Reactions Lab

**HIGH SCHOOL**

**Green Chemistry & Sustainable Science**

Distinguishing between single-displacement, double-displacement, composition, and decomposition reactions

**Teacher Background Information:**

This lab discusses types of reactions and replaces traditional reaction experiments involving chemicals such as lead (II) nitrate, barium chloride, and silver nitrate. This lab is designed to challenge students to identify types of chemical reactions and distinguish between those that use safer, less hazardous chemicals and those that are more dangerous. Students will make a choice as to which reaction they will perform using the 12 Principles of Green Chemistry. They will ultimately learn the difference between composition, decomposition, single-displacement, and double-displacement reactions.

**Safety Information:**

* Hydrochloric acid at lower concentrations is a skin irritant and, if it comes into contact with the skin, should be washed with soap and water.
* Copper (II) sulfate is a skin irritant and, if it comes into contact with the skin, should be washed with soap and water.
* One reaction uses a wooden splint to test for the generation of gases, which involves the use of matches in the classroom; proper safety using matches should be practiced.
* Another reaction involves the use of a Bunsen burner; exercise proper laboratory safety when using the Bunsen burner.

**Learning Objectives:** Students will…

* Perform composition, decomposition, single-displacement, and double-displacement reactions
* Make observations of chemical reactions and categorize them
* Write and balance chemical equations
* Analyze the reactions against the 12 Principles of Green Chemistry

**Key Terms**: Reaction Classification, Chemical Changes

**Materials (per group of 2–3 students):**

* Goggles
* Gloves
* 2 (10 mL) graduated cylinders
* 3 test tubes
* Magnesium strip
* Steel wool
* 3 M hydrochloric acid
* Zinc strip or galvanized nail
* 5 mL 0.1 M copper (II) chloride solution
* 5 mL 0.1 M copper (II) sulfate solution
* 5 mL 0.1 M potassium carbonate solution
* 5 mL 0.1 M sodium carbonate solution
* 5 mL 0.1 M calcium chloride solution
* 5 mL hydrogen peroxide (5–6%)
* Catalase/potato piece
* Calcium oxide
* Copper wire
* Rubber stopper
* Wooden splint
* Match
* Calcium carbonate chips
* Wire gauze
* Bunsen burner
* Scoopula

**Time Required:** 60- to 75-minute class period

NGSS Standards Met:

* **HS-PS1-1** Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
* **HS-PS1-2.** Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns in chemical properties.
* **HS-PS1-7.** Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

**Teacher Preparation:**

Teachers should prepare…

* 3 M hydrochloric acid (HCl)

Hint: Concentrated HCl (36%) is 11.65 M. To make 100 mL 3 M HCl, add 25.8 mL concentrated HCl to de-ionized water. Remember to always add acid to water.

* 0.1 M aqueous solution of copper (II) chloride (CuCl2 FW = 134.45 g/mol)

Hint: To prepare 100 mL of 0.1 M aqueous solution of copper (II) chloride, dissolve 1.34 g CuCl2 in 100 mL of water.

* 0.1 M aqueous solution of copper (II) sulfate (CuSO4 FW = 159.61 g/mol)

Hint: To prepare 100 mL of 0.1 M aqueous solution of copper (II) sulfate, dissolve 1.60 g CuSO4 in 100 mL of water.

* 0.1 M aqueous solution of potassium carbonate (K2CO3 FW = 138.21 g/mol)

Hint: To prepare 100 mL of 0.1 M aqueous solution of potassium carbonate, dissolve 1.38 g K2CO3 in 100 mL of water.

* 0.1 M aqueous solution of calcium chloride (CaCl2 FW = 110.98 g/mol)

Hint: To prepare 100 mL of 0.1 M aqueous solution of calcium chloride, dissolve 1.11 g CaCl2 in 100 mL of water.

* Potato catalase: Cut a potato into small pieces (about 6-cm cubes; this does not have to be exact).

Keys for Success:

Explain to the students that today they will be exploring reactions through a series of labs. Chemists developing products or procedures in the lab constantly have to evaluate reactions and decide which ones will meet a specific need. The students will be evaluating reactions and looking at them through the perspective of green chemistry.

