Topic 1

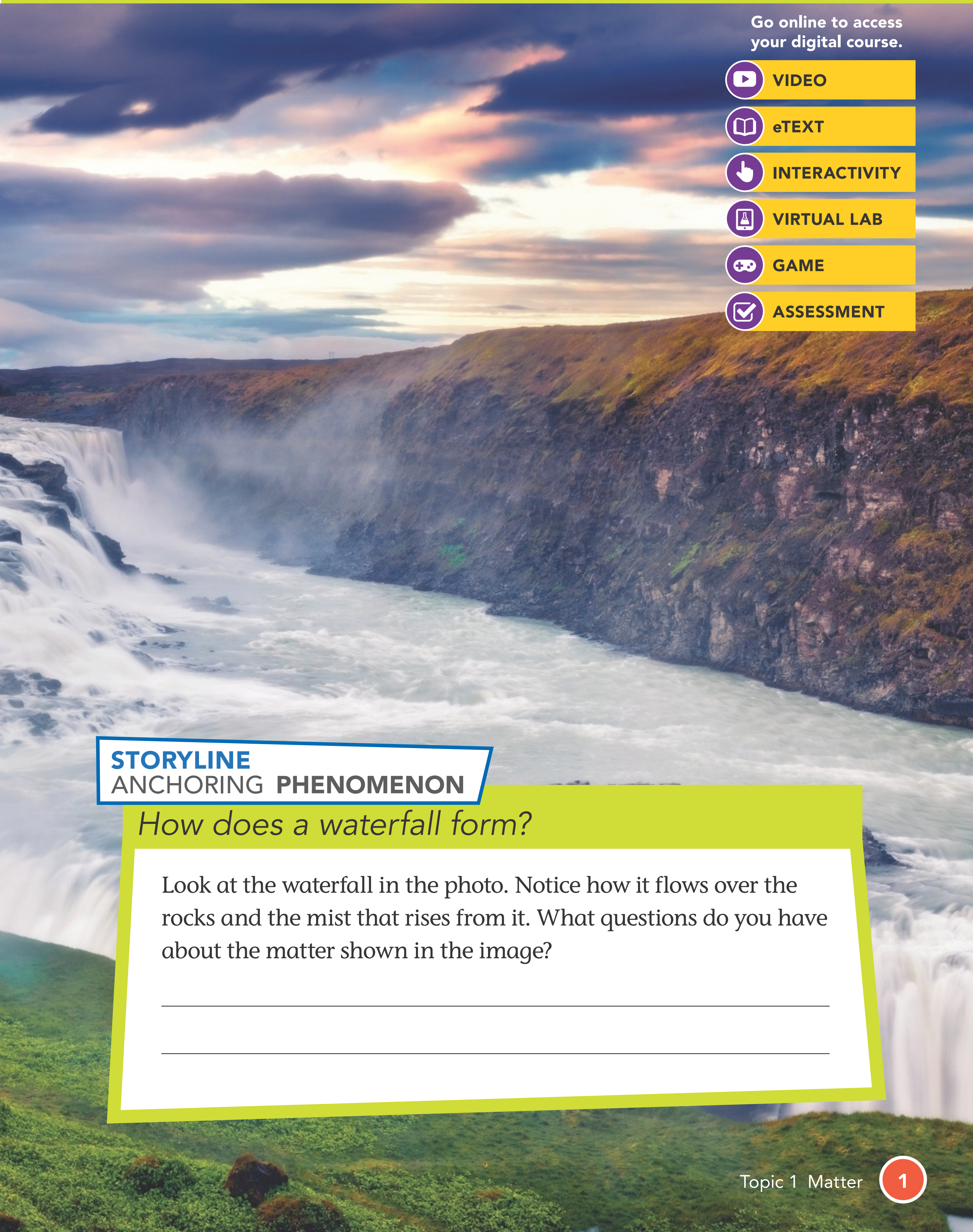
Matter

Tennessee Academic Standards for Science

3.PS1.1 Develop a model of solids, liquids, and gasses to describe that each state of matter is made of particles too small to be seen.

3.PS1.2 Construct an explanation about the effects of heating and cooling a substance differentiating between changes that can be reversed (i.e., freezing & melting) and those that cannot (e.g., baking a cake or burning fuel).

3.PS1.3 Construct an argument based on evidence that materials have both fixed and changing properties, some of which are useful for identification of a material.



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STORYLINE
ANCHORING **PHENOMENON**

How does a waterfall form?

Look at the waterfall in the photo. Notice how it flows over the rocks and the mist that rises from it. What questions do you have about the matter shown in the image?

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uConnect Lab

HANDS-ON LAB

TN: 3.PS1.1, 3.PS1.3, SEP.2, SEP.3

How can you change a property of a material?

Scientists study how materials look and behave. How can you use models to explain how a material changes when you chill it?

Materials

- juice in a clear plastic cup
- ice cube tray
- freezer

Make sure not to taste anything in this activity.

Procedure

- [ ] **1.** Examine the juice in the cup. What do you notice about it? How would you describe the juice? Write your observations.

