**Light**

**Lesson #5: Colors**

**Time Frame:** 60 minutes

*Please write the vocabulary on the board before each lesson.*

**Vocabulary**

**Color** - a property of visible light waves that is determined by its wavelength

**Pigment** - a property of an object that is determined by the wavelengths of light that it reflects

**Absorption** - when light enters a medium and is retained rather than reflected

**Reflection** - when light hits a surface and bounces back

**Learning Standards:**

*Science*

Waves and their Applications in Technologies for Information Transfer

1. An object can be seen when light reflected from its surface enters the eyes.

Light Energy

1. Recognize that light can be reflected and absorbed.

**Student will be able to:**

1. Understand that color is made of different frequencies of light waves.
2. Distinguish between colors of light and colors of pigment.

**Resources and Materials:**

|  |  |
| --- | --- |
| **Item** | **Amount** |
| Science Journals |  |
| Additive and Subtractive colors (overhead or make copies) | (in binder) |
| Flashlights | 3 (in bin) |
| Flashlight filters | 3 (red, green, blue) (in bin) |
| Rubber bands | 3 or more (in bin) |
| Large books | 2 (in classroom) |
| Mirror | 1 (in bin) |
| White Card | 2 (in bin) |
| Black Card | 1 (in bin) |
| Exploring Color Record Sheets | 25 (in bin) |
| Color Venn Diagrams Sheet | 25 (in bin) |

**Focus Activity:** On a table in the front of the class, position two large books so that they form a right angle. This activity will demonstrate the phenomenon of reflection as it relates to color. Begin with a mirror, which reflects the most light. Each trial will reflect less light than the previous trial.

**Trial 1:** Prop a small mirror against one of the books. Then tape a white card against the other book. Turn out the lights and position the flashlight so that the beam hits the mirror and bounces onto the card. Have students observe the path of the light and notice the brightness of the light on the white card.

**Trial 2:** Replace the mirror with another white card. Turn out the lights and position the flashlight so that the beam hits the first white card and reflects onto the second white card. Have students observe the path of light. Is the light reflected from the white card as bright as the light reflected on the mirror?

**Trial 3:** Replace the white card with a black card. Turn out the lights and position the flashlight so that the beam hits the black card and reflects onto the white card. Have students observe the path of light. Compare the amount of light reflected from the three different materials. What happened to the amount of light that was reflected in each instance and why?

*Teacher Explanation: We have already seen the way that mirrors reflect light, but reflection isn’t limited to mirrors. All non-luminous objects that we can see reflect light. But objects with different colors reflect different amounts of light. White objects reflect almost all light, because white light is formed when all colors of light combine. This is why there is more light reflected from the white card than the black card.*

**Introduction:** Watch the following video about color: What Is Color? - Colm Kelleher TEDEducation <http://www.youtube.com/watch?v=UZ5UGnU7oOI>. Discuss the fact that different colors of light have different wavelengths using the poster of the electromagnetic spectrum. Explain that white light, like the light from the sun, contains all colors of light. A red object, like a tomato, appears red to the human eye because it reflects red wavelengths of light and absorbs all the other wavelengths of light. Tell students that in today’s lesson, they will be exploring the difference between mixing colors of light and colors of pigments.

**Activity: Why Is Light White?**

\*Note: It is difficult to combine red, blue, or green light with homemade equipment. So when doing this activity, you probably will not actually see pure yellow, magenta, cyan, or white light produced. When teaching this lesson, focus on how the combinations of colored light do not produce the expected secondary colors from art. Then use the “colors” page on the Bobo & Light app to demonstrate what would happen when you mix together pure red, blue, or green light. Talk to your classroom teacher about setting up an iPad before the start of the lesson to be able to project onto the board. The “colors” part of the Bobo & Light app is in the middle into the app, so you will probably need to find it by scrolling through the table of contents.

