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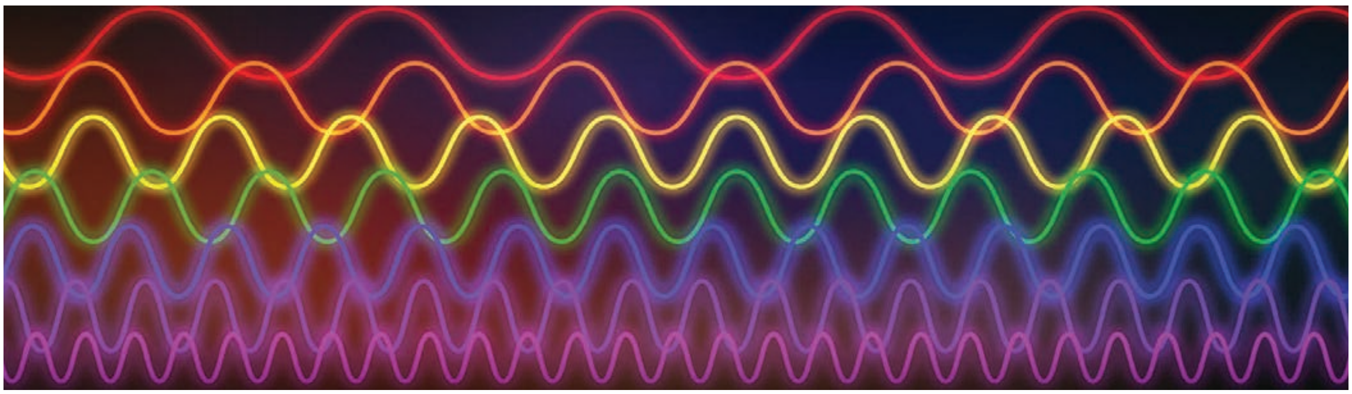

Light Waves:

Skin Cancer in Australia

Investigation Notebook with Article Compilation

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These materials are based upon work partially supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305A130610 to The Regents of the University of California. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.

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Light Waves: Skin Cancer in Australia
ISBN: 978-1-947002-91-3
AMP.NA18

Light Waves:
Skin Cancer in Australia

Investigation Notebook

Table of Contents

Safety Guidelines for Science Investigations 1
***Light Waves: Skin Cancer in Australia* Unit Overview** 3

Chapter 1: Changes Caused by Light

Chapter Overview 4

Lesson 1.2: Light and Energy 5
Warm-Up 6
Skin Cancer in Australia 7
Evidence of Energy from Light 8–9
Homework: Anticipation Guide 10

Lesson 1.3: Explaining Changes from Light 11
Warm-Up 12
Energy and Light 13–14
Investigating Genetic Material in the Sim 15
Homework: Changes Caused by Light 16

Lesson 1.4: Explaining Sunlight and Skin Cancer 17
Warm-Up 18
Modeling the Cause of Skin Cancer 19–20
Write and Share: Student 1 21–22
Write and Share: Student 2 23–24
Write and Share: Student 3 25–26
Homework: Writing About Claim 1 27–28
Homework: Check Your Understanding 29–30

Chapter 2: Light as a Wave

Chapter Overview 31

Lesson 2.1: Investigating Different Light Sources 32
Warm-Up 33
How Different Light Sources Change Materials 34
Reflecting on the Investigation Question 35
Homework: Investigating Light Sources in the Sim 36

Lesson 2.2: “Harvesting Sunlight” 37
Warm-Up 38
Reading “Harvesting Sunlight” 39
Homework: Comparing the Sun to a Light Bulb 40

Table of Contents (continued)

Lesson 2.3: Wave Properties ... 41
Warm-Up ... 42
Rereading "Harvesting Sunlight" ... 43
Investigating Different Types of Light ... 44–45
Reflecting on Wave Properties ... 46
Homework: Reading "Why No One in Space Can Hear You Scream" ... 47

Lesson 2.4: Effects of Different Types of Light ... 48
Warm-Up ... 49
Investigating Light's Effect on Genetic Material ... 50–53
Discussing the Cause of Skin Cancer ... 54–55
Homework: Reading "What Is Melanin?" ... 56

Lesson 2.5: Analyzing Evidence About Melanin and UV Light ... 57
Warm-Up ... 58
Write and Share: Student 1 ... 59
Write and Share: Student 2 ... 60
Write and Share: Student 3 ... 61
Discussing Skin Cancer Factors ... 62–64
Homework: Supporting a Claim ... 65
Homework: Check Your Understanding ... 66–67

Chapter 3: More Light Interactions

Chapter Overview ... 68

Lesson 3.1: Following the Path of Light ... 69
Warm-Up ... 70
Investigating the Path of Light ... 71–72
Testing Glass and Aluminum Foil ... 73–75
Homework: Reading "How Fiber-optic Communication Works" ... 76

Lesson 3.2: "What Eyes Can See" ... 77
Warm-Up ... 78
Reading "What Eyes Can See" ... 79
Homework: Revisiting the Anticipation Guide ... 80
Homework: Reading "Making Waves at Swim Practice" ... 81

Lesson 3.3: Reflection, Transmission, and Energy ... 82
Warm-Up ... 83
Energy in Reflection and Transmission ... 84–85

Table of Contents (continued)

Rereading "What Eyes Can See" 86
Homework: Revisiting the Warm-Up 87

Lesson 3.5: Light and the Atmosphere 88–89
Warm-Up 90
Blue Group: Light Traveling Through the Atmosphere 91–95
Purple Group: Light Traveling Through the Atmosphere 96–98
Green Group: Light Traveling Through the Atmosphere 99–101
Sharing Results 102

Lesson 3.6: Explaining Australia's Skin Cancer Rate 103
Warm-Up 104
Modeling Ultraviolet Light in the Atmosphere 105–107
Preparing to Write 108
Homework: Writing an Argument About Australia's Skin Cancer Rate 109
Homework: Check Your Understanding 110–111

Chapter 4: Science Seminar

Chapter Overview 112

Lesson 4.1: Analyzing Evidence 113
Warm-Up 114
Evidence Cards 115
Sorting Evidence 116

Lesson 4.2: Science Seminar 117
Warm-Up 118
Preparing for the Science Seminar 119
Science Seminar Observations 120
Homework: Reflecting on the Science Seminar 121

Lesson 4.3: Writing a Scientific Argument 122–123
Warm-Up 124
Using the Reasoning Tool 125
Preparing to Write 126
Writing Scientific Arguments 127–129
Homework: Revising an Argument 130–131
Homework: Check Your Understanding 132

***Light Waves* Glossary** 133–134

Safety Guidelines for Science Investigations

1. **Follow instructions.** Listen carefully to your teacher's instructions. Ask questions if you don't know what to do.
2. **Don't taste things.** No tasting anything or putting it near your mouth unless your teacher says it is safe to do so.
3. **Smell substances like a chemist.** When you smell a substance, don't put your nose near it. Instead, gently move the air from above the substance to your nose. This is how chemists smell substances.
4. **Protect your eyes.** Wear safety goggles if something wet could splash into your eyes, if powder or dust might get in your eyes, or if something sharp could fly into your eyes.
5. **Protect your hands.** Wear gloves if you are working with materials or chemicals that could irritate your skin.
6. **Keep your hands away from your face.** Do not touch your face, mouth, ears, eyes, or nose while working with chemicals, plants, or animals.
7. **Tell your teacher if you have allergies.** This will keep you safe and comfortable during science class.
8. **Be calm and careful.** Move carefully and slowly around the classroom. Save your outdoor behavior for recess.
9. **Report all spills, accidents, and injuries to your teacher.** Tell your teacher if something spills, if there is an accident, or if someone gets injured.
10. **Avoid anything that could cause a burn.** Allow your teacher to work with hot water or hot equipment.
11. **Wash your hands after class.** Make sure to wash your hands thoroughly with soap and water after handling plants, animals, or science materials.

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Name: ____________________ Date: ____________________

Light Waves: Skin Cancer in Australia
Unit Overview

Sunlight is an important part of life on Earth. It warms us, helps plants grow, and makes our world habitable. However, the same light that sustains life on Earth can also be harmful to us. For example, every year, millions of people are diagnosed with skin cancers caused by sunlight. Australia has the highest rate of skin cancer in the world: More than half of the people who live there will be diagnosed with skin cancer in their lifetime. In the *Light Waves* unit, you will take on the role of a student spectroscopist working for the Australian Health Alliance. Your job is to investigate why Australia's cancer rate is so high and help the people of Australia understand your findings. You will use the *Light Waves* Simulation, conduct hands-on activities, read articles, and watch videos to learn about the factors that make Australia's skin cancer rate so high.

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Chapter 1: Changes Caused by Light
Chapter Overview

Australia has the highest rate of skin cancer in the world. You will work as a student spectroscopist to help Australian citizens understand why the skin cancer rate in their country is so high. In this chapter, you will investigate why light can cause materials to change. This will help you understand how light from the sun can cause skin cancer.

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Lesson 1.2: Light and Energy

You have probably been told to put on sunscreen before spending time in the sun. You probably know that people's skin can get sunburned if they don't use sunscreen. But do you know that light from the sun can also cause a type of cancer called skin cancer? Australia has one of the highest rates of skin cancer in the world. Why is that? In this unit, you will take on the role of a student spectroscopist, studying the properties of light to investigate this question. You will first need to understand more about how light can cause materials to change. Today, you will conduct a hands-on investigation and make observations about how light interacts with materials.

Unit Question

- How does light interact with materials?

Chapter 1 Question

- How does light from the sun cause skin cancer?

Vocabulary

- energy
- light

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Warm-Up

The sun causes changes to things on Earth. Think of an object you have observed before and after it was left out in the sun. Describe how it changed.

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Skin Cancer in Australia

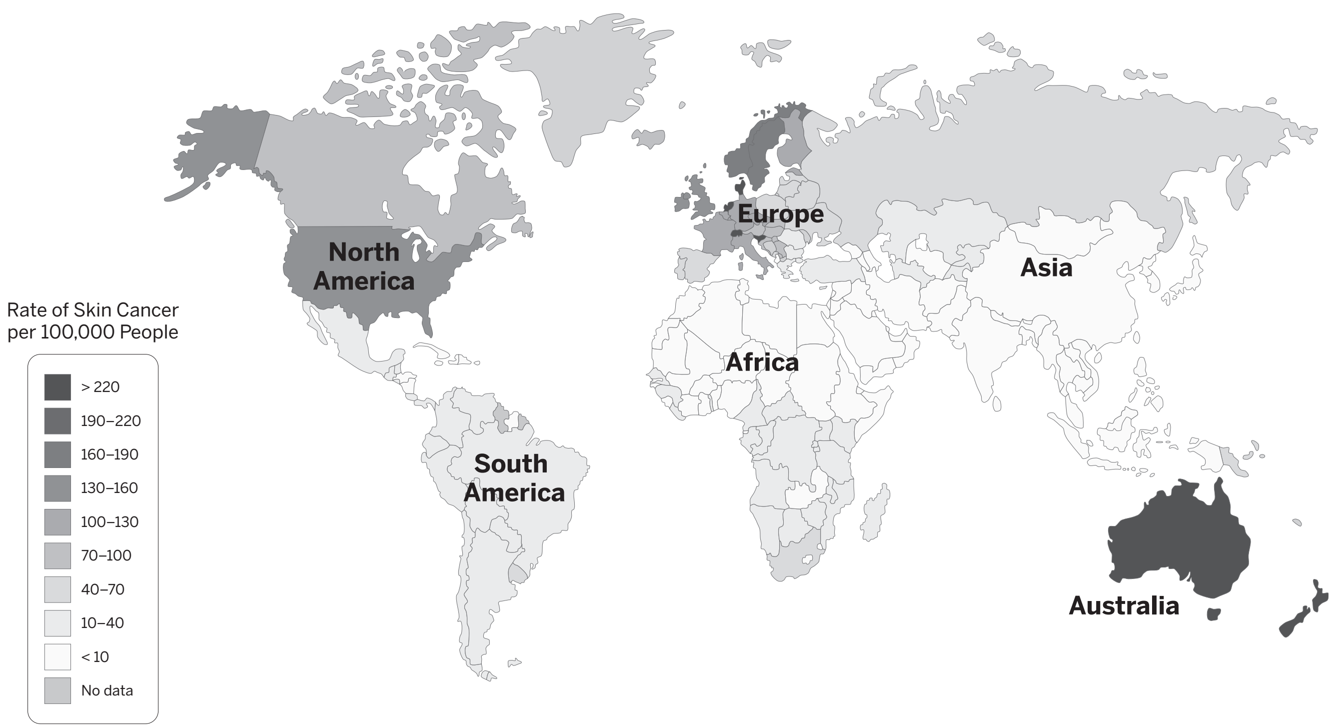
Discussing the World Skin Cancer Map

Look at the map and talk to your partner about what you notice, discussing any questions you may have. When you are finished, discuss these questions:

- Which places have the lowest rates of skin cancer?
- Which places have the highest rates of skin cancer?
- What ideas do you have about why different places have lower or higher rates of skin cancer?

Note: Your teacher will project a color version of this map.

World Skin Cancer Map



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Evidence of Energy from Light

Part 1: Gathering Evidence that Light Carries Energy

Work with your group to gather evidence that light carries energy, then answer the questions below.

Shine the flashlight on the liquid crystal sheet. Did you observe evidence that light carries energy? (check one)

- ☐ yes
- ☐ no

Describe any evidence that you observed.

____

____

____

Shine the flashlight on the solar panel of the solar-powered toy. Did you observe evidence that light carries energy? (check one)

- ☐ yes
- ☐ no

Describe any evidence that you observed.

____

____

____

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Evidence of Energy from Light (continued)

Part 2: Analyzing Thermometer Test Results

Pay attention as your teacher checks the temperatures of the test thermometer (under the light) and the control thermometer (away from the light), then answer the questions below.

Compare the temperatures of the two thermometers. Did you observe evidence that light carries energy? (check one)

- ☐ yes
- ☐ no

Describe any evidence that you observed.

____

____

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Name: ______________________________ Date: ________________

Homework: Anticipation Guide

1. For each statement, indicate whether you **agree** or **disagree.**

Don't worry about being right or wrong. This is your chance to think about what you already know about light. As you learn more during the unit, you will return to this guide to revise and explain your answers.

______________ Light causes the same change to all materials.

______________ All light is the same, whether it comes from the sun, a light bulb, or anywhere else.

______________ All light can be seen.

______________ Light can travel through materials that you cannot see through, like wood or aluminum foil.

2. Circle the statement you are most sure about. It can be a statement that you agree or disagree with.

Why do you agree or disagree with the statement you chose? Explain your thinking.

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Lesson 1.3: Explaining Changes from Light

In Lesson 1.2, you learned that light carries energy and that energy can cause changes to materials. Today, you will use the *Light Waves* Simulation to investigate why this happens, specifically why light can change genetic material. The work you do today will help you understand why light from the sun can cause skin cancer. This will bring you one step closer to helping the people of Australia understand why the skin cancer rate is so high there.

Unit Question

- How does light interact with materials?

Chapter 1 Question

- How does light from the sun cause skin cancer?

Key Concepts

- The movement of energy can be tracked by observing the changes the energy causes to matter.
- Light carries energy that causes materials to change.

Vocabulary

- absorb
- energy
- light
- light source
- visualize

Digital Tools

- *Light Waves* Simulation

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Name: ______________________________ Date: ____________________

Warm-Up

Exploring the *Light Waves* Simulation

Throughout this unit, you will be using a digital simulation to gather evidence about how light interacts with materials. Open the *Light Waves* Simulation and explore its features. Be ready to share what you discover. Use the space below to write down anything you want to share.

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Energy and Light

Sim Mission: Energy and Light

Use the *Light Waves* Simulation to complete the following mission: Find one material that is changed by light from the sun and one material that is not. This will help you answer the Investigation Question: *Why can light cause materials to change?*

Open the *Light Waves* Simulation in Simple mode and follow the steps below.

1. Choose a material and drag it to a platform in the testing area.
2. Keep SUN as the light source and turn it ON.
3. Press INSPECT to see the effect of the light on the material.
4. Observe whether light from the sun causes the material to change.
5. Place different materials in the testing area until you find at least one material that is changed by light from the sun and one that is not.
6. Answer the questions below.

Light from the sun **causes** the ________ to change. (circle all that apply)

plant	**glass**	**melanin**
solar panel	**aluminum**	**genetic material**

Light from the sun does **not cause** the ________ to change. (circle all that apply)

plant	**glass**	**melanin**
solar panel	**aluminum**	**genetic material**

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Name: ______________________________ Date: ______________

Energy and Light (continued)

Next, work with a partner to compare two materials.

1. **Partner A:** Choose a material that the light from the sun changes and place it in the testing area.
2. **Partner B:** Choose a material that the light from the sun does not change and place it in the testing area.

Both Partners:

3. Keep SUN as the light source and turn it ON.
4. Turn Show Energy on.
5. Compare the tests side by side and discuss the following questions:
   - What happens to the energy from the light when the material changes?
   - What happens to the energy from the light when the material does not change?

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Name: ______________________________ Date: ______________

Investigating Genetic Material in the Sim

Use the Sim to investigate how light from the sun affects genetic material in skin cells.

Open the *Light Waves* Simulation in Simple mode and follow the steps below.

1. Drag GENETIC MATERIAL to a platform in the testing area.
2. Keep SUN as the light source and turn it ON.
3. Turn Show Energy on.
4. Press INSPECT to see how light changes the material.
5. Answer the questions below.

What change to genetic material do you observe?

____

____

____

How is it possible for light to change genetic material? Include evidence from the Sim in your answer and use the vocabulary terms *light*, *energy*, and *absorb.*

____

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Name: ______________________________ Date: ____________________

Homework: Changes Caused by Light

In today's lesson, you gathered evidence that light from the sun can change materials in different ways. Can light from a light bulb also change materials?

Sim Mission: Find all the different types of changes that can be caused by light from a light bulb to the materials listed in Simple mode.

Open Simple mode of the *Light Waves* Simulation and follow the steps below.

1. Change the light source to LIGHT BULB and turn it ON.
2. Drag a material to a platform in the testing area.
3. Press INSPECT to see if light from the light bulb changes the material, and what types of changes it causes.
4. Note the type of change below.
5. Repeat steps 2–4 until you have tested every material and noted every type of change.

Which changes were caused by light from a lightbulb? (circle all that apply)

damage **increased kinetic energy** **warmth**

increased electrical energy **photosynthesis**

What must happen for light to change a material?

____

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Name: ______________________________ Date: ________________

Lesson 1.4: Explaining Sunlight and Skin Cancer

Student spectroscopists, the Australian Health Alliance is counting on you to help Australian citizens understand the high skin cancer rate in their country. Today, you will create a visual explanation that will help people understand how light from the sun can cause skin cancer. Then, you will participate in the Write and Share routine to evaluate evidence that will help you explain why the skin cancer rate in Australia is so high.

Unit Question

- How does light interact with materials?

Chapter 1 Question

- How does light from the sun cause skin cancer?

Key Concepts

- The movement of energy can be tracked by observing the changes the energy causes to matter.
- Light carries energy that causes materials to change.
- When light hits a material, the material can absorb energy from the light.
- When a material absorbs energy from light, the energy causes the material to change.

Vocabulary

- absorb
- energy
- light
- visualize

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Name: ______________________________ Date: ______________

Warm-Up

In Lesson 1.2, you observed that a solar-powered toy moved when you shined a flashlight on it. Check all of the statements below that accurately explain how this happened.

- ☐ Light from the flashlight carried energy.
- ☐ There was energy in the toy that was activated by the light.
- ☐ Energy from the flashlight was absorbed by the toy.
- ☐ The flashlight absorbed energy from the toy.

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Modeling the Cause of Skin Cancer

The Australian Health Alliance is counting on you to help people understand how skin cancer occurs. Use the Modeling Tool activity: The Cause of Skin Cancer on the next page to show your thinking, following the steps below. When you are finished, add a written explanation of how light from the sun can cause skin cancer.

Goal: Show how light from the sun can cause skin cancer.

Do:

- Choose a *source* from the word bank and add it to the model.
- Choose a *change* from the word bank and add it to the model.
- Use a yellow highlighter to trace the path of energy.
- Annotate your model to help explain your ideas.

How can light from the sun cause skin cancer?

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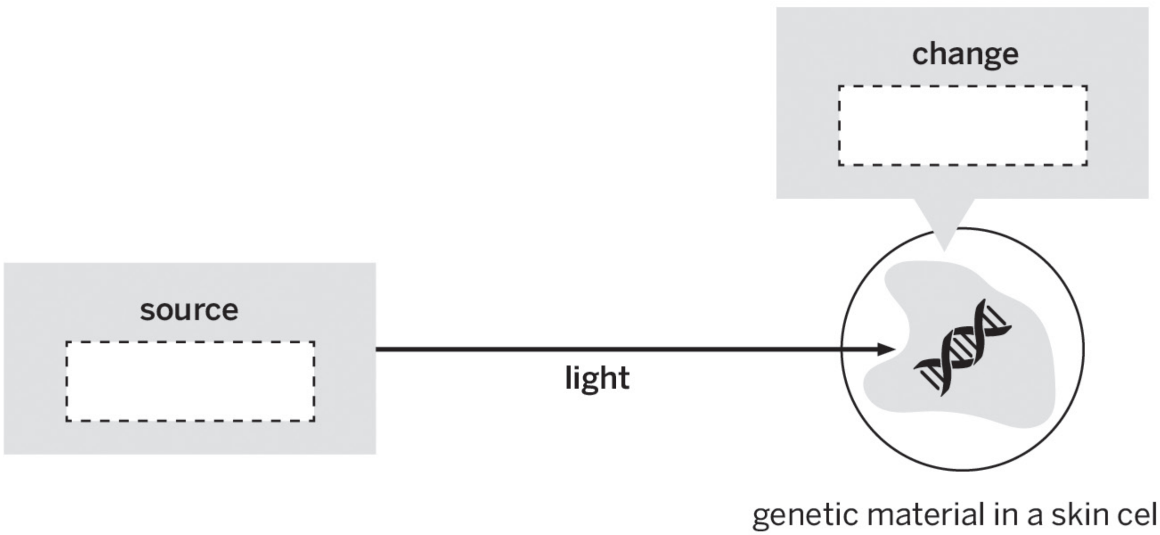
Name: ______________________ Date: ______________

Modeling the Cause of Skin Cancer (continued)



sources

- light bulb
- sun

changes

- damage
- movement
- photosynthesis
- warmth
- none

energy

yellow highlight

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Name: ____________________ Date: ____________

Write and Share: Student 1

Why is Australia's skin cancer rate so high?

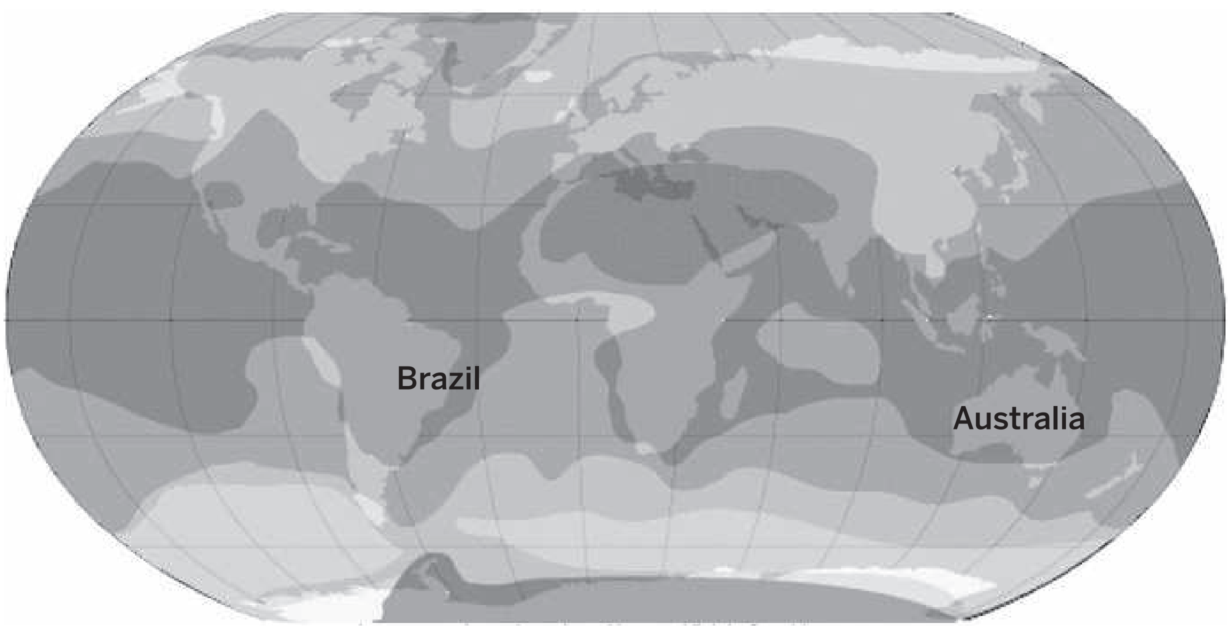
Claim 1: Australia gets a lot of sunlight.

If Claim 1 is accurate, would you expect Brazil's skin cancer rate to be higher, lower, or the same as Australia's skin cancer rate? Why?

Add annotations to the map that help you answer this question, then record your thinking on the next page.

Note: Your teacher will project a color version of this map.

World Sunlight Map



Total hours of bright sunlight per year (on average)

Over 3000 | 2000 - 3000 | 2000 - 1000 | 1000 - 500 | Under 500

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Name: ______________________ Date: ______________

Write and Share: Student 1 (continued)

If Claim 1 is accurate, I would expect Brazil to have a cancer rate that is __________ Australia's. (check one)

- ☐ higher than
- ☐ lower than
- ☐ the same as

Why? Record your thinking below. Use all of these words in your explanation: *absorb, energy, light.*

____

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Name: ______________________ Date: ______________

Write and Share: Student 2

Why is Australia's skin cancer rate so high?

