

STORYLINE MATRIX 6.2.1 & 6.2.2: Energy Affects Matter

Strand 6.2 ENERGY AFFECTS MATTER

Matter and energy are fundamental components of the universe. Matter is anything that has mass and takes up space. Transfer of energy creates change in matter. Changes between general states of matter can occur through the transfer of energy. Density describes how closely matter is packed together. Substances with a higher density have more matter in a given space than substances with a lower density. Changes in heat energy can alter the density of a material. Insulators resist the transfer of heat energy, while conductors easily transfer heat energy. These differences in energy flow can be used to design products to meet the needs of society.

Standard 6.2.1

Develop models to show that molecules are made of different kinds, proportions, and quantities of atoms. Emphasize understanding that there are differences between atoms and molecules, and that certain combinations of atoms form specific molecules. Examples of simple molecules could include water (H₂O), atmospheric oxygen (O₂), or carbon dioxide (CO₂). (PS1.A)
NGSS Correlation: MS-PS1-1

Standard 6.2.2

Develop a model to predict the effect of heat energy on states of matter and density. Emphasize the arrangement of particles in states of matter (solid, liquid, or gas) and during phase changes (melting, freezing, condensing, and evaporating). (PS1.A, PS3.A)
NGSS Correlation: MS-PS1-4

Phenomena Statements:

WHAT ARE ATOMS: When I look at a blade of grass under a microscope I can see more details about the structures and smaller parts of grass than I can with just my eyes.

EVERYTHING IS MADE OF ATOMS: There are many different types of matter but only 118 elements.

AIR IS MADE OF DIFFERENT SUBSTANCES: When I wave my hands in front of my face, I can feel something.

MOLECULE MOVEMENT CREATES DIFFERENT CHARACTERISTICS AND DENSITIES: Solids, liquids and gases have different properties

Expected Student Explanation: **Develop models** to show that molecules are made of different kinds, proportions, and quantities of atoms.

Science & Engineering Practices (SEP)

Crosscutting Concepts (CCC)

Disciplinary Core Ideas (DCI)

Develop and Use a Model Developing and Using Models: Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Develop a model to predict and/or describe phenomena. (MS-PS1-1)	<u>Scale, Proportion, and Quantity:</u> Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-PS1-1)	PS1.A: Structure and Properties of Matter • Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. • Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).
Storyline Narrative		Documents for Storyline
6.2.1 Storyline Narrative: To engage students in this storyline, students look for patterns by observing a <u>system</u> of a patch of grass, a blade of grass, blade of grass under a magnifying glass, and a blade of grass under a microscope. Students ask questions about what else could be going on in the blade of grass on a <u>scale</u> that is unobservable to the naked eye. Students reason that all living and nonliving things are made up of smaller particles that we can't see called atoms. Students read an article about atoms and molecules. Students discover by observing patterns and characteristics that certain combinations of atoms make up all the molecules that make up all <u>matter</u>. Students create models of different types of simple molecules as evidence that molecules are made of different types and quantities of atoms. Proportional reasoning is also emphasized. Students investigate the structure of the air that they breathe and ask is it the same year round? Students are left wondering how molecules are organized in the different states of matter that make up our world. 6.2.2 Storyline Narrative: SEEd Standard 6.2.2 asks students to develop a model to predict the <u>effect</u> of heat energy on states of matter and density. Students should emphasize the arrangement of particles in each state of matter and during phase changes.		Review and/or print out the following documents for this storyline. To edit the following documents you must open, then make your own copy. Links: Storyboard Slides - episode instructions are in the slide notes Storyline Matrix Student Journal or composition notebook Summative Assessment

Students **engage** by observing solid, liquid, and gaseous substances to understand how the structure of the molecules in each state of matter determines many of its properties. Students classify substances into the different states of matter based on the behavior of the molecules in each substance. Students reason that the structure of the molecules in a substance determine its properties. Students **ask questions about how** substances can change from one state of matter to another.

Students **explore** by observing patterns in a system in which energy is added to different states of matter. Students will **develop models** to show how energy changes the states of matter. Students are asked the question “what is heat?” As students **construct explanations** to describe heat, they are presented with a phenomenon of toothpicks connected by wax to a metal rod.

Students are asked to **explain** what caused the toothpicks to drop off the spoon in order as a flame was held on the opposite end of the spoon. Students will **model** the movement of molecules in each part of the system when heat energy is added. Students learn that molecules are always moving and heat energy causes the molecules to move faster and collide with other molecules. This causes the molecules of a substance to spread out.

Students then **investigate** and **elaborate** on how heat energy affects the density of substances. By observing hot water floating on cold water, students reason that heat energy causes the molecules of a substance to speed up and spread apart which will lower the density of that substance. Students **ask questions** about what happens when heat is removed from a system. Students are presented with a variety of systems in which heat energy is both added and removed, including melting, evaporating, condensing, and freezing.

