What's in a Change?

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Name:

The terms physical change and chemical reaction are thrown around a lot in science class, but what do each of these terms really mean?

During a physical change a new substance is not created. At the molecular level, the molecules you start with will not change. This means that the material you start with is the same as the material you end up with. Even though the material is the same it might have undergone a change in size, by crushing or cutting it, or a change in state of matter, starting as a solid but melting to a liquid. Sometimes we can observe a physical change when molecules dissolve in one another. For example, when we dissolve sugar in water, the water and sugar molecules are unchanged, but are now suspended next to one another.

Chemical reactions are different because the materials that go in are different from the materials that come out. This means that the starting materials, or reactants, can combine and rearrange themselves to make entirely new products. We can tell those new products apart because they will have different properties than the materials we started with. These changes can be indicated by a change in color, change in temperature, change in smell, formation of a gas, or formation of a precipitate. A precipitate is a product that is insoluble in the liquid, like when lemon is added to milk, and the milk curdles. Precipitates can make the reaction turn cloudy, and if left in the liquid long enough, they will fall to the bottom of the reaction vessel.

While clues like change in smell and formation of a gas can be useful to indicate a chemical reaction, the only way to tell for sure is to test the properties of the reactants and the products. These properties can be physical, like the way it looks, or chemical, like how it reacts with other substances. If a new substance is created, it will have different physical and/or chemical properties from the reactants.

In the activities below, we will observe two combinations of materials: dry ice (CO_2) with water (H_2O) and acetic acid (CH_3COOH) with calcium carbonate ($CaCO_3$). We will make observations to help us tell the difference between a physical change versus a chemical change.

If the reactant has the same properties as the product of an interaction, did a physical or chemical change occur? Why?

MATERIALS NEEDED

- Peg rack
- Dry ice
- Water
- Calcium carbonate, rock and powdered
- Acetic acid
- Limewater
- Forceps
- ¼ tsp measure
- Funnel
- Small flask/bottle
- Rubber stopper with vinyl tubing
- Transfer pipette
- Graduated cylinder
- Test tubes
- Permanent Marker

PART I — Dry Ice (CO_2) and Water (H_2O)

Observing Physical and Chemical Properties of Reactants

- ☐ 1. View the dry ice (CO_2) and water (H_2O) and record physical observations in Table 1 under "Physical Properties."
- ☐ 2. Take two test tubes and label one "D" for dry ice and the other "W" for water.
- ☐ 3. Take two pipettes and label one "L" for limewater and the other "W" for water.
- ☐ 4. With the pipette labeled "L," add 3mL of limewater into test tubes "D" and "W."
- ☐ 5. With the forceps, place a small piece of dry ice into tube "D." Observe the test tube for 10 to 15 seconds then record your observations in Table 1 under "Chemical Properties."
- ☐ 6. With the pipette labeled "W," add 1mL of water into tube "W." Observe the test tube for 10 to 15 seconds then record your observations in Table 1 under "Chemical Properties."

Observing Physical and Chemical Properties of Products

- ☐ 7. Take a new test tube and label it "U" for the unknown product.
- ☐ 8. With the pipette labeled "L," add 3mL of limewater to test tube "U."
- ☐ 9. With a graduated cylinder, measure 5mL of water. Pour this into the small flask/bottle.
- ☐ 10. With the forceps, add one small piece of dry ice to the small flask/bottle. Record your physical observations of the unknown product in Table 2 under "Physical Properties."
- ☐ 11. Place the rubber stopper over the end of the flask and place the tubing into test tube "U" so it sits within the solution. Observe the test tube for 10 to 15 seconds then record your observations in Table 2 under "Chemical Properties."

TABLE 1	Physical Properties		Chemical Properties
Reactant	**Color**	**State of Matter**	**Limewater Precipitate?**
Dry Ice (CO_2)			
Water (H_2O)			

TABLE 2	Physical Properties		Chemical Properties
Product	**Color**	**State of Matter**	**Limewater Precipitate?**
Unknown			

QUICK CHECK:

Does the product have similar chemical properties to either of the reactants?

If only the physical properties differ between the reactants and products, what kind of change occurred? (Hint: CO_2 *(s)* + H_2O *(l)* ➡ CO_2 *(g)* + H_2O *(l)*)

PART II — Calcium Carbonate ($CaCO_3$) and Acetic Acid (CH_3COOH)

Observing Physical and Chemical Properties of Reactants

- ☐ 1. View the calcium carbonate ($CaCO_3$) and acetic acid (CH_3COOH) and record your physical observations in Table 3 under "Physical Properties".
- ☐ 2. Take two test tubes and label one "A" for acetic acid and the other "C" for calcium carbonate.
- ☐ 3. Take one pipette and label it "A" for acetic acid.
- ☐ 4. With the pipette labeled "L," add 3mL of limewater into tubes "A" and "C."
- ☐ 5. With the pipette labeled "A," add 1mL of acetic acid to tube "A." Observe the test tube for 10 to 15 seconds then record your observations in Table 3 under "Chemical Properties."
- ☐ 6. With the forceps, add a small piece of calcium carbonate rock to tube "C." Observe the test tube for 10 to 15 seconds then record your observations in Table 3 under "Chemical Properties."

Observing Physical and Chemical Properties of Products

- ☐ 7. Take a new test tube and label it "U" for the unknown product.
- ☐ 8. With the pipette labeled "L," add 3mL of limewater to test tube "U."
- ☐ 9. With ¼ tsp measure and funnel, add ¼ tsp of powdered calcium carbonate to the screw top bottle.
- ☐ 10. With a graduated cylinder, measure 5mL of acetic acid.
- ☐ 11. Place the vinyl tubing into test tube "U" so it sits within the solution.
- ☐ 12. Pour the acetic acid from the graduated cylinder into the small flask/bottle, then immediately cover the bottle with the rubber stopper. Observe the test tube for 10 to 15 seconds then record your observations in Table 4 under "Chemical Properties."
- ☐ 13. If necessary, add more acetic acid and powdered calcium carbonate to observe the physical properties of the unknown product.

TABLE 3	Physical Properties		Chemical Properties
Reactant	**Color**	**State of Matter**	**Limewater Precipitate?**
Calcium carbonate ($CaCO_3$)			
Acetic acid (CH_3COOH)			

TABLE 4	Physical Properties		Chemical Properties
Product	**Color**	**State of Matter**	**Limewater Precipitate?**
Unknown			

QUICK CHECK:

Compare the unknown product to the reactants. Does the unknown product have different properties than the reactants? What type of change occurred: chemical or physical? Why?