6th Grade
Energy Affects Matter

Teaching the Science and Engineering Education (SEEd) Standards

UVU College of Engineering & Technology
UTAH VALLEY UNIVERSITY

UVU CREATIVE LEARNING STUDIO

UVU School of Education
UTAH VALLEY UNIVERSITY

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SEEd 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 (H_2O), atmospheric oxygen (O_2), or carbon dioxide (CO_2). (PS1.A)

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)

Standard 6.2.3 Plan and carry out an investigation to determine the relationship between temperature, the amount of heat transferred, and the change of average particle motion in various types or amounts of matter. Emphasize recording and evaluating data, and communicating the results of the investigation. (PS3.A)

Standard 6.2.4 Design an object, tool, or process that minimizes or maximizes heat energy transfer. Identify criteria and constraints, develop a prototype for iterative testing, analyze data from testing, and propose modifications for optimizing the **design solution**. Emphasize demonstrating how the structure of differing materials allows them to function as either conductors or insulators. (PS3.A, PS3.B, ETS1.A, ETS1.B, ETS1.C)

6.2.1 Making Molecules

Grade: 6th

Lesson Topic: Models of Molecules

Utah SEEd Standard:
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 (H_2O), atmospheric oxygen (O_2), or carbon dioxide (CO_2). (PS1.A)

Lesson Performance Expectations:

- Students will plan and carry out an investigation to gather evidence to support that molecules are made of different atoms and amounts.
- Students construct explanations to demonstrate understanding of how atoms and molecules differ.
- Students will create a model detailing different kinds and amounts of atoms (scale, proportion, and quantity) found in their molecules.

Phenomenon: Water and Hydrogen both contain a Hydrogen atom but we can see water and not Hydrogen.

Gather

1. Develop questions to investigate the structure of various substances to find clues for how molecular structures may cause observable differences.
2. Students will plan and carry out an investigation to determine how changing the amount of atoms or the type of atoms will affect a molecule.
3. Students will obtain information from the video and readings about the structures and properties of various household atoms.

Reason

4. Develop physical models of a simple molecule and atoms from the table and will compare the structures of each. Students will be looking for different patterns in the compound.
5. Construct an explanation that the composition of molecules causes differences in the properties of substances.

Class Discussion:
Questions to initiate Discussion:
Q: How does increasing or decreasing one atom affect the molecule?
Q: What are the differences between an atom and molecule?
Q: Why does the amount of atoms in each molecule differ?

Communicate Reasoning 6. Present a model from step 4 that represents simple molecules such as carbon dioxide and water. Giving explanations that substances made from the same type of atoms, can combine to make different structures that have different properties.

Science and Engineering Practices	Pose models to describe mechanisms at unobservable scales. Obtain information to develop models
Develop and use models obtain information	
Crosscutting Concepts	Identify the quantity and proportions of atoms to make up each molecule. Differentiate the scale or size between atoms and molecules
Scale, Proportion, and Quantity	
Disciplinary Core Ideas	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. (MS-PS1-1)
PS1.A: Structure and Properties of Matter	

Lesson adapted from: Structure of Molecules

Appendix A - Student Prompts for the Lesson

Phenomenon: Water and Hydrogen both contain a Hydrogen atom but we can see water and not Hydrogen.

Group Performances:

1. Develop questions to investigate the structure of various substances to find clues for how molecular structures may cause differences in observable properties.
2. Students will plan and carry out an investigation to determine how changing the amount of atoms or the type of atoms will affect a molecule.
3. Students will obtain information from the video and readings about the structures and properties of various household atoms.
4. Develop physical models of a simple molecule and atoms from the table and will compare the structures of each. Students will be looking for different patterns in the compound.

Class Discussion

5. Construct an explanation that the composition of molecules causes differences in the properties of substances.

Individual Performances:

6. Present a model from step 4 that represents simple molecules such as carbon dioxide and water.

Giving explanations that substances made from the same type of atoms, can combine to make different structures that have different properties.

Teacher prep - read through chapter 2 of the OER 6th Grade Science Textbook there are phenomenal readings for these lessons in Ch. 2. OER 6th Grade This is a link to a PDF version of the book. QR code below.

Lesson Steps:

1. Introduce the lesson by asking students about the phenomenon. Emphasize that scientists and engineers experiment with molecules and use this knowledge to design new things. Vocabulary:
    a. Molecule-the smallest particle of a substance that retains all the properties of the substance and is composed of one or more atoms.
    b. Hydrogen- the smallest particle of an element that can exist either alone or in combination
    c. Atom- the smallest particle of an element that can exist either alone or in combination
    d. Compound- To put together (parts) so as to form a whole
    e. Property- A quality or trait belonging and especially peculiar to an individual or thing
2. Tell them that they will be researching and investigating atoms and molecules and comparing their makeup.
3. At this point show them the Atoms, Molecules, elements, Compounds video clip. Watch

from (15 seconds -6:20 seconds)

4. Hold a group discussion/ create a table about atoms and molecules.
    a. Have the students then read the information in appendix B2 and Revisit the discussion/table from the previous step and add in more details.
5. Have the students break into small groups and analyze the table in appendix B1. Emphasize the two types of sugars and their differences. The differences between molecules is due to different kinds, proportions, and quantities of atoms. Emphasize that an atom is the smallest particle and that it can not be separated. Water is an excellent molecule to use for this investigation.
6. In small groups of 3-5, students will create a simple molecule model, simple molecules found on the table, and identify the atoms in it. In these steps the students will be using the chemistry molecule kit to create models of their simple molecules. This section is to allow the students to express their creativity in creating their models as well as to help them create a model that they can understand and explain to the class.
7. Students will present their model and present their findings to the class. Students may find it helpful to have a diagram of their model in order to complete this part. It may be helpful to have the students draw and label a picture before constructing the model.

https://www.uen.org/emedia/resources/oer/6thGradeSEEd.pdf

Teaching Suggestions:

- Begin with the class discussion to determine what the students know. Allow for enough time to cover any new or different questions the students may come up with.
- Have the students examine the information in appendix B.
- After this, conduct another short discussion based on what the students observed.
- The students will then create their own model of the molecule (can be a variation from the table or another molecule that the students want to do).
    - Students will use the molecule kit to create their molecules.
- Students will compare how their molecules differ or are the same to their classmates' and construct an explanation as to why.
- Students will write a written explanation comparing the similarities and differences of their molecules.

Note: it may be helpful for some students to draw out the diagram of their molecule and label it on paper before creating the model.

Appendix B

Materials list:

- Chemistry Molecule Kit
- Online tools: molview.org, you can search molecules/compounds to show the 3D models online.

