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Matter Chatter: Exploring the effect heat has on states of matter using the five senses

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by Annie Overose McGill

Introduction

Magic is real. It exists all around us. My Kinderscholars have proudly informed me of this every year that I have taught. They inform me of the reality of Santa Claus, the Tooth Fairy, and the Easter Bunny. After providing me with their facts, they always seek confirmation from me. I used to smile at their enthusiasm and advise them to have this discussion with their family. Then, it occurred to me that this is a missed opportunity; a teachable moment lost. Why not engage their sense of wonder and fascination with magic to teach them the science of every day magic?

Modern day scientists are what I imagine history saw as sorcerers or wizards. Scientists can understand the world around them down to the atoms. Knowledge is their magic and with it they can produce results that dazzle the mind. A form of modern day magic that this unit focuses on is cooking. Cooking is a commonality of which all of my scholars can relate. Magic occurs every day when a chef produces a culinary delight out of ingredients that boggle the mind. They take a list of ingredients that seem questionable to the palate and make it extraordinary. Bakers create magic when they manipulate molecules into intricate desserts that are as much a pleasure aesthetically as they are orally. Desserts such as Marjolaine, Baked Alaska, Croquembouche, and chocolate soufflé are exquisite in appearance and taste. Yet all it takes is one small misstep and the dessert is destroyed.

This unit engages their sense of wonder and thirst for knowledge. It takes a topic that intrigues them, magic, and makes it an attainable skill through science. How does the magic of science function? How can this be explained to kinderscholars? This unit seemed like a lofty goal when I first began the research. My education in science was a minimal broad overview instead of an in-depth investigation. This has been a weakness I have been seeking to strengthen since I have begun teaching. Thus, each area of content for this unit begins with the basics and builds up to a higher level for those teachers out there that have similar educational backgrounds. The scholars will use their five senses to explore states of matter, heat, heat transfers, chemical reactions and ultimately what happens when heat is applied to states of matter. The scholars will become the scientist who can produce magic. This unit gives them the power of knowledge so that they can attain the ability to understand and create that which fascinates them.

The Kinderscholars at my school arrive armed with curiosity and little else. The majority of these scholars

have never been to school and several are new to speaking English and living in the United States. Their families are highly mobile, moving within the historical yet crumbling and neglected neighborhoods of North Tulsa. The demographics for my school state that these scholars are mostly African American with single digit percentages of Pacific Islander, Hispanic, Native American, Mixed, and Caucasian. My school relies on local donations and programs to provide the basic supplies needed in the classroom. The teachers provide the rest of the materials which is a phenomenon that is becoming the norm. These scholars do not have the advantages that many children are given around the nation. I consider these factors and embed their needs into the curriculum but the scholars have ample amounts of what I need from them…curiosity.

Rationale

Science tends to be an afterthought in today's early childhood curriculum. Minimal curriculum is provided and the brunt of teaching time is required for Language Arts and Mathematics. Any cross-curricular usage is created by the teachers. This is a disservice to all scholars. The world around us is not just made up of reading and math. The young child's brain has incredible potential to build neural connections and create a strong foundation. The older a child is the less chance they have for building those connections, and those they do build are weaker. Why then does the curriculum not emphasize a strong complete foundation in early childhood? It does not make any logical sense other than the underlying concern over test scores. Test scores should not define the scholar. This unit seeks to bring balance to the academic rigor in early childhood. Science is necessary to every scholar's foundation. These concepts, skills, and experiments have the capability to provide scholars with strong neural connections and motivate their curiosity in learning.

Current standards dictate that all units must have clearly stated, rigorous objectives. My Kinderscholars will master the following objectives. They will identify, research, experiment, and analyze the three basic states of matter: solid, liquid, and gas. Scholars will identify what heat is and three types of heat transfer. They will explain the effect heat has on states of matter. The scholars will use their five senses to investigate the result of heat when applied to states of matter in cooking. They will create a presentation and share their knowledge with another class. These objectives tie into numerous standards which are listed in the appendix of this unit.

Laws of Thermodynamics

The research for this unit begins with the origins of thermodynamics. This is the foundation for comprehension of states of matter and heat. Over the years, four laws of thermodynamics have been discovered. However, since only three of the laws are relevant to this project; those will be the ones explained. They are the zeroth, first, and second laws of thermodynamics. The discovery of these laws are credited to decades of work by a vast group of pioneers including but not limited to: Carnot, Kelvin, Clausius, Gibbs, Helmholtz, Joule, Maxwell, and Mayer.[1] There is much debate regarding the founder of each law. Comprehending each person's contribution to thermodynamics would need extensive research and a broader understanding of thermodynamics than this unit warrants.