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- [ ] **2.** Write a plan to use the materials to test what happens when juice is frozen. Show your plan to your teacher before you begin.
- [ ] **3.** What did your juice look like after it was frozen? Record your observations.

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Science Practice

Scientists **use models** to construct explanations.

Model

Analyze and Interpret Data

4. Model Use your observations to make a model showing what the juice looked like before and after you froze it.

Use Evidence from Text

When you read a text, you can look for evidence to help you understand the subject better. Evidence is something that supports a main idea.

Read this text about icicles. Look for evidence from the text that supports the main idea.

Icicle Formation

Have you ever seen an icicle? Icicles are pieces of ice that are formed when dripping water freezes. They can be found hanging from tree branches or roofs on cold days after it has snowed or rained.

After a snowy day, heat from the sun can melt some of the snow on the roof. The water will start to drip down. If it is below 32 °F outside, the water drops will change into ice before they can drop off of the building. Drop by drop, the icicle starts to form. It becomes longer as more drops freeze on it.

The base of the icicle is often much thicker than the tip. The tip can be sharp and pointy. If the icicle gets big enough, it can become very heavy.

READING CHECK Use Evidence from Text
What evidence supports the explanation for how icicles form? Underline the evidence in the text.

Lesson 1

Properties of Matter

I can...

Use evidence to identify the properties of materials.

TN: 3.PS1.3

Literacy Skill

Use Evidence from Text

Vocabulary

matter
mass
properties
texture
hardness

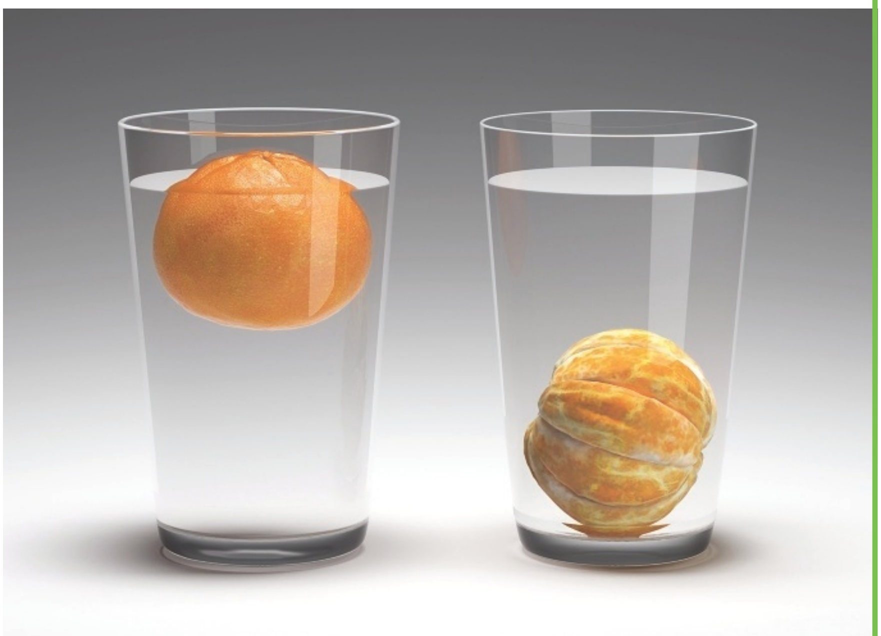
Academic Vocabulary

quality
observe
appear

STEM Connection

Take a look at these mandarins. What do you notice about them? How can you explain these things? The mandarin on the left has a peel, but the mandarin on the right has been peeled. They are the same size. Both are in a glass of water. The one with a peel floats. The one without the peel sinks. This is a unique **quality**, or feature, of mandarins. The peel on the mandarin is what allows it to float. This quality doesn't exist in all fruits. An apple that has been peeled will still float. You can use qualities you observe to identify things. When you **observe** something, you notice something about it.

Write About It In your science notebook, explain how you can use what you observe to talk about items around you.



uInvestigate Lab

HANDS-ON LAB

TN: 3.PS1.3, SEP.3, SEP.7

How can we compare things?

Scientists use observations to sort and group objects. We might look for ways they are the same or different. How might you sort these objects?

Materials
- baseball
- basketball
- golf ball
- ping-pong ball
- soccer ball
- tennis ball

Procedure

☐ **1.** Think about different ways you can sort the objects. Also think about ways you can test each object.

☐ **2.** Make a plan to observe and test each ball. You will use your findings to sort the balls. Show your plan to your teacher before you begin.

☐ **3.** Conduct your investigation and record the data.

Science Practice

Scientists **use observations** to engage in arguments.

Analyze and Interpret Data

4. SEP Engage in an Argument How did you decide to sort the balls? List your results.

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Observations

INTERACTIVITY

Complete an activity on matter and mass.

