Dear Educator,

Your students may not be aware that among the many ways science touches their lives are the coatings that provide protective, decorative, and restorative finishes to countless objects they encounter and use every day. From preventing rust, food spoilage, and UV damage to giving paint magnetic and other novel properties, coatings cover 70 percent of the products made in the U.S.!

This free educational program, ***Got You Covered!***, created by the American Coatings Association (ACA) in cooperation with the curriculum specialists at Young Minds Inspired (YMI), uses standards-based activities to investigate a broad array of STEM-related coatings applications with your students. In addition to sparking dialogue about how technological advancements influence everything in our lives, from environmental conservation to art and design, this program can also introduce students to opportunities for careers in science and engineering.

We hope your classes find fun and inspiration in completing these activities and furthering their studies in STEM subjects. Please let us know your opinion of the program by returning the enclosed reply card or by commenting at **ymiclassroom.com/feedback-aca**. We depend on your feedback to continue providing free educational programs that make a real difference in students' lives.

Sincerely,

Dr. Dominic Kinsley
Editor in Chief
Young Minds Inspired

For questions, contact us toll-free at 1-800-859-8005 or by email at feedback@ymiclassroom.com.

American Coatings Association

GOT YOU COVERED!

Target Audience

This program is designed for middle school students, grades 6-9, as a supplement to the STEM curriculum.

Program Objectives

- To help students understand the many ways coatings improve and enhance our world.
- To guide students' appreciation of the science behind modern coatings.
- To challenge students' imaginations and encourage them to consider a career in advancing the future of science and technology.

Program Components

- This one-page teacher's guide
- Three reproducible student activity sheets
- A colorful classroom wall poster
- Follow-up activities found at **ymiclassroom.com/aca**
- A STEM career guide for students to share with their families, available at **ymiclassroom.com/aca**
- A reply card for your comments or comment online at **ymiclassroom.com/feedback-aca**

How To Use This Program

Photocopy the teacher's guide and activity sheets to share with fellow teachers and your school science department before displaying the poster. Review and schedule the activities and have students take their sheets home to share with a parent. This program aligns with Next Generation and National Science Standards for grades 6-9. For more information, visit **ymiclassroom.com/aca**.

Representatives from the paint and coatings industry may be available to visit your classroom and teach students more about the science of coatings. For further information, please visit **www.paint.org/got-you-covered**.

Activity 1 • You're Covered

Begin by asking students for examples of coatings. They might name different kinds of paint, polyurethane, shellac, etc. Then ask students to speculate on the roles they think coatings play in their lives. Distribute the activity sheet and have them complete **Part 1** to test their awareness, then ask if any of the answers were a surprise. ***Answers:*** A. 5; B. 3; C. 7; D. 8; E. 9; F. 6; G. 2; H. 1; I. 4; J. 10.

Complete **Part 2** as a group. ***Possible answers:***

A. Glass and plastics on television and tablet screens; wireless charging stations; defibrillator

B. Antimicrobial, odor-fighting sneaker liners; polyurethane (PU) faux leather on pants and purses; PU breathable "wet bags" to carry wet clothing and diapers; anti-glare eyeglass coating; washable linings on lunch bags; reflective vests

C. Food storage can and carton liners; galvanized finishes on steel and iron; enamel finishes on cast-iron pans; Teflon coating on non-stick pans; automobile paint; grease on bicycle chains; stain on wood floors and furniture

D. Nail polish; wall paint in gloss, magnetic, or other finishes

Activity 2 • What's Your Wavelength?

Prior to introducing this exercise, obtain the materials

listed in **Part 1** below and practice creating and decoding your own messages. As you will see, it works best with light pressure and a cyan or light blue crayon and very precise cross-hatching with red ink and yellow highlighter over top. We also recommend setting specific guidelines, based on your school's code of conduct, for the content of the secret messages. (Note: Decoder glasses are available at ideastage.com.)

Begin the lesson by asking students what they already know about the science behind color.