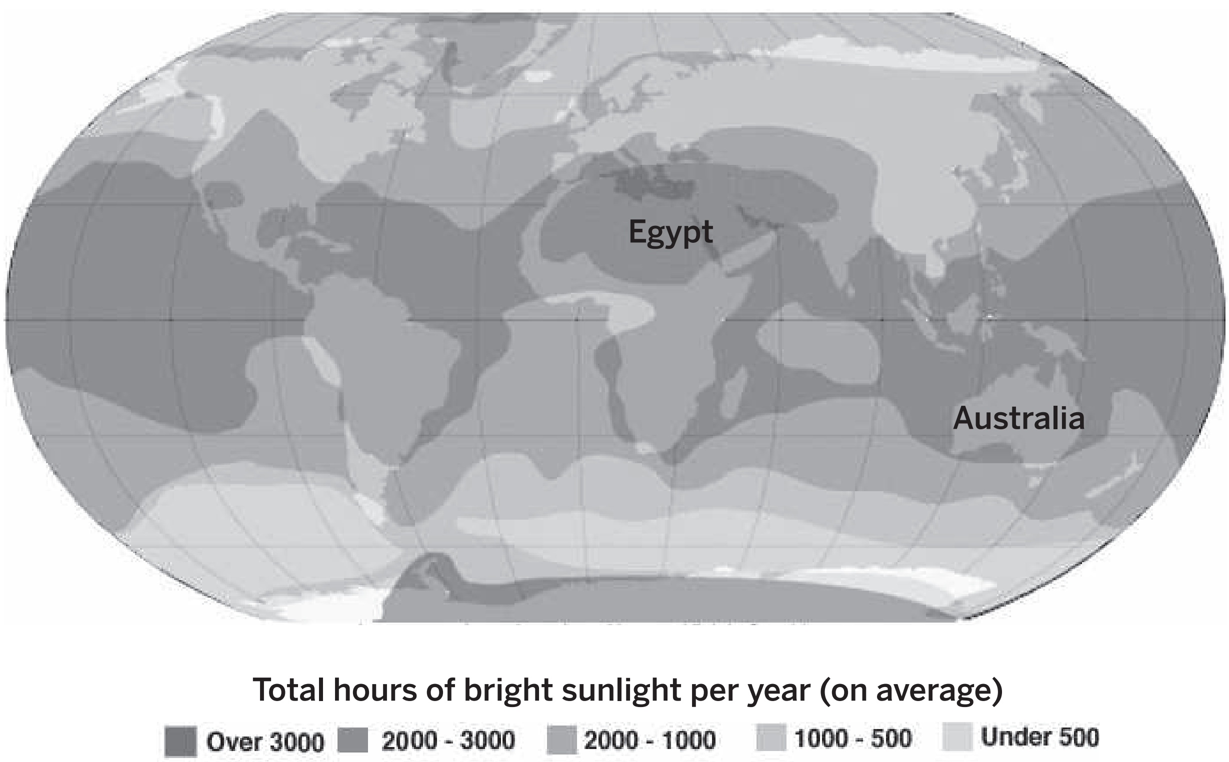
Claim 1: Australia gets a lot of sunlight.

If Claim 1 is accurate, would you expect Egypt's skin cancer rate to be higher, lower, or the same as Australia's skin cancer rate? Why?

Add annotations to the map that help you answer this question, then record your thinking on the next page.

Note: Your teacher will project a color version of this map.

World Sunlight Map



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Name: ______________________________ Date: ________________

Write and Share: Student 2 (continued)

If Claim 1 is accurate, I would expect Egypt to have a cancer rate that is __________ Australia's. (check one)

- ☐ higher than
- ☐ lower than
- ☐ the same as

Why? Record your thinking below. Use all of these words in your explanation: *absorb, energy, light.*

____

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Name: ______________________ Date: ______________

Write and Share: Student 3

Why is Australia's skin cancer rate so high?

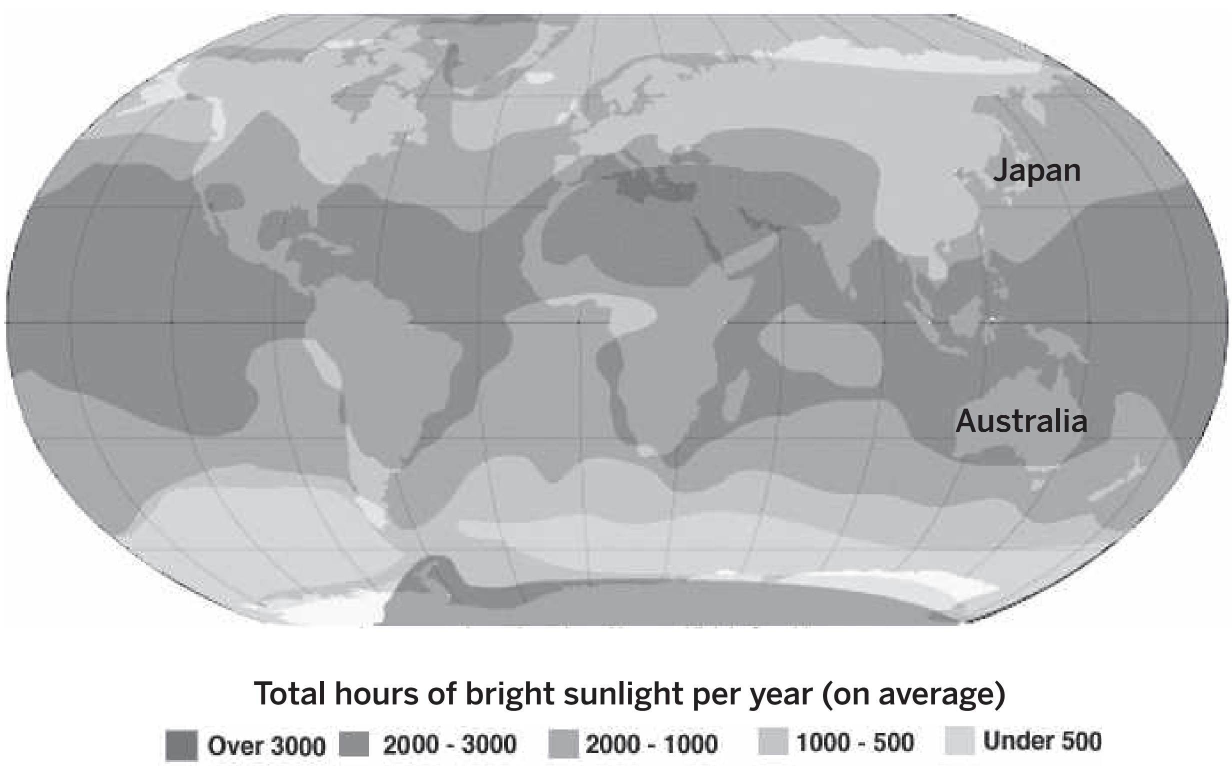
Claim 1: Australia gets a lot of sunlight.

If Claim 1 is accurate, would you expect Japan's skin cancer rate to be higher, lower, or the same as Australia's skin cancer rate? Why?

Add annotations to the map that help you answer this question, then record your thinking on the next page.

Note: Your teacher will project a color version of this map.

World Sunlight Map



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Name: ______________________________ Date: ________________

Write and Share: Student 3 (continued)

If Claim 1 is accurate, I would expect Japan to have a cancer rate that is __________ Australia's. (check one)

- ☐ higher than
- ☐ lower than
- ☐ the same as

Why? Record your thinking below. Use all of these words in your explanation: *absorb, energy, light.*

____

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Name: ____________________ Date: ____________

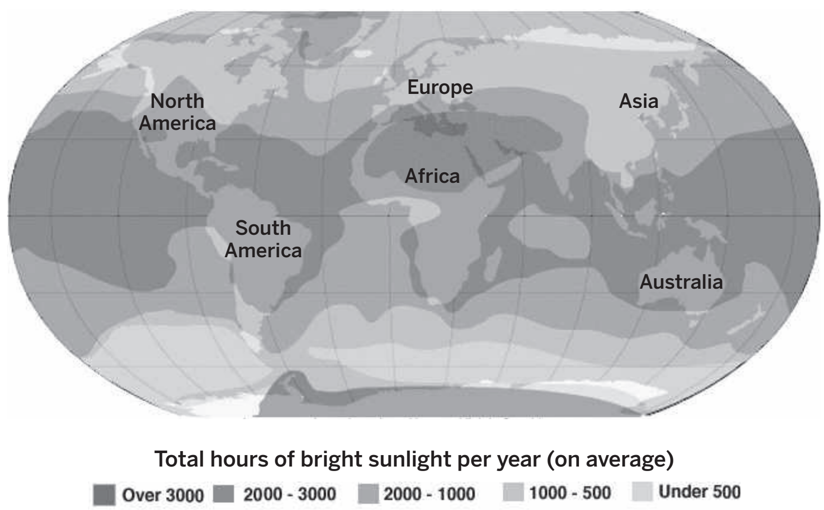
Homework: Writing About Claim 1

Why is Australia's skin cancer rate so high?

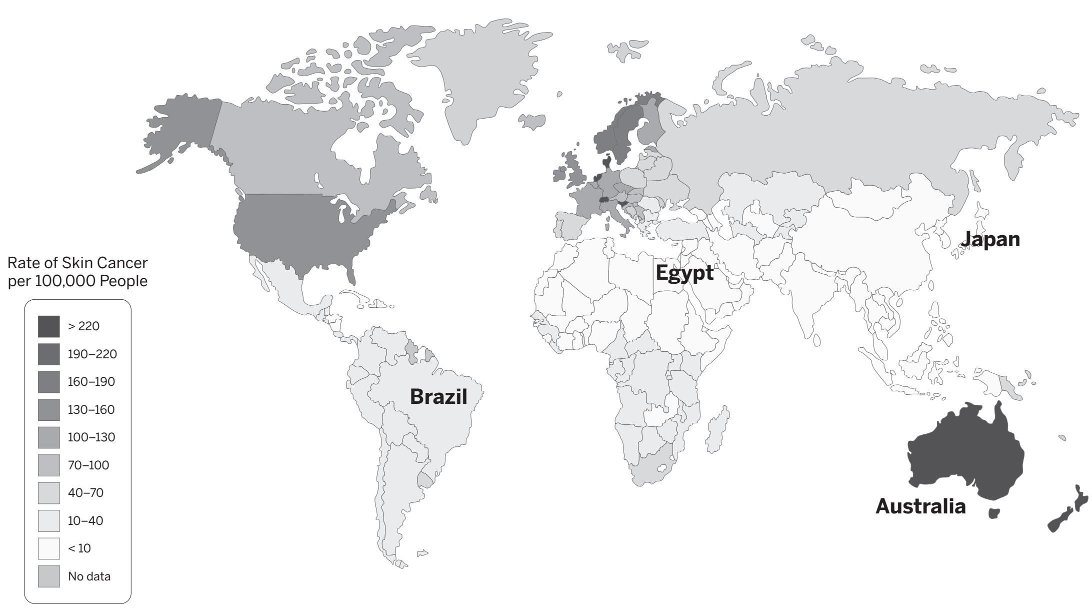
Claim 1: Australia gets a lot of sunlight.

Today, you gathered evidence from the World Sunlight Map and the World Skin Cancer Map to evaluate Claim 1. Based on what you know so far, answer the questions on the next page.

World Sunlight Map



World Skin Cancer Map



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Homework: Writing About Claim 1 (continued)

What does the World Sunlight Map tell you about how much sunlight Australia gets compared to Brazil?

____

____

____

What does the World Skin Cancer Map tell you about how the skin cancer rates of Australia and Brazil differ?

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What ideas do you have about how two places could have the same amount of sunlight but different skin cancer rates?

____

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Name: ____________________ Date: ____________

Homework: Check Your Understanding

This is a chance for you to reflect on your learning so far. This is not a test. Be open and truthful when you respond to the questions below.

Scientists investigate in order to figure things out. You have been investigating why Australia's skin cancer rate is so high. Are you getting closer to understanding the cause of Australia's high skin cancer rate?

1. I understand how light from the sun can cause skin cancer. (check one)

   ☐ yes

   ☐ not yet

Explain your answer choice.

____

____

2. I understand why different types of light can change materials in different ways. (check one)

   ☐ yes

   ☐ not yet

Explain your answer choice.

____

____

3. I understand the different things that can happen when a light wave hits a material. (check one)

   ☐ yes

   ☐ not yet

Explain your answer choice.

____

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Name: ______________________ Date: ______________

Homework: Check Your Understanding (continued)

4. I understand why light sometimes changes a material and sometimes doesn’t. (check one)

- ☐ yes
- ☐ not yet

Explain your answer choice.

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5. What do you still wonder about how light can interact with materials?

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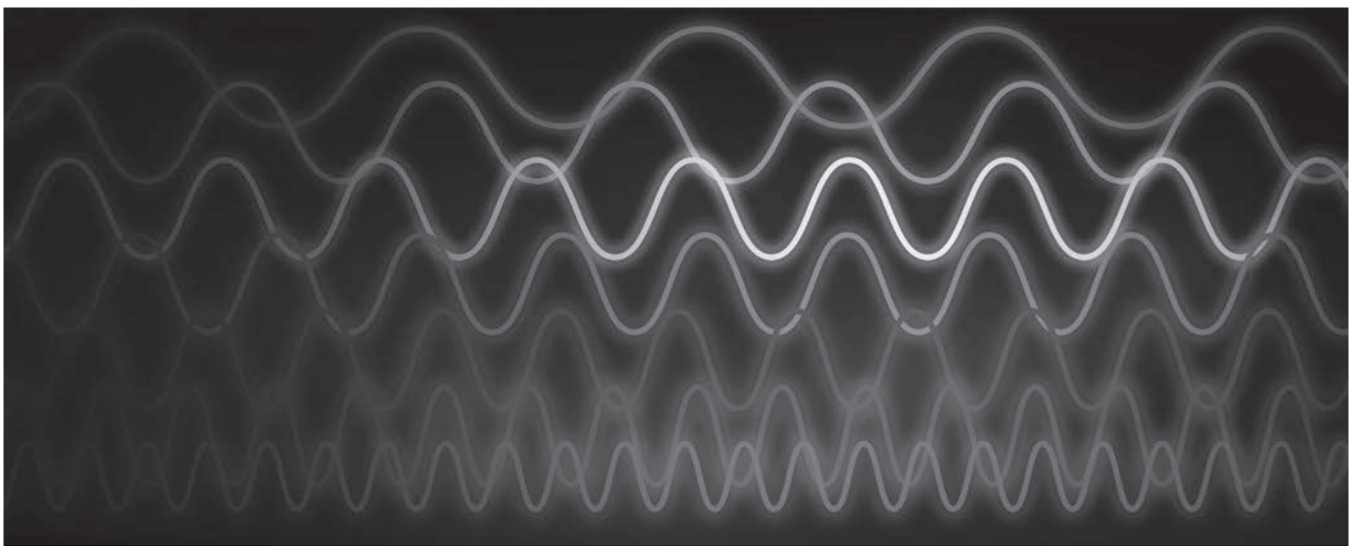
Name: ______________________________ Date: ______________

Chapter 2: Light as a Wave
Chapter Overview

At the end of Chapter 1, you received puzzling data: Australia has a higher skin cancer rate than Brazil, even though the two countries receive the same amount of sunlight. How can the same amount of sunlight lead to different rates of skin cancer? Is there something different about the sunlight in Australia? To answer these questions, you will investigate whether all light is the same.



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Name: ______________________________ Date: ______________________

Lesson 2.1: Investigating Different Light Sources

In the previous lesson, you learned that Brazil and Australia receive the same amount of sunlight, yet Australia has a higher skin cancer rate than Brazil. How can the same amount of sunlight cause different rates of skin cancer? Is there something different about the sunlight in Brazil? Is this even possible, or is all light the same? Today, you will conduct a hands-on investigation and gather evidence to answer this question.

Unit Question

- How does light interact with materials?

Chapter 2 Question

- How can the same amount of sunlight cause different rates of skin cancer?

Vocabulary

- absorb
- emit
- light
- light source

Digital Tools

- *Light Waves* Simulation

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Name: ______________________ Date: ______________

Warm-Up

Light Sources and Skin Cancer

Goal: Share your ideas about which light sources can cause skin cancer by sorting the words into the columns.

Do:

- If you think the light from a light source can cause skin cancer, write it in the left-hand column.
- If you think the light from a light source cannot cause skin cancer, write it in the right-hand column.

Light Sources

sun	campfire	tanning bed
flashlight	fluorescent light	desk lamp

Can cause skin cancer	*Cannot* cause skin cancer

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How Different Light Sources Change Materials

Safety Note: Ultraviolet Flashlights

The ultraviolet flashlights may be dangerous if shined into eyes or onto skin. Remember to behave responsibly with both light sources.

The Effects of Different Light Sources

Shine flashlights A and B on each material to help you answer the Investigation Question: *Is all light the same?* Record your observations in the table below. Describe the effects of the light emitted from each flashlight, and note whether they are different from one another.

Material	**Flashlight A**	**Flashlight B**	**Were the effects the *same* or *different?***
liquid crystal paper			
plastic stars			
beads			

Based on your observations, is the light emitted from Flashlight A the same as the light emitted from Flashlight B? How can you tell?

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Reflecting on the Investigation Question

Discuss the Investigation Question with a partner.

Is all light the same?

Use evidence from the hands-on investigation and the *Sun Paper Demo* video to support your answer.

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Name: ______________________________ Date: ________________

Homework: Investigating Light Sources in the Sim

Jonathan claims that light is always the same, even when it is emitted by different light sources (like the sun and a light bulb).

Get evidence for or against Jonathan's claim.

1. Open the *Light Waves* Simulation.
2. Set the SUN as the light source and turn it ON.
3. Drag one of the following materials to a platform in the testing area and observe any changes: PLANT, SOLAR PANEL, MELANIN, or GENETIC MATERIAL.
4. Keeping your chosen material in the testing area, change the light source to LIGHT BULB and observe any changes to the material.
5. Repeat steps 2–4 with two more materials.
6. Decide whether your observations support or refute Jonathan's claim, then write about some examples of your evidence in the lines below.

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Do you agree or disagree with Jonathan's claim? I (**agree** / **disagree**) with the claim that light is always the same, even when it is emitted by different light sources (like the sun and a light bulb).

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Name: ______________________________ Date: ______________

Lesson 2.2: "Harvesting Sunlight"

In order to figure out why the skin cancer rate in Australia is so high, you have been investigating the question *Is all light the same?* You have gathered evidence that different light sources cause materials to change in different ways, so something must be different about the light they emit. But how can light be different? To answer this question, you will read an article about different types of light and photosynthesis.

Unit Question

- How does light interact with materials?

Chapter 2 Question

- How can the same amount of sunlight cause different rates of skin cancer?

Vocabulary

- absorb
- emit
- energy
- light
- light source
- reflect

Digital Tools

- *Light Waves* Simulation

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Warm-Up

Returning to the Anticipation Guide

Review your original response to this statement from the Anticipation Guide (on page 10).

All light is the same, whether it comes from the sun, a light bulb, or anywhere else.

Do you agree or disagree with this statement now? (circle one)

agree **disagree** **not sure**

Which piece(s) of evidence support your ideas about the statement? (check one)

- ☐ Energy from light caused the solar-powered toy to move.
- ☐ In the Sim, light from the sun causes damage to genetic material but causes no change to aluminum foil.
- ☐ Light from the sun can change sun paper but light from a light bulb cannot.

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Reading "Harvesting Sunlight"

1. Read and annotate the article "Harvesting Sunlight"
2. Choose and mark annotations to discuss with your partner. Once you have discussed these annotations, mark them as discussed.
3. Now, choose and mark a question or connection, either one you already discussed or a different one you still want to discuss with the class.
4. Answer the reflection question below.

Rate how successful you were at using Active Reading skills by responding to the following statement:

As I read, I paid attention to my own understanding and recorded my thoughts and questions. (check one)

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Frequently/often
- ☐ All the time

Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

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Name: ______________________________ Date: ______________

Homework: Comparing the Sun to a Light Bulb

You have used the Sim to compare changes to materials caused by light from the sun and light from a light bulb. Now compare the types of light these sources emit.

1. Open the *Light Waves* Simulation.
2. Keep the SUN as the light source and turn it ON.
3. Tap on the beam to inspect the light.
4. Observe the types of light the sun emits.
5. Change the light source to LIGHT BULB.
6. Tap on the beam to inspect the light.
7. Observe the types of light the light bulb emits.

What is a type of light that the sun emits but a light bulb does not?

- ☐ gamma ray
- ☐ X-ray
- ☐ ultraviolet (UV)
- ☐ visible
- ☐ infrared (IR)
- ☐ microwave
- ☐ radio

What is a type of light that both the sun and a light bulb emit?

- ☐ gamma ray
- ☐ X-ray
- ☐ ultraviolet (UV)
- ☐ visible
- ☐ infrared (IR)
- ☐ microwave
- ☐ radio

Does every light source emit only one type of light?

- ☐ yes
- ☐ no

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Name: ______________________________ Date: ________________

Lesson 2.3: Wave Properties

Not all light is the same, but what exactly makes types of light different? Today, you will use the Sim to make a custom light wave. This will allow you to observe how types of light are different from one another. Understanding different types of light will bring you closer to explaining why Australia has a higher rate of skin cancer than other places in the world.

Unit Question

- How does light interact with materials?

Chapter 2 Question

- How can the same amount of sunlight cause different rates of skin cancer?

Key Concepts

- There are different types of light that can change a material in different ways.

Vocabulary

- absorb
- emit
- energy
- light
- light source
- wave
- wavelength
- visualize

Digital Tools

- *Light Waves* Simulation

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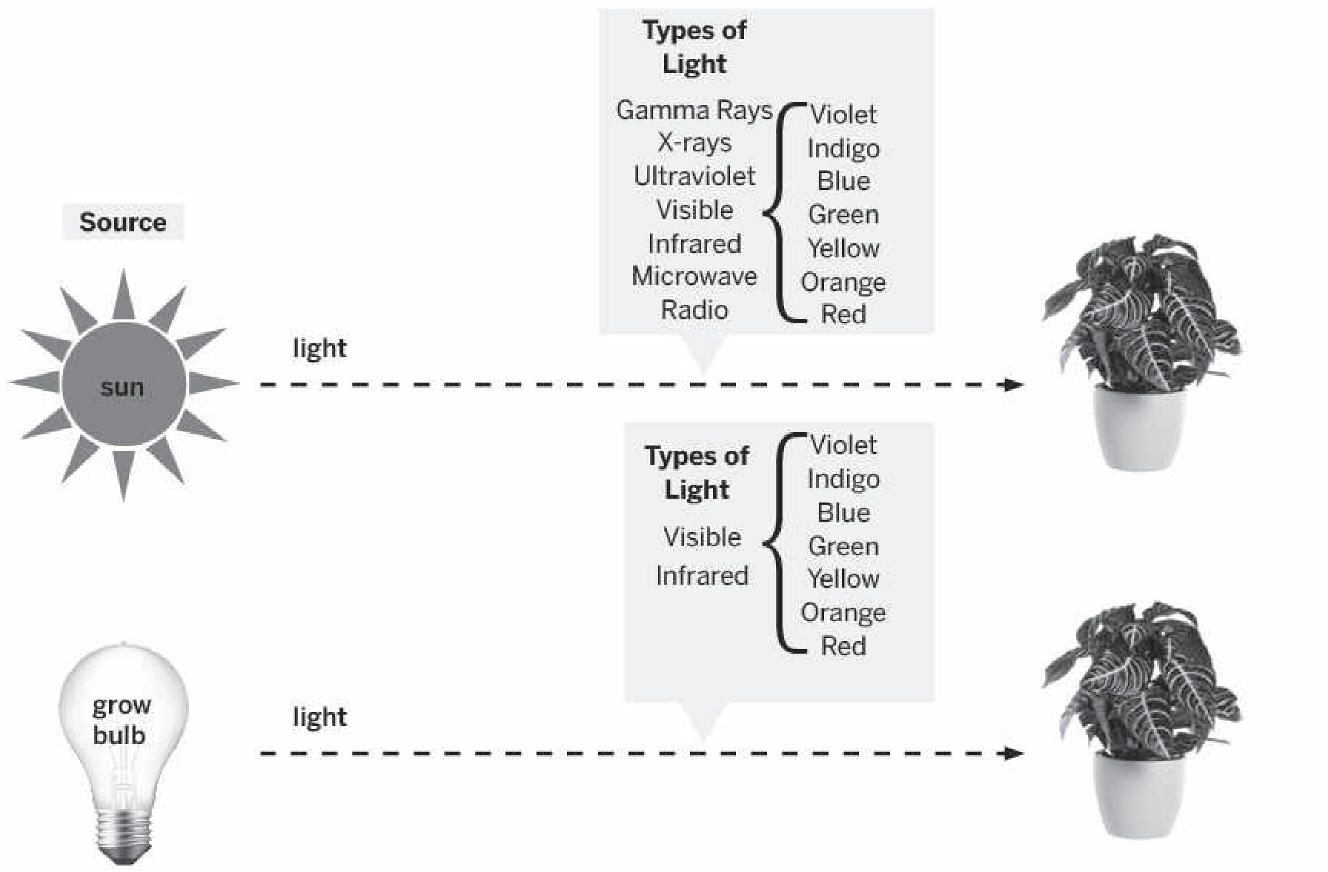
Warm-Up

Review this diagram from the "Harvesting Sunlight" article, then answer the question below.



The sun emits all types of light. A grow bulb is designed to emit a lot of the types that plants need for growth and very little of the types that plants don't need.

How is the light from a grow bulb different from light from the sun? Use the information in the diagram to explain.

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Rereading "Harvesting Sunlight"

How Different Types of Light Affect Plants

Preview the questions below, then reread the second and third paragraph in the "Harvesting Sunlight" article and answer the questions. As you read, you may want to highlight or annotate parts of the text that will help you to answer the questions.

Do plants absorb all types of light? (check one)

- ☐ yes
- ☐ no

What is one type of light that can be used for photosynthesis? (check one)

☐ gamma ray	☐ blue	☐ infrared
☐ X-ray	☐ green	☐ microwave
☐ ultraviolet	☐ yellow	☐ radio
☐ violet	☐ orange	
☐ indigo	☐ red	

Which type of light causes damage to plants? (check one)

☐ gamma ray	☐ blue	☐ infrared
☐ X-ray	☐ green	☐ microwave
☐ ultraviolet	☐ yellow	☐ radio
☐ violet	☐ orange	
☐ indigo	☐ red	

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Investigating Different Types of Light

Sim Mission: Create Different Types of Light

Mission: Use what you learned from the "Harvesting Sunlight" article to create two different types of light that have different effects on plants. As you complete the mission with your partner, pay close attention to what makes types of light different from one another.

Make a Custom Wave and adjust its properties.

1. Open the *Light Waves* Simulation.
2. Choose the CUSTOM light source and then press EDIT WAVE.
3. Adjust AMPLITUDE by dragging the vertical arrows up and down. Notice how the light wave changes.
4. Adjust WAVELENGTH by dragging the horizontal arrows left and right. Notice how the light wave changes.

Sim Mission:

Partner A: Create a type of light that will cause a plant to photosynthesize.

Partner B: Create a type of light that will cause a plant to be damaged.

1. Return to the Amplify Science screen and press the back button to view the "Harvesting Sunlight" article. Use the article as a reference for what types of light cause these changes to plants.
2. Return to the Sim and adjust Amplitude and/or Wavelength until you have created a type of light that can cause a plant to photosynthesize (Partner A) or be damaged (Partner B).
3. Press CONFIRM and turn on the light.
4. Drag the plant to the testing area and press INSPECT to observe the results.
5. Complete the statement and answer the questions below.

