

Chemical Reactions Worksheets

Synthesis Reactions occur when two or more reactants combine to form a single product.

Recall that there are several common types of synthesis reactions:

- A metal combines with a nonmetal to form a binary salt.
- Metallic oxides and water form bases (metallic hydroxides).
- Nonmetallic oxides and water form acids. The nonmetal retains its oxidation number.
- Metallic oxides and non metallic oxides form salts.

Decomposition Reactions occur when a reactant is broken down into two or more products.

Recall that there are several common types of decomposition reactions:

- Metallic carbonates decompose into metallic oxides and carbon dioxide
- Metallic chlorates decompose into metallic chlorides and oxygen.
- Ammonium carbonate decomposes into ammonia, water, and carbon dioxide.
- Sulfurous acid decomposes into sulfur dioxide and water.

Directions: Predict and balance the following synthesis and decomposition reactions. Use abbreviations to indicate the phase of reactants and products.

1. A sample of calcium carbonate is heated.
2. Sulfur dioxide gas is bubbled through water.
3. Solid potassium oxide is added to a container of carbon dioxide gas.
4. Liquid hydrogen peroxide is warmed.
5. Solid lithium oxide is added to water.
6. Molten aluminum chloride is electrolyzed.
7. A pea-sized piece of sodium is added to a container of iodine vapor.
8. A sample of carbonic acid is heated.
9. A sample of potassium chlorate is heated.
10. Solid magnesium oxide is added to sulfur trioxide gas.

Single Replacement Reactions are reactions that involve an element replacing one part of a compound. The products include the displaced element and a new compound. An element can only replace another element that is less active than itself.

General Activity Series for Metals													
(most active)	Li	Ca	Na	Mg	Al	Zn	Fe	Pb	[H ₂]	Cu	Ag	Pt	(least active)

General Activity Series for Nonmetals					
(most active)	F ₂	Cl ₂	Br ₂	I ₂	(least active)

Directions: Predict and balance the following single replacement reactions.

Use abbreviations to indicate the phase of reactants and products.

Note: Not all of the reactions will occur. For those that do not, write no reaction.

1. A piece of copper is dropped into a container of water.
2. Liquid bromine is added to a container of sodium iodide crystals.
3. An aluminum strip is immersed in a solution of silver nitrate.
4. Zinc pellets are added to a sulfuric acid solution.
5. Fluorine gas is bubbled into a solution of aluminum chloride.
6. Magnesium turnings are added to a solution of lead (II) acetate.
7. Iodine crystals are added to a solution of sodium chloride.
8. Calcium metal is added to a solution of nitrous acid.
9. A solution of iron (III) chloride is poured over a piece of platinum wire.

Double Replacement (Metathesis) Reactions are reactions in which two aqueous compounds appear to switch partners. All double replacement reactions must have a "driving force" or a reason why the reaction will occur or "go to completion." The driving force in metathesis reactions is the removal of at least one pair of ions from the solution.

This removal of ions can occur in one of three ways:

1. Formation of a precipitate (insoluble substance)
2. Formation of a gas (i.e. H_2S , CO_2 , SO_2 , and NH_3)
3. Formation of a primary molecular species (the best example is water)

*Directions: Predict and balance the following double replacement reactions.
Use abbreviations to indicate the phase of reactants and products.
All reactants are aqueous. Some of these reactions do not go to completion.*

1. silver nitrate + potassium chromate
2. ammonium chloride + cobalt (II) sulfate
3. lithium hydroxide + sodium chromate
4. zinc acetate + cesium hydroxide
5. ammonium sulfide + lead (II) nitrate
6. iron (III) sulfate + barium iodide
7. chromium (III) bromide + sodium nitrate
8. rubidium phosphate + titanium (IV) nitrate
9. ammonium carbonate + nickel (II) chloride
10. tin (IV) nitrate + potassium sulfite

More Metathesis Reactions

Common gases formed in metathesis reactions are listed in the table below.

Common Gases	
H ₂ S	Any sulfide (salt of S ²⁻) plus any acid will form H ₂ S(g) and a salt
CO ₂	Any carbonate (salt of CO ₃ ²⁻) plus any acid will form CO ₂ (g), H ₂ O and a salt
SO ₂	Any sulfite (salt of SO ₃ ²⁻) plus any acid will form SO ₂ (g), H ₂ O and a salt
NH ₃	Any ammonium salt (salt of NH ₄ ⁺) plus any soluble strong hydroxide react upon heating to form NH ₃ (g), H ₂ O and a salt

Reactions that produce three of the gases (CO₂, SO₂, and NH₃) involve the initial formation of a substance that breaks down to give the gas and H₂O.

For example: The reaction of Na₂SO₃ and HCl produces H₂SO₃
Bubbling is observed in this reaction because the H₂SO₃ is unstable and immediately decomposes to give H₂O and SO₂ gas. The complete reaction is as follows:
$$\text{Na}_2\text{SO}_3(\text{aq}) + 2\text{HCl}(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{SO}_2(\text{g}) + 2\text{NaCl}(\text{aq})$$

Directions: Predict and balance the following double replacement reactions. Use abbreviations to indicate the phase of reactants and products. All reactants are aqueous unless otherwise noted.

1. ammonium sulfate + potassium hydroxide
2. ammonium sulfide + hydrochloric acid
3. cobalt (II) chloride + silver nitrate
4. solid calcium carbonate + sulfuric acid
5. potassium sulfite + hydrobromic acid
6. potassium sulfide + nitric acid
7. ammonium iodide + magnesium sulfate
8. solid titanium (IV) carbonate + hydrochloric acid