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## Substrate Color vs. Temperature Experiment

### Introduction:

**Heat** is a form of **energy** that can be transferred from one **substance** to another. This energy affects the **molecules** of a substance; when energy is added, the molecules move/vibrate faster, causing an increase in temperature. There are ways that heat energy can be generated, but in nature the biggest energy source is the sun. The sun's energy heats the earth's surface which makes it suitable for life. When the sun heats up the water in a lake, stream, **bayou**, or the ocean it affects the things that live in the water too. All organisms can only survive within certain temperature ranges. If the temperature gets too high or too low living things can become stressed, ill, or even die. Some larger organisms can move to different areas if the temperature of their environment becomes unsuitable. However, many other organisms that are too small, move too slowly, or do not move at all cannot leave the area. Many things affect how much of the sun's energy is transferred to the water. These things can include the kind or color of the **substrate**, the amount of **suspended particles**, and surrounding plants/structures within the **water column**.

### Helpful Terms:

- **Bayou** - a body of water found in a flat, low-lying area, and can either be a slow-moving stream or river
- **Energy** – the power to do work that produces light, heat, or motion
- **Heat** – the quality of being hot, the total amount of energy of all the molecules in an object or substance
- **Molecules** – the smallest particle (made up of atoms) in an element or compound
- **Substrate** – the earthy material that is on the bottom of a water body, like dirt, rocks, sand, or gravel
- **Substance** - material from which something is made
- **Suspended Particles** – small solids that remain unsettled in water due to the motion of water
- **Water Column** - column of water from the surface of a water body to the bottom sediment

The first step in science is always to have a question we want to answer. Have you ever noticed that you get hotter in the sun when you wear darker colors, can the same be true for a body of water? Have you ever noticed any difference in the temperature of water in a shaded area versus an unshaded area? Today we want to investigate how the color of a substrate affects the temperature of a body of water.

The second step in the scientific process is coming up with a Hypothesis. A hypothesis is an educated guess that can be tested by doing an experiment or making an observation. For this activity you will be conducting an experiment. A hypothesis is a statement you make about what YOU expect will be the result of your experiment. Can you make a hypothesis for this experiment?

Here are a few guiding questions to help:

- Do you expect that there will be a difference in the change of the temperature of water if we use different colors as substrates? Or do you think there will not be any difference because of color?
- Do expect that different colors of substrate will affect the rate at which temperature changes?

Write your hypothesis here:

Step three is to have a really good experimental design to test your hypothesis. This is a very important step. It is important because you need to have a well thought out plan to make sure that you are actually going to collect data that will answer your question and test your hypothesis. If your experimental design does not do either of those things you are not going to be able to make a conclusion at the end. You then will have done a lot of work for nothing.

To help you out we have provided you with an experimental design on the next page. But first we need you to gather all the materials you are going to need for the experiment. Remember to ask your adult for permission before starting this experiment. Maybe you can even convince them to help.

*These are the materials you are going to need:*

- 3 containers that will hold water. They will need to be clear and have a wide opening. You also need to be sure they are all the same size and shape.
- Different colors of paper or fabric (like a bandana) – at least 3 different colors (1 dark color, 1 medium color, 1 light color). You can also use play sand if you have it, but you need 3 different colors.
- A thermometer – any thermometer that can be used in water and starts reading at rough 60 degrees F.
- A measuring cup to measure the volume of water
- Water
- Datasheet (page 4) and a pencil



*Experimental Design: IMPORTANT THINGS TO KEEP IN MIND*

It is very important that the only thing that is different about each container is the color we put on the bottom. That way we can be sure that the only thing that is causing a difference in the water temperatures being measured is the color on the bottom.

For this experiment we are going to need three containers with water in them. That means each container is going to need to have exactly the same amount of water. Be sure to measure your amount of water for each container very carefully. The containers will have to be put in a sunny area. Be sure that all three of your containers are exactly the same and within 8 inches of each other but not touching.

All the containers will also need to have the same amount of sun for the entire time you are carrying out your experiment. So be sure to pick a spot where it will not get shady during the experiment.

Procedure:

- 1) Gather materials and find a location that will stay sunny for at least two hours

- 2) Create colored “substrates” - make sure each container is set up as similarly as possible
  - If using colored sand, measure the same amount of sand into each clear container making sure the entire bottom is covered.
  - If using colored paper or fabric, make sure your containers are completely clear (not frosted). Position paper/fabric under each container so the color shows through the bottom. Additionally, you can fold the fabric/cut and tape the paper so it covers the sides of the container as well
- 3) Use a measuring cup to fill each container with the same amount of water and place in a sunny location. To avoid carrying containers full of water and spilling, you could also set the empty containers out, and then use a pitcher to bring enough water for all the containers and use the measuring cup to fill containers once they are in their sunny spot.
- 4) Take note of weather conditions continuously throughout the experiment, especially at the time of the first and the last measurements.
- 5) Measure the temperature of each container and record them in the data table under 0 minutes (ideally, they should all start at the same temperature).
  - NEVER take the thermometer out of the water to read it.
  - The thermometer should never touch the sides or bottom of the container
  - You should leave the thermometer in the water for at least 30 seconds before reading it
  - If you are using a thermometer that you have to read from the side make sure that you read it while it is at eye level.
- 6) Measure the temperatures of each container every 15 minutes for at least 2 hours. Record your measurements in the table at the time you get them, never wait. Remember to note weather conditions, especially if there are changes.
- 7) *Optional:* After you have collected all your data, create a graph. If you know how to use excel or other program you can create a digital graph.



# Substrate Color vs. Temperature Datasheet

Date:

Start time:

Notes (write notes about anything going on around the experiment you think are important):

	Colors that are being tested (write each color in the first box of each column)			
Time	Color #1	Color #2	Color #3	Color #4
0 min				
15 min				
30 min				
45 min				
60 min				
75 min				
90 min				
105 min				
120 min				



*Follow-up Questions:*

- Does your data support your hypothesis?
- What patterns do you see in the data?
- Why do you think you see these patterns?
- Are there any changes you would make to this experiment to make it better?
- What effect do you think substrate color would have on organisms living in the water?

*Questions for More Fun:*

- *Question:* How does shading help improve the water quality of a body of water?
  - Follow the same procedure but with 2 sets or samples. Put one set in the direct sunlight and the other in a shaded area. Compare shaded and unshaded samples.
- *Question:* Temperature is important to the health of a water body and the organisms that live in it. Use the internet to investigate the relationship between temperature and oxygen.
  - *Helpful websites:*
    - LUMCON's Bayou Side Classroom <https://bayousideclassroom.lumcon.edu/>
    - Gulf of Mexico Hypoxia <https://gulfhypoxia.net/>
    - USGS Water Science School [https://www.usgs.gov/special-topic/water-science-school/science/dissolved-oxygen-and-water?qt-science\\_center\\_objects=0#qt-science\\_center\\_objects](https://www.usgs.gov/special-topic/water-science-school/science/dissolved-oxygen-and-water?qt-science_center_objects=0#qt-science_center_objects)