Students are **evaluated** as they model heat energy as it flows in and out of each system to show that heat energy always flows from high energy to low energy and its effect on matter.

STORYLINE: Episodes Matrix 6.2.1 & 6.2.2

Episode	Phenomenon/Next Questions	Episode Descriptions & Student Performance Prompts	Conceptual Understandings	
			What We Figured Out: what will the students discover	Next Questions or Steps: what they will investigate next

Episode 1 Engage Time: 60 min.	Phenomenon: There is more to matter than what is observable to the naked eye.	Nearpod lesson link: https://share.nearpod.com/e/QDgs5NyAlab Resources Grass Slideshow: moving the lens in, to a molecular level Grass Slideshow Atoms and Molecules Intro Gather 1. Students investigate a patch of grass, an individual blade of grass, a magnified blade of grass, and a blade of grass under a microscope to help them develop a model of <u>scale</u>. 2. Students will observe and record patterns from their models and write an explanation of why the things they observe change as scale increases. <i>Teacher suggestions: Show students the following slides of a patch of grass, then a blade of grass, then a blade of grass under a magnifying glass, and then a blade of grass under a microscope. At each level, allow students time to draw the model and note patterns they are seeing. Encourage students to pay attention to detail as they make models of the grass. The more detailed their models, the easier it is for them to see patterns and understand scale. The patterns that students observe will change as the scale changes. Students should notice that they can see more details as we go from small scale to large scale</i> <i>Patterns that could be observed:</i> Blades of grass stand up straight Blades of grass are all close to the same color Blades of grass are long, thin, and usually flat The veins in grass are vertical The edge of grass blades have little hairs		Living and nonliving things are made up of small particles that we can't see with the naked eye called atoms. Atoms make up molecules.	How do atoms and molecules make up matter?
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		<i>In between the veins there are “pockets” of stuff</i> <i>The grass slide show is contained within this powerpoint but here is a copy of the presentation. Grass Slideshow</i> <i>See Student Science Journal page 2</i> Reason 1. Students will use their models as evidence to predict what they would see if they could keep zooming in on a blade of grass at a smaller and smaller <u>scale</u>. <i>Teacher Suggestions: Use the following questions to guide student reasoning. After students answer the first question about the blade of grass, discuss what evidence students have to support their predictions. Use the questions below to facilitate a discussion to support student learning. Then have students answer the 2nd prediction.</i> <i>Teacher Questions:</i> • <i>Are you able to investigate everything that could be happening in a blade of grass?</i> • <i>What differences or similarities do you think occur as you zoom in on different types of matter?</i> • <i>Using the evidence that you have gathered, how small do you think the building blocks of matter are?</i> <i>See Student Science Journal page 3</i> 2. Students obtain and evaluate information about atoms and molecules to help them understand what is happening at a <u>scale</u> that is unobservable			
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		with the naked eye. <i>Teacher Suggestions: Have students read the short article about atoms and molecules to help them understand what is happening at the scale that is unobservable with the naked eye. Article is found on pages 4-5 of the student journal.</i> <i>Printable copy of article: Atoms and Molecules Intro</i> <i>Students should use the information in the article to reason through what makes up grass and all other matter. Help students to reason about the scale of atoms and molecules by discussing their previous predictions of what they will see if they keep zooming in on a blade of grass. Discuss that we don't have tools strong enough to see atoms or molecules.</i> Communicate 1. Individually, students construct and communicate their explanation to describe what makes up <u>matter</u>. <i>See Student Science Journal page 6</i> Formative Assessment <i>Students' writing should demonstrate an understanding that matter is made up of particles that are too small for us to see. Students need to mention an understanding that atoms and molecules are different as they will be addressed in the coming episodes.</i>			
Episode 2 Explore	Phenomenon: There are so many different materials in the world, but there	Nearpod lesson link: https://share.nearpod.com/e/Q1b8MnAAlab Gather		Different types and quantities of atoms combine to make molecules and molecules	Many molecules have to combine to create observable matter