Part 1: Provide paired-off students with cardboard, a pattern for glasses, red acetate or cellophane (available from Amazon, Walmart, and most craft or photography shops), blue crayons, red ink pens, and yellow highlighters. Provide time for them to make and decorate their glasses (you can have them do this at home to save time), and to write and disguise their secret messages. Then, have them trade and decode their papers. Provide some guidance as they experiment with the density of the cross-hatching and highlighter to get this to work well.

Part 2: Divide the class into groups. Distribute a set of watercolor paints and colored construction paper and allow time for students to experiment. If possible, use cyan, magenta, and yellow to replicate how printers and other subtractive mixing systems work. If time is short, demonstrate this activity.

Activity 3 • Cool & Collected

Begin this lesson by reminding students about the subtractive mixing experiment they completed, and ask them to make a hypothesis about the impact dark and light colors would have on temperature. Then, divide the class into teams and give each group these materials — small transparent plastic cups, a plate or shallow bowl, and a variety of materials to use for the roof (plastic wrap, aluminum foil, Styrofoam, cardboard, white and black paint, and felt or fabric in 2-3 colors of varying darkness). Students will create structures by turning the cup upside down on top of the plate, so that the bottom of the cup becomes the top of the structure. The roof materials will then be placed on the cup. When their structures are complete, they will place an ice cube (try to have ice cubes of a consistent size) on the plate and then put the cup back on top. If doing this experiment indoors, placing the structures in direct sunlight (such as on a windowsill) or using heat lamps will mimic performing the experiment outside. As students work, make suggestions such as painting certain parts of the cup black vs. painting the entire cup, or using a variety of roofing materials.

Conclusion: Remember that black objects appear black because they are absorbing all colors of light, while white objects appear white because they are reflecting all colors of light. How comfortable would students feel wearing all-black clothing on a hot day?

Resources

- **ymiclassroom.com/aca**
- **www.paint.org/got-you-covered**

You're Covered

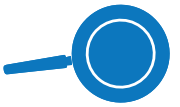
Did you know that 70 percent of the items you encounter every day have some sort of protective or decorative coating? Whether it's on your walls, inside the tomato cans in your pantry, or covering the touchscreen of your tablet, coatings have got you covered!

PART 1: Coatings help protect the infrastructure and the environment; allow you to live, work, and play better every day; and even help you express your personality! See if you can match the objects listed below to the type of coating that helps them work for you. Write the correct letter in the column in front of the number.

A. Sneakers

B. Touchscreen

C. Raincoat



D. Frying Pan

E. Bridge

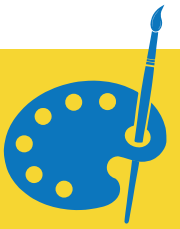
F. Sunglasses

G. Vegetable Can

H. Bedroom

I. Bicycle

J. Sports Field



PAINTING YOUR FUTURE

Can coatings paint your future? Think about your favorite hobby and how you might plan a career path that uses the science behind the coatings process to create an improvement or innovation in that hobby. Discuss your ideas with your family!

	1. Wall paint, available in thousands of colors and dozens of textures, allows you to personalize your space.
	2. Coatings keep metal from corroding and leeching into foods like tomatoes and beans.
	3. Invisible coating conducts an electrical charge so you can learn, play, and communicate.
	4. Special paint keeps metal frames from rusting; lubrication keeps all parts moving smoothly.
	5. Antimicrobial linings can help keep your feet smelling fresh; rubber soles give you traction.
	6. Anti-glare and scratchproof coatings are cost-effective ways to protect your eyes.
	7. High-tech coatings made from materials like rubber, resin, and plastic enable fabrics to repel water.
	8. Non-stick coatings make for quick cleanup after a late-night snack.
	9. Concrete and steel elements are coated to prevent rust and deterioration.
	10. Specialized paints are able to withstand friction from game play while maintaining boundary lines.

