Experiment #5

Investigating Chemical Reactions

Overview

The common types of chemical reactions are studied and performed in this investigation, including synthesis, decomposition, single replacement, double replacement, and combustion. Chemical products are predicted for each reaction based on observations and chemical tests. A balanced chemical equation will be written for each reaction. After the investigation, a series of known reactions will be presented to classify and balance.

Objectives

- Describe common types of chemical reactions.
- Predict products from common chemical reactions, including synthesis, decomposition, single replacement, double replacement, and combustion.
- Write balanced chemical equations.
- Classify chemical reactions by type.
- Identify heat as a possible product or reactant.

Background

Types of Chemical Equations

Chemical Reaction

Reactant → Product.

initial final

ex) $H_2 + O_2 \rightarrow H_2O$

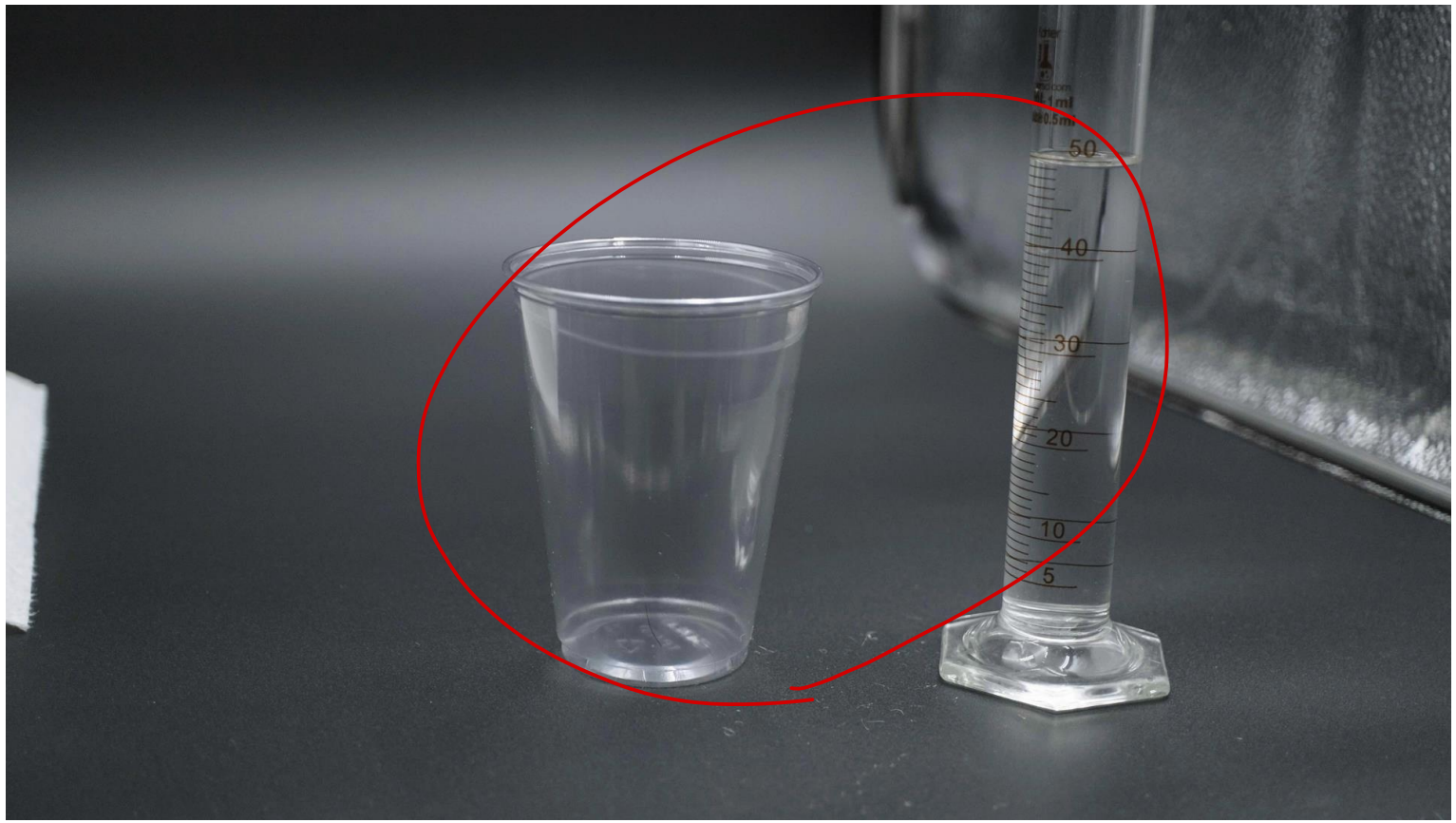
Class	Reactants	Products	Example
Decomposition	1 compound	2 elements (or smaller compounds)	$CD \longrightarrow C + D$
Combination (Synthesis)	2 elements or compounds	1 compound	$A + B \longrightarrow AB$
Single-displacement	1 element and 1 compound	1 element and 1 compound	$A + CD \longrightarrow C + AD$
Double-displacement	2 compounds	2 compounds	$CD + EF \longrightarrow CF + ED$

