Identifying Chemical Change

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Science Content Standards: Grade 5, 1a — *Students know* that during chemical reactions the atoms in the reactants rearrange to form products with different properties. Grade 5, 1f — *Students know* that differences in chemical and physical properties of substances are used to separate mixtures and identify compounds.

Lesson Concept: In a chemical change, atoms rearrange and form one or more new substances.

Conceptual Flow:

Substances can be changed physically and chemically.

- In a physical change, the substance still retains its original properties.
  - A change in size (e.g., shredded paper), shape (e.g., molding clay), or state (solid to a liquid, liquid into gas, etc.) is a physical change, as long as the identity of the substance is unchanged.
  - Dissolving a substance (e.g., sugar) into another substance (e.g., water) to form a solution (sugar water) is a physical change.
  - Mixing substances and the substances remain unchanged is a physical change.
- In a chemical change, atoms rearrange and form one or more new substances.
  - Examples of evidence that a chemical change has occurred are: a change in temperature; the formation of a gas; a change in color; light given off.
  - A chemical change (usually) cannot be reversed.

Teacher Background:

A physical change is any change in the size, shape, or the state of matter in which the identity of the substance is unchanged. The appearance of the substance may change, but the identity of the substance does not change.

Dissolving is mixing a substance into another substance to form a solution. As sugar dissolves in water, it disappears from view and seems to become a part of the water. But by boiling the water away, the sugar becomes visible again. Dissolving is a physical change because the

dissolved substance is unchanged. Other similar examples of this type of physical change are mixing: salt into water; chocolate syrup or powder into milk; "Kool-Aid" into water; instant tea or coffee into water.

When mixing some substances and neither one dissolves in the other(s); it is a physical change because the original substances are unchanged. Examples of mixtures are: irons filing, sand, and salt; fruit salad; mixed vegetables; milkshake. All the original substances still have their original properties.

Changes in the state of the matter can also be a physical change. Water can become ice and can turn to vapor, but it still has its original properties of water (H_2O).

A chemical change is the change of one or more substances into other substances; the atoms rearrange and form one or more new substances. Chemical changes generally are not easily reversed.

When paper is burned, the new substances produced are ash, carbon dioxide, and water. The ash, carbon dioxide, and water cannot be recombined to make the paper again. Evidence that a chemical reaction has occurred is the heat and light given off during the reaction.

When vinegar and baking soda are combined, the mixture foams as carbon dioxide gas bubbles out. The evidence that a chemical reaction has occurred is that the mixture gets very cold (colder than the original temperature of either of the original substances) and a gas is formed. (Adapted and excerpted from the *Glencoe: Focus on Physical Science, Grade 8*.)

Five pieces of evidence that a chemical change has occurred are: a change in odor, a change in color, a solid precipitate is formed, a gas is formed, there is either absorption or release of heat. (From www.wiki.answers.com)

One example of a chemical change is when a divergent color appears in the substances that were mixed. When iodine is added to a starch (potato or cornstarch), the area where the iodine contacts the starch turns a deep black-purple. The iodine is originally orange and the starch item is white; the black-purple color is the chemical reaction between the iodine and the starch. Another example is phenolphthalein (a clear liquid) turns bright pink when it comes in contact with a base (such as, ammonia, also a clear liquid). (From Jody Sherriff, Regional Director, K-12 Alliance/WestEd)

Some examples of chemical changes are:

- The combustion of methane to produce carbon dioxide and water.
- Mixing an acid with a base, resulting in water and a salt.
- Decomposition
- Photosynthesis — a process in which carbon dioxide and water are changed into sugars by plants.

- Cracking heavy hydrocarbons to create lighter hydrocarbons (part of the process of refining oil).
- Cooking examples: cake, pancakes, eggs, etc.
- Oxidation examples: rust or tarnishing
- Ripening examples: bananas, tomatoes, avocadoes

(Excerpted from http://en.wikipedia.org/wiki/Chemical_change)

A **prediction** is based on previous experience; otherwise it is only a guess.

Materials Needed for the Lesson:

Teacher Materials

- Piece of paper to tear, another piece of paper to burn, matches, forceps or tongs to hold the burning paper (for "Engage")
- Make a large poster with two headings: "physical change" and "chemical change"
- "Stickie" notes (post-it notes) (Students will place stickie notes with their examples of physical and chemical changes on the poster.)

For Four Groups (each will be rotating through the 4 stations)

Provide paper towels to clean-up spills.

