Science Unit: ***Matter***

Lesson 6: ***Chemical Changes to Matter – Part 1***

School year:	2004/2005
Developed for:	Queen Alexandra Elementary School, Vancouver School District
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Grade level:	Presented to grades 1 - 2; appropriate for grades 1 - 4 with age appropriate modifications.
Duration of lesson:	1 hour and 20 minutes with extension activities for 1 hour and 20 minutes
Notes:	Please see the Matter unit, Lesson 7, *Chemical Changes to Matter – Part 2*, available from the Scientist in Residence Program website http://www.scientistinresidence.ca

Objectives

1. Review permanent and reversible changes to matter.
2. Learn about chemical changes to matter.
3. Learn about molecules and atoms.
4. Learn that molecules in different substances recombine during chemical changes to form new substances.

Background Information

Matter is anything that occupies space. The three states of matter are solids, liquids and gases. A solid is a state of matter that has its own shape. The shape of solids can change but the solid material takes up the same amount of space. Liquids and gases are states of matter that do not have their own shape. Liquids take up the same amount of space regardless of the size and shape of the container. Gases do not always take up the same amount of space and you cannot pick up a gas unless it is contained in something. All matter is made up of molecules, and molecules are made up of atoms and sub-atomic particles. Matter cannot be created or destroyed but it can change. Chemical changes can happen to matter when two or more substances react with each other. The atoms or molecules from one substance recombine with the atoms or molecules in another substance to form a new substance. This results in reorganization of one or more molecules in a substance. There are many different types of chemical reactions and they result in changes to the types of atoms in molecules. Most chemical changes to matter are permanent and it is not possible to turn the reaction back to the original state of the substances used in the reaction (e.g. baking muffins). However, some chemical changes are reversible and they have forward and backward reactions.

Vocabulary

Matter:	Something (a substance) that occupies space; what something is made of; the three states of matter are solids, liquids and gases; matter is made up of molecules.
Solid:	A substance that has its own shape (keeps its form); a solid usually feels firm; the shape of solids can change but the solid material takes up the same amount of space.
Liquid:	A substance that flows easily and takes the form of its container; liquids take up the same amount of space regardless of the size and shape of the container.

Gas:	A substance that does not have its own shape; it can expand indefinitely or be contained in a container.
Molecule:	The smallest particle of a substance that retains all of the properties of the substance; comprised of two or more atoms and sub-atomic particles.
Atom:	The smallest particle of an element that can exist either alone or in combination.
Chemical:	Something that makes up matter (any substance); chemicals are comprised of elements and the most basic element is comprised of identical atoms; chemical compounds contain a mixture of elements.
Permanent:	Something that stays the same, it does not change.
Reversible:	Something that can change and then go back to the original condition.

Materials

Chemical Change Demonstration:

- empty 1-liter clear plastic or glass bottle
- baking soda
- empty balloon
- vinegar
- teaspoon
- funnel

Shine Your Penny Activity

- ketchup
- tarnished pennies (1 for each student)
- shiny pennies (1 for each group of students for comparative purposes)
- small container to hold a tablespoon of ketchup (1 for each student)
- plastic bucket
- paper towels
- string necklaces attached to colored paper signs labeled with the words copper (4 signs in the 1st color), oxygen (2 signs in the 2nd color), and hydrogen (4 signs in the 3rd color)

In the Classroom

Introductory Discussion

1. Review physical changes to matter, and permanent and reversible changes. Emphasize that the molecules don't change with a physical change to matter.
2. Discuss chemical changes to matter and emphasize that molecules and atoms rearrange themselves (the atoms in the molecules change partners) and a new compound is formed.
    - What happens when you eat and digest food?
    - What happens when you bake cookies?
    - What happens to leaves when they fall to the ground in the autumn?
    - How is compost formed?
    - What happens when a tin can is left out in the rain?

- Promote a discussion by asking for examples of other chemical changes to matter.

