, the results should come out as planned. Many bulb holders develop shorts over years of student use and may need checking. Students will ask questions regarding the brightness of the bulbs or what would happen if a certain bulb were taken out or unscrewed.

Test It! Activity (page 134)

Become a Circuits Performer!

Purpose

- Students build a circuit to accomplish a specific task.

Science Background

A sample diagram is provided below as an answer to question 6 in the What to Do section.

The physics teacher at your school may have a supply of buzzers and be able to tell you the voltage required for the circuits to work adequately with them.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
2 days before	• Obtain equipment.
1 day before	• If using, photocopy **BLM 7–3 Circuits Performer** and any assessment masters you decide to use.

APPARATUS	MATERIALS
• batteries • bulbs • buzzers • switches • wires	

Suggested Timing

60–90 min

Safety Precautions

- Remind students of the safety precautions for working with circuits (check all equipment, remove jewellery, work in a clean area, connect loads in order, face all batteries the same way, keep switches off).
- Students should not close any circuits until you have checked them.
- Remind students to clean up their work area, put away all equipment and wash their hands after this investigation.

Activity Planning Notes

The goal is for students to apply the knowledge gained from previous activities and build a circuit that will meet strict criteria. Some students will want to immediately start building a circuit and test it as they go along. Remind students that they can begin building their circuits only after you have approved their plan.

It is crucial for the students to make predictions using circuit diagrams. It may happen that the circuit diagram that they verbally describe to you will be different than the one drawn. A good approach would be for students to appoint a member of their group to describe the circuit (i.e., what each component will do) on the circuit diagram.

This is the first time that students have used buzzers, so a fair amount of "enthusiasm" is possible. Show students the circuit symbol for buzzers before they draw the circuits.

You may want to have the students use **BLM 7–3 Circuits Performer** so they can provide extended responses to questions 15, 16, and 17.

Remind the students of your expectations on group work since this will be part of the activity. Students can complete **Assessment Master 1 Co-operative Group Work Checklist** as they work.

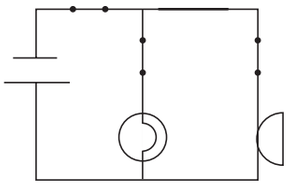
Students could complete **Assessment Master 11 Using Tools and Equipment Checklist** as they work.

Accommodations

- Some students could use the circuit symbols from **BLM 6–2 Symbols for Circuits** to design their circuits, and once approved by you, they can glue the symbols in place and then set up their circuits using the diagram. They can make buzzer symbols to add to the diagram.
- ESL and LD Learners could be paired with students who have stronger language skills.

Test It! Answers (pages 134–135)

6. One potential circuit arrangement is the following:



7. Sample material list: source, buzzer, bulb, three switches

12. Answers will vary.

13. Answers will vary. Students should be able to explain their observations with reference to the properties of series and parallel circuits.

14. Answers will vary. Similarities among successful circuits include the following: bulb and buzzer are connected in parallel; bulb is connected in series with one switch; buzzer is connected in series with another switch; a third switch is located between the source and both branches of the parallel circuit. Differences among circuits will include the specific arrangement of circuit components. For example, the switch controlling the bulb may be located on either side of the bulb; the switch controlling the buzzer may be located on either side of the buzzer; the switch controlling both bulb and buzzer may be located on either side of the source.

15. Answers will vary. Answers should relate the student's observations to the properties of series and parallel circuits.

16. Answers will vary. Students might benefit from discussing this question with group members.

17. Student answers will vary. Students might benefit from discussing this question with group members.

Activity Wrap-up

- This is an excellent time to emphasize the scientific method, planning, and communication of results. Have students complete **Assessment Master 3 Lab Report Checklist**.
- Group work is an essential part of a scientist's daily life. Some emphasis should be made with the class as to how questions 15, 16, and 17 relate to science outside of school.

Alternative Activity

- Students could follow the directions on **BLM 7–4 Parallel Circuit** to perform an alternative investigation. Note that Diagram 3 on the blackline master shows a voltmeter connected across one bulb. Students are to connect the voltmeter across each bulb in succession.