- For Station #1: Purple cabbage liquid, 1/3 cup ammonia, 1/3 cup vinegar, 2 cups of water, twelve 3-oz cups for mixing the solutions, 12 teaspoons (plastic is okay); provide a container into which students can place "dirty" teaspoons
- For Station #2: Four 6-inch round party balloons (get the high quality ones), 1 small box of baking soda, 1 pint of white vinegar, four small bottles with small necks (use 1 pint water bottles)
- For Station #3: Four sandwich size zip-lock baggies, a tablespoon, 8 tablespoons calcium chloride, container of water (about 8 oz)

  Note about Calcium Chloride: $CaCl_2$ can be obtained from Flinn Scientific or other science stores. Sometimes $CaCl_2$ can be found in swimming pool supply stores. Note that not all powders labeled as "Calcium Chloride" provide the results in the way this lesson indicates. For example one container that came with a class science kit was labeled as "Calcium Chloride" but the label further indicated that it also contained potassium chloride and strontium chloride and when used in this lesson, did not provide the expected results. So make certain to test the $CaCl_2$ first.

  Alternative to using Calcium Chloride: An instant ice pack may be used to show temperature change as an example of a chemical change.

- For a Station #4: 10-12 glow sticks - all the same color ("Dollar" stores often have these), 2 vials with tightly fitting lids, 8 test tubes

- Answers to Student Assessment "Chemical Changes"

Student Hands-on Materials

See "Advanced Preparation."

These activities can be done at stations with students rotating to each station or they can be done as a demo in front of the classroom or even a mixture of both. The students should not handle the liquid from the glow stick. If students are rotating through stations, they should wear safety glasses at each station.

Student Handouts

- "Directions for Each Station"
- "Observations of Chemical Changes"
- "Chemical Changes" (Student Assessment)

Advanced Preparation

1. Make copies of the "Directions for Each Station."
2. For Station #1 – Cabbage Juice: Cut one head of purple cabbage into quarters or sixths and cover with water and boil for one hour. Reserve the liquid and store in refrigerator. The purple cabbage juice is an indicator for bases and acids (turns pink with vinegar or lemon juice; turns blue/green with ammonia). Dilute the vinegar with water (1/3 cup vinegar to 1 cup water) and label: "vinegar water". Dilute the ammonia with water (1/3 cup ammonia to 1 cup water) and label: "ammonia water". Test a few drops of cabbage juice with a few drops of the vinegar water; do the same with the ammonia water and cabbage juice. (This is to make certain that you get a definite color change.) Place 12 clean teaspoons at the station and a container where students can place "dirty" teaspoons.
3. For Station #2 –Balloon on Bottle: Four small bottles with small necks (1 pint sized from bottled water), four party balloons (6" round), vinegar, baking soda. Place 2 tablespoons of baking soda into each of the balloons. Put 4 tablespoons of vinegar into each water bottle.
4. For Station #3 – Plastic Baggie: Container (8 oz) of water, one tablespoon for putting water into the baggie, four zip-lock baggies each with 2 tablespoons of calcium chloride. An alternative is to use cold packs that turn cold when punched (allowing the chemicals to mix).
5. For Station #4 – Two Mystery Liquids: Inside the glow sticks are two liquids; one is in first layer of the glow stick and the second is inside a glass capsule so that when the capsule is broken the two liquids mix resulting in a glowing light. The trick is to remove both liquids and put them into separate glass vials with tightly fitting lids. Carefully cut one end of a glow stick and put the first liquid into vial "A". Then remove glass vial from the glow stick, carefully break it, and pour that liquid into vial "B". Continue placing

liquids into vial "A" or vial "B" with all other glow sticks. Provide 8 test tubes and a test tube rack. Provide two medicine droppers: one for use with vial "A" and for vial "B".

5E Lesson: Identifying Chemical Change

Teacher Does	Student Does	Concept
ENGAGE: Tear a piece of paper. Ask: ▸ *Is this a physical change or a chemical change?* Burn a piece of paper. ▸ *Is this a physical change or a chemical change? Discuss with a partner which one is a physical change and which one is a chemical change and discuss your reasoning for your answer.* **Note**: If students do not know the answers, do not give them the answers. Let them figure this out by themselves after they complete this lesson. Give each student a "stickie" note. ▸ *Working with a partner, write down one example of a physical change on one stickie and one example of a chemical change on the other stickie.* Use the large poster previously prepared with headings: physical change and chemical change. ▸ *Place your stickie notes where you and your partner think they belong.* Physical Change | Chemical Change _ | _	**Expected Student Response (ESR):** Note that some students may not have had the background or experience with chemical and physical changes. Therefore they won't be able to tell you the answer without guessing. Some students may know that ripping paper is a physical change because you still have paper; it is just in smaller pieces. **ESR:** Some students may know that burning the paper is a chemical change because you no longer have any paper; you have ashes. With a partner, write an example of physical and chemical change and place them on the large poster.	Matter can change physically and chemically.