3. Demonstrate a chemical change to matter by pouring ¼ cup of vinegar into a clear one liter bottle
   - Place a funnel in the opening of a balloon, and add 2 teaspoons of baking soda.
   - Place the opening of the balloon over the opening of the bottle and then lift up the balloon and tap the baking soda into the bottle. The balloon will inflate as carbon dioxide gas is produced.
4. Describe the Shine Your Penny activity. Have students look at shiny and dull pennies: What things are different? What will happen when the tarnished penny is covered with ketchup? Record predictions on a flip chart prior to doing activity.
5. Safety rules: Ask questions if you don't understand how to do something in an experiment. Don't put anything in your mouth or near your eyes during the science experiment. Wash your hands after the science activity.

Science Activity/Experiment

Shine your Penny:

1. Students will record observations of the tarnished penny before it is covered with ketchup (color, shape, shiny/dull, hardness, etc.).
2. Each student will take a penny and place it in the ketchup so that it is completely covered with ketchup.
3. Students will make a drawing of their observations of the penny covered in ketchup.
4. Ask students to rub the penny with their fingers while it is in the ketchup, count to 10, take the penny out of the ketchup, rinse the ketchup off the penny, and dry the penny. Students will then record observations of their penny.
5. Science Journal: Students will record observations on an activity sheet in their science duo-tang. Follow-up can include students recording what they were surprised by and what they learned from the science experiment.

Closure Discussion

1. Discuss predictions, observations and results for the Shine Your Penny activity.
   - Why was the penny dull at the start of the activity?
   - Why did the penny get shiny after it was covered with ketchup and rinsed with water? Is the change to the penny a permanent or reversible change?
   - What is a chemical change to matter?
   - What surprised you during the experiment? What did you learn?

Background information:

Pennies are coated with copper, and the copper atoms are packed close together in the solid surface. Pennies become tarnished when the individual copper atoms on the surface of the penny join with individual oxygen atoms from oxygen molecules in the air, and change to copper oxide. If free hydrogen ions are available (as they are in ketchup), two hydrogen ions can join with an oxygen atom from the copper oxide to form water (H_2O). The copper atoms on the surface of the penny are freed from oxygen and therefore the copper oxide doesn't exist any longer. This chemical reaction is summarized below with 2 copper atoms and appropriate amounts of oxygen and hydrogen.

2 copper atoms (Cu) + 1 oxygen molecule (O_2) = 2 copper oxide molecules (CuO)

[Cu, Cu] + [O_2] = [CuO, CuO] tarnish

2 copper oxide molecules + 4 hydrogen ions (H^+) = 2 copper atoms + 2 water molecules (H_2O)

[CuO, CuO] + [H^+, H^+, H^+, H^+] = [Cu, Cu] + [H_2O, H_2O]

2. Show students a model of a water molecule and discuss that a water molecule is made of 2 hydrogen atoms and 1 oxygen atom. The model can be made of balls of clay, using 1 color to represent oxygen and another color to represent hydrogen.

    - Direct 10 students to act out the above chemical reaction to reinforce student understanding of chemical reactions. Each student will wear one sign as follows:
        - 4 students will each wear a paper sign (color 1) that is printed with the word copper.
        - 2 students will each wear a paper sign (color 2) that is printed with the word oxygen.
        - 4 students will each wear a paper sign (color 3) that is printed with the word hydrogen.
    - The 4 students wearing copper signs will stand close together with their arms linked but hands free (representing copper atoms on the surface of a shiny penny).
    - The two students wearing oxygen signs will stand with their arms linked (representing an oxygen molecule).
    - The pair of students with oxygen signs will walk towards the students with copper signs. They unlink their arms and each student will walk towards 1 student wearing a copper sign and take that student's hand. These 4 students now represent 2 copper oxide molecules (tarnish on the penny surface).
    - The 4 students wearing hydrogen signs will walk towards the students representing copper oxide molecules. Students representing copper oxide will let go of their hands. Two students wearing hydrogen signs will grab a student with an oxygen sign and these 3 students will hold hands, with the oxygen in the middle (representing a water molecule).
    - This will be repeated with the other 2 students wearing hydrogen signs. The tarnish is now removed from the penny. The atoms changed partners during the chemical reaction. See reference section for additional information.

