

A Common Core State and Next
Generation Science Standards-Aligned
Discussion/Activity Guide
for Grades PK-3

Perkins's Perfect Purple: How a Boy Created Color with Chemistry

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Illustrated by Francesca Sanna

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The fascinating true story of groundbreaking chemist William Perkin, who used the scientific method to invent a new way for creating the color purple.

Many years ago, the color purple was available only to a privileged few. Making purple was tricky. The dye was concocted from a certain snail, and later, from plants, bugs, and rocks. Then it had to be soaked in minerals and . . . urine! The process was very complicated and expensive (not to mention smelly!).

Until 1856, when a boy named William Henry Perkin invented a new way. While testing a hypothesis about a cure for malaria, he found that his experiment resulted in something else -- something vivid and rare for the times: synthetic PURPLE. Perkin, a pioneer of the modern scientific method, made numerous advances possible, including canned food and chemotherapy. But it was his creation of purple that started it all.

Guide created by
Debbie Gonzales, MFA



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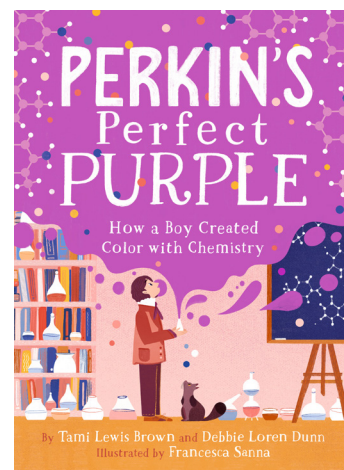
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Pre-Reading Discussion

Consider the illustration on the cover:

- Describe the action taking place in this scene. Where do you think this story will take place? List the clues that suggest where the setting may be.
- What is the young man holding in his hand? What type of vapor is being released from the glass object in his hand? What does the vapor suggest about what the young man is doing?
- Observe the young man's clothing. List ways that his clothing is both similar and different than pants and jackets worn today.
- Read the title of the story. Predict what you think this book is going to be about.



Meet the authors – Tami Lewis Brown and Debbie Loren Dunn:

- Tami and Debbie share a passion for science. So much so, they have co-created a website dedicated to STEM books and activities for curious kids. Imagine what their friendship might be like. Imagine what two inquisitive women might find talk about together.
- When asked what their favorite things to do as a child were, Tami said liked to ride horses. Debbie stated that she loved math. Yet, their love for books brought them together as friends. How about you? What common interests do you share with your friends? List your differences. Do you think you might like to co-author books with a friend or two? Explain your answer.
- Tami and Debbie invite you to stop by their shared website at brownanddunn.com, which is packed with fascinating activities, projects, information, and fun!



Meet the illustrator – Francesca Sanna:

- Francesca works as both an illustrator and a children's book author. Compare and contrast both types of storytelling. How do they differ? In what ways are they alike?
- Francesca grew up in Italy, currently lives in Zurich, Switzerland, yet she has illustrated a book that children in the United States can understand and enjoy. Identify the skills and techniques required to communicate a message through art that transcends any language barrier.
- Illustrations are pictures that tell a story. On her website, Francesca features examples of her illustrations that she has created for a variety of projects. Access her website at francescasanna.com. Discuss the messages she is communicating through her art.



Post-Reading Discussion

So where could Queen Victoria's cap maker find perfectly purple velvet for her coronation crown?

- Explain why it was easier to find silver, gold, diamonds, rubies, and pearls for the queen's crown than the color purple.
- Which is rarer – the valuable metals and jewels or the color purple? Explain your answer.
- Examine the process of using the marine mollusk named *Bolinus brandaris* as the source of creating purple. Do you think this type of effort required to make a color is worthwhile? Explain your answer.
- Describe your reaction to the requirements to soak fabric dyed purple in urine in efforts to save the color from fading.

Young William dreamed of being an artist, a musician, a photographer, or a botanist. . . . William was interested in everything!

- The word innovative means original, creative, and imaginative. Identify ways that, at an incredibly young age, William Henry Perkin was innovative.
- Discuss how William Henry Perkin's original thinking made him different than the other members of family. Describe his father's reactions to William's creative and imaginative thinking.
- Study the spread featuring William facing a building at the Royal College of Chemistry. Notice the colors coming from the suitcase in his hand. Explain what the colors represent. How do the colors predict what would become William's ultimate success? Explain your answer.