Procedure:

* Hand out the pre-lab questions and ask students to complete questions 1–4 on the worksheet. You can have them do their own research in order to evaluate the “greenness,” or you can use the Supplemental Information sheet.
* In the Supplemental Information sheet, you may wish to add molecular formulas. They are not included in the sheet as written, in case you wish to have students derive the molecular formula from the name of each compound.
* For question #5, you will need to give them the Student Lab Sheet. In this question, the students will be looking at the set of experiments in the main procedure for this lab and choosing between two reaction procedures. Again, you can have them do their own research to determine the safety and “greenness,” or you can give them the Supplemental Information sheet. After they come to a conclusion, have a discussion with them to determine which reaction they will do. ***The intention of this lab is that only one of the two reactions in each of the sections will be done.***
* The materials list on the Student Lab Sheet includes materials for each procedure option presented for all four types of reactions. The teacher materials list, however, includes **only** the materials for the safer, “greener” procedure. This is meant to prevent students from assuming which procedures they will do based on their given materials. ***Again, it is intended that the teacher only prepare the materials needed for the safer, “greener” procedure options for each reaction type.***
* Put students into lab groups of 2–3 and have them perform the 4 experiments that they have chosen. Ask students to fill out the corresponding observation table for each experiment on the Student Worksheet. Have students answer the questions on the Student Worksheet upon completion of the reactions.
* For Reaction Type C, we use potato as a source of catalase. You may also use yeast—commonly used to discuss enzymes in biology experiments—or beef or chicken liver for a more dramatic reaction.

**Disposal Information:**

* All solutions should be collected for hazardous waste disposal. Potato pieces should be removed and disposed in solid waste.

Reactions Lab—Student Pre-Lab Questions

For each of the following experimental procedures and observations:

a) Write a balanced chemical equation.

b) Name the product(s).

c) Identify the type of reaction.

d) Evaluate the “greenness” of the reaction using the 12 Principles of Green Chemistry.

1. A student heats barium metal over a flame and it begins to react with oxygen gas in the air. A white, crystalline solid begins to form on the barium. (2 points)
2. A chemist mixes lead (II) nitrate and potassium iodide solutions (both of which are clear liquids). A yellow precipitate appears in the final solution. The remaining liquid is an ionic solution. Solid precipitates containing lead are always yellow. (2 points)
3. Magnesium metal is placed in sulfuric acid. The solution begins to bubble. The remaining liquid is an ionic solution. (2 points)
4. Water is placed in an electrolysis machine. The water placed in the machine begins to bubble. The gas is collected in two separate containers. It is noticed that when a glowing splint is placed in one gas, it flames up. In the other gas, a glowing splint produces a small popping sound, signifying a tiny explosion. (2 points)
5. Analyze each reaction type in the Student Lab Sheet. Of the two possible reaction procedures within each group, use the 12 Principles of Green Chemistry to decide which reaction your group will complete. Fill out the table with your criteria for choosing those procedures.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Procedure chosen  (1 or 2) | Criteria for choosing the procedure used | Green Chemistry Principle that guided your choice |
| Reaction A |  |  |  |
| Reaction B |  |  |  |
| Reaction C |  |  |  |
| Reaction D |  |  |  |

Reactions Lab

Student Supplemental Information

**Barium**, at low doses, acts as a muscle stimulant and in higher doses it can affect the nervous system, causing cardiac irregularities, tremors, weakness, anxiety, dyspnea, and paralysis. Different forms of barium can have different effects on humans—but most forms are poisonous to humans. However, because barium sulfate is insoluble in water and in stomach acids, it can be consumed orally without any harmful effect.

**Barium oxide** is an irritant to if it comes in contact with skin or eyes, or is inhaled; but it can be very dangerous if ingested, causing nausea, diarrhea, muscle paralysis, cardiac arrhythmia, and even death. Barium oxide is also harmful to aquatic organisms.

**Lead (II) nitrate** is toxic and ingestion can lead to lead poisoning. All soluble lead compounds can lead to lead poisoning and all inorganic lead compounds are classified as carcinogens. They have been linked to renal, brain, and lung cancer in humans. Lead can also cause fetal damage.

**Potassium iodide** is generally regarded as safe. It is a mild irritant and should be handled with gloves. Overexposure can have adverse effects.

**Potassium nitrate** is generally regarded as safe. It is a very mild irritant and should be handled with gloves. It is an oxidizer and should not be stored with flammable materials.

**Magnesium metal** is highly flammable when in smaller pieces, thin strips, or in powder form, but harder to ignite in bulk. Once ignited, the fire is difficult to extinguish.

**Sulfuric acid** is corrosive. The main risks are skin contact, which leads to burns, and exposure to the fumes through eyes, respiratory tract, and mucous membranes. It is reactive with metals and will lead to the evolution of hydrogen gas. Lower concentrations are safer.