Time: 60 min.	are only 118 different types of atoms.	1. Students construct explanations about atoms and molecules by looking for <u>patterns</u> in how they are organized in different types of matter. <i>Teacher suggestions: Have students list their observations and questions about the pictured atoms and molecules.</i> <i>Discuss: (students can share as small groups or as a whole class) what they observed about the atoms and molecules. Listen for student understanding:</i> - within substances atoms do not change, ig. an oxygen atom is still oxygen even when it is a part of water. - some molecules have more than one of the same kind of atom, ig. water has 2 hydrogen atoms - the same kind of atom can be used to make many different substances, ig. oxygen is found in both carbon dioxide and water - each combination of atoms used to make a molecule is unique - the number of atoms that you use is important, ig. adding an extra oxygen make water turn to hydrogen peroxide <i>Students should compare and contrast hydrogen peroxide and water by writing down similarities and differences between the two substances. (this is a great teamwork activity as students can share ideas with each other)</i> <i>Students main focus should be on the molecular make-up of the substances but physical properties of the substances can be used as well.</i> <i>Student responses:</i> <i>similarities:</i> <i>both are made of atoms</i> <i>both use 2 hydrogen atoms</i> <i>both use oxygen and hydrogen atoms exclusively</i> <i>both are clear liquids</i>		make up all matter.	
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		<i>both can be used for cleaning</i> <i>differences:</i> <i>water only has 3 atoms and hydrogen peroxide has 4</i> <i>hydrogen peroxide has 2 oxygen atoms</i> <i>you should not drink hydrogen peroxide</i> <i>hydrogen peroxide is used to disinfect and can be poisonous</i> <i>Have students pick two other substances from the pictures of atoms and molecules. (depending on your student's needs and understanding, you might want to give a brief explanation of what each substance is)</i> <i>See Student Science Journal page 7-8</i> Reason 2. Students will develop models of atoms and molecules using appropriate <u>quantities and proportions</u> of atoms. <i>Teacher suggestion: Students will label the atoms and molecules on page 7 of the journal with their chemical formula, based on the <u>quantity and proportion</u> of atoms used to make-up the molecule. It is not important to go into the details of what atom is listed first - focus on using the proper chemical symbol and subscript to accurately represent the number of atoms used. This will help students with the next activity of drawing models using chemical formulas.</i> <i>Students will create models made of different kinds and quantities of atoms. Have students color the "atoms key" using a different color or pattern for each atom. Then have the students go through the 8 molecules listed and draw models of each using the proper colors and quantities of atoms. It is not important to focus on how the atoms are</i>			
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		<i>connected, just that they are connected together and that they become one molecule instead of separate atoms.</i> <i>See Student Science Journal page 9-10</i> <i>Optional:</i> <i>Provide students with Legos, gumdrops, or molecule kits to construct simple models of atoms and molecules that exist in matter. Have a “Molecule Walk” to allow students to observe the possible patterns of molecules found in matter.</i> Teacher Resource: Build a Molecule Student Simulation https://phet.colorado.edu/en/simulations/build-a-molecule Communicate Students will construct models to show that molecules are made of different <u>types and proportions</u> of atoms. <i>Students will construct a model/explanation as to what makes each molecule unique.</i> <i>Optional: Have students compare their models with others to help them continue to make sense of how quantity and proportion impact molecule types.</i> Formative Assessment <i>Students should communicate that all molecules are made of specific types and proportions of atoms.</i>			
Episode 2b Explore Time: 30 min.	Phenomenon: To make a greater amount of matter, you need more molecules	Resources How many atoms are in a single drop of water: https://safeshare.tv/x/5-bUibEIYRI# Gather		All matter is made up of different types and proportions (quantities) of molecules.	How are molecules organized in the states of matter?

		1. Students will obtain information about <u>scale and proportion</u> of molecules. <i>Teacher Suggestions: Show students the pictures of water on the slide. Have the students draw what molecules are in each object. They do not need to draw quantities, just types of molecules.</i> <i>Teacher questions:</i> • What is a glass of water made of? • What is the water in a water tower made of? • What is ice made of? <i>Students should understand that all things made of water are made of water molecules, so all three pictures should show a water molecule.</i> <i>Teacher Questions:</i> • If we broke up the water in your bathtub and the water in a glacier into individual molecules, what would you find? • If we broke up water in your bathtub and the water in a glacier into individual atoms, what would you find? • Why do you think a drop of water and the water in a lake are made of the same thing? Reason 1. Students obtain and evaluate information about what makes up <u>matter</u> to help them understand types and <u>proportions</u> of molecules in matter. <i>Teacher Suggestions: Place a drop of water on a surface. Ask students to guess how many molecules are in the drop of water. Have students draw a model of their guess of how many molecules are in a single drop of water in their journal. Then have students discuss with each other why they made their specific prediction. Based on their</i>			
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		<i>discussion have the student groups come up with one estimation of how many molecules are in a drop of water. Have students write their group's prediction in their journal and then have them share and write their predictions on the board.</i> <i>Teacher Questions:</i> • <i>How big is a molecule?</i> • <i>Can we see individual molecules?</i> • <i>How big is an atom ... How many atoms make up a molecule of water?</i> <i>Do not give answers, let students discuss and think about this concept.</i> Watch the video: How many Atoms are in a Single Drop of Water? https://safeshare.tv/x/5-bUibEIYRI# <i>After the video have students discuss what number the video gave about how many molecules are in a drop of water. Let students know that a single drop of water has 1.67×10^{21} molecules of water in it. You can write this number on the board so that students can better understand the proportion of molecules in a single drop of water. (1,670,000,000,000,000,000,000) Have students reevaluate their guesses to see if anyone was even close. Have students put the number 1.67×10^{21} into the formula on page 12 of their student journal and then calculate the total number of molecules in a glass of water.</i> <i>Teacher questions:</i> • <i>Why was it hard for us to guess the proportion of molecules in a single drop of water?</i> • <i>Do you think that other molecules are the same size as water molecules?</i> ○ <i>The exact size of molecules varies but it is important for students to know that all molecules are too small for us to see with our eyes.</i> • <i>What can you think of that is comparable in size</i>			
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		<i>and proportion to the molecules in a drop of water?</i> • <i>Why is it important for us to understand the size of atoms and molecules?</i> <i>Students will write an explanation about why there are so many molecules in a cup of water.</i> Reason 1. Students obtain and evaluate information about what makes up <u>matter</u> to help them understand types and <u>proportions</u> of molecules in matter. <i>Teacher suggestions: Students will read the article on page 12 of the student journal about what matter is made of.</i> <i>Discuss the differences between different types of matter. You should discuss physical differences and molecular differences. Use the examples of pasta noodles and playdough given in the article to move the discussion forward.</i> <i>Teacher Questions/Possible Answers</i> • <i>What are the similarities and differences between playdough and pasta noodles?</i> ○ <i>Playdough: not edible, salty, grainy texture, dries out, moldable, leaves salty substance on table, etc. Pasta Noodles: edible, plain taste, smooth texture, dries out, moldable, cookable, etc.</i> • <i>Why are playdough and pasta noodles different? (focus on why different quantities of molecules make the matter different</i> ○ <i>Playdough has more salt molecules which makes it taste salty and leave salt residue, Playdough has more salt molecules which make the texture more grainy, Pasta</i>			
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noodles have less salt molecules which makes the taste more bland, etc.

Have students discuss why it is important to keep the original ratios for each type of matter. Have them fill out the charts on page 13 to show how to keep the ratio the same for playdough and pasta noodles as the amount increases. (you can have the students increase the ratios in whatever way you like, but to make it easier to compare the 2 substances you might want to increase the starch in playdough to 12 (multiply entire recipe by 6))

- *What would happen if we changed the ratios in the recipe for pasta noodles?*
 - *We would not get pasta noodles or we would get noodles that did not look like, behave like, or taste like pasta noodles.*

Optional: You can start your discussion with water and lemonade if students need additional discussion about how different molecules in different quantities create different matter.

Teacher questions / possible answers:

- *How is water different than lemonade?*
 - *taste, color, texture, etc.*
- *What is the difference between the molecules found in water and those found in lemonade?*
 - *Water just has water molecules, Lemonade has to have water molecules in addition to sugar molecules and the molecules that make up lemon (lemon is made up of multiple molecules (citric acid, vitamin C, essential oils, etc.) - it is not necessary to go into that much detail about the different molecules in lemon)*

		Communicate 4. Students will construct an explanation to describe how there are millions of different types of <u>matter</u>. Formative Assessment <i>Students should communicate that all matter is made up of different types and proportions (quantities) of molecules.</i>			
Episode 3 Explain Time: 60 min	Phenomenon: Solids, liquids, and gasses have different characteristics.	Nearpod lesson link: https://share.nearpod.com/e/DCeZlVBAIab <i>Teacher suggestions: Show students the different images and ask them what they see. This should look like “I see clouds”, “I see a mountain”, “I see a waterfall”, “I see a snowman”. Then ask them what they notice. Then ask them what they notice. This might look like, “Every picture has water”, “Some places are wet”, “Some places are cold”. Lead them to talking about the different characteristics of the water.</i> Gather 1. Students will obtain information about a basic solid, liquid, and gaseous substance and their <u>structure</u> and construct a model of each state of matter. <i>Teacher Suggestions: Have students look at the images of water in the form of a solid, liquid and gas and draw what they see. Have students record what the molecules are doing for each state and the characteristics.</i> <i>See Student Science Journal page 16</i> Reason		The molecules in solids, liquids, and gasses are arranged and behave in different ways. This arrangement causes the objects to have certain characteristics, including different densities. Molecules constantly move and vibrate more freely depending on which state it is in.	How do substances change from a solid to a liquid or liquid to a gas?

		2. Students will continue to develop models of the behavior of molecules in different states of <u>matter</u>. <i>Teacher suggestions: Show students a variety of solids (on the slides or items in person), including rocks, sand, fur, or powder. Students may need to reason about why some of these substances are considered solid. For example, even though sand or powder as a whole can move around like a liquid, the small pieces still hold their shape, making them a solid substance. Next move to a conversation about liquids. Show (or talk about) how ice cubes placed in a cup will not take the shape of the cup until the ice cubes become a liquid because liquids can take the shape of any container they are in (e.g., water). Then talk about gasses and how they will fill any space evenly, no matter how big or small. You may want to demonstrate this with a balloon animal. For background information on the characteristics of the states of matter, go to 6th -OER Textbook.</i> <i>Teacher Support for understanding the characteristics of matter: States of Matter (6.2.2) CK-12 Foundation</i> <i>As you move through the different states of matter, consider using the following questions to guide students' thinking.</i> <i>Q. Can the molecules move freely?</i> <i>Q. Is it easy to separate molecules?</i> <i>Q. What is the motion of the molecules in this state of matter?</i> <i>Q. Would this state of matter contain more or fewer molecules than the others?</i> <i>Q. From what you know about this state of matter, what do you think is going on at a molecular level?</i> Discuss the similarities between the characteristics of each state of matter and their molecular behavior.			
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		3. Students will develop their models further through research about density and its role in the behavior of molecules in <u>matter</u>. <i>Teacher suggestions: Use the following website to support students' understanding about the role of density in the states of matter. Students should not yet learn how temperature affects density as that will be addressed in later episodes.</i> <u>ck12-density</u> <i>Discuss the similarities between the states of matter and their densities. Students should return to their previous models of the states of matter and use new evidence to add to the molecular behavior and density of each state as part of the substances' defining characteristics. Make certain students understand the characteristics of each state of matter. Students should understand that different substances can have different densities according to the amount of matter in a given volume.</i> Communicate 4. Students will argue from evidence about their models to explain why solids, liquids, and gasses make <u>matter</u> behave the way they do. Formative Assessment <i>Student explanations must clearly state that the characteristics of solids, liquids, and gasses depend on the arrangement of their molecules.</i>			
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Episode 4 Elaborate Time: 60 min.	Phenomenon: Ice melts in a pan and becomes water; boils and becomes steam.	Nearpod lesson link: https://share.nearpod.com/e/F9U0PxDAIab Gather 1. Students will gather information and develop a model for the flow of heat <u>energy</u> in a <u>system</u>. <i>See Student Student journal page 16 (video #1)</i> <i>Teacher suggestions: Have students watch the video, Phase Changes in Water. Students should create models of what is happening at the visible level and the molecular level. Models should include the heat source and the flow of heat energy.</i> <i>Discuss: ask students to describe their developing ideas on their models in order to understand students' current levels of understanding of the system.</i> Phase Changes in Water https://www.youtube.com/watch?v=8kpkrl7h1WY https://www.youtube-nocookie.com/embed/8kpkrl7h1WY https://safeshare.tv/x/ss5e90e7b21a45c <i>Information on Models</i> <i>There are a variety of ways to have students create models from this video and the videos on the following slides. Here are some suggestions ... choose what is best for your students.</i> <i>Option 1: Have the students watch the video and create their models based on the visible and non-visible changes they observe. Go through the models and have students share key points that they noticed - including molecular structure and movement, heat source, and heat energy flow. Have students update and fill in the missing information on their models.</i> <i>Option 2: Have the students watch the video and create</i>		Matter changes state according to the total heat energy within the system.	How do substances change from a solid to a liquid or liquid to a gas?
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		<i>models based on the visible changes they can see. Follow up the video with a discussion and have the students explain what is happening at the molecular level. As students explain molecular behavior have them draw call-out boxes on their models to show the molecules. Discuss heat energy flow and help students draw in arrows showing how heat energy is moving.</i> <i>Option 3: Let students know that they are creating a storyboard of what is happening in the video. Have them divide their box into 3 separate sections. Have students draw 3 points in time from the video that explain the story of what is happening. Go through the models and have students share key points that they noticed, including heat source, heat energy flow, and molecular structure and movement. Discuss any important information that is missing and have students update their models.</i> <i>Option 4: Have the students watch the videos and create their models based on the visible changes they observe. Then have students go the following simulation to see what happens to the molecules as the state of matter changes. As they interact with the simulation have them add to their models to show the molecular structure and movement. Follow up with a discussion about where the heat energy is coming from and how it is moving.</i> <i>Simulation: Phase Change (Phase Diagrams, Phase Diagram for Water, Heating and Cooling Curves, Change of State) Chemistry CK-12 Exploration Series (CK-12 simulations may require a login)</i> <i>There are many ways that models for this type of phenomenon can be drawn. Students may want to focus on one specific moment in time, they might want to draw the end results, they can draw a beginning and an end, or they can draw multiple images. You might want to remind students that scientific models should include a title, labels, and descriptions. Models should be clear, accurate, include details, and they should convey factual information.</i> Gather			
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		2. Students will gather information and develop a model for the flow of heat <u>energy</u> in a <u>system</u>. <i>See Student Science Journal page 16-17 (videos 2-4)</i> <i>Teacher suggestions:</i> <i>Have students draw models as they watch the following videos. Students should create models of what is happening at the visible level and the molecular level. Models should include the heat source and the flow of heat energy.</i> <i>Teacher questions:</i> • <i>What details do you notice about how the physical properties of matter are changing?</i> • <i>When do you notice a change of state?</i> • <i>Does the change in the properties of matter happen all at once or gradually?</i> • <i>What is happening with the heat source ... is the heat the same or does it get more or less intense?</i> Ice cubes melting https://www.youtube.com/watch?v=YRU5vkZUTOg https://www.youtube-nocookie.com/embed/YRU5vkZUTOg https://safeshare.tv/x/ss5e90e7fa2b7b9 Time Lapse Test - Freezing A Glass of Water https://www.youtube.com/watch?v=xFRu2mt6SgQ https://www.youtube-nocookie.com/embed/xFRu2mt6SgQ https://safeshare.tv/x/ss5e90e8489098a Boiling water in slow motion https://www.youtube.com/watch?v=0xcxumccf8Q https://www.youtube-nocookie.com/embed/0xcxumccf8Q https://safeshare.tv/x/ss5e90e87eba560			
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		Reason 3. Students will use their models to write <u>cause and effect</u> relationships concerning what happens to matter when heat energy is added. <i>Teacher suggestions:</i> <i>Have students create cause and effect statements using the sentence frame and word bank. The student journal has one example partially completed. A completed cause and effect sentence will resemble this:</i> <i>"Adding heat energy causes a liquid to change to a gas because the molecules become less dense."</i> Students' statements should include the effect of heat energy in both a solid and a liquid. <i>Have students share their cause and effect statements in small groups. Within their groups students should discuss whether they agree with the statements or disagree and why. Students should correct their statements if they are inaccurate.</i> <i>See Student Science Journal page 18.</i> Communicate 3. Students will use models to communicate what happens when heat <u>energy</u> is added to <u>matter</u> at a molecular level. <i>Teacher Suggestions:</i> After student groups have discussed their cause and effect statements, have each student write an explanation about the effects of adding heat energy into a system. Formative Assessment			
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		Students' explanations should include that added heat causes the molecular arrangement of solids and liquids to change, causing the state of matter to change.			
Episode 5 Elaborate Time: 60 min.	Phenomenon: Toothpicks on a rod fall off when over a lit candle.	Nearpod lesson link: https://share.nearpod.com/e/aXWpwNEAlab Gather - Students will obtain information from an image to predict the role of adding heat energy to a <u>system</u>. <i>Teacher suggestions: Before playing the video, have students look at the image and make predictions about the toothpicks.</i> <i>See student science journal page 19, 1st question in the table.</i> Links: https://www.youtube.com/watch?v=iXuA3U41hGA https://www.youtube-nocookie.com/embed/iXuA3U41hGA https://safeshare.tv/x/iXuA3U41hGA# Gather - Students will obtain information and create a model from a video about the <u>effect</u> on molecules by adding heat energy to a <u>system</u>. <i>Teacher suggestions: Have students record their observations as they watch the video. Discuss as a class how this phenomenon relates to the videos from the previous lesson.</i> <i>See student science journal page 19, 2nd question in the table.</i>		Molecules are always moving. Heat energy causes molecules to move more and collide with other molecules. More energy equals more movement.	How does heat affect the density of molecules?

		<i>Teacher Questions:</i> • <i>Why did the toothpicks fall one at a time?</i> • <i>Why did the toothpicks fall in the order that they did?</i> • <i>Why did the toothpicks not fall before the heat was applied?</i> • <i>What do you think happened to the wax?</i> • <i>How do you think heat is traveling through the metal rod?</i> <i>Links:</i> https://www.youtube.com/watch?v=iXuA3U41hGA https://www.youtube-nocookie.com/embed/iXuA3U41hGA https://safeshare.tv/x/iXuA3U41hGA# <i>See Student Science Journal page 19</i> Gather 3. Students will read the article, “Explainer: How Heat Moves” and construct an explanation of how heat energy moves through a system. <i>Teacher Suggestions: Have students read through the article, “How Heat Moves”. Students will write an explanation about how heat energy affects matter on the molecular model. Student explanation should include that heat causes molecules to move more and to spread out, therefore causing them to “bump” into other molecules and create a flow of energy.</i> <i>Teacher Suggestions:</i> <i>Discuss what heat is. Students should understand heat as the rapid movement of molecules. The faster the molecules</i>			
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		<i>are moving, the more heat energy they have.</i> <i>See Student science journal pg. 20</i> Reason 3. Students will physically model the previous phenomenon, acting as molecules to show how <u>energy</u> flows in the <u>system</u>. 4. Using their ideas and models, students will construct a model about the flow of <u>energy</u>. <i>Teacher Suggestions: Students should be allowed to direct as much of the modeling as they are capable of understanding on their own. Teachers can provide students with role cards for each part of the model that explain how that molecule should act in this situation. Role cards are included in the student journal on page 21</i> <i>The human model should include the following:</i> A. The molecules of the rod. B. The flame. C. The molecules of the wax. D. The molecules of the toothpicks. E. The movement of the molecules with and without the flame. <i>Have a whole-class discussion, guide students to focus on the molecules to describe the way the heat energy moved. As the model is being created, each student will be given the opportunity to explain their role in the model and how the heat energy affects them. The human model should show that heat energy is the increased movement of the molecules and that molecules only move when other molecules collide into them.</i>			
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		<i>Have students return to page 19 in their journals to draw out the model that they just enacted. Before they create their models they should create a model bank of things that they should include in their model. You can have a class discussion or small group discussions about what needs to be included in the model. Here are suggested items to be included in the model bank:</i> • <i>Physical model (heat source, metal rod with wood handle, toothpicks, wax)</i> • <i>Description/drawing of the molecules and their properties before and after heat was introduced into the system</i> • <i>Arrows to show flow of energy</i> <i>See student science journal page 19, model question in the table.</i> Communicate 5. Students will use their models to communicate “What is heat?” and the <u>effect</u> of adding heat energy to a system. Formative Assessment <i>Students have already answered this question in their student journals on page 20. Go back and have students refine their explanation (if needed).</i>			
Episode 6 Evaluate Time: 60 min.	Phenomenon: Hot water on cold water.	Nearpod lesson link: https://share.nearpod.com/e/ZRUivKFAlab <i>Teacher suggestions: Begin with talking about why it might be that a hot air balloon can fly in the sky. Students could mention the parts of the hot air balloon and how it works, the presence of air, etc.</i> Gather		Heat causes the density of a substance to change by speeding up the molecules and causing them to spread slightly	What happens when heat is removed from a system?