Classroom materials:

- paper
- colored pencils

Readings:

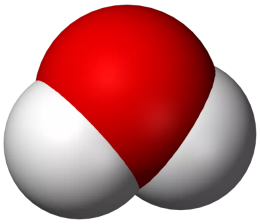
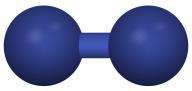
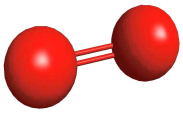
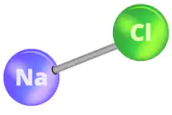
OER Textbook - Matter and energy are fundamental components of the universe. Matter is anything that has mass and takes up space. Transfer of energy creates change in matter. Changes between general states of matter can occur through the transfer of energy. Density describes how closely matter is packed 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 that meet the needs of society.

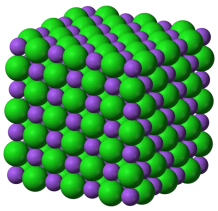
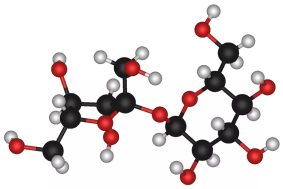
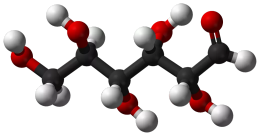
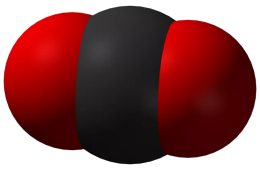
A molecular formula is an expression of the number and type of atoms that are present in a single molecule of a substance. It represents the atoms of a molecule.

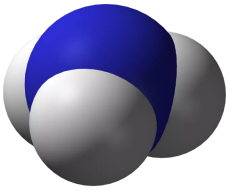
In order to make it easier to describe elements and molecules, chemical formulas are used. For example, “H” represents one atom of hydrogen and "O" represents one atom of oxygen. If we want to represent two atoms of hydrogen, instead of writing H-H, we write H_2. Subscripts after element symbols represent the number of atoms. If there is no subscript, it means one atom is present in the molecule of a substance. The subscript "2" means that two atoms of the element hydrogen have joined together to form a molecule. A **subscript** is only used when more than one atom is being represented.

The molecular formula of common chemicals, such as salt, sugar, vinegar, and water, as well as models and descriptions for substances.

Appendix B-1- Student table

Substance	Model	Description and Properties
Water H_2O		Water is the most abundant molecule on the Earth's surface and one of the most important molecules to study in chemistry. Water is a chemical compound. Each molecule of water, H2O, has two atoms of hydrogen bonded to one atom of oxygen. Liquid water is described as water, water as gas is referred to as vapor or gas water and solid water is called ice. - Drinking Water
Hydrogen H_2		Hydrogen gas is the smallest and simplest possible molecule. At standard temperature and pressure, hydrogen is a nontoxic, nonmetallic, odorless, tasteless, colorless, and highly combustible diatomic gas with the molecular formula H_2. Hydrogen is also prevalent on Earth in the form of chemical compounds such as hydrocarbons and water.
Oxygen O_2		Oxygen gas makes up a fifth of the atmosphere, amounting to more than a million billion tonnes. The oxygen in the Earth's atmosphere comes from the photosynthesis of plants, and has built up in a long time as they utilised the abundant supply of carbon dioxide in the early atmosphere and released oxygen. Nearly every chemical will bind with oxygen to form compounds. - Air we breath Read more: https://www.lenntech.com/periodic/elements/o.htm#ixzz6aOcLYP5S
Salt is NaCl		Salt - NaCl is a three-dimensional ionic substance. NaCl is referred to as a chemical or molecular formula. Substances like this are described as having a network structure that goes to very large crystals. The NaCl represents the ratios of sodium to chlorine, but it is not a single unit. - Common table salt

		
Sugar Sucrose $C_{12}H_{22}O_{11}$		Sugar – three-dimensional representation of table sugar, which is sucrose $C_{12}H_{22}O_{11}$ is a molecular substance that can form into larger crystals. There are many types of sugar with similar but slightly different structures. Glucose is $C_6H_{12}O_6$ but generally, when you ask for the molecular formula of sugar, you are referring to table sugar. The molecular formula for sucrose is $C_{12}H_{22}O_{11}$. Each sugar molecule contains 12 carbon atoms, 22 hydrogen atoms, and 11 oxygen atoms. - Sucrose is the sugar we put on our breakfast cereal.
Sugar Glucose $C_6H_{12}O_6$		The molecular formula for glucose is $C_6H_{12}O_6$. Glucose is the sugar that is produced by plants during photosynthesis and used by plants and animals in cellular respiration. Glucose is a product of photosynthesis.
Carbon Dioxide $NaHCO_3$.		Carbon dioxide is a gas that is found in the atmosphere. In solid form, it is called dry ice. The chemical formula for carbon dioxide is CO_2. carbon dioxide is present in the air you breathe. Plants "breathe" it in order to make glucose during photosynthesis. You exhale carbon dioxide gas as a by-product of respiration. Carbon dioxide in the atmosphere is one of the greenhouse gases. You find it added to soda, and in its solid form as dry ice.
Carbon Monoxide CO		Carbon monoxide is a highly toxic, colorless, odorless gas produced when fuels have incomplete combustion.

Ammonia NH_3		Ammonia is a gas at room temperature and has the molecular formula of NH_3. A solution of ammonia is used for household cleaning.

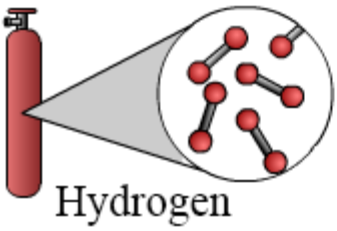
Appendix B - 2 -Student Reading

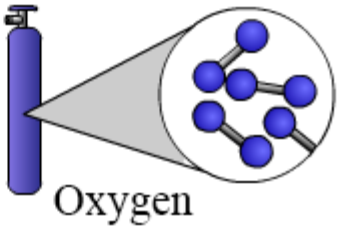
Reading on substances with the same atoms but different structures - examples CO and CO_2 or Diamonds and Graphite or Glucose and Fructose.

Atoms are building blocks. If you want to create a language, you'll need an alphabet. If you want to build molecules, you will need atoms from different elements. Elements are the alphabet in the language of molecules. If you read a book, you will find words on each page. Letters make up those words. In English, we only have twenty-six letters, but we can make thousands of words. In chemistry, you are working with almost 120 elements. When you combine them, you can make millions of different molecules. Molecules are groups of atoms in the same way that words are groups of letters. While atoms from different elements have different masses and structures, they are all built with the same parts.

A variety of different substances that exist result from atoms from different elements combining to form molecules. Different substances can react together to form a new substance with different properties and structures. The structures of molecules differ from the elements that compose the molecule and molecules are made from the same elements that can differ depending on how the atoms are connected.

All matter, such as solids, liquids, and gases, is composed of **atoms**. Any material that is composed of only one type of atom is called an element.



