

## DESCRIPTION OF SCIENCE CONTENT

The states of matter studied by elementary students are solid, liquid, and gas. States of matter are also called phases of matter. Things move between states by physical means, such as adding or losing energy. Things can move between phases and still be the same substance. For example, water can turn into gas (vapor) by boiling and then condense back to a liquid as it cools. Water can also be frozen into a solid. Water that does not change temperature can evaporate to become a gas due to the energy in particular molecules.

Water is perhaps the easiest substance for children to study. Not only can it display all three phases within an easily accessible temperature range, but it is nonhazardous to children. Children in Bloomington have likely experienced rain, fog, snow, and ice. Many children have seen water boil at home or seen a parent make ice cubes in the freezer. Water freezes at roughly 0° Celsius (32° Fahrenheit) and boils at roughly 100° Celsius (212° Fahrenheit), depending on atmospheric pressure. Bloomington is close enough to sea level (within 1000 feet) that we would expect values obtained for freezing and boiling water to be near the standard values measured at sea level (one atmosphere).

### CHARACTERISTICS OF SOLIDS, LIQUIDS, AND GASES FOR THIRD GRADE

<b>Gas</b>	<b>Liquid</b>	<b>Solid</b>
Takes both the shape and the volume of its container	Takes the shape of its container	Maintains its own shape
Can be compressed	Not easily compressible	Not easily compressible
Flows easily	Flows easily	Does not flow easily

The basic states of matter are certainly within the ability of third graders to understand. They have had experience with solids, liquids, and gases in their daily lives. Third graders are able

to learn about the differences among the three states. They are also capable of performing investigations of the three states and keeping records of their investigations.

The interviews indicated a lack of experience with evaporation, which is a second-grade benchmark. Our first lesson (prepared by Julie Sullivan), will review evaporation and introduce basic information about the three states of matter. The first lesson in my series (the second lesson presented to the class) will allow the students to have some hands-on experience with different substances and objects and let them practice categorizing those substances based on their observations. These two lessons will also set up the rest of the lesson series in order to cover some of the items the students did not yet know from the interviews. Specifically, the benchmarks concerning stable weight of a substance that changes states as well as their ability to describe substances by their properties must be addressed.

#### BENCHMARKS AND STATE STANDARDS ADDRESSED

Standard	Description
4B/P2	Water can be a liquid or a solid and can go back and forth from one form to the other. If water is turned into ice and then the ice is allowed to melt, the amount of water is the same as it was before freezing.
4D/P1	Objects can be described in terms of their properties. Some properties, such as hardness and flexibility, depend upon what material the object is made of, and some properties, such as size and shape, do not.
4D/E2	No matter how parts of an object are assembled, the weight of the whole object is always the same as the sum of the parts; and when an object is broken into parts, the parts have the same total weight as the original object.
4D/E6	All materials have certain physical properties, such as strength, hardness, flexibility, durability, resistance to water and fire, and ease of conducting heat.
9A/E4	Measurements are always likely to give slightly different numbers, even if what is being measured stays the same.
9D/E1	Some predictions can be based on what is known about the past, assuming that conditions are pretty much the same now.
12A/E1	Keep clear and accurate records of investigations and observations.
12A/E2	Offer reasons for claims and consider reasons suggested by others.
12A/E3	Records of observations are helpful when trying to recall those observations later.
12D/E7	Write a clear and accurate description of a real-world object or event.
3.1.4	Discuss the results of investigations and consider the explanations of others.
3.1.5	Demonstrate the ability to work cooperatively while respecting the ideas of others and communicating one's own conclusions about findings.
3.2.7	Ask "How do you know?" in appropriate situations and attempt reasonable answers when others ask the same question.

## INTRODUCTION

The lessons will be taught in a third grade classroom where there is no specialized equipment. The teacher and students will have a short discussion to begin the lesson and instructions concerning the lesson. Afterwards the students will explore materials in small groups and make notes on worksheets provided by the teacher. The teacher will circulate the classroom, listening to students and asking open-ended questions about their thoughts and decisions. After all students have had a chance to work with the materials, the class will gather as a whole in order to have another discussion about its findings. The students will already have had a brief exposure to the content in an introductory lesson given by another field participant.

