

TYPES OF CHEMICAL REACTIONS

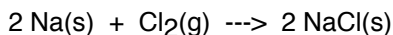
PART I INTRODUCTION

It is useful to classify reactions into different types, because products of reactions can be predicted. No one classification scheme can accommodate all known reactions but the following classification of reactions is based on the fact that many reactions can be classified as combination (composition), decomposition, single replacement, double replacement, and replacement reactions. combustion

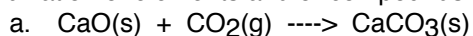
Classifying Chemical Reactions

A. Combination reactions

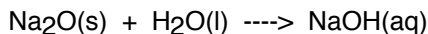
1. Simple combination of two elements to form a binary compound



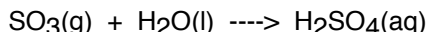
2. Combination of elements and/or compounds



- b. Metal oxides react with water to form bases

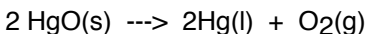


- c. Nonmetal oxides react with water to form acids

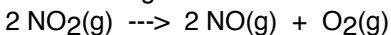


B. Decomposition reactions (often promoted by heat or light)

heat

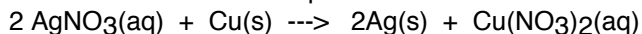


light

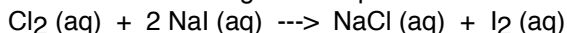


C. Single replacement reactions

1. A more active metal will replace a less active metal



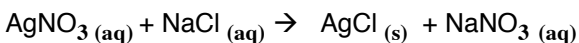
2. A more active halogen will replace a less active halogen.



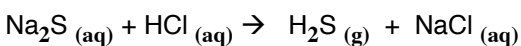
D. Double Replacement

The products of a double replacement reaction are

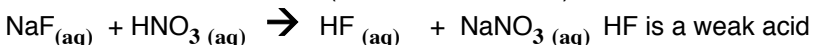
1. a precipitate



2. a gas



3. a less ionized substance (weak acid or water)



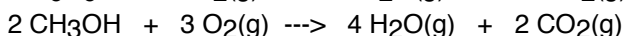
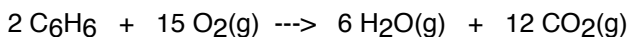
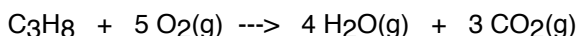
E. Combustion Reactions

A combustion reaction is the reaction of an organic compound with oxygen producing carbon dioxide and water. This reaction gives off heat and light.

An organic compound will contain carbon and hydrogen in its formula, with possibly oxygen or other nonmetals present.

Examples: C_3H_8 C_6H_6 CH_3OH $(\text{C}_2\text{H}_5)_2\text{O}$

Organic compounds react with oxygen to produce water and carbon dioxide at high temperature



Safety goggles **must** be worn at all times



AgNO₃ will stain your hands black. Rinse your hands with tap water after handling.

NaOH solutions are corrosive to the skin.

Dilute hydrochloric acid (HCl) and sulfuric acid (H₂SO₄) can harm eyes, skin, and clothing.

Handle with care. Any acid or base spilled on the skin, clothes, or splashed into your eyes must be rinsed with a large volume of water. Wash your eyes at the eye wash station.

PART II PROCEDURE

[Remember: DO NOT PUT ANY EXCESS REAGENTS BACK INTO THE REAGENT BOTTLES!]

PART A. COMBINATION REACTIONS

1. a. With a crucible tong, hold a strip of magnesium and heat it with a Bunsen burner.
*WARNING! Hold it away from your face. The magnesium will flare up and emit a bright blinding light!! Do not look directly at the light.

Chemical Equation: _____

- b. Drop the ash (Magnesium oxide) from the above experiment onto a glass plate. Add a few drops of deionized water. Mix with a stirring rod to partially dissolve the ash. Press pieces of both blue and red litmus paper into the mixture.

Is the solution neutral, acidic or basic? _____

Chemical Equation: _____

2. Take a glass plate from your locker. Obtain a "gas bottle" from the side shelf and a metal "Deflagrating spoon" from under the hood. Your instructor will put a very small amount of red phosphorus into the spoon. UNDER THE HOOD, light the phosphorus in the flame of a burner. Lower the spoon with the burning phosphorus into the bottle.