William was eager for this challenge. Could he cure rich and poor with chemistry?

- Describe William's motivation to discover an affordable way to synthesize quinine.
- August Wilhelm von Hofmann, a teacher at the Royal College, instructed William to use the Scientific Method to guide his experimental exploration. (A summary of the Scientific Method is provided in the Author's Notes.) State reasons why following a prescribed series of steps of experimentation is important for scientists to follow.
- In the end, was William successful? Was he able to discover a process through which quinine could be synthesized from tar? Explain how this process affected William.



*It wasn't the cure for malaria. But could a color help people?
What good could his invention do? William wasn't sure . . . but
he knew his purple was important.*

- List ways that discovering the process to replicate a color helps people.
- Discuss how William's discovery benefitted not only the queen but the world, at large.
- Not only was William's discovery important, the scientific process he followed was essential. Some say that his greatest achievement was the role he played in the "invention of the method of invention," the step-by-step process William's teacher, Alfred North Whitehead, instructed him to follow.
- Determine the significance of using the Scientific Method to prove a hypothesis, also known as an educated guess, in replicating experimental results.

*They bought land to build a factory, pooled their money, time,
and labor. And they called their company Perkin & Sons.*

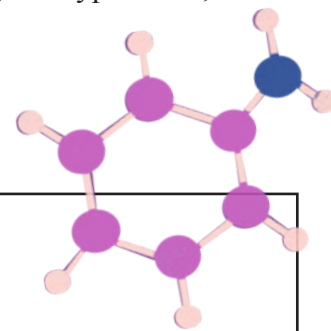
- When William was a young man his father was very resistant to allow him to pursue his interest in science. In fact, his father felt that chemistry was trickery. The word trickery means dishonesty, deception, and hocus-pocus! Consider how hard it must have been for his father to eventually allow William to attend the Royal College of Chemistry.
- In the end, William's father "sold everything to invest in his son's endeavor." What brought about his change of heart?
- Explore ways that William Perkin's perfect purple has affected the world. His life's work was motivated by the desire to help others. In the end, was he successful? Explain your answer.



Scientific Method Graphic Organizer

Perkin's purple set off a chemical reaction— a scientific revolution— a brighter, bolder, healthier, and happier tomorrow...

Note: The scientific method is a methodical process for performing scientific experiments. William followed the Scientific Method when initially performing experiments. He would then use the method to repeatedly test his results to assure that his findings could be replicated. Use the guide below to prove your hypotheses, then replicate your experiments to assure that your findings can be replicated, as well.



Name of Experiment: _____

Identify a problem or make an observation.

Perform research. Develop a vocabulary of terms and some basic understanding of science behind the experiment.

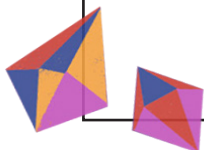
Form a hypothesis. Make an educated guess of what the results of the experiment might be.

Perform the experiment. Take notes to be used as reference when replicating your findings.

Analyze the results and draw a conclusion.

Revise your hypothesis, if necessary, and experiment again.

Share your findings with the class.



