

PHYSICAL AND CHEMICAL CHANGES

Objective: To determine whether changes occurring following the mixing of two chemicals are due to physical changes or chemical changes.

Introduction: Our natural world is composed of chemical substances. The face of this world is continuously changing due to both physical and chemical processes. For example, weather erosion (wind and rain) will cause a mountain range to change its physical appearance over the centuries. Much of this transformation is due to physical changes as bits of rock get broken off the larger mass and get washed or blown away in a process sometimes called weathering. However, the industrial revolution created pollution, which in turn created acid rain through the chemical combination of atmospheric water with carbon, nitrogen, or sulfur oxides. Erosion by acid rain involves more than simple weathering, rather, the acidic components of acid rain chemically react with the basic components in rock causing the rock to dissolve. This type of erosion results in the formation of new chemical substances resulting in chemical changes.

In a nutshell, a chemical change always involves a chemical reaction and results in formation of a new chemical substance. A physical change may alter the appearance of a substance; however, no new substance is formed.

Physical changes may include phase transformations such as liquid changing into vapor (i.e. evaporation of water), solid turning to vapor (i.e. sublimation of dry ice), liquid turning to solid (i.e. freezing of water to form ice), or solid turning to liquid (i.e. the melting of metal during smelting in metallurgical technology). The dissolving of minerals in water to form a solution (hard water) is also a physical process.

It is not always easy to distinguish between chemical and physical transformations, but careful observation may facilitate the detection of a chemical change. Some clues that may indicate that a chemical change has occurred are: 1) evolution of a gas, 2) formation of a precipitate (an insoluble solid formed by a chemical reaction occurring in a liquid solution), 3) an abrupt color change, or 4) a spontaneous temperature change. Hence, your observations should involve the senses of sight, touch, and smell.

A gas evolved during a chemical reaction is usually detected by the appearance of bubbles. Occasionally, gases can be observed by formation of colored fumes, or by a characteristic odor.

Precipitates are usually observed when a solution becomes cloudy. Frequently, a solid with characteristic color and texture will sink to the bottom of the reaction vessel and is easily observed.

Color changes can be confusing. However, as a general rule, if a dramatic color change occurs it is usually due to a chemical change. A slight color change such as when water is added to iced tea may be due to simple dilution and is a physical change.

Spontaneous temperature changes very often accompany chemical reactions. The temperature of a solution will drop if a reaction is endothermic, or rise if the reaction is exothermic. Care must be taken, however, because not all temperature changes are due to chemical reactions. Frequently, dissolution of salt in water will cause a noticeable temperature change that is due to a physical rather than a chemical reaction.

Safety tips: Sodium hydroxide (NaOH), sulfuric acid (H₂SO₄), and hydrochloric acid (HCl) solutions are corrosive and toxic. Copper sulfate (CuSO₄) solution is toxic and an irritant. Prevent contact of these materials with eyes, skin, and clothing.

Equipment: The tools of your senses of sight, smell and touch.
5 small test tubes labeled appropriately (wash and dry between experiments)
1 test tube rack
1 test tube clamp
1 medicine dropper or pipet (rinse and dry between solutions)

Chemicals: 2 M hydrochloric acid (HCl), 2 M sodium hydroxide (NaOH), phenolphthalein, baking soda, 3 M HCl, 0.1M copper sulfate (CuSO₄), magnesium turnings, solid ammonium chloride (NH₄Cl), distilled water.

Procedure:

1. A. Sodium hydroxide (NaOH) and phenolphthalein

Place 10 drops of 2 M NaOH in a clean, dry test tube. Add a drop of phenolphthalein. Observe the contents of the test and record your observations.

B. NaOH and hydrochloric acid (HCl)

Add 13 drops of 2 M HCl to the test tube in part A. Observe the contents of the test tube and record your observations. Dispose of the mixture in the waste container labeled 1, 2, 6, & 7)

2. Baking soda (sodium hydrogen carbonate, NaHCO₃) and HCl

Obtain a small amount of baking soda and place it in a small, clean, and dry test tube. Slowly add 10 drops of 3 M HCl. Observe the contents of the test tube and record your observations. Dispose of the mixture in the waste container labeled exp. 1, 2, 6, & 7.

3. Copper sulfate (CuSO₄) and water (H₂O)

Place 5 drops of 0.1 M CuSO₄ solution into a small, clean, and dry test tube. Add 10 drops of distilled water. Observe the contents of the test tube. Record your observations. Dispose of the mixture in the waste container marked exp. 3, 4, & 5.

4. Copper sulfate and sodium hydroxide

Place 5 drops of 0.1 M CuSO₄ solution into a small, clean, and dry test tube. Add 5 drops of 2 M NaOH. Shake the tube to mix the contents. Observe the contents of the test tube. Record your observations. Dispose of the mixture in the waste container marked exp. 3, 4, & 5.

5. Magnesium (Mg) and copper sulfate

Place several pieces of magnesium turnings into a small, clean, and dry test tube. Add 10 drops of 0.1 M CuSO₄ solution. Observe the contents of the test tube. Record your immediate observations. Allow the test tube to stand for 10 minutes, and then shake it. Record your observations. Dispose of the mixture in the waste container marked exp. 3, 4, & 5.

6. Magnesium and hydrochloric acid

Place several pieces of magnesium turnings into a small, clean, and dry test tube. Add 10 drops of 3 M HCl and observe the contents of the test tube. Record your observations. Dispose of the mixture in the container labeled exp. 1, 2, 6, & 7.

7. Ammonium chloride (NH₄Cl) and water (H₂O)

Transfer one fourth of a spatula of NH₄Cl into a small, clean, and dry test tube. Add 1 mL of distilled water. Mix well. Observe the contents of the test tube. Record your observations. Dispose of the mixture in the container labeled exp. 1, 2, 6, & 7.

Data and Observations

1. A. NaOH and phenolphthalein

Observations:

Conclusion: (what type of change occurred?)

B. NaOH and hydrochloric acid (HCl)

Observations:

Conclusion: (what type of change occurred?)

2. Baking soda (sodium hydrogen carbonate, NaHCO₃) and HCl

Observations:

Conclusion: (what type of change occurred?)

3. Copper sulfate (CuSO₄) and water (H₂O)

Observations:

Conclusion: (what type of change occurred?)

4. Copper sulfate and sodium hydroxide

Observations:

Conclusion: (what type of change occurred?)

5. Magnesium (Mg) and copper sulfate

Observations:

Conclusion: (what type of change occurred?)

6. Magnesium and hydrochloric acid

Observations:

Conclusion: (what type of change occurred?)

7. Ammonium chloride (NH₄Cl) and water

Observations:

Conclusion: (what type of change occurred?)

Write a general conclusion describing your observations and how you used them to determine the difference between physical and chemical changes.

Chemistry 1215 Experiment II: Physical and Chemical Changes, Postlab Questions

Name _____

1. Based on the results of your experiment, is it correct to say that only one observable change accompanies a chemical reaction? Explain using examples from your experimental results.
2. Based on your experimental results, can you conclude that heat is always noticeably released during a chemical reaction? Explain using examples from your experimental results.
3. A green solution of a pH indicator was added to a sample of spring water. The resulting solution was yellow. Was the observed change due to a physical or a chemical change? Explain
4. Based on this experiment and using only ingredients commonly available in your home, how can you verify the presence of baking soda in laundry powder?