**Reaction Types: Single Replacement**

Important notes to remember: (1) NONE of the equations are balanced!! and (2) make sure to write correct formulas. DO NOT just copy the subscripts from the reactants over into the products.

During single replacement, one element replaces another element in a compound. There are two different possibilities:

1. One cation replaces another. Written using generic symbols, it is:

AX + Y ---> YX + A

Element Y has replaced A (in the compound AX) to form a new compound YX and the free element A. Remember that A and Y are both cations (postively-charged ions) in this example.

Some examples are:

Cu + AgNO3 ---> Ag + Cu(NO3)2
Fe + Cu(NO3)2 ---> Fe(NO3)2 + Cu
Ca + H2O ---> Ca(OH)2 + H2
Zn + HCl ---> ZnCl2 + H2

Notice how, when hydrogen gets displaced, I write it as a diatomic. I do that because elemental hydrogen is diatomic. Don't forget that!!

2. One anion replaces another. Written using generic symbols, it is:

A + XY ---> XA + Y

Element A has replaced Y (in the compound XY) to form a new compound XA and the free element Y. Remember that A and Y are both anions (negatively-charged ions) in this example.

The only examples we know about involve halogens, so here are two examples:

Cl2 + NaBr ---> NaCl + Br2
Br2 + KI ---> KBr + I2

In single replacement, one reactant is always an element. It does not matter if the element is written first or second on the reactant side. The other reactant will be a compound.

Typically, you will be given the left-hand (reactant side) and asked to provide the products to the reaction. You need to be able to recognize single replacement reactions AND be able to break a formula apart into proper cations and anions as well as write correct formulas

Here are several examples which are solved below:

1) ZnS + O2 --->
2) K + H2O --->
3) Fe + HCl --->
4) NaI + Br2 --->

**Example #1**

How to figure out the right (or product side):

(1) Decide if the reactant element (O2 in this case) is normally positive or negative. (It is a negative 2. Just use O, not O2.)

(2) Identify the opposite charged (from step one) portion of the compound and its charge. (Zn has a charge of +2.)

(3) Write a formula using information from step one & two. (ZnO since Zn = +2 and O = -2.)

(4) Write the left over element as the second product. Write it as diatomic if it is. (In this case all you write is S, since sulfur is not diatomic. Now, if you knew a bit more chemistry, you'd write sulfur as S8. We'll just leave it as S for now.)

So the final answer looks like this:

ZnS + O2 ---> ZnO + S

**Example #2**

How to figure out the right (or product side):

(1) Decide if the reactant element (K in this case) is normally positive or negative. (It is a positive 1.)

(2) Identify the opposite charged (from step one) portion of the compound and its charge. (OH has a charge of negative 1.)

Special note on water - the +1 cations, the +2 cations and Al3+ will kick out only ONE hydrogen, leaving hydroxide (OH¯) behind.

(3) Write a formula using information from step one & two. (KOH since K = +1 and OH = -1.) Keep in mind that OH¯ is involved, NOT O2-

(4) Write the left over element as the second product. Write it as diatomic if it is. (In this case since hydrogen is diatomic, we write H2.)

So the final answer looks like this:

K + H2O ---> KOH + H2

**Example #3**

How to figure out the right (or product side):

(1) Decide if the reactant element (Fe in this case) is normally positive or negative. (It can be a +2 or a +3. The ion produced depends on conditions such as concentration or temperature. Check with your teacher on how to deal with multiple charge cations. Keep in mind, that to be safe - especially if your teacher is unclear on what to do - you may want to do all possible answers. I'll use +3 in this example.)

(2) Identify the opposite charged (from step one) portion of the compound and its charge. (Cl has a charge of negative 1.)

(3) Write a formula using information from step one & two. (FeCl3 since Fe = +3 and Cl = -1.)

(4) Write the left over element as the second product. Write it as diatomic if it is. (In this case since hydrogen is diatomic, we write H2.)

So the final answer looks like this:

Fe + HCl ---> FeCl3 + H2

**Example #4**

How to figure out the right (or product side):

(1) Decide if the reactant element (Br in this case) is normally positive or negative. (It is a negative 1.)

(2) Identify the opposite charged (from step one) portion of the compound and its charge. (Na has a charge of +1.)

(3) Write a formula using information from step one & two. (NaBr since Na = +1 and Br = -1.)

(4) Write the left over element as the second product. Write it as diatomic if it is. (In this case since iodine is diatomic, we write I2.)

So the final answer looks like this:

NaI + Br2 ---> NaBr + I2

**Practice Problems**

Note that none of the example problems above are balanced. Balance the equations after you figure out the products.

Write correct formulas for the products in these single replacement reactions.

1) Al + Pb(NO3)2 --->

2) Cl2 + NaI --->

3) Fe + AgC2H3O2 --->

4) Al + CuCl2 --->

5) Br2 + CaI2 --->

6) Al + HCl --->

7) Mg + HCl --->

8) Zn + H2SO4 --->

9) Fe + CuSO4 --->

10) Cl2 + MgI2 --->

### Practice Problem Answers

Write correct formulas for the products in these single replacement reactions.

**Unbalanced Answers**

1) Al + Pb(NO3)2 ---> Pb + Al(NO3)3

2) Cl2 + NaI ---> I2 + NaCl

3) Fe + AgC2H3O2 ---> Ag + Fe(C2H3O2)2
If Fe(III) is used, then Fe(C2H3O2)3 would result.

4) Al + CuCl2 ---> Cu + AlCl3

5) Br2 + CaI2 ---> I2 + CaBr2

6) Al + HCl ---> AlCl3 + H2

7) Mg + HCl ---> MgCl2 + H2

8) Zn + H2SO4 ---> ZnSO4 + H2

9) Fe + CuSO4 ---> Cu + FeSO4
If Fe(III) is used, then Fe2(SO4)3 would result.

10) Cl2 + MgI2 ---> I2 + MgCl2