Name

Single Replacement Reactions

Read from Lesson 2 Classifying Chemical Reactions in the Chemistry Tutorial Section Chapter 8 of The PhysicsClassroomPart c: Single Replacement ReactionsPart c: Single Replacement ReactionsPart e: Predicting Products

Single Replacement Reactions

A single replacement (displacement) reaction is a reaction in which one element replaces another element in a compound.

Common types of single replacement reactions are

1. Metal-metal replacement: $A + BC \rightarrow AC + B$

e.g. $Mg(s) + 2 AgNO_3(aq) \rightarrow Mg(NO_3)_2(aq) + 2 Ag(s)$ A + BC \rightarrow AC + B

- 2. Active metal replaces H from water: $M + H_2O \rightarrow MOH + H_2$ e.g Ba(s) + 2 H₂O(l) \rightarrow Ba(OH)₂(aq) + H₂(g)
- 3. Active metal replaces H from acid: $M + HX \rightarrow MX + H2$ e.g. $Ba(s) + 2 H_2O(l) \rightarrow Ba(OH)_2(aq) + H_2(g)$
- 4. Halide-halide replacement: $D + BC \rightarrow BD + C$ e.g. $3 \operatorname{Cl}_2(g) + 2 \operatorname{AlI}_3(aq) \rightarrow 2 \operatorname{AlCl}_3(aq) + 3 \operatorname{I}_2(g)$

| Metal Reactivity Series | | | | | | | | | |
|-------------------------|---|-----------|--------|------------------|------------|------------|----|------------|--|
| Most Reactive | | Name | Symbol | | Reactivity | | | | |
| | | Potassium | K | Reacts | | | | | |
| neat | | Sodium | Na | with cold | | | | | |
| | | Barium | Ba | H ₂ O | | | | | |
| | | Calcium | Ca | L L | | acts | | | |
| | | Magnesium | Mg | | I | ith ute | | | |
| | | Aluminum | Al | | | ids | | | |
| | | Zinc | Zn | | | | Re | acts | |
| | | Iron | Fe | | | | | ith air | |
| | | Nickel | Ni | | | | | | |
| | | Tin | Sn | | | | | | |
| | | Lead | Pb | | | , | | | |
| | | Hydrogen | Н | | | | | | |
| | | Copper | Cu | | | | | | |
| | l | Silver | Ag | | | | | | |
| Lea | | Mercury | Hg | | | | | , | |
| Read | | Platinum | Pt | | | | | | |
| | | Gold | Au | | | | | | |

| Halogen Reactivity | | | | | | |
|-----------------------------|-----------------|--|--|--|--|--|
| From most to least reactive | | | | | | |
| Fluorine | F2 | | | | | |
| Chlorine | Cl2 | | | | | |
| Bromine | Br ₂ | | | | | |
| lodine | l ₂ | | | | | |

The same thing is applied to halogens and their reactivity series. The single halogen must be more active (listed higher) than the halide in the dissolved compound.

This reaction occurs as written: $3 \operatorname{Cl}_2(g) + 2 \operatorname{AlI}_3(aq) \rightarrow 2 \operatorname{AlCl}_3(aq) + 3 \operatorname{I}_2(g)$ because Cl_2 is listed above I_2 . Cl_2 is more reactive than I_2 .

This reaction: $3 I_2(g) + 2 AlCl_3(aq) \implies 2 AlI_3(aq) + 3 Cl_2(g)$ would NEVER happen because I_2 is less reactive than Cl_2 .

All of the reactions mentioned above will take place, but not every possible reaction will actually occur.

Not every metallic element can replace a metal ion in a dissolved compound. Metals are ranked based on their reactivity, and only a more reactive metal can replace a metal ion in a compound.

Using a metal reactivity series like the one shown to the left, the single metal must be more active (listed higher) than the metal in the dissolved compound.

Notice how in example 1, Mg replaced Ag. In this activity series, Mg is listed above Ag, or higher in the list.

This reaction:

 $Ag(s) + Mg(NO_3)_2(aq) \xrightarrow{} AgNO_3(aq) + Mg(s)$ would NEVER happen because Ag is less reactive than Mg.

Chemical Reactions

Name

For the following questions, predict the product of these single replacement reactions, using the reactivity series for metals or halogens. Write NR (for no reaction) if the reaction does not occur. If the reaction does occur, write the skeleton equation (proper formulae, no coefficients). Then add coefficients to balance the chemical equation. Remember: *metals* replace *metals* or *hydrogen*! *Halogens* replace *halogens*!

- 1. A piece of barium is added to cold water.
- 2. A piece of copper is added to a solution of silver chloride.(If a reaction occurs, assume copper(II) forms.)
- 3. An iron nail is dropped into water. (If a reaction occurs, assume iron(III) forms.)
- 4. Aluminum foil is dropped into a solution of magnesium fluoride.
- 5. Tin metal is placed in an aqueous solution of iron (III) acetate. (If a reaction occurs, assume tin (IV) forms.)
- 6. Sodium pellets are added to water.
- 7. Liquid bromine is combined with aqueous zinc fluoride.
- 8. Iron pellets are added to a solution of tin(II) acetate . (If a reaction occurs, assume iron(II) forms.)
- 9. Fluorine gas is added to potassium bromide.
- 10. Copper wire is added to a solution of iron(III) sulfate. (If a reaction occurs, assume copper(II) forms.)
- 11. Calcium pellets are added to a solution of potassium selenide.
- 12. An iron nail is dropped into a solution of nitric acid. (If a reaction occurs, assume iron(III) forms.)
- 13. Aluminum foil is dropped into a solution of iron(II) chloride.
- 14. A piece of potassium is dropped into an aqueous solution of lead (II) sulfide.
- 15. A cube of aluminum is placed into a solution of hydrochloric acid.