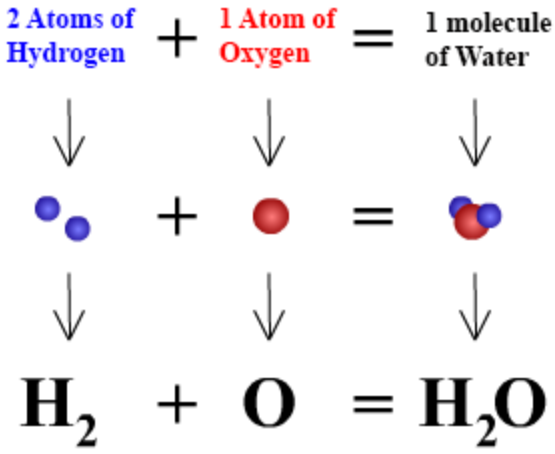


The atoms in

oxygen are identical to each other. The atoms in hydrogen are identical to each other. However, the atoms of oxygen are different from the atoms of hydrogen.

Water is formed by combining the atoms of different elements.

The graphic below illustrates the formula for water using symbols.



Appendix B-3-Student Video

Video Link https://www.youtube.com/watch?v=AfXxZwNLvPA

BBC Video (15 seconds -6:20 seconds)

6.2.2 Matter On The Move

Grade: 6th **Lesson Length: Might be best as a 2-day lesson**

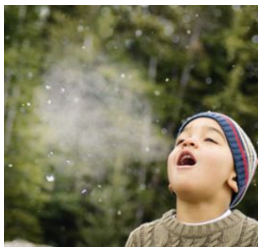
Lesson Topic: States of Matter and phase changes

Utah SEEd Standard:
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)

Lesson Performance Expectations:

- Students carry out an investigation to change states of matter.
- Students will demonstrate the states of matter through movement of their bodies.
- Students will create a model to show how matter and energy move into or out of systems.

Phenomenon: When you breathe out on a cold day, you can see your breath.



Gather

1. Students **plan and carry out an investigation** to observe breathing into the cold air and make observations of the **changes** that exist when they can see their breath.
2. Students **obtain information** about changes in the states of matter through videos and readings.

Reason

3. Students **develop a model** to show how **matter and energy** move into or out of the **system** of their breath and the surrounding air.
4. Students **construct an explanation** for the **cause** of water condensing from their breath into a cloud on a cold day but not on a warm day.

Class Discussion:

Questions to initiate Discussion:

Q: Where does the water we see in our breath come from?
Q: How does water from your breath condense into a cloud on a cold day?
Q: What causes the water in your breath to change from gas that we cannot see, into liquid water droplets that we can see?
Q: How does this phenomenon relate to the causes of other clouds we see?
Q: Why can we say that the snow on the mountain has some water that we breathe out at an earlier time?
Q: How are changes in the system of the phenomenon of water collecting on the cold mug and the system of the phenomenon of seeing our breath similar and different?

Communicate Reasoning

5. Students **develop a model** to show how **matter and energy** move into or out of **systems**.

Science and Engineering Practices Carry Out an Investigation Construct an Explanation Develop and Use a Model	Make careful observations that generate evidence. Create explanations of the science phenomenon. Explain science observations using evidence. Share explanations with others. Use models to reflect on mechanisms of how things work. (states of matter) Share science findings in writing and graphic presentations to others.
Crosscutting Concepts Systems Cause and Effect Energy and Matter Stability and Change	Describe the interactions of specific parts of a system. Explain the inputs and outputs of matter, energy, and/or the effects of forces in systems. Explain why a specific order of events is necessary to cause some phenomenon to occur. Identify the causes of observed patterns in natural systems. Describe the transfer of energy in systems.
Disciplinary Core Ideas	The cycling of matter on Earth requires energy. When matter changes energy is involved. When matter changes state heat energy is involved. Matter is made of particles.

States of matter	Matter cycles. Matter is conserved.

Appendix A - Student Prompts for the Lesson

Phenomenon: When you breathe out on a cold day, you can see your breath.

Group Performances:

1. Students **plan and carry out an investigation** to observe breathing into the cold air and make observations of the **changes** that exist when they can see their breath.
2. Students **obtain information** about changes in the states of matter through videos and readings.
3. Students **develop a model** to show how the **matter and energy** move into or out of the **system** of their breath and the surrounding air.
4. Students **construct an explanation** for the **cause** of water condensing from their breath into a cloud on a cold day but not on a warm day.

Class Discussion

Individual Performances:

5. Students **develop a model** to show how **matter and energy** move into or out of **systems**.

Teacher prep - read through ch 2 of the OER 6th Grade Science Textbook there are phenomenal readings for these lessons in Ch. 2. OER 6th Grade This is a link to a PDF version of the book. QR code below.

Lesson steps:

1. Introduce the lesson by testing the phenomenon. If it is cold enough outside, have students go outside and observe their breath as it hits the cold air. Invite students to observe changes that exist as they breathe. Make sure students have proper clothing to go outside.
    a. If it is too warm when you are doing this lesson, freeze jars or mugs and have students breathe inside them and observe what happens to the cup (condensation forms on the inside and looks foggy).
    b. Be sure to mention that Molecular engineers use tools and instruments to make and analyze interactions of molecules on different molecular surfaces.
2. After performing this investigation, students should read the article and watch videos to learn more about the phenomenon. You can split students into groups to read if you want.
    a. Change of State in Water Cycle Article
    b. Phases of Matter Article
    c. Changes of state Video
3. Then have your group discussion about what they learned and observed. Get students to explain what is happening in the phenomenon.
    a. When water evaporates, energy is transferred from the surrounding into the water; when water condenses, energy is transferred from the water to the surrounding [e.g., clouds, contrails, fog, breath on a cold day are droplets of liquid water. Emphasized energy is involved because heat from the warm exhaled air (gas) leaves one system (body) and enters another system (atmosphere) and changes state to a liquid (condensation). The source of water for the engagement activity with the mugs is from the air, the source of water from the breathing out exploring activity is from the students' breath.
4. As a class, come up with a physical model using your bodies to show how particles are moving during the phenomena.
    a. You can then have students participate in a class activity of moving around like water particles. You might consider turning on some music to get them moving. Call out different phases of matter and have them move their body to act like those particles. Ex. frozen Solid ice is tightly compacted together everyone moves close together, liquid vapor is more easy going every slowly moving around flowing like water, vapor runs freely everywhere the class moves more quickly and sporadicallyIndividually or in small groups students will then create a model to show how matter and energy move in and out of different states.
5. Students could create a video model using adobe spark that shows the states of matter. Like we did as a class. Students could also create a drawing that demonstrates the

transformation between at least two states of matter. ex. Solid to liquid, liquid to gas, gas to liquid, etc. or they can create a model to show the changes between all three states of matter. See examples for both options in appendix B. Students should include labels such as freezing, melting, condensation, evaporation, etc..)

Teaching suggestions: If you want to show the Bout that phase...states of matter song. It was created by students and done very well. We would recommend it.