Matter and Mass

Think of anything you can touch or see. Rocks, water, houses, cars, people—what do they all have in common? They are all examples of matter. **Matter** is anything that takes up space and has mass. **Mass** is the amount of matter in an object. When you see a rock on the ground, you can observe that it takes up space. When you pick the rock up, you can observe that it has mass or weight. It feels heavy in your hand.

Matter also includes things you cannot touch or see. Air, for example, is matter. It has mass. If you pump air into a basketball, you can see that it fills up. It gets bigger. Why is that? It is because that air takes up space inside the ball.

Reading Check **Use Evidence from Text** Would you expect a blown-up balloon to weigh the same as a flat balloon? Use evidence from the text to explain your answer.

Identifying Matter by Its Properties

Properties are things you can observe or measure about an object by using your senses. Is a rock hard or soft? Is it bumpy or smooth? Is it round or irregular? Does the rock have a smell? Probably not.

Observable properties can tell you a lot about an object. Look at these two balls. What materials might they be made of? They are the same size and shape, so you cannot use their size or shape to identify the materials. The balls have the same **texture**, or how an object feels to the touch. You cannot use texture to identify the materials here. You may be able to use their colors. One ball appears to be clear. To **appear** means to look like. The other ball appears to be made of metal.

The properties of an object depend partly on what it is made out of. You can test the balls to find out other properties. You can use your evidence to argue what they are made of.

Infer Your friend hands you two clear marbles. One weighs a lot more than the other. One marble is made of glass. One marble is made of plastic. How do you know which is which?

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Literacy ▸ Toolbox

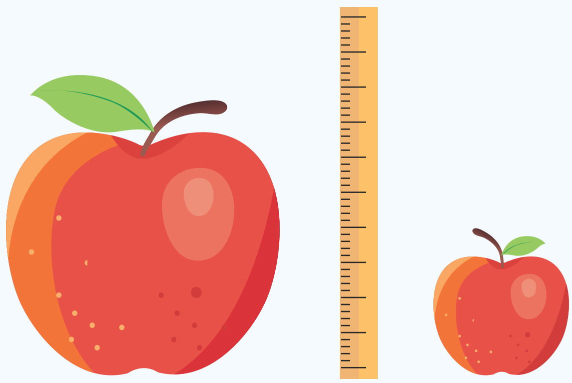
Use Evidence from Text
What evidence can you use to identify what the balls are made of? On a sheet of paper, list your evidence and explain your reasoning.

Visual Literacy Connection

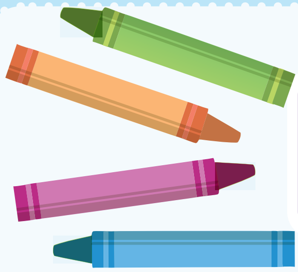
What properties can we observe?

Some properties of matter are size, shape, color, texture, and hardness. These are all things we can observe with our senses.

Size is how big or small something is. Size is a property you can measure with a ruler. You can also compare objects to see which one is larger.

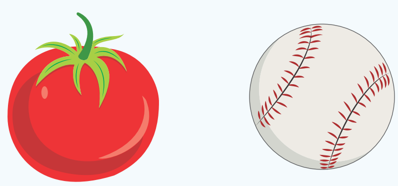


An object's shape is what its outline looks like. There are many different kinds of shapes.



Color is a property. Color is what you see when light shines off of an object. What colors do you see?

Texture is a property. Some objects may be soft. Others may be hard. Some objects may be smooth. Other objects may be rough.



Hardness describes how firm something is. A baseball and a tomato may be about the same size. But a baseball is much harder than a tomato.

Think about an object. Identify two observable properties that you can notice or measure about that object.

INTERACTIVITY

Complete an activity on the properties of matter.

Properties Can Change

Properties do not always stay the same. For example, if you paint a red toy car blue, its property of color has changed. Even though it is a new color, it is still made of the same material. Think about if you cut a square piece of paper into a star. The properties of size and shape have changed. The star is made of a smaller amount of paper. It is also in a different shape. This doesn't change the material the paper is made of.

Draw Conclusions Does the weight of the paper square change when it is cut into a star? Explain your reasoning.