**Copper (II) chloride** is an irritant and should be handled with gloves. Copper compounds exhibit aquatic toxicity.

**Hydrochloric acid** in high concentrations is corrosive and can cause damage to human tissue and mucous membranes. In lower concentrations it is safer, but it is still listed as an irritant.

**Zinc metal** is the protective coating on galvanized nails. The coating of zinc inhibits the formation of rust. Zinc metal is generally regarded as safe.

**Copper (II) sulfate** is an irritant and should be handled with gloves. Copper compounds exhibit aquatic toxicity.

**Potassium carbonate** is generally regarded as safe. It is a very mild irritant and should be handled with gloves.

**Hydrogen peroxide** in high concentrations has a number of risks: it is explosive, can undergo hazardous reactions, and is corrosive. In low concentrations (3–8%), it acts as an oxidizing agent and can be used to clean wounds on skin, as toothpaste (along with baking soda and salt), and to bleach hair (mixed with ammonium hydroxide).

**Calcium carbonate** is generally regarded as safe.

**Calcium oxide**, or quicklime, causes severe irritation when inhaled or placed in contact with moist skin or eyes because of its vigorous reaction with water. Inhalation may cause coughing, sneezing, and labored breathing. It may then evolve into burns with perforation of the nasal septum, abdominal pain, nausea, and vomiting. Although quicklime is not considered a fire hazard, its reaction with water can release enough heat to ignite combustible materials.

**Copper** in the form of a wire is generally regarded as safe.

**Sodium carbonate** is generally regarded as safe.

**Calcium chloride** is generally regarded as safe. It is a mild irritant and should be handled with gloves.

**Reactions Lab—Student Lab Sheet**

Potential materials to be used in the reactions in this laboratory procedure.

Materials:

* Goggles
* Gloves
* 2 (10 mL) graduated cylinders
* 3 test tubes
* Magnesium strip
* Steel wool
* 3 M hydrochloric acid
* Zinc strip or galvanized nail
* 5 mL 0.1 M copper (II) chloride solution
* 5 mL 0.1 M copper (II) sulfate solution
* 5 mL 0.1 M potassium carbonate solution
* Water
* pH paper
* 5 ml 0.1 M sodium carbonate solution
* 5 mL 0.1 M calcium chloride solution
* 5 mL hydrogen peroxide (6%)
* Catalase/potato piece
* Calcium oxide
* Copper wire
* Rubber stopper
* Wooden splint
* Matches
* Calcium carbonate chips
* Wire gauze
* Bunsen burner
* Scoopula
* Crucible Tongs

Procedure:

Of the two procedures listed under each reaction type, use the 12 Principles of Green Chemistry to decide which you will conduct.

Reaction Type A

*Procedure 1:*

1. Place a 5-mL sample of copper (II) chloride solution in a test tube.
2. Obtain a piece of magnesium metal and sand it with the steel wool.
3. Record the physical properties of both the solution and the magnesium metal.
4. Place the magnesium metal in the test tube, then record your observations. Complete Reaction Type B and then record any additional observations.

*Procedure 2:*

1. Place a 5-mL sample of dilute hydrochloric acid solution in a test tube.
2. Obtain a piece of zinc and sand it with the steel wool.
3. Record the physical properties of both the solution and the zinc metal.
4. Place the zinc metal in the test tube, then record your observations. Complete Reaction Type B and then record any additional observations.

Reaction Type B

*Procedure 1:*

1. Obtain a 5-mL sample of copper (II) sulfate and place it in a test tube. Record its physical properties.
2. Obtain a 5-mL sample of potassium carbonate. Record its physical properties.
3. Mix the two solutions in the test tube. Observe and record the outcome.
4. Leave the test tube in the test tube rack. Complete Reaction Type C and then return to the test tube to make sure your observations are complete.

*Procedure 2:*

1. Obtain a 5-mL sample of calcium chloride and place it in a test tube. Record its physical properties.
2. Obtain a 5-mL sample of sodium carbonate. Record its physical properties.
3. Mix the two solutions in one test tube. Observe and record the outcome.
4. Leave the test tube in the test tube rack. Complete Reaction Type C and then return to the test tube to make sure your observations are complete.

Reaction Type C

*Procedure 1:*

1. Place a 15-mL sample of hydrogen peroxide in a test tube.
2. Add a small sample of potato/catalase into the test tube. Quickly place the rubber stopper LIGHTLY onto the test tube.
3. Observe what is happening. Allow the reaction to carry on for about 10 seconds.
4. Light a wooden splint using a match. When the splint has burnt a bit, blow out the flame. The splint should be glowing. Take the stopper off the test tube and place the glowing splint into the test tube.
5. Observe and record what happens to the splint.