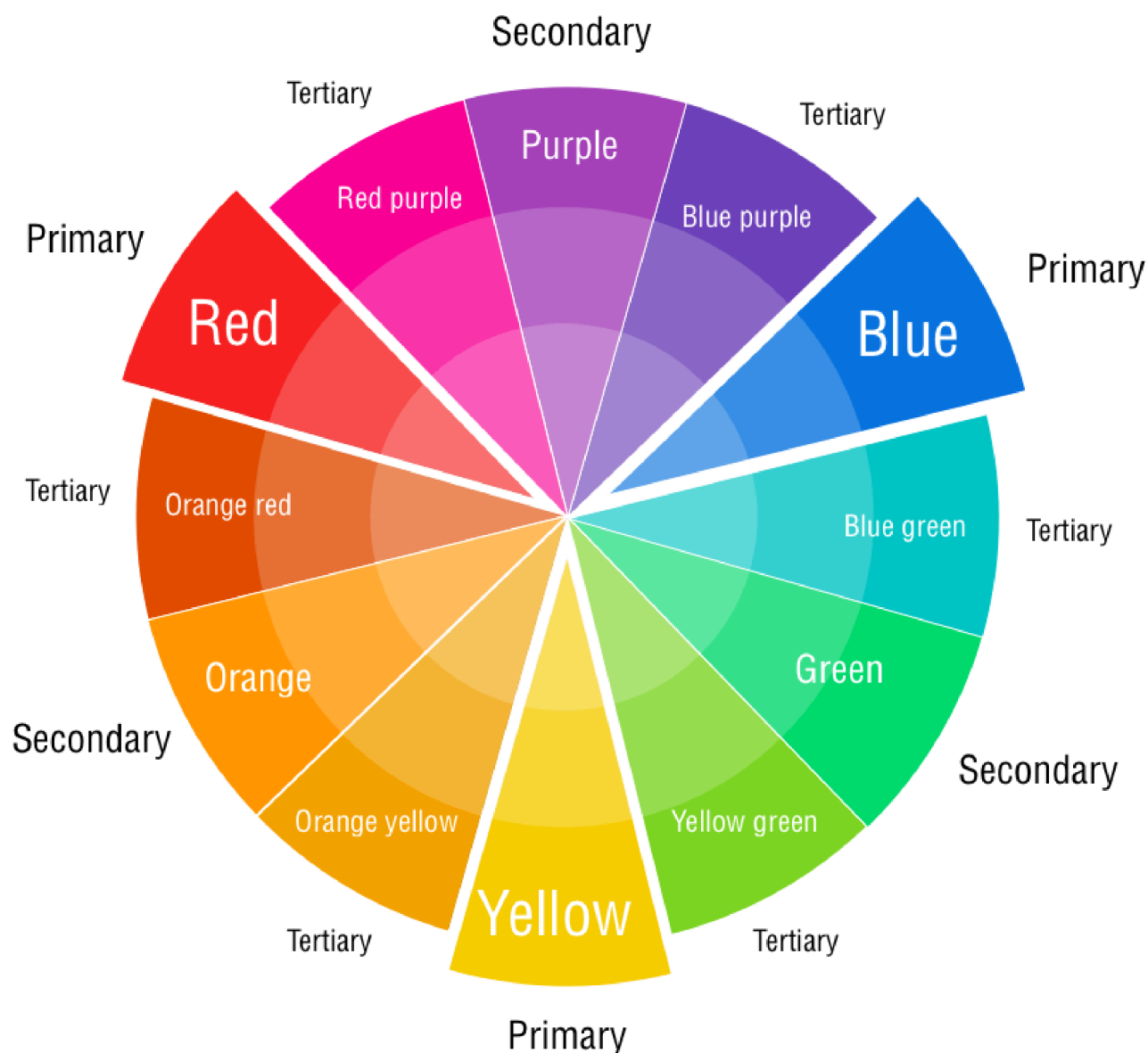
The Color Wheel

*Perkin's vivid purple was concocted from common sludge,
not the milk of rare snails.*

The Color Wheel is a combination of art and science. It was invented in 1666 by Isaac Newton, establishing the science of color theory. The Color Wheel shows how colors relate to one another. Consider how important the Color Wheel was to William Henry Perkin's research.

The Color Wheel below is divided into three categories of colors:

- Primary: Colors that cannot be mixed from other colors.
- Secondary: Colors that are created by mixing two primary colors.
- Tertiary: Colors made by combining a secondary color with a primary color.



Color Mixing: An Experiment

There he mixed and measured, experimented and examined.

Objective: To investigate and determine whether the mixing of two or more substances results in new substances, resulting in documented findings that can be replicated.

Materials:

- Scientific Method Graphic Organizer (Guide, pg. 6)
- The Color Wheel (Guide, pg. 7)
- Three small cups of water (baby food jars work best)
- Food coloring – primary colors
- Three eyedroppers
- Color mixing palettes



Procedure:

- Choose the red, blue, and yellow colors from the box of food colors. Add 5 or 6 drops of each primary color in cup of water, creating a source of yellow, red, blue to use in the experiment.
- Encourage students to explore the color creating process by mixing drops of color in the color mixing palettes.
- Have students to choose a tertiary color from the Color Wheel. Following the Scientific Method, instruct students to hypothesize how many drops of color would be required to create their chosen tertiary color.
- After students find success in creating their chosen color, have them replicate the process.
- Have students share their findings with the class.
- Instruct students to write an essay making a connection with their experience in creating a shade of color and William Henry Perkin's quest to create a deep shade of purple, rich enough to please the Queen.



