Bay Area Scientists in Schools Presentation Plan

Lesson Name: Chemistry "Magic!" How do we know if there is a chemical change or only a state change?

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Grade Level 5 th Standards Connection(s): Atoms, Elements and Periodic Table and Molecular properties. During chemical reactions atoms rearrange into different products with different properties. All matter is made of atoms, which combine to form molecules. Each element is one kind of atom, organized in Periodic Table. Properties of common molecules and common properties of salts.

Next Generation Science Standards:

5-PS1-3. Make observations and measurements to identify materials based on their properties.

5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. Develop a model to describe phenomena. (**5-PS1-1**) *Planning and Carrying Out Investigations* Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (**5-PS1-4**) Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (**5-PS1-3**)	*PS1.A: Structure and Properties of Matter* Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon; the effects of air on larger particles or objects. (**5-PS1-1**) The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (**5-PS1-2**) Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (**5-PS1-3)** *PS1.B: Chemical Reactions* When two or more different substances are mixed, a new substance with different properties may be formed. (**5-PS1-4)**	*Cause and Effect* Cause and effect relationships are routinely identified, tested, and used to explain change. (**5-PS1-4**) *Connections to Nature of Science* Scientific Knowledge Assumes an Order and Consistency in Natural Systems Science assumes consistent patterns in natural systems. (**5-PS1-2**)

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Common Core Standards:

ELA/Literacy:

W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.

Mathematics:

MP.2 Reason abstractly and quantitatively.

MP.5 Use appropriate tools strategically.

MP.4 Model with mathematics.

FOSS Connections:

Grade 5 Module: *Mixtures and Solutions*

Teaser: Is Chemistry Magic? No! Learn how to understand, control, and manipulate the very elements of the universe! Students will see a demonstration and each will perform their own experiment designed to help them identify a mere state change from a chemical change.

Objective: Students will gain insight into the use and application of the periodic table, review atoms, molecules, phases of matter, and then analyze a list of substances to find the scientific basis for classifying a change in matter as a physical property or a chemical property. Students will see a live chemistry demonstration for both a phase change and a chemical change, and each student will perform their own experiment. Students will have a review of the scientific process and basic chemistry.

At the end of the lesson, students will have confidence in their own ability to understand and manipulate the world around them, and have an idea of what to expect in further chemistry classes.

In this lesson students will learn how to:

- Develop testable questions
- Conduct a simple investigation
- Identify the dependent and controlled variables in an investigation and use this information to determine fair testing
- Identify a single independent variable in a scientific investigation and describe what will be learned by collecting data on this variable
- Record data using appropriate graphic representation (including charts, graphs, and labeled diagrams), and make inferences based on those data
- Draw conclusions based on scientific evidence and indicate whether further information is needed to support a specific conclusion

- Write a report of an investigation that includes tests conducted, data collected or evidence examined, and conclusions drawn

Vocabulary/Definitions:

- **Sublimation, Deposition, Vaporization, Condensation, Freezing, Melting, Deionization, Ionization**: state changes that matter can undergo (see diagram labeled Image 1 which will be used to convey meaning).
- **Ionic and covalent bonds**, atoms attach via attraction due to polarity or they attach by sharing electrons.
- **Aqueous**: the state of something dissolved in water.
- **Solution**: a mixture that is uniform in composition , like soda (water and sugar).
- **Mixture**: the combination of two or more substances. We classify mixtures on based on the degree in which the materials are combined. For example, oil and water, sand and water, sweet tea, air.
- Chemical names and their common name counterpart as arise from students' questions.

Provided Materials: For the Demonstration all materials and necessary equipment will be provided. The complete material list is:

- Water: as an ice cube, room temperature liquid, and hot liquid
- Dry Ice
- 5% Acetic Acid solution (house-hold vinegar)
- Sodium bicarbonate (commercial baking soda)
- Beakers
- Dishes
- Paper towels
- Safety equipment
- Avocado and small bag of corn chips
- Tea bags
- Precipitation demonstration solutions

For students' experiment each student will be given:

- A sheet of graph paper and index card
- Paper bag with three ziplock bags of pre-measured, grocery-store baking soda
- A small paper cup for vinegar (to be dispensed from several plastic bottles with help from me and my partner)
- Paper towels
- Wet-wipes
- A garbage bag will also be provided for the classroom.