*Procedure 2:*

1. Using a set of tongs, obtain a sample of calcium carbonate. Record its physical properties.
2. Place the calcium carbonate on wire gauze (outside the clay circle if there is one present) and heat it in the blue part of a Bunsen burner flame for 5 minutes. The temperature of the chip must reach 850 °C.
3. Allow the chip to cool for 2 minutes. Inspect the chip and record its physical properties.

Reaction Type D

*Procedure 1:*

1. Using a scoopula, obtain a very sample of calcium oxide and place it into 2 test tubes. Record its physical properties.
2. Add 15 mL of water to one of the test tubes containing calcium oxide and record any observations.
3. Add 15 mL of water to a 3rd test tube. Record its physical properties.
4. Use pH paper to test the pH of the sample in each test tube (1. calcium oxide, 2. calcium oxide + water, and 3. water).
5. Observe what happens to the pH of the water when it is reacted with calcium oxide.

*Procedure 2:*

1. Obtain a small piece of copper wire and hold it at one end using the crucible tongs. Record its physical properties.
2. Place the opposite end of the wire into the hottest part of the flame in the Bunsen burner (the blue part) for 30 seconds.
3. Remove the wire from the flame and examine it. After the wire has cooled, scrape the surface with the edge of a scoopula and record its physical properties.

Reactions Lab—Student Sheet

Data and Observations:

|  |  |  |  |
| --- | --- | --- | --- |
| Reaction type | Procedure chosen  (1 or 2) | Observations before reaction (physical properties) | Observations after reaction |
| A |  |  |  |
| B |  |  |  |
| C |  |  |  |
| D |  |  |  |

Questions:

1. Write a balanced chemical equation for each reaction you performed:

Reaction A \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Reaction B \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Reaction C \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Reaction D \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. For the products identified in your chemical equations, match the physical observations you made to the products predicted by your chemical equation (for example: if your reaction were to produce a yellow precipitate, then you would have to say: *In Part X, the yellow precipitate formed was lead (II) iodide*). Complete for all parts in the lab. (Hint: compounds containing the polyatomic ion carbonate and large metal cations *are not soluble and will form a precipitate****.***)

Reaction A \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Reaction B \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Reaction C \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Reaction D \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. Identify the types of reactions seen in this lab.

Reaction A \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Reaction B \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Reaction C \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Reaction D \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. How do you know chemical changes occurred in each reaction?
2. If you were to mass the reactants before the reaction and then mass the products after the reaction, what would you expect to find? Why? How is this related to balancing your equations?

Reactions Lab—Student Pre-Lab Questions

Teacher Key

For each of the following experimental procedures and observations:

a) Write a balanced chemical equation.

b) Name the product.

c) Identify the type of reaction**.**

d) Evaluate the “greenness” of the reaction using the 12 Principles of Green Chemistry.