The zeroth law states "If two thermodynamic systems are each in thermal equilibrium with a third, then they

are in thermal equilibrium with each other".[2] This means that you have three objects. The first object has no net heat transfer with the second. The second objects has no net heat transfer with the third. Then, without measuring it you know that the first and third object also have no net heat transfer. Basically, if you put a slice of pie on a plate and you stick a fork into the pie then walk away for a bit. After a while, you know that all three of them will be in thermal equilibrium with each other. This law was discovered after the first law but was deemed the vital foundation for thermodynamics; hence, it was named the zeroth law.

Next, is the first law which states "energy cannot be created or destroyed; only changed".[3] This means that energy does not just appear when we need it but must come from elsewhere. If you eat food then your body converts the chemical energy to kinetic energy. The burst of energy did not just suddenly manifest; it changed forms.

After that, is the second law of thermodynamics. Heat will always be transferred from the hot object to the cold object.[4] This means that if you place a hot item and a cold item together then the heat will always transfer to the cold item. This applies to the object being left alone and not being forced to change temperature as they would in a freezer. An example for this is a cup of hot tea. The heat from the tea transfers to its environment. It also works in reverse, a cup of iced tea will have the heat of its environment transferred to it. The heat always transfers to the cold with the objects always wanting to achieve equilibrium.

These laws built a solid understanding of thermodynamics in my mind. Yet I was still wondering what is heat and how it transfers to states of matter. Upon researching heat, I found a clear explanation. "The amount of heat in a substance is the total vibrational energy of all the atoms and molecules that make up the substance".[5] An important tidbit to remember it that heat and temperature are two different things. Heat is the vibrational energy of all of the molecules and temperature is the average heat per molecule. That was easy to understand, so I ensued with researching how heat transfers to molecules.

Heat Transfer

This led me to the principles of heat transfer. There are three different types of heat transfer: conduction, convection, and radiation. I began with conduction as it seemed the easiest to understand. "Conduction occurs when two objects at different temperatures are in contact with each other. Heat flows from the warmer to the cooler object until they are both at the same temperature".[6] An example of conduction is when you turn on the stove and place a skillet on it. Then, you touch the handle of a skillet. This is where the heat transfers from the skillet to your hand. Another example is when you sit in a chair. Your body heat warms the chair.

Next, I delved into convection. This concept is easier to grasp if you have experience cooking. Research states "Convection occurs when warmer areas of a liquid or gas rise to cooler areas in the liquid or gas. As this happens, cooler liquid or gas takes the place of the warmer areas which have risen higher. This cycle results in a continuous circulation pattern and heat is transferred to cooler areas".[7] Convection occurs when you boil water or use a crock pot. The heat element is at the bottom of the pots and pans. It heats the substance at the bottom and the liquid or gas rises up to heat the middle and top of the substance. This concept should definitely be introduced to young scholars. I had a conversation with a high school chemistry teacher to

discuss the vertical alignment of this unit. He stated that high school students struggle all year to understand convection. This type of heat transfer may need more emphasis for scholars to master.

Radiation is the last method of heat transfer that I researched. Radiation is explained thus "it does not rely upon any contact between the heat source and the heated object".[8] If you have ever stepped outside on a sunny day then you have experienced radiation heat transfer. The sun shining down on you and warming your skin is a method of radiation. The heat from a fire warming you is an another source of radiation. An additional example would be a solar oven. The solar oven is warmed by the heat of the sun and then cooks the food inside of it. Everyday examples are toaster ovens and microwaves. The heating elements produce radiant heat. An interesting note, toaster ovens use all three types of heat. They have a radiant heating element, use the convection method and have a metal tray that conducts heat.

Now, the research was much easier for me to understand than the laws of thermodynamics. At least, it did not have me talking to myself in the grocery store as I suddenly made connections. People eyeing my strangely as I mutter "Hmm, so that box of cookies at the top of the pile must be the same temperature as the shelf. That doesn't seem that complicated. Why did that make my head ache to think about it earlier?" Needless to say, an hour in a grocery store can make more progress in comprehending than trying to force the connection.

States of Matter

Subsequently, I delved into the molecular structure of states of matter. Quickly, I discovered that the information I learned as a scholar has evolved. The three states of matter, have been expanded into five states of matter: solid, liquid, gas, plasma, and Bose-Einstein Condensates. Here is a brief explanation of each state of matter. A solid maintains a fixed shape, and volume. Solids are not easy to compress. This is due to the high density of molecules. The particles do not have as much kinetic energy due to the lack of space between them. An important note is that there is more than one type of solid. An example of another solid is a soft solid, such as butter. Soft solids can act like a liquid or a solid. This is higher level than most early childhood scholars will achieve. However, I noted it because there may be that one scholar that will inquire about its characteristics. It is important to be able to explain that there are soft solids.

