The Ups and Downs of Temperature

Written by: UTeach Outreach
Date of Lesson: Week of September 29th, 2014
Description of Class: 4th Grade Heterogeneous Classroom
Length of Lesson: 50 minutes
Source of the Lesson: UTeach Outreach

References:
http://www.standards.dfes.gov.uk/schemes2/secondary_science/sci08i/
http://www.rpdp.net/sciencetips_v2/P12A1.htm
http://www.sciencekidsathome.com/science_topics/hot_air.html
http://www.teachingboxes.org/jsp/teachingboxes/weatherEssentials/wind/sequence/lesson2_activity2.jsp
http://www.beaconlearningcenter.com/Lessons/1198.htm
http://people.wm.edu/~madisa/circus.pdf

TEKS Addressed:
4.(5) Matter and energy. The student knows that matter has measurable physical properties and those properties determine how matter is classified, changed, and used. The student is expected to:
(A) measure, compare, and contrast physical properties of matter, including size, mass, volume, states (solid, liquid, gas), temperature, magnetism, and the ability to sink or float;
(B) predict the changes caused by heating and cooling such as ice becoming liquid water and condensation forming on the outside of a glass of ice water;

I. Overview
This lesson’s purpose is to help develop students’ understanding about what causes matter to change states. The lesson begins with students observing how an ice cube can change from a solid to a liquid by the addition of heat. In the exploration, the students will investigate how long it takes for different chocolate chips to melt. Students will predict, measure, compare and contrast changes in physical properties of chocolate as heat is applied. Students will learn that particles are in constant motion and this motion changes with the addition or removal of heat. Students should conclude that the addition or removal of heat is sometimes a good way to identify the probable type of particles in a sample of matter. This is an essential skill to master at this level before students learn to identify matters in 5th grade by their boiling and melting points.

II. Performance Objectives
Students will be able to:
1. Students will predict and explain changes that can be caused by heating and cooling of substances.
2. Students will measure, compare and contrast physical properties of matter as objects are heated or cooled.

III. Resources, materials, and supplies

Engagement
Per Student
- 1 Ice Cube
- One piece of paper towels

Exploration
Per Group:
- 1 Heat Pack
- 1 Thermometer
- 1 of each of the following types of chocolate in a zip lock bag:
  - White Chocolate Chip
  - Semi-Sweet Chocolate Chip
  - Milk Chocolate Chip
  - Milk Chocolate Kiss
Per Class:
- 1 Digital Timer (can use computer)

Explanation
Per Class:
- 1 Balloon

Elaboration
Per Group:
- 1 Fortune Fish

IV. Advanced Preparation
Obtain ice from the school cafeteria or your freezer. Be sure to have paper towels for the engage. Before the elaboration, clear the room so students are free to move. This can include: moving the desks to the corner, and making sure that the floors are clear from backpacks and other personal items.
V. Supplemental Worksheets, materials and handouts
One Per Student:
- “Ups and Downs of Temperature Data Sheet”
- “Temperature Recording & Vocabulary Sheet”
- “Thermometer Sheet”
- “Ups and Downs of Temperature Quiz”

One Per Class:
- Copy of Figure 2: States of Matter Diagram to be used on the doc cam.

VI. Background Information

College Level:
All particles are constantly in motion and possess kinetic energy which is directly related to temperature. At higher temperatures particles have higher kinetic energy than particles at lower temperatures. Interactions between particles in motion determine their physical states.

There are four states of matter: solid, liquid, gas and plasma. For the purposes of these experiments, an understanding of the basic properties of solids, liquids and gases is necessary.

1. In a **solid**, the strong intermolecular attractions cause particles to be held together and vibrate around a fixed position. Solids have defined volumes and shapes because their particles are held in fixed positions. Solid state particles have the lowest kinetic energy.

2. In a **liquid**, particles are randomly packed and have room to move past one another. Intermolecular attractions between individual molecules are weaker than the attractions in solids and thus molecules can stay close together. When heated, they undergo minimal thermal expansion. Thus, a liquid has definite volume but no defined shape. Liquid state particles’ kinetic energy is between those of solids and gasses.

3. In a **gas**, the intermolecular attractions between gas particles most of the time are weak van de Waals forces, so they usually have brief interactions with one another. The particles are not limited to any specific volume or shape. They take on the shape and volumes of the containers they are placed in. Gas molecules have the highest kinetic energy.

Matter changes from one state to another when it is cooled or heated. The vocabulary associated with these changes is in the following figure:
**Figure 1 – Complex Phase Changes Diagram**

**Vaporization** is when a substance changes from a liquid to a gas state. **Boiling** occurs when the molecules of a substance are heated and gain kinetic energy. The molecules begin to move faster and eventually reach a point when their intermolecular bonds are broken. **Boiling** is the transition phase at or above the boiling point of the compound. **Evaporation** is the transition phase below the boiling point of the compound.

**Condensation** is when a substance changes from a gas state to a liquid. It is the opposite of vaporization. When condensation occurs, water vapors in the air slow down, form intermolecular bonds, and turn back into a liquid.

**Freezing** is when a substance changes from a liquid state to a solid state, occurring at the freezing point; or the temperature at which a liquid turns to a solid.

**Melting** is the process of a solid changing into a liquid. This typically occurs after applying heat or pressure to a substance. When the temperature in the substance reaches its unique melting point, which is the same as the freezing point, the rigid ordering of the molecules which compose the solid break down and the solid liquefies.

**What Determines the Melting Point of Chocolate?**
The type of chocolate and its ingredients will have an effect on the heat resistance and melting of the finished product. Melting is important for the texture and taste of the chocolate. In chocolate the fat polymers form the continuous phase in which all other ingredients are embedded. Therefore, the melting characteristics of the fat used are of importance to the stability of the chocolate in a tropical climate. The supplier of the chocolate should be able to provide information on its melting point and solid fat contents over a range of temperatures.
**Melting Point**

This should be at or just above 36 °C to ensure that the product melts in the mouth. If the melting point is too high it will result in a waxy mouth feel and not melt entirely. If the melting point is too low the product may not be stable during storage in the summer or in hot climates. Fats melt over a temperature range and so at any temperature below the melting point the fat is partly in solid form and partly liquid.

**Milk Fat**

The addition of milk fat to make milk chocolate can soften the product and make it less heat resistant. Milk fat has a different crystalline form compared to cocoa butter, and the resulting incompatibility can lead to a destabilization of the product. The fat element of the cocoa butter can be replaced wholly or in part with vegetable fats in order to improve heat resistance.

**Tempering and Cooling**

Tempering is required to ensure that the chocolate has the necessary shelf life. Tempering is conducted in a continuous process where the chocolate is cooled and the cocoa butter forms stable and unstable seed crystals. To keep only the desired beta crystals the chocolate is warmed to a temperature that is intermediate between the melting points of the two forms, 31-32 °C for milk chocolate and 32-33 °C for semi-sweet chocolate. Milk chocolate is tempered at lower temperatures because the milk fat suppresses the formation of seed crystals. The temperatures will vary depending on the ingredients and the quality of the raw materials. At this point most of the unstable crystals are melted out, but some seed crystals will remain. Tempering time is also important, as seed crystals need time to grow in size and mature. The chocolate should have some 'residence' time before use in the enrobing or molding plant. The length of time will vary depending on the intended use of the chocolate.

Tempered chocolate needs to be cooled under gentle conditions to promote the preferential growth of stable crystals. The best temperature for this process is 13-15 °C.

**Elementary Level**

There are three states of matter: solids, liquids and gases.
A substance can change from one state to the other. Sometimes we call this a “change in phase.” All changes always occur when there is a change of heat. The following diagram summarizes phase changes:

![Phase Changes Diagram](image)

**Figure 2 – States of Matter**

When a substance changes from a solid to a liquid, this is called **melting**. Heat goes into the solid, and as a result, the solid melts. An example of something melting is when you take an ice cube out of the fridge and then place it on a counter. When a substance changes from a liquid to a solid this is called **freezing**. Heat leaves the liquid as the substance freezes. An example of something freezing is when you put melted ice cream back into the freezer. **Vaporization** occurs when a substance changes from a liquid to a gas. This includes a substance boiling or evaporating. Heat goes into the liquid as it evaporates. After a rain shower puddles can evaporate thus leaving the ground free of water. When gases change into liquids, this is called condensation. While you take a hot shower, the surrounding gas in your bathroom may condense and form a liquid on a mirror because the mirror is cooler than the air – water vapor condenses (changes back to a liquid when it is cooled or heat leaves it). Heat leaves the gas as it condenses. Condensation can also be seen on a glass of ice water.
VII. Possible Misconceptions:

- **Students may not believe that particles in a solid move.** Particles in a solid are still moving even though you can’t see them. You can say they are vibrating in place because they are so tightly compacted that there isn’t space for them to move freely.

- **Students believe that particles decompose or disappear during vaporization or other phase changes.** Particles do not disappear, but instead change phases. During vaporization water molecules are spreading further apart and moving more freely so they become harder to see. Gases are made of particles and are usually invisible to the naked eye.