Combustion. = burning fuel + oxygen

ACTIVITY 1

A Synthesis Reaction

1. Measure 50 mL of white vinegar in the graduated cylinder, and then pour it into the small cup.
2. Measure the room temperature using a thermometer, and record the measurement in Data Table 1.
3. Place the thermometer and a rubber band on a paper towel.
4. While wearing protective gloves, tear or cut the steel-wool pad in half. Place one of the halves of steel wool on the paper towel. This half will be used later for comparison. Assume that this piece of steel wool remains at room temperature.
5. Place the other half of steel wool in the cup containing the white vinegar, and gently press it down to completely submerge it in the vinegar. Keep this steel wool submerged in the vinegar for 2 minutes.
6. Remove the steel wool from the cup, and carefully squeeze the excess vinegar back into the cup. **Keep the small cup of vinegar for use in Activity 4.**



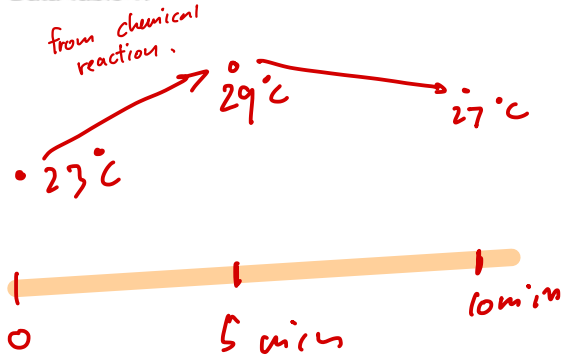
7. Wrap the damp steel wool piece around the bulb of the thermometer, and secure it in place with the rubber band.

