Setting the Stage
Episode 9:
We Need to Be Scene

SC Grades 3, 5, & 8
NC Grades 3, 5, & 6
3.P.2A.2 Construct explanations using observations and measurements to describe how matter can be classified as a solid, liquid or gas.

2.P.3A.1 Analyze and interpret data from observations and measurements to describe the properties used to classify matter as a solid or a liquid.

5.P.2B.1 Obtain and communicate information to describe what happens to the properties of substances when two or more substances are mixed together.

8.S.1A.6 Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams

ISTE.4a. Students know how to use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.

ISTE.4c Students develop, test, and refine prototypes as part of a cyclical design process.

3.P.2.2 Compare solids, liquids, and gases based on their basic properties.

3.P.2.3 Summarize changes that occur to the observable properties of materials when different degrees of heat are applied to them, such as melting ice or ice cream, boiling water or an egg, or freezing water.

5.P.2.3 Summarize properties of original materials, and the new material(s) formed, to demonstrate that a change has occurred.

6.P.2.1 Recognize that all matter is made up of atoms and atoms of the same element are all alike, but are different from the atoms of other elements.
PART I - HISTORY OF SET DESIGN

The history of set design is typically linked to the Greeks around the sixth century BCE, but that is only because at that time in history, no records were kept. It is believed that theater design started long before in Indian Sanskrit theaters around 100 CE. Regardless of the culture where theater design began, theater became identified as an art form in Athens when the first record of a competition for Greek tragedy was awarded in 534 BCE. In those times, theaters were portable carts and a stage could be built in any location. Basically, the artist went to the people. According to an article from *Encyclopedia Britannica Online*, sets evolved into open air theaters and *skense* (Greek for scene-building) were added. Scene building started as a place where the actors could change costumes and evolved into the background with wings on the side. Originally, it was just a curtain that framed out the back of the stage, but the Romans improved on the design by building permanent stone structures that resembled building facades.¹

The Renaissance is truly when set design took off. Italian designer Giacomo Torelli is credited for adding changeable scenery and a rope and pulley system. His rope and pulley system, called the “Chariot and Pole System,” rolled scenic flats back and forth across the stage.² As one flat was rolled out, the next flat or scene rolled in. He made a complete scenic transformation possible. From there, props were added and box sets were designed creating the feeling of “rooms” on stage. Scenic designer Adolphe Appia is credited for adding the scenic lighting we know today. He introduced the idea that lighting could do more than pinpoint actors on stage; it could also set a mood and add to the production.³

Have you ever wondered how stages are designed for rock shows? In this workshop, Gaillard Center’s Technical Manager, Colin Skinner, will take you through the set design process as we begin to create the Ri-Dog Rock Show.
As Colin explains, a truss frame provides a window to draw the audience's attention to the center of the stage. It also gives a space to hang lights and light up the stage. The Gaillard Center's truss is made from aluminum because it is such a lightweight material. A truss is made up of many straight pieces that are connected at joints. The long, straight corner pieces are called the **chords** and the “V” shape pieces are called the **diagonals**. When you put the chords and diagonals together, you have a truss. These pieces connect to create a strong triangular shape. Triangles are so structurally sound; their acute angles can hold large loads, so they are actually the strongest shape.

When a lot of force is put on a square, it will flatten. Engineers put a diagonal piece across a square to turn it into two triangles in order to make it stronger.\(^4\) Trusses can be seen everywhere including bridges and rooftops. Take a look at the Don Holt Bridge on I-526 in Charleston, SC. It is a perfect example of truss construction.