Lesson 1 Check

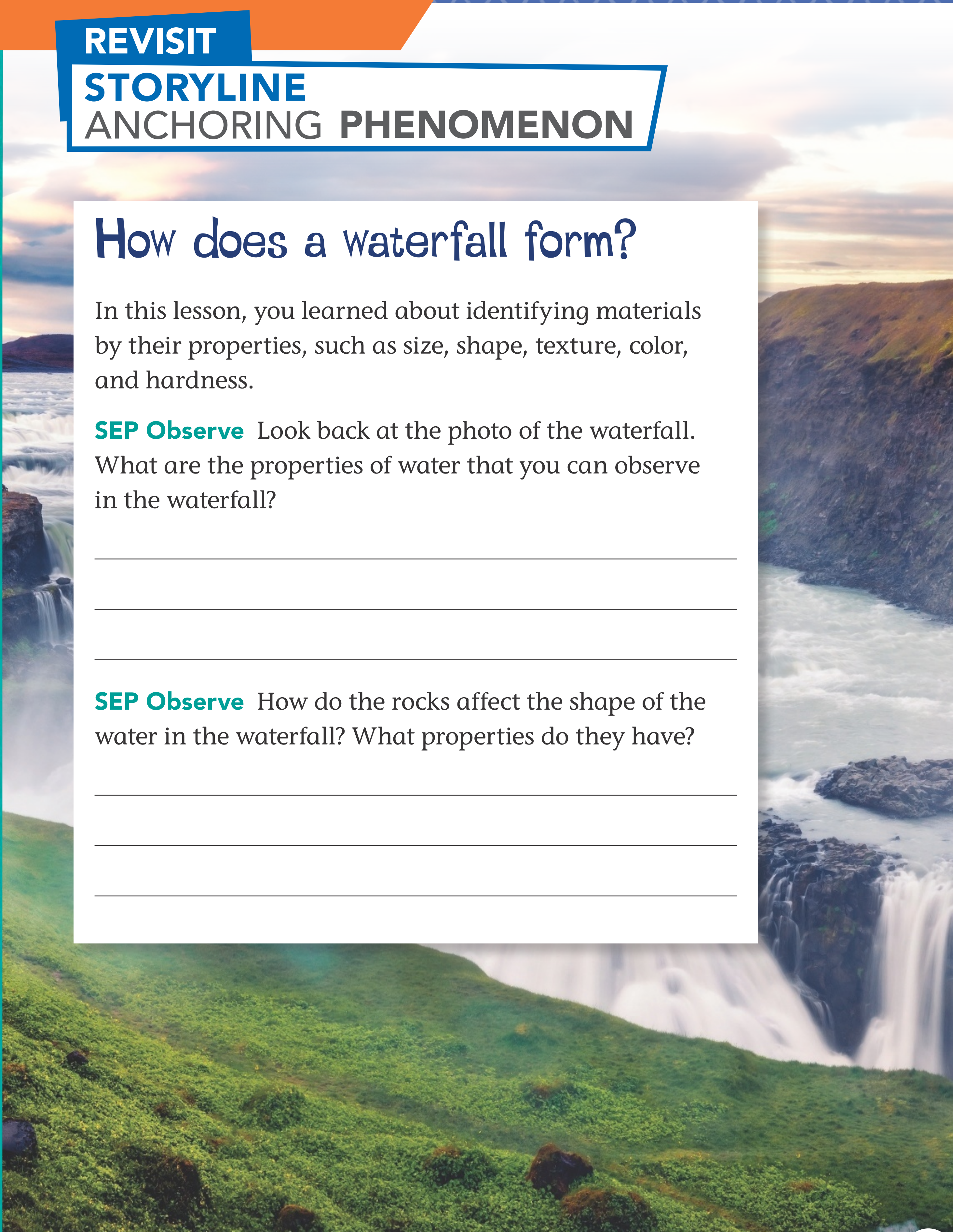
1. **Explain** What are two different properties you can observe? How can you observe them?

2. **Identify** What property can you use a ruler to measure?

REVISIT

STORYLINE

ANCHORING **PHENOMENON**



How does a waterfall form?

In this lesson, you learned about identifying materials by their properties, such as size, shape, texture, color, and hardness.

SEP Observe Look back at the photo of the waterfall. What are the properties of water that you can observe in the waterfall?

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SEP Observe How do the rocks affect the shape of the water in the waterfall? What properties do they have?

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uEngineer It! Design STEM

TN: 3.PS1.3, SEP.2, SEP.8

Understanding Properties

Phenomenon Engineers design the things you use. They think about properties when choosing materials for their designs. Look at these toys. A toy engineer thought about color when planning their designs. The property of color is important when designing some items. Texture and shape are important when designing other items, like furniture.

Some materials are better for certain kinds of designs. Engineers also think about properties when designing buildings. They test the properties of materials they will build with. This is to find out which materials will work best.

Design It

- [ ] Think of an item you would like to design.
- [ ] Draw a model of your item in the space. Then label the parts.

? Circle a part of your design. What are two materials that you could use for this part?

How would you test the materials to make sure they would work in your design?

Lesson 2

Solids, Liquids, and Gases

I can...

Use a model to describe the states of matter.

TN: 3.PS1.1, 3.PS1.2, 3.PS1.3

Literacy Skill

Use Evidence from Text

Vocabulary

particle
state
solid
liquid
gas
melt
freeze
boil
condense

Academic Vocabulary

behave

CURRICULUM Connection

The Great Smoky Mountains is a national park in Tennessee. It was founded in 1934. The park is home to many different types of plants and animals. It is the most visited national park in the country. In 2021, over 14 million people went to see the beauty of the mountains.

But how did the mountains get their name? Are they on fire all the time? You can see what looks like smoke over the trees in this picture. But this isn't smoke! Tiny droplets of water and other chemicals released by plants float over the forest. When light hits these droplets, it makes the sky look "smoky."