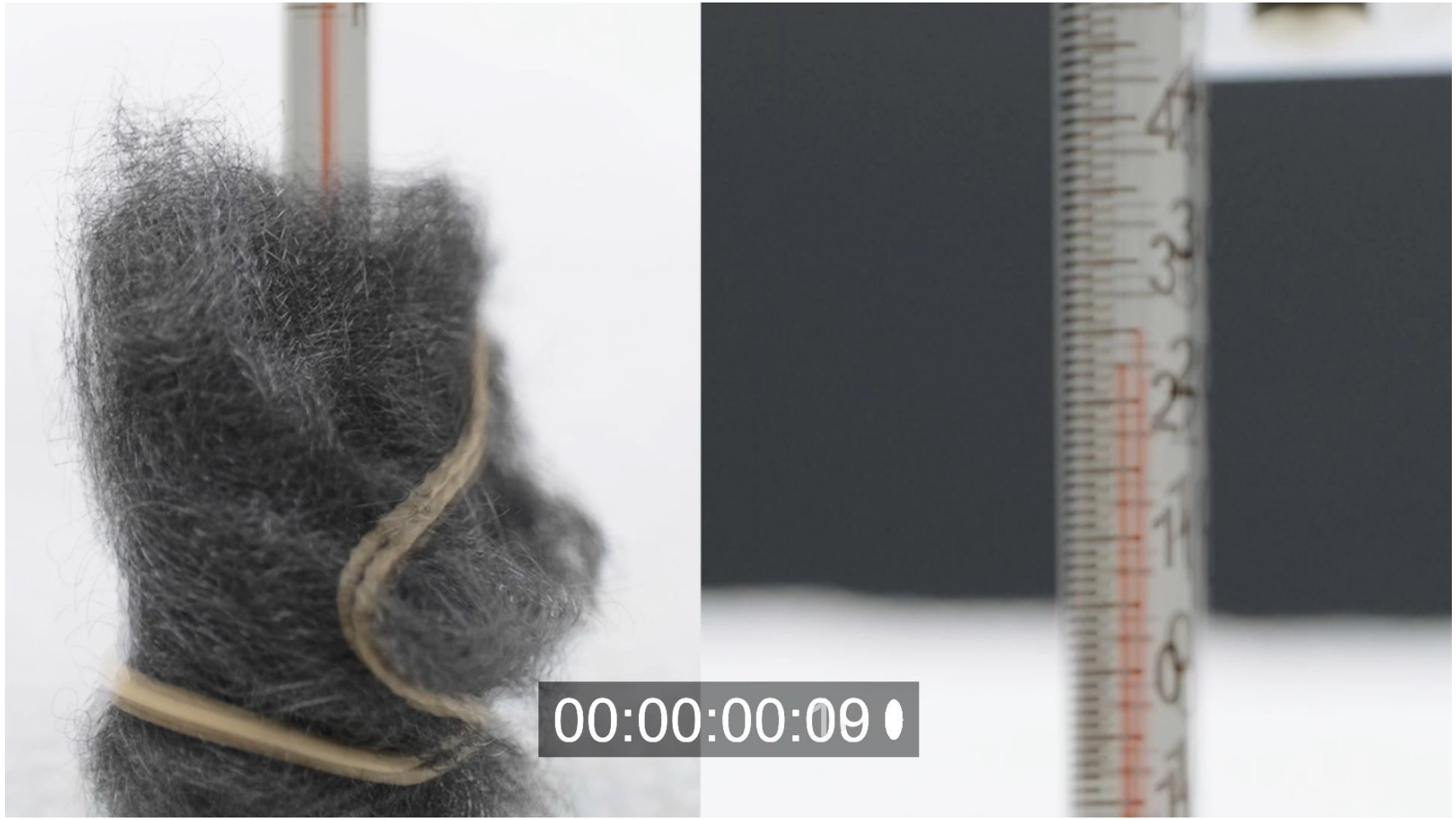
Figure 4

8. Place the steel-wool-wrapped thermometer on the paper towel.

9. Record the temperature of the damp steel wool. Start the timer.

10. Observe the synthesis reaction for 10 minutes. Record the temperature of the steel wool at 5 and 10 minutes after the start of the synthesis reaction. Enter your data into Data Table 1.





