Balancing Chemical Equations Worksheet

One of the most useful devices for communicating information related to chemical changes is the **chemical equation**. The equation contains both qualitative and quantitative information related to the nature and quantity of the substances involved in the chemical reaction. It may also include the energy change involved.

Atoms are fundamental building blocks of all matter. For the purpose of equation balancing we say that they can be neither created nor destroyed (the Law of Matter). Thus the number of atoms at the beginning of a reaction (**reactants - left side of the equation**) must equal the number of atoms at the end of the reaction (**products - right side of the equation**). Note that the number of atoms on each side of an equation must balance.

The subscripts in a correct formula tell the number of atoms in one molecule. The **coefficients (numbers in front of a formula)** in a correctly balanced equation tell the number of molecules involved in a reaction.

There is a particular order that you can follow in balancing. It is the **MINOH method** (Me know chemistry, said Tarzan as he climbed the stoichiome-tree…… stoichiometry is the study of the quantities of substances in chemistry……. Sorry for the bad joke ☺….)

M - metals. Balance metals such as Fe or Na first.

I - ions. Looks for polyatomic ions (such as PO_4^{-3} or SO_4^{-2} that cross from reactant to products unchanged. Balance them as a group.

N - non-metals. Look for Cl or S, these are common ones.

O - oxygen and then

H - hydrogen.

Often, balancing H and O will involve water on one side or the other. Also, look carefully for elements which occur in only one place on each side of the arrow. These should be balanced before examining elements that are spread over several compounds. Often, either H or O will be spread out over several compounds. This is the one to leave to the last. Remember, you cannot change a subscript to balance the equation, nor can you add in new compounds.

Example 1. Determine if the following reaction is balanced or not.

$$Ca(OH)_{2(cr)} \text{ ---> } CaO_{(cr)} + H_2O_{(g)}$$

Let us make an organized tally table and compare both sides of the equation;

$Ca(OH)_{2(cr)}$ ---> $CaO_{(cr)} + H_2O_{(g)}$							
Reactant Side				Product Side			
Elements	Ca 1 atom	O 2 atoms	H 2 atoms	Elements	Ca 1 atom	O 2 atoms	H 2 atoms

As you can see, this reaction is balanced, so no coefficients are necessary.

Example 2. Check the balance on the following chemical reaction;

$$Ca(OH)_{2(aq)} + HCl_{(aq)} \text{ ---> } CaCl_{2(aq)} + H_2O_{(l)}$$

$Ca(OH)_{2(aq)} + HCl_{(aq)}$ ---> $CaCl_{2(aq)} + H_2O_{(l)}$							
Reactant Side				Product Side			
Ca 1 atom	O 2 atoms	H 3 atoms	Cl 1 atom	Ca 1 atom	O 1 atom	H 2 atoms	Cl 2 atoms

As you can see, this reaction is <u>not</u> balanced. <u>You are not allowed to change any subscripts</u>, but coefficients may be added in order to obtain balance.

Balancing chemical equations is a skill that only develops with practice, but for starters, look at the tally above. Notice that you need more Cl on the reactant side. What would the tally look like if we add a coefficient of 2 to the HCl on the reactant side?

$$Ca(OH)_{2(aq)} + 2HCl_{(aq)} \text{ ---> } CaCl_{2(aq)} + H_2O_{(l)}$$

By doing this you also need to adjust how much hydrogen you have in the tally:

$Ca(OH)_{2(aq)} + 2HCl_{(aq)}$ ---> $CaCl_{2(aq)} + H_2O_{(l)}$							
Reactant Side				Product Side			
Ca 1 atom	O 2 atoms	H 4 atoms	Cl 2 atoms	Ca 1 atom	O 1 atom	H 2 atoms	Cl 2 atoms

Now we need more oxygen and more hydrogen on the product side. Let's add a coefficient of 2 to the H2O on the product side and check the balance again.

$$Ca(OH)_{2(aq)} + 2HCl_{(aq)} \text{ ---> } CaCl_{2(aq)} + 2H_2O_{(l)}$$

$Ca(OH)_{2(aq)} + 2HCl_{(aq)}$ ---> $CaCl_{2(aq)} + 2H_2O_{(l)}$							
Reactant Side				Product Side			
Ca 1 atom	O 2 atoms	H 4 atoms	Cl 2 atoms	Ca 1 atom	O 2 atom	H 4 atoms	Cl 2 atoms

Now the equation is balanced.