1. You will need 3 flashlights covered with red, blue, or green filters attached with a rubber band.
2. Turn the lights off so the room is dark. Have students make a hypothesis about what color they will see when you turn on the “red” flashlight. On an open space on the wall or a white piece of paper, shine the red light so that a red spot appears. Repeat for the “blue” and “green” flashlights individually, having students make hypotheses and write down their observations on their record sheets. Explain to students that the filters on the flashlights absorb some colors of light, but allow others to pass through. The red flashlight, for example, allows red light to pass through and absorbs green and blue light.
3. Next, tell the students that they will be observing what happens when colors of light are mixed. Have students write a hypothesis about what color they will see when red and green light is mixed. Ask for two student volunteers. One will hold the red flashlight and another will hold the green flashlight. Have the two students shine their flashlights at the same spot so that the colors combine. A yellow spot should be produced. Have students record their observations on their record sheets.
4. Have students make a hypothesis about what color they will see when red and blue light is mixed. Ask for two new student volunteers. One will hold the red flashlight and another will hold the blue flashlight. Have the two students shine their flashlights at the same spot so that the colors combine. A magenta spot should be produced. Have students record their observations on their record sheets.
5. Have students make a hypothesis about what color they will see when green and blue light is mixed. Ask for two new student volunteers. One will hold the green flashlight and another will hold the blue flashlight. Have the two students shine their flashlights at the same spot so that the colors combine. A cyan spot should be produced. Have students record their observations on their record sheets.
6. Tell students they will be combining all three colors of light. Have students make a hypothesis about what color they will see when all three colors of light, red, green, and blue, are mixed. This time you will need three student volunteers. They will each hold one flashlight. Have the students shine their flashlights at the same spot so that the colors combine. A white spot should be produced. Have students record their observations on their record sheets.
7. Show students the overhead. Lights and pigments produce different colors when mixed. Lights are additive colors. Additive colors mix, or “add”, together their wavelengths of light to make new colors. Additive colors result from transmitted light from light sources such as TV or iPad screens. This is why secondary additive colors are brighter than primary additive colors: there is literally more light used to create secondary additive colors than primary additive colors. Pigments are subtractive colors. Subtractive colors absorb, or “subtract”, some wavelengths of light and reflect others. The wavelengths of light that are reflected are the colors that we see. Examples of pigments are paints or ink. Subtractive colors result from reflected light and each color acts as a “filter” which absorbs only certain wavelengths of light and reflects others. This is why secondary subtractive colors are darker than primary subtractive colors: there is literally more light filtered out in secondary subtractive colors than primary secondary colors.
8. Using the observations on their record sheets, students should fill out Venn diagrams on the Color Venn Diagrams worksheet to model the additive properties of colors of light. Students may write the names of the colors and draw using colored pencils or crayons.
9. Extension (if time remains): Have students complete the second Venn diagram to model the subtractive properties of colors of pigments. Students may write the names of colors and draw using colored pencils or crayons. At the overlapping parts of the Venn diagram, there should be secondary colors. Consult with your classroom teacher and the art teacher to determine whether students can experiment with mixing paints.

**Closure:** Discuss the following questions as a class: What do white light and black pigment have in common? On a sunny summer day, why would it be good for a baseball player to wear black ointment under his eyes but a white uniform?

**Assessment:** Record sheets, Venn diagram models of light





Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_      Date:\_\_\_\_\_\_\_\_\_\_\_\_\_

Exploring Color Record Sheet

Each of the three flashlights we’ll be testing is a different color: one is red, one is blue, and one is green. For each combination of flashlights, predict what color the light will be. Then, observe the actual color produced by each combination and record your observations.

|  |  |  |
| --- | --- | --- |
| Flashlight color | Hypothesis | Observed |
| Red |  |  |
| Blue |  |  |
| Green |  |  |
| Red and Green |  |  |
| Red and Blue |  |  |
| Blue and Green |  |  |
| Red, Blue, and Green |  |  |

Did any of the color combinations look different from the colors you get when you mix red, blue, or green paint together?