Reading Check **Use Evidence from Text** In the paragraph above, circle the things that make the Great Smoky Mountains look smoky.

uInvestigate Lab

HANDS-ON LAB

TN: 3.PS1.1, 3.PS1.3, SEP.3, SEP.6

How can you make ice disappear?

Ice has very different properties from water. How can you change the properties of ice?

Materials
- clear plastic cup
- ice cubes

⚠ Make sure to clean up any spills!

Procedure

☐ **1.** Observe the ice and record the properties you identify.

☐ **2. SEP Plan an Investigation** Make a plan to test ways you can change the properties of ice. Consider how you can make ice disappear. Show your plan to your teacher before you begin.

☐ **3.** Conduct your investigation. Record your observations.

Science Practice
Scientists **investigate** to observe outcomes.

Analyze and Interpret Data

4. SEP Construct Explanations How did the properties of your ice change?

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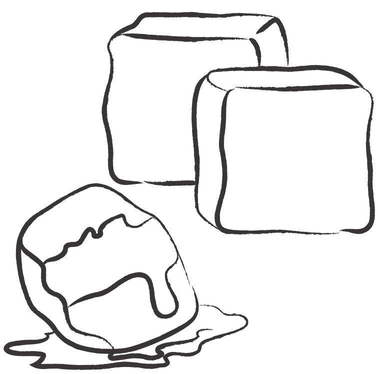
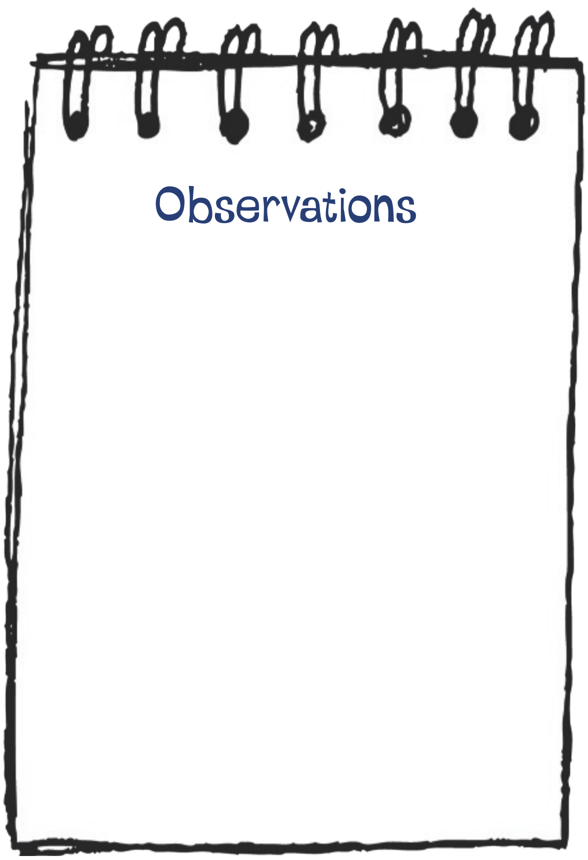




INTERACTIVITY

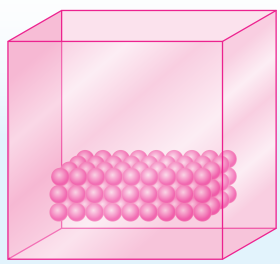
Complete an activity on the states of matter.

States of Matter

All matter is made of small particles. A **particle** is a piece of matter that is so small we cannot see it with our eyes. In some types of matter, the particles are held tightly together. In other types, the particles are loosely held together.

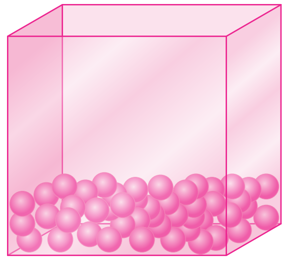
Matter exists in different **states**, or forms. The state of matter depends on how its particles **behave**, or act. The state of matter is a property of matter that you can observe. There are three main states of matter—solid, liquid, and gas.

A **solid** is made of particles that are closely packed together. They cannot move around much. Solids have a definite shape. You can measure the amount of space they take up. You can also measure their mass. Think of a building block. You can measure its sides with a ruler. You can weigh it on a scale.



Particles in a solid

A **liquid** is something that takes up a fixed amount of space but does not have a fixed shape. Liquids take the shape of the container they are in. Particles in a liquid are farther apart and can move past each other. Juice is an example of a liquid. It takes the shape of the glass that it is in. If you knock the glass over, the juice will spill out. There will be the same amount of juice, but it will have a different shape.



Particles in a liquid

A **gas** is something that fills its container. In a gas, the particles are very far apart and move very freely. The particles will fill the container evenly. This balloon is filled with air, and air is a gas.

Explain How are the particles in a solid and a liquid different?

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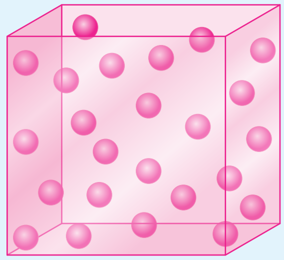

Particles in a gas

INTERACTIVITY

Complete an activity on solids changing to liquids.

