**All the Colors of the…Thermometer Activity Template**

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| **5-Part Plan Title:** | **All the Colors of the …Thermometer** |
| **Engineering Grand Challenge Covered:** | **Make Solar Energy Economical** |
| **Fellow Contributor(s) / Group Number:** | **Rebekah Johnston** |
| **Grade Level(s):** | **1-4** |

1. **Subject Area(s):** Physics and Engineering
2. **Associated Unit or Lesson**: None
3. **Time Required**: 45 minutes
4. **Group Size:** 2
5. **Expendable Cost per Group**: $7.00
6. **Summary**: This activity focuses on discovering and analyzing how different colors are able to absorb differing amounts of heat when placed under the same light source. This phenomena stems from the ability of objects to absorb and reflect light. In fact, the color an object appears to be is due to an object absorbing all other colors of light except for the reflecting light of that color. Consequently, the more light (energy) an object can absorb then the more heat it will absorb. This is why black colored objects, which absorb all light waves, are able to absorb the most heat. Students will implement these concepts by measuring the temperature before and after placing different colored bottles under a light source for 5 minutes.
7. **Engineering Connection**: The concept of objects being able to absorb varying energies is a universal idea to physics and biology. In particular, students will also be introduced to basic concepts of optics by focusing on the relationship between color type and heat retention. These characteristics are fundamental considerations engineers have to account for when designing solar panels and other energy efficient technology.
8. **Key Search words:** Heat, Light, Light Wavelengths, Colors
9. **Educational Standards**: See attached standards grid for a complete mapping to all pertinent STEM standards.
	1. Common Core Math Standards: 3.MD.3, 3.MD.4, 4.MD.1, 4.MD.4
	2. NC Essential Science Standards: 3.P.3.2, 4.P.3.1, 4.P.3.2
10. **Pre-Requisite Knowledge:** None
11. **Learning Objectives** (After this activity, students should be able to):understand the basic concept of energy absorption and the factors that make up visible colors. Additionally, they will be made aware that lamps or other light sources produce light and heat. They will understand that white reflects everything in the color spectrum while black absorbs everything. Consequently, there are particular colors that are able to absorb light more efficiently than others.
12. **Materials List:**
	1. Bottle/container
	2. Spray Paint
	3. Thermometer
	4. Lamp
	5. Light bulbs
	6. Ruler
13. **Introduction / Motivation**: If it is 100°F outside, what type of clothes do you wear outside? What colors are you wearing? Why wouldn’t you like to wear black? How much do you think black absorbs versus white? When engineers design machines to be energy efficient, it is important for them to understand how objects absorb energy as well as the factors that may influence it. One simple phenomenon that illustrates this concept is the ability of varying colored objects to absorb different amounts of heat. This is all due to colors being an occurrence of light waves reflecting and absorbing. Black absorbs the most energy due to it absorbing all waves in the color spectrum while white reflects all the wavelengths.
14. **Vocabulary / Definitions:**

Light – A form of energy that makes things visible and vision possible.

Color – A phenomenon of light that enables one to differentiate otherwise identical objects.

Wavelength – The distance between successive crests of a wave.

Heat – A form of energy that causes substances to rise in temperature (fuse, evaporate, expand).

Energy – The capacity for doing work.

Absorb –To take in; to transform (radiant energy) into a different form especially with a resulting rise in temperature.

Reflect – To bounce waves of light, sound or heat off a surface.

Solar Panel – A panel designed to absorb the sun’s rays as a source of energy for generating electricity or heating.

1. **Procedure:**
* Before the Activity – One class should be devoted to going over concepts of general physics such as light, heat and color spectrum as well as the idea of absorption and reflection.
* With the Students – The instructor should pose the questions stated in the introduction to the class. After some preliminary discussion, the students should be split up into groups of two. Each group will be asked to paint a bottle a specified color. The initial and final temperature will be recorded of the thermometer placed in the bottle. A bar graph will be created to visualize the effects of color on heat absorbed.
* Cleanup – All materials will be put away in the activity box. The bar graph can be placed on the wall for further reinforcement of the concepts. Over time, further discussion can be formulated on the concepts of light and heat.
1. **Attachments:** None
2. **Safety Issues**: In the presence of younger students, the bottles can be painted at some time before the beginning of the lesson so that students are not exposed to the spray-paint fumes.
3. **Troubleshooting Tips**:
4. **Investigating Questions:**
	1. How does a thermometer work? What does it measure?
	2. How does the lamp, light, affect the thermometer inside the colored bottles?
	3. Why do certain colors absorb more energy than others?
	4. What colors do you wear in the winter? In the summer?
5. **Assessment**: None
6. **Contributors:** Rebekah Johnston, Samantha Perez
7. **Supporting Program**: Duke Boeing Grand Challenge K12 Outreach Fellows Program