# LESSON 1: THREE STATES OF MATTER INVESTIGATION

## OBJECTIVES:

1. Students will be able to describe objects and substances by their properties.
2. Students will be able to list two or more general properties of solids, liquids, and gases.

## MATERIALS:

- Large paper and marker
- Solid/Liquid/Gas Identification Worksheets (see end of lesson for worksheet, will be double-sided)
- Pencils
- Solids: Wood, sand, fabric, plastic, vegetable shortening, ice in a baggie (cold pack set underneath)
- Liquids: Water, vegetable oil, orange juice, cornstarch gel, soda
- Gases: Mylar balloon filled with helium, mylar balloon filled with air, open cup or jar, closed cup or jar
- Paper towels (for cleanup)
- Candle
- Matches
- Tubs to contain the liquids so students can move them between containers without spilling in the classroom.
- Scoops or measuring cups for exploring the liquids and small solids
- Small magnifying glasses
- Empty containers to let the students move substances between containers

## PLAN

### *OPENING*

Teacher will show students a candle that has been burning long enough to have liquid wax in the middle and explains what parts of the candle are solid, liquid and gas (classroom teacher has given permission for this activity). Teacher will ask students what they think the heat is doing to the parts of the candle (wax and wick).

### *LAUNCHING DISCUSSION*

Teacher describes the activity and the worksheets. Teacher will specifically instruct students not to taste anything (there is nothing harmful in the lesson, but several of the students

really like orange juice and soda). Students will begin the investigation at their regularly assigned tables and stay in those groups throughout the investigation.

### *INVESTIGATION*

At each table will be a collection of objects for the students to study. They will make notes on the provided worksheet and try to categorize each object as a solid, liquid or gas and justify their classification. Students will spend about 5 minutes at each of 4 tables.

### *LOGISTICS*

Teacher will circulate in order to answer questions and help where needed. Teacher will also ask students to explain why they have categorized various items as they have.

### *CLOSURE*

The whole group will come together to discuss its findings and to discuss any disagreements in classification. Adjustments will be made to the original list of ideas about the states of matter and the list will be posted in the classroom for students to refer to it. Future lessons will further refine the list (see additional worksheet at end of lesson once class is confident their ideas have been refined as far as they can).

### *ASSESSMENT*

During the investigation the teacher will be able to determine if the students have a concept of states of matter and how they are applying that knowledge. The teacher will listen for students to name the states of matter and for students to use words that describe the items being investigated by their properties, using a checklist to keep track of students' discussions. The teacher will also be listening for students to explain why they have categorized each item as they have. The teacher will review the completed worksheets to determine if students were able to describe the objects using their properties in order to determine if further instruction needs to occur in that area. After future lessons, students will be asked to write what they know about solids, liquids, and gases in order to incorporate their science into their language arts writing

requirements. The teacher will be looking again for the names of the states of matter and for descriptions of the states according to properties that items in those states have.

## DIFFERENTIATION

### *GEARING DOWN*

All the students in the target class are capable of joining the activity. One student is an English language learner with limited English skills. For him we will provide printed cards with the names of the objects on them. His task will be to identify which items go with which names in order to increase his vocabulary. The second field participant (the one not giving the lesson) will assist him in then placing the name cards in columns marked for the three states of matter.

### *GEARING UP*

Several of the students will likely require a challenge in order to keep them interested. They are high-ability learners but also have some behavior management needs. The teacher will present them with some questions about the challenge items in the lesson, such as the cornstarch gel (which has properties of both a solid and a liquid) and the soda (which is a liquid that has gas bubbles in it). They can also be questioned as to why they think one balloon floats but the other does not.

## LESSON 2: STATES OF MATTER WEIGH-IN

This lesson takes place over two days. During the second day, three observations spaced several hours apart will be made.

### OBJECTIVES:

1. Students will be able to describe how changing states affects (or does not affect) weight.
2. Students will be able to describe how changing states affects (or does not affect) volume.
3. Students will be able to describe what happens when water is frozen and thawed.