States of matter and structure game- This is a fun game you could give to a fast finisher or create an experiment out of for when you have a sub. See other games at Legends of learning.com

Appendix B -

Materials:

Provided Materials:

Classroom Materials:

- Technology device to video and use Adobe Spark
- Cold day or frozen mug or jar
- Students and space to move
- Art supplies- markers, pencils, big paper

Student Reading/video:

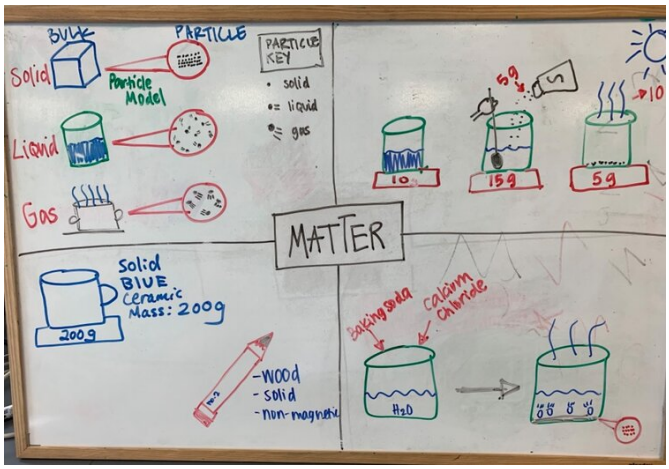
Change of State in Water Cycle

Phases of Matter

Changes of State Video

Picture/Video Examples:

Video Example



Appendix C -

Additional information:

About that phase... States of matter song

States of matter and structure game- This is a fun game you could give to a fast finisher or create an experiment out of for when you have a sub. See other games at Legends of learning.com

6.2.3 Convection Current Experiment

Grade: 6th

Lesson Topic: Temperature and Heat Transfer (Convection Currents)

Utah SEEd Standard: 6.2.3
Plan and carry out an investigation to determine the relationship between temperature, the amount of heat transferred, and the change of average particle motion in various types or amounts of matter. Emphasize recording and evaluating data, and communicating the results of the investigation. (PS3.A)

Lesson Performance Expectations:

- **Develop questions** to **plan an investigation for** what **causes** the food coloring to move differently in the container of water when different temperatures are placed beneath it.
- **Plan and carry out an investigation** to gather evidence for what **causes** the food coloring to move differently in containers of water of different temperatures.

Phenomenon: **Food coloring moves differently depending on the temperature.** Video

Gather

1. Students **develop questions** to **plan an investigation** of the **causes** of food coloring moving differently when in contact with different temperatures.
2. Students **plan and carry out an investigation** to gather evidence for what **causes** the food coloring to move differently depending on the water temperature.

Class Discussion - to develop one investigation for the Class

3. Students use the **class data chart** to add their data and findings with the class. (See Appendix B-2)
4. Students **gain information** from reliable online resources and books about how **changes** in energy **affect** the motion of particles.

Reason

5. Students will **analyze the data** given from other students on the class data chart to find **patterns** in the rate of motion.
6. Students **construct an explanation** for the **cause** of food coloring acting differently depending on the temperatures of water.

Class Discussion:
Questions to initiate Discussion:
Q: What could be the cause of the differences in the way food coloring acts in the water?
Q: How does the motion of the particle/molecule of water change when energy is added? Do the particles/molecules speed up, slow down or stay the same?
Q: Why does the amount of energy (temperature) cause food coloring to act differently?
Q: How is the motion of particles related to the speed of the particles? How does it affect their movement?

Communicate Reasoning

7. Students will **use a model** to present an **explanation** for why the motion of particles/molecules **change** when **energy** is added to a **system** of food coloring in water.

Science and Engineering Practices Asking Questions Obtaining Information Constructing Explanations Using Models	Ask questions to obtain information. Obtain information to support explanations for natural phenomena. Use models to reflect on how things work. Use representation to clarify cause and effect relationships. Construct science explanations to explain phenomena.
Crosscutting Concepts Energy and Matter Stability and Change Systems	Explain the relationship of energy to change the motion of particles within th system. Analyze interactions within a system. Model simple systems.
Disciplinary Core Ideas Energy and Matter	Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. Conceptual Models - Matter is made of particles. The matter is conserved. Energy is involved when matter changes.

Lesson adapted from: [Dye in Motion]

Appendix A - Student Prompts for the Lesson

Phenomenon: Food coloring moves differently in cold water than in hot water.

Group Performances:

1. Develop questions to investigate the causes of food coloring moving differently when in contact with different temperatures.
2. Plan and carry out an investigation to gather evidence for the causes of food coloring moving differently in the water of different temperatures.

Class Discussion about Planning a Class investigation

3. Obtain information from reliable online resources for how changes in energy affect the movement of matter particles.
4. Add your data to the class data chart.
5. Each group analyzes the class data chart to find patterns.
6. Construct an explanation for the cause of food coloring moving more quickly in hot water but much slower in cold water.

Class Discussion

Individual Performances:

7. Use a model to present an explanation for why the motion of particles changes when energy is put into a system of food coloring in water.

Teacher prep - read through ch 2 of the OER 6th Grade Science Textbook there are phenomenal readings for these lessons in Ch. 2. OER 6th Grade This is a link to a PDF version of the book. QR code below.

Lesson steps -

1. Show this video to introduce the phenomenon and initiate discussion.
2. Highlight that molecular engineers use tools and instruments to make and analyze interactions of molecules on different molecular surfaces.
3. Ask students to create a hypothesis for what is happening in the video.
    a. Q: What could cause differences in the way food coloring is dispersed in the water?
    b. Q: How does the particle (molecule) motion of the water change when energy is added?
    c. Q: Why does the input of energy cause food coloring to act differently?
    d. Q: How is the motion of particles related to the speed the particles are moving?
4. Students should write down their questions and hypotheses.
5. Split students into groups and have each group perform the experiment.
    a. Students will fill one container with cold water and one with hot water.
    b. Students will add one drop of food coloring to each container at a time.

   c. Have them write down their observations for each container simultaneously. Make sure they are addressing the questions they wrote down before to guide them. Make sure that only one student puts the food coloring in the water.
      i. Observations paper provided in appendix B.
6. Create a class chart/graph utilizing data from each group's investigations. Have a class discussion to share each group's findings. Highlight similarities between each group's findings to draw attention to overall principles.
   a. you will want to help bring out the following ideas - Heating a substance causes molecules to speed up and spread slightly further apart, occupying a larger volume that results in a decrease in density. Likewise, cooling a substance causes molecules to slow down and get slightly closer together, occupying a smaller volume that results in an increase in density. The cold water has less energy, less particle movement.
7. After the chart/graph is complete as a whole class analyze the data and then have each group revisit their hypothesis and revise them if needed.
   a. This data can also be graphed individually.
8. To end, have students draw a picture of what is happening with a paragraph explaining it.
9. This can be demod with the density tank provided at the end of the lesson to reinforce students' discoveries.

