# Physical and Chemical Change Experiments

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**Grade level**: 5th

**Objective:** Students will conduct a series of experiments to learn the difference between physical and chemical changes.

**TEKS:** 5.1a, 5.2a-d, 5.4a, 5.7a-d **Time Allotment:** 80 - 90 minutes

**Materials:**

Safety goggles
Graduated cylinders
Small plastic cups
Small plastic jars
Ice
Antacid tablets
Play-doh
Baking soda
Lemon juice
Vinegar
Milk
Kool-Aid powder

**Engage:** Hold up a beaker of starch solution and ask the students what they think will happen if you add iodine. Perform the demonstration (the solution will quickly become bluish-black). Ask the students if a new substance was created when you added the iodine, and what clues did they use to determine this. Draw a helix (spiral) on the board and tell the students that starch takes this form when it is dissolved in water. When iodine is added, the iodine molecule inserts itself into the center of the helix and makes the helix rigid. This creates a new substance and causes the solution to turn blue. Tell the students that substances react in different ways when they are combined. Sometimes these combinations create new substances (chemical change), but sometimes the reactants merely change physical form or state (physical change). Physical changes are reversible, while most chemical changes are not.

**Exploration:**

Introduce the activity by asking several of the students to read aloud the situation given at the beginning of the worksheet (below). The scenario is that the class has landed in Mars on a rocket but needs to create more fuel to return to Earth. The only way to create fuel is to try to create an entirely new substance from materials on board. This background scenario will create interest in the activity and provide continuity between the individual experiments.

Divide students into small groups (3 - 4 students). Instruct the students that goggles must be worn at all times. Remind students that although they will use some food items in the lab, they may not eat, drink, or taste anything. Review the difference between chemical and physical properties. Physical properties are traits that can be observed. Chemical properties are only observable during a chemical reaction. Chemical changes (reactions) result in formation of a new substance, while physical changes do not. Ask

students to identify some clues that could suggest that a chemical reaction has occurred (generation of heat, precipitate formation, gas production, a new odor, etc.). Remind students to look for these clues during their investigations, but there may be some exceptions. While providing instructions, be careful to use correct terminology (i.e. don't confuse solutions, mixtures, elements, compounds).

The worksheet will guide students through the experiments. The relative amounts of materials have been adjusted to minimize messiness, but it is suggested that the experiments be conducted in a plastic box with newspaper covering the lab table.

**Explanation:**
When the students have finished their experiments, they should clean up the lab prior to discussion (all used materials can be safely added to a waste bucket and disposed of in the sink). For each experiment, ask students to raise their hands to indicate whether they observed a physical or chemical change. Students should recognize that breaking the antacid tablet and Play-doh into small pieces are physical changes because no new substances are created. The melting of ice is also a physical change because it involves only a change of state and the substance is still water. The other reactions cause chemical changes and are accompanied by the following clues:
Gas production: antacid + water; baking soda + vinegar; lemon juice + baking soda
Precipitate formation: milk + vinegar
Heat production: baking soda + vinegar

Ask students why they observed color change (a common indicator of chemical change) during a physical change when Kool-Aid was dissolved in water. Answer: The Kool-Aid already had red food dye in it and addition of water made the color more visible. Pass around a cup of dry Kool-Aid powder so they can observe the subtle color of the dry powder. The students may argue that a new substance (Kool-Aid drink) was made, but remind them that the Kool-Aid powder molecules dissolved and are suspended among water molecules. No new molecules were created. Ask a student to draw the two types of molecules (water and Kool-Aid) on the board and explain how they could exist as discrete molecules near each other in a mixture.

**Elaboration:**
Provide a very basic introduction to written chemical reactions. Write the chemical reaction between vinegar and baking soda on the board in both chemical notation and words:

$CH_3COOH + NaHCO_3 \rightarrow NaC_2H_3O_2 + H_2O + CO_2$
Vinegar + baking soda → acetate + water + carbon dioxide

This will probably be the students' first introduction to a chemical equation, so explain that scientists use this notation as a code to refer to elements, compounds, and the reactions they undergo. The reactants (starting substances) are on the left, the arrow

indicates that they are changing into new substances, and the products (end substances) are on the right. Tell them that the letters indicate elements (C = carbon, H = hydrogen, O = oxygen, Na = sodium). Elements come together to form compounds ($CH_3COOH$, $NaHCO_3$, $NaC_2H_3O_2$, $H_2O$, $CO_2$) and the small number after the element indicates how many atoms of that element are in the compound; the absence of a number indicates "one". Ask students if they think there will be the same number of each type of atom on both sides of the equation (before and after the reaction), and how they could determine that. If they add the number of each atom on either side, the numbers will be equal for each element. Even though matter may change state during chemical reactions, atoms are neither created nor destroyed. Ask students what state of matter carbon dioxide exists as (a gas) and why bubbles were created when vinegar was mixed with baking soda (the reaction produced carbon dioxide gas, which tried to escape to the atmosphere). Where else do we find carbon dioxide? (humans and other animals exhale it, plants take it up and use it in photosynthesis, it is dissolved in soft drinks, etc.)