### MATERIALS:

- Digital kitchen scale
- 2 Quarter cup liquid measuring cups (59-60 ml)
- 4 Zip-top sandwich bags
- 4 Permanent markers (red, black, blue, and green)
- Cold tap water
- 4 Empty plastic clear cups that can be written on
- Observation sheet (see end of document)
- Tape measure and ruler
- Large paper

### PLAN

#### *OPENING*

The whole group will have a discussion about what happens when water freezes and when it thaws. Does it change? What might change? How can that be measured? Ideas will be written on the large paper. Some students may know that many things contract when they freeze or that water expands when it is frozen. Other students may believe that the weight will change. All ideas will be accepted and written down.

#### *LAUNCHING DISCUSSION*

The teacher will show the students how to use the scale. The whole group will decide a way to measure liquid volume as consistently as possible (at the top of cup, as full as it will go, on a mark of some kind, etc.). Students will be divided into four groups based on input from the cooperating teacher.

## *INVESTIGATION*

### **Day 1:**

Each group of students will perform the following steps:

1. Label a bag with the group number (will be written on group's table ahead of time)
2. Measure one quarter cup of water.
3. Put water in the bag.
4. Weigh the bag and write down the results.
5. Label a plastic cup with the group number.
6. Measure one quarter cup of water.
7. Put water in the bag.
8. Draw a line with a black permanent marker where the water line is when the cup is resting flat. Students who wish to do so may measure the height of the water from the table and note that on their observation form.
9. Put the bag and cup in the freezer.

### **Day 2 (early in the day in order to allow thawing time):**

Each group of students will perform the following steps:

1. Remove cup and bag from the freezer.
2. While the water is still frozen, weigh the cup and write down the results.
3. While the water is still frozen, weigh the bag and write down the results.
4. While the water is still frozen, draw a line with a red permanent marker where the water line is when the cup is resting flat. Again, students who wish to do so may measure the height of the water with a ruler or a tape measure.
5. Put the bag and cup in a safe spot for them to melt.
6. Add notes in the comment section of the observation form about any surprises.

### **Day 2 (while there is still some ice in the bag and cup):**

Each group of students will perform the following steps:

1. As before, weigh the cup and bag and note the results.
2. Draw a line with a blue permanent marker where the water line is when the cup is resting flat. Students may measure the height of the water in the cup if desired.
3. Add notes in the comment section of the observation form about any surprises.

### **Day 3 (when all the water has melted):**

Each group of students will perform the following steps:

1. As before, weigh the cup and bag and note the results.
2. Draw a line with a green permanent marker where the water line is when the cup is resting flat. Students may measure the height of the water in the cup if desired.
3. Add notes in the comment section of the observation form about any surprises.

## *LOGISTICS*



Teacher will circulate in order to answer questions and help where needed. Teacher will also ask students to talk about the observations they are making at each step. If students notice anything that differs from the class' original predictions, teacher will ask what those differences are and why that might be.

## CLOSURE

The whole group will come together to discuss its findings. The class will discuss where their observations do not match their predictions and why that might be so.

## ASSESSMENT

During the investigation the teacher will be listening for comparison (more/less/same) words, weight and volume discussion, as well as states of matter vocabulary, using a checklist to keep track of which students use the vocabulary appropriately. Students will be expected to talk about the processes (freezing and thawing) as well as use the words "weight" and "volume" properly during the investigation. Whole-class discussion will provide another opportunity for the teacher to listen to the students' thinking.

## DIFFERENTIATION

### *GEARING DOWN*

All the students in the target class are capable of joining the activity. One student is an English language learner with limited English skills. For him we will provide printed instructions done with both pictures and English words so that he may participate in the process. As his father helps him in the evenings, we will provide a letter explaining the investigation to him to review with the student at home afterward, highlighting the English vocabulary we used with the class.

### *GEARING UP*

The target class has several high-ability learners who also have some behavior management needs. In this case, the participating teacher and the second field participant will help to circulate the room in order to keep the process as smooth as possible. If the groups that have one or more

high-ability students finish more quickly than the others, the teacher will ask these students to be more specific about their predictions. For example, if one of them claims the weight of the water will change when it freezes, the teacher will ask by how much it will change and for the student to give reasons for his or her belief. Students done quickly may also be asked to help operate the digital scale and take water samples to the freezer.

## LESSON 3: BUILDING TOY WEIGH-IN

### OBJECTIVES:

1. Students will be able to describe demonstrate that the weight of a set of building toys does not change when the configuration changes, assuming the components remain the same.

