# Chemical Reactions Types and Their Equations

*Use this worksheet as a guideline for experiments 1-4 of the lab. Fill in the blanks of the background information and complete the lab experiment data, calculations and conclusions based on the video. Once completed, go to Study Place and complete the Lab Quiz.*

[*http://somup.com/cqeFI9nTjS*](http://somup.com/cqeFI9nTjS)

**Purpose**

Describe the five classes of chemical reactions. Observe chemical reactions for qualitative results. Write balanced chemical equations for chemical reactions.


**Figure 1. Disposable Heat Pack**
A chemical reaction provides the energy to make a heat pack warm.

### *Making Heat with Chemical Reactions*

Have you ever wondered how an instant heat pack works? A disposable heat pack works by a chemical reaction that combines iron in the package with oxygen from the air when the outer packaging is removed producing iron oxide. You have probably seen the product of this reaction in what is commonly called rust. The reaction releases heat, which allows the pack to reach a sufficient temperature that is not uncomfortable. A disposable heat pack is pictured in **Figure 1**.

### **Balanced Chemical Equations**

Every chemical equation represents a specific chemical reaction. Equations identify the \_\_\_\_\_ (the substances that interact together) and the \_\_\_\_\_ (new substances that are formed as a result of that interaction).

Reactants appear on the \_\_\_\_\_ side of an equation, and the products appear on the \_\_\_\_\_. They are separated by an \_\_\_\_\_ (→), which indicates a reaction has taken place and the \_\_\_\_\_ of the reaction. For an equation to be correct, it must be \_\_\_\_\_: the same \_\_\_\_\_ of each \_\_\_\_\_ of atom must appear on \_\_\_\_\_ sides of the equation. For example, when iron rusts, it combines with oxygen to form a new compound, iron (III) oxide (Fe2O3). The balanced chemical equation for this reaction is shown below.

4Fe(s) + 3O2(g) → 2Fe2O3(s)

This equation indicates that \_\_\_\_\_ iron atoms combine with \_\_\_\_\_ molecules of \_\_\_\_\_ oxygen (for a total of six oxygen atoms) to produce the \_\_\_\_\_ formula units of iron (III) oxide, each with two atoms of iron and three atoms of oxygen.

Signs are used to indicate what state the molecules are in:

* (s): \_\_\_\_\_
* (l): \_\_\_\_\_
* (g): \_\_\_\_\_
* (aq): \_\_\_\_\_ (compound dissolved in water)

### **Types of Chemical Reactions**

A \_\_\_\_\_ reaction is the change of a substance into a \_\_\_\_\_ substance with a different chemical identity.

A chemical reaction is usually accompanied by easily observable changes, such as the emission of heat and light, the formation of a precipitate, the evolution of gas, or a color change. There are many different types of chemical reactions. Chemists have classified the reactions into five general categories based on similarities.

#### **\_\_\_\_\_ Reactions**

In a synthesis reaction, two or more substances combine to form \_\_\_\_\_ new compound. For example, hydrogen gas added to oxygen gas makes water as a synthesis reaction. This type of reaction is represented by the general equation:

\_\_\_ + \_\_\_ → \_\_\_

Where A and B represent the \_\_\_\_\_ elements or compounds and AB represents a compound as the \_\_\_\_\_.

#### **\_\_\_\_\_ Reactions**

In a decomposition reaction, a \_\_\_\_\_ compound undergoes a reaction that \_\_\_\_\_ two or more simpler substances. Decomposition reactions are often initiated with the addition of heat or electricity. A decomposition reaction can be represented by the general equation:

\_\_\_ → \_\_\_ + \_\_\_

Where AB represents a \_\_\_\_\_ compound and A and B represent \_\_\_\_\_ or \_\_\_\_\_ as the products.