____________________ causes the light to change type. (circle one)

changing amplitude **changing wavelength**

What type of light did you make? ______________________________

Did the light you made cause photosynthesis or damage? (circle one)

photosynthesis **damage**

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Name: ______________________________ Date: ______________________________

Investigating Different Types of Light (continued)

6. Press EDIT WAVE to review the light you made. Compare the type of light you made with the type of light your partner made and discuss the following:

   - How are the two types of light different?

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Reflecting on Wave Properties

Reflecting on What Makes Light Waves Different

Examine the diagram below. Observe the waveform and effect for Light Source 1, and the effect for Light Source 2. Then, decide which waveform (A, B, or C) could represent the light emitted by Light Source 2. Consider the following questions to help you decide:

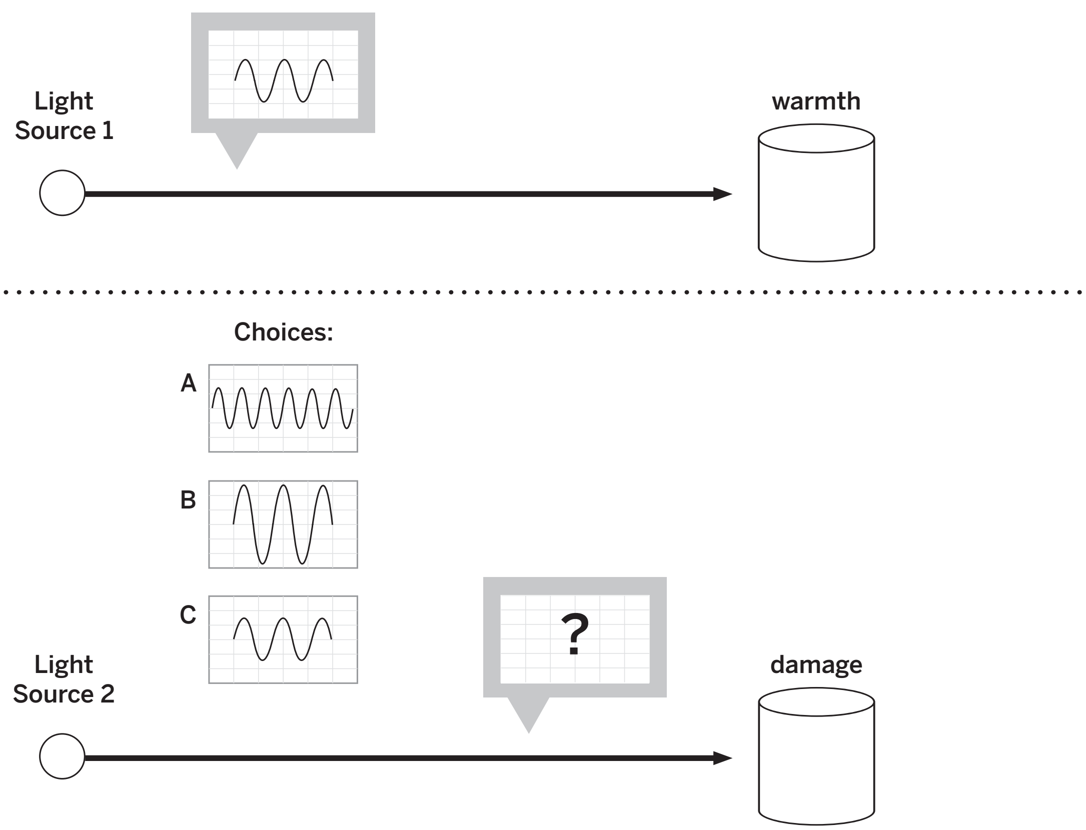
- Is Light Source 2 emitting light that is the same or different from the type of light emitted by Light Source 1? How do you know?
- Which types of light (A, B or C) have the same wavelength as the type of light emitted from source 1? Which have different wavelengths?

Which waveform could describe the light emitted from Light Source 2? (check one)

☐ A

☐ B

☐ C



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Name: ______________________________ Date: ______________

Homework: Reading "Why No One in Space Can Hear You Scream"

Today, you learned that light is a kind of wave. Sound is another kind of wave. Read the "Why No One in Space Can Hear You Scream" article and annotate while you read. Then, answer the questions.

1. Why can't sound waves travel through space?

2. What are things that sound waves can travel through?

3. Can light waves travel through space? Explain.

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Name: ______________________________ Date: ____________________

Lesson 2.4: Effects of Different Types of Light

We know that types of light are different because they have different wavelengths, and that these different types of light can change materials in different ways. The sun emits all types of light, but which types can cause skin cancer? Today, you will use the *Light Waves* Simulation to investigate this question. Determining which types of light can cause skin cancer will bring you one step closer to figuring out why the rate of skin cancer in Australia is so high.

Unit Question

- How does light interact with materials?

Chapter 2 Question

- How can the same amount of sunlight cause different rates of skin cancer?

Key Concepts

- There are different types of light that can change a material in different ways.
- A light source can emit more than one type of light.
- Different types of light have different wavelengths.

Vocabulary

- absorb
- emit
- energy
- light
- light source
- wave
- wavelength

Digital Tools

- *Light Waves* Simulation

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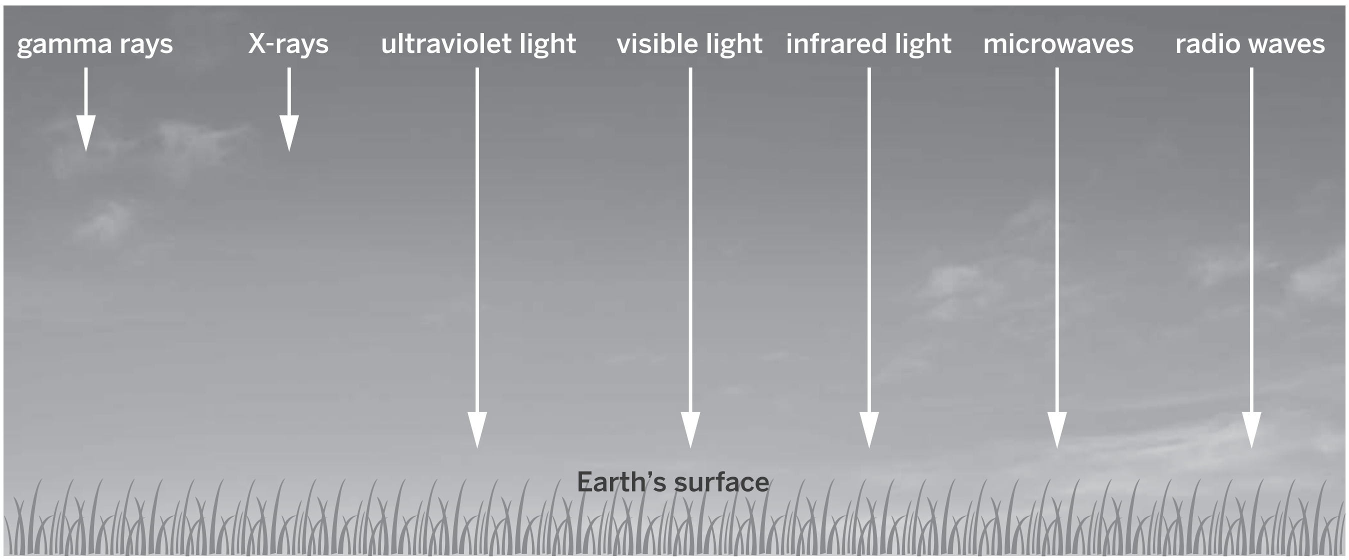
Name: ______________________ Date: ______________

Warm-Up

Light that Reaches Earth's Surface

Earth's atmosphere can absorb some wavelengths of light emitted from the sun. The diagram below shows which types of light are absorbed in the atmosphere, and which types of light travel through the atmosphere and reach Earth's surface. Use this diagram to help you think about which types of light could be causing the damage that can lead to skin cancer.



Which types of light reach Earth's surface? (check all that apply)

- ☐ gamma rays
- ☐ X-rays
- ☐ ultraviolet light
- ☐ visible light
- ☐ infrared light
- ☐ microwave
- ☐ radio waves

From the types of light that reach Earth's surface, which do you think could be causing skin cancer? Explain your reasoning.

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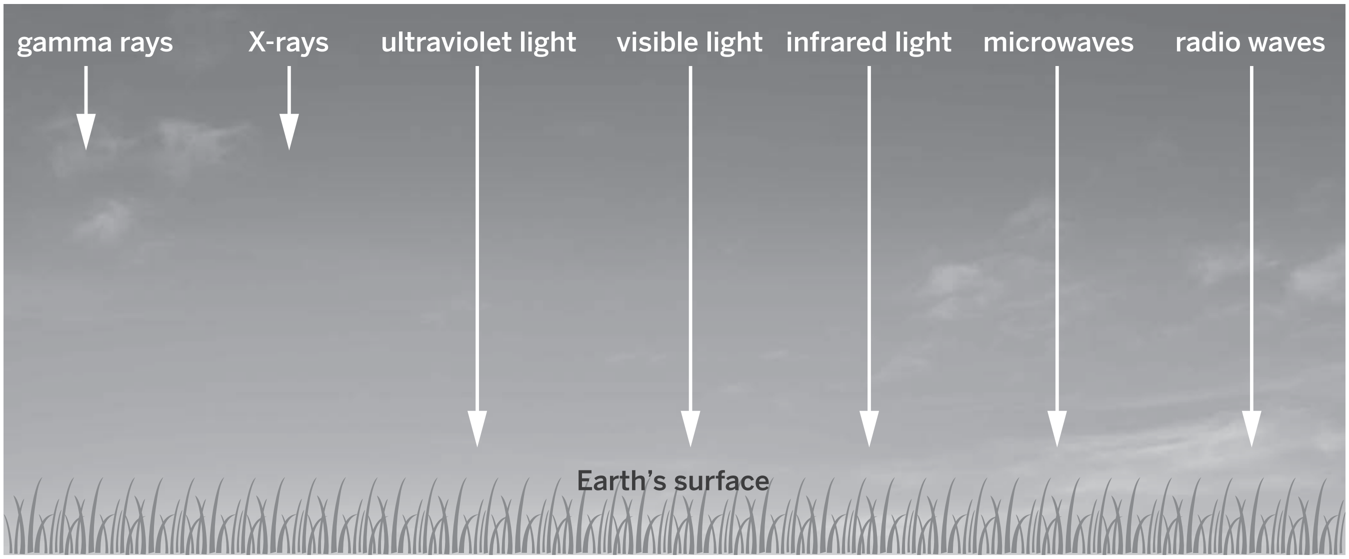
Investigating Light's Effect on Genetic Material

Part 1: Modeling Light's Effect on Genetic Material



Goal: Show what happens to genetic material when it is exposed to different types of light from the sun.

Do:
Use the *Light Waves* Simulation to test the effects of different types of light from the sun on genetic material. Refer to the image above to see which types of light from the sun reach Earth's surface. Turn Show Energy on.

- Drag GENETIC MATERIAL to a platform in the testing area.
- Set the light source to LASER and turn on the light.
- Use the slider to change the type of light the laser emits. Test:
    - Ultraviolet (UV)
    - Visible (any color)
    - Infrared (IR)
    - Microwave
    - Radio
- Record the results on your Modeling Tool activity: Investigating Light's Effect on Genetic Material on pages 51–52.
    - If the type of light has an effect on genetic material, record it on Model A.
    - If the type of light has no effect on genetic material, record it on Model B.
    - Use a yellow highlighter to trace energy on both Model A and Model B.
    - Draw an arrow from each type of light box to a change box to show which type of light causes which change.

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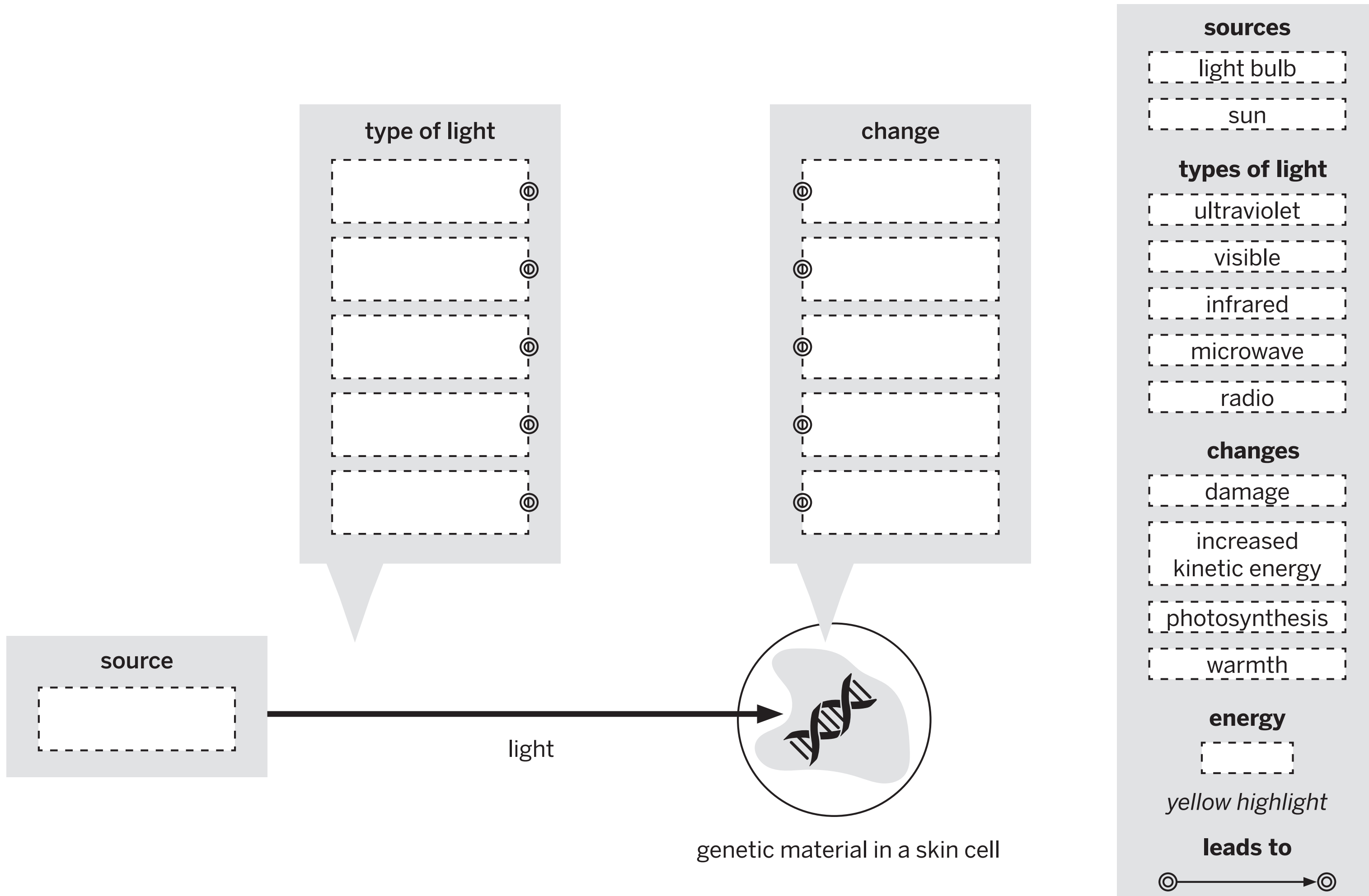
Investigating Light's Effect on Genetic Material (continued)

Model A: Show how different types of light from the sun can cause different changes to genetic material in a skin cell.



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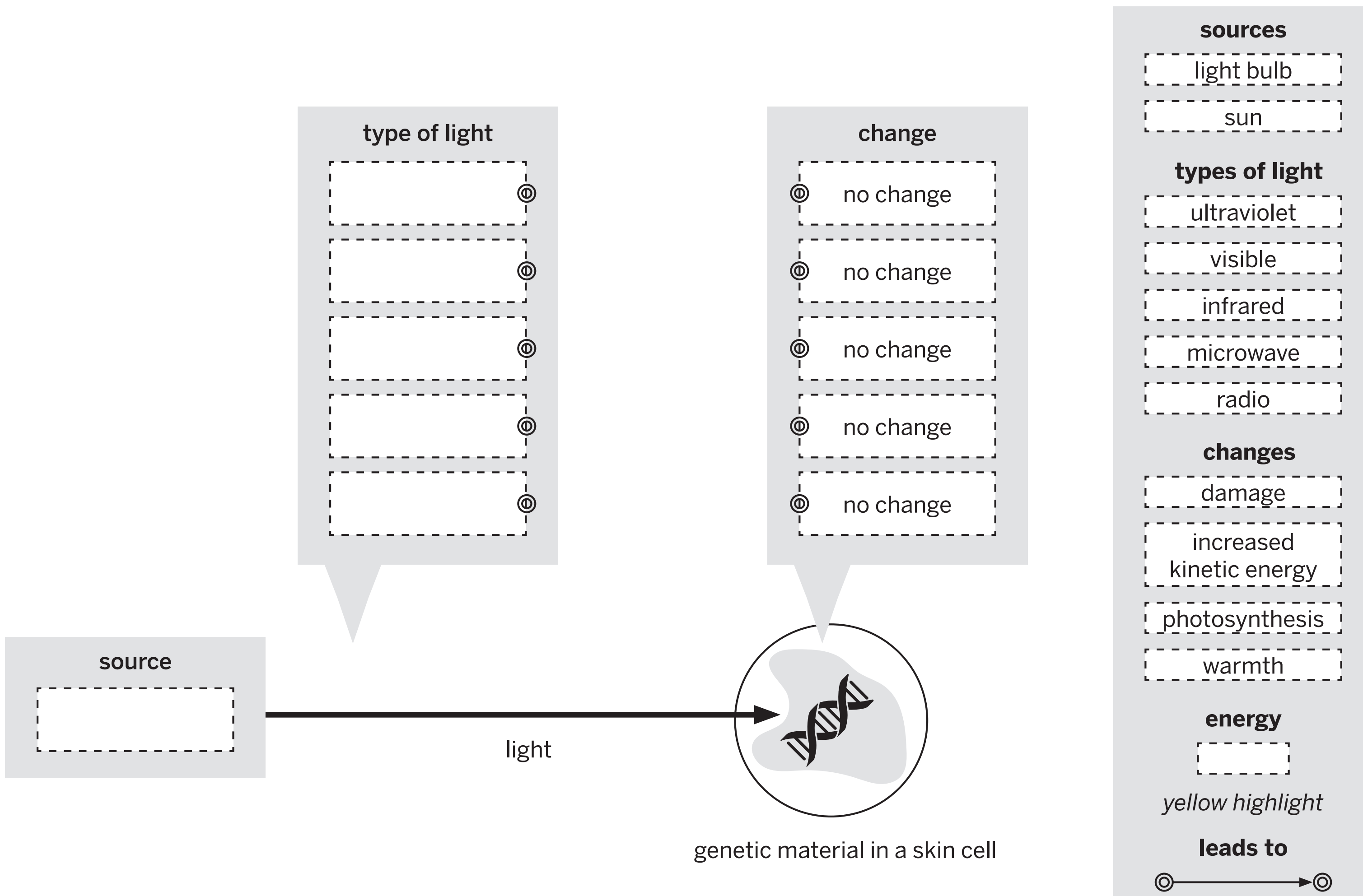
Investigating Light's Effect on Genetic Material (continued)

Model B: Show what happens when different types of light from the sun cause no change to genetic material in a skin cell.



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Investigating Light's Effect on Genetic Material (continued)

Part 2: Summarizing Results

After you have tested the five types of light from the sun that reach Earth's surface, answer these questions by choosing one or more options.

Which types of light are absorbed by genetic material? (check all that apply)

- ☐ ultraviolet (UV)
- ☐ visible
- ☐ infrared (IR)
- ☐ microwave
- ☐ radio

Which types of light cause damage to genetic material? (check all that apply)

- ☐ ultraviolet (UV)
- ☐ visible
- ☐ infrared (IR)
- ☐ microwave
- ☐ radio

Which types of light are not absorbed by genetic material? (check all that apply)

- ☐ ultraviolet (UV)
- ☐ visible
- ☐ infrared (IR)
- ☐ microwave
- ☐ radio

Write **yes** or **no** to the following questions, based on your investigation.

Can ultraviolet (UV) light cause damage that leads to skin cancer? ____________

Can visible light cause damage that leads to skin cancer? ____________

Can infrared (IR) light cause damage that leads to skin cancer? ____________

Can microwaves cause damage that leads to skin cancer? ____________

Can radio waves cause damage that leads to skin cancer? ____________

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Name: ______________________________ Date: ________________

Discussing the Cause of Skin Cancer

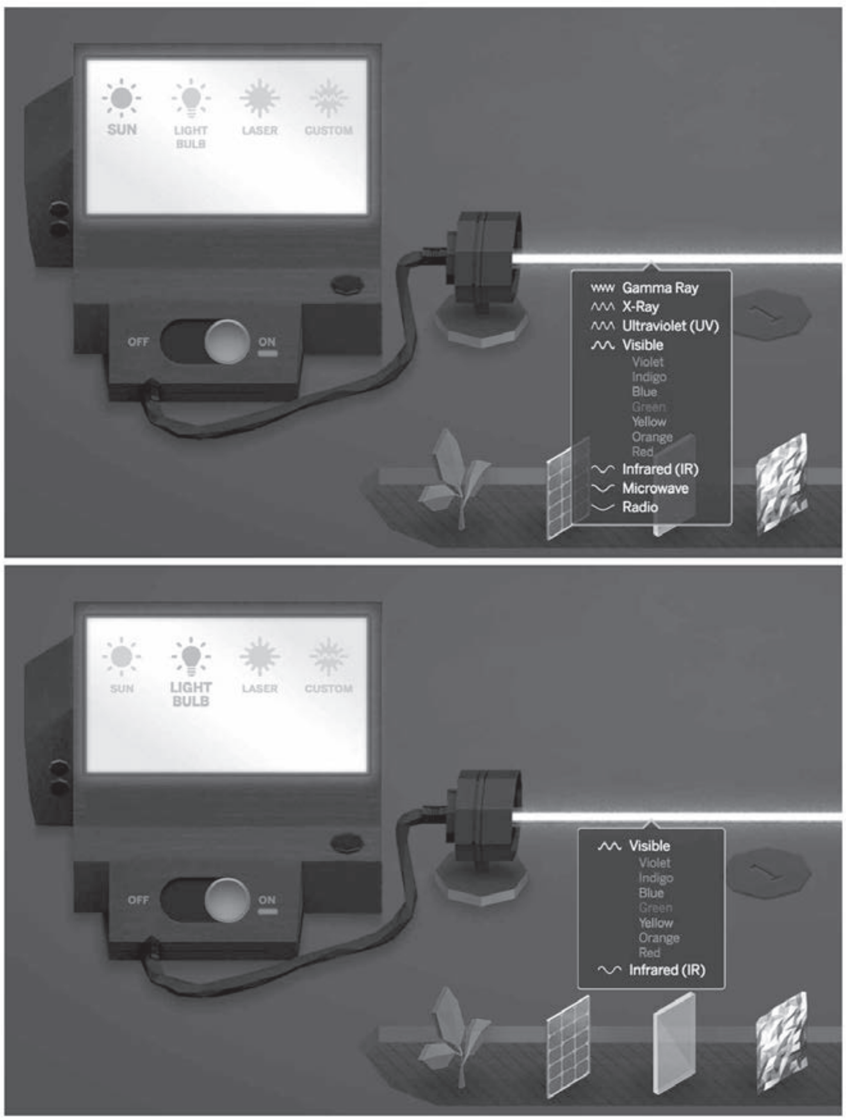
Can a light bulb cause skin cancer?

Consider these two claims:

Claim 1: Light from the sun and light from a light bulb can cause skin cancer.

Claim 2: Light from the sun can cause skin cancer, but light from a light bulb cannot.

The image below shows evidence from the Sim about these two light sources. Use this image and your completed Modeling Tool activity: Investigating Light's Effect on Genetic Material on pages 51–52 to decide which claim is supported by the evidence. Discuss your argument with your partner and then record your thinking on the next page.



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Discussing the Cause of Skin Cancer (continued)

Which claim do you agree with? (circle one)

Claim 1

Claim 2

Which claim does your partner agree with? (circle one)

Claim 1

Claim 2

What evidence supports your claim?

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Choose one type of light that can cause skin cancer and one type of light that cannot, then explain why.

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Name: ____________________ Date: ____________

Homework: Reading “What Is Melanin?”

Learning more about melanin, which is found in skin cells, might help you solve the mystery of Australia’s high skin cancer rate. Read and annotate the article using the Active Reading strategies that work best for you. Then, answer the questions below.

1. What did you find interesting in the article?

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2. What questions do you have about melanin?

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Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

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Name: ______________________ Date: ______________

Lesson 2.5: Analyzing Evidence About Melanin and UV Light

We now know that when ultraviolet (UV) light travels through the atmosphere and reaches someone's skin, it can be absorbed by the genetic material in skin cells and cause damage that can lead to skin cancer. Luckily we have something in our skin called melanin, which provides some protection against UV light. In this lesson, you will investigate how melanin protects skin and examine evidence about melanin levels and UV light in Australia. This will allow you to make a clearer explanation of why the skin cancer rate in Australia is so high.

Unit Question

- How does light interact with materials?

Chapter 2 Question

- How can the same amount of sunlight cause different rates of skin cancer?

Key Concepts

- There are different types of light that can affect a material in different ways.
- A light source can emit more than one type of light.
- Different types of light have different wavelengths.
- A material absorbs energy from some types of light and not others.

Vocabulary

- absorb
- claim
- emit
- energy
- evidence
- light

Digital Tools

- *Light Waves* Simulation

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Name: ______________________________ Date: ____________________

Warm-Up

Melanin and Genetic Material

Use the *Light Waves* Simulation to learn about how melanin can protect genetic material in skin cells from ultraviolet (UV) light.

1. Open the *Light Waves* Simulation.
2. Drag a MELANIN molecule to platform 1 and GENETIC MATERIAL to platform 2.
3. Set the light source to LASER.
4. Use the slider to change the type of light to Ultraviolet (UV) and turn on the light.
5. Turn Show Energy on and observe what happens to the energy from UV light. Inspect the genetic material.
6. Remove the MELANIN from platform 1 and repeat the test with only the GENETIC MATERIAL on platform 2.

What did you observe about the energy from the UV light when melanin was blocking the genetic material?