CAUTION: Do not touch the bottle with the hot spoon.

Remove the spoon and use the glass plate to keep the smoke inside the bottle. Add 1 ml of deionized water to the bottle. Quickly cover then shake well.

Test the solution with blue and red litmus paper.

Is the solution acidic or basic? _____

The white smoke that formed when the phosphorus burned in the presence of air is diphosphorus pentoxide. Write the chemical equation for this reaction.

Chemical Equation: _____

When the diphosphorus pentoxide dissolves in water an acid forms.

Write the equation for this reaction.

Combination Equation: _____

PART B. DECOMPOSITION REACTIONS

1. Put about 3 ml of fresh hydrogen peroxide solution into a small test tube. Add a small amount (match head size) of manganese dioxide (MnO₂), a catalyst.

Observation: _____

Chemical Equation: _____

- * DISPOSAL: Dispose of the hydrogen peroxide reaction mixture in the waste container labeled "Manganese dioxide/Hydrogen peroxide mixture".

2. Put a small amount (pea size) of solid copper (II) carbonate into a crucible and gently warm for one minute followed by 3 minutes of high heat

Observation: _____

Decomposition Equation: _____

PART C. SINGLE REPLACEMENT REACTIONS

1. Activity Series for metals and hydrogen gas

Clean your spot plates. Place a paper towel under the plates.

For each reaction place about 5 drops of solution with one piece of metal in individual wells of the spot plate. Label each reaction. Examine each reaction mixture and record your observations. If there is no reaction, write N.R.

NOTE: Some reactions are slow. If a reaction does not occur immediately, go back and examine the well after ten to fifteen minutes.

Spot Plate #1

- a. Cu metal + aqueous silver nitrate solution

Observations: _____

Chemical equation: _____

Which is more active copper or silver ? Arrange them in order of activity

_____ > _____
more active less active

***DISPOSAL: Dispose of the AgNO₃ reaction mixture into the silver nitrate waste container before going on to another experiment**

Spot Plate #2

- b. Cu metal + 3 M sulfuric acid (above your lab bench)

Observations: _____

Chemical equation: _____

Which is more active copper or H₂ ? Arrange them in order of activity

_____ > _____
more active less active

- c. Mossy zinc + 3 M sulfuric acid (above your lab bench)

Observations: _____

Chemical equation: _____

Which is more active zinc or H₂ ? Arrange them in order of activity

_____ > _____
more active less active

- d. Mossy zinc + aqueous magnesium sulfate

PART E. DOUBLE REPLACEMENT REACTIONS

Clean both spot plates. Place a paper towel under the spot plate and write the reaction mixture next to each well. Mix equal volumes of solutions (4-5 drops) and then look for evidence of a chemical reaction. Record any precipitate that forms and its color. If there is no reaction write N.R. Write the balanced equation for those reactions that do occur. Identify the unknown by mixing 4-5 drops of each solution with 4-5 drops of your unknown. Record all observations on page 6. **Each reaction is to be performed only once. Use a separate plate for the reactions involving silver nitrate. Dispose of silver nitrate in the Waste container labeled "silver waste."** Boxes are shaded to remind you not to perform the same reaction twice. But it might be helpful in determining the identity of your unknown if you filled in the shaded boxes with observations as well as the non shaded boxes.

***DISPOSAL:** Dispose of the AgNO_3 reaction mixture into the silver nitrate waste container when the reaction is completed

	KNO_3	AlCl_3	AgNO_3	NaCl	$\text{Zn}(\text{NO}_3)_2$	Na_2CO_3	NaOH
KNO_3							
AlCl_3							
* AgNO_3							
NaCl							
$\text{Zn}(\text{NO}_3)_2$							
Na_2CO_3							
NaOH							
Unknown #							

***Note: Perform the reactions with silver nitrate separately and then dispose of the reaction mixtures in the waste container labeled "silver waste" before going on to the next experiment**

Write the balanced equations for only those reactions that occurred. Be sure to show all states. To help you determine the precipitate that formed, it would be helpful to refer to the boxes in which the products were both soluble. For example you should have obtained a precipitate for the reaction between silver nitrate + sodium chloride \rightarrow sodium nitrate + silver chloride. Only one of these products is a precipitate. Looking at the observation (no reaction) for the mixing of sodium chloride + aluminum nitrate reveals that both products, sodium nitrate and aluminum chloride are soluble. Therefore, the precipitate in the reaction between sodium chloride and silver nitrate is silver chloride and not sodium nitrate.

