

Light Energy
A 40 session unit
Seeds of Science/Roots of Reading Program
Grades 3-4

Seeds of Science/Roots of Reading units provide rich and varied opportunities for students to inquire about important topics in science as they **investigate** through firsthand inquiry, **read** content-rich science books, **talk** with others about their investigations, and **write** to record and reflect on their learning. Students learn important strategies to comprehend science texts and gather information to support their inquiry by reading. As they read and investigate, they develop flexible knowledge of new vocabulary and learn to communicate using the language of science, a significant academic discourse.

The *Light Energy* integrated science-literacy unit immerses students in learning about the **characteristics of light, the multiple ways light interacts with different materials, light as energy**, and other key physical science concepts. The unit has four investigations—each with 10 sessions, in which students engage in the inquiry processes of making predictions, recording and analyzing data, making explanations from evidence, evaluating claims and evidence, and summarizing. Nine student books engage students in reading and talking about these important science concepts and skills. About half of the sessions in the unit have a literacy focus. As students read the books, they learn reading comprehension strategies such as making predictions and summarizing. Students also learn to use a variety of nonfiction text features to locate information and understand important ideas. Students write scientific explanations and summaries of written text, and learn to use and interpret data tables. Throughout the unit, students are provided with opportunities for oral discourse and discussions focusing on the nature and practices of science.

The *Light Energy* Kit includes:

- 18 copies each of 9 books, for a total of 162 student books
- Student Investigation Notebooks for each student
- Materials and equipment for leading the unit with 32 students
- The *Light Energy* Teacher's Guide

The *Light Energy* Teacher's Guide includes:

- Detailed lesson plans for enacting four inquiry-based science investigations comprised of 10 sessions each
- Science and literacy assessments and scoring rubrics
- Instructional scaffolds and accommodations for English Language Learners
- Background information pertaining to the science content introduced in the unit

Learning Goals in the *Light Energy* unit

Science Goals

Science Knowledge

- Characteristics of light
- Light interactions
- Light as energy

Science Inquiry

- Making predictions
- Summarizing
- Making explanations from evidence
- Recording and analyzing data
- Evaluating Claims and Evidence

Nature and Practices of Science

- Understanding that science knowledge is based on evidence
- Recognizing that the scientific community seeks to improve explanations
- Understanding how scientists engage in the practices of science

Literacy Goals

Reading

- Making predictions
- Summarizing
- Understanding and Using Tables
- Using nonfiction text features

Writing

- Writing Scientific Explanations
- Writing Summaries
- Using Scientific Language and Vocabulary

Listening/Speaking

- Participating in Scientific Discourse
- Making Explanations from Evidence
- Using Scientific Language and Vocabulary

<p><u><i>Light Energy Science Books</i></u> <i>Cameras, Eyes, and Glasses</i> <i>Can You See in the Dark?</i> <i>Handbook of Light Interactions</i> <i>I See What You Mean</i> <i>It's All Energy</i> <i>Light Strikes!</i> <i>Sunlight</i> <i>and Showers</i> <i>The Speed of Light</i> <i>Why Do Scientists Disagree?</i></p>	
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Teaching Support and Considerations

Science Notes

About Light and Dark. Light is energy we can see. In fact, the reason we can see things is because light energy travels to our eyes. Total darkness is the absence of all light. Dark nights, dark bedrooms, and dark movie theaters are situations with very little light, but they are not completely dark. It's actually very difficult to find a place that is completely dark. When your eyes begin to adjust to a place that seems very dark, you start to see dark shapes because of the small amount of light that is present.

About How Light Travels. Light always comes from a source that produces light energy. A lightbulb, a flame, a star, red-hot lava, a laser, and a firefly are all sources of light. Each of these sources emits light energy. One of the properties of light is that it always travels in a straight line, no matter what the source is. The substance through which light travels does not affect this property—so whether light is traveling through empty space, air, water, glass, or clear plastic, it still travels in straight lines.

Literacy Notes

Language of Science. One goal of the *Seeds of Science/Roots of Reading®* program is to develop students' ability to use academic language. On every right-hand page of this guide, you will find lists of science vocabulary as well as language constructions that are useful throughout the unit. They are divided into three categories:

- **Unit-specific Vocabulary.** These words are specific to the content of this unit. They represent the key academic words related to the unit's main ideas.
- **Science Inquiry Vocabulary.** These words are essential for doing, talking, writing, and thinking about science inquiry. Many of them are also generalizable to other subject areas.
- **Language of Argumentation.** These are phrases that you and your students can use when writing and talking about science. They are part of the academic language of science and are meant to help students engage in scientific discourse.