Next is liquid. A liquid will change to fit its container but has a fixed volume. Water has more potential energy than a solid because there is more freedom for the particles to move. Though its particles can shift and flow, it is not easy to compress due to the lack of space between the particles. You cannot take a liquid and squish it into a ball. Water and oil are great examples of a Newtonian liquid. "Newtonian fluids, such as water or cooking oil, don't change their behavior as a result of how they have been handled, such as having been mixed or being left stagnant for days".[9] Cake Batter is a Non-Newtonian fluid. Non-Newtonian fluids are both liquid and solid.[10] This concept is above the comprehension of most early childhood scholars. However, a great experiment to demonstrate Non-Newtonian fluid is what I call "Oobleck" thanks to Dr. Seuss. Oobleck is cornstarch and water mixed together. It appears similar to a cake batter but when you scoop it into your hand and squeeze it hardens. Yet, as soon as you open your hand it flows back to liquid. It is quite fun. I will warn you that it is extremely messy but easy to clean up. Colloids are another type of liquid that need to clarified. Colloids are substances such as blood or milk. "A colloid is a solution that has particles ranging between 1

and 1000 nanometers in diameter, yet are still able to remain evenly distributed throughout the solution".[11]

After liquid, there is gas. Gas will assume the shape and volume of its container. This is due to the amount of free space between particles. This means it has a lot of kinetic energy due to the space. That free space makes it easy to compress, as well. Example of gases are oxygen and carbon dioxide. Carbon dioxide occurs in cooking when baking powder is mixed with a liquid and heat is applied. It can occur when baking soda and vinegar are mixed which has created the "lava" component for many scholars' volcano science experiments. Dry ice also gives off carbon dioxide gas.

Now, here are the higher level states of matter. Plasma is similar to gas but has free ions and electrons that gives it the ability to conduct electricity. The particles exist in an excited state and can jump energy levels which gives off light. Plasma is easy to compress due to the free space between particles. "Bose-Einstein Condensates (BEC) occur when a gas of bosonic particles is cooled below a critical temperature and condenses".[12] Currently, the academic standards for Kindergarten focuses on the three original states of matter. Plasma, and Bose-Einstein, while vital to know, are not included in this research beyond acknowledging their existence. Basically, my scholars will know that plasma and BEC exist but that they will learn about them later in their education.

Chemical Reactions in Baking

After all this research, it still did not explain why cake batter rises and stays risen once it is cooked and cools back down. It would seem that the vibrational energy of the heat would slow down as it cooled and the cake would flatten. How did it stay expanded? After much investigation, the information was revealed. The answer was…a chemical reaction occurs. This was the piece of information that I had been missing to complete this research puzzle. It was not just applying heat to a state of matter; there had to be a chemical reaction. So, why does cake batter rise and hold its shape? It is because of the molecules and how they interact with each other…scientific magic. Now, there is a big difference between making the cake from scratch and using a boxed cake mix. It is much simpler and cheaper to pick up a boxed cake mix but the scholars identify more of the ingredients if you make it from scratch. The magic of cake's chemistry will be explained from the perspective of making it from scratch.

Let's begin with the flour. The flour you chose to use makes an impact on what you are creating. You need cake flour if you are making a fluffy cake from scratch. However, if you are making a pie crust then you use all-purpose flour. The protein count in the cake flour is lower which provides a lighter texture and the all purpose flour has a higher count which creates a more dense texture. The proteins in flour are gliadin and gluten. These proteins are made up of amino acids that when mixed with sugar will later create the Maillard reaction when they are exposed to heat. The Maillard reaction is the source of browning and heightened flavor of the cake.[13] Once moisture is added to flour it allows these two proteins to intertwine. This process creates a webbing of proteins which with another ingredient of the flour creates the structure. What is this additional ingredient in flour besides those vital proteins? It is starch. "Starches are made up of two compounds, amylase and amylopectin".[14] Basically, they assist in thickening a mixture. They can be used to gelatinize a mixture such as gravy or meringue, as well. This one ingredient, cake flour, is primed and ready to create this magic. It awaits vital ingredients to activate its chemistry.

Next, we add in the baking powder which is the main ingredient to creating baking magic. Baking powder and soda are responsible for creating carbon dioxide in the mixture. This is vital because the carbon dioxide is what creates the bubbles that give cake its light and fluffy texture. If you forget to add this to your mix, then you will have a hard brick-like cake. Please, note that baking powder and baking soda are different ingredients. Baking soda requires acidic ingredients like buttermilk or lemon juice to active the chemical reaction. If your recipe does not have an acidic ingredient then the baking soda will never do its magic. Baking powder, however, has acidic chemicals added into the mix that allows it to complete its magic. Double-acting baking powder has two levels of reactions. One, when it is mixed with wet ingredients, and another, when it is introduced to heat. Finally, we mix in the salt to this dry mixture of ingredients. Salt assists in masking bitterness and enhancing flavors. There are flavor nuances that our senses would never register if the salt molecule did not bind with them to allow them to be experienced. It is extraordinary how the simplest molecule can make such a huge difference in a mixture!