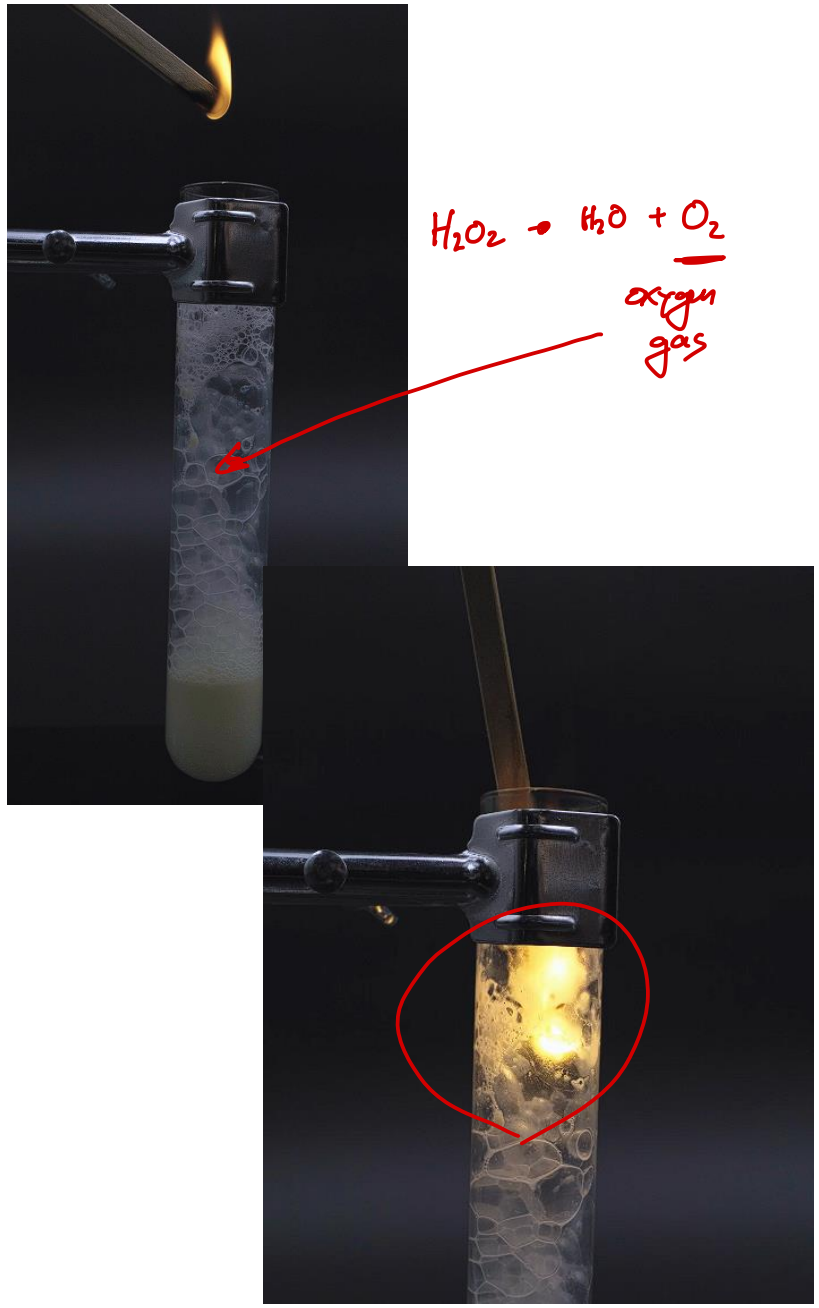
$Fe + O_2 \rightarrow Fe_2O_3 + Heat$

11. At 10 minutes after the start of the synthesis reaction, compare the appearance of the vinegar-treated steel wool to that of the dry steel wool. Record your observations in Data Table 1. Photograph your observations.

ACTIVITY 2

A Decomposition Reaction

1. Measure 10 mL of hydrogen peroxide (H_2O_2) solution in the graduated cylinder, and then pour it into the large glass test tube.
2. Place the large test tube containing H_2O_2 upright in a clean, empty, 250-mL beaker.
3. Use the plastic minispoon to measure two level spoonfuls of dry yeast; add both spoonfuls to the hydrogen peroxide solution in the large test tube. Start the timer.
4. Observe the decomposition reaction for 1 minute, and record your observations in Data Table 1. Photograph your observations.
5. Gently swirl the contents of the large test tube for one minute and record your observations in Data Table 1.
6. Using the information described in "Standard Tests for Gaseous Products" predict the result of 6a and 6b.
   a. Insert a **glowing** splint into the large test tube. Record your observations in Data Table 1.
   b. Insert a **flaming** splint into the large test tube. Record your observations in Data Table 1.
7. After finishing Step 6, dispose of the contents of the large test tube down the drain.
8. Thoroughly rinse the 250-mL beaker and large test tube with purified water, and dry them with paper towels.



