Engineering the Best Shade Ball Coating

Objective:
You will apply your understanding of heat adsorption, reflection, and algae growth to create and test a shade ball prototype. Once you have chosen a coating material and the most effective number of layers, you will build a prototype and place it in a small water system to collect data on water temperature and algae growth.

Scenario:
A local city is exploring the use of shade balls in its water storage tanks to reduce water temperature increases and limit algae growth. Your team has been tasked with developing and testing a shadeball prototype using one of two materials to find the most effective. You will use small-scale fish bowl aquariums and collect data on both temperature and algae development over time to make an advertisement so the city engineers will choose your idea.

Materials:
- 3 to 4 plastic shade balls
- Spray adhesive
- Carbon black paint
- Activated charcoal powder
- Paintbrushes
- Tweezers
- Disposable gloves
- Aquarium
- Measuring cup
- Algae culture — 80 milliliters per group
- Secchi disk
- Thermometer
- Paper towels or newspaper
- Permanent marker

Procedures:
Step 1: Prepare Your Workspace
- Label your aquarium and shade balls with your group number, coating material, and number of layers.
- Put on gloves if handling materials by hand.

Step 2: Build Your Shade Ball Prototype
1. Choose your coating material:
    - Carbon black paint (liquid)
    - Activated charcoal powder
2. Coating method (for either material):
    - Use spray adhesive to lightly coat the entire surface of a plastic shade ball.
    - Then apply your chosen coating using one of the following:
        - Gloved hand: roll or dip the sticky shade ball directly into the powder or paint.
        - Tweezers: hold the ball and either dip it or use a paintbrush to coat it.
        - Paintbrush: brush the carbon black paint directly onto the adhesive, or dust on the activated charcoal powder

3. Apply additional layers:
    - Allow the ball to dry completely (check with your teacher, ~5–10 minutes between coats).
    - Repeat the spray-and-coat process to apply 2 or 3 total layers, depending on your design.
4. Label your shade balls with the coating type and number of layers.

Step 3: Set Up the Aquarium

1. Use a measuring cup to add 100 oz of water into your aquarium or fishbowl.
2. Add 80 mL of algae culture to the water to simulate natural conditions.
3. Carefully place 3–4 completed shade balls into the aquarium.
4. Place your aquarium in the assigned testing area under the lamp
5. Record your starting water temperature in Celsius(Day 1) using a thermometer.

Step 4: Collect Your Data

1. Temperature:
    - For 5 days, measure and record the water temperature once per day at the same time.
2. Algae Growth (using Secchi disk):
    - Every day (for 5 days), use the Secchi disk to measure the water clarity:
        - Lower the Secchi disk into the aquarium until it is no longer visible.
        - Record the depth in centimeters at which the disk becomes invisible. This will indicate the clarity of the water and give a measure of the algae growth.

Step 5: Clean-Up

- Once data collection is complete, carefully clean up using these steps:
  1. Making sure you are wearing protective gloves and googles, carefully lift the shade balls from the aquarium using tongs. Rinse them with warm, soapy water tray or sink to remove algae residue and then place on a paper towel to dry. Set aside for reuse.
  2. Dispose of algae culture. Pour the algae water from the aquarium slowly down the sink with running water, flushing continuously to prevent buildup. Avoid pouring large clumps or solid algae down the drain. Place those pieces in the trash.
  3. Clean the aquarium by rinsing it thoroughly with warm, soapy water and allowing it to air dry.
  4. Wash Secchi disks, thermometers, and any other supplies used with soapy water as well. All to air dry.
  5. Wipe down tables and sink with disinfectant or wipes.

Hypothesis:

I believe that using ____ number of coats on shade balls coated with ___ [material] will be most effective because _____

_____

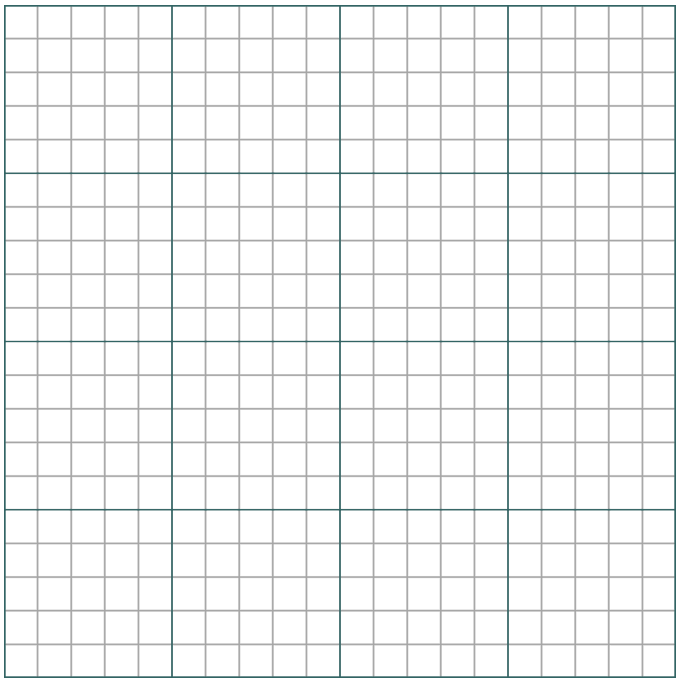
Data Table: Water Temperature

Day	Current Temperature (°C)	Previous Temperature	Total Change (°C)
1			
2			
3			
4			
5			

Data Table: Algae Growth (After 3–5 Days)

	Day 1	**Day 2**	**Day 3**	**Day 4**	**Day 5**
Depth where Disk Disappeared (cm)					

Graph:
Create a double-line graph comparing temperature change and algae rating across different conditions.



Analysis Questions:
1. Which material worked best overall to reduce both temperature and algae growth?

2. Which number of coats of material gave the best results?

3. Were your predictions correct? Why or why not?

4. How might your results change in a larger, real-world water reservoir?

5. Based on your data, what information will you include in your advertisement to give to the city engineers?