Teacher Does	Student Does	Concept
Do not correct students at this time. They will revisit this chart at the end of the lesson and will have a chance to make any corrections. Review a few of the student's examples of physical change. Ask several students to share their thinking about their example of a physical change. Review a few of the student's examples of chemical change. Ask several students to share their thinking about their example of a chemical change. (This will provide you with any misconceptions students have about this topic.) Explain that today the class will be observing some chemical changes. ▸ *By observing the chemical changes, we will determine some characteristics that can be used as evidence of a chemical change.*	**ESR:** (Answers will depend on experiences students had with various physical changes.) Water turning to ice; ice melting to water; smashing a rock; dirt becoming mud; chopping lettuce; breaking a pencil. **ESR:** (Answers will depend on experiences students had with various chemical changes.) Mixing baking soda and vinegar because it bubbles and foams; wood turns to ash when it is burned.	
EXPLORE: Distribute "Observations of Chemical Changes" to each student. ▸ *There are four stations: Station #1: Cabbage Juice; Station #2 Balloon on Bottle; Station #3 Plastic Baggie; Station #4 Two Mystery Liquids.* ▸ *Wear your safety glasses at each station.* ▸ *At each station follow the directions carefully. Then record observations of what occurs when different substances are mixed.* Allow five minutes at each station and one minute for students to go from one station to another. After the stations, do group share of observations from each station; chart on the board or chart paper.		A chemical change is the change of one or more substances into other substances; the atoms rearrange and form one or more new substances. Evidence that a chemical change has occurred can be: color change, formation of a gas, temperature change, heat and/or light emitted.

<table>
<tr><th>Teacher Does</th><th>Student Does</th><th>Concept</th></tr>
<tr>
<td>
<table>
<tr><td>Cabbage juice</td><td>Balloon on Bottle</td><td>Calcium chloride & water</td><td>Two liquids</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>
Record student responses for each station but do not write repeat responses.
</td>
<td>
ESR:
<table>
<tr><td>Cabbage juice</td><td>Balloon on Bottle</td><td>Plastic Baggie</td><td>Two Mystery Liquids</td></tr>
<tr><td>Turned pink with vinegar

Turned blue/green with ammonia</td><td>Balloon inflated

Bubbled and foamed in bottle</td><td>It got warmer than it was before</td><td>Liquids started to glow (whatever color the light sticks were)</td></tr>
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<u>EXPLAIN</u>:
From our investigations, let's see what we have learned about chemical changes.

In Station #1 what type of evidence indicated that this was a chemical change?
In Station #2 what type of evidence indicated that this was a chemical change?
In Station #3 what type of evidence indicated that this was a chemical change?
In Station #4 what type of evidence indicated that this was a chemical change?
What did our experiments help us to find out?

Review students' original examples of chemical change. Name a chemical change suggested by students (from the chart developed in the "Engage" section).

Based on the learning from our investigation, is it really a chemical change? How do you know?

Allow students to make changes to where they placed their stickie notes in "Engage."

Share some examples of appropriate
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ESR: Color changed.

ESR: The balloon inflated when the vinegar and baking soda were mixed. A gas was formed.

ESR: The temperature of the water increased when the calcium chloride was added to the water. There was a temperature change.

ESR: When we mixed two liquids light formed. When the two clear liquids were mixed there was a bright purple glowing light (color depends on the light sticks purchased).

ESR: When we see that there is a color change, a gas made, a change in temperature, or light is emitted, we can say a chemical change has occurred.

ESR: That one is a chemical change because most likely there is a (temp. change, gas formed, light emitted, color changed).
</td>
<td>Evidence that a chemical change has occurred can be: color change, formation of a gas, temperature change, heat and/or light emitted.</td>
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Teacher Does	Student Does	Concept
physical changes and explain that a physical change is any change in the size, shape, or the state of matter in which the identity of the substance is unchanged. Relate this to some examples given by students. Light a match. Ask students what type of change this is and to offer an explanation. If students also say that since the match emitted smoke, it is therefore a chemical reaction, you may need to hold a discussion about whether smoke is a gas (see explanation in "Extend") and whether the presence of smoke indicates that a chemical reaction occurred. Distribute the Student Assessment: "Chemical Changes" and ask students to complete these. Collect and review the assessment to see whether students understood what evidence indicated that a chemical change took place. Discuss the answers to the assessment with students. Decide whether further instruction about chemical and physical changes is needed.	**ESR:** Physical change. It emits light.	
EXTEND: Have students look up on the internet whether smoke is a gas. And whether smoke indicates that a chemical reaction took place. **Note:** Gas is a single or multiple collection of molecules or atoms (oxygen, methane, carbon dioxide) while smoke is a dispersion of very small solid particles or liquid droplets that are dispersed in the air. Smoke may have gas products in it, such as CO_2 and water vapor, but also dust particles, etc. So this means smoke does consist of gas, but it is not only a gas. However, if there is smoke this usually signifies burning and therefore that a chemical reaction took place.		