ACTIVITY 3

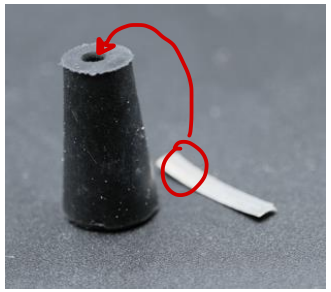
A Single-Replacement Reaction

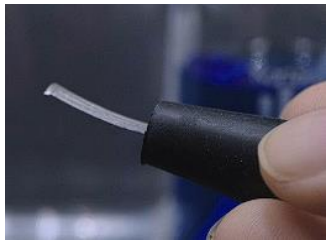
1. Cut a 1-cm strip off of the longer strip of magnesium.
2. Insert the 1-cm strip of magnesium a few millimeters into the hole on the smaller tapered end of the small, #00 1-hole rubber stopper as shown in Figure 5.
3. Fill the 250-mL beaker with tap water to within 3 centimeters from the rim.
4. Using the 10-mL graduated cylinder, measure 3 mL of 1 M HCl, and add it to the small glass test tube.
5. Add 50 mL of purified water to the 50-mL graduated cylinder.
6. Hold the small glass test tube containing the HCl at a 45-degree angle.
7. Use the plastic pipette to slowly add the water from the graduated cylinder to the test tube containing the HCl. Try to layer the water on top of the HCl by gently pipetting the water down the side of the glass test tube.
8. Continue filling the glass test tube by repeating Step 6 until the water level is within one centimeter from the top of the test tube.
9. Hold the glass test tube over the beaker, and then carefully insert the stopper fitted with the magnesium strip into the opening of the glass test tube. Allow any overflow water to drain into the beaker.
10. Place your forefinger over the hole in the rubber stopper, carefully invert the test tube, and then place the inverted test tube into the beaker of water, allowing it to rest in the beaker at a 45-degree angle as seen in Figure 6. Start the timer.
11. Observe the single-replacement reaction for 10 minutes. Record your observations in Data Table 1.

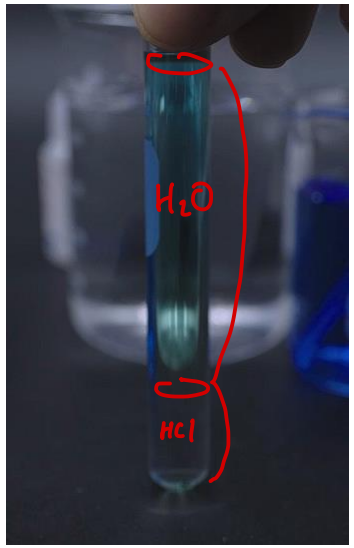
Carefully remove the stopper, and place the opening of the inverted glass test tube on a level surface. A tube full of a gas has been collected.

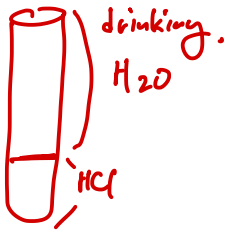
$HCl + Mg \rightarrow MgCl_2 + H_2$ gas.

Drinking water.