Required Materials: If possible, each student should have a pen, ruler, and calculator.

Classroom Set-up: I will need about 10 minutes of prep time and about 5 minutes to clean up. This lesson can be completed as is, however if projection equipment is available I will include pictures of atoms, molecules, and other multi-media support.

Classroom Visit

Personal Introduction: **_____5_____ Minutes**

Hello! I am Melissa, and I am here to share my knowledge of chemistry with you. I am a student just like you but I have been in school much longer! I have our agenda on the board so you know what to expect.

Lesson Agenda
Introduction
Demonstration
Experiment protocol
Live Experiment!
Review and Quiz
Wrap-up and Take-home Information

I have a lot to show you and not much time, so I'm going to go fast, just raise your hand if you want me to slow down or repeat anything.

I love chemistry because I like to play and ask questions. Scientific experimentation is play but we take notes about the game. Does anyone know how to play a sport? Does anyone know how to play a video game? Excellent! Have you ever asked a question?... Great! You have the skills you need to be a chemist! So, for the next hour you are all fellow chemists! I am going to use words and symbols that may seem strange. I will explain each one so if you ever feel like you are missing information or need a better explanation than I give you at first, please ask me to make things clear for you.

Chemists write a lot. So much in fact that they all go tired and decided to write in code so they could write less and perform more experiments. I am going to use this code for you.

Topic Introduction: **_____20_____ Minutes**

Starting with an ice cube, we will explore state changes, liquid to solid to gas. I will have ice cubes on a plate, a bowl of room temperature water and a mug of hot water.

What do chemists do? Chemistry is a science and so chemists follow the scientific method of investigation. (Refer to slide or board and ask class to read out loud.) Now lets use this to explore a fundamental question in chemistry: Is it a state change or a chemical change? How will I know the difference?

We are going to begin with a game. I call it the State of Matter game. (Here students form 3 groups - one for each of the three basic states and we learn how each state behaves: total of 10 minutes of running around.)

OK, everyone back to their seats! We are going to put our knowledge to the test! (I'll have three clear glass containers in front of me, one with ice, one with room temp water and one with steamy, hot water) What are the states of this water (I'll write H_20 on the board) Are all three of these things the same stuff? ... But look, they do not act the same...I can put a tea bag on top of this ice cube and nothing happens. In cold water it seems to be different, and in hot water it is clearly different. Of course this is all water but water in different states, or phases. We have a solid, a liquid, and here above the hot water we have water vapor which is a gas. Now keep in mind the tea bag made the hot water turn a different color. We are going to come back to this and investigate more, but first lets learn what states are possible and what changes can happen...

A phase change or state change means the matter itself does not change. For example, if I cut up a piece of fruit is it different stuff than then whole piece? What about this avocado? Have you ever eaten one? OK, I'm going to smash it ... is it still an avocado? But, it does not look like and avocado does it? How do we know it is the same thing? How about these corn chips? Are they the same thing when whole or smashed? [Get volunteer to taste them, verify they are the same kind of 'matter.' Write answers on board].

This is carbon dioxide (write on board: CO_2). Has anyone heard of it? This is stuff is normally a gas at room temperature. Temperature plays an important role in state changes. Remember our "hard water" it is a solid because it is cold...see it now, we have a pool of liquid where it is melting. Chemists say room temperature to mean how it feels to be here in this room right now. On the periodic table we note what state substances are at room temperature. [show table and how to identify states]. Now, take a look at this block of Dry Ice. Do you see any liquid? Do you see any steam? Hum, steam is warm right? But this is cold! [Have volunteer come up to wavy hand over both and verify temperature.] What is going on? Sublimation! [refer to image 1] Now we started with very cold CO_2 and we ended with the same thing...so is this a state change. The matter does not change only the "state" or formation of the matter has changed.

