Everything about Equations

A chemical equation contains a lot of information. Many equations show evidence of a chemical change such as a change in temperature (exothermic – give off heat; endothermic – absorb heat), release of a gas, or formation of a precipitate. Other identifying characteristics of a chemical equation such as a change in color or a change in odor cannot be demonstrated in the equation. Some changes and/or conditions are shown using symbols such as [1] solid precipitate – (*s*) or ↓; [2] liquid – (ℓ); [3] gas – (*g*) or ↑; [4] dissolved in water or aqueous – (*aq*); [5] heat – Δ; [6] electricity – elec.; and [7] light – ↑|. Symbols and formulas that are neither reactants nor products are written above or below the yield sign (→). Examine the equation below:

$$2KClO_3(s) \xrightarrow[\Delta]{\mathbf{MnO_2}(s)} 2KCl(s) + 3O_2(g)$$

The equation tells us the following: [1] The reactant is $KClO_3$; [2] $KClO_3$ is a solid; [3] $KClO_3$ decomposes, particularly when heated (Δ) in the presence of the catalyst MnO_2; [4] One of the products is KCl, a solid; [5] The other product is O_2, a gas. [6] Conservation of mass is shown because the reactants contain 2 atoms of K, 2 atoms of Cl, and 6 atoms of O, and the products contain 2 atoms of K, 2 atoms of Cl, and 6 atoms of O also.

Sometimes a reaction results in the formation of a precipitate from dissolved reactants. Examine the equation below:

$$K_2SO_4(aq) + Ca(NO_3)_2(aq) \rightarrow 2KNO_3(aq) + CaSO_4(s)$$

The equation tells us the following: [1] The reactants are K_2SO_4 and $CaNO_3$; [2] Both reactants are dissolved; [3] A double-displacement reaction occurs resulting in the formation of a precipitate; [4] The precipitate is identified using *Table F–Solubility Guidelines*; [5] Conservation of mass is shown because the reactants contain 2 atoms of K, 1 sulfate ion, 1 atom of Ca, and 2 nitrate ions, and the products contain 2 atoms of K, 1 sulfate ion, 1 atom of Ca, and 2 nitrate ions; [6] The sum of the coefficients is 5 as in the example below.

Example

Unbalanced Equation:	$CuSO_4 + AgNO_3 \rightarrow Cu(NO_3)_2 + Ag_2SO_4$
Balanced Equation:	$CuSO_4 + 2AgNO_3 \rightarrow Cu(NO_3)_2 + Ag_2SO_4$
Sum of the Coefficients:	$1 + 2 + 1 + 1 = \underline{5}$

Examine the unbalanced equations in the table on the next page. Determine the following: [1] The sum of the coefficients of the balanced equation; [2] The type of reaction (*direct combination, decomposition, single displacement, double displacement*); [3] Identify the phase(s) of the product(s); and [4] The signs that a chemical change has occurred.

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Unbalanced Equation	Sum of the Coefficients	Reaction Type	Phase	Evidence of Chemical Change
1. $FeCl_3(aq) + NaOH(aq) \rightarrow NaCl(?) + Fe(OH)_3(?)$				
2. $Al(s) + HCl(aq) \rightarrow AlCl_3(?) + H_2(?)$				
3. $Mg(s) + O_2(g) \rightarrow MgO(?)$				
4. $H_2O_2(aq) \xrightarrow{MnO_2} H_2O(?) + O_2(?)$				
5. $H_2CO_3(aq) \rightarrow H_2O(?) + CO_2(?)$				
6. $Pb(s) + CuSO_4(aq) \rightarrow PbSO_4(?) + Cu(?)$				
7. $H_2O(\ell) + N_2O_5(g) \rightarrow HNO_3(?)$				
8. $Na(s) + H_2O(\ell) \rightarrow NaOH(?) + H_2(?)$				
9. $K_2CrO_4(aq) + Al(NO_3)_3(aq) \rightarrow KNO_3(?) + Al_2(CrO_4)_3(?)$				
10. $NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(?) + H_2O(?)$				
11. $C_2H_6(g) + O_2(g) \rightarrow CO_2(?) + H_2O(?)$				
12. $Cu(s) + AgNO_3(aq) \rightarrow Cu(NO_3)_2(?) + Ag(?)$				
13. $N_2(g) + O_2(g) \rightarrow N_2O_5(?)$				
14. $O_3(g) \underset{\uparrow\downarrow}{\longrightarrow} O_2(g)$				
15. $Ca(ClO_3)_2(aq) + Li_2SO_4(aq) \rightarrow CaSO_4(?) + LiClO_3(?)$				

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