Input Question: What is an example of a physical change? (Engage)

Process Question: Group the following "events" into physical change or chemical change: lighting a match, dissolving salt into water; putting cream in coffee; fireworks, putting instant tea into water, using gas to drive a car. (Explain – Evaluate)

Output Question: Is baking a cake a physical change or a chemical change? (Explain - Evaluate)

Name: _____

STUDENT HANDOUT

Directions for Each Station

As a safety precaution, students and teacher should wear safety glasses.

Directions for Station #1
Purple Cabbage Juice

- Put 2 teaspoons of purple cabbage juice into each small cup.
- Use a clean teaspoon and put 2 teaspoons of "vinegar water" into one cup and observe what happens; record observations.
- Use a clean teaspoon and put 2 teaspoons of "ammonia water" into the other cup of purple cabbage juice and observe what happens; record observations.
- Place used (dirty) teaspoons into the container provided.

Directions for Station #2
Balloon on Bottle

- Put 4 teaspoons of white vinegar into a water bottle.
- Inside your balloon is baking soda. Take a balloon, being very careful not to spill the baking soda out of the balloon, and stretch the neck of the balloon over the top of the bottle.
- Carefully raise the balloon and let the baking soda fall into the bottle.
- Observe what happens; record observations.

Directions for Each Station *(continued)*

Directions for Station #3
Plastic Baggie

- Observe the baggie by feeling the calcium chloride (from the outside of the baggie).
- Add 2 tablespoons of water and seal the baggie.
- Observe the baggie by touching the calcium chloride (from the outside of the baggie).
- Record how the calcium chloride feels different after the water was added.

Option 1: Teacher can do this station. Have students use a thermometer to read the temperature of the water in a glass. The teacher adds two teaspoons of Calcium Chloride and the temperature is read again. There should be at least a 5 degree difference.

Option 2: Using a cold pack. Students feel the pack before and after it is "punched" to allow the chemicals to mix together.

Directions for Station #4
Two Mystery Liquids

- Observe the liquids in vial "A" and vial "B."
- Place the following into a test tube: with a medicine dropper place a dropper full of liquid from of vial "A"; then use the other dropper to add a dropper full of liquid from vial "B."
- Observe; record observations.

Name: _____

STUDENT HANDOUT

Observations of Chemical Changes

Station #1: Purple Cabbage Juice
Observations:

The evidence of chemical change was: _____

Station #2: Balloon on Bottle
Observations:

The evidence of chemical change was: _____

Station #3: Plastic Baggie
Observations:

The evidence of chemical change was: _____

Station #4: Two Mystery Liquids
Observations:

The evidence of chemical change was: _____

Examples of evidences of chemical changes include: change in temperature; gas is produced; change in color; light is produced.

Name: _____

STUDENT ASSESSMENT

Chemical Changes

1. Name four types of evidence that shows that a chemical change happened:

2. Group the following "events" into physical change or chemical change: lighting a match; dissolving salt into water; putting cream in coffee; fireworks; putting instant tea into water; using gas to drive a car

Physical Change	Chemical Change

3. I mixed eggs, sugar, flour, baking soda, and milk to make a cake. I placed the batter in the oven, then an hour later I took out the cake. Is baking the cake a physical change or a chemical change? What is your evidence?

ANSWERS TO STUDENT ASSESSMENT

Chemical Changes

1. Name four types of evidence that shows that a chemical change happened:

   Gas forms *Temperature changes*

   Color changes *Light is given off*

2. Group the following "events" into physical change or chemical change: lighting a match; dissolving salt into water; putting cream in coffee; fireworks; putting instant tea into water; using gas to drive a car

Physical Change	Chemical Change
dissolving salt into water	*lighting a match*
putting cream in coffee	*fireworks*
putting instant tea into water	*using gas to drive a car*

3. I mixed eggs, sugar, flour, baking soda, and milk to make a cake. I placed the batter in the oven, then an hour later I took out the cake. Is baking the cake a physical change or a chemical change? What is your evidence?

   Baking the cake is a chemical change because you cannot get the eggs, flour, milk, etc. back. You have a new substance, the cake. The little holes in the cake are evidence that gas was emitted (from the baking soda).