So now that you have some state changes, lets talk about chemical changes. If the same stuff can be solid, liquid, gas or plasma how will we know when a chemical change has occurred? Lets go back to my tea brewing here. Does it look like the other liquid water? Do you think there is a chemical change? Me too! But

alas we are all wrong! This tea is not a pure substance like the water or carbon dioxide. It is a mixture of two substances, in this case water and the leaves of a plant which is where tea comes from. Remember our corn chip? It too is a mixture, it is not pure corn which itself is a mixture of water, protein, starch, and sugars. The distinction between physical and chemical is not as easy as we would like it to be so lets review what we just learned.

Take a careful look at the chemical change pictogram. (reference material at end of this document) I want to make sure you notice that in the stage or phase change images the "stuff" does not change, only the space between the particles. Now look at the one for chemical change...what do you notice? Yes, we have different stuff! So a chemical change is when we take one thing and make another. Now lets look at what happens when we mix this clear solution with this clear solution... AH! Look at that, a solid formed! Did we see a chemical or physical change? Was this a chemical or physical reaction?

OK, now each of you is going to do your own experiment!

Learning Experience(s): **____20___ Minutes**

Students will begin their own experiment forming a gas from the mixture of a solid and a liquid.

Here is what we are going to do: we are going to mix sodium carbonate (a solid in powder form) with acetic acid in liquid form. The chemical reaction looks like this:

$NaHCO_{3(s)} + HC_2H_3O_2 \rightarrow CO_{2(g)} + C_2H_3O_{2(aq)} + Na_{(aq)} + H_2O_{(L)}$

Ack! What does that mean! Do not worry, this is just the code chemists use. We read it like so...sodium bicarbonate (composed of sodium, hydrogen, carbon, and oxygen atoms - here they are on the periodic table)...

Now each of you will be able to control this reaction. Each of you is a chemist! This is what Chemists do when they perform experiments:

Your experiment may fail or succeed, but the knowledge you gain and give to others is what counts.

You will be respectful of the chemicals. They are your tools so treat them with care and caution.

As chemists, you will not be afraid to ask questions. If you need any help raise your hand!

Take a look at your lab report - Please put your name on it now.

[Here I will read over the experimental procedure with the class and we will begin the experiment. I will give the students about 20 minutes to conduct three trials.]

Each student will get printed procedures and a paper bag with 3 sandwich-sized plastic zip-lock bags. Each of the plastic bags will have a number (1,2, and 3). Every student's bag 1 will have 1/2 tsp baking soda, bag 2 will have 1 tbs baking soda, and bag 3 will have 2 tbs baking soda. Each student will be given 3 condiment-sized plastic zip-lock bags with a number (1,2,3), and each student will get a small paper cup with vinegar. They will add the vinegar to the baking soda bag, recording their actual procedure. Once the acid has been added, the student will seal the bag and shake it. After all three bags have been used, they will make observations and write those on the graph paper provided. After a class discussion, students will have a minute or two to write a conclusion on their lab report.

Wrap-up: Sharing Experiences **____8____ Minutes**

OK, may I have your attention! So, how did it go? OK, please raise your hand if you got a full bag at least once...twice...all three times...Wow, here are the class results!

OK, so lets review chemical and physical changes...here we had both a state change: solid + liquid = gas and clearly we also had a chemical change because we got a different material. OK, take two minutes to write a conclusion. Please put all your trash in the bag and wipe your hands clean with the wet wipes and paper towels. Now please take the index card and get ready for the quiz! Here we go!

Please write your name.

Is a whole avocado a different kind of matter than a smashed up avocado?

Please list one example of a state change.

The experiment you just did was a _____ change. (chemical/physical)

Please tell me what sublimation means. (Is it a physical or chemical change?)

Discuss any student responses that differ and end with each student getting a certificate of participation, and a page to take home and repeat this experiment and places to find information about chemistry that is age approbate.