Example 2. Write a balanced chemical equation for the reaction below;

$$C_3H_{8(g)} + O_{2(g)} \text{ ----> } CO_{2(g)} + H_2O_{(g)}$$

Now, let us tally the information in a table:

$C_3H_{8(g)} + O_{2(g)}$ ----> $CO_{2(g)} + H_2O_{(g)}$					
Reactant Side			Product Side		
C 3 atoms	H 8 atoms	O 2 atoms	C 1 atom	H 2 atoms	O 3 atoms

Well, a quick look shows us that we will need more hydrogen and more carbon on the right hand side. Let us start by multiplying the number of hydrogen on the product side by four, giving us a total of 8 atoms of hydrogen. Be aware that this will also change the number of oxygen atoms on the product side. Let us look at how a coefficient of 4 in front of water changes things.

$C_3H_{8(g)} + O_{2(g)}$ ----> $CO_{2(g)} + 4H_2O_{(g)}$

$C_3H_{8(g)} + O_{2(g)}$ ----> $CO_{2(g)} + 4H_2O_{(g)}$					
Reactant Side			Product Side		
C 3 atoms	H 8 atoms	O 2 atoms	C 1 atom	H 8 atoms	O 6 atoms

Now we have a match with the number of hydrogen atoms. Let us balance the carbon atoms next, because in order to change the carbon atoms on the product side, it will also affect the number of oxygen atoms. We need to multiply the number of carbon atoms on the product side by three, so we will place a coefficient of three in front of the carbon dioxide and check the tally again.

$C_3H_{8(g)} + O_{2(g)}$ ----> $3CO_{2(g)} + 4H_2O_{(g)}$

$C_3H_{8(g)} + O_{2(g)}$ ----> $3CO_{2(g)} + 4H_2O_{(g)}$					
Reactant Side			Product Side		
C 3 atoms	H 8 atoms	O 2 atoms	C 3 atom	H 8 atoms	O 10 atoms

Now, we have matched the number of atoms for two of the elements. A subscript of 5 in front of the oxygen on the reactant side should finish the job.

$C_3H_{8(g)} + 5O_{2(g)}$ ----> $3CO_{2(g)} + 4H_2O_{(g)}$

$C_3H_{8(g)} + 5O_{2(g)}$ ----> $3CO_{2(g)} + 4H_2O_{(g)}$					
Reactant Side			Product Side		
C 3 atoms	H 8 atoms	O 10 atoms	C 3 atom	H 8 atoms	O 10 atoms

We have achieved proper balance! In practice, the process is not nearly as long and tedious as this may have appeared. Once you gain some experience, you will find that you can balance these equations quickly and painlessly.

Now try these ones in your exercise books!!! Make sure you draw the tally tables up – it does make it easier!!!

1. H_2 + O_2 ---> H_2O
2. S_8 + O_2 ---> SO_3
3. HgO ---> Hg + O_2
4. Zn + HCl ---> $ZnCl_2$ + H_2
5. Na+ H_2O---> $NaOH$+ H_2
6. $C_{10}H_{16}$ + Cl_2 ---> C + HCl
7. Si_2H_3 + O_2 ---> SiO_2 + H_2O
8. Fe + O_2 ---> Fe_2O_3
9. $C_7H_6O_2$ + O_2 ---> CO_2 + H_2O
10. FeS_2 + O_2 ---> Fe_2O_3 + SO_2
11. Fe_2O_3 + H_2 ---> Fe + H_2O
12. K + Br_2 ---> KBr
13. C_2H_2 + O_2 ---> CO_2 + H_2O
14. H_2O_2 ---> H_2O + O_2
15. C_7H_{16} + O_2 ---> CO_2 + H_2O
16. SiO_2 + HF ---> SiF_4 + H_2O
17. $KClO_3$ ---> KCl + O_2
18. $KClO_3$ ---> $KClO_4$ + KCl
19. P_4O_{10} + H_2O ---> H_3PO_4
20. Sb + O_2 ---> Sb_4O_6
21. C_3H_8 + O_2 ---> CO_2 + H_2O
22. Fe_2O_3 + CO ---> Fe + CO_2
23. N_2+H_2--->NH_3
24. N_2+O_2--->N_2O
25. CO_2 + H_2O ---> $C_6H_{12}O_6$ + O_2