Appendix B -

Materials List:
Provided Materials:
- Thermometers
- Clear containers
- Density tank

Classroom materials:
- Different colors of food coloring
- Graph paper/ paper to record findings on

Resources: States of Matter video:
https://www.youtube.com/watch?time_continue=89&v=AVY5aKpy55s
The video is a brief overview of the states of matter and their characteristics. It's a helpful visual and explanation for your struggling readers.
Particle Movement: https://www.chem.purdue.edu/gchelp/liquids/character.html
The website has additional information, specifically regarding the particle movement in each phase and a chart students can copy into their notes.
Simulation:
https://phet.colorado.edu/sims/html/states-of-matter/latest/states-of-matter_en.html
The simulation has 3 different tabs. You will want to have students click on the "States" tab when they go to the Phet website. They can observe how a few different atoms and molecules behave when energy is added and removed. Have students first complete the simulation with

water and then they can play around with the other options. When playing with the simulation, students will need to click and drag the lever to add heat(shows a flame) or remove heat(shows ice cubes). They will need to click and hold the lever in place when they let it go it will go back to the center.

Readings:

The source of water (matter) for the engagement phase with the frozen mugs is from the air, the source of water from breathing out is from your breath. When we breathe, we use liquid water. When we don't see breath, we still breathe out gas but warmer temperatures prevent us from seeing our breath. When we exhale, there is heat from warm air, water molecules condense and change state.

Motion of Particles

The matter is made of particles. When particles have more energy they move faster. Adding energy to a system causes the particles in the system to move faster. Hot air balloons work by heating air and the air moves faster causing less air to occupy the same space. When the air in a hot air balloon expands it pushes air out the bottom of the balloon causing the balloon to weigh less because it has less air in the same space.

The more kinetic energy a substance has, the warmer it will be and the faster particles will be moving, which reduces the density of the substance.

When the change in temperature is significant enough, a substance can change its phase from a solid to a liquid or gas, or condense from a gas to a liquid or solid. Cooling a substance causes molecules to slow down and get slightly closer together, taking up less space, which results in an increase in density. Warming a substance increases the energy the particles have and the molecules spread out, decreasing density.

When temperatures increase, objects expand and become larger and therefore the density decreases. When temperatures decrease, objects condense and become smaller so density increases.

Resources: https://sciencing.com/temperature-effects-density-5521664.html

https://www.youtube.com/watch?time_continue=89&v=AVY5aKpy55s

	Each Group uses graph paper behind the cup and a camera to measure how far the coloring moves.			
Group/ Temperature	**1 minute**	**2 minutes**	**5 minutes**	**10 minutes**
1 - Hot				
1 - Cold				
2 - Hot				
2 - Cold				
3 - Hot				
3 - Cold				
4 - Hot				
4 - Cold				
5 - Hot				
5 - Cold				
6 - Hot				
6 - Cold				
7 - Hot				
7 - Cold				

Appendix C - Acting on Evidence of Learning

Description of instruction action and response to support student learning.

- action for students who display partial or limited understanding - Return to the data chart and the PHET to help students at this point.
- extensions of learning for students who display a full understanding - Open a bottle of strong perfume in one corner of the room and graph the student responses as the perfume moves across the room. Have students develop a graph that shows the spread of the perfume. Strong food flavoring oils also work. YOU can only do this once in a room.

6.2.4 Stop The Melting Ice

Grade: 6th

Lesson Topic : Energy Affects Matter

Utah Seed Standard:

Standard 6.2.4 Design an object, tool, or process that minimizes or maximizes heat energy transfer. Identify criteria and constraints, develop a prototype for iterative testing, analyze data from testing, and propose modifications for optimizing the **design solution**. Emphasize demonstrating how the structure of differing materials allows them to function as either conductors or insulators. (PS3.A, PS3.B, ETS1.A, ETS1.B, ETS1.C)

Lesson Performance Expectations:

- Use a model to communicate differences in the transfer of heat energy between two systems to cause the melting.
- Construct an explanation that builds on evidence found for the causes of the ice cubes melting slower on the towel.
- Students will obtain information that some materials make good conductors while others do not.

Phenomenon: An ice cube melts faster when placed directly on the countertop than on a towel.

Gather

1. Students will **ask questions** about the **causes** of the difference in the rate of two ice cubes melting.
2. Students **plan and carry out an investigation** to get evidence and data to support their idea of the causes in the difference of the rate heat energy is transferred between two **systems** causing ice to change from a solid to a liquid.

Reason

3. Students will **construct an explanation** supported by evidence found during the investigation for the causes of the differences in the rate that heat energy is transferred through different substances to cause ice to change from solid to a liquid.
4. Students will analyze data and revise their hypothesis based on the new evidence from the discussion on what causes the system to react.

Class Discussion:

Questions to initiate Discussion:

Q: How does the heat energy move between the two systems?

Q: What causes the ice cube to melt faster on the countertop than on the towel?

Q: What needs to be the same in each test to make the experiment a fair test? What's the controlled variable?
Q: How could we speed up or slow down the process of the Ice melting?
Q: Why does it take more energy to change an ice cube into liquid water?
Q: How does the material between the ice cube and countertop affect the rate of heat moves?

Communicate Reasoning

5. Students use two models to communicate differences in the transfer of heat energy between two systems (class experiment and student one) causing ice to change from a solid to a liquid.
6. Students will construct an explanation explaining how different materials can be used to slow down the melting of a chocolate bar and what materials cause this effect to happen.

Science and Engineering Practices Plan and carry out an investigation Developing and using models	Develop questions to obtain information Use a model to test hypothesis and show the result Gathering information from investigation Make observations and gather evidence for what causes the phenomenon
Crosscutting Concepts Cause and effect Developing an argument Patterns	Use cause and effect to explain the results Use a model to test an argument Identifying patterns to make predictions
Disciplinary Core Ideas Energy	Energy can be transferred through different types of matter and can manifest itself in different ways.

Lesson adapted from: Keep it Cold

Appendix A - Student Prompts for the Lesson

Phenomenon: An ice cube melts faster when placed directly on the countertop than on a towel.

Group Performances:

1. Students ask questions about the causes of the difference in the rate of two ice cubes melt.
2. Students plan and carry out an investigation to obtain data to use as evidence for the causes of the difference in the rate heat energy is transferred between two systems causing ice to change from a solid to a liquid.

Class Discussion

3. Students construct an explanation supported by evidence from the investigation for the causes of the differences in the rate that heat energy is transferred through different substances to cause ice to change from solid to a liquid.
4. Students will analyze data and revise their hypothesis based on the new evidence from the discussion on what causes the system to react.

Individual Performances:

5. Students use two models to communicate differences in the transfer of heat energy between two systems (class experiment and student one) causing ice to change from a solid to a liquid.

6. Students will construct an explanation explaining how different materials can be used to slow down the melting of a chocolate bar and what materials cause this effect to happen.

Teacher prep - read through ch 2 of the OER 6th Grade Science Textbook there are phenomenal readings for these lessons in Ch. 2. OER 6th Grade This is a link to a PDF version of the book. QR code below.