		1. Students will obtain information about how <u>energy</u> flows in a hot/cold water experiment. <i>Teacher Suggestions: Previously, students have learned that different substances can have different densities according to the amount of matter in a given volume. Now students will learn that the same substance can have different densities at different temperatures. The experiment can be shown in person or through the video.</i> <i>See the directions for the amazing water trick:</i> https://www.exploratorium.edu/science_explorer/watertick.html <i>Video Link of the experiment:</i> <i>Hot and Cold Water Density Experiment</i> https://www.youtube.com/watch?v=hYFIImOebWs&t=11s https://safeshare.tv/x/ss5e90e90cde0b7 Reason 2. Students will construct explanations about the <u>effect</u> of thermal <u>energy</u> on density. <i>Teacher suggestions: After the experiment, facilitate a discussion asking the following:</i> <i>Q. Why did the cold water sink to the bottom and mix with the hot water?</i> <i>Q. What did the hot water stay on top of the cold water?</i> <i>Students should understand that the hot water must have a lower density than the cold water so it stays on top. Have students model what molecules look like at hot, cold and room temperature. Present slides 43-44 that show how the molecules of water change when they are heated or cooled. Present them with the following questions:</i>		apart.	
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		Q. How many molecules are there? (Did the mass change?) Q. How much space do the molecules take up? (Did the volume change?) Q. How does the change in the amount of space that the molecules take up affect the density? <i>Have students revise their models as necessary.</i> <i>Student Science Journal page 22</i> 3. Students will construct explanations of the <u>structure and function</u> of density of different temperatures of water. <i>Teacher's Note: Using evidence from the pictures, students should explain that as water is cooled the molecules come together and sink, and as water is heated the molecules spread apart and rise.</i> Communicate 4. Students will use their model to explain how density <u>causes</u> a hot air balloon to fly. 5. Students will return to their models of the boiling water system from Episode 4 and revise them using evidence from the rod/wax and hot/cold water models to show how <u>energy</u> flowing into the system affects the matter in the system. Formative Assessment <i>Students' models of the melting/evaporating system should include the flow of heat energy, as well as its effect on the molecules of the matter in the system. The stove causes the molecules of the pan to move quickly, which causes the molecules in the ice to move quickly. As the molecules in the ice move more quickly, it changes state (melting). As the water molecules increase in energy, they become less</i>			
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		<i>dense and change state again (evaporating).</i>			
Episode 7 Evaluate Time: 60 min.	Phenomenon: A nice refreshing cup of ice water never gets colder than 32 °F no matter how much ice I add.	Nearpod lesson link: https://share.nearpod.com/e/J9wBrBsEhbb <i>Teacher background: Three different systems will be analyzed in this episode. A system refers to all of the energy and matter within a defined investigation or area of study. For example, when looking at a pot of water boiling, the matter includes burner, pan, water, and air. The energy includes heat in the air, heat from the flame, and heat in the water.</i> Gather Students will use their models of the melting and evaporating system to make sense of <u>matter</u> and <u>energy</u> in the video. Teacher suggestions: Using their models from episode 4, students will gather information from the condensation video to continue to make sense of energy and matter in a system. Students should label all matter and energy within the system. As they are labeling energy, facilitate a discussion for students to rank energy from highest to lowest. See Student Science Journal page 24 condensation https://www.youtube.com/watch?v=bymT5AcV-C4 https://www.youtube-nocookie.com/embed/bymT5AcV-C4 https://safeshare.tv/x/ss5e90e9de7c5d8 Time Lapse Test - Freezing A Glass of Water https://www.youtube.com/watch?v=xFRu2mt6SgQ https://www.youtube-nocookie.com/embed/xFRu2mt6SgQ		Increases and decreases in energy cause changes in the arrangement and behavior of molecules in each state of matter. Heat always flows from high energy to low energy.	What is the air made up of and how does heating and cooling affect air movement.