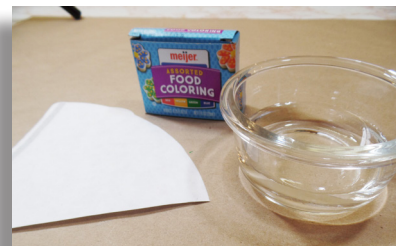
Color Diffusion: An Experiment

*But his father said, NO!
Chemistry is nothing but trickery.*

Objective: To examine the effects of color diffusion as it pertains to primary and secondary colors.

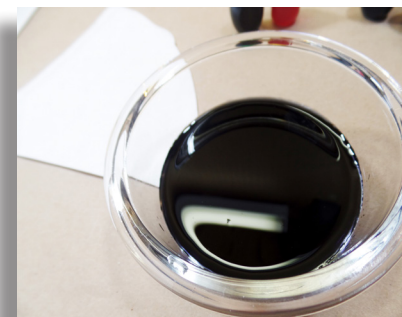
Materials:

- Scientific Method Graphic Organizer (Guide, pg. 6)
- Small bowl
- Food coloring
- Water
- Coffee filters



State a Hypothesis:

- Instruct students to begin the experimental process using the Scientific Method Graphic Organizer as a guide.
- Explain that the process of diffusion involves molecules moving from areas of high concentration to area of lower concentration. Have students hypothesize how the process of diffusion occurs with primary colors versus secondary colors.
- Tell student to create a hypothesis statement using this reasoning.



Procedure:

- Using the small bowl, water, and the red and blue food coloring, create purple.
- Dip an end of a coffee filter in the color. Allow the coffee filter to absorb some of the color.
- Remove the coffee filter. Observe the color diffusion process. Describe the molecular change taking place on the coffee filter.
- Instruct students to record their observations and findings on the Scientific Method Graphic Organizer.
- The word “diffusion” is defined as being the movement of molecules from one region of higher concentration to a region of lower concentration. Have students apply this definition to the phenomenon that took place during the experiment.
- William Henry Perkin’s father described chemistry as being “trickery.” Instruct students to write an essay exploring reasons why William Henry Perkin’s father might consider color diffusion to be trickery. Explain why it is not.
- Encourage students to share their work with the class.



The Color Spectrum Spinner: An Experiment

When he was twelve, a friend showed him experiments with crystals, and he knew this was far more exciting than any other subject.

Objective: To investigate the effect of blending primary and secondary colors of the color wheel.

Materials:

- Cardstock
- 3 ft. of strong string
- 2 buttons
- Salad plate
- Scissors
- Push pin
- Ruler
- Pencil
- Markers

State a Hypothesis:

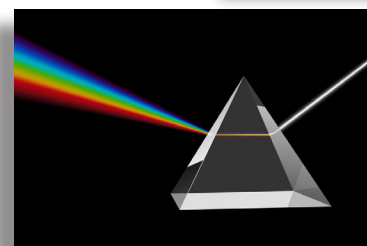
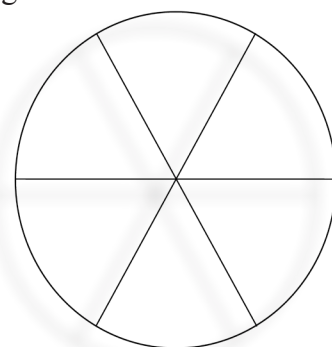
- Instruct students to begin the experimental process use the Scientific Method Graphic Organizer.
- Ask the students to explore the following question. “If you mix red and blue together, the color purple is formed. If you mix black, white, and yellow, the color brown is formed. What color is formed when primary and secondary colors are mixed together?”
- Tell student to create a hypothesis using this reasoning.

Construction:

- Use a pencil and the salad plate to trace a circle on the cardstock.
- Use scissors to trim around the outer border of the circle.
- Use ruler to draw 6 pie-shapes in the circle.
- Use markers to color in the pie shapes following the sequencing of the colors of the color wheel.
- Find the center of the circle. Using the push pin, poke two holes in the cardstock in the center of the circle.
- Thread the string through the circle and the buttons.
- Tie the two free ends of the string together.