Lesson Steps:

1. Introduce the phenomenon by first conducting an experiment of an ice cube melting on the counter top as a whole class. Take an ice cube and set it on the empty counter top. Let it sit and time how long it takes to completely melt. Assign a student or two to check its progress.
    a. While the ice cube is melting, discuss what the students think is happening in the system that is causing the ice cube to melt. Then have the student formulate a hypothesis about what will happen when a towel is placed between the counter and the ice cube.
        i. Place the small towel on the counter, and place another ice cube on top

of it, using another timer to see how long it takes it to melt.

b. Lead the class in a discussion that focuses on the heat transfer in the system. If the students need a quick review or some help understanding the principle of the lesson watching this video
c. Emphasize that engineers design solutions to keep things cold longer. Introduce the vocabulary:
    i. Energy Transfer- The conversion of one form of energy into another, or the movement of energy from one place to another.

2. Students will complete the investigation in groups of 2-4.
    a. They will be assigned to create a way for an ice cube to stay cold for as long as possible.
    b. They can use the provided materials (towels, fabric, aluminum tins, etc.) to build a device that will keep the ice cube cold.
    c. Students will use the heat lamps and thermometers to test their designs. Place the thermometers inside the device with the ice cubes and shine the lamps on the ice cubes. They can record and track their progress to see which device keeps the ice cube from melting the best.
3. Students will then participate in a group discussion to review their designs, how they worked, and how they would revise them if they were to do a second trial.
    a. For more questions to initiate discussion, see above in the Reason section.
    b. The discussion should also talk about energy transfer. How can different objects slow down or speed up this transfer between two objects?
4. Students will then construct an explanation to describe how different materials can slow down or speed up heat transfer from one object to another (lamp to ice cube)

Appendix B -

Materials list:

Provided materials:

- Lamps
- Thermometers
- Fabric Squares
- Aluminum Tins
- Small towels

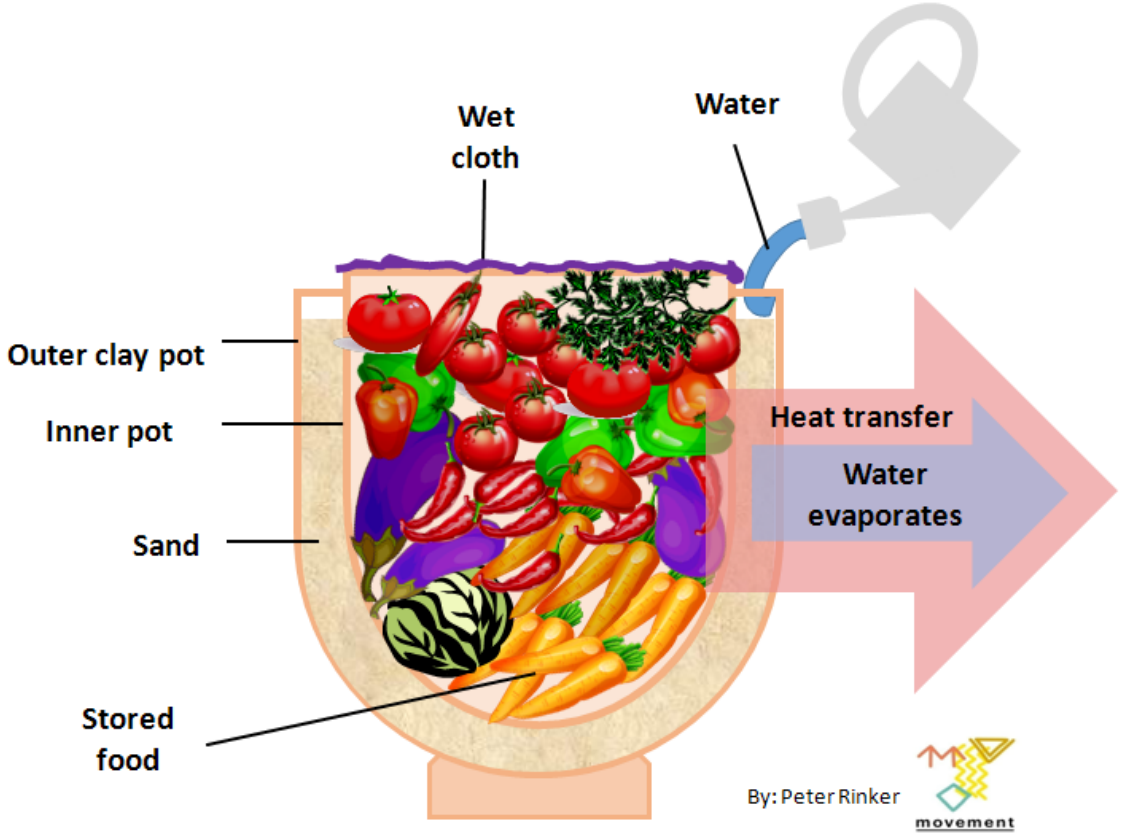
Classroom materials:

- Paper towels
- Cardboard

- Scissors
- Tape
- Brown wrapping paper/brown lunch bags
- Construction paper
- Pencils (colored)
- Ice cubes

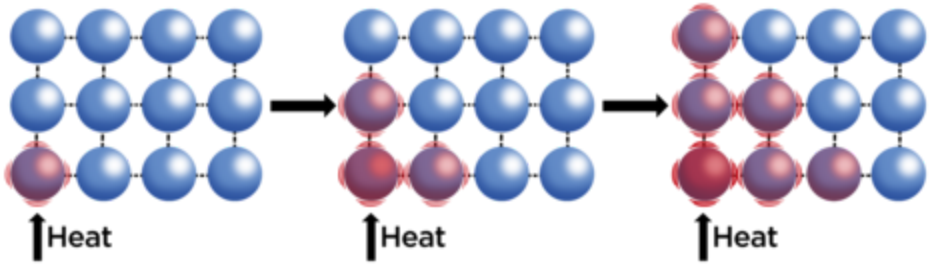
This is a helpful video to explain and refresh both the different types of heat conduction and it will help to explain the idea of the project the students will be doing.

[Reduce Heat Transfer Energy Loss in Design]



[In pot refrigeration system]

[Why do coolers stay cool?]



How heat spreads

Heat conductors and insulators

What makes a good insulator

Types of materials and their effectiveness as insulators

Appendix C - T

Extension of the lesson

Engineering Challenge

Engineering Challenge: Design and build a device capable of keeping ice frozen overnight.

Gather

1. Students **define the problem** of how to design a device to keep ice cold or to keep water hot.
2. Students **obtain information** about how the **structure** of insulators and conductors of heat **function** to slow or speed the transfer of heat.

(Teaching Suggestions: A familiarity with basic concepts about heat energy and the relationship between heat and temperature. Heat is a measure of energy and is measured by the mass of matter that changes temperature. Students need a good understanding of thermal energy, heat and heat transfer, including the concepts of conduction, convection, and insulation. Try to help students understand that cold is not transferred, only heat. Students should know how to acutely read thermometers and record data. Students work in teams to design a device to either prevent ice from melting or to keep hot water hot. Challenge Limitations - The total mass of the materials used cannot exceed _____ grams (e.g., the total mass of materials used can not exceed 100 grams or 200 grams). The teacher decides on the mass. The students select different materials that do not exceed the set mass and build a device. The mass includes the materials the student uses to hold the device together (e.g., glue, tape, string).