Now, it is time to discuss the wet ingredients. The dry ingredients are left in their own container and a new container is used for wet ingredients. The sugar, which is sucrose, is the first ingredient to be measured. Sugar's role in cake is twofold. First, it sweetens the mixture and second it works with the amino acids to achieve the Maillard reaction. Fat is the first ingredient to mix with the sugar. This is called creaming the sugar. The fat in a cake recipe is the butter or shortening. Also, it needs to be room temperature instead of chilled. Chilled butter is for recipes such as pie crusts. Temperature plays an important role in how fat mixes with other ingredients. Chilled butter coats other ingredients while room temperature butter mixes with other ingredients. Promptly begin mixing the butter into the sugar with a whisk. This process will continue until the two ingredients cannot be distinguished separately. The process of creaming the sugar with butter traps the air into the mixture. The more air bubbles that are in the cake the less the result will be like a rock.

Next, the eggs are added into the mixture one at a time. The eggs' role is to bind the ingredients together and assist in trapping the air into the cake's structure. Egg whites can become mechanically leavened if they are whisked and air is trapped within the denatured proteins. This applies to recipes such as a meringue pie not to a cake. These wet ingredients are whisked until all are evenly mixed. Last, the milk is added. Milk provides moisture to the cake as well as assisting the flour proteins in forming their crosslinks.

Finally, it is time to mix everything together. The dry ingredients are slowly mixed into the wet ingredients. This allows all the ingredients to be saturated and evenly mixed. The baking powder is producing carbon dioxide. The flour, sugar, and eggs are trapping the gases, and the structure is being strengthened. If you do not mix the ingredients correctly, then the mixture is doomed. If you do not mix it enough then it cannot form the bonds needed to strengthen the structure to trap the gases. However, if you over-mix it then the bonds that were formed become broken. If the recipe calls for 50-70 strokes then 30 or 100 strokes is not going to create an ideal cake. Also, it states that an electric beater can be used but you must pay close attention to the speed and length of time. Pour the batter into the appropriate container and apply the required heat. Cakes can successfully be baked in all three of the listed forms of heat. The baking powder will produce more carbon dioxide causing the cake to rise. The bonds formed will maintain the structure as the cake rises. The sugar and amino acids cause the Maillard reaction and the cake browns as the flavor heightens. The magic of chemistry is occurring and your delicious potion will soon be ready to eat.

Exploring the Five Senses

The five senses are the core of the ability to experience the flavor of this cake and other foods. This section delves into the exploration of this relationship. My kinderscholars will already have learned that they have five senses and how each sense is used. Originally, I had planned to include the background for how the five senses work into this unit. Upon reflection, I decided that information is better served in a unit about the five senses. I have included a resource that delves into that topic which will be included in the teacher resource section. This unit will explore how smell and taste combine to effect flavor.

As a child, I recall pinching my nose to be able to eat some horrid vegetable set on my plate. It was never a choice not to eat it. Thus that coping mechanism was formed without thought. As an adult, I never stopped to ponder why it worked until I began researching this unit. If the receptors on my tongue are responsible for taste then how did plugging my nose change the flavor of the vegetables? This research led me to discovering that taste and smell function as a cohesive team. They blend together to create a whole experience when we eat. Our brain is quite the clever magician too. It fools us into thinking that when we drink a chocolate milkshake we are tasting all the nuances of the ingredients. Actually, what is happening is the receptors are tasting salty and sweet. That is all that we are tasting! Our sense of smell absorbs the scent of chocolate, dairy, a hint of vanilla and egg.[15] Then, the stimulus is sent to our brain via electronic pulses and bam the chocolate milkshake illusion is complete. After allowing this to render me speechless for a few moments, I realized that this reinforces my idea that science is modern day magic. Every person carries within them the capacity to perform magic. They are doing it every day when they enjoy a meal. The more knowledge each person attains, then the better magician they can become.

Strategies

My Kinderscholars have a wide-variety of needs. The vital strategy that I use throughout all of my teaching is differentiated instruction. Differentiated instruction is exactly what is sounds like it should be. The instruction is adapted to meet the needs of the scholars. This includes scaffolding the scholars who are ELL (English Language Learners) that need support with vocabulary. I provide this support with imagery built into every lesson, numerous hands-on visual activities, and additional small group time. This strategy accommodates a variety of learning styles which are the best style in which a scholar learns. There are numerous learning styles and the following is a simplified definition of each style. Visual means that the scholar learns by seeing. The auditory mode is for the scholars that learn by hearing. Musical, which is a form of auditory, is when learning takes place through song and dance. Kinesthetic or tactile is for a scholar that learns by hands-on experiments and recreating it for themselves. Logical or mathematical scholars relate to facts that can be organized and analyzed. Interpersonal consists of scholars that learn through a whole and small group format. Intrapersonal is a scholar that learns best working independently. Naturalists are scholars that excel at learning outdoors. Another key element to differentiation is flexible seating. Flexible seating can be as simple or complex as the scholars' needs. It might be a choice between a chair and lying on the floor. The scholar may need a space to work that allows for constant motion such as a chair that rocks. It may be a space that is secluded. It is entirely dependent on the scholar. Another method for differentiation is the technology I have available. There are several laptops and an iPad that offer numerous scientific applications