Solids to Liquids

Matter can change states if it is heated or cooled. Think about what happens when you are eating an ice pop outside on a hot day. It starts off as a solid, and you can feel that it is cold. But after some time, it starts to change state. The heat from the sun begins to melt the pop. To **melt** means to change from a solid to a liquid.

Think about how particles act in solids and liquids. When the ice pop is a solid, the particles are not moving a lot. When the ice pop begins to melt, the particles are moving more freely. What would happen if you put the ice pop in a freezer? It would begin to **freeze**, or change from a liquid to a solid.

Reading Check **Use Evidence from Text** Changes of state can be reversed. In the text above, circle evidence that melting is reversible.

REVISIT STORYLINE
ANCHORING PHENOMENON

How does a waterfall form?

In this lesson, you learned about states of matter.

SEP Evaluate Using what you learned about the states of matter, sort the materials in the photo at the beginning of the topic by their state of matter.

Liquids to Gases

Liquids can also turn into gases. When a liquid is heated, it can begin to boil. When a liquid **boils**, it changes from a liquid to a gas. This can happen when a pot of water is heated until it bubbles. When water boils, it forms water vapor. Water vapor is a gas.

Like other gases, water vapor does not always stay a gas. Gases can change back to a liquid when they **condense**. Dew forms on grass when water vapor changes back into liquid water.

Write About It In your science notebook, write about a time you noticed dew outside. Was the weather hot or cold at the time?

Lesson 2 Check

1. **Explain** Do particles move more freely in solids or gases?

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2. **Compare** What are the properties of solids, liquids, and gases? In the space below, make a model showing how the particles are arranged in each state of matter.

Changes in Matter

I can...

Explain how some changes can be reversed but others cannot.

TN: 3.PS1.2, 3.PS1.3

Literacy Skill

Use Evidence from Text

Vocabulary

mixture
solution
evaporate
physical change
chemical change

Academic Vocabulary

conduct

CURRICULUM Connection

Cotton candy! Did you know that the cotton candy machine was invented in Tennessee? In 1897, a dentist and a candymaker designed and built the first cotton candy machine.

Sugar was placed in the middle of a bowl. The sugar was heated until it melted into a liquid syrup. Then, the machine would spin the liquid sugar through a screen with tiny holes. This would form long, thin sugar threads. This was cotton candy. This original cotton candy was white. Now, you can get cotton candy in many colors. Adding food dye to the sugar allows these new colors to be made.

Write About It Suppose you were trying to design an invention to make a new type of food. In your science notebook, describe the type of food you would want to make. Make sure to explain how your invention would make the food!

uInvestigate Lab

HANDS-ON LAB

TN: 3.PS1.3, SEP.3, SEP.6

What happens when things are mixed?

Baking soda is a powder. Vinegar is a liquid. What happens when these two materials are mixed?

Materials
- baking soda
- plastic cup
- plastic spoon
- vinegar

Wear safety goggles.

Procedure

- [ ] **1. SEP Plan an Investigation** Make a plan to investigate what happens when baking soda and vinegar are mixed. Use all the materials.
- [ ] **2.** Show your plan to your teacher before you begin.
- [ ] **3.** Record your observations.

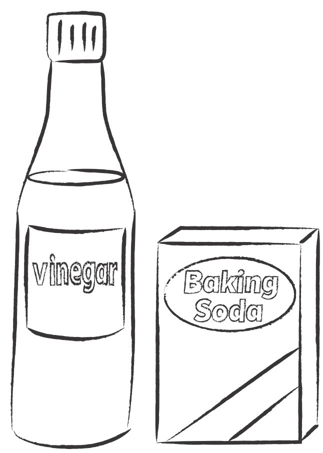
Science Practice

Scientists **make observations** to construct explanations.

Analyze and Interpret Data

4. What states of matter did you start with? What states of matter did you finish with?

5. SEP Construct Explanations Explain what you think happened in your investigation.



Mixtures and Solutions

Different types of matter can be combined. One way to combine material is called a **mixture**. A mixture is a combination of two or more things where each thing keeps its own properties. None of them is changed by being combined. Look at this trail mix. It is made up of different types of nuts. Each piece of the mix could be sorted by its physical properties. For example, you could take all the peanuts out of the mix and eat them separately. Or you could add more peanuts to the mix.

A **solution** is a special kind of mixture in which one part is evenly mixed into the other part. A glass of salt water is an example of a solution. The salt has been mixed into the water evenly. Each sip will taste equally salty. You cannot take some of the salt out without also taking out the water it is mixed with.

Identify Name one example of a mixture from your life. Name one example of a solution from your life.

INTERACTIVITY

Complete activity on mixtures and solutions.

Crosscutting Concepts ▸ Toolbox

Stability and Change
Scientists make observations to see how things change over time. What do salt and water look like before you mix them together? What do they look like after you mix them?