Challenge Criteria: Build a device to keep ice frozen or hot liquids hot for as long as possible.

Reason

3. Students design and build a device to slow the transfer of heat energy into or out of a system.
4. Students develop a model to show the transfer of heat energy into and out of the system of their device.

Class Discussion:
Questions to initiate classroom discussions
Q: Why do people like cold drinks on a hot day?
Q: How do you keep a cold drink cold and a hot drink hot?
Q: Which direction does heat flow in the device you build?
Q: How does heat move through a material?
Q: What are the properties of good insulators?

(Teaching Suggestions: Over the years, engineers have spent a lot of time trying to come up with creative ways to keep some things hot and other things cool. Today, we are going to act as if we are engineers and explore ways to keep something hot. Show demo-blocks and ice Show video- http://www.abc.net.au/catalyst/stories/3296880.htm Video)

Communicate Reasoning

5. Students construct an explanation for how their device changed the rate of heat energy transfers into or out of the system.

These websites will help in providing the science behind the engineering challenge.

https://www.online-sciences.com/the-matter/the-importance-of-good-and-bad-conductors-of-heat/

https://www.hunker.com/13416236/why-is-aluminum-foil-a-better-insulator-than-cotton-or-paper

Materials List By Lesson

6.2.1 - Making Molecules:

Provided Materials:

- Chemistry Molecule Kit (4)
- Molecule Book (2)
- Online tools: molview.org, you can search molecules/compounds to show the 3D models online.

Classroom materials:

- Paper
- Colored pencils

6.2.2 - Matter on the Move

Provided Materials:

Classroom Materials:

- Technology device to video and use adobe spark
- Cold day or frozen mug or jar
- Space to move
- Art supplies- markers, pencils, big paper

6.2.3 - ConvectionCurrent Experiment

Provided Materials:

- Thermometers (2)
- Clear containers + Lids (49)
- Density tank (1)

Classroom materials:

- Different colors of food coloring
- Graph paper/paper to record findings on

6.2.4 - Stop the Melting Ice

Provided materials:

- Lamps (7)
- Thermometers (2)
- Fabric Squares (180)

- Small Towels (21)
- Aluminum Tins

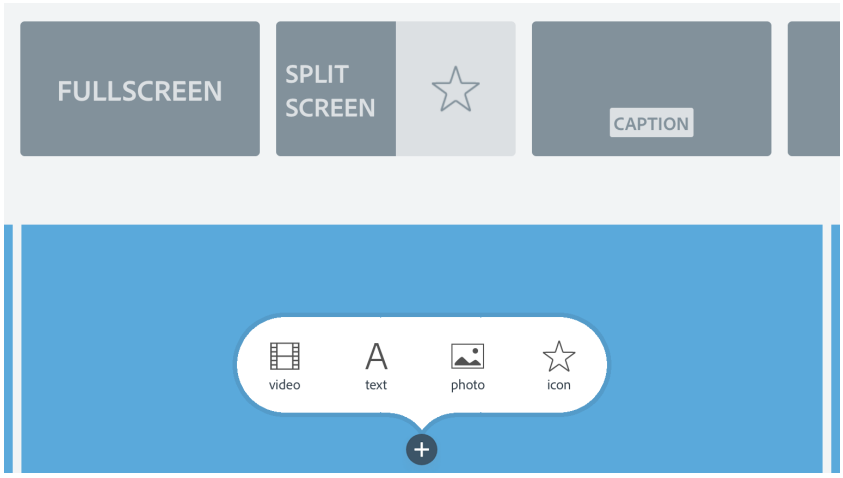
Classroom materials:

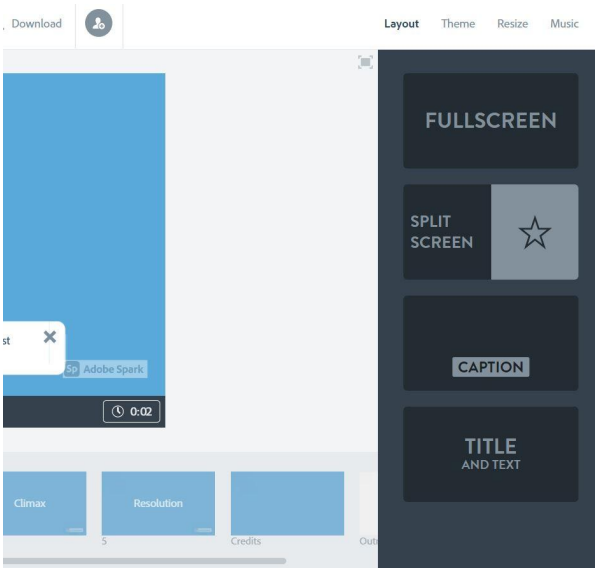
- Paper towels
- Cardboard
- Scissors
- Tape
- Brown wrapping paper/lunch bags
- Construction paper
- Pencils (colored)
- Ice cubes