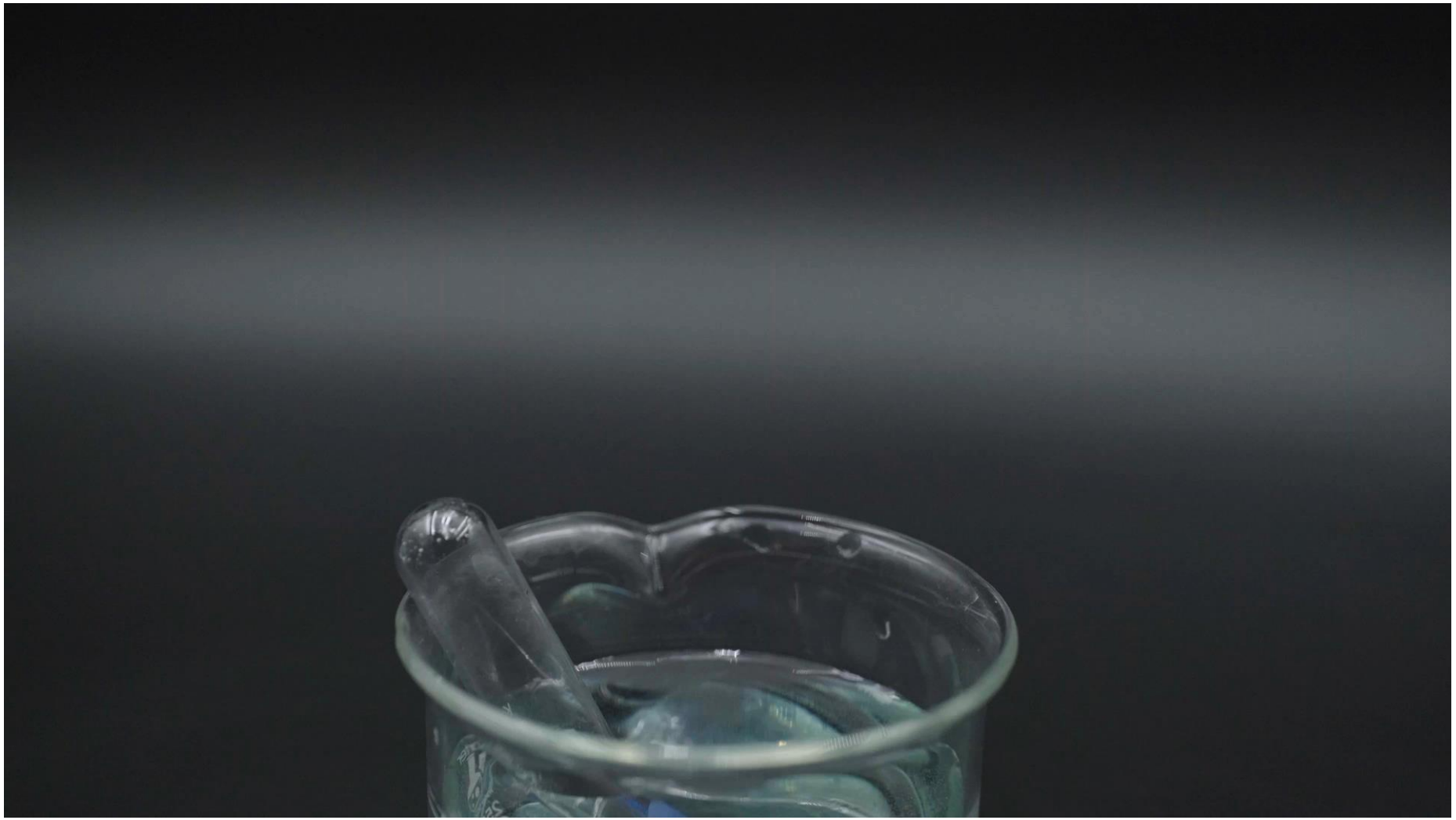








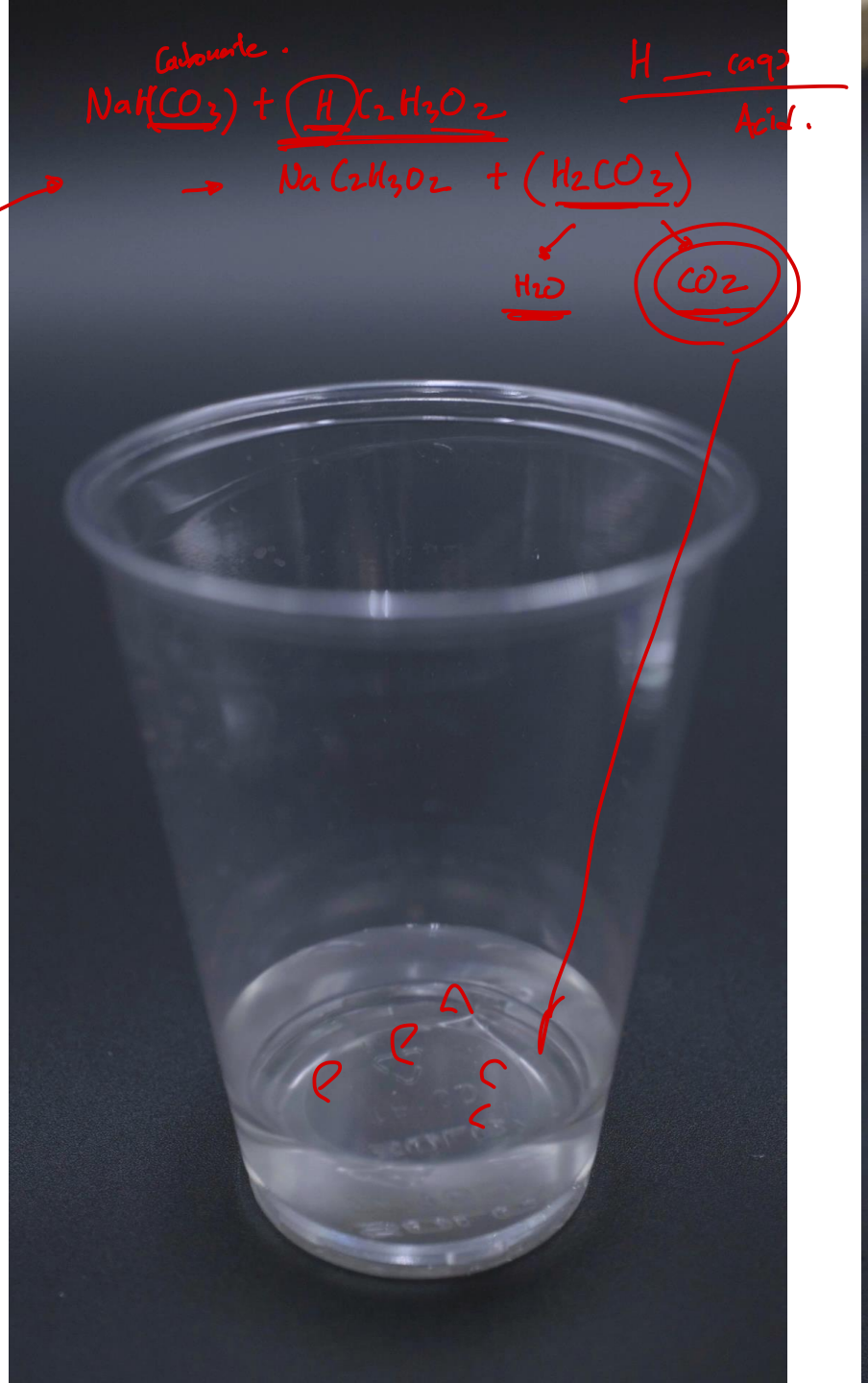
12. Refer to the section describing the standard tests for confirming gases ("Standard Tests for Gaseous Products"). Pick up the glass test tube and hold it, still inverted, at a 45-degree angle.
13. Insert a flaming splint into the opening of the glass test tube. Record your observations in Data Table 1.



ACTIVITY 4

A Double-Replacement Reaction

1. Locate the cup containing 50 mL of vinegar that was saved from Activity 1.
2. Use a weighing boat to measure 10 g of baking soda (sodium bicarbonate, $NaHCO_3$) on the balance.
3. Pour the baking soda into the small cup containing the vinegar.
4. Loosely cover the cup with a small piece of paper towel to retain more of the gas in the cup. Start the timer.
5. Observe the double-displacement reaction for 1 minute. Photograph your observations.
6. Gently swirl the contents of the cup to complete the reaction. Remove the small piece of paper towel covering the top of the cup, and observe the contents.
7. Record your observations in Data Table 1.
8. Refer to the section describing the standard tests for confirming gases ("Standard Tests for Gaseous Products").
   a. Insert a glowing splint into the small cup. Record your observations in Data Table 1.
   b. Insert a flaming splint into the small cup. Record your observations in Data Table 1.
9. Keep the small cup containing vinegar and baking soda to use in Activity 5.
10. Keep the weighing boat used for measuring the baking soda to use in Activity 6.



Data Table 1: Experimental Data and Observations

Activity	Observations and Data
1. Synthesis reaction	
2. Decomposition reaction	
3. Single-replacement reaction	
4. Double-replacement reaction	
5. Combustion reaction	
6. Precipitation reaction	
7. Combustion reaction	