All of these words and phrases are part of the language of science and should be heard in the classroom repeatedly—spoken by teachers and students alike. The vocabulary words that relate most directly to each session are in boldface type. This is to help remind you to use these words often as you talk to students, and to encourage students to use the words in their oral discourse and writing.

LANGUAGE OF SCIENCE

Unit-specific Vocabulary
absorb
block
characteristic
emit
energy
interact/interaction
lens
light
material
ray
reflect
refract
shadow
source
transform/transformation
transmit
travel

Science Inquiry Vocabulary
analyze
claim
data
diagram
evidence
explanation
investigate/investigation
observe/observation
predict/prediction
record
scientific community

Language of Argumentation
What do you think?
What is your claim?
Why do you think that?
What is your evidence?
My claim is...
My evidence is...
I agree because...
I disagree because...

Can You See in the Dark?

READING

INVESTIGATION 1

Characteristics of Light

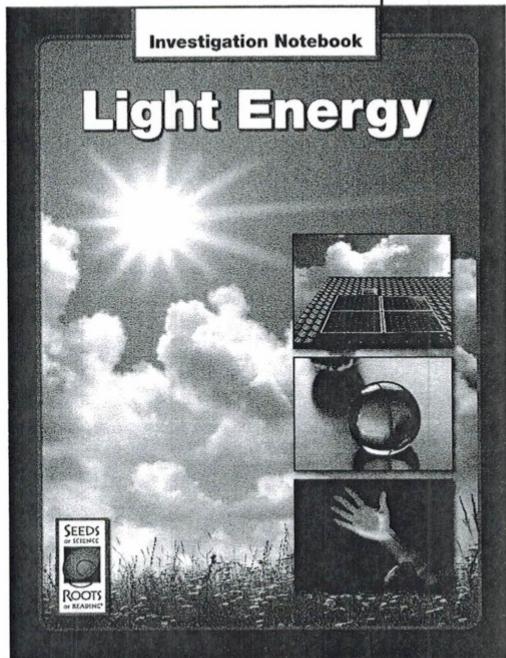


Figure 1–1. Students use the Investigation Notebook to guide and support their learning throughout the unit.

Introducing the Unit

1. Invite students to wonder about light. Ask students to raise their hands if they have ever wondered:

- What is light?
- Where does light come from?
- How do people see?
- Why do things warm up in the sunlight?

Tell the students they are beginning a unit on the study of light. As they learn about light, these questions and others they may wonder about will be answered.

2. Invite students to be scientists. Tell the students they will become classroom scientists. Hold up an Investigation Notebook (Figure 1–1) and say, “Scientists often use notebooks to record their observations and write down their ideas. You will do the same with these Investigation Notebooks.” Let the students know they will be using this notebook throughout the unit. In addition to recording their observations, they will investigate, read, write, and talk about light in the same ways scientists do.

3. Activate prior knowledge. Direct the students’ attention to the What We Know and Wonder About Light anticipatory chart you prepared before class. Have them think about what they already know. Model this by sharing your own “what I know” statement. Say, “I know that it’s light during the day and dark at night.” Record this statement in the “What we think we know about light” column of the chart. Invite students to add additional statements. Record these statements on the chart.

4. Encourage students to share ideas. Explain that it’s okay for students to share any ideas they have, even if they’re not sure they’re correct. Record all students’ ideas, whether or not they are correct. Tell students that the anticipatory chart will be revisited throughout the unit and ideas will be revised using new information students collect.

Teaching Support and Considerations

Instructional Rationale

Value of Investigation Notebooks. This unit uses a large number of student sheets to guide instruction. Teachers who used an Investigation Notebook rather than distributing individual student sheets reported:

- Students were more motivated to do careful work.
- Students referred back to their work more often.
- Teacher preparation time before each session was significantly reduced.
- Paper management in the classroom was simplified.
- Student work was simpler to monitor and assess.

It's expensive to purchase individual notebooks for students or duplicate a class set using the master notebook supplied in the kit; however, we strongly recommend that you find a way to provide your students with notebooks.

Instructional Routine

Anticipatory Chart. An anticipatory chart guides students to think about what they already know about a topic before beginning investigations. The What We Know and Wonder About Light chart will be revisited several times in the unit, so keep it handy. As the unit progresses, it is likely that students will have many questions that can be added to the chart. Revisiting the chart helps students connect what they learn to what they already knew. To read more about this routine and others that serve similar purposes, please see Instructional Routines in the Teacher Resources section.



Assessment

About Quick Checks for Understanding. Throughout the teacher's guide, we will point out strategic opportunities for teachers to take notice of students' progress with important skills and understandings. Quick Checks do not require the use of a scoring guide or even a detailed examination of all student work. They are meant to be used informally to help guide the instruction of the unit.

Quick Check for Understanding: Anticipatory Chart About Light. The What We Know and Wonder About Light anticipatory chart can provide insight into students' preexisting ideas and may reveal misconceptions. This can help you decide on the emphasis for leading the discussion after reading. You may want to refer to the Characteristics of Light Scoring Guide (in the Assessment section), which is not required to score this assessment, but may be informative in thinking about students' progress toward the Characteristics of Light unit goal. For information regarding misconceptions about light, refer to the Science Content Background in the Unit Overview section of this teacher's guide.

LANGUAGE OF SCIENCE

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Science Inquiry Vocabulary

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Language of Argumentation

What do you think?
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Why do you think that?
What is your evidence?
My claim is...
My evidence is...
I agree because...
I disagree because...

INVESTIGATION 1

Characteristics of Light

- 5. Record student questions.** Have students share questions they have about light. Model by posing your own question. Say, “I have always wondered, ‘Why is it hard to see in a dark room?’” Record this question on the chart in the “What we wonder about light” column. Invite students to contribute their own questions and record these questions on the chart (Figure 1–2).

What We Know and Wonder About Light	
What we think we know about light	What we wonder about light
It's light during the day and dark during the night. Light comes from the Sun. Light can make things brighter.	Why is it hard to see in a dark room? Where does light come from? What is light?

Figure 1–2.

- 6. Introduce guiding question.** Tell the class you will pose questions throughout the unit to help guide their investigations. Encourage the students to keep these questions in mind as they read, write, and discuss ideas. Post the guiding question you prepared before class on the board and read it aloud.

What are the characteristics of light?

- 7. Define *characteristic*.** Tell students that, in science, a *characteristic* is what something is like. For example, a characteristic of candy is that it is sweet. Explain that the question you posted means the same as, “What is light like?” Let the students know they will be doing activities in class that will help them answer this question.

Teaching Support and Considerations

Instructional Rationale

The Role of Guiding Questions. Posting guiding questions on the wall throughout the unit is a valuable way to focus students' attention on the most important content of the sessions. Guiding questions act as reminders to students of their goals for learning and help them relate specific experiences to broader concepts. Introducing guiding questions before a session prepares students for a lesson and activates prior knowledge. Reviewing guiding questions after a lesson helps students summarize and synthesize what they have learned during the lesson and relates specific experiences to broad learning goals. Students' ability to answer guiding questions more and more completely as they progress through the unit can be a rewarding experience. Incorporating the guiding questions into the concept wall (see below) will help students relate ideas in the unit to the guiding questions.

Why Create a Concept Wall? There are many benefits to posting key concepts and guiding questions—along with related drawings and artifacts—on the wall throughout the unit. A concept wall creates a bank of concepts that students can refer to and represents how these concepts relate to one another. Watching the accumulation of knowledge on the wall is powerful for students and underscores the importance of what's being learned. A concept wall contributes to creating a language-rich environment, "wallpapering" the classroom with the ideas and language of science. We suggest that you organize the concept wall by using the guiding questions as headings and posting evidence that helps answer those questions beneath them. Some of this evidence will be the key concepts that summarize class learnings; other evidence will be drawings and artifacts from student activities. Creating a concept wall takes time and extra space in your classroom, but many teacher find it's well worth the effort.

Instructional Suggestions

What Several Teachers Did: Finding Space. While dedicating a large bulletin board or portion of the classroom wall to the concept wall is ideal, this isn't always possible. One teacher began posting the key concepts in the small strip of wall space between the top of the whiteboard and the ceiling. When this was full, she kept moving around the room, posting the key concepts in this unused space just below the ceiling at the top of cabinets, bulletin boards, and so on. Another teacher built the concept wall in the hallway. Keeping the wall current with the growing number of key concepts and illustrations became a rotating classroom responsibility. Yet another teacher built the concept wall on the back of a rolling whiteboard.

LANGUAGE OF SCIENCE

Unit-specific Vocabulary

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Science Inquiry Vocabulary

analyze
claim
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investigate/investigation
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record
scientific community

Language of Argumentation

What do you think?
What is your claim?

Why do you think that?
What is your evidence?

My claim is...
My evidence is...

I agree because...
I disagree because...

INVESTIGATION 1
Characteristics of Light

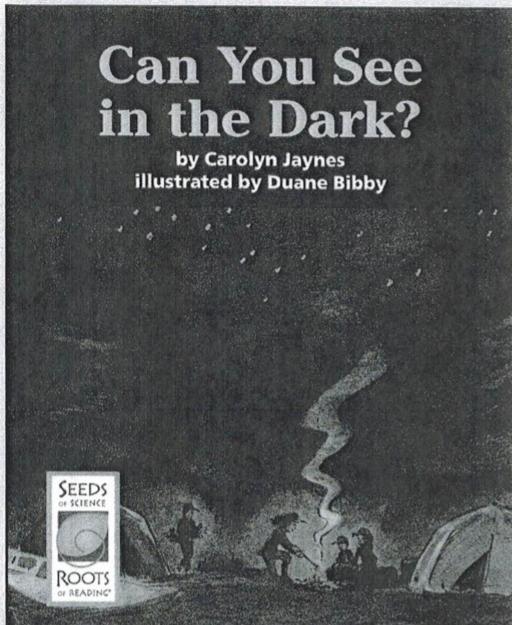
- 8. Introduce posing questions and searching for answers.** Explain that part of learning is asking questions and searching for answers to those questions. During this unit, the class will ask and answer questions about light.

Before Reading

- 1. Introduce making predictions.** Say, “A prediction is a thoughtful guess about what will happen or what you’ll learn. Predictions are based on what you already know. Predictions are not ‘right’ or ‘wrong,’ but when you make a prediction, you should be able to explain how you came up with it. You should use what you already know as well as information and illustrations found in the text.”
- 2. Introduce the book.** Show the cover of *Can You See in the Dark?* Read the title and the names of the author and illustrator. Let the students know they will make predictions about light using the cover of the book.
- 3. Make predictions.** Guide student volunteers to make predictions using the book’s cover. Read the title aloud. Ask, “Based on this title, what might be an important idea in the book?” Follow up by asking, “What clues made you think so?” Show the cover illustration. Ask, “What might be another important idea in the book?” Follow up by asking, “What clues made you think so?”
- 4. Introduce revisiting predictions.** Explain to students that predictions are a useful way to anticipate what a text might be about. However, predictions should be confirmed and revised as new information is gathered. Let students know that they will make and discuss predictions with their partners as they read.

Teaching Support and Considerations

About the Book



Overview. *Can You See in the Dark?* invites students to wonder about whether or not people need light to see. The book details a search for a completely dark place, following the narrator from a movie theater to a dark campsite to a closet and finally into a cave where there truly is no light at all. This book introduces the idea that all light comes from a source. It enables students to identify many different sources of light in the text and illustrations. *Can You See in the Dark?* provides an introduction to the *Light Energy* unit and poses a question that students will return to many times as they learn more about how people see.

Literacy Notes

About Making Predictions. Research on skillful readers indicates that they use a variety of strategies to actively engage with text. The comprehension strategy, making predictions, is made up of several components: (1) activating prior knowledge; (2) previewing a text or topic; (3) making an informed guess; and (4) reading to confirm or revise. Encourage students to make predictions both before and during reading. When introducing this strategy, demonstrate how you make predictions by thinking aloud. Students practicing this strategy will monitor their comprehension and connect background knowledge to information presented in the text.



Assessment

Quick Check for Understanding: Making Predictions. *Can You See in the Dark?* is the students' first encounter with reading in the *Light Energy* unit. Listening to students read during this session will help you determine how familiar they are with the reading comprehension strategy and unit goal of Making Predictions. This unit emphasizes making predictions based on available information in the text, as well as revising predictions during reading as new information becomes available. Pay special attention to the type of evidence (text or illustration) students use to explain their predictions.

LANGUAGE OF SCIENCE

Unit-specific Vocabulary

- absorb
- block
- characteristic**
- emit
- energy
- interact/interaction
- lens
- light**
- material
- ray
- reflect
- refract
- shadow
- source**
- transform/transformation
- transmit
- travel

Science Inquiry Vocabulary

- analyze
- claim
- data
- diagram
- evidence
- explanation
- investigate/investigation
- observe/observation**
- predict/prediction**
- record**
- scientific community

Language of Argumentation

What do you think?
What is your claim?

Why do you think that?
What is your evidence?

My claim is...
My evidence is...

I agree because...
I disagree because...

Can You See in the Dark?

READING

Investigation Notebook, p. 2
(optional)

Getting Ready to Read

Can You See in the Dark?

Before reading the book, *Can You See in the Dark?* read the sentences below. If you Agree with the sentence, write an "A" in front of it. If you Disagree with the sentence, write a "D" in front of it. Then read the book. After you read, come back to this page and see if your ideas have changed. Be ready to explain your thinking.

- Light floats around.
- There is no light in a movie theater.
- A cave is completely dark, with no light at all.
- People need light to see.
- Light comes from a source.*

After Reading

*Write what you learned about this statement from reading the book.

INVESTIGATION 1

Characteristics of Light

During Reading

- 1. Read book in pairs.** Distribute one book to each pair of students. Have them read pages 3–5.
- 2. Make predictions.** Call on a student to make a prediction. Ask questions such as “Is there light in the theater at all? What makes you think so?” Prompt students to provide evidence from the text or illustrations to support their predictions. If students have trouble, model how to support a prediction with evidence from an illustration or the text.
- 3. Continue reading pages 6–10.** Prompt the students to make more predictions. You may want to pose additional questions. After page 8, “Will it be completely dark in the parking lot?” “What makes you think so?” After page 10, “What sources of light can be found out in the woods?”
- 4. Distribute sticky notes to pairs of students.** As the students read the rest of the book, encourage them to make predictions. Have them place a sticky note to mark a place in the text where they made a prediction. Tell them they will discuss the predictions they made after they finish reading.
- 5. Early Finishers.** If students finish early during partner reading, have them return to Getting Ready to Read on page 2 of the Investigation Notebook (if you had them use this optional activity before reading) or have them turn to page 3 and complete the optional Reading Reflections page. Note: For more information about Reading Reflections, see page 25 of this teacher’s guide.

Guidelines for Partner Reading

1. Sit next to your partner and put the book between you.
2. Take turns reading.
3. Read in a quiet voice.
4. Be respectful and polite to your partner.
5. Ask your partner for help if you need it. Work together to make sure you both understand what you have read.

Figure 1–3. Consider posting this optional set of guidelines if your students need practice in partner reading.

Teaching Support and Considerations

Literacy Notes

Suggested Approach to Reading. Throughout this unit, we suggest that students read the books in pairs. Partner reading allows students time to apply and practice the reading strategies they are learning, keeps them focused on the task at hand, and provides opportunities for them to assist each other with reading. Of course, you may use any effective grouping strategy or reading routine that is already implemented in your class as long as students are reading the books themselves. Additionally, it's valuable to have students read the books more than once. Repeated reading helps build fluency, gives students additional practice with new vocabulary and concepts, and is a good opportunity to practice reading strategies.

Instructional Suggestions

About Partner Reading. Setting clear expectations for partner work takes some time at the beginning of the unit, but will pay off in terms of student learning and management of the reading sessions. You may provide direct instruction on reading with a partner by posting and reviewing Guidelines for Partner Reading (Figure 1-3). One effective way to reinforce the guidelines is to break the task down and focus on one guideline at a time. Take a moment after each partner reading session to reflect on how things went, highlighting the particular focus for that session. Over time, students will gain practice working together and will need fewer reminders about reading together effectively.

Providing More Experience

Prepare: Getting Ready to Read. For each book in the unit, we provide an optional anticipation guide in the Investigation Notebook called Getting Ready to Read. An anticipation guide activates students' prior knowledge in preparation for reading, promotes active reading, and encourages students to monitor their understanding. Anticipation guides are helpful for all students, but are especially recommended for English learners. To use the optional anticipation guide, have students turn to page 2 in their Investigation Notebooks, Getting Ready to Read: *Can You See in the Dark?* Explain that students should work with a partner to decide if they agree or disagree with each statement. Have them write, in front of each statement, an "A" if they agree or a "D" if they disagree. After reading, ask partners to revisit the statements and discuss whether they want to change any of their responses based on what they read. Encourage students to use evidence from the text in their discussions. After reading, you can also ask students to write what they learned about the last statement on the anticipation guide and encourage them to refer to the book for evidence to support their responses. For additional suggestions that may be helpful in reading this and other books in the unit, please see English Language Learner (ELL) Considerations in the Teacher Resources section.

LANGUAGE OF SCIENCE

Unit-specific Vocabulary

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transform/transformation
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Science Inquiry Vocabulary

analyze
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Language of Argumentation

What do you think?
What is your claim?