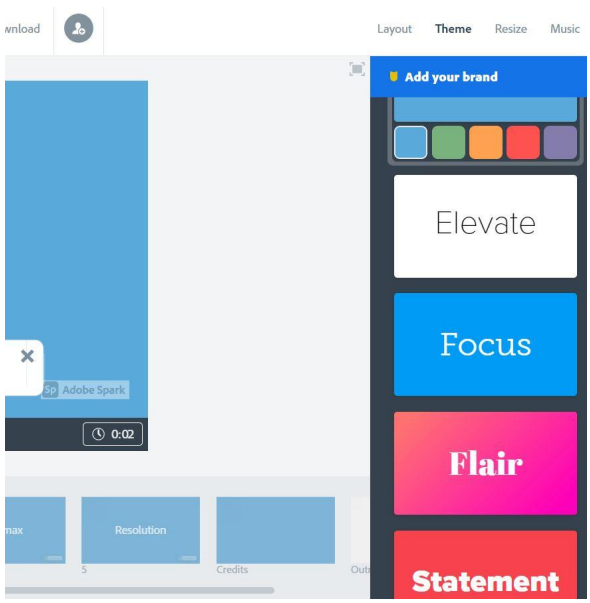
Procedure Cards

Adobe Spark

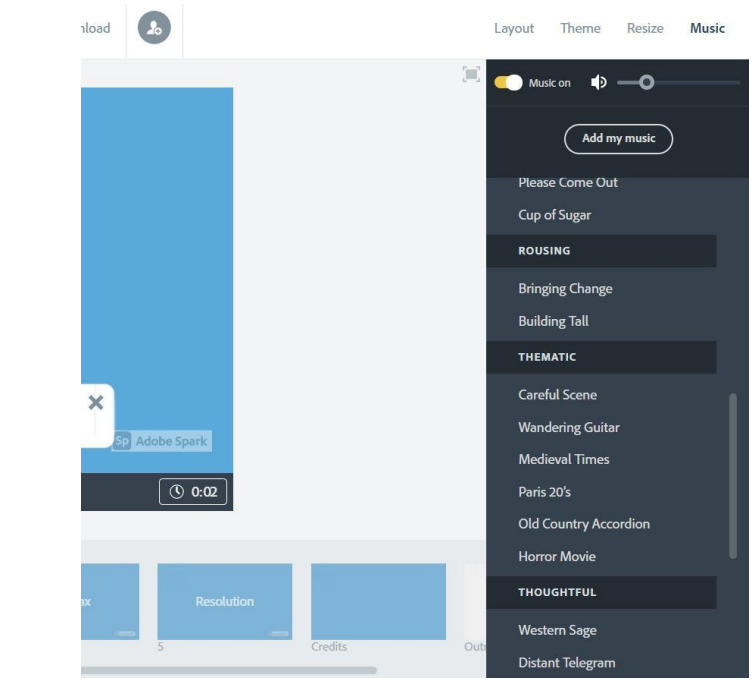
Step 1: Open and log in to Adobe Spark or open Adobe Spark App
Step 2: Press the plus button and click on the “Video” tab. Or scroll down the home page and click on the “Slideshow” button.
Step 3: Type in your title.
Step 4: Select a template (Hero’s Journey, Show and Tell, Create your own from scratch, etc.)
Step 5: Watch the tutorial video. It will pop up automatically.
Step 6: Add title, video, text, and theme. Customize anyway you want.

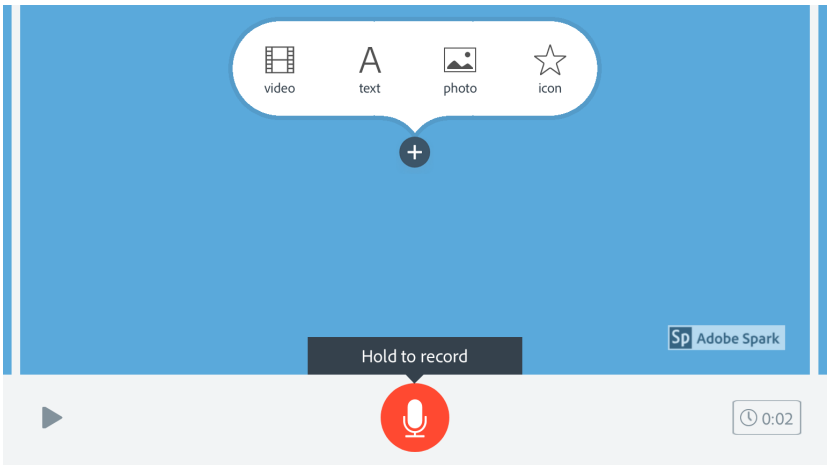




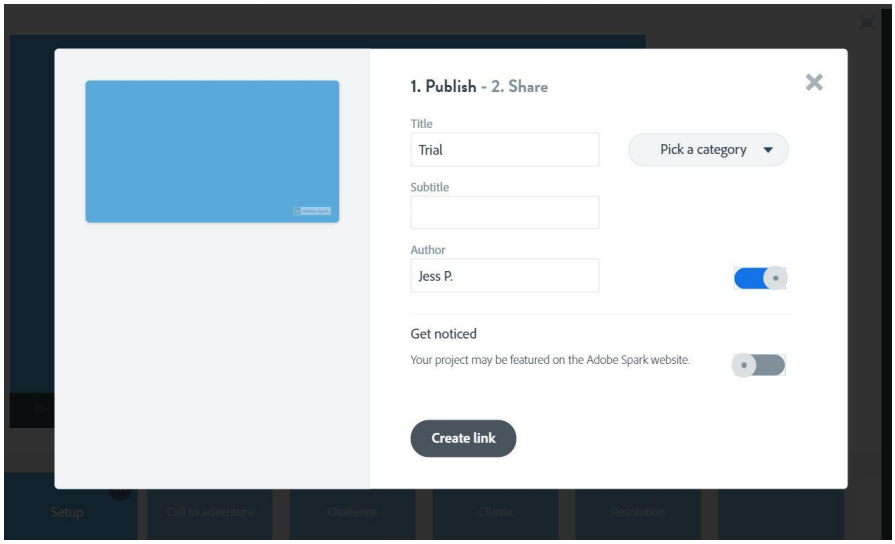


Step 7: Add voiceover and music.





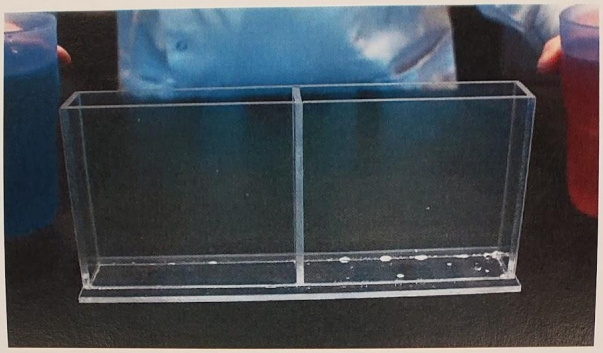
Step 8: Preview video, by pressing the preview tab located at the top.
Step 9: Download or share using the tabs at the top of the screen.
Step 10: Click the share button, then select publish. Double check that all of the information is correct. Be sure to Turn off the " get noticed tab"



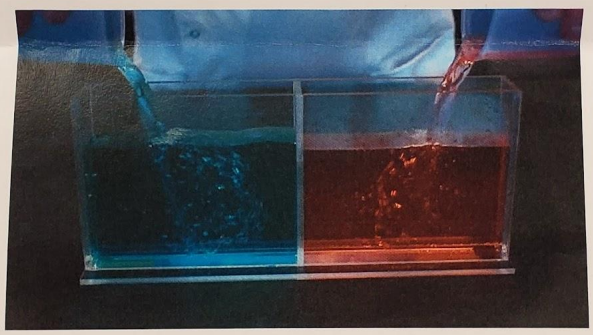
Step 11: Then click " get link button"
Step 12: You can then share the link with the teacher or wherever else you need too. Anyone with the link can view the video.

SPLIT DEMO TANK INSTRUCTIONS

Begin with an empty tank in front of the class along with two glasses of water, one cold with blue food coloring and the other warm with red food coloring. There is no need to heat the water, just use warm water from the tap. If you have not used these tanks before, they have a removable center divider that keeps the liquids separated until you are ready to mix them together. You can use hot/cold water or salted/unsalted water.



Fill one side of the tank with warm water and the other with cold water ***at the same time*** *to prevent one side from leaking* into the other. The pressure from the two liquids will push against the center divider *and prevent the colors from leaking* until you pull out the divider.



Take a moment to ask the students to (silently) predict what they think will happen when the liquids are free to mix. *Will both liquids mix to make green? Will the liquids form two layers? Which color will be on top?*

OK, when you are ready, remove the divider and watch the show!