**Don Holt Bridge**  
Ashley Rose Stanol,  
Charleston City Paper

\(^4\)“Truss Bridge,” Science Made Fun, High Touch High Tech, accessed April 20, 2020,  
https://sciencemadefun.net/downloads/Truss%20Bridge_EOTD_May%205th.pdf
PART III - STAGE EFFECTS

Trusses are not the only thing needed to create a scene. We sometimes add depth or mood with fog. In the video workshop, Colin discusses how we use a low fogger, or a “pea souper,” to create fog on stage. There are three types of matter: solid, liquid, and gas. When in a solid state, the molecules are held tightly together and do not move easily. In the liquid state, the molecules are looser and can move about easily. In the gas state, the molecules are more spread apart and move quickly. The fogger makes the gas form of matter using dry ice and water. Dry ice is frozen carbon dioxide and comes as a solid. When it is placed in hot water, the sudden temperature change makes the solid turn into a gas. This results in a fog or haze blowing across the stage. This effect can make a scene look spooky or mysterious, or represent a boat in the ocean. A scene designer can do a lot with a fog machine.

- **SOLID**
  - Rigid
  - Fixed Shape
  - Fixed Volume

- **LIQUID**
  - Not Rigid
  - No Fixed Shape
  - Fixed Volume

- **GAS**
  - Not Rigid
  - No Fixed Shape
  - No Fixed Volume
PART IV - EXPERIMENTS

Before you begin the experiments, you will need a science notebook. Use your science notebook to document the scientific process for each one of the experiments. **Include one drawing of each experiment in your science notebook as part of your response.**

1. Ask a question: what are we trying to find out?

2. Gather information and observe: what do you know about this topic?

3. Make a hypothesis: what do you think will happen?

4. Experiment and test your hypothesis.

5. Analyze your test results.

6. Present a conclusion: what happened? Was your hypothesis correct or incorrect? What did you learn?
PART IV - EXPERIMENTS

Experiment 1
Gum Drop Truss Structure

Supplies:
• Science notebook
• 30 Toothpicks per person
• 20 Gum Drop candies per person
• Weighted objects

In the workshop video, Colin explains the basic truss structure and how they are used in a theater for scenic design. In this experiment, students will engineer a truss structure using toothpicks and gumdrops. Use what you learned about chords and diagonals to build a truss that can hold the most weight.

Instructions
1. In your science notebook, sketch and design a structure using 30 toothpicks and 20 gumdrops. Your challenge is to create a structure that can hold the most weight. As part of your design, label the chords, diagonals, and joints in your structure.

2. As you design, think of how you will add weight to your structure. Where will your truss be able to distribute the most weight? Write two to three sentences about the logic of your design.

3. The next step in the engineering process is to build your gumdrop structure.

4. Once completed, begin to add weight and record till your structure breaks. Try again, and this time design a new structure using a new shape and record your findings.

5. Wrap it up: What happened? Which structures held the most weight? How did the structures differ? If you were to do this for a third time, what would you do differently? Write about it in your science journal.
PART IV - EXPERIMENTS

Experiment 2
Inflate Balloons with Baking Soda

Supplies:
• 1 cup white vinegar
• 1/3 cup baking soda
• Plastic bottle
• Two balloons

In the workshop video, Colin explains how special effect clouds are created using dry ice and water. The frozen carbon dioxide (dry ice) is a solid, but when placed in hot water, the sudden temperature change makes the solid into a gas. In this experiment, you will observe a reaction between a liquid and a solid and how it creates a gas to inflate a balloon.

Instructions
1. Use a funnel to add 1/3 cup baking soda to the inside of a balloon.
2. Fill a plastic bottle with approximately 1 cup vinegar.
3. Attach the balloon to the mouth of the plastic bottle, then lift the balloon upright so the baking soda falls and causes the reaction.
4. Observe how the balloon begins to inflate.
5. How does this work? The vinegar and the baking soda mix together to make an acid-base reaction. The reaction creates carbon dioxide gas that bubbles up from the mixture. The gas expands up and out of the bottle and inflates the balloon.
6. You can also observe the difference between the carbon dioxide filled balloon verses a balloon filled with air. Since carbon dioxide is heavier than air, you will notice it will fall faster to the ground than a regular balloon.
7. Wrap it up: What is happening? In your science notebook, draw and record the reaction. Make sure to include a description of the molecules and how they change.
RESOURCES & ASSESSMENTS

Explore More Resources
Amazing Dry Ice Experiments

Assessments and Rubrics
Gum Drop Truss Rubric
Pre/Post Assessment: States of Matter

CITATIONS

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