<https://safeshare.tv/x/ss5e90e8489098a>

Reason

2. Students will **evaluate information to construct an explanation** of how energy flowed through the system.
3. Students will **argue from evidence** whether energy always flows through matter from high to low.

Teacher suggestions: Students should discuss how the energy flowed from the matter with the highest energy to the matter with the lowest energy. Students will use evidence to determine why energy would flow from high to low energy.

Repeat the Gather and Reason sections using the freezing video. Go through each example separately. Make sure that students conclude in each example that the flow of energy in the specific system went from high to low. Refer back to student evidence in the first example of melting and evaporation of water in a pan.

See Student Science Journal page 22

Communicate

4. Students will **use models to communicate** the effect of adding or removing energy to matter.

Teacher Suggestions: Students' models should show the flow of energy among solids, liquids, and gaseous molecules.

Formative Assessment

Students need to explicitly state that energy always flows from high energy to low energy.

Episode 8 Explore Time: 60 min.	Phenomenon: When I wave my hands in front of my face I can feel something.	Nearpod lesson link: https://share.nearpod.com/e/ESEMChBALab <i>Teacher Background Knowledge: Use the Breathe Utah website to build your understanding of Utah's Summer and Winter Pollution before teaching.</i> Gather - Students will investigate the phenomenon of fanning their face with their hands and what is <u>causing</u> them to feel something. <i>Teacher Suggestions: Have students fan their face with their hands and ask what they notice and how they might explain it.</i> Q. What are you feeling? Q. How do you know something is there? Q. Why can't we see it? Q. What is air? What do you mean by air? - Students obtain information on the types and <u>proportions</u> of <u>matter</u> found in the air. <i>Teacher suggestions: Have students read an article "What Gasses Make Up the Air We Breathe?" and complete the chart in their student science journal. Students should record the names of the gas, the percent it makes up in the air, the chemical formula (ex. O₃), a drawing of the molecule, and facts about the gas. Then have students look at the article "Major Air Pollutants" and draw the molecules of the pollutants in our air.</i> See Student Science Journal pages 10-14 Reason		What is the air made up of and how does heating and cooling affect air movement.	What factors affect how energy is transferred?

		3. Students will evaluate the information from the reading and the slides to construct an explanation describing <u>matter</u> in the air at different times of the year in Utah. <i>Teacher suggestions: Have a class discussion about the images of Utah's air at different times of the year. Consider using the following questions:</i> <i>Have students look at the table to make sense of the gasses in the air for 2016 and 2017, comparing them to the permissible amounts.</i> Communicate 4. Students construct an explanation to describe how changing the proportions and quantities of <u>matter</u> in the air affects Utah's air quality. 5. Students will argue using evidence, from the reading and slides, for how they might lower the proportion of <u>matter</u> in the air that causes air pollution. See Students Science Journal page 15 Formative Assessment <i>Student's explanation should show an understanding that air pollution is made up of a variety of molecules that vary in quantity and proportions of atoms.</i> <i>Optional: Students may wish to visit the "Current Conditions" page to see what the air in Utah currently has in it.</i>			
Summative Assessment	6.2.1-6.2.2 Assessment				

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[6.2.1 Formative Assessment](#)
[6.2.2 Formative Assessment](#)