and websites with short educational videos and activities to reinforce the concepts. As an adult, I understand the environment and strategies I need to succeed in learning. As a teacher, it is my job to ensure that I am observing my scholars and identifying their needs to be successful in learning. If I would not sit in a hard chair to write a paper, then why should the scholars be required to do this?

Another key strategy is the design cycle which goes hand-in-hand with the scientific method. The first day of school, I model for my scholars that making a mistake means that there is an opportunity to learn. They stop seeing mistakes as a negative experience. A mistake is an opportunity to analyze and use problem solving to understand what happened. I use the acronym F.A.I.L. which stands for their First Attempt In Learning. Scholars need to understand the mistakes do not mean that you give up but that you try again and discover new ways to succeed. Today's scholars need to learn grit and determination. These are not characteristics that are as commonplace as they were in my childhood. Now, let us discuss the wording used by my kinderscholars for the scientific process. It is to make an observation, ask questions (research), make a hypothesis, conduct the experiment, draw conclusions and report the results. I use an anchor chart that states this process in a cyclical format along with graphics depicting each stage. I introduce this at the beginning of the year and refer to it at the beginning of every science unit. Another similar strategy is the Design cycle. Though they share similarities, they have different foci on the outcome. The Design cycle steps include: Ask, Imagine, Plan, Create, and Improve. It is an ever-continuing cycle until success is met. The scholars ask a question, imagine the solution, plan how to implement it, create it, and then discover how to improve it. This is a vital strategy in my classroom as I have found that problem solving seems to be a forgotten concept nowadays. This is a generation of Google and Siri where most of the answers are available at the touch of a button. These scholars need to learn how to problem solve without relying on technology to provide the answers. The Design cycle has a cyclical anchor chart that the scholars refer to throughout the year. It is reviewed before any engineering activities and design challenges.

Visual aids are important strategies for young scholars. This unit uses anchor charts that are made as concepts are learned such as the scientific method and states of matter. Then, the scholars refer to them whenever they need to refresh their knowledge. Another visual aid used is a graphic organizer. Graphic organizers can be a wide variety of materials. The visual aids provide the organization that they need to stay focused and finish the unit or lesson to fidelity. A second visual aid is our word wall. The word wall stays in one place in my classroom throughout the school year. The words change as new vocabulary is introduced and the scholars identity the beginning letter/sound and place it accordingly. Each word has a small image attached to it to assist with recall. Finally, scientific journals will be used throughout this entire unit. The scholars will use imagery, labels and sentences to document what they observe throughout the unit. The scholars will not be writing multiple sentences until near winter break so in the beginning it will be words and single sentences they use to record data. Their journals will have blank sheets for sketches that they will draw with pencil and then illustrate with different art media. Graphic organizers for documenting the scientific process or design process will be inserted into the journals when appropriate for the knowledge that they learned. There are numerous additional strategies that I use in my classroom which would fill pages if I were to list them all. Thus, I have just listed the main strategies.

Activities

Week 1 - Solids

This unit will be split into six week-long sections. The first week will begin with an exploration into the solid state of matter. I will have a mystery bag with an assortment of different solid classroom materials. The scholars will reach in and pull an item out of the bag until the bag is empty. The scholars will discuss what they think these items have in common. I will neither confirm nor deny their theories. Next, I will read aloud the book *States of Matter: Solids* by Maria Koran. After identifying and describing key vocabulary, I will assist the scholars in creating an anchor chart for solids. Next, the scholars will then revisit the items and discuss what they have in common. The sought answer is that they are all solids. Day two will be for researching solids on the website PebbleGo. The scholars will document their findings in their scientific journals during small group time. Day three, the scholars will experiment with solid states of matter through engineering a shape made entirely of solids. Day four, the scholars will document about a solid (such as a LEGO) in their scientific journals using their five senses. Day five, each small group will share their discoveries with the rest of the class through a written or oral presentation.

Objectives:

1. Scholars will identify that solid is a state of matter.
2. Scholars will name the characteristics of a solid using their five senses.
3. Scholars will conduct research using technology to discover information about solids.
4. Scholars will record data about solids in their journals.

Materials:

A small bag or sack

An assortment of classroom materials that are solid

States of Matter: Solids book by Maria Koran

Anchor chart paper

Scientific journals

Computers for research

Solid material for building shapes, examples: blocks, LEGO, K'Nex

Evaluation:

Scholars will meet all of the objectives listed in the objectives section.

Week Two - Liquids

The state of matter for this week is liquid. Day one will begin with the scholars observing five bottles that I brought to school. Each bottle will contain a different liquid and the last will contain multiple liquids. The

scholars will engage in a discussion over what each of these items have in common. I will read the book *States of Matter: Liquids* by Maria Koran. Last, the scholars will create an anchor chart for liquids. Day two, the scholars will research liquids using the websites PebbleGo and BrainPop Jr. The scholars will document their findings in their scientific journals during small group time. Day three, the scholars will experiment with the liquid state of matter through creating their own bottle of colored liquids with varying densities. They will explore why liquids separate within the bottles. Day four, the scholars will document about a liquid in their scientific journals using their five senses. Day five, each small group will share their discoveries with the rest of the class through a written or oral presentation.

Objectives:

1. Scholars will identify that liquid is a state of matter.
2. Scholars will name the characteristics of a liquid using their five senses.
3. Scholars will conduct research using technology to discover information about liquids.
4. Scholars will record data about liquids in their journals.

Materials:

Five bottles with different liquids

States of Matter: Liquids by Maria Koran

Anchor chart paper

Scientific journals

Computers for research

Four or five liquids dyed using food coloring to create density bottles

One small bottle for each scholar

Glue gun to glue bottle shut

Evaluation:

Scholars will meet all of the objectives listed in the objectives section.

Week 3 - Gases

Gas is the state of matter for this week. Day one will begin with the scholars observing two balloons; one filled with helium and one filling up with carbon dioxide. The scholars will engage in a discussion over what these balloons have in common. I will read the book *States of Matter: Gases* by Maria Koran. Last, the scholars will create an anchor chart for gases. Day two, the scholars will research gases using the websites PebbleGo and BrainPop Jr. The scholars will document their findings in their scientific journals during small group time. Day three, the scholars will experiment with gas by blowing regular bubbles and then they will try to catch smoke bubbles. Day four, the scholars will document about gases in their scientific journals using their five senses. Day five, each small group will share their discoveries with the rest of the class through a written or oral presentation.

Objectives:

1. Scholars will identify that gas is a state of matter.
2. Scholars will name the characteristics of a gas using their five senses.
3. Scholars will conduct research using technology to discover information about gases.
4. Scholars will record data about gases in their journals.

Materials:

Helium filled balloon

Bottle of pop with regular balloon

States of Matter: Gases by Maria Koran

Anchor chart paper

Scientific journals

Computers for research

Bubble mix

Bubble wands

Dry ice

One mitten for each scholar to catch smoke bubble

Evaluation:

Scholars will meet all of the objectives listed in the objectives section.

Week 4 - Heat Transfer: Conduction

This is the second portion of this unit. Scholars have mastered the three basic states of matter. Now, they will be learning about heat and how it is transferred. This week the scholars will learn what is heat and how is it transferred through conduction. The hook for heat will be the scholars rubbing their hands together until they become warm. This will lead into the discussion of heat resulting in an anchor chart displaying the key facts. The scholars will delve into heat conduction through a series of experiments done in small groups. First, they will melt ice cubes in their hands. Next, they will make pancakes on a griddle. Last, they will make butter from whipping cream. Each experiment will be documented in their scientific journals using their five senses. The last day of the week, each small group will share their discoveries with the rest of the class through a written or oral presentation. This information will be used to create an anchor chart about conduction.

Objectives:

1. Scholars will explain what is heat.
2. Scholars will identify sources of heat conduction.
3. Scholars will analyze experiments to understand the process of conduction.

4. Scholars will use their five senses to explore how heat conduction works on matter.
5. Scholars will work as a team.

Materials:

Ice cubes

Pancake mix

Water

Spatula

Griddle

Heavy whipping cream

Salt

2 small glass baby food jars

Evaluation: Scholars will meet all of the objectives listed in the objectives section.

Week 5 - Heat Transfer: Convection

This week the scholars will learn about convection. During the week, the scholars will delve into heat convection through a series of experiments done in small groups. Each experiment will be documented using the scientific process. First, they will create a paper spiral and hang it over a regular lamp bulb. They will observe what happens to the spiral as it hangs over the lamp. Next, they will observe a lava lamp and notice what happens after turning on the lamp. Last, they will make applesauce using a crockpot. They will use their five senses to explore what is occurring to the apples throughout the process. The last day of the week, each small group will share their discoveries with the rest of the class through a written or oral presentation. This information will be used to create an anchor chart about convection.

Objectives:

1. Scholars will identify a source of convection.
2. Scholars will analyze experiments to understand the process of convection.
3. Scholars will work as a team.
4. Scholars will use their five senses to explore how heat convection works on apples.

Materials:

Paper for spirals

Lamp with regular lightbulb (LED bulbs will not work)

String

Lava lamp

Pre-diced apples

Sugar

Water

Cinnamon

Crock pot

Bowls

Spoons

Evaluation: Scholars will meet all of the objectives listed in the objectives section.

Week 6 - Heat Transfer: Radiation

This week the scholars will learn about radiation. The scholars will delve into heat radiation through a series of experiments done in small groups throughout the week. Each experiment will be documented using the scientific process and their five senses. The first experiment will require that the scholars place crayons on paper plates and set them outside in the sunlight. They will observe what happens to the crayons after an hour. The next experiment will be to create S'mores using sunlight. They will place an open S'more in the bottom of a clear plastic cup. They will place another plastic cup upside down on top of the first cup and tape them together. Each scholar will place their cup outside in the sunlight. Last, the scholars will create a solar oven and then bake cupcakes inside of it. This will be a two-day project. The first day each team will create the solar oven. The second day, each team will bake a small batch of mini-cupcakes in their solar oven. The last day of the week, each small group will share their discoveries with the rest of the class through a written or oral presentation. This information will be used to create an anchor chart about radiation.

Objectives:

1. Scholars will identify a source of radiation.
2. Scholars will analyze experiments to understand the process of radiation.
3. Scholars will work as a team.
4. Scholars will use their five senses to explore how heat radiation works on cupcakes.

Materials:

Crayons

Paper plates

Two plastic cups per scholar

Tape

Graham crackers

Chocolate

Marshmallows

Solar oven materials (link in web resources)

Pizza boxes (one per team)

Aluminum foil

Scissors

Clear wrap

Clear tape

Ruler

Thermometer

Evaluation: Scholars will meet all of the objectives listed in the objectives section.

The unit will conclude with each team creating a presentation demonstrating their mastery over the states of matter, heat, heat transfer and how heat effects states of matter. Their presentation will be created using Power Point or an iMovie. The teacher will assist with the technology but the scholars will be responsible for the content. Then, the scholars will show their presentation to another class and follow with a question and answer session.

Notes

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1. Richard Caulham, "History of Thermodynamics" University of Waterloo, 25 May 2017, www.mhtl.uwaterloo.ca/courses/me354/history.html.
2. Nancy Hall, "Thermodynamic Equilibrium" *NASA*, 13 June, 2017, https://www.grc.nasa.gov/www/k-12/airplane/thermo0.html
3. Nancy Hall, "First Law of Thermodynamics" *NASA*, 13 June, 2017, https://www.grc.nasa.gov/www/k-12/airplane/thermo1.html
4. Nancy Hall, "Second Law of Thermodynamics" *NASA,* 13 June 2017, https://www.grc.nasa.gov/www/k-12/airplane/thermo2.html
5. "Moving Molecules - The Kinetic Molecular Theory of Heat" *Coolcosmos.ipac.caltech.edu*, last modified August 6 2013, http://coolcosmos.ipac.caltech.edu/page/lesson_moving_molecules.
6. Doris Daou, and Linda Hermans-Killam, *iPAC, California Institute of Technology*. Accessed. May 30, 2017. www.coolcosmos.ipac.caltech.edu/cosmic_classroom/light_lessons/thermal/transfer.html
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10. Petrobras Divulgação, "Soft solids and the science of cake" *University of Cambridge,* 24 February 2016, http://www.cam.ac.uk/research/features/soft-solids-and-the-science-of-cake

11. Brar Abheetinder, and Jimmy Law, “Colloids” University of California, 9 January 2017, https://chem.libretexts.org/Core/Physical_and_Theoretical_Chemistry/Physical_Properties_of_Matter/Solutions_and_Mixtures/Colloid
12. Wolfgang Ketterle, *Massachusettes Institute of Technology*. Accessed 28 May 2017, www.cua.mit.edu/ketterle_group/Popular_papers/BEC%20Enc%20preprint.pdf.
13. Robert L. Wolke,*“What Einstein told his cook”*(New York, Norton & Company, Inc. 2002) 24
14. Jeff Potter, “*Cooking for Geeks”* (California, O’Reilly Media, Inc., 2010) 81
15. Jeff Potter, “*Cooking for Geeks”* (California, O’Reilly Media Inc., 2010) 305

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https://chem.libretexts.org/Core/Physical_and_Theoretical_Chemistry/Physical_Properties_of_Matter/Solutions_and_Mixtures/Colloid

Caulham, Richard. “History of Thermodynamics” University of Waterloo, 25 May 2017, www.mhtl.uwaterloo.ca/courses/me354/history.html.

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“Moving Molecules - The Kinetic Molecular Theory of Heat” *Coolcosmos.ipac.caltech.edu*, last modified August 6 2013,

http://coolcosmos.ipac.caltech.edu/page/lesson_moving_molecules.

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https://www.grc.nasa.gov/www/k-12/airplane/thermo1.html

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https://www.grc.nasa.gov/www/k-12/airplane/thermo0.html

Potter, Jeff, “*Cooking for Geeks”* California, O’Reilly Media, Inc., 2010

Potter, Jeff, “*Cooking for Geeks”* California, O’Reilly Media Inc., 2010

Wolke, Robert L., *“What Einstein told his cook”* New York, Norton & Company, Inc. 2002

Teacher Resources

Carol Boynton. *Sensing our Five Senses.* http://teachers.yale.edu/curriculum/viewer/initiative_09.06.02_u

This resource provides the background information needed on the five senses for early childhood grade levels.

Harry Kindergarten Music. *Matter Chatter.* www.youtube.com/watch?v=C33WdI64FiY

Jessica Claire. *Chemistry of Baking* www.scholarcommons.sc.edu/cgi/viewcontent.cgi?article=1014&context=senior_theses.

This is a wonderful resource for higher-level comprehension over the states of matter and chemical reactions.

Lerner Classroom. *Teaching States of Matter.* https://www.lernerbooks.com/services/eSourceDownloads.aspx?isbn=9780822568360

This fantastic resource breaks down how to teach states of matter including strategies, activities and assessments.

Web Resources

https://jr.brainpop.com

https://www.homesciencetools.com/a/build-a-solar-oven-project

https://www.khanacademy.org

https://www.nasa.gov/centers/glenn/home/index.html

https://nzic.org.nz/ChemProcesses/food/6D.pdf

http://pebblego.com

https://www.sugar.org/images/docs/sugar-functional-roles.pdf

Student Resources

Boothroyd, Jennifer, *What is a gas?* Minnesota: Lerner Classroom, 2007.

Boothroyd, Jennifer, *What is a liquid?* Minnesota: Lerner Classroom. 2007.

Boothroyd, Jennifer. *What is a solid?.* Minnesota: Lerner Classroom, 2007.

All of these books by Jennifer Boothroyd provide simple and clear explanations of each state of matter.

Dr. Seuss. *Bartholomew and the oobleck*. New York: Random House Books for Young Readers, 1949.

This book is a perfect read aloud before creating a non-Newtonian state of matter.

Garrett, Ginger. *Solids, liquids and gases*. Connecticut: Children's Press, 2005.

Koran, Maria. *States of Matter: Gases.* United States: Eye Discover, 2016.

Koran, Maria. *States of Matter: Liquids.* United States: Eye Discover, 2016.

Koran, Maria. *States of Matter: Solids.* United States: Eye Discover, 2016.

These three books over the states of matter by Maria Koran are engaging and come with interactive online content.

Mason, Adrienne. *Change It! Liquids, Solids, Gases and you.* Toronto: Kids Can Press, 2006.

This book discusses what is matter and the different states of matter in an engaging story.

Mason, Adrienne. *Touch it! Materials, Matter, and you.* Toronto: Kids Can Press, 2005.

This book takes a hands-on approach to teaching states of matter.

Ontario Science Center. *Solids, Liquids, and Gases.* Toronto: Kids Can Press 1995.

This book has 13 kid-friendly experiments over the states of matter.

Zoehfeld, Kathleen. *What is the World Made Of? All about Solids, Liquids and Gases*. New York: Harper-Collins, 1998.

This is a fun book that investigates the states of matter.

Appendix

Next Generation Science Standards for Kindergarten - Second Grade

Science and Engineering expected practices include:

- Asking questions (for science) and defining problems (for engineering)
- Developing and using models Modeling in K–2 builds on prior experiences and progresses to include using and developing models that represent concrete events or design solutions.
- Planning and carrying out investigations
- Analyzing and interpreting data using mathematics and computational thinking
- Constructing explanations (for science) and designing solutions (for engineering)
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

K-PS3-1. Make observations to determine the effect of sunlight on Earth's surface.

Oklahoma Academic Standards for Kindergarten - Second Grade

K.D.1 Collect, organize, and interpret categorical data.

K.D.1.1 Collect and sort information about objects and events in the environment.

K.D.1.2 Use categorical data to create real-object and picture graphs.

K.1.R.2 Students will ask and answer questions to seek help, get information, or clarify about

information presented orally or through text or other media with guidance and support.

K.1.R.3 Students will engage in collaborative discussions about appropriate topics and texts with peers and adults in small and large groups with guidance and support.

K.1.W.2 Students will work respectfully with others with guidance and support.

K.6.W.2 Students will find information from provided sources during group research with guidance and support.

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