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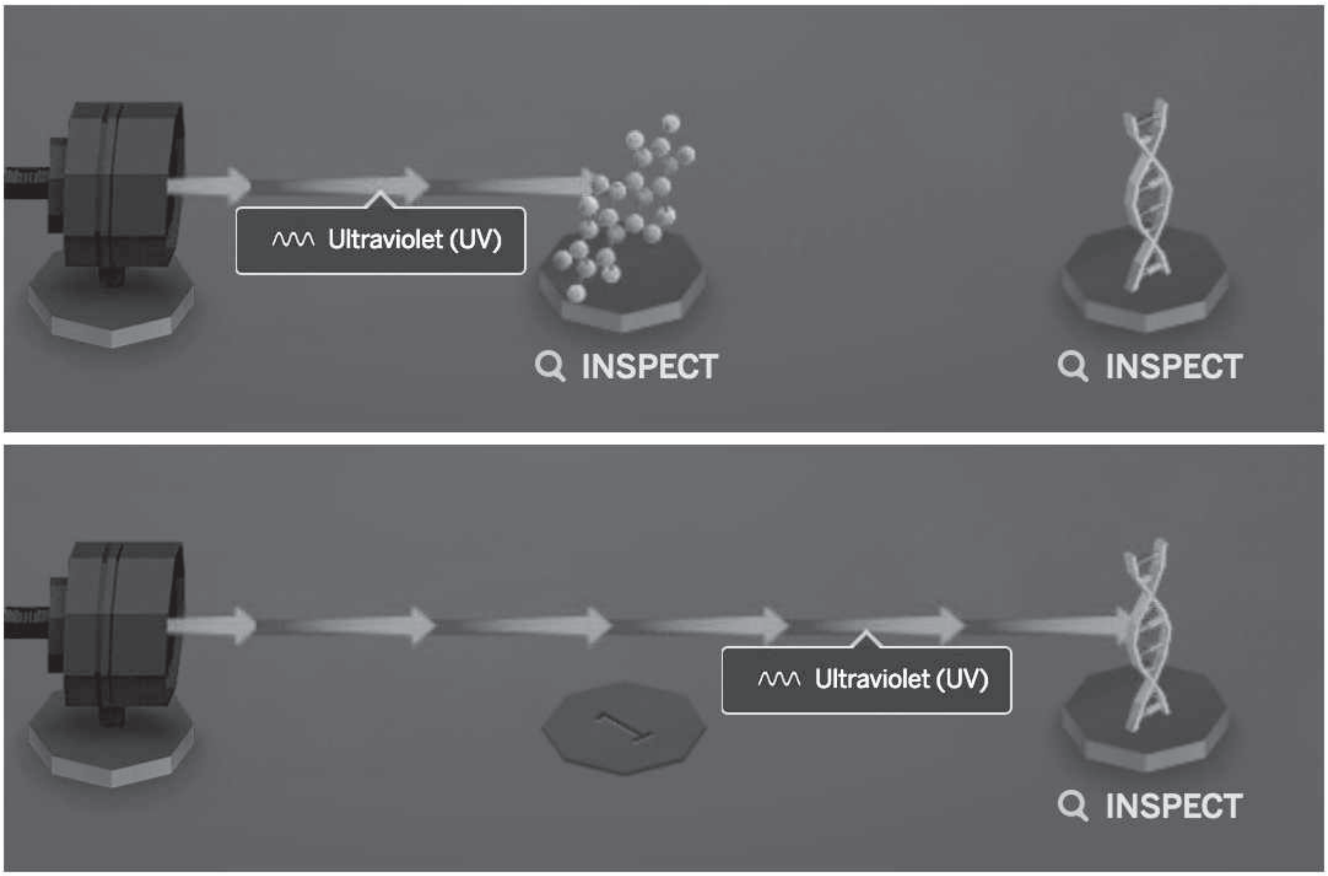
Name: ______________________________ Date: ________________

Write and Share: Student 1

Evidence Source: Screenshot from the *Light Waves* Simulation.



Prompt: How does melanin provide protection against skin cancer?

Examine and annotate this screenshot from the Sim, then write an explanation of how this evidence helps answer the question. Use the following words in your explanation: *absorb, energy, light.*

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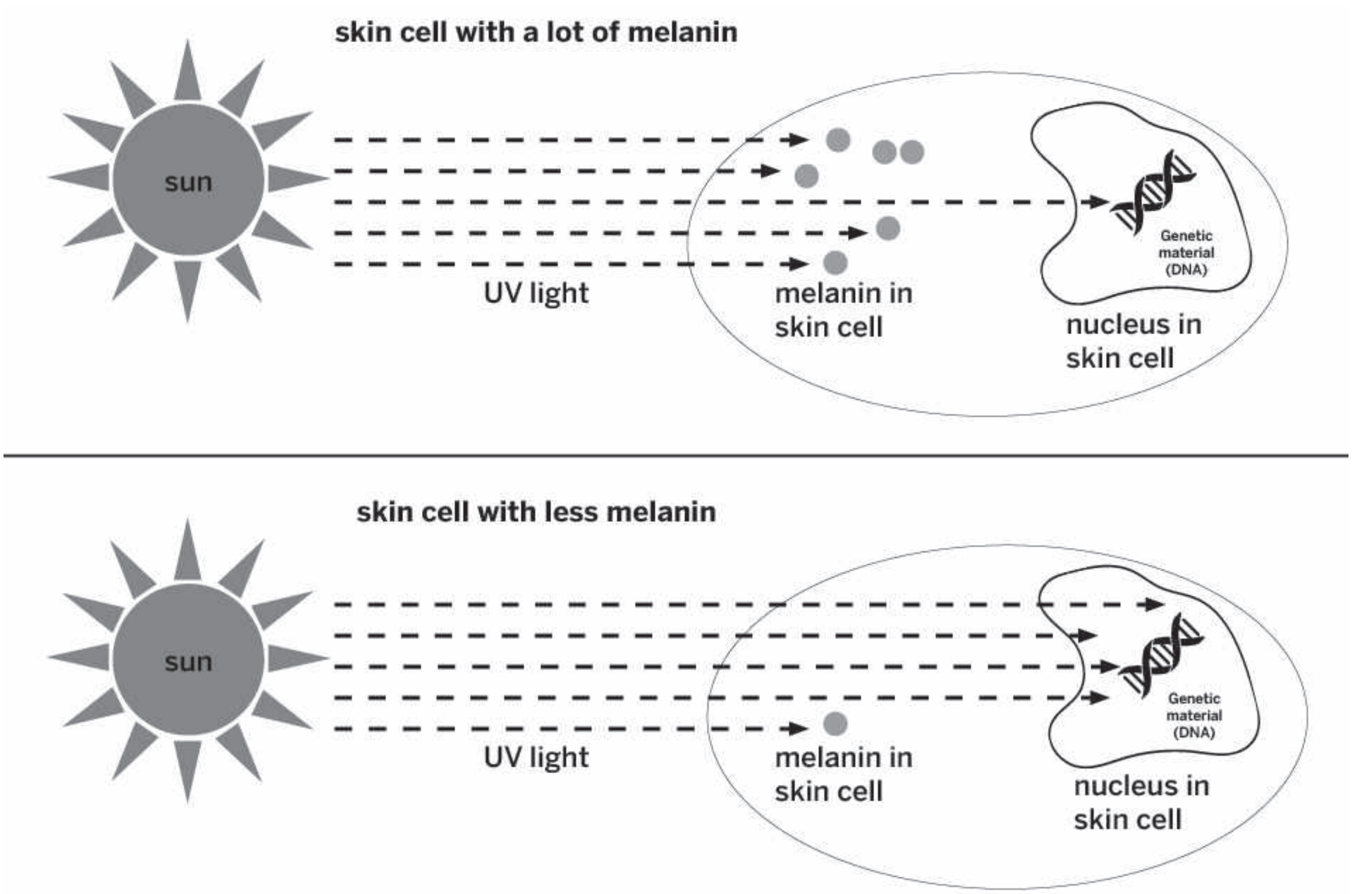
Name: ____________________ Date: ____________

Write and Share: Student 2

Evidence Source: Diagram from the "What Is Melanin?" article.



Prompt: How does melanin provide protection against skin cancer?

Examine and annotate the diagram from the "What Is Melanin?" article, then write an explanation of how this evidence helps answer the question. Use the following words in your explanation: *absorb, energy, light.*

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Name: ______________________________ Date: ____________________

Write and Share: Student 3

Prompt: How does melanin provide protection against skin cancer?

Read and annotate the second paragraph of the "What Is Melanin?" article, then write an explanation of how this evidence helps answer the question. Use the following words in your explanation: *absorb, energy, light.*

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Name: ______________________________ Date: ____________________

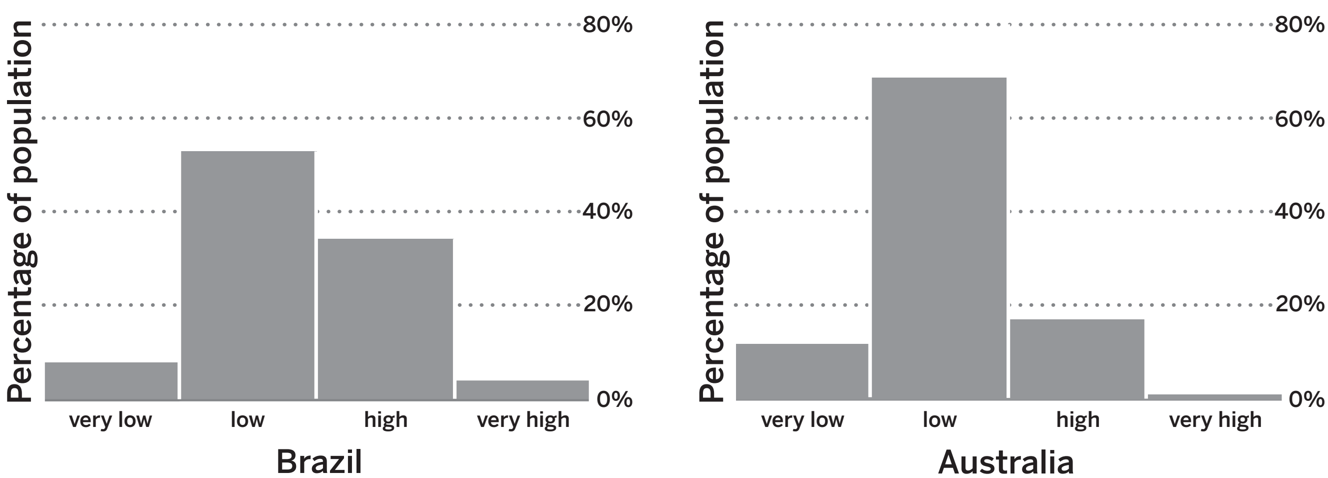
Discussing Skin Cancer Factors

Part 1: Discussing Melanin Levels Bar Graphs

When studying the connection between melanin levels and skin cancer risk, scientists group people by how much melanin they have in their skin cells. Below are two bar graphs, one for Australia and one for Brazil. Each bar graph shows the estimated percentage of the population with different levels of melanin. Examine and annotate this evidence, using the questions below to guide you.

- Compare the graphs. What does the evidence show?
- How does this evidence help explain why the skin cancer rate is higher in Australia than in Brazil, even though the two countries get the same amount of sunlight?

Estimated Percentage of Populations with Each Melanin Level



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Discussing Skin Cancer Factors (continued)

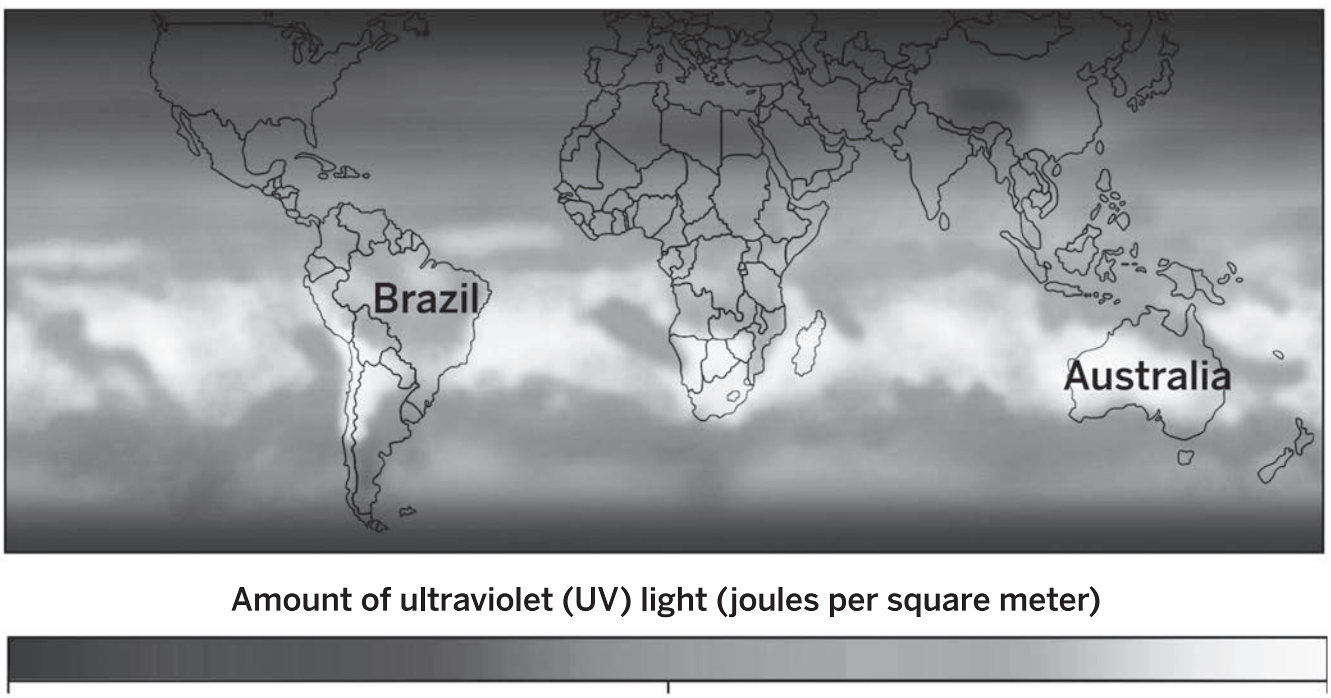
Part 2: Discussing World Ultraviolet (UV) Light Evidence

The World Ultraviolet (UV) Light Map below shows the amount of UV light reaching the surface. Examine and annotate the map, using the questions below to guide you.

- What does the evidence show?
- How does this evidence help explain why the skin cancer rate is higher in Australia than in Brazil, even though the two countries get the same amount of sunlight?

Note: Your teacher will project a color version of this image.

World Ultraviolet (UV) Light Map



Source: NASA Earth Observatory

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Name: ______________________________ Date: ______________

Discussing Skin Cancer Factors (continued)

Part 3: Returning to Claims About Australia's Skin Cancer Rate

You have been investigating why Australia's skin cancer rate is so high. Talk to your partner about the evidence you have so far that supports or goes against the claims below. This will help you prepare to write an argument for the Australian Health Alliance (AHA).

Question: Why is Australia's skin cancer rate so high?

Claim 2: There is something different about the sunlight in Australia.

Claim 3: More people in Australia have skin that is easily damaged by light from the sun.

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Homework: Supporting a Claim

You have been investigating why Australia's skin cancer rate is so high. The Australian Health Alliance has asked you to write a short argument that explains this to the Australian public. Remember to explain how your evidence supports your claim to make your argument as complete and convincing as possible. You can agree with one or both of the claims.

Question: Why is Australia's skin cancer rate so high?

Australia has a higher skin cancer rate because . . .

Claim 2: There is something different about the sunlight in Australia.

Claim 3: More people in Australia have skin that is easily damaged by sunlight.

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Homework: Check Your Understanding

This is a chance for you to reflect on your learning so far. This is not a test. Be open and truthful when you respond to the questions below.

Scientists investigate in order to figure things out. You have been investigating why Australia's skin cancer rate is so high. Are you getting closer to understanding the cause of Australia's high skin cancer rate?

1. I understand how light from the sun can cause skin cancer. (check one)
   - ☐ yes
   - ☐ not yet

Explain your answer choice.

____

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2. I understand why different types of light can change materials in different ways. (check one)
   - ☐ yes
   - ☐ not yet

Explain your answer choice.

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3. I understand the different things that can happen when a light wave hits a material. (check one)
   - ☐ yes
   - ☐ not yet

Explain your answer choice.

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Homework: Check Your Understanding (continued)

4. I understand why light sometimes changes a material and sometimes doesn't. (check one)
   - ☐ yes
   - ☐ not yet

Explain your answer choice.

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5. What do you still wonder about how light can interact with materials?

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Chapter 3: More Light Interactions
Chapter Overview

Australia receives more UV light than Brazil, but how is this possible when each place receives the same amount of sunlight? In Chapter 3, you will investigate what can happen to light as it travels. This will help you to determine if something different is happening to the light as it passes through the atmosphere above Australia. Soon, you will be able to explain why the skin cancer rate in Australia is so high.

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Lesson 3.1: Following the Path of Light

Australian citizens are still waiting to understand why the skin cancer rate in their country is so high. You now know that skin cancer rates are affected by differences in the amount of melanin in skin cells and by differences in the amount of ultraviolet (UV) light that skin cells absorb. Why does Australia receive more UV light than Brazil, even though the two countries receive the same amount of sunlight? To answer this question, you will need to know more about what happens to light as it travels.

Unit Question

- How does light interact with materials?

Chapter 3 Question

- Why does Australia get more ultraviolet light than other parts of the world?

Vocabulary

- absorb
- energy
- light
- light source
- reflect
- transmit
- visualize
- wave

Digital Tools

- *Light Waves* Simulation

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Name: ____________________ Date: ____________________

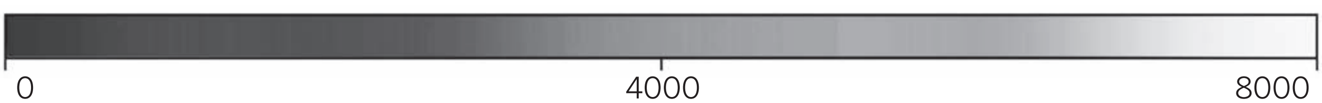
Warm-Up

Ultraviolet Light

You've learned that light from the sun includes different types of light, including gamma rays, X-rays, ultraviolet (UV) light, infrared light, microwaves, radio waves, and visible light. You've also learned that Australia gets more UV light than other parts of the world. **Note:** Your teacher will project a color version of this map.

World Ultraviolet (UV) Light Map (joules per square meter)

Amount of ultraviolet (UV) light



Source: NASA Earth Observatory

Why does Australia get more UV light than other parts of the world? Record your initial ideas.

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Name: ______________________________ Date: ________________

Investigating the Path of Light

Safety Note: Laser Pointers

Although the laser pointers in the kit are fairly low energy, they should not be shined into eyes.

Path of Light Mission

Your mission is to set up the materials so that the red light from the laser touches every object in its path. During this mission, you will gather evidence to support or refute these claims about how light moves:

- **Claim 1:** Light can travel in a curved line.
- **Claim 2:** Light can go through a material.
- **Claim 3:** Light can bounce off a material.

When you have found a setup that works, draw a diagram of your setup on the next page. Use a dotted line to draw the path of light from the laser to each of the objects.

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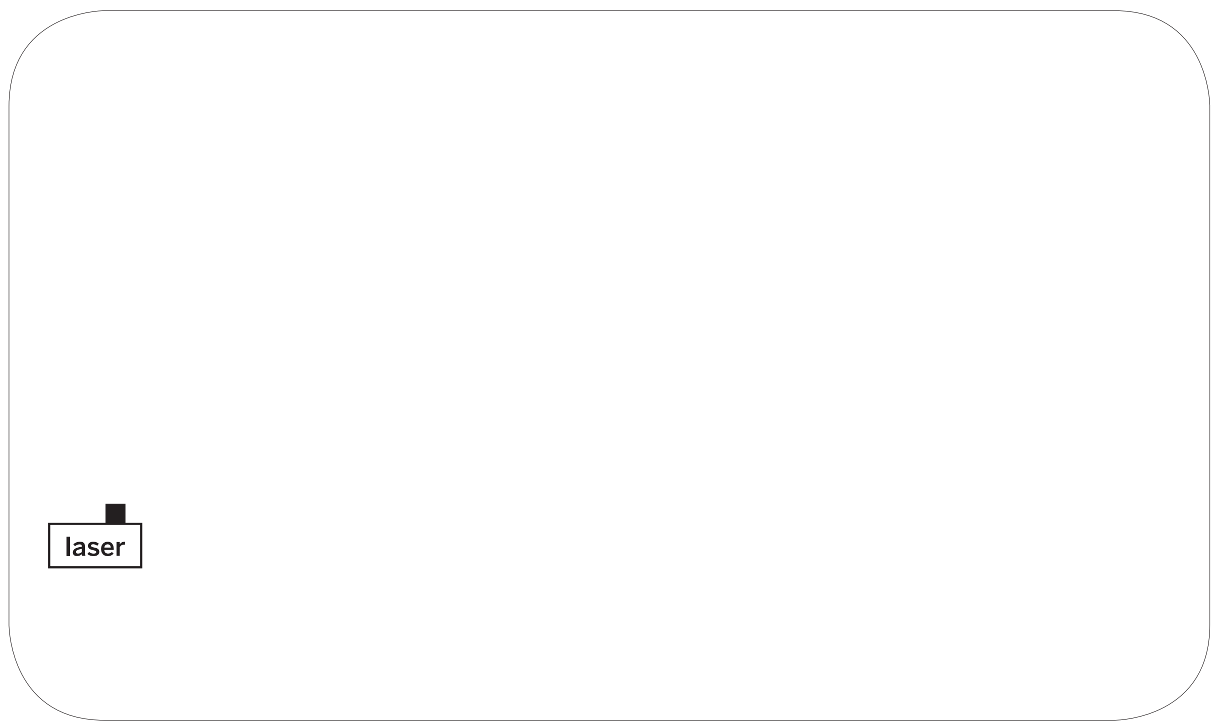
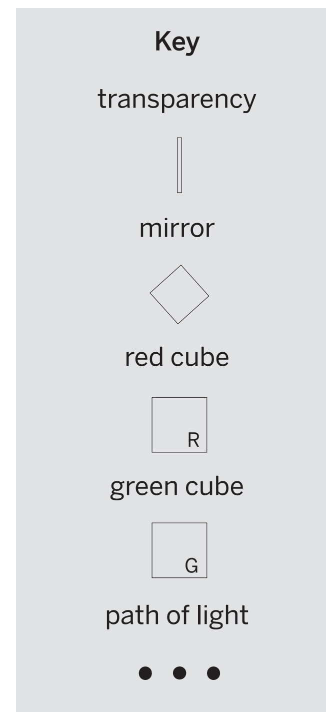
Name: ____________________ Date: ____________________

Investigating the Path of Light (continued)

Using the key below, draw a simple diagram of the path the light from the laser traveled in order to touch each object. Be sure to label each of your materials. Use a dotted line to draw the path of the light. The laser has been drawn for you.





Discussion Prompts:

- What evidence do you have to support or go against Claim 1: *Light can travel in a curved line?*
- What evidence do you have to support or go against Claim 2: *Light can go through materials?*
- What evidence do you have to support or go against Claim 3: *Light can bounce off materials?*

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Testing Glass and Aluminum Foil

Part 1: Predictions About Glass and Aluminum

With a partner, discuss which types of light you think will pass through glass and which will pass through aluminum foil. Note your predictions below.

glass

aluminum foil

I predict that ____________________ will pass through glass. (check one)

- ☐ all types of light
- ☐ some types of light
- ☐ no light

I predict that ____________________ will pass through aluminum foil. (check one)

- ☐ all types of light
- ☐ some types of light
- ☐ no light

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Name: ______________________________ Date: ____________________

Testing Glass and Aluminum Foil (continued)

Part 2: Investigating Glass and Aluminum

Investigate what happens when light hits glass and when light hits aluminum foil. Remember:

If the light is taken in by the material, it is absorbed.

If the light passes through the material, it is transmitted.

If the light bounces off the material, it is reflected.

1. Open the *Light Waves* Simulation
2. Choose LASER and turn the light source on.
3. Drag GLASS to a platform in the testing area.
4. Partner A: Move the slider to select different types of light and test how they interact with glass.
5. Partner B: Record the results below.
6. Switch roles and repeat steps 3 and 4 with ALUMINUM FOIL.
7. When you are done testing, discuss the results with your partner and answer the questions below.

What happened to each type of light when it hit glass? Write **absorbed**, **transmitted**, or **reflected**.

gamma ray: ______________________________

X-ray: ______________________________

ultraviolet (UV): ______________________________

visible (all colors): ______________________________

infrared (IR): ______________________________

microwave: ______________________________

radio: ______________________________

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Name: ______________________________ Date: ____________________

Testing Glass and Aluminum Foil (continued)

What happened to each type of light when it hit aluminum foil? Write **absorbed**, **transmitted**, or **reflected**.

gamma ray: ______________________________

X-ray: ______________________________

ultraviolet (UV): ______________________________

visible (all colors): ______________________________

infrared (IR): ______________________________

microwave: ______________________________

radio: ______________________________

Did the same thing happen to every type of light when it hit glass? Use evidence from the Sim to explain your answer.

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Did the same thing happen to every type of light when it hit aluminum foil? Use evidence from the Sim to explain your answer.

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Name: ______________________________ Date: ______________

Homework: Reading “How Fiber-optic Communication Works”

Did you know that light can be used to send information? To find out how, read and annotate the article using the Active Reading strategies that work best for you. Then, answer the questions below.

1. How does a fiber-optic cable send information quickly over long distances?

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2. Why are digital signals an accurate and reliable way to record and send information?

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Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

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Lesson 3.2: “What Eyes Can See”

To learn more about what is happening to ultraviolet light as it reaches Australia, you are investigating what can happen to light as it travels. Humans have amazing light-detection tools that can help investigate this: our eyes! Today, you’ll read an article about vision that will help you learn more about transmission, reflection, and absorption.

Unit Question

- How does light interact with materials?

Chapter 3 Question

- Why does Australia receive more ultraviolet light than other parts of the world?

Key Concepts

- Light travels in a straight line.
- When a light wave hits a material, the light can be absorbed by the material, transmitted through the material, or reflected off the material.

Vocabulary

- absorb
- emit
- energy
- light
- light source
- reflect
- transmit
- wave
- wavelength

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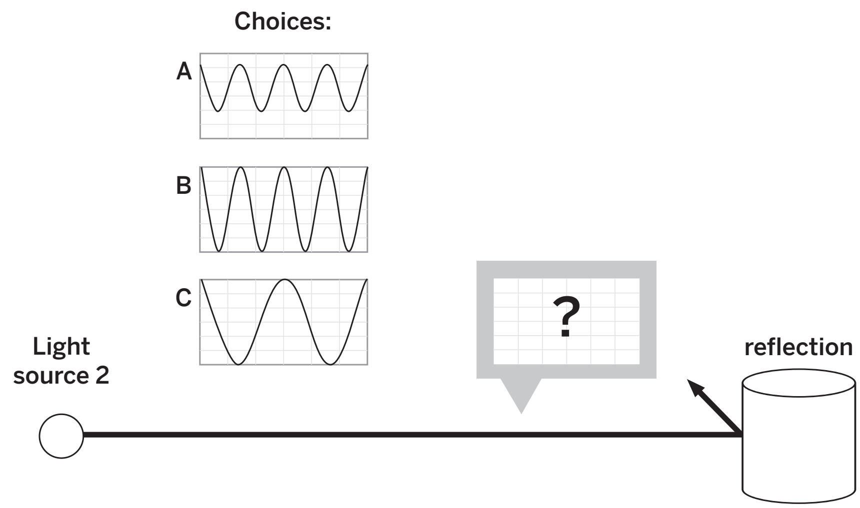
Name: ______________________________ Date: ____________________

Warm-Up

Examining Light Waves

The diagram below shows two different types of light shining on the same material. The type of light from Light Source 1 transmits through the material. The type of light from Light Source 2 reflects off of the material. Examine the diagram, then decide which light wave could be emitted from Light Source 2.



Which light wave could be emitted from Light Source 2? (check one)

☐ A ☐ B ☐ C

Explain your answer.

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Name: ____________________ Date: ____________

Reading "What Eyes Can See"

1. Read and annotate the article "What Eyes Can See."
2. Choose and mark annotations to discuss with your partner. Once you have discussed these annotations, mark them as discussed.
3. Now, choose and mark a question or connection, either one you already discussed or a different one you still want to discuss with the class.
4. Answer the reflection question below.

Rate how successful you were at using Active Reading skills by responding to the following statement:

As I read, I paid attention to my own understanding and recorded my thoughts and questions.

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Frequently/often
- ☐ All the time

Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

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Homework: Revisiting the Anticipation Guide

Review your original responses to these statements from the Anticipation Guide on page 10.

1. All light can be seen.

   Do you agree or disagree with this statement now? (check one)

   ☐ agree

   ☐ disagree

   ☐ not sure

Explain your thinking.

____

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____

2. Light can travel through materials that you cannot see through, like wood or aluminum foil.

   Do you agree or disagree with this statement now? (check one)

   ☐ agree

   ☐ disagree

   ☐ not sure

Explain your thinking.

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Name: ______________________________ Date: ________________

Homework: Reading "Making Waves at Swim Practice"

Note: If you do not have access to Amplify Science at home, your teacher will provide you with an alternate way to complete this homework.

When you think of waves at a pool, you might only think of water. But, you have been investigating a different kind of wave: light waves. In this article, you will learn more about what happens to light waves as they travel through different materials. You also have a chance to learn about what happens to a different kind of wave—sound waves—as they travel through metal, air, and water.

Read the article while using the Active Reading strategies that work best for you. When you are finished reading, answer the question below.

Question: You read that light waves travel through air and water at different speeds. What is one way this can affect what you see around you?

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Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

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Lesson 3.3: Reflection, Transmission, and Energy

You know that a material changes when it absorbs energy from light. What about when a material reflects or transmits light? Today, you will return to the article "What Eyes Can See" and use the *Light Waves* Simulation to investigate what happens to energy from light when light is reflected off or transmitted through a material. Understanding all the ways light can travel will help you explain why Australia gets more UV light than other parts of the world.

Unit Question

- How does light interact with materials?

Chapter 3 Question

- Why does Australia get more UV light than other parts of the world?

Key Concepts

- Light travels in a straight line.
- When a light wave hits a material, the light can be absorbed by the material, transmitted through the material, or reflected off the material.
- A material transmits or reflects some types of light and not others.

Vocabulary

- absorb
- emit
- energy
- light
- light source
- reflect
- transmit
- wavelength
- visualize

Digital Tools

- *Light Waves* Simulation

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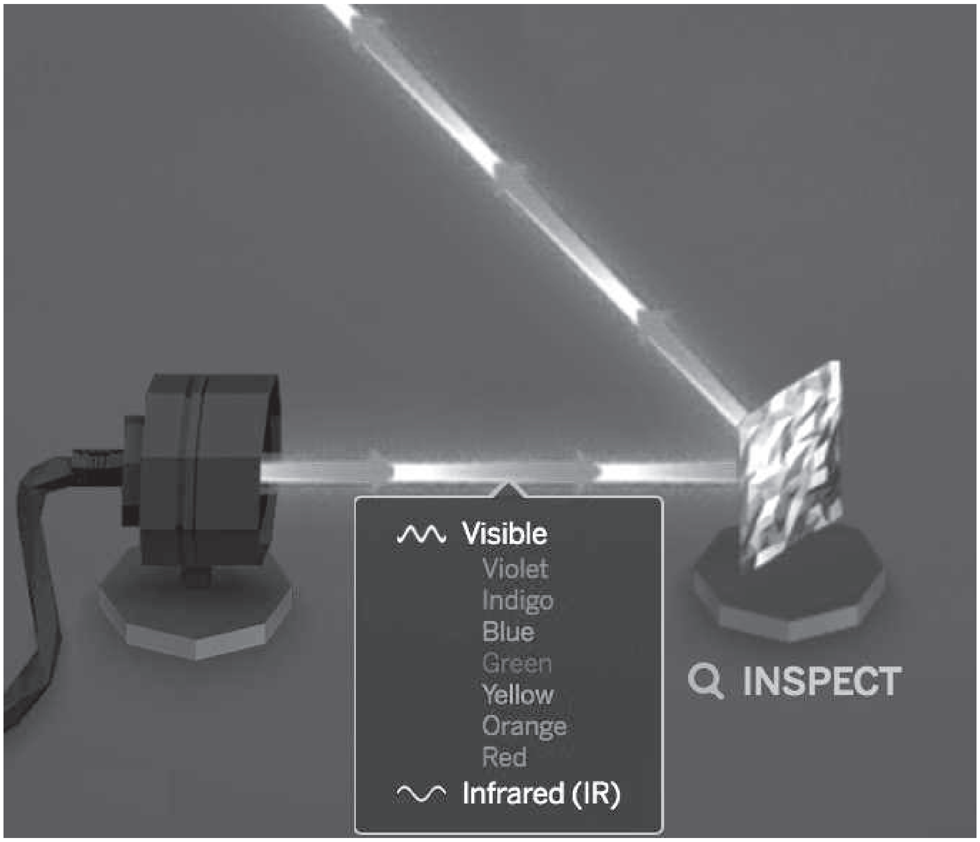
Name: ______________________ Date: ______________

Warm-Up



The image above shows light from a light bulb reflecting off aluminum foil. All of the light is being reflected. Do you think that the aluminum foil will get warm? (check one)

- ☐ yes
- ☐ no

Explain your answer.

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Name: ____________________ Date: ____________

Energy in Reflection and Transmission

Sim Mission: Reflection and Transmission

In this mission, you will find two materials that transmit green light and two materials that reflect green light. Then, you will observe what happens to energy when light is transmitted or reflected. Use your observations in this mission to help you answer the Investigation Question: *What happens to energy when light is transmitted through or reflected off a material?*

1. Open the *Light Waves* Simulation
2. Set the light source to LASER, set the color to GREEN, and turn it ON.
3. Search for materials that transmit or reflect green light by dragging them to a platform in the testing area, one at a time.
4. When you find a material that either **transmits** or **reflects** light, do the following:
   - Turn Show Energy on to observe what happens to the energy in the light.
   - Press INSPECT to observe whether the material changes.
   - Record your observations in the data table below.
5. Repeat steps 3–4 until you have completed the data table with two materials that transmit green light and two materials that reflect green light.

What happened to the green light?	Material tested	What happened to the energy in the light?	Did the material change?
Transmitted			
Reflected			

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Name: ______________________________ Date: ________________

Energy in Reflection and Transmission (continued)

Use your observations from the Sim to answer the Investigation Question: *What happens to energy when light is transmitted through or reflected off a material?*

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Name: ____________________ Date: ____________

Rereading "What Eyes Can See"

How Visible Light Affects Temperature

When visible light shines on black objects, the objects get warm, but when the same light shines on white or clear objects, there is no change. How can this be true? Preview the question below, then reread the fifth and sixth paragraphs in the "What Eyes Can See" article to answer the question. As you read, you may want to highlight or annotate parts of the text that will help you to answer the question.

Question: What happens to visible light as it hits black, white, and clear objects?

Discuss your ideas with your partner and then write your response below.

1. When visible light shines on a black object, it gets warm because . . .

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2. When visible light shines on a white object or a clear object, there is no change because . . .

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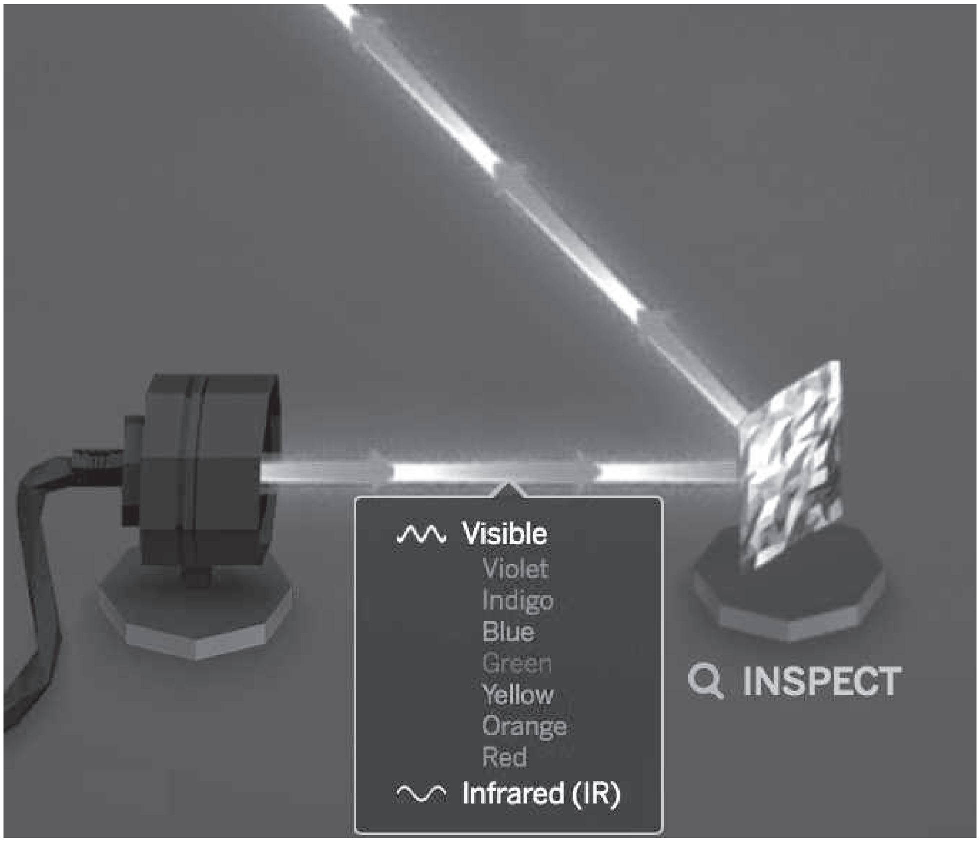
Name: ______________________ Date: ______________

Homework: Revisiting the Warm-Up

Revisit your ideas from the Warm-Up. Revise or add to your explanation using what you learned in this lesson.



The image above shows light from a light bulb reflecting off aluminum foil. All of the light is being reflected. Do you think that the aluminum foil will get warm? (circle one)

yes **no**

Explain your answer.

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Name: ______________________ Date: ______________

Lesson 3.5: Light and the Atmosphere

As student spectroscopists, you are trying to figure out why Australia gets more ultraviolet (UV) light than other parts of the world. Does something different happen to UV light when it travels through the atmosphere above Australia? Today, you will learn about substances in the atmosphere and use the *Light Waves* Simulation to learn about what happens to UV light when it hits these substances. This activity will also help you to review important ideas about how light interacts with materials.

Unit Question

- How does light interact with materials?

Chapter 3 Question

- Why does Australia get more UV light than other parts of the world?

Key Concepts

- The movement of energy can be tracked by observing the changes the energy causes to matter.
- Light carries energy that causes materials to change.
- When light hits a material, the material can absorb energy from the light.
- When a material absorbs energy from light, the energy causes the material to change.
- There are different types of light that can change a material in different ways.
- A light source can emit more than one type of light.
- Different types of light have different wavelengths.
- A material absorbs energy from some types of light and not others.
- Light travels in a straight line.
- When a light wave hits a material, the light can be absorbed by the material, transmitted through the material, or reflected off the material.
- A material transmits or reflects some types of light and not others.
- When light is transmitted through or reflected off a material, the energy is not absorbed, so the material does not change.

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Name: ____________________ Date: ____________

Lesson 3.5: Light and the Atmosphere (continued)

Vocabulary

- absorb
- emit
- energy
- light
- light source
- reflect
- transmit

Digital Tools

- *Light Waves* Simulation

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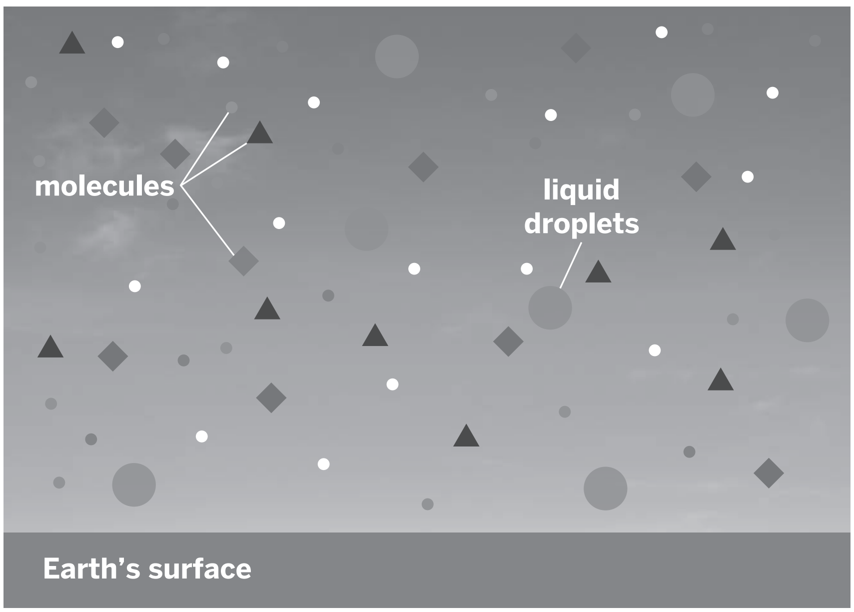
Name: ____________________ Date: ____________________

Warm-Up

Light in the Atmosphere

Today, you will investigate how light interacts with different materials in Earth's atmosphere. Examine the diagram and read the information in the caption, then answer the question below.

What's in the Atmosphere?



Earth's atmosphere is made up of gases like oxygen, nitrogen, carbon dioxide, and ozone, as well as some tiny liquid droplets such as sulfuric acid. When light from the sun passes through the atmosphere, it can hit these materials. Different things can happen to the light, depending on the type of light it is and the type of material it hits.

What are some things that might happen to light when it hits different materials on its way through Earth's atmosphere?

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Name: ____________________ Date: ____________

Blue Group: Light Traveling Through the Atmosphere

Part 1: Investigating UV light

You will be investigating ozone, but first you will learn a little more about ultraviolet (UV) light. You know that UV light damages genetic material in skin cells—but is UV light dangerous to all materials? *Does ultraviolet (UV) light affect all materials the same way?* Use the *Light Waves* Simulation to investigate this question.

First, make a prediction. (check one)

- ☐ UV light will cause damage to all materials.
- ☐ UV light will cause damage to some materials but not others.
- ☐ UV light will only cause damage to genetic material.

Then, test your prediction:

1. Open the *Light Waves* Simulation.
2. Set the light source to LASER, use the slider to select UV light, and turn it on.
3. Turn Show Energy on.
4. Test the following materials to see if your prediction is correct: GENETIC MATERIAL, GLASS, ALUMINUM, SUNSCREEN, and CARBON DIOXIDE.
    - Drag each material to platform 1 in the testing area.
    - INSPECT each material and observe the movement of energy. Note your results on the next two pages.

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Name: ______________________ Date: ______________

Blue Group: Light Traveling Through the Atmosphere (continued)

Material	**Was light absorbed, reflected, or transmitted?**	**What was the effect: warmth, damage, or no change?**	**Was energy absorbed or carried with the light?**
Genetic material			
Glass			
Aluminium			
Sunscreen			
Carbon Dioxide			

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Name: ______________________ Date: ______________

Blue Group: Light Traveling Through the Atmosphere (continued)

When light is transmitted or reflected, is any energy absorbed? (check one)

☐ yes

☐ no

How can you tell?

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Was your prediction about UV light accurate? Explain.

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Name: ______________________________ Date: ______________

Blue Group: Light Traveling Through the Atmosphere (continued)

Part 2: Investigating Ozone

Ozone is a gas found in the atmosphere. The Australian Health Alliance thinks that ozone might have an effect on the skin cancer rate in Australia. *How do the different types of light emitted by the sun interact with ozone?* Use the *Light Waves* Simulation to investigate this question.

First, make a prediction. (check one)

- ☐ Different types of light will all interact with ozone in the same way, because all light is the same.
- ☐ Different types of light will interact with ozone in different ways.

Then, test your prediction.

1. Open the *Light Waves* Simulation.
2. Drag an OZONE molecule to platform 1 in the testing area.
3. Set the light source to SUN and turn it on.
4. Tap on the beam to inspect the light before and after it hits the ozone molecule and observe what happens to the different types of light.
5. Note your results below.

Light	**Absorbed, transmitted, or reflected?**
gamma ray	
X-ray	
ultraviolet (UV)	
visible	
infrared (IR)	
microwave	
radio	

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Name: ______________________ Date: ______________

Blue Group: Light Traveling Through the Atmosphere (continued)

Based on your investigation, could the amount of ozone in the atmosphere be a factor in why Australia gets more UV light than other parts of the world? (check one)

☐ yes

☐ no

Explain your answer.

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Based on your investigation, do all types of light interact with materials in the same way? (check one)

☐ yes

☐ no

Explain your answer.

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Name: ______________________ Date: ______________

Purple Group: Light Traveling Through the Atmosphere

Part 1: Investigating Sulfuric Acid

Sulfuric acid is found in the atmosphere in the form of tiny liquid droplets. The Australian Health Alliance thinks that sulfuric acid might have an effect on the skin cancer rate in Australia. *How do the different types of light emitted by the sun interact with sulfuric acid?* Use the *Light Waves* Simulation to investigate this question.

First, make a prediction: (check one)

- ☐ All types of light will be absorbed by sulfuric acid.
- ☐ All types of light will be transmitted by sulfuric acid.
- ☐ All types of light will be reflected by sulfuric acid.
- ☐ Different types of light will interact with sulfuric acid in different ways.

Then, test your prediction.

1. Open the *Light Waves* Simulation.
2. Drag a SULFURIC ACID DROPLET to platform 1 in the testing area.
3. Set the light source to SUN and turn it on.
4. Tap on the beam to inspect the light before and after it hits the sulfuric acid droplet and observe what happens to the different types of light.
5. Note your results below.

Light	**Absorbed, transmitted, or reflected?**
gamma ray	
X-ray	
ultraviolet (UV)	
visible	
infrared (IR)	
microwave	
radio	

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Purple Group: Light Traveling Through the Atmosphere (continued)

Based on your investigation, could the amount of sulfuric acid in the atmosphere be a factor in why Australia gets more UV light than other parts of the world? (check one)

☐ yes

☐ no

Explain your answer.

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Part 2: Investigating Energy and Reflection

You know that light carries energy. You discovered that sulfuric acid reflects ultraviolet (UV) light. *What happens to the energy the UV light is carrying when the UV light is reflected?* Use the *Light Waves* Simulation to investigate this question.

First, make a prediction: (check one)

☐ When UV light is reflected, the energy the light is carrying will be transferred to the sulfuric acid.

☐ When UV light is reflected, the energy the light is carrying will not be transferred to the sulfuric acid; it will travel with the light.

Then, test your prediction.

1. Open the *Light Waves* Simulation.
2. Drag a SULFURIC ACID DROPLET to platform 1 in the testing area.
3. Set the light source to LASER, use the slider to select UV light, and turn it on.
4. Turn Show Energy on.
5. INSPECT the sulfuric acid droplet to see if it was affected by the UV light.
6. Note your results on the next page.

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Purple Group: Light Traveling Through the Atmosphere (continued)

Was the sulfuric acid droplet affected by the UV light? (check one)

☐ yes

☐ no

Was the energy from the UV light absorbed by the sulfuric acid droplet? (check one)

☐ yes

☐ no

How can you tell?

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Going Further: Sulfuric acid *transmits* radio waves. What do you think happens to the energy in the radio waves?

Explain your thinking.

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If you have time, test your idea to see if you are right.

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Green Group: Light Traveling Through the Atmosphere

Part 1: Investigating Carbon Dioxide

Carbon dioxide is found in the atmosphere as a gas. The Australian Health Alliance thinks that carbon dioxide might have an effect on the skin cancer level in Australia. *How do the different types of light emitted by the sun interact with carbon dioxide?* Use the *Light Waves* Simulation to investigate this question.

First, make a prediction: (check one)

- ☐ All types of light will be absorbed by carbon dioxide.
- ☐ All types of light will be transmitted by carbon dioxide.
- ☐ All types of light will be reflected by carbon dioxide.
- ☐ Different types of light will interact with carbon dioxide in different ways.

Then, test your prediction.

1. Open the *Light Waves* Simulation.
2. Drag a CARBON DIOXIDE molecule to platform 1 in the testing area.
3. Set the light source to SUN and turn it on.
4. Tap on the beam to inspect the light before and after it hits the carbon dioxide molecule and observe what happens to the different types of light.
5. Note your results below.

Light	**Absorbed, transmitted, or reflected?**
gamma ray	
X-ray	
ultraviolet (UV)	
visible	
infrared (IR)	
microwave	
radio	

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Green Group: Light Traveling Through the Atmosphere (continued)

Based on your investigation, could the amount of carbon dioxide in the atmosphere be a factor in why Australia gets more UV light than other parts of the world? (check one)

☐ yes

☐ no

Explain your answer.

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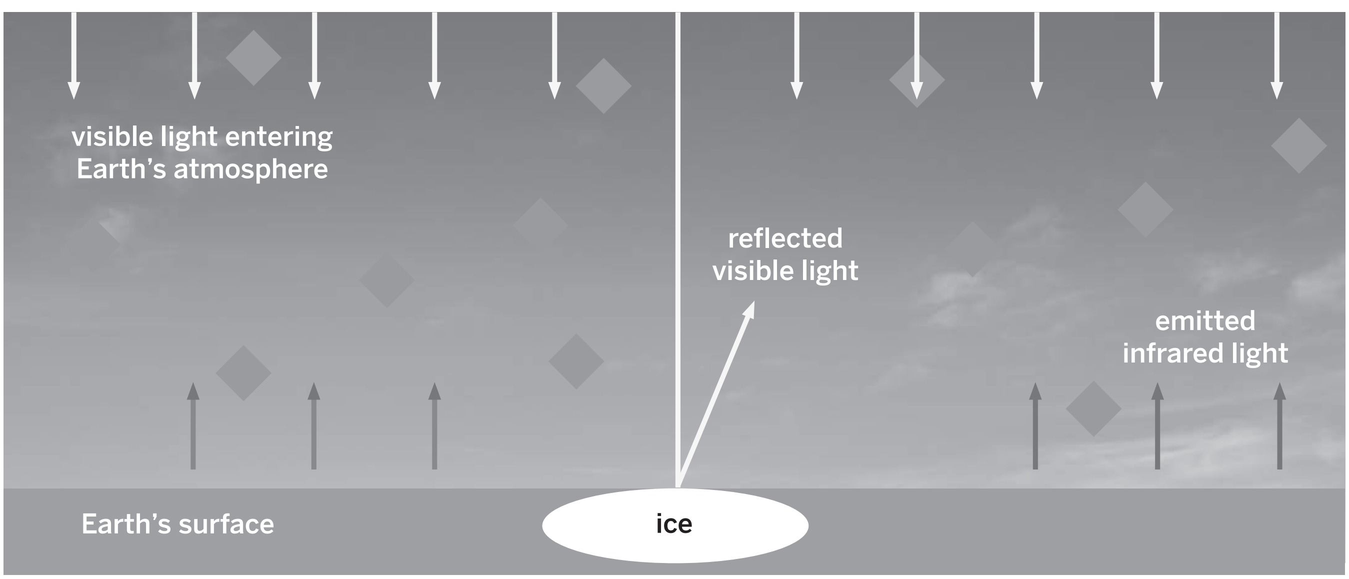
Part 2: How Carbon Dioxide Affects Earth's Atmosphere

You've discovered that carbon dioxide has no effect on the UV light that reaches Earth's surface. But does that mean it doesn't matter how much carbon dioxide there is in the atmosphere?



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Green Group: Light Traveling Through the Atmosphere (continued)

Carbon Dioxide and Light in the Atmosphere

As you've discovered, some types of light from the sun are absorbed by the atmosphere before they reach Earth's surface. Most of the light that makes it to Earth's surface is visible light. When visible light hits Earth's surface, it can be *reflected* back up into the atmosphere, or it can be *absorbed.* You've felt the effect of that absorption if you've walked on a hot sidewalk on a sunny day: light energy that is absorbed warms Earth. This energy can then be emitted again in the form of infrared light, which we can't see. As you discovered in your last investigation, carbon dioxide *transmits* visible light (as well as UV light), allowing visible light to come in. But carbon dioxide *absorbs* infrared light, so the infrared light can't get out! This results in something called the greenhouse effect: energy carried by light from the sun is transmitted through the carbon dioxide in the atmosphere and absorbed by Earth. But when that energy is emitted in the form of infrared light, that same carbon dioxide absorbs it. The energy from the light is trapped, just like in a greenhouse.

Summarize what you've learned about carbon dioxide.

Carbon dioxide ____________ ultraviolet (UV) light. (circle one)

absorbs **transmits** **reflects**

Carbon dioxide ____________ visible light. (circle one)

absorbs **transmits** **reflects**

Carbon dioxide ____________ infrared light. (circle one)

absorbs **transmits** **reflects**

Why do you think increasing carbon dioxide in the atmosphere could be a problem?

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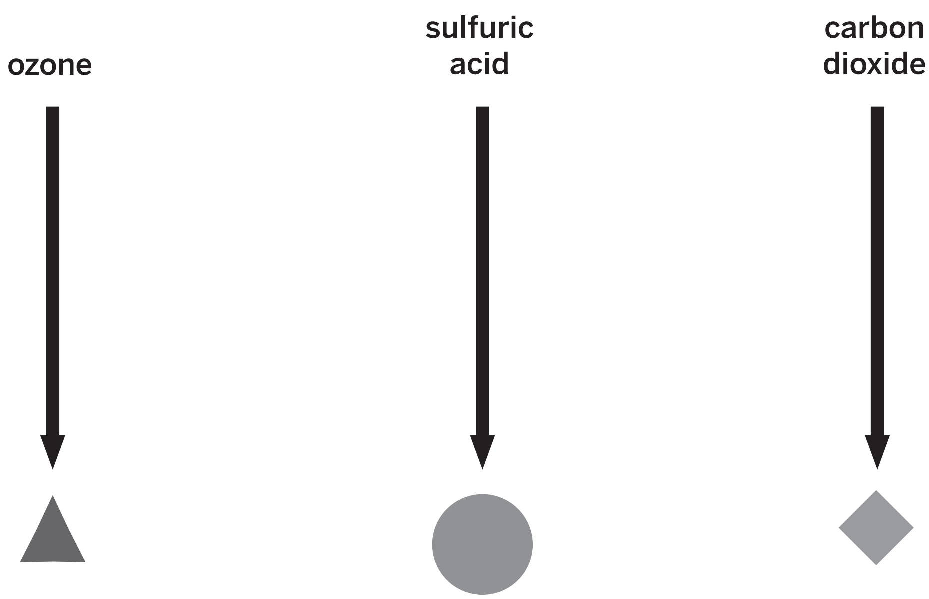
Sharing Results

Substances in the Atmosphere and UV Light

Discuss these questions with your classmates:

- What happens to UV light when it hits ozone molecules?
- What happens to UV light when it hits sulfuric acid droplets?
- What happens to UV light when it hits carbon dioxide molecules?
- Which of these materials could prevent UV light from reaching the surface, and why?

Interactions with UV Light



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Lesson 3.6: Explaining Australia's Skin Cancer Rate

You've learned a lot about what can happen to light as it travels! Today, you will use what you have learned to show why Australia gets more UV light than other parts of the world. Using the Modeling Tool, you'll compare what happens to UV light as it travels through the atmosphere above Australia and the atmosphere above Brazil. The Reasoning Tool (on page 108) will help you organize your evidence before you revise your argument about why the skin cancer rate in Australia is so high. Finally, you'll be ready to help the people of Australia!

Unit Question

- How does light interact with materials?

Chapter 3 Question

- Why does Australia get more UV light than other parts of the world?

Key Concepts

- Light travels in a straight line.
- When a light wave hits a material, the light can be absorbed by the material, transmitted through the material, or reflected off the material.
- A material transmits or reflects some types of light and not others.
- When light is transmitted through or reflected off a material, the energy is not absorbed, so the material does not change.

Vocabulary

- absorb
- energy
- light
- reflect
- transmit
- visualize

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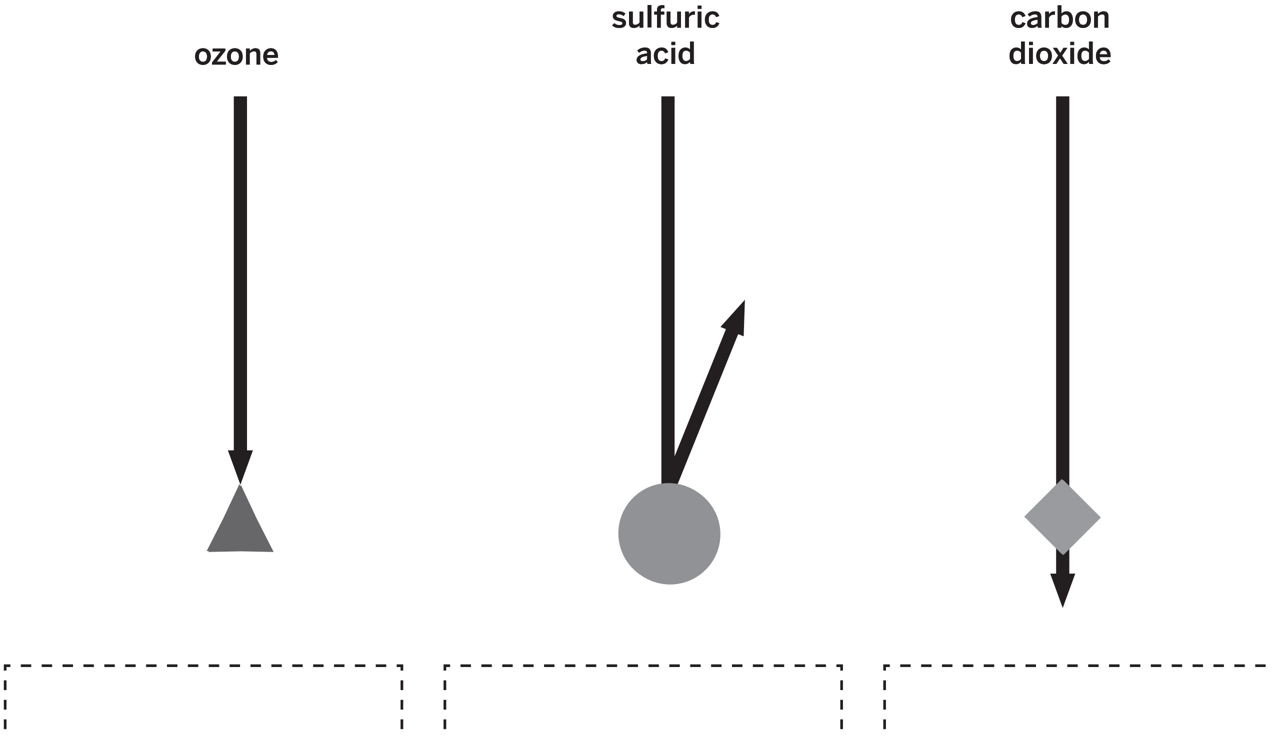
Warm-Up

Ultraviolet Light in the Atmosphere

Review what you learned in the last lesson about how ultraviolet (UV) light interacts with ozone, sulfuric acid, and carbon dioxide. Write the correct label under each interaction to show what happens when UV light hits each material.

Results of Interactions with UV Light



reflects	transmits	absorbs

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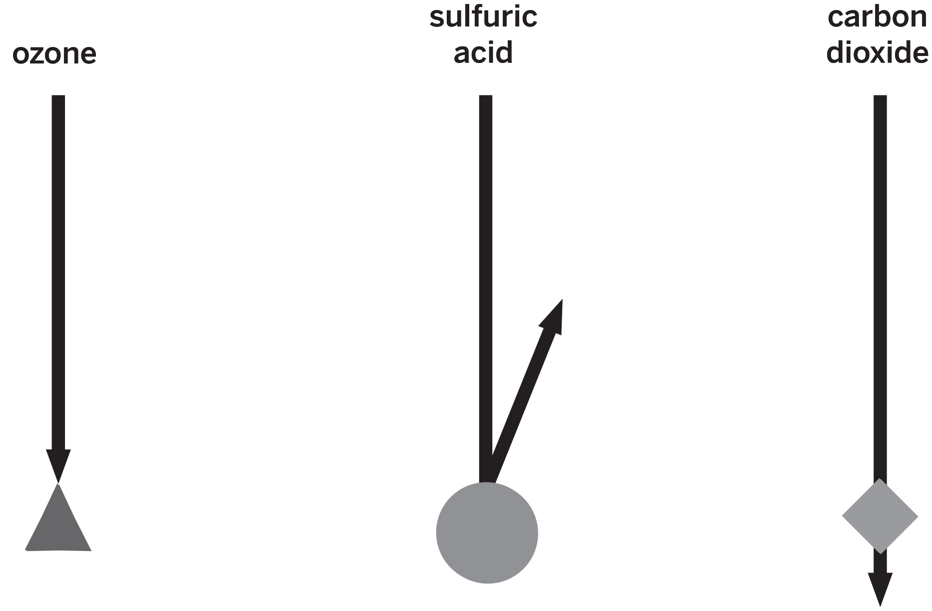
Modeling Ultraviolet Light in the Atmosphere

Part 1: Discussing Evidence

The Australian Health Alliance has sent some new evidence about the atmosphere over Brazil and Australia. Discuss this evidence with your partner. Use the questions below to guide you.

- What is different about the atmosphere above Brazil compared to the atmosphere above Australia?
- Does this difference help explain why Australia gets more UV light than Brazil? If so, how?

Results of Interactions with UV Light



	Ozone	Sulfuric acid	Carbon dioxide
Amount in atmosphere above the country	Brazil has **more** than Austrailia	Brazil and Austrailia have the **same amount**	Brazil and Austrailia have the **same amount**

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Modeling Ultraviolet Light in the Atmosphere (continued)

Part 2: Ultraviolet Light in Australia and Brazil

The Australian Health Alliance is counting on you to help people understand why the skin cancer rate in Australia is so high. Use the Modeling Tool activity: Ultraviolet Light in Australia and Brazil on the next page to show your thinking, following the steps below.

Goal: Show why Australia gets more UV light than Brazil by modeling how UV light waves travel through the atmosphere above each place.

Do:

- Extend each arrow showing the path of UV light as it travels through the atmosphere toward Earth's surface. If the light hits a material in the atmosphere, show what happens to the UV light.
- Use a yellow highlighter to trace the path of energy.
- Annotate your model to help show why Australia gets more UV light than Brazil.

Tips:

- Some materials will not be hit by a UV light wave in your model. This is okay.

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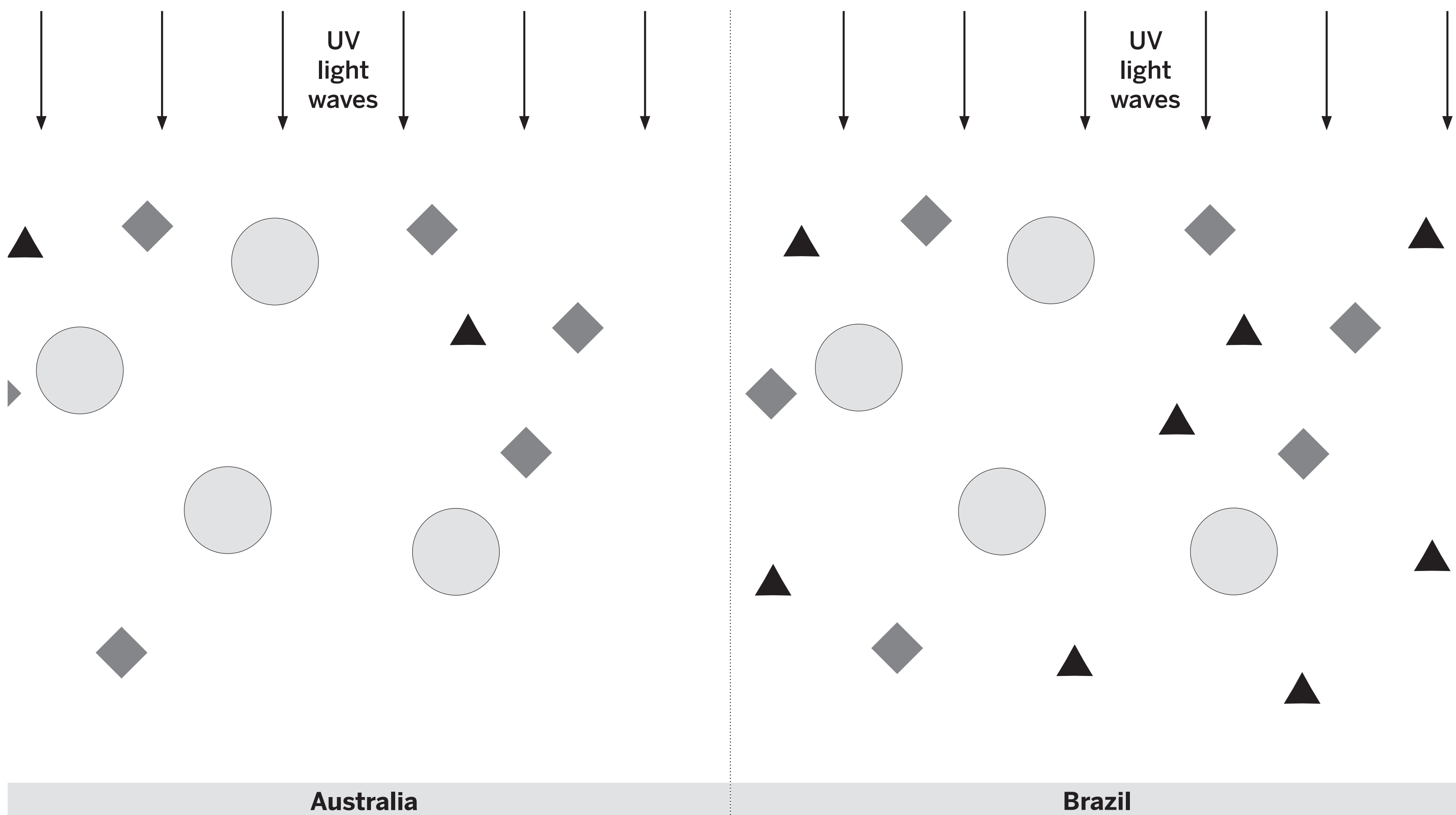
Modeling Ultraviolet Light in the Atmosphere (continued)

Ultraviolet Light in Australia and Brazil

Key: sulfuric acid ○ carbon dioxide ◆ ozone ▲



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Preparing to Write

Reasoning About the Evidence

You have been investigating why the cancer rate in Australia is so high. Use the Reasoning Tool below to connect each piece of evidence to the claim you think is accurate. Explain why each piece of evidence matters, then note the claim you think the evidence supports.

Question: Why is the skin cancer rate in Australia so high?

Claim 2: There is something different about the sunlight in Australia.

Claim 3: More people in Australia have skin that is easily damaged by light from the sun.

Evidence	**This matters because . . .** (How does the evidence support the claim?)	**Therefore, . . .** (claim)
The atmosphere above Australia has less ozone than the atmosphere above other parts of the world. Ozone in the atmosphere absorbs UV light before it reaches Earth.		
A lot of Australians have low levels of melanin in their skin cells. Melanin in skin cells absorbs UV light before it reaches the genetic material inside the cell		

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Homework: Writing an Argument About Australia's Skin Cancer Rate

You now have enough evidence to explain why Australia's skin cancer rate is so high. Review your argument from Chapter 2 and think about how you will convince the AHA that both Claim 2 and Claim 3 are accurate. You will use your completed Reasoning Tool from Activity 3 to revise and add to your argument.

Question: Why is the skin cancer rate in Australia so high?

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Homework: Check Your Understanding

This is a chance for you to reflect on your learning so far. This is not a test. Be open and truthful when you respond to the questions below.

Scientists investigate in order to figure things out. You have been investigating why Australia's skin cancer rate is so high. Are you getting closer to understanding the cause of Australia's high skin cancer rate?

1. I understand how light from the sun can cause skin cancer. (check one)

   - [ ] yes
   - [ ] not yet

Explain your answer choice.

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2. I understand why different types of light can change materials in different ways. (check one)

   - [ ] yes
   - [ ] not yet

Explain your answer choice.

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3. I understand the different things that can happen when a light wave hits a material. (check one)

   - [ ] yes
   - [ ] not yet

Explain your answer choice.

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Name: ______________________________ Date: ____________________

Homework: Check Your Understanding (continued)

4. I understand why light sometimes changes a material and sometimes doesn’t. (check one)

   ☐ yes

   ☐ not yet

Explain your answer choice.

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5. What do you still wonder about how light can interact with materials?

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Chapter 4: Science Seminar
Chapter Overview

You will now apply your understanding of how light interacts with materials to answer a new question: *Can crabs see the plankton they eat near the ocean floor?* Through analysis of evidence about how light interacts with materials in the ocean, you will explain whether or not you think the crab can see its prey.

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Lesson 4.1: Analyzing Evidence

Congratulations on completing your research about the rate of skin cancer in Australia! In this chapter, you will use your expertise as student spectroscopists to answer a different question. Marine biologists are studying a species of crab that lives on the ocean floor, where there is limited light. The researchers want to know: Can the crabs see the plankton they eat near the ocean floor? You will use what you have learned about how light interacts with materials to investigate this question. Good luck!

Unit Question

- How does light interact with materials?

Chapter 4 Question

- Can the crabs see the plankton they eat near the ocean floor?

Key Concepts

- The movement of energy can be tracked by observing the changes the energy causes to matter.
- Light carries energy that causes materials to change.
- When light hits a material, the material can absorb energy from the light.
- When a material absorbs energy from light, the energy causes the material to change.
- There are different types of light that can change a material in different ways.
- A light source can emit more than one type of light.
- Different types of light have different wavelengths.
- A material absorbs energy from some types of light and not others.
- Light travels in a straight line.
- When a light wave hits a material, the light can be absorbed by the material, transmitted through the material, or reflected off the material.
- A material transmits or reflects some types of light and not others.
- When light is transmitted through or reflected off a material, the energy is not absorbed, so the material does not change.

Vocabulary

- absorb
- claim
- emit
- evidence
- light
- light source
- reasoning
- reflect
- transmit

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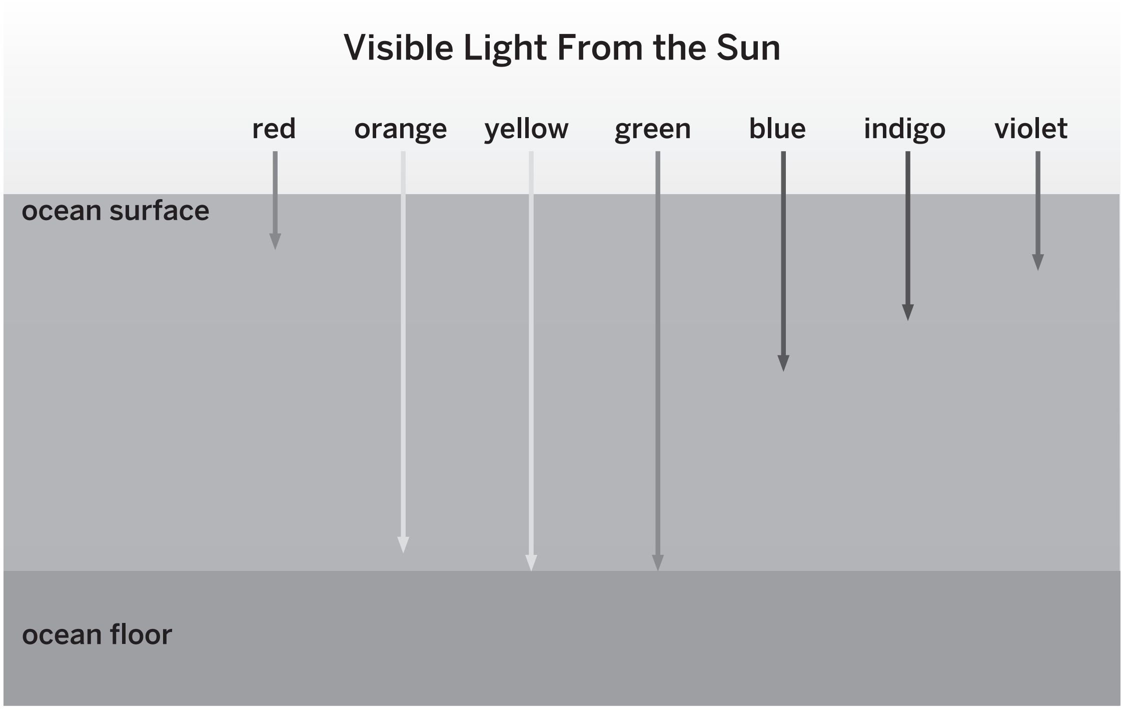
Warm-Up

Visible Light in the Ocean

Different colors of visible light transmit different distances in the ocean. Look at the diagram below and then answer the questions.

How Far Visible Light Transmits in the Ocean



Which colors are absorbed closest to the surface? (circle all that apply)

red **orange** **yellow** **green** **blue** **indigo** **violet**

What ideas do you have about how this might affect the color that a material might appear on the ocean floor?

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Evidence Cards

Part 1: Annotating Evidence Cards

Read and annotate each Evidence Card, following the instructions below.

1. Read each card carefully.
2. Make annotations on each card. Consider the following:
    - What questions do you have about the evidence?
    - How is the evidence connected to what you have been learning about what happens to light as it travels?
    - How might the evidence help you answer the question about whether the crabs can see the plankton they eat near the ocean floor?

Part 2: Partner Discussion

- Discuss questions you have about the evidence cards, and see if you can help each other answer them.
- Look at each evidence card. Are there any two pieces of evidence that could work together? How do you think the two cards are connected?

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Sorting Evidence

Sorting Evidence Cards

Can the crabs see the plankton they eat near the ocean floor?

Claim 1: Yes, the crabs can see the plankton and the plankton appear __________ (red, orange, yellow, green, blue, indigo, violet).

Claim 2: No, the crabs can't see the plankton.

Decide which evidence cards support or refute each claim.

1. With a partner, discuss whether each piece of evidence supports or goes against a claim. Use the Sentence Starters below to help you talk with your partner.
2. Add new annotations to each Evidence Card:
   - If the evidence supports a claim, write "Supports Claim ____ (1 or 2)" on that card.
   - If the evidence refutes a claim, write "Refutes Claim ____ (1 or 2)" on that card.
   - If the evidence connects with another evidence card, write "Connects with Evidence Card ____ (A–H)" on that card.
3. Place each evidence card under the claim you feel it supports or refutes. If you are unsure, you can place the card off to the side.

Sentence Starters

I think this piece of information supports this claim because . . .

I don't think this piece of information supports this claim because . . .

I agree because . . .

I disagree because . . .

Why do you think that?

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Name: ____________________ Date: ____________

Lesson 4.2: Science Seminar

Can crabs see the plankton they eat near the ocean floor? If so, what color do the plankton appear? In today's Science Seminar, you and your classmates will discuss the evidence, listen to one another's ideas, and try to arrive at an understanding of the best answers to these questions. At the end of the lesson, you will be ready to write a convincing argument for Head Marine Biologist Ellen Siva about just what the crabs can see near the ocean floor.

Unit Question

- How does light interact with materials?

Chapter 4 Question

- Can the crabs see the plankton they eat near the ocean floor?

Key Concepts

- The movement of energy can be tracked by observing the changes the energy causes to matter.
- Light carries energy that causes materials to change.
- When light hits a material, the material can absorb energy from the light.
- When a material absorbs energy from light, the energy causes the material to change.
- There are different types of light that can change a material in different ways.
- A light source can emit more than one type of light.
- Different types of light have different wavelengths.
- A material absorbs energy from some types of light and not others.
- Light travels in a straight line.
- When a light wave hits a material, the light can be absorbed by the material, transmitted through the material, or reflected off the material.
- A material transmits or reflects some types of light and not others.
- When light is transmitted through or reflected off a material, the energy is not absorbed so the material does not change.

Vocabulary

- absorb
- claim
- emit
- evidence
- light
- light source
- reasoning
- reflect
- transmit

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Warm-Up

Revisiting the Evidence

In today's Science Seminar, you and your classmates will discuss the evidence, listen to one another's ideas, and try to arrive at the best answer for the Science Seminar Question.

Review the evidence cards and your annotations from Lesson 4.1. Use the evidence cards to answer the questions below.

Can the crabs see the plankton they eat near the ocean floor?

Circle the claim you think is the most convincing.

Claim 1: Yes, the crabs can see the plankton and the plankton appear _______ (red, orange, yellow, green, blue, indigo, violet).

Claim 2: No, the crab can't see the plankton.

If you chose Claim 1, what color or colors do you think the plankton appear to the crabs? (circle all that apply)

red **orange** **yellow** **green** **blue** **indigo** **violet**

Explain why you chose that claim.

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Preparing for the Science Seminar

Preparing a Science Seminar Argument

1. Take turns with your partner sharing which claim you think is the most convincing.
2. Use your Warm-Up responses and the Scientific Argument Sentence Starters to help you share ideas.
3. Refer to the claims and evidence cards as needed.

Scientific Argument Sentence Starters

Describing evidence:	Explaining how the evidence supports the claim:
The evidence that supports (or refutes) my claim is . . .	If ___, then . . .
My first piece of evidence is . . .	This is important because . . .
Another piece of evidence is . . .	Since, . . .
This evidence shows that . . .	Based on the evidence, I conclude that . . .
	This claim is stronger (or weaker) because . . .

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Science Seminar Observations

Write a check mark in the right-hand column every time you hear one of your peers say or do something listed in the left-hand column. If you hear an interesting idea, write it in the last row of the table.

Observations during the seminar	**Check marks**
I heard a student use evidence to support a claim.	
I heard a student respectfully disagree with someone else's thinking.	
I heard a student explain how her evidence is connected to her claim.	
I heard a student evaluate the quality of evidence.	
I heard an idea that makes me better understand one of the claims. That idea is:	

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Homework: Reflecting on the Science Seminar

Now that the Science Seminar is over, think back on the claim you selected at the beginning of the lesson. After participating in the discussion, you may have changed your mind about which claim you think is best supported. Show your current thinking by answering the questions below.

Can the crabs see the plankton they eat near the ocean floor?

Circle the claim you think is the most convincing.

Claim 1: Yes, the crabs can see the plankton and the plankton appear _______ (red, orange, yellow, green, blue, indigo, violet).

Claim 2: No, the crab can't see the plankton.

If you chose Claim 1, what color or colors do you think the plankton appear to the crabs? (circle all that apply)

red **orange** **yellow** **green** **blue** **indigo** **violet**

Did the Science Seminar cause your thinking about the claims to change? Explain your answer.

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Lesson 4.3: Writing a Scientific Argument

Can the crabs being studied by the Australian Institute of Marine Biology see the plankton they eat near the ocean floor, or do the crabs have to detect their food some other way? If the crabs can see the plankton, what do the plankton look like so far down in the ocean? You have already carefully considered the claims and available evidence. You have discussed these claims and the evidence with your fellow classmates. Now it is time to write your argument for Head Marine Biologist Ellen Siva. Do your best to make your argument as convincing as possible.

Unit Question

- How does light interact with materials?

Chapter 4 Question

- Can the crabs see the plankton they eat near the ocean floor?

Key Concepts

- The movement of energy can be tracked by observing the changes the energy causes to matter.
- Light carries energy that causes materials to change.
- When light hits a material, the material can absorb energy from the light.
- When a material absorbs energy from light, the energy causes the material to change.
- There are different types of light that can change a material in different ways.
- A light source can emit more than one type of light.
- Different types of light have different wavelengths.
- A material absorbs energy from some types of light and not others.
- Light travels in a straight line.
- When a light wave hits a material, the light can be absorbed by the material, transmitted through the material, or reflected off the material.
- A material transmits or reflects some types of light and not others.
- When light is transmitted through or reflected off a material, the energy is not absorbed so the material does not change.

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Lesson 4.3: Writing a Scientific Argument (continued)

Vocabulary

- absorb
- claim
- emit
- evidence
- light
- light source
- reasoning
- reflect
- transmit

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Warm-Up

Shoshauna and Tamir are students who have been investigating whether a material reflects blue light. Read and compare their arguments, then answer the questions below.

Shoshauna's Argument

The material does not reflect blue light. The material appears green, not blue. This is evidence that it does not reflect blue light.

Tamir's Argument

The material does not reflect blue light. A material appears a certain color when that color of visible light reflects off the material and into someone's eyes. This material appears green and not blue, so it must reflect green light, not blue light.

Which argument is more convincing? (check one)

- ☐ Shoshauna's argument
- ☐ Tamir's argument

What makes one argument more convincing than the other?

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Using the Reasoning Tool

Use the Science Seminar Reasoning Tool sheet to explain how the evidence supports your claim. Follow the instructions below.

1. Record the claim that you think is best supported by the evidence (in the **Therefore,** column). If you prefer, you can also write and record your own claim.
2. Tape the evidence cards that support your claim to the Reasoning Tool (in the **Evidence** column). You do not need to use all the cards, but you can use more than one to support your claim.
3. Use the middle column (**This matters because . . .**) to record how the evidence in the left column connects to the claim in the right column.

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Preparing to Write

Organzing Your Reasoning Tool

- Draw a circle around your strongest piece of evidence.
- Draw an X over a piece of evidence if you do not plan to use it in your argument.
- Draw an arrow to connect two pieces of evidence if you think that they go together.

Example

Evidence	This matters because . . . (How does this evidence support the claim?)	Therefore, . . . (claim)
Example Evidence Card A	Your ideas about how the evidence supports the claim	Your claim
~~Example Evidence Card B~~	~~Your ideas about how the evidence supports the claim~~	
Example Evidence Card C	Your ideas about how the evidence supports the claim	

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Writing Scientific Arguments

Write a scientific argument that addresses the question *Can the crabs see the plankton they eat near the ocean floor?*

Claim 1: Yes, the crabs can see the plankton and the plankton appear _____ (red, orange, yellow, green, blue, indigo, violet).

Claim 2: No, the crabs can't see the plankton.

1. Review your completed Reasoning Tool. Be sure to include your strongest piece of evidence and make a connection between the pieces of evidence that go together.
2. State your claim. If you are supporting Claim 1, be sure to state what color or colors you think the plankton appear.
3. Then, use the evidence to support your claim.
4. Use the Scientific Argument Sentence Starters below to help you explain your thinking.
5. To make your argument more convincing, be sure to answer the following questions:
   - If you are supporting Claim 1, what evidence do you have that the color or colors you chose transmit to the ocean floor and are visible to the crab?
   - If you are supporting Claim 2, what evidence do you have that no colors of visible light transmit to the ocean floor?

Scientific Argument Sentence Starters

Describing evidence:	**Explaining how the evidence supports the claim:**
The evidence that supports (or refutes) my claim is . . .	If ___, then . . .
My first piece of evidence is . . .	This is important because . . .
Another piece of evidence is . . .	Since, . . .
This evidence shows that . . .	Based on the evidence, I conclude that . . .
	This claim is stronger (or weaker) because . . .

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Writing Scientific Arguments (continued)

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Writing Scientific Arguments (continued)

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Name: ______________________ Date: ______________

Homework: Revising an Argument

1. Reread the scientific argument you wrote in class. Complete your argument, if needed.
2. Consider reading your argument aloud or having another person read it.
3. Look for ways you could make your argument clearer or more convincing.
4. Consider the following questions as you review your argument:
    - Does your argument clearly explain whether the crabs can see the plankton?
    - If you are arguing that the crabs can see the plankton, does your argument clearly explain what color the plankton appear to the crab?
    - Do you describe your supporting evidence?
    - Do you thoroughly explain how the evidence supports your claim?
5. Rewrite any sections of your argument that could be clearer or more convincing.

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Homework: Revising an Argument (continued)

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Homework: Check Your Understanding

This is a chance for you to reflect on your learning so far. This is not a test. Be open and truthful when you respond to the questions below.

1. I understand that scientists may revise their claims when they get new evidence.

   ☐ yes

   ☐ not yet

Explain your choice.

____

____

____

____

2. What are the most important things you have learned in this unit about how light interacts with materials?

____

____

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____

____

____

3. What questions do you still have?

____

____

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____

____

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Light Waves Glossary

absorb: to take in
absorber: traer hacia adentro

amplitude: the maximum height of a wave
amplitud: la altura máxima de una onda

emit: to give off
emitir: echar hacia fuera

energy: the ability to make things move or change
energía: la capacidad de hacer que las cosas se muevan o cambien

frequency: the number of peaks of a wave that pass in a second
frecuencia: el número de picos en una onda que pasan en un segundo

light: a type of wave that carries energy from one place to another, even through empty space
luz: un tipo de onda que lleva energía de un lugar a otro, incluso a través del espacio vacío

light source: an object that emits light
fuente de luz: un objeto que emite luz

matter: anything that has mass and takes up space
materia: cualquier cosa que tenga masa y ocupe espacio

molecule: a group of atoms joined together in a particular way
molécula: un grupo de átomos unidos de una manera particular

rate: how often or fast something happens
ritmo: qué tan frecuente o qué tan rápido pasa algo

reflect: to bounce off without absorbing
reflejar: rebotar sin absorber

spectrum: a range of wavelengths
espectro: un rango de longitudes de onda

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Light Waves Glossary (continued)

transmit: to pass through
transmitir: pasar a través de algo

ultraviolet: a type of invisible light that is beyond violet on the spectrum
ultravioleta: un tipo de luz invisible que está más allá del violeta en el espectro

visualize: to form a mental picture of something that cannot be seen
visualizar: formarse una imagen mental de algo que no se puede ver

wave: a pattern that describes how energy is carried from one place to another
onda: un patrón que describe cómo la energía es llevada de un lugar a otro

waveform: a curved line that shows the characteristics of a wave
forma de onda: una línea curva que muestra las características de una onda

wavelength: the distance from one peak of a wave to the next
longitud de onda: la distancia que hay desde un pico de onda hasta el siguiente

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Light Waves:

Skin Cancer in Australia

Article Compilation

Table of Contents: Articles

Harvesting Sunlight A1–A2

Why No One in Space Can Hear You Scream B1–B2

What Is Melanin? C1–C2

How Fiber-optic Communication Works D1–D3

What Eyes Can See E1–E3

Making Waves at Swim Practice F1–F2

Harvesting Sunlight

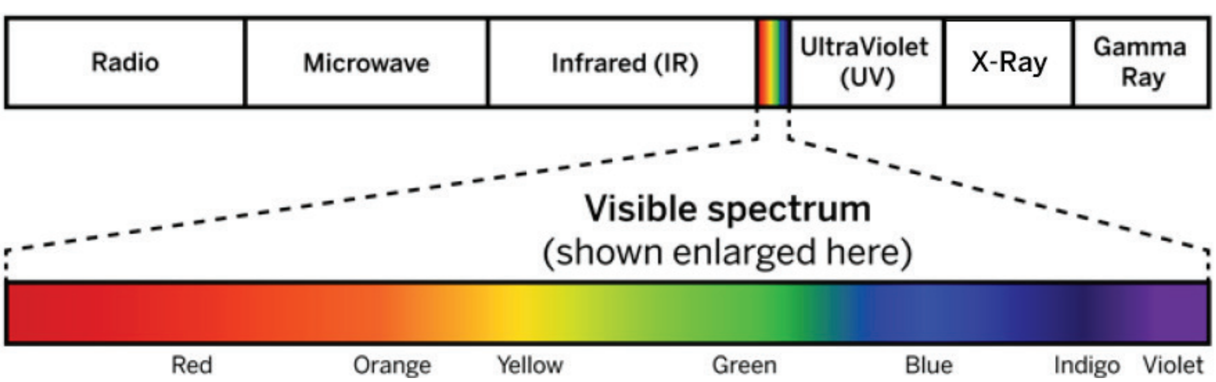
Plants absorb most types of visible light. However, they do not absorb green light. The green light that can't be absorbed is reflected instead, which is why most plants appear green.

Your body needs energy to breathe, move, think, digest food, and do everything else you need it to do. To power all these tasks, your body gets energy from the food you eat. Of course, humans aren't the only organisms that need energy to live. The same is true of all organisms, including plants. However, plants don't eat the way humans do—they have their own way of taking in energy. It's called photosynthesis, and it's the process of absorbing energy from light to make food.

If plants can use energy from the sun to make food, can they use energy from any light source for food? How about a flashlight or a laser? Some light sources can power photosynthesis and others can't, depending on the types of light those light sources emit. That's because plant cells only absorb certain types of light, including infrared, most visible light, ultraviolet light, and X-rays. Even though a plant's cells absorb several types of light, plants can only use some of those types for photosynthesis. Most plants use the energy from blue and red light for photosynthesis. These are the types of light that help plants grow.

The sun is a light source that emits lots of different types of light, including types that can't be absorbed by plant cells or used for photosynthesis. What happens when these types of light come in contact with plants? It depends on the type of light. Some types of light, like radio waves, pass straight through the plants without being absorbed. Other types of light are reflected instead of absorbed—most plants appear green because they reflect green light.

The types of light that plant cells absorb but can't use for photosynthesis change the plants in other ways: infrared light causes plants to



The types of visible light are red, orange, yellow, green, blue, indigo, and violet (ROYGBIV). Humans can see these types of light, but most of the light emitted from the sun is invisible to humans.

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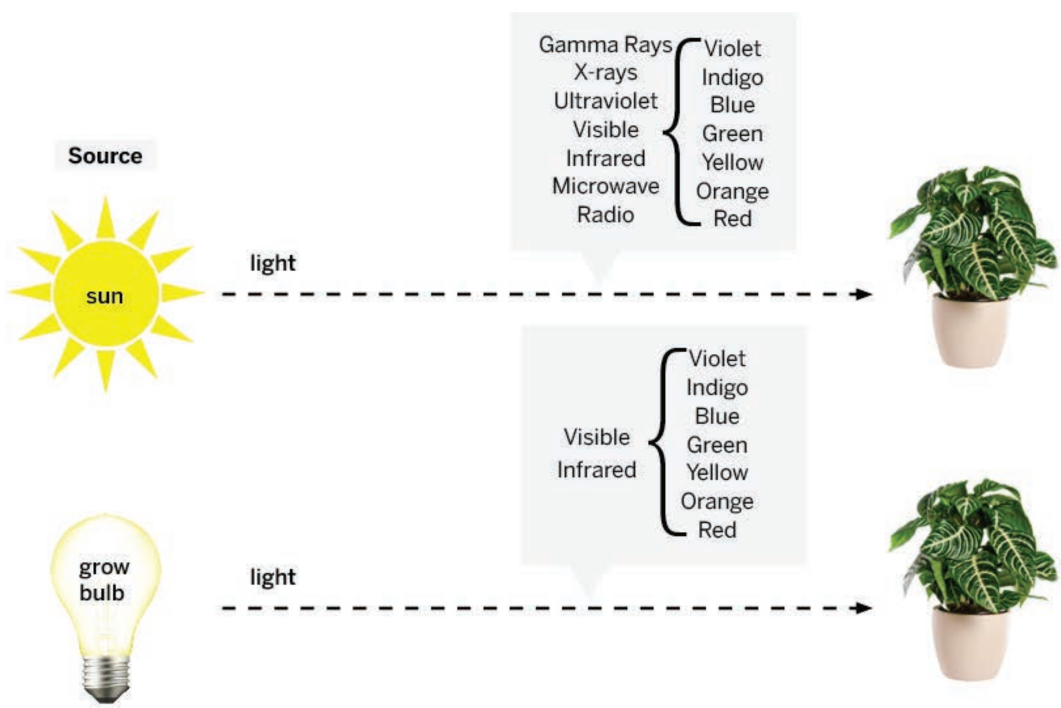
heat up, and ultraviolet light actually damages plants. Too much ultraviolet light can cause plants to die! These different examples show that absorbing different types of light can affect plants in different ways—some that are helpful to the plants, and some that aren't so helpful.

Light Emitted from the Sun

Can plants use light from a lightbulb to grow? Yes, if the lightbulb emits the right types of light. In fact, some people have figured out how to use lightbulbs to grow plants for food in especially dark places, like Antarctica. Antarctica gets no sunlight for six months of the year. Since people in Antarctica cannot depend on sunlight to grow plants, they use special bulbs that emit a lot of the types of light that plants can use for photosynthesis, and less of the types that plants don't need. These "grow bulbs" emit all the types of visible light (red, orange, yellow, green, blue, indigo and violet) and some infrared, but they do not emit gamma rays, X-rays, ultraviolet, or radio waves, like the sun does.

Antarctica is dark for six months of the year, and there isn't enough light for plants to grow there naturally.



The sun emits all types of light. A grow bulb is designed to emit a lot of the types that plants need for growth and very little of the types that plants don't need.

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Explosions in space can produce a lot of light, but they can't produce any sound. An artist created this image of a space explosion.

Why No One in Space Can Hear You Scream

Imagine it's a Saturday night and you're watching a movie that is set in space. Things are getting really exciting as one spacecraft chases another, and suddenly...BANG! The villain's spacecraft explodes in a big, noisy ball of fire. The explosion sound effect used in the movie is loud and booming—and it's also not scientifically accurate. If you were in space, you wouldn't be able to hear an explosion or anything else, because sound doesn't travel in space.

Space is silent. That's because sound is produced by sound waves, and sound waves need something to travel through. The medium sound travels through can be solid, liquid, or gas—on Earth, it's often air. However, in space, there is no air or any other matter between objects (such as planets, moons, and the sun), so there's nothing to carry sound from place to place.

Sound waves are produced when something vibrates. The object's vibrations make it bump into the nearest atoms or molecules—on Earth, those are usually the molecules that make up the air surrounding it. Those molecules then bump into the molecules next to them, which bump into the molecules next to them, and so on. That pattern of molecules bumping into each other is a wave, and when it reaches your eardrum, you hear it as sound.

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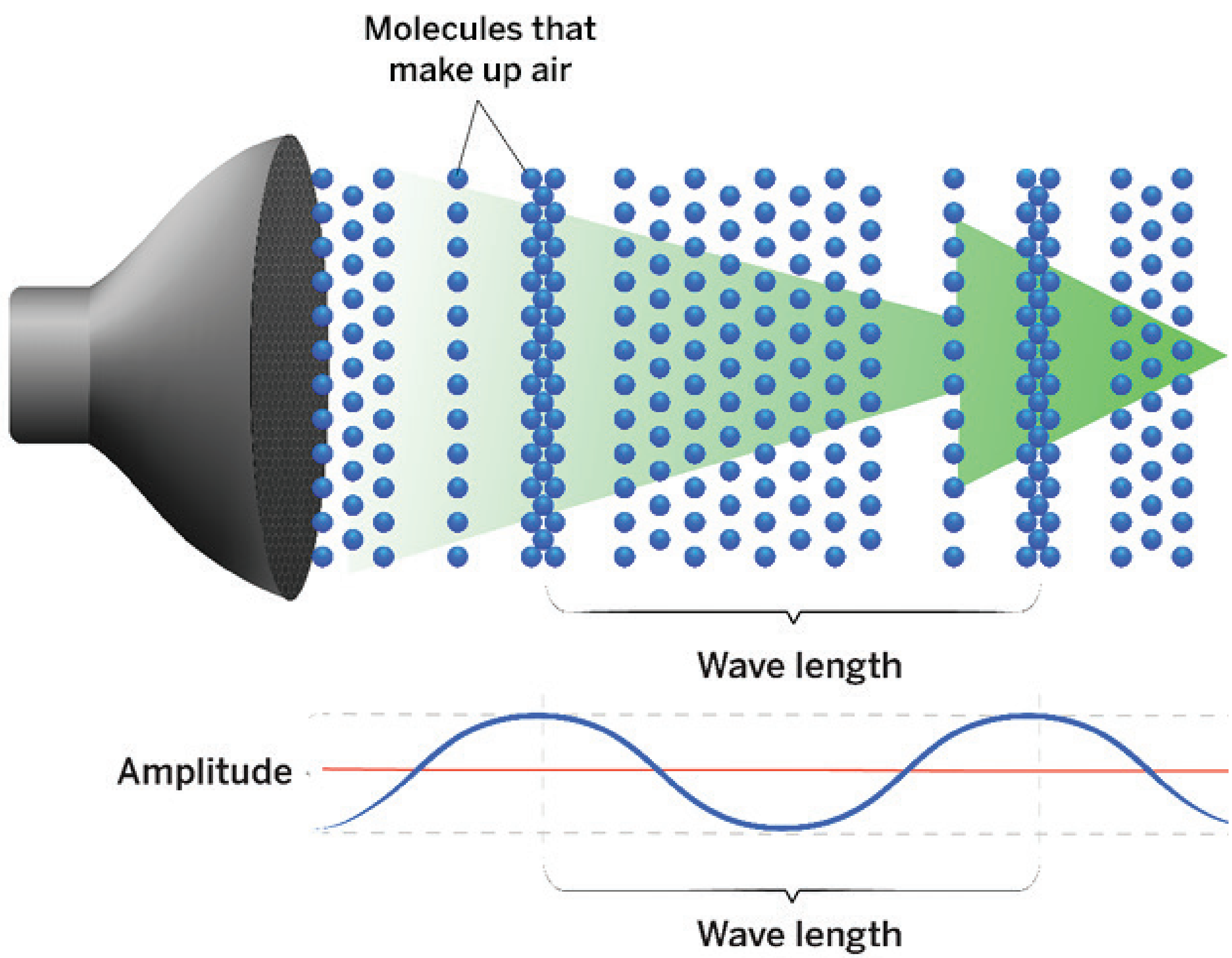
In space, there are no molecules for a vibrating object to bump into—objects like planets and the sun can vibrate, but the motion doesn't set off a wave. Therefore, even dramatic events in space, like explosions, are totally silent!

Sound waves can't travel in space, but other kinds of waves can. Electromagnetic waves, including light waves, don't need anything to travel through, so they can get around in space. Explosions put out light waves that can make it to your eyes whether there's matter around or not—that's why you would be able to see the spacecraft's explosion but not hear it.



Sound waves occur when an object, like part of a speaker, vibrates. The vibration pushes nearby molecules into the molecules next to them, and those molecules are pushed into the molecules next to them, and so on, forming a wave that moves away from the speaker. When molecules are pushed into the molecules next to them, it's called compression.

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Melanin inside our cells determines our hair, skin, and eye colors. For example, people with blond hair and pale skin tones don't have very much melanin in their hair and skin. People with dark hair and pale skin tones have a lot of melanin in their hair, but not very much melanin in their skin. People with dark hair and dark skin tones have a lot of melanin in both their hair and their skin.

What Is Melanin?

Nearly everyone on Earth has cells that make a substance called melanin. Melanin can be found in our hair, skin, eyes, and many other organs, including the kidneys, spleen, liver, lungs, and heart. Skin tone, like hair and eye color, is determined by the amount of melanin produced in our cells. People with darker skin tones have more melanin in their skin cells than people with paler skin tones.

Melanin doesn't just help determine our appearance—it also protects our skin against damage from the sun. Scientists are researching the important role melanin plays in keeping us healthy. The sun emits ultraviolet (UV) light that can damage our skin, leading to sunburns and even skin cancer. Skin cancer is a disease caused by damage to the DNA inside our skin cells. DNA is the genetic material found inside the nuclei of our cells. DNA can be damaged when it absorbs energy from UV light. Skin cancer does not happen every time the DNA in our skin is damaged, but the more it is damaged the more likely it is that cancer can develop. The melanin in skin cells can absorb UV light as the light enters the cells, before it gets to the nucleus where it can damage the DNA. (See the diagram on the next page.) The more melanin there is inside a cell, the more energy is absorbed before UV light can reach the nucleus and cause damage. This means that people with a lot of melanin in their skin have more protection against skin damage from UV light. More melanin gives people more protection against skin damage, but it doesn't give them complete protection. Anyone can get skin cancer, whatever the level of melanin in their skin.

People can actually make more melanin in response to being exposed to UV light. This is what we call a suntan. The skin gets darker because the body starts producing more melanin to protect its DNA. However, a suntan only provides some protection against UV light. UV light can still get through and lead to DNA damage.

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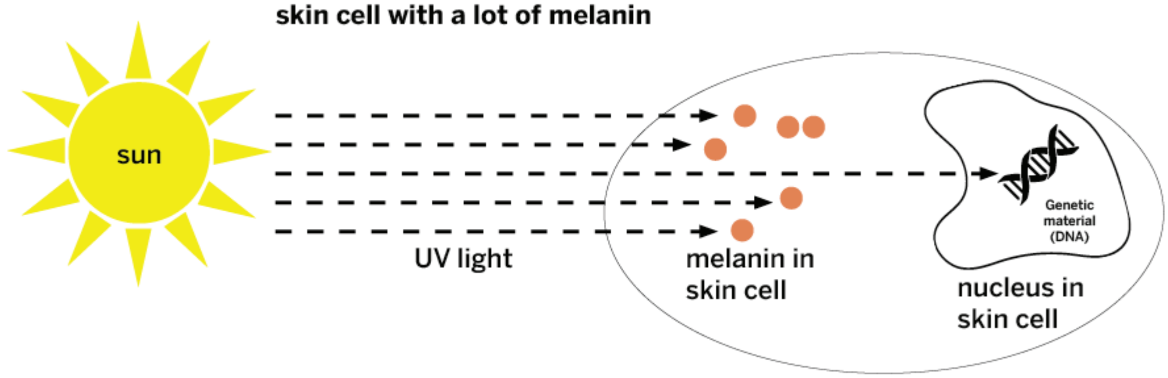
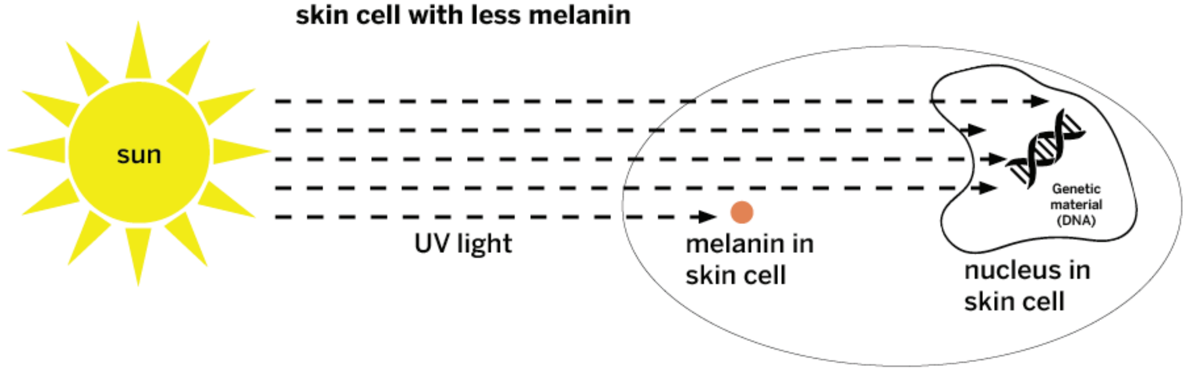
skin cell with a lot of melanin



skin cell with less melanin



This diagram shows how melanin inside the skin cell can protect against damage from UV light.

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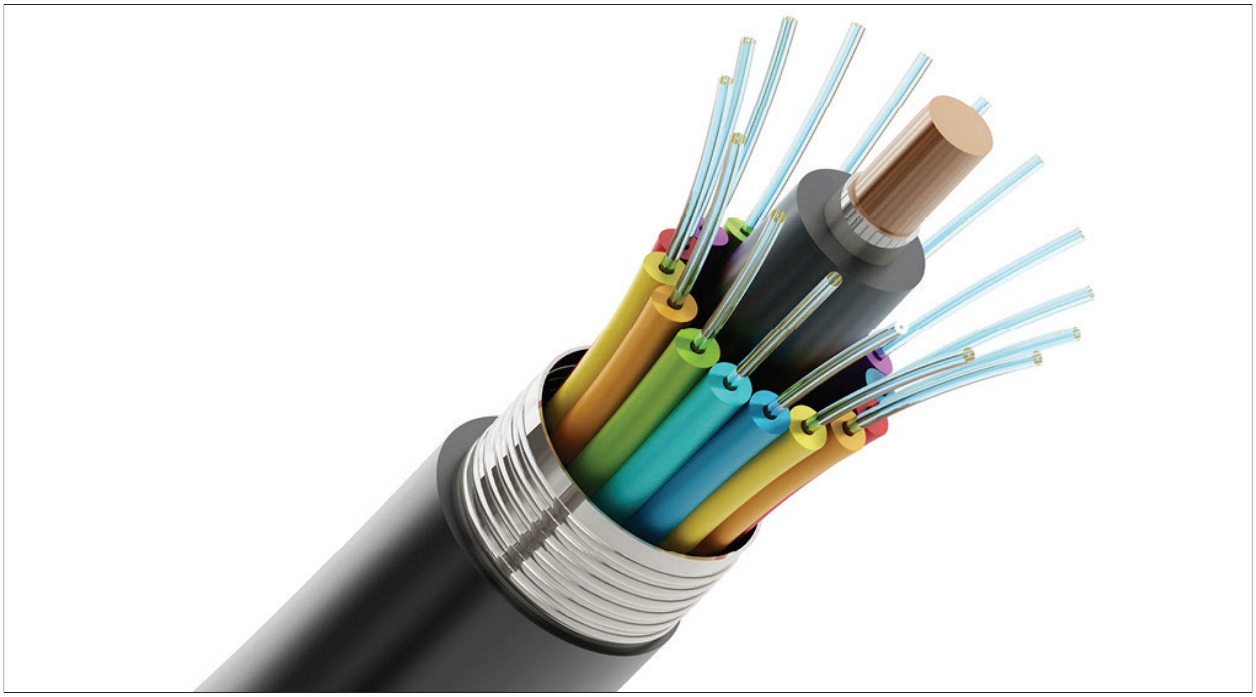

Fiber-optic cable can be used to send information very quickly over long distances.

How Fiber-optic Communication Works

As far as we know, nothing moves faster than the speed of light. In a single second, light can travel all the way around Earth 7.5 times! Because of its incredible speed, light can be used to transport information in an instant. One way of using light to carry information is through fiber-optic cable.

Fiber-optic cable is made of long, thin strands of glass about the width of a human hair. These strands are made of very pure glass that reflects light well and are covered in a protective coating. Light bounces along inside the fiber-optic cable at the speed of light, making fiber-optic cable the fastest possible way to get information from place to place. One fiber-optic cable can transmit information about 100 kilometers (60 miles). After 100 km, there's a device that receives the signal traveling along the cable and re-transmits it along the next cable for another 100 km (60 mi).

How can light transport information? First let's look at different ways a specific kind of information—your voice—can be transported. When you are talking to your friend and she is standing right next to you, your vocal cords create a sound wave that travels through the air into your friend's ear. But what if your friend is far away? Before cell phones and fiber-optic cables, the only option was to talk to your friend on telephones connected by metal wires (what we now call landlines). If you talk on a landline phone, the phone changes the sound wave of your voice into

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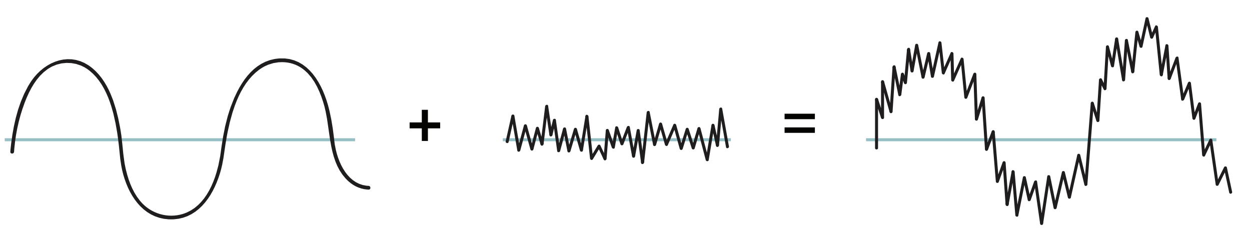
an electrical signal that carries the information from the sound wave. As the electrical signal travels along the wire, it loses power and picks up “noise.” “Noise” is when a wave gets changed little by little as it travels. When the electrical signal reaches your friend’s telephone, it gets changed back into a sound wave, but the noise is now part of the sound wave. This isn’t a problem for short distances, but over very long distances, the noise can sound like static in your friend’s ear!

A better way to transport information over long distances is by sending light through fiber-optic cables. The information carried by the light takes the form of a digital signal. Sound waves and other kinds of waves are not digital, but they can be converted to digital form. To convert the sound wave created by your vocal cords to digital form, a device measures the height of the wave a certain number of times per second. It records the height of the wave at each moment as a number. When it’s time to recreate the wave, those numbers can be used in the right order to produce a wave with exactly the same heights at exactly the same places in the wave—that is, it will be nearly exactly the same wave that was recorded. A wave that has been digitized can be played back as a wave over and over, and it will be the same every time. For that reason, digital signals are a very reliable way to record information—as long as the numbers in the digital signal don’t change, the information can be reproduced exactly over and over again.

To make a digitized signal into something that can be transmitted by light, all those numbers are converted again into a pattern of light flashes (wave pulses). Each pattern of flashes represents one number in the signal. The pattern of light flashes is sent along the fiber-optic cable by a laser that can flash very quickly—hundreds of times per second. When the flashes of light are received on the other end of the fiber-optic cable, they are converted back into numbers and then back into sound waves we can hear with our ears. This means your friend won’t hear any static, even if she’s halfway around the world when you talk to her!



original sound wave **noise** **sound wave with noise**

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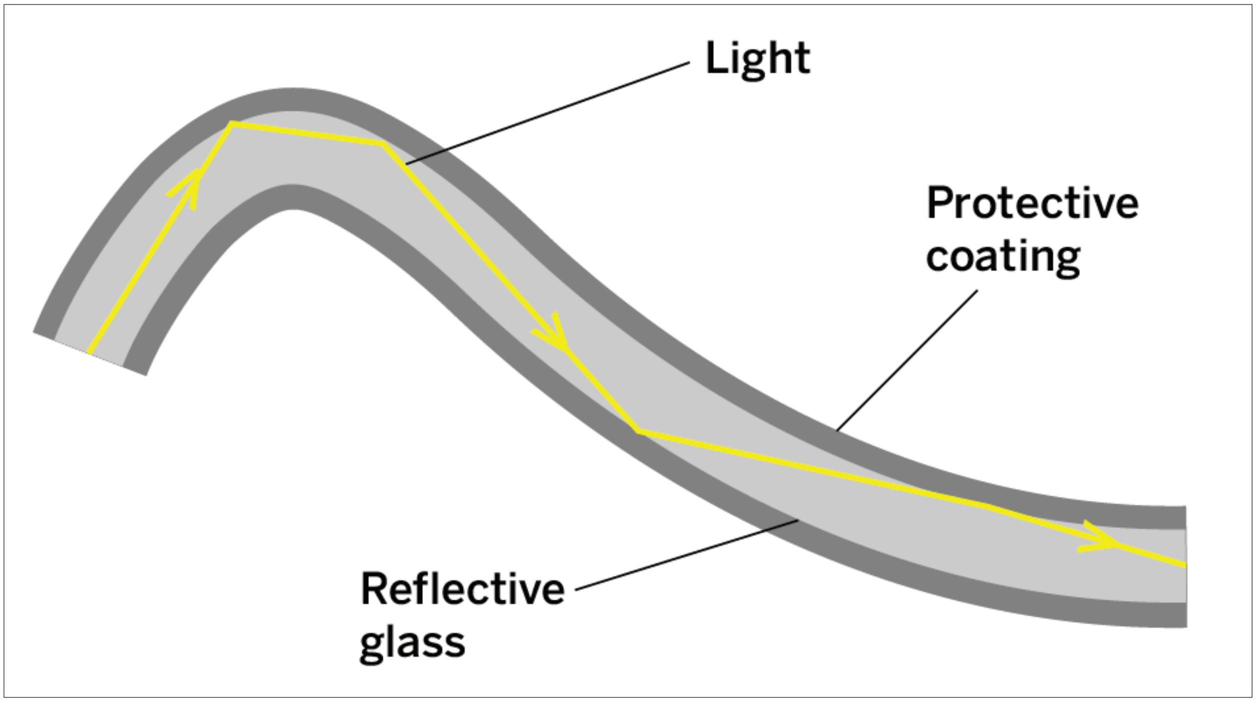
Fiber-optic Cable



Fiber-optic cables are made of strands of reflective glass coated with a protective substance. The light bounces along inside the strands of glass.

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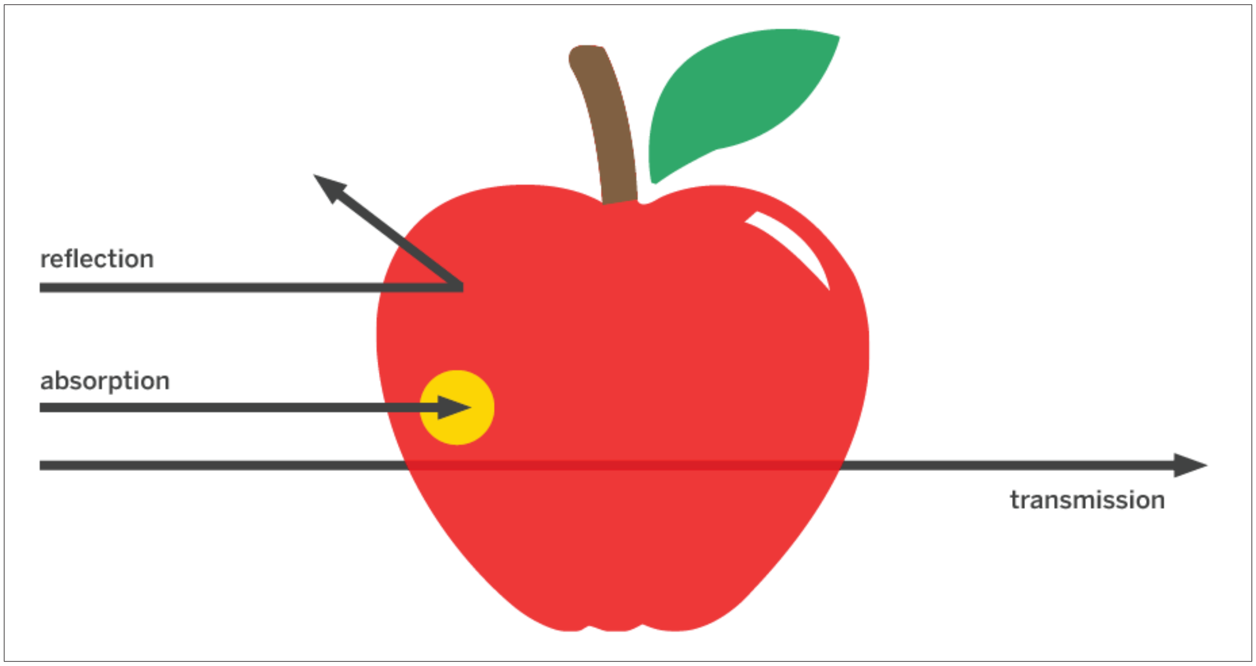
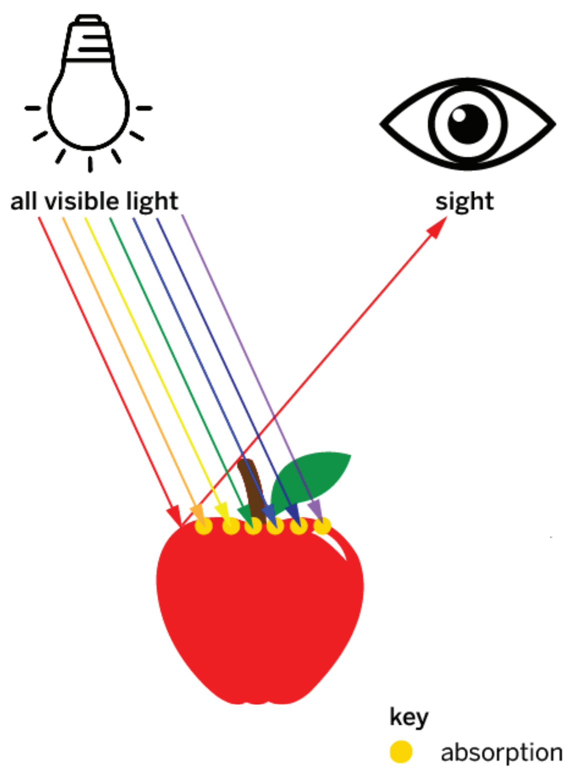


This diagram shows the three things that can happen when light interacts with a material: energy can be absorbed (taken in), transmitted (allowed to pass through), or reflected (caused to bounce off).

What Eyes Can See

Look around. What do you see? Take a careful look at the objects closest to you. You might see a desk, your friend, maybe an apple. Are you really seeing those things? What you are actually seeing is light bouncing off the objects around you. The only thing that eyes can actually see is light.



The color of an object is determined by the way it absorbs, transmits, and reflects energy from light.

Light carries energy. When light hits a material, three different things can happen: the material can absorb the energy (take it in), transmit the energy (let it pass through), or reflect the energy (cause it to bounce off). Depending on the material and the types of light hitting it, all three things can happen at once.

These three possibilities determine the way you see: light moves from a light source to your eye in a straight line, passing through some materials

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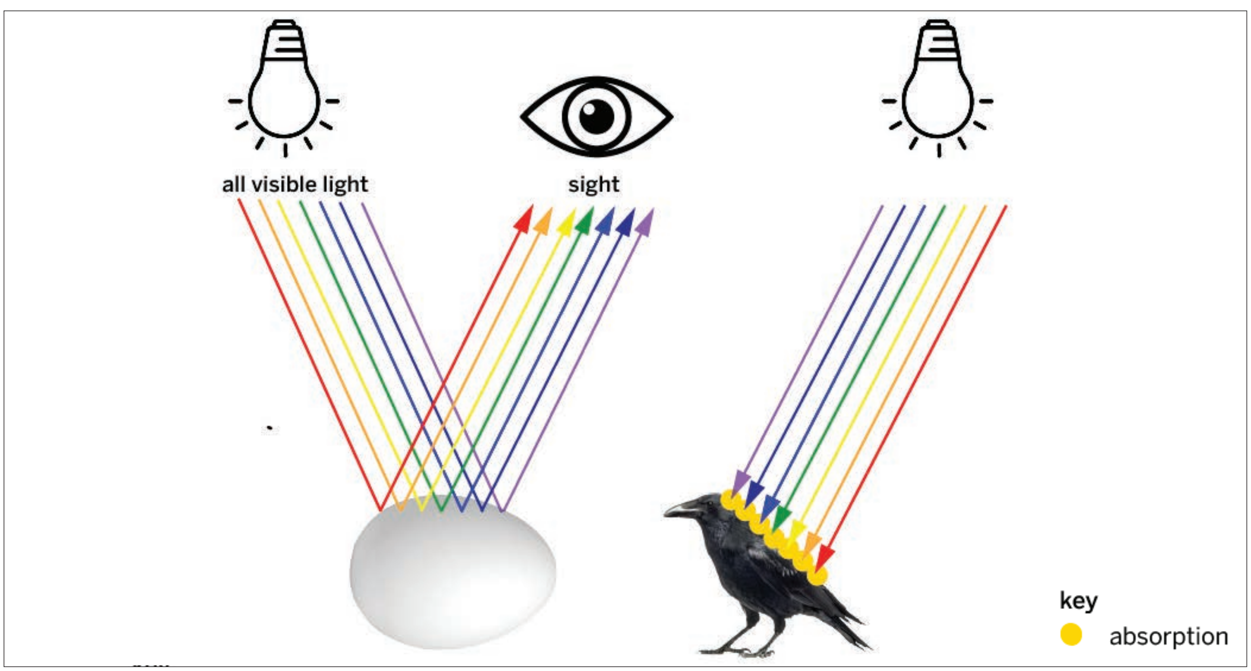
and bouncing off others, before the light is finally absorbed by the back of your eyeball. There, tiny organs called rods and cones absorb energy from the light. This energy triggers a chemical signal with information about the color and brightness of the light. Depending on the wavelength of the light, different signals are sent to the brain. We perceive different signals as different colors.

So your eyes are actually seeing light. Still, this does not explain why you see certain objects as certain colors. For instance, why are some apples green and other apples red? Red apples look red because they reflect red light. The energy from red light is not absorbed by the apple; it bounces off instead. When you look at the apple, reflected red light waves hit your eye and are absorbed. The energy you take in from these light waves sends a signal to your brain, which causes you to see the color red when you look at the apple. The process is the same for green apples, except green apples reflect green light instead of red light.

What about when you look at something black, like a crow, or something white, like an egg? People usually think of black and white as colors, just like red. To your eyes, however, black and white are different from the colors of the rainbow. Black is what we see when no visible light is reflected off an object. Black objects don't reflect any visible light because they absorb all types of visible light. Taking in energy from so many different types of light can make black clothes feel hot and uncomfortable on sunny days. White, on the other hand, is what we see when all colors of visible light reflect off an object. White objects reflect all types of visible light. White clothes are great for staying cool on a sunny day because they don't absorb any energy from visible light.

If black is the absence of color, what about things that appear to have no color, like a clear piece of glass? Clear glass seems to have no color of its own, but it isn't black, either. When you look through a piece of clear glass, you see



White objects, like this egg, reflect all types of visible light. Black objects, like this crow, do not reflect any types of light. To your eyes, white is the combination of all colors, and black is the absence of color.

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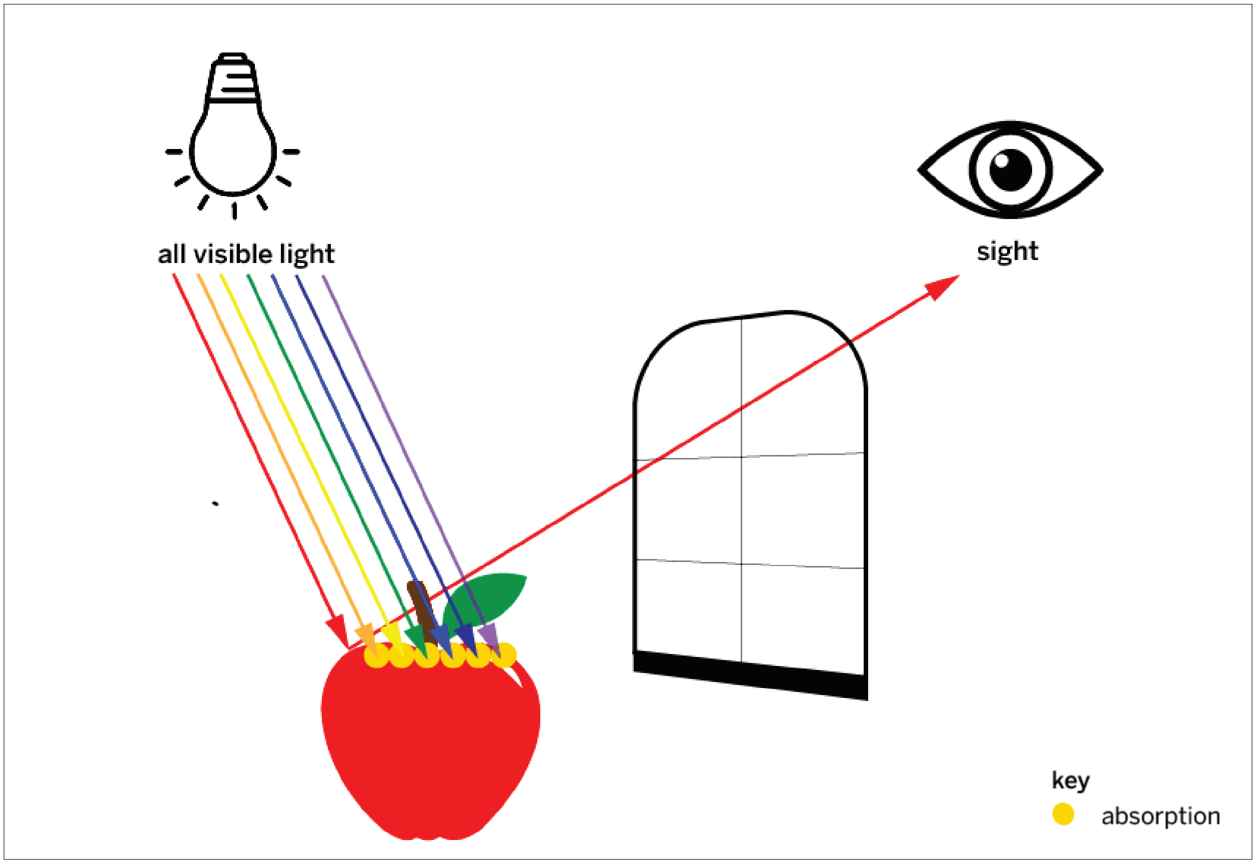
the colors of objects on the other side. This is because clear glass transmits all types of visible light. When these light waves hit a pane of glass, they pass right through, carrying their energy across to the other side. Through a clear glass window, you see a world full of colorful objects, each of which is reflecting certain wavelengths of light through the glass to your eye.

As you look around, what you see isn't really what you see. Everything you can see is just light reflecting off things. The colors of objects are determined by the colors of light they reflect. If apples didn't reflect visible light, they would look black to us—and if our eyes responded to a different type of light with a different range of wavelengths, everything in our world would look very different!



Clear glass transmits all types of visible light, so your eyes see the colors of the objects behind the glass instead of the glass itself.

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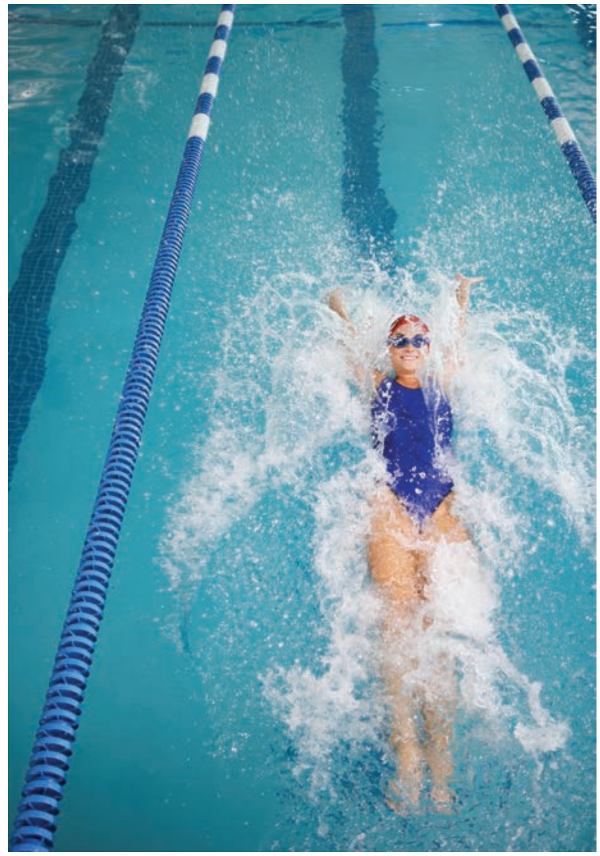
Making Waves at Swim Practice



You're sitting with the rest of the swim team, waiting for practice to start. Everybody's on a long metal bench next to the pool. Suddenly, you hear banging over and over, and it's really annoying. You look around, and realize a teammate at the other end of the bench is kicking the bench—that's what's making the noise. You get up to go ask them to stop, but as soon as you get off the bench you can barely hear the sound of the kicking anymore. You try sitting back down, and it's just as loud as before. Is your teammate playing a trick on you? Why can you hear the sound when you sit on the bench, but not when you're standing up? It's not a trick—when you're sitting on the bench, that banging sound is actually traveling to you through the metal of the bench. You probably know sound waves can travel through the air, but they can also travel through solid materials like metal. That's because metal and air are both made of matter.

Sound waves can travel through any kind of matter, including water and other liquids. After practice starts and you jump into the pool, you can hear splashing sounds underwater. Sometimes, during free swim time, you and your friends sing and shout words to each other underwater for fun. People sound different underwater than they do in the air, so it's not always easy to understand what a person is saying underwater. That's because sound waves travel a little bit differently in water than they do in the air. Sound waves travel at different speeds in different materials. When sound waves are moving through water, they travel faster than they do through air. Surprisingly, sound waves travel fastest when they are moving through solid materials like the metal of the bench.

Now practice is over, and you and the rest of the team are resting on the edge of the pool, dangling your feet in the water. You notice how weird everybody's feet and legs look through the water. When they're in the water, your legs look ripply and even seem to bend in odd directions, but if you pull them out, they look straight again. It's not your legs that are bending in the water, it's light! Both water and air transmit light, meaning light can pass through them. Light reflects off your legs, traveling through the water and then passing into the air. The light bends as it passes from the water to the air, and the bending light makes your legs look bent. This bending of light is called refraction: light refracts when it passes from one material (such as water, air, glass, or plastic) into another.

Why does light refract? Just like sound waves, light waves travel at different speeds depending

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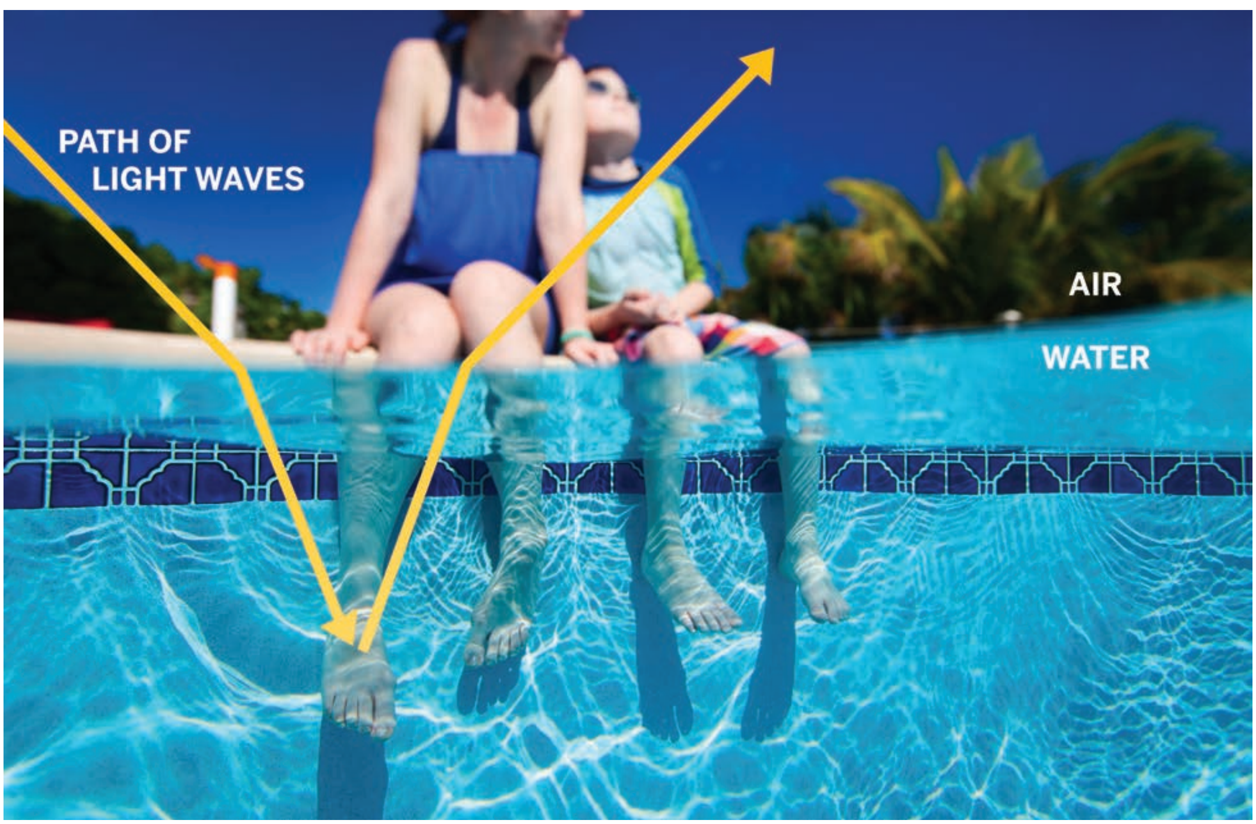
on what they are traveling through. Light always travels fast, but light waves move fastest when they are traveling through empty space. (Unlike sound waves, light waves can move through empty space—they don't need matter to travel through.) Light waves move a little bit more slowly when they travel through matter, such as the gases that make up air. When traveling through water, light waves move more slowly than they do when they move through air. As the light waves pass from one material to another, they speed up or slow down, and this change in speed makes the light bend.

When light bends, interesting things happen. Have you ever noticed a rainbow in the spray of water droplets from a hose? Rainbows also happen because of refraction. White light (such as sunlight) is actually made up of many different colors of light, and each color has a different wavelength. For example, blue light has a shorter wavelength than red light. The wavelength of a light wave affects the angle at which it bends when it passes from one material to another. (That's called the angle of refraction.) When sunlight passes from the air into droplets of water, all the different colors in the light refract differently—some bend farther than others because they have different wavelengths. Refraction separates the white light into bands of different colors, and we see a rainbow.

All waves—light waves, sound waves, and every other kind of wave—travel at different speeds in different materials. That affects the way you see and hear everything around you, from an annoying noise to the sparkle of sunshine on the water.



Light waves refract (bend) as they pass from the air to the water. Then they reflect off the leg. The light waves refract again as they pass from the water to the air.

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Light Waves:
Skin Cancer in Australia

THE LAWRENCE
HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

Amplify.

Published and Distributed by Amplify.
www.amplify.com

AMP.NA18

ISBN 978-1-947002-91-3

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