Ongoing Assessment

- Use **Assessment Master 8 Scientific Communication Rubric** to assess students' scientific communication skills during the What's Going On? activity.
- Consider using the following assessment masters to assess students' work during the Test It! investigation.
  - Use **Assessment Master 2 Co-operative Group Work Rubric** and/or **Assessment Master 12 Using Tools and Equipment Rubric** to assess students' lab work.
  - Students can write a paragraph describing how the scientific method was applied in this investigation. Use **Assessment Master 4 Lab Report Rubric** to assess their paragraphs.

Technology Links

- Consider using the free OESS software Edison 4 and TINA Pro 6. Go to **www.mcgrawhill.ca/books/Se9** and follow the links to Free Downloads.
- For more information on building circuits, go to **www.mcgrawhill.ca/books/Se9** and follow the links to Circuit Building Resources.

Chapter 7 Review (page 136)

SUGGESTED TIMING

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

BLACKLINE MASTERS

Master 3 Certificate
Master 4 List of Skills
BLM 7–5 Label the Circuit Diagrams
BLM 7–6 Chapter 7 Practice Test
BLM 7–7 Chapter 7 Test
OHT B–12 Name the Circuit
OHT B–13 Circuit Diagram

Accommodations

- In advance, prepare an index card that lists the key terms for the unit. Provide the card to students who struggle with vocabulary and spelling during review activities.
- 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.
- **BLM 7–6 Chapter 7 Practice Test** can be customized to produce extra reinforcement questions.

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.

Consider using the following overhead transparencies:
- **OHT B–12 Name the Circuit**
- **OHT B–13 Circuit Diagram**

To provide additional reinforcement of key terms, have students complete **BLM 7–5 Label the Circuit Diagrams**. Once the review is completed and taken up, assign **BLM 7–6 Chapter 7 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 a)	7.2	On Parallel Tracks (page 127)
1 b)	7.1	Current and Voltage in a Series Circuit (page 126)
1 c)	7.2	On Parallel Tracks (page 127)
1 d)	7.1	Series Circuits: The Only Way to Go (page 123)
2 a)	7.3	Combination Circuits (page 132)
2 b)	7.1	Series Circuits: The Only Way to Go (page 123)
2 c)	7.2	On Parallel Tracks (page 127)
3	7.2	On Parallel Tracks (page 127)
4	7.1, 7.2	Series Circuits: The Only Way to Go (page 123), On Parallel Tracks (page 127)
5	7.3	Combination Circuits (page 132)
6	7.3	Combination Circuits (page 132)
7	7.3	Combination Circuits (page 132)
8	7.3	Combination Circuits (page 132)
9	7.3	Combination Circuits (page 132)

Chapter 7 Review Answers (pages 136–137)

1. a) F. Current has more than one path to follow in a parallel circuit. Or, Current has only one path to follow in a series circuit.

b) F. Current decreases as you add loads in series. Or, Current increases as you add loads in parallel.

c) T

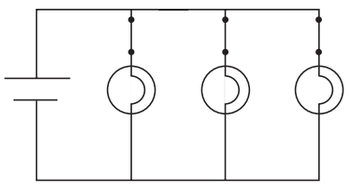
d) T

2. a) combination circuit

b) series circuit

c) parallel circuit

3.



4. Unscrew one bulb. If the lights are wired in series, all lights will go off when one bulb is unscrewed. If the lights are wired in parallel, the remaining lights will continue to burn.

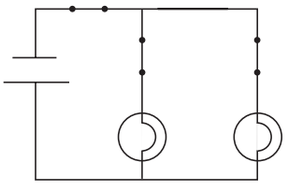
5. All bulbs will be lit.

6. Only Bulb 2 and Bulb 3 will be lit.

7. No bulbs will be lit.

8. Only Bulb 1 will be lit.

9.



Summative Assessment

- Have students complete **BLM 7–7 Chapter 7 Test** to assess individual skills.
- You may wish to develop **Master 3 Certificate** to show students what they have learned during this chapter. Cut and paste the related skills from **Master 4 List of Skills**.