Separating Mixtures and Solutions

Parts of a mixture can be separated according to the materials they are made of. For example, pasta in a pot of water is a mixture. After the pasta is done cooking, you pour out the water to get the pasta. A strainer is used to separate the pasta and water. Water has the property of needing a container. Because the strainer has holes, the strainer is not a good container for water. It flows right through it. The pasta has the property of a definite shape. It is too big to slip through the holes of the strainer.

Solutions can be separated into their parts, too. Suppose you have a solution of sugar and water. If you let the sugar water sit long enough, all the water would evaporate. To **evaporate** means to change from liquid to a gas. Solid sugar would be left behind.

Reading Check Use Evidence from Text

Examine this glass of lemonade. Lemonade is made of lemon juice, water, and sugar. This glass also has ice. Is it a mixture? Is it a solution? Use evidence from the text to support your answer.

Physical Changes

Matter can experience physical change. In a **physical change**, some properties of matter change. However, the changes do not result in a new form of matter. For example, an object's shape, size, or state can change. When an ice cube melts, the water it is made of changes its shape. It also changes its state—from a solid to a liquid. But it is still water. It has not become a different type of matter. Other examples of physical changes can include changing the color of something or changing its size. For example, if you cut a piece of cloth, it is still cloth. This is a physical change because only the property of size has changed.

Some physical changes can be reversed. Think about water. If you cool it, it will freeze and become a solid. This change can be reversed. The ice can be heated. This will cause the ice to melt and become liquid water again. If you cool the liquid water again, it will change back into a solid piece of ice.

Explain Why can some physical changes be reversed?

uBe a Scientist

Physical or Chemical Change?

Over the span of a week, observe different kinds of changes around you. Record if each change produces any new smells or materials. Draw conclusions about what you observe.

Chemical Changes

Matter can also experience chemical change. In a **chemical change**, new materials with new properties are formed. Chemical changes cannot be reversed. Consider a log burning in a fire. Once the log is burned, it is no longer wood. It becomes new materials. These materials are ashes and gases. You can see the ashes. You can smell the gases. Ashes and gases have different properties than wood. They cannot be burned to give off heat. They cannot be reassembled to become a log again.

Compare How is burning wood in a fire different from chopping wood?

INTERACTIVITY

Complete an activity on physical and chemical changes.

Identifying Materials

Properties can be used to identify materials. Remember that some properties are easily observed. Some objects may be made of things that are easily identified. Sometimes, it is hard to tell what something is made of. You may need to **conduct**, or run, an experiment to identify the material. For example, maybe only one material releases a gas when heated. This is a chemical change you can test for. This may help you find out what the material is.

Write About It In your science notebook, describe an experiment you might conduct to identify a mysterious powder.

Lesson 3 Check

1. **Identify** Give an example of a physical change you have observed.

2. **Identify** Give an example of a chemical change you have observed.

Oobleck!

Have you ever played with Oobleck? Oobleck is a mixture of cornstarch and water. If you squeeze Oobleck, it acts like a solid. But when you open your hand, it flows through your fingers like a liquid. How can this be?

Materials like Oobleck don't follow the usual rules of liquids. These materials act differently. Their properties can change based on time, temperature, and force. This is because of what they are made of. Even though Oobleck looks like a solution, it isn't. The cornstarch particles float in the water. When you press on Oobleck quickly, you push the starch particles together. This pushes water out from between them, making it act like a solid. Both the starch and the water will move away if you slowly put your finger in. This is how a liquid would act.

Scientists study the properties of materials like Oobleck to develop new technologies. For example, materials that act like Oobleck might be used to make body armor for police. The material would become hard and protect the police officer if hit.

What questions would you like to investigate about Oobleck?

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REVISIT

STORYLINE

ANCHORING **PHENOMENON**

How does a waterfall form?

In this lesson, you learned about physical and chemical changes to matter.

SEP Evaluate What physical changes might be happening to the water that makes up the waterfall?

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SEP Evaluate What physical changes might be happening to the land the waterfall flows over?

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SEP Evaluate Why is a change of state, like when water changes into water vapor, a physical change but not a chemical change?

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Career Connection

Food Scientist

Have you ever wondered where the information on a nutrition label comes from? It's probably from a food scientist. Food scientists study the ingredients in food. Some food scientists test foods to see how safe they are. Others may study how healthy foods are. Food scientists examine a food's properties to make sure it has the properties you want. For example, most people think popcorn should be crunchy. A food scientist makes sure that popcorn has the texture, color, and taste that it should.

Food scientists can work in labs. They can also work on farms or in factories. Food scientists need a college degree. They need to know how to test different kinds of foods. They also need to know how to design an investigation.

Write About It
Do you think you would enjoy being a food scientist? Explain why you think so in your science notebook.


Assessment

1. **Evaluate** Which is an example of a reversible change?
   - **A.** burning a piece of paper
   - **B.** melting chocolate on a sunny day
   - **C.** cooking an egg in a pan
   - **D.** baking bread in an oven

2. **Vocabulary** Look at the picture of the eggs in the pot of boiling water. Use vocabulary learned in this topic to explain what is happening.