#### **\_\_\_\_\_ -Displacement Reactions**

In a single–displacement reaction, a \_\_\_\_\_ replaces another \_\_\_\_\_ in a compound or a \_\_\_\_\_ replaces another \_\_\_\_\_ in a compound. Single-displacement reactions can be represented by the general equation:

AX + B → BX + A or AX + Y 🡪 AY + X

In the first equation, AX is a reacting compound and B is a \_\_\_\_\_ \_\_\_\_\_ \_\_\_\_\_ that will replace metal, A. BX is a product compound and A is the displaced metal. Likewise, in the second equation, AX is a reacting compound, and Y is a \_\_\_\_\_ \_\_\_\_\_ \_\_\_\_\_ that will replace non-metal, X.**AY is a product compound and X is the displaced non-metal.**

Single–displacement reactions are usually the result of a \_\_\_\_\_ reaction where one element gains \_\_\_\_\_ and another loses electrons as an ion in the reacting compound is displaced by the elemental form of the reacting element. In the reaction below, a \_\_\_\_\_ replaces another \_\_\_\_\_, Cu (copper) replaces silver, Ag+, in silver nitrate:

2AgNO3(aq) + Cu(s) → Cu(NO3)2(aq) + 2Ag(s)

#### **\_\_\_\_\_ -Displacement Reactions**

In a double-displacement reaction, the ions of two \_\_\_\_\_ compounds exchange places in an aqueous solution to form two new compounds. This reaction is often called an \_\_\_ -\_\_\_\_\_ reaction. A double-replacement reaction can be represented by the general equation:

\_\_\_ + \_\_\_ → \_\_ + \_\_\_

Where A, B, C, and D are ions and AB, CD, AC, and BD are ionic compounds.

One of the products of a double-displacement reaction is a \_\_\_\_\_, an insoluble gas, or a molecular compound such as water. The other product is usually soluble and remains dissolved in the solution. For example, AgCl is precipitated when solutions of AgNO3 (aq) and NaCl (aq)  are combined by the double-displacement reaction below:

AgNO3(aq) + NaCl(aq) → AgCl(s) + NaNO3(aq)

**About This Lab**

In this lab, you will perform the five classes of chemical reactions. In the synthesis and decomposition reactions, you will observe changes in the appearance of substances and changes in mass. In the single-displacement reaction, you will use a pressure gauge and thermometer to observe the changes. In the double-displacement reaction, you will observe the formation of a precipitate after combining solutions. Finally, in the combustion reaction, you will observe a canon explosion. After performing these reactions, you will identify the products formed and write a balanced chemical equation for each of those reactions.

Complete the following while watching the video: “Chemical Reaction Types”.

**Experiment 1: Synthesis Reaction**

1. Record the following information for the magnesium before being heated in the crucible:

Mass of crucible \_\_\_\_\_

Mass of crucible & Magnesium \_\_\_\_\_

Mass of Magnesium alone \_\_\_\_\_

2. What happened to the mass of the contents of the crucible after heating?

A. It increased.

B. This information was not determined in this experiment.

C. It decreased.

D. It was unchanged.

3. Record the mass of crucible & magnesium after being heated in the crucible:

 \_\_\_\_\_

Mass of crucible contents alone \_\_\_\_\_

4. Approximately how many grams of product remained in the crucible after heating? [Subtract out the mass of the crucible.] *Choose the closest answer*.

A. 5.0 g B. 4.1 g C. 8.3 g D. 6.8 g

5. Why was the mass of the product actually greater than the mass of the reactant? In other word, where did the extra mass come from? (*Hint: The final product is magnesium oxide*)

6. The white powder produced is magnesium oxide (MgO, MM = 40.3 g/mol). How many moles of magnesium oxide were formed? Use the following to calculate:

number of moles = mass (g) / molar mass (g/mol)

A. 0.41 moles B. 0.31 moles C. 0.21 moles D. 0.11 moles

7. The lab video showed “perfect” results. Describe the result if the mass only increased to 2.300 g?

**Experiment 2: Perform a Decomposition Reaction**

1. Record the following information for the copper (II) carbonate hydroxide hydrate before being heated in the crucible:

Mass of crucible \_\_\_\_\_

Mass of crucible & copper (II) carbonate hydroxide hydrate \_\_\_\_\_

Mass of copper (II) carbonate hydroxide hydrate alone \_\_\_\_\_

2. What happened to the contents of the crucible during heating on the Bunsen Burner?

A. The substance turned from green to black.

B. The substance turned from green to red.

C. The substance turned from black to green.

D. The substance turned from red to green.

3. What happened to the mass of the contents of the crucible after heating?

A. It was not determined.

B. It was unchanged.

C. It increased.

D. It decreased.

4. Record the mass of crucible & contents after being heated in the crucible:

 \_\_\_\_\_

Mass of crucible contents alone \_\_\_\_\_

Decrease in mass of crucible contents \_\_\_\_\_

5. Approximately how many grams of product were in the crucible after heating? Remember to subtract the mass of the crucible. *Choose the closest answer*.