Make it Work:

- Hold one end of the string in each hand.
- Wind the string by flipping the circle towards your body. Create a twist in the string.
- Once string has been wound fifteen or twenty times, pull the twisted string outwards. The circle will spin as the string unwinds and will rewind itself again in the opposite direction.
- Look closely at the spinning patterns. Describe what happens to the colors as the circle spins.
- Complete the Scientific Method Graphic Organizer.
- Discuss the results of the experiment with your class.
- Note that all the colors of the spectrum are mixed at full strength the color white is created. When light is diffused through a crystal spectral colors – rainbow colors – are created. When William was young, he was fascinated by experimentation with crystals. Write a short essay connecting William’s early experiences with crystals and the color spectrum. Examine how his early interests helped to prepare him for the discoveries he made in later life.



Common Core State Standards Alignment

English Language Arts Standards » Reading: Informational Text		Discussion	Color Mixing: An Experiment	Color Diffusion: An Experiment	The Color Spectrum Spinner: An Experiment
CCSS.ELA-LITERACY.RI.K.1	With prompting and support, ask and answer questions about key details in a text.	●	●	●	●
CCSS.ELA-LITERACY.RI.K.2	With prompting and support, identify the main topic and retell key details of a text.	●	●	●	●
CCSS.ELA-LITERACY.RI.K.3	With prompting and support, describe the connection between two individuals, events, ideas, or pieces of information in a text.	●	●	●	●
CCSS.ELA-LITERACY.RI.K.4	With prompting and support, ask and answer questions about unknown words in a text.	●	●	●	●
CCSS.ELA-LITERACY.RI.K.5	Identify the front cover, back cover, and title page of a book.	●			
CCSS.ELA-LITERACY.RI.K.6	Name the author and illustrator of a text and define the role of each in presenting the ideas or information in a text.	●			
CCSS.ELA-LITERACY.RI.K.7	With prompting and support, describe the relationship between illustrations and the text in which they appear (e.g., what person, place, thing, or idea in the text an illustration depicts).	●			
CCSS.ELA-LITERACY.RI.K.8	With prompting and support, identify the reasons an author gives to support points in a text.	●	●	●	●
CCSS.ELA-LITERACY.RI.K.10	Actively engage in group reading activities with purpose and understanding.	●	●	●	●
CCSS.ELA-LITERACY.RI.1.1	Ask and answer questions about key details in a text.	●			
CCSS.ELA-LITERACY.RI.1.2	Identify the main topic and retell key details of a text.	●			
CCSS.ELA-LITERACY.RI.1.3	Describe the connection between two individuals, events, ideas, or pieces of information in a text.	●	●	●	●
CCSS.ELA-LITERACY.RI.1.4	Ask and answer questions to help determine or clarify the meaning of words and phrases in a text.	●	●	●	●
CCSS.ELA-LITERACY.RI.1.6	Distinguish between information provided by pictures or other illustrations and information provided by the words in a text.	●			
CCSS.ELA-LITERACY.RI.1.7	Use the illustrations and details in a text to describe its key ideas.	●			
CCSS.ELA-LITERACY.RI.1.10	With prompting and support, read informational texts appropriately complex for grade 1.	●	●	●	●
CCSS.ELA-LITERACY.RI.2.1	Ask and answer such questions as <i>who</i> , <i>what</i> , <i>where</i> , <i>when</i> , <i>why</i> , and <i>how</i> to demonstrate understanding of key details in a text.	●	●	●	●
CCSS.ELA-LITERACY.RI.2.3	Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text.	●	●	●	●
CCSS.ELA-LITERACY.RI.2.6	Identify the main purpose of a text, including what the author wants to answer, explain, or describe.	●	●	●	●