Why do you think that?
What is your evidence?

My claim is...
My evidence is...

I agree because...
I disagree because...

Can You See in the Dark?

READING

Investigation Notebook, p. 3
(optional) with sample response

Reading Reflections

Can You See in the Dark?

List all the light sources you found in the book.

Light bulbs, exit signs, light from bulbs coming under the door, street lamps, car headlights, glowing signs, campfire, flashlights.

Reread page 21. What do you think will happen if the guide turns the lights back on? Why do you think so?

I think you will be able to see again because the light is back, but it will take a second or two for your eyes to adjust to the light. I think this because you can only see when there is light. You can't see without it.

INVESTIGATION 1

Characteristics of Light

After Reading

- 1. Review predictions.** Ask volunteers to share predictions they made as they read. Have them give their predictions, tell where in the text they made them, and explain what clues they used to predict.
- 2. Discuss light sources.** Call on several students to share what they learned about light sources from reading the book. Prompt them to think about the various types of light sources mentioned in the book.
- 3. Introduce first key concepts of the unit.** Show the students the key concepts you prepared before class and read them aloud:

All light comes from a source.

Some examples of light sources are the Sun, lamps, and flashlights.

Tell the students these are the first of many key concepts they'll be learning in the unit. Explain that key concepts are important ideas about science.

- 4. Introduce the concept wall.** Post the key concepts in the area you designated for the concept wall. Tell the students they will keep track of important ideas by posting them on the wall. Move the guiding question **What are the characteristics of light?** to the concept wall, too.

Teaching Support and Considerations

Instructional Suggestions

Additional Support: Reading. While the *Light Energy* books were designed to be accessible to third and fourth graders, you may find that you need to provide additional support for some students. You could pair readers who need more support with stronger readers. You can also create a reading group for a book so you can provide support to a few students while the remainder of the class reads in pairs. Getting Ready to Read, Reading Reflections, repeated readings of the text, and extra reading time are also supportive activities to consider. Please note that we discourage teachers from reading the book aloud, as it denies students the opportunity to practice important reading skills.



English Language Learners

Idiomatic Expressions. To help English learners understand this book, some accommodation may be needed to help them understand idiomatic expressions. Before reading, discuss idiomatic expressions in general. Write on the board "Finishing my homework is a piece of cake." Tell the students this sentence contains a phrase that means something different from what you might think based on the words. In this case, the phrase does not mean the homework is made of cake! Ask the students if they think the sentence means that the homework is easy or hard. Write on the board these five idiomatic expressions found in the book: "light is creeping in"; "none, nada, zip, zilch"; "put the fire out"; "dive under your bed"; and "a smile crosses your face." Have students work in pairs to find and read the page where the idiom is found and figure out what is meant. As a class, discuss the meaning of each idiom.

Providing More Experience

Reinforce: Reading Reflections. Reading Reflections pages for each book are included in the Investigation Notebook. These optional pages provide short, written activities designed to reinforce and extend concepts introduced in the books. They can be assigned to early finishers during independent/partner reading or used to reinforce concepts and strategies after a second reading. The Reading Reflections page for *Can You See in the Dark?* appears on page 3 of the Investigation Notebook. It asks students to make a list of light sources they found in the book and to make a prediction about how light behaves.

Reinforce: Home Activity. The optional Home Investigation 1: Trying to See in the Dark invites students to explore their homes and search for the darkest places they can find, paralleling the quest in *Can You See in the Dark?* Students draw and write about their darkest places, then share and debrief with the class. See page 138.

LANGUAGE OF SCIENCE

Unit-specific Vocabulary

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Science Inquiry Vocabulary

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Language of Argumentation

What do you think?
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Why do you think that?
What is your evidence?

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INVESTIGATION 1
Characteristics of Light

- 5. Discuss dark places.** Ask, "Can you think of any completely dark place, where there is NO light coming from any source?" Accept all student responses. If students suggest a place that isn't completely dark, ask, "What are some sources of light in this place?" [In the desert there are stars in the sky. In dark rooms light usually comes in under the door or through windows.]
- 6. Revisit the title of the book.** Hold up the book again and read aloud its title, *Can You See in the Dark?* Ask, "After reading the book, what do you think the answer is?" Lead a short discussion about students' ideas.
- 7. Post another key concept.** Read aloud the key concept you prepared before class:

People need light to see.

Post this key concept on the concept wall.

- 8. Conclude the session.** Let the students know they will continue their investigations to learn more about light.