1. A student heats barium metal over a flame, and it begins to react with oxygen gas in the air. A white, crystalline solid begins to form on the barium. (2 points)
2. 2 Ba (s) + O2 (g) 🡪 2 BaO (s)
3. Barium oxide
4. Composition (synthesis) reaction
5. Answer may vary; students must logically reference the 12 principles
6. A chemist mixes lead (II) nitrate and potassium iodide solutions (both of which are clear liquids). A yellow precipitate appears in the final solution. The remaining liquid is an ionic solution. Solid precipitates containing lead are always yellow. (2 points)
7. Pb(NO3)2 (aq) + 2 KI (aq) 🡪 PbI2 (s) + 2 KNO3 (aq)
8. Lead iodide (solid) and potassium nitrate (aqueous ions)
9. Double-displacement reaction
10. Not a green experiment: potential for lead toxicity
11. Magnesium metal is placed in sulfuric acid. The solution begins to bubble. The remaining liquid is an ionic solution. (2 points)
12. Mg (s) + H2SO4 (aq) 🡪 MgSO4 (aq)+ H2 (g)
13. Magnesium sulfate and hydrogen gas
14. Single-displacement reaction
15. Answer may vary; students must logically reference the 12 principles
16. Water is placed in an electrolysis machine. The water placed in the machine begins to bubble. The gas is collected in two separate containers. It is noticed that when a glowing splint is placed in one gas, it flames up. In the other gas, a glowing splint produces a small popping sound, signifying a tiny explosion. (2 points)
17. H2O2 (l) 🡪 H2 (g) + O2 (g)
18. Hydrogen gas and oxygen gas
19. Decomposition reaction
20. Answer may vary; students must logically reference the 12 principles
21. Analyze each reaction type in the Student Lab Sheet. Of the two possible reactions within each group, use the 12 Principles of Green Chemistry to decide which reaction your group will complete. Fill out the table with your criteria for choosing those procedures.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Procedure chosen  (1 or 2) | Criteria for choosing the procedure used | Green Chemistry Principle that guided your choice |
| Reaction A | 2 | Zinc is safer than magnesium (especially if you are using a nail). Hydrochloric acid in dilute solutions is safer. | #3: less hazardous chemical synthesis; #12: accident prevention (no Mg) |
| Reaction B | 2 | Copper (II) sulfate exhibits aquatic toxicity.  Calcium chloride and sodium carbonate are both generally considered safe. | #1: pollution prevention; #3: less hazardous chemical synthesis |
| Reaction C | 1 | Use of a catalyst in #5 is good. Hydrogen peroxide is dilute solution.  Use of a Bunsen burner in procedure 2 is very energy intensive. | #6: energy efficiency; #7: use of renewable feedstocks (potato); #8: catalysis (potato); #9: design for degradation (potato will degrade) |
| Reaction D | 2 | Calcium oxide causes burns, is hazardous, and reacts violently with water (which can cause enough heat to ignite combustible materials).  Procedure 2 still uses a Bunsen burner (energy intensive), but seems like a better alternative. | #3: less hazardous chemical synthesis; #12: accident prevention |

**Reactions Lab—Teacher Key**

Data and Observations:

|  |  |  |  |
| --- | --- | --- | --- |
| Reaction type | Procedure chosen  (1 or 2) | Observations before reaction (physical properties) | Observations after reaction |
| A | 2 | HCl solution is a clear liquid.  Zinc (or nail) is solid. | Bubbles formed in the liquid solution, color of zinc may change. |
| B | 2 | Both are clear solutions. | A white precipitate forms. |
| C | 1 | Hydrogen peroxide is a clear liquid. Potato is solid. | Bubbles form upon addition of potato. The wooden splint should reignite due to generation of oxygen. |
| D | 2 | Copper wire is solid and shiny copper color. | Copper wire turns black; upon scraping, the shiny copper should appear where the area was scraped. |

Questions:

1. Write a balanced chemical equation for each reaction you performed (NOTE: in Part 5, the potato piece/catalase is a CATALYST. It is not used up in the chemical reaction. Do not add it into the chemical equation for part 5.).

Reaction A 2 HCl (aq) + Zn (s) 🡪 ZnCl2 (aq) + H2 (g)

Reaction B CaCl2 (aq) + Na2CO3 (aq) 🡪 CaCO3 (s) + 2 NaCl (aq)

Reaction C 2 H2O2 (aq) 🡪 2 H2O (l) + O2 (g)

Reaction D 2 Cu (s) + O2 (g) 🡪 2 CuO (s)

1. For the products identified in your chemical equations, match the physical observations you made to the products predicted by your chemical equation (for example: if your reaction were to produce a yellow precipitate, then you would have to say: *In Part X, the yellow precipitate formed was lead (II) iodide*). Complete for all parts in the lab. (Hint: compounds containing the polyatomic ion carbonate and large metal cations *are not soluble and will form a precipitate*.)

Reaction A In procedure 2, the bubbles that formed were hydrogen gas.

Reaction B In procedure 2, the precipitate that formed was calcium carbonate.

Reaction C In procedure 1, the bubbles that formed were oxygen gas.

Reaction D In procedure 2, the black powder that formed on the copper wire was copper oxide.

1. Identify the types of reactions seen in this lab.

Reaction A Single Displacement

Reaction B Double Displacement

Reaction C Decomposition

Reaction D Composition (Synthesis)

1. How do you know chemical changes occurred in each reaction?

There was evidence of a reaction (i.e., bubbles formed, precipitate formed, the formation of black coating, etc.).

1. If you were to mass the reactants before the reaction and then mass the products after the reaction, what would you expect to find? Why? How is this related to balancing your equations?

In reaction A-2, the weight would be less due to the loss of hydrogen.

In reaction B-1, the weight should be the same since nothing was lost.

In reaction C-1, the loss of oxygen should reduce the mass.

In reaction D-2, the weight should increase due to the addition of oxygen (although this is probably hard to measure since the scales are most likely not that sensitive).