**Evaluation:** The questions at the end of the data sheet can be used to test student comprehension. This lesson requires students to synthesize prior knowledge about states of matter, solutions, and mixtures to understand chemical and physical properties & change. Therefore, any deficiencies in comprehension are likely to become apparent during discussions and/or in answers to the worksheet questions. To test whether students have a full understanding of the subject, present them with some additional scenarios and ask them whether a physical or chemical change occurred. A few examples:
Cutting paper (physical)
Burning paper (chemical)
Rusting of metal (chemical)
Sugar dissolving in water (physical)
Blowing soap bubbles (physical)

# Chemical and Physical Changes: Student Worksheet

Imagine that we are the first group of astronauts to land on Mars. Our space ship's fuel tanks were lost during landing. Some friendly Martians have offered to help us make fuel. However, Mars doesn't have the ingredients to make the type of fuel that is used on Earth. The Martians have told us that none of the substances that we have on our ship right now can be used as rocket fuel, but we might be able to fuel the rocket by creating an entirely **new substance** from supplies we already have. All that we have to work with are some supplies from our ship's first-aid kit and food stores, including antacid, baking soda, lemon juice, vinegar, milk, Kool-Aid powder, ice, and Play-doh.

You will do several experiments today. To prevent spills, keep the jars and cups inside of a plastic shoebox and only pour ingredients over the box. Keep your goggles on at all times. As you observe the changes that occur during the experiments, your goal is to decide which changes are chemical and which changes are physical. Be sure to fill out the group datasheet with observations of the ingredients before, during, and after they undergo physical or chemical change. When you are done with all of the experiments, work as a group to answer the questions on the datasheet.

Experiment A: Antacid tablet

1. Observe and describe the **antacid tablet** at your table.
2. Break the tablet into small pieces. Is this a physical or chemical change?
3. Using a graduated cylinder, measure 50 ml of **water** and add it to a cup. Drop the tablet pieces into the cup.
4. Observe what happens and write whether it is a physical or chemical change.
5. When you are finished, empty the cup into the waste bucket at the front of the room. Rinse the cup with water from a squirt bottle and save the cup for experiment B.
6. A doctor might tell someone to use an antacid if their stomach produces too much acid. Based on what you observed, how do you think antacids work?

Experiment B: Ice

1. In the empty cleaned cup from experiment A, place 1 **ice cube**. Observe and record how the ice looks and feels.
2. Set the cup and ice cube aside until you are finished with the other experiments.

Experiment C: Baking soda and lemon juice

1. With a graduated cylinder, measure 40 ml of **lemon juice** and add it to a small jar.
2. Add 1 teaspoon of **baking soda** to the jar.
3. Observe and record the changes.
4. On the datasheet, write whether this is a physical or chemical change.
5. Empty the jar into the waste bucket and rinse it with a squirt bottle. Save the jar for experiment G.

Experiment D: Play-doh

1. Remove the **Play-doh** from its container and describe how it looks, feels, and smells.
2. Break the Play-doh up into many small pieces.
3. Observe and record the change.
4. On the datasheet, write whether this is a physical or chemical change.

Experiment E: Baking soda and vinegar

1. Start with a new cup (NOT the one the ice cube was in) and add 1 teaspoon of **baking soda** to it.
2. Using the graduated cylinder, measure 10 ml of **vinegar** and add it to the same cup.
3. Observe and record the change.
4. On the datasheet, write whether this is a physical or chemical change.
5. Empty the cup into the waste bucket and rinse the cup with a squirt bottle. Save the cup for experiment F.

Experiment F: Milk and vinegar

1. Using the graduated cylinder, measure 25 ml of **milk** and add it to the cup saved from experiment F.
2. Using the graduated cylinder, measure 30 ml of **vinegar** and add it to the same cup.
3. Observe and record the change.

4. On the datasheet, write whether this is a physical or chemical change.

Experiment G: Kool-Aid and water

1. Add 1 teaspoon of **Kool-Aid powder** to the cleaned small jar from Experiment C.
2. Using the graduated cylinder, add 60 ml of **water** to the same jar.
3. Close the lid of the jar and gently mix by swirling it.
4. Observe and record the change.
5. On the datasheet, write whether this is a physical or chemical change.

Back to Experiment B: ice

- Look at the cup that held the ice cube from experiment B.
- Observe and record the change.
- On the datasheet, write whether this is a physical or chemical change.

| Experiment | Original substance(s) | Describe *before* change | What happened *during* change? | Describe *after* change | Is it a physical or chemical change? |
|---|---|---|---|---|---|
| A | Antacid crushed | | | | |
| A | Antacid in water | | | | |
| B | Ice | | | | |
| C | Baking soda & lemon juice | | | | |
| D | Play-doh broken into bits | | | | |
| E | Baking soda & vinegar | | | | |
| F | Milk & vinegar | | | | |
| G | Kool-Aid & water | | | | |

Questions to answer as a group on separate paper

1. How were you able to tell the difference between physical and chemical changes?
2. Can it ever be confusing to tell the difference between physical and chemical changes? Give 2 examples.
3. Does the mass of the ingredients change during physical changes? What about during chemical changes?
4. In one of today's experiments, you made a mixture where the ingredients kept their physical properties. Which experiment was it?
5. If you wanted to learn more about all the physical changes possible for water, what 3 states of matter would you study?