Connections & Close: **____2____ Minutes**

Each student will get printed instructions for performing the same experiment at home. In addition, the web links listed below will be included so students interested can research the subject at school or home.

http://flamechallenge.org

http://www.middleschoolchemistry.com

www.sciencenewsforkids.org

http://www.ipl.org/IPL/Finding?Key=chemistry&collection=youth

Total 50 – 60 Minutes

Differentiated Instruction:

English Learners: Repeat directions, if necessary, and physically model how to mix the substances in the bags. Write vocabulary words on the board and read words aloud. Vocabulary words can also be visually demonstrated using an illustration or action and redefined in very simplistic terms.

Advanced Learners: Have students write down hypotheses about what other substances would have similar chemical reactions. Students should explain their reasoning.

Follow-up Possibilities

ELA Activity:

Students answer the following prompt:

"Write a letter to a friend explaining what you learned about chemical changes."

Mathematics Activity:

Students can graph the results of the bag experiment. Students can also write simple equations for their chemical reactions.

Other:

Students can report back on their at home experiment, they can discuss what the saw or read on one of the suggested web sites. They can work together on a challenge problem that I will leave with their teacher so they can explore the connection between chemical and non-chemical (state) changes.

Supplimental Information (will be presented as slides, writen on board or printed)

Scientific Method:

Making observations. Observations may be qualitative (the sky is blue; water is a liquid) or quantitative (water boils at 100°C; a certain chemistry book weighs 2 kilograms). A qualitative observation does not involve a number. A quantitative observation (called a measurement) involves both a number and a unit.

2. Formulating hypotheses. A hypothesis is a possible explanation for the observation.

Making predictions. The hypothesis then is used to make a prediction that can be tested by performing an experiment.

Performing experiments. An experiment is carried out to test the hypothesis. This involves gathering new information that enables a scientist to decide whether the hypothesis is correct—that is, whether it is supported by the new information learned from the experiment. Experiments always produce new observations, and this brings the process back to the beginning.

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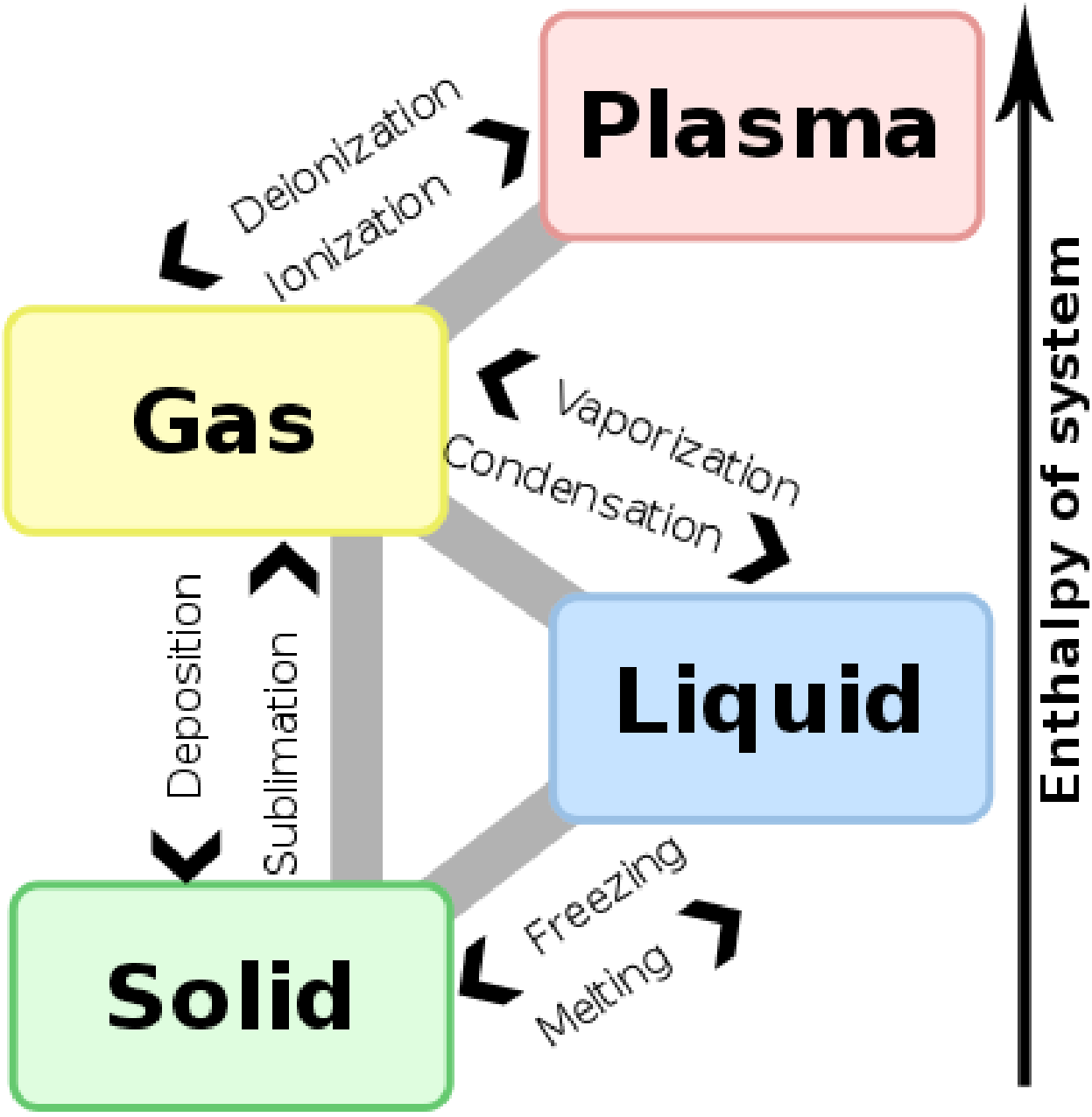