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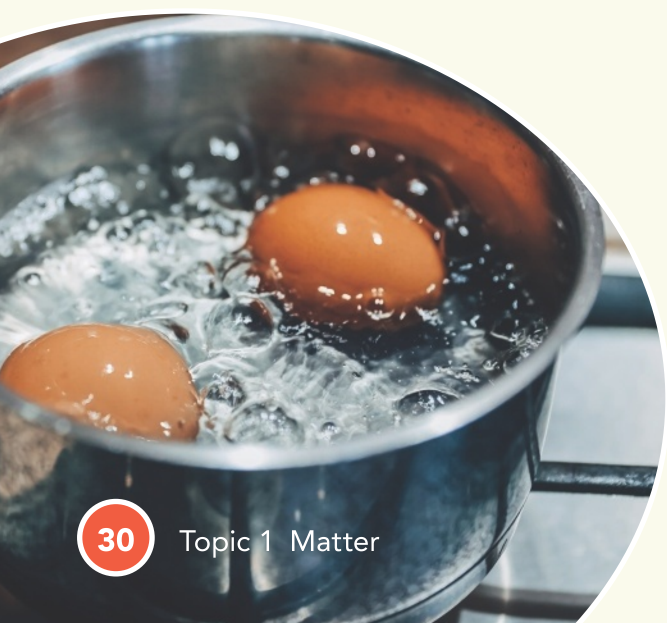

3. **Develop a Model** Luanna wants to model the particles in a liquid. Which choice describes how she should build the model?
   - **A.** showing the particles moving very quickly
   - **B.** showing the particles fixed in place
   - **C.** showing the particles filling the space
   - **D.** showing the particles sliding past each other

4. **Patterns** You have three items. One item is made of aluminum. The other two items are made of glass. What property can you use to identify the item made of metal?

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5. **Infer** A student observes two samples. One is a solid at room temperature, and the other is a liquid. Both samples are clear. The samples have no smell. The sample that is solid is the same weight as the sample that is liquid. Which property can the student use to identify the material?

A. state

B. smell

C. color

D. weight

6. **Explain** Why does ice melt when left outside on a sunny day?

REVISIT
STORYLINE
ANCHORING **PHENOMENON**

How does a waterfall form?

SEP Use Evidence Think about what you have learned about properties of matter and how matter changes in this topic. How does a waterfall form? Cite evidence from the topic. Use vocabulary from this topic in your response.

Evidence-Based Assessment

This table shows information about five different samples. Look at the table and then answer the questions.

Sample	Takes the shape of container at room temperature?	Flows before it is heated?	Flows after it is heated?	Can heating it be reversed?
gelatin	no	no	yes	yes
cookie dough	no	no	no	no
cake batter	yes	yes	no	no
rubbing alcohol	yes	yes	yes	yes
air	yes	yes	yes	yes

1. **Identify** Gelatin is a solid at room temperature. Which sample has the same state as gelatin at room temperature?
   A. cookie dough
   B. cake batter
   C. rubbing alcohol
   D. air

2. **Analyze** Which sample becomes a liquid after heating?
   A. air
   B. gelatin
   C. cake batter
   D. cookie dough

3. **Apply** You need to identify what a sample is made of. You observe that it does not flow. The sample does not take the shape of its container. The sample cannot flow after being heated. Heating can't be reversed. Which is the sample most likely made of?

   A. ice

   B. rubbing alcohol

   C. cake batter

   D. cookie dough

4. **Use Evidence** Describe the evidence that supports your answer to question 4. Were the properties described fixed or changing? How did that help identify the sample?

5. **Cause and Effect** The effect of heating can be reversed for some of the samples. Why can the effects of heating not be reversed for the cake batter and cookie dough?

STEM uDemonstrate Lab

TN: 3.PS1.2, 3.PS1.3, SEP.1, SEP.6

How can you use properties to identify materials?

Materials

- objects made of different materials
- water
- bowl
- heating lamp
- ice pack
- scale

Phenomenon Scientists construct explanations based on observations. Materials have different properties. How can we use the properties of materials to identify what something is made of?

Do not touch hot lamp.

Procedure

☐ **1.** Study the table of known properties of metal, wax, and wood.

Material	Easily becomes cold	Easily melts	Floats in water
metal	yes	no	no
wax	no	yes	yes
wood	no	no	yes

☐ **2.** **SEP Ask Questions** What are some properties that you can observe about your objects? Are these properties fixed or changing? What is a question you have about their properties? Make predictions about if the objects are made of metal, wax, or wood.

Science Practice Scientists investigate to collect evidence.

☐ **3. SEP Plan an Investigation** Make a plan to use the physical properties of the objects to identify what materials they are made of.

☐ **4.** Get your teacher's approval before you begin. Conduct your investigation. Record your data.

Analyze and Interpret Data

5. Use Evidence Do the data you collected support your predictions? Use evidence to support your answer.

6. Construct An Argument What did your investigation tell you about fixed and changing properties? How can these be used to identify materials? Explain your reasoning.