Look at the product side of the reactions and then list the identities of the precipitates that formed. These ionic compounds are insoluble (or very slightly soluble) in water.

Unknown # _____ Determine the identity of your unknown _____
 Give an explanation for how you determined you unknown. Give evidence.

Below is a list of all of the ions that you mixed in the above experiment. Look at your observations and the list of precipitates that formed. Try to find a pattern for each ion. Make a general statement about compounds that might contain the particular ion. For example, you could write "This ion is always soluble", or "This ion is generally soluble except with hydroxide."

K^+

NO_3^-

Zn^{+2}

Cl^-

Na^+

Ag^+

OH^-

CO_3^{2-}

PRACTICE:

Single Replacement Reactions: Complete the chemical equations for the reactions below.
For those that do not react, write N.R.

1. Calcium and water _____
2. Magnesium and silver nitrate _____
3. Potassium bromide and iodine _____

Decomposition, Combination and Combustion Reactions:

4. Decomposition of potassium oxide

5. Combustion of butane, C₄H₁₀

6. Sulfur dioxide combines with water

7. Combustion of benzene, C₆H₆

Double Replacement Reactions

8. Sulfuric acid solution is mixed with sodium hydroxide

9. Calcium nitrate solution is mixed with a solution of sodium carbonate

10. Solutions of potassium sulfide and cupric sulfate are mixed

EXPERIMENT 11

TYPES OF REACTIONS

A. SINGLE REPLACEMENT REACTIONS

1. a. Cu metal + aqueous silver nitrate solution

Observations: _____

Chemical equation: _____

Which is more active? _____ > _____

more active less active

- b. Cu metal + Dil sulfuric acid (above your lab desk)

Observations: _____

Chemical equation: _____

Which is more active? _____ > _____

more active less active

- c. Mossy zinc + Dil sulfuric acid

Observations: _____

Chemical equation: _____

Which is more active? _____ > _____

more active less active

- d. Mossy zinc + aqueous magnesium sulfate

Observations: _____

Chemical equation: _____

Which is more active? _____ > _____

more active less active

- e. Calcium metal + water

Observations: _____

Chemical equation: _____

Which is more active? _____ > _____

more active less active

- f. Magnesium metal + hot water

Observations: _____

Chemical equation: _____

Which is more active? _____ > _____

more active less active

Which is more active magnesium or calcium ?

_____ > _____

more active less active

List the identities of the precipitates that formed. These ionic compounds are insoluble (or very slightly soluble) in water.

Unknown # _____ Determine the identity of your unknown _____

Give an explanation for how you determined you unknown. Give evidence.

Below is a list of all of the ions that you mixed in the above experiment. Look at your observations and the list of precipitates that formed. Try to find a pattern for each ion . Make a general statement about compounds that might contain the particular ion. For example, you could write “ This ion is always soluble”, or “ This ion is generally soluble except with hydroxide.”

K ⁺
NO ₃ ⁻
Zn ⁺²
Cl ⁻
Na ⁺
Ag ⁺
OH ⁻
CO ₃ ²⁻

PRACTICE:

Single Replacement Reactions: Complete the chemical equations for the reactions below.
For those that do not react, write N.R.

1. Bromine and potassium chloride _____
2. Aluminum bromide and chlorine _____
3. Copper and zinc sulfate _____
4. Zinc and silver sulfate _____
5. Copper and silver nitrate _____
6. Zinc and sulfuric acid _____

Decomposition, Combination and Combustion Reactions:

Complete the chemical equations for the reactions below:
For those that do not react, write N.R.

10. Sulfur + oxygen, forming sulfur dioxide

11. Silver "tarnishes" (reacts) in the presence of sulfur

12. Iron rusts, forming ferric oxide

Double Replacement Reactions

11. Sulfuric acid solution is mixed with sodium hydroxide

12. Calcium nitrate solution is mixed with a solution of sodium carbonate

13. Solutions of potassium sulfide and cupric sulfate are mixed
