Reaction Types: Decomposition

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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 decomposition, one compound splits apart into two (or more pieces). These pieces can be elements or simpler compounds

Written using generic symbols, it is usually shown as:

$AB \longrightarrow A + B$

However, that really only works for splitting apart into the elements, like these examples.

$HgO \longrightarrow Hg + O_2$
$H_2O \longrightarrow H_2 + O_2$
$MgCl_2 \longrightarrow Mg + Cl_2$
$FeS \longrightarrow Fe + S$

Decomposition can also split one compound into two simpler compounds (or compound and an element) as in these examples:

$CaCO_3 \longrightarrow CaO + CO_2$
$Na_2CO_3 \longrightarrow Na_2O + CO_2$
$KClO_3 \longrightarrow KCl + O_2$
$Ba(ClO_3)_2 \longrightarrow BaCl_2 + O_2$

Notice how, in every case so far, there is only one substance on the left-hand (reactant) side. This is always the case in a decomposition reaction. Don't forget that!!

Figuring out what the products are in decomposition is harder (maybe you'll think it's easier!!) because you will have to recognize several categories of decomposition reactions. Here are your first (yes, there's more!) three:

1) All binary compounds (like the four in the first example set above) will break down into their elements.
2) All carbonates (like the first two in the second example set above) break down to the oxide and carbon dioxide.
3. Chlorates (like $KClO_3$ and $Ba(ClO_3)_2$ in the example) will break down to the binary salt and oxygen.

Here is one more category of decomposition reactions:

$Ca(OH)_2$ ---> $CaO + H_2O$
$NaOH$ ---> $Na_2O + H_2O$
HNO_3 ---> $N_2O_5 + H_2O$
H_3PO_4 ---> $P_2O_5 + H_2O$

The first two substances are bases and the last two are acids. In each case, the acid or base breaks down into the oxide of the metal (in the case of bases) or the oxide of the nonmetal (in the case of acids) plus water.

Here is one example of each category which are then solved below:

1) $NaClO_3$ --->
2) Li_2CO_3 --->
3) KOH --->
4) NaCl --->

Example #1

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

(1) Identify the type of compound decomposing:

$NaClO_3$ is a chlorate

Notice that you have to be able to "read" a formula and identifiy the parts (cation and anion) that make it up.

(2) Apply the rule for that type:

chlorates decompose to the binary salt and oxygen gas

(3) Write two new (CORRECT!!) formulas using the rule from step two.

NaCl since Na is positive 1 and Cl is minus one
O_2 since oxygen is a diatomic gas

So the final answer looks like this:

$NaClO_3$ ---> $NaCl + O_2$

Example #2

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

(1) Identify the type of compound decomposing:

Li_2CO_3 is a carbonate

(2) Apply the rule for that type:

carbonates decompose to the binary oxide and carbon dioxide gas

(3) Write two new (CORRECT!!) formulas using the rule from step two.

Li_2O since Li is positive 1 and O is minus two
CO_2 is the formula for carbon dioxide gas

So the final answer looks like this:

Li_2CO_3 ---> $Li_2O + CO_2$

Example #3

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

(1) Identify the type of compound decomposing:

KOH is a base

(2) Apply the rule for that type:

bases decompose to the binary oxide and water

(3) Write two new (CORRECT!!) formulas using the rule from step two.

K_2O since K is positive 1 and O is minus two
H_2O is the formula for water

So the final answer looks like this:

KOH ---> $K_2O + H_2O$

Example #4

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

(1) Identify the type of compound decomposing:

NaCl is a binary compound (that is not an acid or a base. I left this point until now.)

(2) Apply the rule for that type:

binary compounds decompose to the elements

(3) Write two new (CORRECT!!) formulas using the rule from step two.

Na is the proper symbol
Cl_2 is the proper symbol for chlorine since it is diatomic

So the final answer looks like this:

NaCl ---> $Na + Cl_2$

Example #5

There is another type of acid which does not have oxygen in it. HCl, HBr and HI are examples. These acids simply decompose into their elements:

$HCl \rightarrow H_2 + Cl_2$

Practice Problems

Note that none of the example problems above are balanced. Your teacher may require this, but the ChemTeam will only provide some of the following answers balanced. The rest are up to you!!

Write correct formulas for the products in these decomposition reactions. #3 might be tough - remember to preserve nitrogen's oxidation number.

1) $Ni(ClO_3)_2 \rightarrow$

2) $Ag_2O \rightarrow$

3) $HNO_2 \rightarrow$

4) $Fe(OH)_3 \rightarrow$

5) $ZnCO_3 \rightarrow$

6) $Cs_2CO_3 \rightarrow$

7) $Al(OH)_3 \rightarrow$

8) $H_2SO_4 \rightarrow$

9) $RbClO_3 \rightarrow$

10) $RaCl_2 \rightarrow$

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