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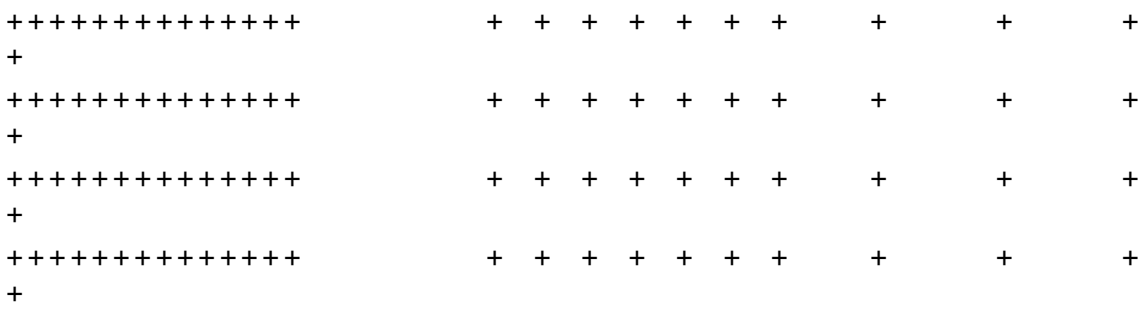
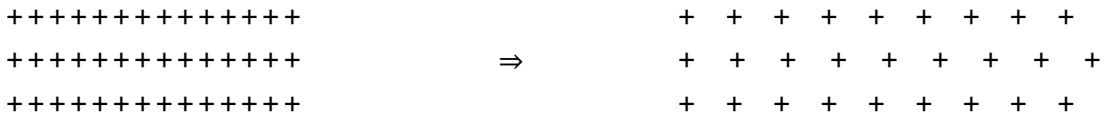
Here is a solid: Here is a liquid Here is a gas



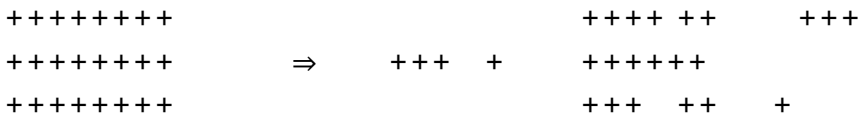
For each state, there is more or less space between the particles.

This is our solid melting:



We have the same stuff in both cases but there is more space between the particles in the liquid than there is in a solid.

This is something breaking apart (like smashing an avocado or crushing a corn chip):



See we have the same stuff, but in different chunks. We went from a whole avocado to pieces of avocado.

This is a chemical change: