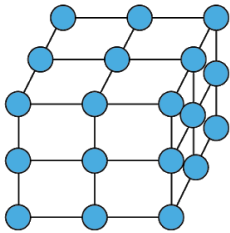
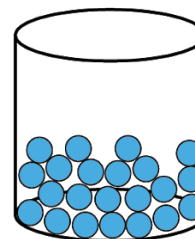
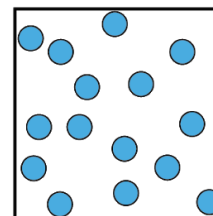


The Three States of Matter		Grade 5 - Properties and Changes in Matter
Lesson Plan	Safety Notes	Adult supervision is recommended if boiling water to make rock candy.
		Gloves or mittens are recommended for protection from cold.
Description		
In this lesson, students will learn about the three main states of matter: solid, liquid, and gas. They will learn about how matter can change between these states and how this relates to particle theory.		
Materials		
Ice Cream: <ul style="list-style-type: none"> - 1 gallon sized Ziploc bag - 1 quart sized Ziploc bag - Ice cubes - Salt - Cream - Sugar - Vanilla 	Rock Candy: <ul style="list-style-type: none"> - Jar - Stick or string - Water - Sugar - Flavour extract (optional) - Food colouring (optional) 	Butter: <ul style="list-style-type: none"> - Jar and lid - Heavy cream (35% or higher) - Salt (optional) - Herbs (optional)
Science Background		
<p>Matter is any substance that has mass and takes up space by having a volume. All matter is made up of many small particles called atoms, and they are in a continual state of motion. The degree to which these particles move is determined by the amount of energy they have and their relationship to other particles. Matter exists in various states or phases, the most common of which include solids, liquids, and gases. Other states of matter can exist under highly specialized conditions, such as plasma and Bose-Einstein condensate.</p> <p>Solids have a fixed shape and volume, are difficult to compress, and are often dense because they are composed of many particles packed closely together. The atoms in a solid are held together by strong intermolecular forces and bonds - they are strongly attracted to each other. The atoms are in a fixed position but still vibrate. They contain the least amount of kinetic energy out of the three main states of matter. An example of a solid is ice. By heating the ice and adding kinetic energy to the particles, the solid ice will melt and change states into a liquid when the temperature is above 0°C.</p>		
		

Liquids do not have a fixed shape and volume, and will flow to fill the shape of the container from the bottom up. Like solids, liquids are difficult to compress and are more dense than gases because there is a higher number of particles in a small volume. These particles are held together by weaker intermolecular forces than solids, and thus are able to move around more in all directions. However, this movement is limited due to the attraction of the particles to each other. A liquid is a type of fluid because it flows. An example of a liquid is water. By heating the water and adding even more kinetic energy to the particles, the liquid water will evaporate and change states into a vapour (a gas) when the temperature is above 100°C.



Gases also do not have a fixed shape and volume, and will flow and expand to fill the entire shape of the container. They are easily compressed and often have a low density because there are very few particles in a large volume. The particles in a gas are widely separated from one another and have weaker intermolecular forces than liquids or solids. A gas is also a type of fluid because it also flows.



Activity Procedure

Ice Cream

Note: Gloves or mittens are recommended when handling the bag of ice

1. Pour 1 cup of cream, 1 tbsp of sugar, and $\frac{1}{2}$ tsp of vanilla extract into a quart-sized Ziploc bag. Seal it tightly and carefully.
2. Fill a gallon sized Ziploc bag about $\frac{3}{4}$ full of ice, then add $\frac{1}{3}$ cup of salt
3. Place the smaller bag inside the larger bag of ice and close the seal.
4. Shake the bag hard for 5 minutes.
5. Rinse the small bag off with cold water before opening it to keep the salt water from getting into your ice cream.
6. Eat some delicious homemade science ice cream!

Rock Candy

Note: Using the stove to boil water should be done with adult supervision

1. Prepare your jar by cleaning it and rinsing it with hot water.
2. Prepare what the rock candy will grow on - a stick or a string will work. Dampen it with some water and roll it in some sugar to create the base on which the crystals will form. Set it aside to dry.
3. Bring 2 cups of water to a boil in a medium-sized saucepan over medium heat.

4. Add 1 cup of sugar, and stir to dissolve. Repeat 3 additional times. Notice it will take longer for the sugar to dissolve after each additional cup.
5. Optional: If you want to add food colouring and/or flavour extract, now is the time! Just 2-3 drops of colouring and ½ tsp of flavour extract will be enough. (Tip: try orange food colouring with orange extract)
6. Once all the sugar has been dissolved, remove the syrup from the heat and let it cool for 10 minutes. Then use a funnel to pour it into your jar. Careful, it will still be hot!
7. Carefully lower the sugared skewer or string you prepared earlier until it hangs about 1 inch from the bottom of the jar. Fasten it at the top with clothespins or tape the string to a balanced pencil. Do not let the end of the skewer/string to come too close to the bottom or sides of the jar. Tip: If using a string, use a paperclip or a screw on the end as a weight so it hangs straight.
8. Gently place your jar in a cool place away from sunlight and let it stand undisturbed. You should start to see crystals forming within 4-6 hours.
9. Let the rock candy grow to your desired size. This could take up to a week.
10. Finally, disassemble your crystal growing contraption and reap the delicious rewards of your hard and patient efforts!

Butter

1. Pour the heavy cream into your jar, filling it about half-way full.
2. Optional: If you want salted butter, add ¼ tsp salt per cup of cream.
3. Screw the lid on tight and shake the jar hard. After the first few minutes, you'll have whipped cream. Listen for the formation of a lump inside the jar - then shake an additional minute. This could take up to 15 minutes total depending on the starting temperature of your cream.
4. Remove the solid butter from the jar and place into a bowl. The remaining liquid is buttermilk. You can discard it, or store it in the fridge if you want to use it for a recipe later.
5. Pour cold water over the butter and use your hands to squish it into a ball. Discard the water and repeat the rinsing process until the water run-off is clear to get rid of any remaining buttermilk.
6. Optional: If you want flavoured butter, you can add herbs or even honey!
7. Replenish your jar-shaking muscles by spreading some of that homemade butter on a piece of bread and eating your hard earned reward! (Store for 3-5 days at room temperature or 7-10 days in the refrigerator)

Debrief

Ice Cream

In this experiment, students turn a liquid (cream) into a solid (ice cream). When salt and ice mix, the freezing point of the ice is lowered and the freezing point reached depends on the amount of salt used. The more salt is added, the lower the temperature can get before the saltwater solution freezes. The kinetic energy or heat must come from somewhere to melt the ice. The heat that causes melting comes from the surroundings and, in this case, it's from the warmer cream mixture. By lowering the temperature at which ice freezes, students are able to create an environment in which the cream mixture could freeze at a temperature above 0°C and become ice cream. The shaking moves the warmer cream mixture from the inside to the outside of the bag so it can freeze evenly. That way you make a smoother product. It also adds air to the final product so it's fluffed up a little bit. Yum!

Rock Candy

In this experiment, students turn a solid (sugar) into a liquid (sugar syrup) and then back into a solid (rock candy). When the sugar is mixed with the water, heated, and stirred repeatedly, a supersaturated solution is created. This means there are far more dissolved particles of solute (the sugar) than the solvent (the water) can normally dissolve and hold at a given temperature. By stirring the sugar in hot water instead of room temperature or cold water, the sugar is dissolved faster in the fast moving (heated) water molecules. The supersaturated solution contains more sugar than can stay in the liquid, so as the water cools, the sugar falls out of the solution as a precipitate (particles). These connect with other sugar particles, and a crystal begins to grow. Coating the stick or string with sugar gave the sugar particles in the supersaturated solution a place to grow which formed the rock candy. Sugar molecules will continue to settle and crystalize on the stick/string and until it is removed from the solution.

Butter

Heavy cream has a good deal of fat in it. By shaking the cream, the fat molecules begin to separate from the liquid. The more the cream is shaken, the more these fat molecules aggregate together forming a solid. When this happens, the fat molecules have clearly separated from the liquid in the cream, and this liquid can be removed and made into buttermilk. When molecules are heated, they move faster because they have more energy. Consequently, the molecules in room-temperature cream move faster than the ones in the chilled cream, allowing the room-temperature fat molecules to clump together faster, thereby forming butter faster. For an additional experiment, try this again with two jars of heavy cream: one with room-temperature cream, and the other with refrigerated cream, and compare.

Handout

1. Draw the particles of the three different states of matter (solid, liquid, and gas).

Solid	Liquid	Gas

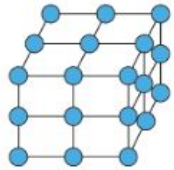
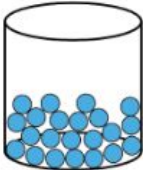
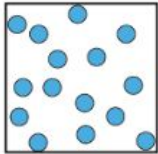
2. Provide an example of each state of matter discussed:

Solid: _____ Liquid: _____ Gas: _____

3. At what temperature does water turn into a solid? _____
4. At what temperature does water turn into a gas? _____
5. Based on the experiments conducted do you think all liquids turn to solid (freeze) at the same temperature? Do you think all liquids turn to gas at the same temperature? Explain.
6. Once something is a solid, does it stay that way forever? Explain.
*Hint: Think about the ice cream experiment and use it as an example.
7. Challenge Question: If sugar is a solid then why does it take the shape of the container it is put in? What about salt or sand?

Handout - Answers

1. Draw the particles of the three different states of matter (solid, liquid, and gas).

Solid	Liquid	Gas
		

2. Provide an example of each state of matter discussed:

Solid: **Any solid (e.g. Chair)** Liquid: **Any liquid (e.g. juice)** Gas: **Any gas (e.g. Oxygen)**

3. At what temperature does water turn into a solid? **0°C**
4. At what temperature does water turn into a gas? **100°C**
5. Based on the experiments conducted do you think all liquids turn to solid at the same temperature? Do you think all liquids turn to gas at the same temperature? Explain.
(Based on any experiment) Different liquids turn to gas at different temperatures. An example would be that the sugar crystals turned back into a solid even though it was not 0°C or below.
6. Once something is a solid, does it stay that way forever? Explain.
***Hint: Think about the ice cream experiment and use it as an example.**
No, it can change back to being a liquid (and possibly a gas). For example, we made ice cream (a solid) out of liquid cream but when I left it out too long some of it started to melt and turn back into a liquid
7. Challenge Question: If sugar is a solid then why does it take the shape of the container it is put in? What about with salt or sand?
Sugar (as well as salt and sand) is still a solid. Each crystal has a fixed shape and volume, does not flow under shear stress, does not take the shape of its container, and is incompressible. Many small solids (grains) moving together can sometimes act like a liquid (called granular flow).