A. 3.3 g B. 6.2 g C. 5.0 g D. 4.1 g

6. The black powder formed at the end of the decomposition reaction is copperII oxide (CuO). How many moles of copperII oxide (Molar mass = 79.545 g/mol) were produced? Use the following to calculate:

number of moles = mass (g) / molar mass (g/mol)

A. 0.062 moles B. 0.032 moles C. 0.052 moles D. 0.042 moles

7. Describe what would happen in a “real life” situation if the reactant (copper (II) carbonate hydroxide hydrate) was not heated long enough?

The product mass would not decrease as much, affecting the yield.

8. Look carefully at the reactant, copper (II) carbonate hydroxide hydrate’s formula: Cu2CO3(OH)2 ∙ H2O, since the product mass is less than the original reactant, what compound or element was heated off?

**Experiment 3: Perform a Single Displacement Reaction**

1. Record the following information for the set up in this experiment:

Total volume of Erlenmeyer Flask \_\_\_\_\_

Volume of HCl(aq) Acid in Flask \_\_\_\_\_

Volume of gas in flask (Total – Acid) \_\_\_\_\_

 (*subtract the volume of acid from the total volume of the flask*).

2. Record the pressure and temperature of the gas in the Erlenmeyer flask with the hydrochloric acid added.

Pressure \_\_\_\_\_

Temperature \_\_\_\_\_

3. Observe the flask after 0.25 g of zinc (Zn) are added. In the single-displacement reaction, what happened to the hydrochloric acid when zinc was added?

A. Color changed from clear to green.

B. A precipitate formed.

C. The volume of acid increased significantly.

D. Bubbles formed.

4. Record the highest pressure and highest temperature of the gas in the Erlenmeyer flask after the zinc was added to the hydrochloric acid in the flask.

Pressure \_\_\_\_\_ Temperature \_\_\_\_\_

5. What happened to the pressure and temperature in the Erlenmeyer flask immediately after the zinc was added to the hydrochloric acid in the flask?

A. The pressure increased, and the temperature decreased.

B. The pressure decreased, and the temperature decreased.

C. The pressure decreased, and the temperature increased.

D. The pressure increased, and the temperature increased.

**Experiment 4: Perform a Double Displacement Reaction**

1. Describe what happens when solutions of NaOH and NiCl2 are combined.

2. How can you tell that a reaction occurred when the compounds were combined?

A. A single product formed from two reactants.

B. A gas formed.

C. Water formed.

D. A precipitate formed.

3. What ions are present in an aqueous solution of NiCl2 (aq)?

4. What ions are present in an aqueous solution of NaOH (aq)?

**Experiment 5: Perform a Combustion Reaction**

*Watch the video provided for this section:* <https://screencast-o-matic.com/watch/cYfoqZzoCr>

Write the reaction forming the calcium carbide canon:

 \_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_ 🡪 \_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_\_\_\_

**Conclusions (Analysis)**

1. Write a general equation for synthesis reaction that occurred in this lab.

2. How can you tell that the reaction from experiment 1 is a synthesis reaction?

A. The color changes.

B. A gas forms.

C. A single product forms from two reactants.

D. A precipitate forms.

3. Write a GENERAL equation for a decomposition reaction.

4. How can you tell that a decomposition reaction has taken place?

A. heat, energy and light are all given off.

B. the products are carbon dioxide and water.

C. A single reactant breaks down into two or more products.

D. A precipitate forms.

5. Write a balanced chemical equation for this single displacement reaction.

6. When the solid sample of metal was dropped into an acidic solution, what happened indicating a single displacement reaction?

A. bubbles formed C. the metal replaced another metal

B. zinc is more active than hydrogen D. all choices are valid

7. Write a complete, balanced equation for the double displacement reaction in this lab. (Hint: The solid is a compound of Ni 2+ ions and hydroxide ions.)  Write the balanced molecular equation rather than the net ionic equation.

8. Write a statement about the double replacement reaction in this lab using the following information:

a) two ionic compounds reacted,

b) an ion exchange took place

c) A yellow precipitate formed.

9. Make a statement using: “Combustion reactions involve \_\_\_ as a reactant and produce \_\_\_ and \_\_\_\_. They generate much heat and energy.”