### MATERIALS:

- Set of LEGO 2x4 building bricks weighing less than 1 kilogram
- Set of wooden building blocks weighing less than 1 kilogram
- Set of Wedgits building toys weighing less than 1 kilogram
- Set of Zoobs building toys weighing less than 1 kilogram
- Set of mixed building toys weighing less than 1 kilogram
- 5 small trays on which to build
- Observation sheet for each student (see end of document)
- Digital Kitchen Scale
- Digital camera

### PLAN

#### *OPENING*

Teacher will weight some of the building materials in front of the students.

#### *LAUNCHING DISCUSSION*

Together, the class will discuss if the weight of the building materials ever changes, and why or why not. The teacher will note the student's discussion points to review at the end of the lesson.

The teacher will then review what the students are to do and go over the observation sheet.

Students will be instructed to build quickly rather than spending great amounts of time designing complicated structures. Students will also be instructed not to change their predictions to match the result so that the class can discuss it later.

#### *INVESTIGATION*

At each of five tables there will be one set of building materials. The class will be divided into five groups, one per table. Each group will weigh the tray with all the materials on it before beginning. After using all the materials provided to create anything they like on the tray, the groups will predict if their creation will weigh more, less, or the same as it did before it was built. Then

they will weigh their creations and note the weight on their observation sheets. As they weigh, the teacher will take a digital photo of the creation so it is available during discussion. They will go back to their tables and continue building and weighing until it seems to the teacher that they understand that the weight does not change. If there is time, the groups will switch tables so that they can try another set of building materials.

### *LOGISTICS*

Teacher will circulate in order to answer questions and help where needed. The teacher will watch to see what predictions the students are making and if they begin to change their prediction strategies based on each weight measurement.

### CLOSURE

The whole group will come together to discuss its findings and to discuss if any of them have changed the way they predicted what will happen. They will be asked to use their observations to explain why they think the way they do. Should some students contend that the weight really does change when the shape of the structure changes, then the class will begin to design a new investigation to demonstrate the stability (or instability) of toy weight as the structure changes.

### ASSESSMENT

During the investigation the teacher be listening to see if the students are predicting accurately. As the investigation continues, more and more students should be predicting no change in the weight of the building toys, which the teacher will track with a checklist.

### DIFFERENTIATION

#### *GEARING DOWN*

All the students in the target class are capable of joining the activity. One student is an English language learner with limited English skills. During this activity we will provide him with graphical more/less/same cards he can use to tell us his prediction. He is able to copy English

words, so we will ask him to copy down the weight measurements with the assistance of another student.

### *GEARING UP*

Several of the students will likely require a challenge in order to keep them interested. They are high-ability learners but also have some behavior management needs. These students will most likely come up with their own ideas to test and the teacher will accommodate these ideas as much as possible. If they finish early and do not want to come up with their own investigation, the teacher may ask them to copy their observations onto the board so that the student can all share the same visual during the whole class discussion.



Object or Substance	Properties	Solid	Liquid	Gas	Why?

WHAT WE KNOW ABOUT SOLIDS, LIQUIDS, AND GASES

NAME: \_\_\_\_\_

<b>States of Matter</b>	<b>Gas</b>	<b>Liquid</b>	<b>Solid</b>
<b>Shape</b>			
<b>Compressibility</b>			
<b>Flow</b>			



# STATES OF MATTER WEIGH-IN OBSERVATION FORM

GROUP NUMBER:

GROUP MEMBERS: \_\_\_\_\_

## Bag

	Weight (in grams)	Observations
Before Freezing		
Frozen		
Partially Thawed		
Completely Thawed		

## Cup

	Weight (in grams)	Height (in cm)	Observations
Before Freezing			
Frozen			
Partially Thawed			
Completely Thawed			

# BUILDING TOY WEIGH-IN OBSERVATION SHEET

NAME: \_\_\_\_\_

Rules:

1. Use all the building pieces given to you in each creation.
2. Build on the tray given to your group.
3. Keep the creation on the tray while you weigh it.

	<b>Predict More/Less/Same</b>	<b>Why I Predicted That</b>	<b>Weight</b>
<b>Beginning Weight Before Building</b>			
<b>Structure #1</b>			
<b>Structure #2</b>			
<b>Structure #3</b>			
<b>Structure #4</b>			



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