		Discussion	Color Mixing: An Experiment	Color Diffusion: An Experiment	The Color Spectrum Spinner: An Experiment
English Language Arts Standards » Reading: Informational Text (cont.)					
CCSS.ELA-LITERACY.RI.2.7	Explain how specific images (e.g., a diagram showing how a machine works) contribute to and clarify a text.	•	•	•	•
CCSS.ELA-LITERACY.RI.3.1	Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.	•	•	•	•
CCSS.ELA-LITERACY.RI.3.2	Determine the main idea of a text; recount the key details and explain how they support the main idea.	•	•	•	•
CCSS.ELA-LITERACY.RI.3.3	Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.	•	•	•	•
CCSS.ELA-LITERACY.RI.3.7	Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur).	•			
English Language Arts Standards » Writing					
CCSS.ELA-LITERACY.W.K.2	Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic.	•	•	•	•
CCSS.ELA-LITERACY.W.K.5	With guidance and support from adults, respond to questions and suggestions from peers and add details to strengthen writing as needed.	•	•	•	•
CCSS.ELA-LITERACY.W.K.8	With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.	•	•	•	•
CCSS.ELA-LITERACY.W.1.2	Write informative/explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure.	•	•	•	•
CCSS.ELA-LITERACY.W.1.8	With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.	•	•	•	•
CCSS.ELA-LITERACY.W.2.2	Write informative/explanatory texts in which they introduce a topic, use facts and definitions to develop points, and provide a concluding statement or section.	•	•	•	•
CCSS.ELA-LITERACY.W.2.7	Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations).	•	•	•	•
CCSS.ELA-LITERACY.W.3.2	Write informative/explanatory texts to examine a topic and convey ideas and information clearly.	•	•	•	•

English Language Arts Standards » Writing (cont.)		Discussion	Color Mixing: An Experiment	Color Diffusion: An Experiment	The Color Spectrum Spinner: An Experiment
CCSS.ELA-LITERACY.W.3.8	Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.	•	•	•	•
English Language Arts Standards » Speaking & Listening					
CCSS.ELA-LITERACY.SL.K.1	Participate in collaborative conversations with diverse partners about <i>kindergarten topics and texts</i> with peers and adults in small and larger groups.	•	•	•	•
CCSS.ELA-LITERACY.SL.K.2	Confirm understanding of a text read aloud or information presented orally or through other media by asking and answering questions about key details and requesting clarification if something is not understood.	•	•	•	•
CCSS.ELA-LITERACY.SL.K.3	Ask and answer questions in order to seek help, get information, or clarify something that is not understood.	•	•	•	•
CCSS.ELA-LITERACY.SL.K.4	Describe familiar people, places, things, and events and, with prompting and support, provide additional detail.	•	•	•	•
CCSS.ELA-LITERACY.SL.K.6	Speak audibly and express thoughts, feelings, and ideas clearly.	•	•	•	•
CCSS.ELA-LITERACY.SL.1.1	Participate in collaborative conversations with diverse partners about <i>grade 1 topics and texts</i> with peers and adults in small and larger groups.	•	•	•	•
CCSS.ELA-LITERACY.SL.1.2	Ask and answer questions about key details in a text read aloud or information presented orally or through other media.	•	•	•	•
CCSS.ELA-LITERACY.SL.1.3	Ask and answer questions about what a speaker says in order to gather additional information or clarify something that is not understood.	•	•	•	•
CCSS.ELA-LITERACY.SL.1.4	Describe people, places, things, and events with relevant details, expressing ideas and feelings clearly.	•	•	•	•
CCSS.ELA-LITERACY.SL.1.6	Produce complete sentences when appropriate to task and situation.	•	•	•	•
CCSS.ELA-LITERACY.SL.2.1	Participate in collaborative conversations with diverse partners about <i>grade 2 topics and texts</i> with peers and adults in small and larger groups.	•	•	•	•
CCSS.ELA-LITERACY.SL.2.2	Recount or describe key ideas or details from a text read aloud or information presented orally or through other media.	•	•	•	•
CCSS.ELA-LITERACY.SL.2.4	Tell a story or recount an experience with appropriate facts and relevant, descriptive details, speaking audibly in coherent sentences.	•	•	•	•
CCSS.ELA-LITERACY.SL.2.6	Produce complete sentences when appropriate to task and situation in order to provide requested detail or clarification	•	•	•	•
CCSS.ELA-LITERACY.SL.3.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on <i>grade 3 topics and texts</i> , building on others' ideas and expressing their own clearly.	•	•	•	•



Next Generation Science Standards Alignment

		Discussion	Color Mixing: An Experiment	Color Diffusion: An Experiment	The Color Spectrum Spinner: An Experiment
2-PS1 Matter and Its Interactions					
	2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.	•	•	•	•
	Cause and Effect ▪ Events have causes that generate observable patterns.		•	•	•
	Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests		•	•	•
5-PS1 Matter and Its Interactions					
	5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.	•	•	•	•
	Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions		•	•	•
	Develop a model to describe phenomena.		•	•	•
	Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.		•	•	•
	Cause and effect relationships are routinely identified, tested, and used to explain change.		•	•	•