- **Students believe heat and temperature are the same.** Students often confuse heat with temperature. Heat is a quantity of energy and temperature is the response of a material to the input of energy.

- **Students believe that there are warm and cold heats.** Heat is a quantity of energy and can only be add or remove. Addition of heat warm up matter, and removal of heat cool down matter.

VIII. Vocabulary and Definitions

**College Level**

- **Solid:** A state of matter that is characterized as having its particles closely packed together.
- **Liquid:** A state of matter that is able to flow and take the shape of the container it is placed in.
- **Gas:** A state of matter where the particles it is composed of are vastly separated.
- **Melting:** Phase change from solid to liquid by addition of heat or an increase in temperature.
- **Melting Point:** The point at which a substance begins to melt.
- **Vaporization:** When a substance changes from a liquid to a gas.
- **Phase Change:** When a substance changes from one state to another state of matter.
- **Kinetic Energy:** the energy that particles have when they are in motion.

**Elementary Level**

- **Solid (sólidos):** A state of matter that is characterized as having its particles closely packed together. A solid has a defined volume and shape.
- **Liquid (liquid):** A state of matter that is able to flow, has a defined volume, and takes the shape of the container it is placed in.
- **Gas (gas):** A state of matter where the particles are spread apart and move around easily. Gas particles do not have definite shape and volume.
- **Melting (de fusión):** When something changes from a liquid to a solid by the addition of heating.
- **Melting Point (punto de fusión):** The temperature when a substance changes from a solid to a liquid.
- **Vaporization (vaporización):** When something changes from a liquid to a gas.

IX. Safety Considerations

- Handle the heat packs with care. Do not throw them at your peers.
- Do not eat any lab materials.
• Have paper towels on hand for ice.

X. **Question of the Day**
How does temperature affect the physical properties of matter?

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<th>ENGAGEMENT</th>
<th>Time: 3 – 4 minutes</th>
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<tr>
<td><strong>What the Teacher Will Do</strong></td>
<td><strong>Probing Questions</strong></td>
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</table>
| **Greet the students.**  
*Hi everyone! I’m [outreach student name] and this is my teaching partner [outreach student name]. We will be coming each week to teach you science lessons.* | | |
| **Tell a little about your major or your research if you have done any or are intending to do any.**  
*First, I want to introduce our favorite spirit signal. When we want to get your attention, we will put our horns up, and say “Hook’em”, and that’s when we need your attention on us. So you’ll put your horns up and say “Horns!” Let’s Practice. “HOOK’EM!”* | | |
| **Have the students practice the “Hook’em” signal.**  
*At the beginning of each lesson, you’ll need to put everything away, except a pencil and your science notebook.* | | |
| **Teacher 1 begins the engagement activity while Teacher 2 prepares the** | | |
**ENGAGEMENT**

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<tr>
<td>Temperature Recording chart on the board.</td>
<td>First we are going to pass out a paper towel. Go ahead and hold your hand in a cup motion like this <strong>(demonstrate)</strong> and I am going to come around and give you a piece of ice. When you receive it, please hold it in your hand for as long as you can and describe some observations you have about to your shoulder partner. Use your senses, but DO NOT taste or eat the ice.</td>
<td></td>
</tr>
<tr>
<td>Pass out a piece of ice and a paper towel to each student. <strong>Note:</strong> If students complain about the ice being cold. Tell them to put the ice on the paper towel. <strong>Hook ‘em...</strong> Go ahead and put your ice on your paper towel and wipe your hand on the paper towel then put in the middle of your table so my partner and I can come around to pick them up.</td>
<td></td>
<td>1. What are some observations you have made? 2. What does the ice feel like? 3. What state was the ice in?</td>
</tr>
<tr>
<td>Write solid on the board and tell class to repeat together. <strong>The ice was a solid when we first passed out the ice to you.</strong></td>
<td>1. It’s cold! It hurts my hand. 2. It’s cold. 3. It was a solid.</td>
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<td><strong>Write → liquid on the board after solid.</strong> Then write melting underneath the arrow and tell class to repeat together.</td>
<td>4. What was happening to the ice as you held onto it?</td>
<td>4. It was melting.</td>
</tr>
<tr>
<td><strong>Your hand was transferring heat energy to the ice causing it to melt. Write heat energy on top of the arrow.</strong></td>
<td>5. What state did the ice turn into?</td>
<td>5. Water! Liquid!</td>
</tr>
<tr>
<td><strong>When ice freezes, it freezes at 0°C.</strong></td>
<td>6. Why was the ice melting?</td>
<td>6. Our hand was warm.</td>
</tr>
<tr>
<td><strong>Teacher 2 writes the freezing temperature on the board in the chart.</strong></td>
<td></td>
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<tr>
<td><strong>Water changes to gas when it boils, so it doesn’t disappear.</strong></td>
<td>7. Now, if we put the water that melted from the ice into a beaker and put the beaker on a hot plate what will happen?</td>
<td>7. It will boil. The ice water will go away. It will disappear. Misconception: water disappears when boils.</td>
</tr>
<tr>
<td><strong>Draw an arrow from liquid to gas and write vaporization. If we were to boil this water, the water would change from a liquid to a gas and this is called vaporization. Water boils at 100°C.</strong></td>
<td>8. What does water change to when it boils?</td>
<td>8. Steam. Gas.</td>
</tr>
<tr>
<td><strong>Write the boiling temperature on the chart.</strong></td>
<td>9. What is this change of state called?</td>
<td>9. Vaporization.</td>
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### ENGAGEMENT

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<tr>
<td>In today’s lesson, we will learn about the different states of matter and what causes them to change, and before we leave you will be able to answer the question of the day: How does temperature affect the physical properties of matter?</td>
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### EXPLORATION

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| Now before we begin our experiment, there are some rules that we need to go over:  
1. Be safe. In order to be safe, everyone needs to follow instructions, including when you should touch or begin with materials.  
2. Think like a scientist.  
3. Listen and look when we give the attention sign. Example: Hook ‘em Horns  
4. As scientists, we will not eat any of our experimenting materials. We will pass out chocolate for this lesson. They are in the small bags. Do not remove the chocolate from the bag.  
Also we will be using heat packs in this experiment. | 1. Will we be eating the chocolate? Why not? | 1. No, because it is science class and we don’t eat our materials. |
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<td>They are pretty warm so you should be careful when handling them.</td>
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<tr>
<td>Next, everyone is going to get a job card for their duties in the lab today. It’s important that you understand the role you have and how to do your tasks.</td>
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<tr>
<td>Divide students into groups of 4. Pass out job cards to each student in a group face down.</td>
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<tr>
<td>Now raise your hand if you have the blue card. Take this time to read your job role to your group. Make sure to pay attention because you may have that role next week. Do the same for all four job roles.</td>
<td></td>
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</tr>
<tr>
<td>1. Material Manager/Technician- picks up and maintains materials 2. Recorder- records the results of experiment 3. Principal Investigator- communicates results to group, class, teacher 4. Timer and Safety Monitor- listens to instructions and enforces rules at table</td>
<td></td>
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<tr>
<td>Pass out Ups and Downs of Temperature Data Sheet and Temperature Recording Sheet to each student. Remind students that they</td>
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<td>must always write their names on their worksheets.</td>
<td>2. What do we use to measure temperature with?</td>
<td>2. A thermometer!</td>
</tr>
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</table>

*We will be using a thermometer to measure temperature today.*

*Today, we will be working with 4 different types of chocolate. In your team, you will receive a milk chocolate chip, a white chocolate chip, a semi-sweet chocolate chip and a big milk chocolate Kiss.*

**Show the different types of chocolate at the front of the room on to the doc cam to the class as you speak.**

*On your worksheets, make predictions about what order you think the different types of chocolate chips will take to melt when we add heat. Rank the different types of chocolate from 1-4 with 1 being the first to melt.*

**Walk around and make sure everyone is completing their predictions. You can also show the types of chocolates on the doc cam.**

*Each team will need to measure the temperature of...*
**EXPLORATION**

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<td>their heat pack. To do this, place the thermometer under the heat pack, read the thermometer, and record the temperature on the Temperature Recording Sheet.</td>
<td></td>
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<tr>
<td>Each of you will get a chocolate chip to put on the heat pack to observe and record the time when your assigned chocolate is completely melted. If you look at the doc cam you can see a diagram of the experiment.</td>
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<tr>
<td>The Recorder will test the white chocolate chip; Principle Investigator will test the semi-sweet chocolate chip; Materials Manager will test the milk chocolate chip; and the Time &amp; Safety Manager will test the milk chocolate kiss.</td>
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<tr>
<td>Demonstrate the set up in the front of the class while explaining.</td>
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<tr>
<td>We will all be testing our chocolates at the same time so please be sure to pay attention to the stop watch and only start when we say, “Go.” Everyone will quickly, but gently, hold the chocolate chip against the heat pack. When your finger is touching the heat pack through the baggie of chocolate, is when</td>
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EXPLORATION

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<tr>
<td>you will stop and record the time it took to melt. The recorder is responsible for recording the time on the Data Sheet when his or her chocolate chip has completely melted. After everyone’s done, you will share your data with everyone in your group.</td>
<td></td>
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</tr>
<tr>
<td>At the bottom of your Data Sheet, there are a few questions we want you to answer when you are done collecting data.</td>
<td></td>
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<tr>
<td>Pass out 1 heat pack, 1 thermometer and bags chocolate to each group. Be sure to crack/press on the metal part to activate the heat pack before handing it to the students.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>You may begin to set up after your group has received all of the materials; but don't put the chocolate on the heat pack until we say so! Don't forget to write down the time when your piece of chocolate is completely melted. Remember all of our rules during our experiments. The number one rule for this part is you may not eat any of the materials we are working with. As scientists, we will practice not eating in the lab.</td>
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<td>Walk around and make sure everyone is on task.</td>
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Time: 25-30 minutes
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<tr>
<td><strong>Stop the timer at three minutes (everyone should be done except the kisses). When all the teams are completely finished, pick up all materials and discuss students’ results.</strong></td>
<td>4. Which chocolate melted first?</td>
<td>4. Milk chocolate chip.</td>
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<tr>
<td></td>
<td>5. Which chocolate melted last?</td>
<td>5. Chocolate Kiss</td>
</tr>
<tr>
<td></td>
<td>6. How long did it take for the white chocolate chip to melt? What about the milk chocolate chip?</td>
<td>6. Milk chocolate took about one minute, white a little more than one minute.</td>
</tr>
<tr>
<td></td>
<td>7. How long did it take for the semi-sweet chocolate chip to melt?</td>
<td>7. The milk chocolate kiss took the longest to melt and the semi-sweet was third from last.</td>
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</table>

At UT we recorded the length of time it took for the chocolate kiss to melt already so we wouldn’t have to wait as long. It took 5 minutes and 20 seconds. Have students record result on their Data Sheet.

Let’s talk about melting points. The melting point is the temperature at which a solid becomes a liquid. Now repeat that with me, “Melting Point.” The melting point of milk chocolate is right around 20°C while the melting point of semi-sweet chocolate chips is at around 35°C. The melting point of white chocolate is 30°C. The melting point of 4. Milk chocolate chip.

5. Chocolate Kiss

6. Milk chocolate took about one minute, white a little more than one minute.

7. The milk chocolate kiss took the longest to melt and the semi-sweet was third from last.
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<tr>
<td>Hershey’s Kiss is also at 20°C because it is made out of milk chocolate. Notice how you can hold a chocolate chip cookie made with semi-sweet chocolate chips without getting sticky, but if you hold a milk chocolate candy bar for a minute it will start to melt.</td>
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<tr>
<td>Write the melting point of each chocolate on the board.</td>
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<tr>
<td>Please write these temperatures down on your Temperature Recording Worksheet.</td>
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<td>Earlier we talked about the freezing point of water and the boiling point of water that we recorded on the Temperature Recording Sheet. We said water freezes at 0°C. Now notice that the C is a capital C because that stands for Celcius. Celsius is a common unit of measurement for temperature. We write that as zero, the little circle means degrees, then a capital C for celcius. Earlier, we also said that water boils at 100°C. Remember to make that a capital C!</td>
<td>1. Have you ever had chocolate melt in your hand? At what temperature do you think the chocolate started to melt at?</td>
<td>1. I don’t know. Body temperature.</td>
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<tr>
<td>Chocolate can melt at our body temperature. Our body temperature is about 37° C. Record the body temperature on your worksheet.</td>
<td>2. What is the difference between the picture of the solid and the picture of the liquid?</td>
<td>2. There is space between the particles in the liquid. Misconception: Solids do not move.</td>
</tr>
<tr>
<td>Students may ask about their temperature being 98°F. Be sure to explain that they are equal, just different units of measurement.</td>
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<tr>
<td>Write body temperature on the board.</td>
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<tr>
<td>Now we are going to go over some vocabulary terms with you all. At the bottom of your Temperature Recording and Vocabulary Sheet, there are some blanks for you to fill in important terms as we go through them.</td>
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</tr>
<tr>
<td>Show the students Figure 2: States of Matter. Point to the picture of the solid and the liquid.</td>
<td></td>
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<tr>
<td>That’s right! A liquid takes the shape of a container, the particles are more spaced out and the particles can move more freely than a solid. A solid’s particles are tightly packed and move very slightly, like small vibrations in place.</td>
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<tr>
<td>Point to the picture of the gas</td>
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<tr>
<td>Correct! Particles in a gas are spread far apart, but move rapidly or very quickly.</td>
<td>3. What about the gas phase? How do particles in a gas behave?</td>
<td>3. They are very far apart, and they move quickly.</td>
</tr>
<tr>
<td>A gas will fill whatever container it is in, just like a liquid, but without a lid the gas is free to move all around the room and in the hallway. We have a balloon to demonstrate how a gas behaves. Blow up a balloon.</td>
<td>4. What would happen to all of the gas if we don’t put a lid on the container?</td>
<td>4. It goes into the air around it.</td>
</tr>
<tr>
<td>That’s right! Gas can stay inside a container, such as a balloon. Holding on to the balloon, slowly let the air out of the balloon.</td>
<td>5. What is in this balloon?</td>
<td>5. Air, gas.</td>
</tr>
<tr>
<td>So when we let the air out of the balloon, the air will now spread out and take the shape of the room. The room is now the gas container.</td>
<td>6. What happened to the gas that was in the balloon? Where did it go?</td>
<td>6. It escaped from the balloon. It went everywhere. It mixed in with the air around it.</td>
</tr>
<tr>
<td>A phase change is when a substance is changing its state, in the case of melting ice, from a solid to a liquid.</td>
<td>7. What is a phase change?</td>
<td>7. When the state changes, like from solid to liquid.</td>
</tr>
<tr>
<td>On the board, write Phase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXPLANATION</td>
<td>Time: 5 minutes</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>------------------</td>
<td></td>
</tr>
<tr>
<td><strong>What the Teacher Will Do</strong></td>
<td><strong>Probing Questions</strong></td>
<td><strong>Student Responses</strong></td>
</tr>
<tr>
<td><strong>Change</strong> = when a substance changes from one state to another. Have students repeat the word. Remind students to write the term down on the vocabulary sheet.</td>
<td>8. Thinking back to our experiment, what examples of a phase change have we seen today?</td>
<td>8. Melting. The chocolate melted. The ice melted. I don’t know.</td>
</tr>
<tr>
<td></td>
<td>9. What is melting? What phase does it change from and into?</td>
<td>9. It’s a change from a solid to a liquid.</td>
</tr>
<tr>
<td><strong>Correct, when we first started, we saw ice melting into water. This is called melting.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Write Melting = when a substance changes from a solid to a liquid. Have students repeat the word. Remind students to fill out the vocabulary sheet.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Remember in the beginning of the lesson today we saw how ice melted into water. Then, we talked about what would happen if we placed the water into a beaker on a hot plate or stove.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>When water is heated with a hot plate or on a stove, the water turns to steam and vaporizes into the air forming a gas.</strong></td>
<td>10. What do we call the phase change when water boils?</td>
<td>10. Vaporization.</td>
</tr>
<tr>
<td><strong>On the board, write Vaporization=change from a</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### EXPLANATION

<table>
<thead>
<tr>
<th>What the Teacher Will Do</th>
<th>Probing Questions</th>
<th>Student Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>liquid to a gas. Remind students to fill in the vocabulary sheet.</td>
<td>11. What do you predict would happen if you put a glass of juice in the freezer?</td>
<td>11. It would freeze. The juice would turn into a solid.</td>
</tr>
<tr>
<td></td>
<td>12. What type of phase change would this be an example of? What phase does it</td>
<td>12. Freezing; liquid to solid.</td>
</tr>
<tr>
<td></td>
<td>change from and into?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13. What do you predict would happen if you left a bag of M&amp;Ms outside in the</td>
<td>13. They would melt. It would turn into a liquid.</td>
</tr>
<tr>
<td></td>
<td>summer?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14. What type of phase change would this be an example of? What phase does it</td>
<td>14. Melting; solid to liquid.</td>
</tr>
<tr>
<td></td>
<td>change from and into?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15. What do you predict would happen if you left a glass of water outside in the</td>
<td>15. It would vaporize. The liquid would turn into a gas. Vaporization!</td>
</tr>
<tr>
<td></td>
<td>sun? What type of phase change would this be an example of?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>16. What causes the chocolate to melt?</td>
<td>16. The heat pack was hot and it made the chocolates melt.</td>
</tr>
<tr>
<td></td>
<td>17. So what physical properties change when ice is melted or when we melted the</td>
<td>17. The shape changed. It turns from a solid to liquid. You can pour it.</td>
</tr>
<tr>
<td></td>
<td>chocolate?</td>
<td></td>
</tr>
</tbody>
</table>

Now let’s make some predictions about phase changes!

Now let’s think back to our experiment.

That is correct. The heat in heat pack was added to the
**EXPLANATION**

<table>
<thead>
<tr>
<th>What the Teacher Will Do</th>
<th>Probing Questions</th>
<th>Student Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>chocolates and made them melt.</td>
<td>18. Why did they all have different melting time? Aren’t they all chocolate?</td>
<td>18. Because they have different ingredients in them.</td>
</tr>
<tr>
<td></td>
<td>19. How do you know which chocolate chip had the lowest melting point?</td>
<td>19. It melted the fastest.</td>
</tr>
<tr>
<td></td>
<td>20. In our experiment which chocolate has the lowest melting point then?</td>
<td>20. The milk chocolate chip.</td>
</tr>
<tr>
<td></td>
<td>22. Why do you think this happened? Isn’t the chocolate kiss also made out of milk chocolate?</td>
<td>22. It was bigger.</td>
</tr>
</tbody>
</table>

A phase change causes the texture and appearance of matter to change. When ice or the chocolate was melted, it could be poured and was no longer solid.

During the chocolate experiment, we tested chocolate chips to see when they would melt using the heat packs.

Right, the chocolate chips were all different kinds of chocolate. They all have a form of chocolate in them but have different amounts of other ingredients as well. The additional ingredients allow for the different chips to have different melting times.

Milk chocolate is usually the softest of these and will melt the fastest. Since milk chocolate melted the fastest, this means that it has the
EXPLANATION

<table>
<thead>
<tr>
<th>What the Teacher Will Do</th>
<th>Probing Questions</th>
<th>Student Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>lowest melting point. A melting point is the temperature when something starts melting.</td>
<td>23. Does the big milk chocolate kiss have the same melting point as the small milk chocolate chip, even though it is bigger? Why or why not?</td>
<td>23. Yes. No. I don’t know. (Yes because the melting temp. is the same, it just takes longer to melt the larger quantity).</td>
</tr>
<tr>
<td>On the board, write Melting Point = temperature when something starts melting. Remind students to fill in the vocabulary sheet. Right, even though the big chocolate kiss is made out of milk chocolate, it was a lot bigger than the small milk chocolate chip that melted first, which is why the big chocolate kiss took a long time to melt. This means that melting points depend on the composition, which in our experiment was different types of chocolate, and size, which we tested with the milk chocolate chip and milk chocolate kiss. Heat and temperature are different. Heat is the quantity of energy while temperature is the response of material when heat energy is transferred to and from that material. Temperature increases when heat is added and decreases when heat is transferred to something else. We don’t have</td>
<td>24. So today we talked about heat and temperature in this lesson. Do heat and temperature have the same definition?</td>
<td>24. Yes. No. I don’t know. Misconception: heat and temperature mean the same thing.</td>
</tr>
</tbody>
</table>

Time: 5 minutes
<table>
<thead>
<tr>
<th>EXPLANATION</th>
<th>Time: 5 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What the Teacher Will Do</strong></td>
<td><strong>Probing Questions</strong></td>
</tr>
<tr>
<td>cold energy we only have heat energy.</td>
<td></td>
</tr>
<tr>
<td>Now, everyone should have their Temperature Recording and Vocabulary Sheet completed, flip the page over to the thermometer side and arrange all of the item’s temperatures on the front page on this thermometer. Review with whole class if time allows.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ELABORATION</th>
<th>Time: 5-10 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What the Teacher Will Do</strong></td>
<td><strong>Probing Questions</strong></td>
</tr>
<tr>
<td>Now we are going to pass a small plastic fish to every group. When you get the fish, place the fish on the table and notice it’s physical properties for about five seconds. After, hold the fish in the palm of your hand and observe what happens. Be sure to take turns. Pass out fish to each group.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. What were some physical properties of the fish?</td>
</tr>
<tr>
<td></td>
<td>2. What happened when you put the fish in your hand?</td>
</tr>
<tr>
<td></td>
<td>3. What physical property changed when you put the</td>
</tr>
</tbody>
</table>
### ELABORATION

<table>
<thead>
<tr>
<th>What the Teacher Will Do</th>
<th>Probing Questions</th>
<th>Student Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>fish in your hand?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. What do you think caused the shape of the fish to</td>
<td>4. The heat from</td>
</tr>
<tr>
<td></td>
<td>change when you put it in your hand?</td>
<td>our hands!</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Our hands are</td>
</tr>
<tr>
<td></td>
<td></td>
<td>hotter than</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the table.</td>
</tr>
</tbody>
</table>

That’s right; the heat of our hands caused the fish to change shape. There are more physical changes than just phase changes, as we just saw with the change in shape of the fish. The fish changed shape when we held it and shape is another example of a physical property that responds to changes in heat.

Pick up fish.

### EVALUATION

<table>
<thead>
<tr>
<th>What the Teacher Will Do</th>
<th>Probing Questions</th>
<th>Student Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Now you are going to</td>
<td></td>
<td></td>
</tr>
<tr>
<td>show us what you know</td>
<td></td>
<td></td>
</tr>
<tr>
<td>about temperature</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td>After they finish the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Show us what you Know”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>worksheet, go over</td>
<td></td>
<td></td>
</tr>
<tr>
<td>answers and then go to</td>
<td></td>
<td></td>
</tr>
<tr>
<td>journal prompt if time</td>
<td></td>
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<tr>
<td>permits.</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Alright, now everyone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>get out their interactive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>journals. Journal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>prompt: Describe what a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>phase change is and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>describe an example that</td>
<td></td>
<td></td>
</tr>
<tr>
<td>you have seen today.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Name: ________________________________ Date: ________________________

**Ups and Downs of Temperature Data Sheet**

**Melting Chocolate Experiment:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Prediction Order of Melting</th>
<th>Actual Melting Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. White Chocolate Chips</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Semi-Sweet Chocolate Chips</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Milk Chocolate Chips</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Milk Chocolate Kiss</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Conclusion:**

1. Was your prediction correct? What were your results?

____________________________________________________________________________
____________________________________________________________________________

2. What physical properties have changed after the chocolate has melted?

____________________________________________________________________________
____________________________________________________________________________

3. Why did the different chocolate chips have different melting times?

____________________________________________________________________________
____________________________________________________________________________

4. Why did the milk chocolate chip and the milk chocolate kiss have different melting times?

____________________________________________________________________________
Show Us What You Know!
Ups and Downs of Temperature

1. What is vaporization?
   a) When a solid changes to a liquid
   b) When a liquid changes to a gas
   c) When a substance changes from one state to another
   d) When gas gets released to its surroundings from the container it was in

2. John accidentally left his ice cream out of the refrigerator for 5 hours, when he had finally remembered about his ice cream, it had turned into a puddle of liquid. What happened to his ice cream?
   a) The ice cream was frozen
   b) The ice cream was melted
   c) The ice cream was evaporated
   d) The ice cream turned into a gas

3. Label the following diagrams with either solid, liquid or gas:

   ____________________  ____________________  ____________________

4. Which of the following is considered a phase change?
   a) Mixing kool-aid with water and sugar
   b) When water-vapor collects and creates rain
   c) Putting ice in the freezer
   d) When an egg is dyed blue
Temperature Recording and Vocabulary Sheet

For the chart below, write down the temperature at which the matter listed begins to change and record how it changed in the “Physical Properties that changed” column.

<table>
<thead>
<tr>
<th>Matter</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice Freezes</td>
<td></td>
</tr>
<tr>
<td>Water Boils</td>
<td></td>
</tr>
<tr>
<td>Body Temperature</td>
<td></td>
</tr>
<tr>
<td>Heat Pack Temperature</td>
<td></td>
</tr>
<tr>
<td>White Chocolate Chip Melts</td>
<td></td>
</tr>
<tr>
<td>Milk Chocolate Chip Melts</td>
<td></td>
</tr>
<tr>
<td>Semi-Sweet Chocolate Chip Melts</td>
<td></td>
</tr>
<tr>
<td>Milk Chocolate Kiss Melts</td>
<td></td>
</tr>
</tbody>
</table>

DEFINITIONS:

1. When a substance changes from one state to another state it is called __________________________.

2. When a substance changes from a solid to a liquid it is called ____________________________.
   Examples:

3. When a substance changes from a liquid to a gas it is called ____________________________.
   Examples:

4. When a substance changes from a liquid to a solid it is called ____________________________.
   Examples:
**Direction:** Label the thermometer below using the temperatures from your chart. Label the temperatures that you have recorded in the chart below by writing the matter out to the side of the thermometer and drawing an arrow to where the temperature is on the scale.
Question of the Day:
How does temperature affect the physical properties of matter?
A substance can change from one state to the other. Sometimes we call this a “change in phase.” All changes always occur when there is a change of heat. The following diagram summarizes phase changes:
• **Solid:** A state of matter that has its particles closely packed together. A solid has a defined volume and shape.

• **Liquid:** A state of matter that is able to flow, has a defined volume, and takes the shape of the container it is placed in.

• **Gas:** A state of matter where the particles are spread apart and move around easily. Gas particles do not have definite shape and volume.

• **Phase Change:** When one state of matter changes to another state through the addition or reduction of heat.

• **Melting:** When a substance changes from a solid to a liquid by the addition of heat.

• **Melting Point:** The temperature when a substance changes from a solid to a liquid.

• **Vaporization:** When something changes from a liquid to a gas by the addition of heat.

• **Freezing:** When a substance changes from a liquid to a solid by the addition of heat.