References

1. Hann, Judith. 1991. How Science Works. A Reader's Digest Book. Pp. 13-41. Dorling Kindersley Limited, London, England
2. Oborne, Louise and Carol Gold. 1995. Solids, Liquids and Gases, Starting with Science series by the Ontario Science Centre. Kids Can Press Ltd.
3. Penrose, Gordon. 1989. Dr. Zed's Science Surprises. Greey de Pencier Books, Toronto, Ontario. [Egg and vinegar activity to demonstrate a chemical reaction]
4. e.enclyclopedia Science, Google. 2004. Matter, pp. 10-17, DK Publishing Inc.
5. http://www.school-for-champions.com/science/matterstates.htm States of Matter by Ron Kurtus, (revised November 6, 2003), School for Champions.
6. http://www.armandhammer.com/myfamily/kids/chemical_reaction.asp Demonstrate Chemical Reactions, Arm & Hammer, Church and Dwight Co. Inc. 2003, [Baking soda + vinegar demonstration of a chemical reaction using a bottle and a balloon].

7. http://media.nasaexplores.com/lessons/01-037/k-4_2.pdf How Clean is Your Penny? NASA Explores, [Shine Your Penny activity].
8. http://rohmhaas.com/company/plabs.dir/htmldocs/Thenatureof.html The Nature of Chemical Change, Rohm and Haas Company, [Acting out an example].
9. http://ga.water.usgs.gov/edu/waterproperties.html Water Properties. U.S. Geological Survey's (USGS) Water Science for Schools web site.
10. http://ianrpubs.unl.edu/foods/nf186.htm Functions of Baking Ingredients by Sharon Lauterbach and Julie A. Albrecht, Nebraska Cooperative Extension NF94-186.
11. http://www.chatham.edu/pti/Kitchen_Chem/BCleveland_01.htm Kitchen Chemistry: Fun Food Activities and Experiments by Christina Blassingame-Cleveland.

Teacher Assessment of Learning

1. During the experiment, the teacher will observe each child's reaction and understanding of the result of the experiment.
2. During the closing discussion, the teacher will observe the child's contribution to the discussion using the scientific vocabulary introduced earlier in the lesson.
3. The teacher will mark recording sheet and reflection sheet to make sure the child has written up the experiment and observations. The child needs to include at least one thing they have learned.

Extension of Lesson Plan

1. Dissolve an eggshell with vinegar. See Penrose, Gordon. 1989. Dr. Zed's Science Surprises in the reference section of this science lesson for additional information.
2. Make muffins. Sort ingredients into solids and liquids; brainstorm about the properties of the ingredients; highlight physical and chemical changes that will happen when heat is used during the baking process.

Baking Muffins

Objective

To give the students the opportunity to experience an everyday chemical change in matter through baking.

Materials

- muffin recipe and ingredients (see below)
- necessary cooking equipment

Marci's Cereal Muffins Recipe

Preheat oven to 400℉

Grease the muffin tins or use foil muffin cup liners.

Mix the following in bowl 1:

1.5 cups Rice Krispies

1.5 cups Bran Flakes

1/3 cup white sugar

½ cup white flour
½ cup whole wheat flour
¼ cup chickpea flour
1¼ teaspoon baking soda
¼ teaspoon salt

Mix the following in bowl 2:
1 egg
1 cup buttermilk
¼ cup oil

Mix the contents of bowls 1 and 2 together.

Add raisins to the batter.

Fill muffin cups half full and bake at 400℉ for 10 -15 minutes. The muffins are done when slightly brown on the top and when a toothpick comes out clean after inserting into the center of a muffin.

Background Information

Buttermilk is an acid and it reacts with the baking soda to produce carbon dioxide gas (this is a chemical reaction). This chemical reaction helps to make the muffins fluffy.