PART 2: Can you think of other ways that your daily needs are covered by coatings? Review the following applications for coatings, then brainstorm with your classmates to list your ideas for each one on the back of this sheet:

A. Conduct an electrical charge.

B. Protect clothing and other personal items.

C. Prevent chemical reactions and corrosion.

D. Add personality to a space or object.

American Coatings Association℠

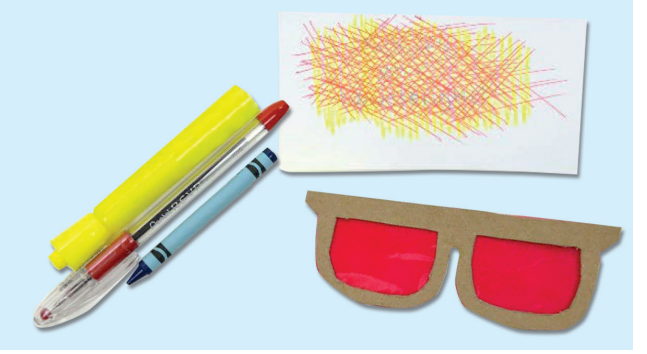
What's Your Wavelength?

Do you like keeping secrets? The properties of light make it really fun to write notes that only your friends can read. Complete this experiment to test it out! Your teacher will give you the materials you need.

COLOR CODES

1. Trace the sunglass pattern onto a sturdy piece of cardboard and cut it out.
2. Trace and cut a set of red cellophane lenses to fit slightly larger than the eyeholes.
3. Glue the lenses to the frames.
4. Use the blue crayon to write a brief, secret message.
5. Draw over the message in a crosshatch pattern with both the red pen and the yellow highlighter. When you're done, it should be difficult to see the blue writing.
6. Trade papers with your partner and try to decipher their message, with and without wearing your glasses.

Hint: Take note of what color the message appears to be.

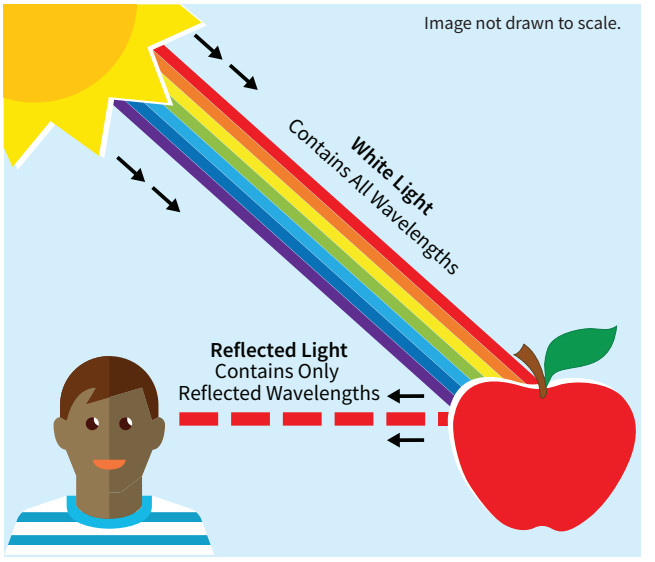


What's Happening Here?

Light travels in waves. White light, such as from the sun, is made up of many different colors. Each color is a separate wave with its own length, called a wavelength. When light hits an object, that object absorbs some wavelengths of light and reflects or scatters other wavelengths. The reflected light is the color we see.

Without your glasses, the light reflected by the blue crayon is lost behind the combination of red ink and yellow highlighter. With your glasses, no light reaches your eye from the blue crayon; the crayon is only reflecting blue light, but the red lenses of the glasses only let red light through. This makes the blue writing appear black (no light reaching your eye), allowing you to clearly read the hidden message amid the red ink and yellow highlighter!

Complete the following to find out why the blue writing appeared black and what happens when you mix different colors together.



COLOR LAB

Follow these steps to mix the different colors of paint and colored paper your teacher gives you. Record your observations on the back of this sheet.

1. Start with one color and one piece of paper of a different color.
2. Then try other combinations of paint and paper as well as mixing together colors of paint.

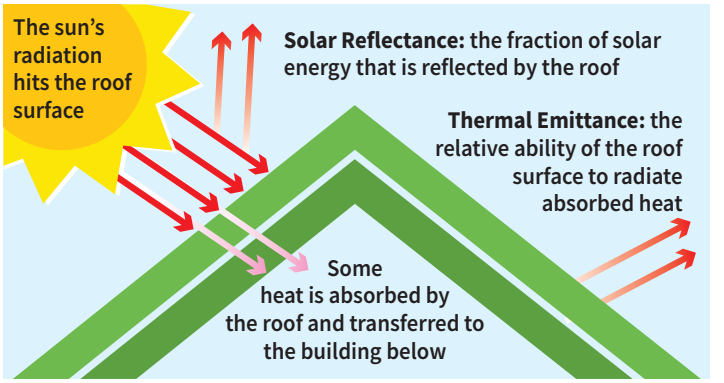
What's Happening Here?

When using paints or pigments, the color you see is the light the object is reflecting. As you mix colors, more and more wavelengths of light are absorbed, and fewer are reflected. When you add all of the colors together, you get black, because the pigments will collectively block all color from reflecting back at you. This is called *subtractive mixing*, and explains why the secret message appeared black.

Cool & Collected

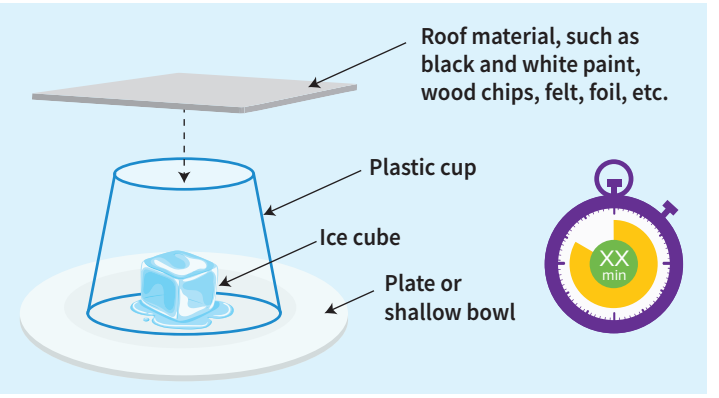
In the same way that visible light is absorbed and reflected, heat and energy from sunlight are absorbed and reflected by everything around us. This is why the seats in a car get hot on a sunny day and why people use umbrellas to prevent sunburn at the beach.

Study the diagram on the right to understand more about how this works. Then complete the experiment to learn how architects and engineers can use this principle to keep things cool, inside and out.



PROJECT BRIEF

The object of this experiment is to test how different roof colors and materials might impact the internal temperature of a structure. Using a plastic cup as the structure, you will work in groups to compare the time it takes to melt an ice cube using various materials.



Materials:

Plastic cup, a plate or shallow bowl, and ice cubes. Your teacher will help guide you in selecting materials to use for the roof, such as black and white paint, wood chips, felt, foil, etc.

Instructions:

1. Begin by making a hypothesis about how fast the ice cube will melt under specific materials. Consider the subtractive principles of color and whether that may be relevant.
2. Choose materials or paint colors to use as the roof of your structure. You will repeat this experiment several times with different selections.
3. Using the plastic cup as the base of your structure, coat, paint, or attach the roofing materials.
4. Place an ice cube on the plate or bowl and place the cup over it.
5. Use a stopwatch to measure how long it takes the ice cube to melt completely, and record your results in the chart below.

Hypothesis: The ice cube will take the longest to melt when_____

Test	Roof Material	Melt Time	Notes
1.	None		Use this as a control for direct light.
2.			
3.			
4.			
5.			

Conclusion: _____

What's Happening Here? Remember subtractive color mixing? Light colors absorb less and reflect more light than dark colors, and black absorbs all of the light. Just as with color, the same is true with light's invisible wavelengths, such as infrared and ultraviolet light. How do you think this would apply to different parts of a building or the pavement?

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