Name: _____ Date: _____ Period: _____ Page: _____

Balancing Equations

In a chemical reaction, one or more reactants change into one or more products. Chemists use chemical equations as a quick shorthand notation to convey as much information as possible about what happens in a chemical reaction

Why Balance Equations? Law of Conservation of Matter: During an ordinary chemical change, there is no detectable increase or decrease in the quantity of matter. The total quantity of matter and energy available in the universe is a fixed amount and never any more or less.

Vocabulary:

Balanced equation: a chemical reaction in which each side of the equation has the same number of atoms of each element and mass is conserved

Reactant: chemicals that you put into the reaction, found on the left side of the arrow

Product: chemicals that you get as a result of the reaction. The product is a combination of the reactants, found on the right side of the arrow

Oxidation Number: The charge on the ion. Positive (cation-metal) or negative (anion-nonmetal)

Coefficients: Whole numbers in front of the formulas in order to balance the equation

Common Symbols in Chemical Equations	
Symbol	**Explanation**
	used to separate two reactants or two products
	"yields," separates reactants from products
	used in place of → for reversible reactions
	designates a reactant or product in the solid state; placed after the formula
	designates a reactant or product in the liquid state; placed after the formula
	designates a reactant or product in the gaseous state; placed after the formula
	designates an aqueous solution; the substance is dissolved in water; placed after the formula
	indicates that heat is supplied to the reaction
	a formula written above or below the yield sign indicates its use as a catalyst

Steps for Balancing Equations:

Step 1: Look at the reactants. Determine the number of atoms of each element.

Step 2: Look at the products. Determine the number of atoms of each element.

Step 3: Ask yourself: Are there the same number of each element on both sides of the equation arrow? If your answer is yes, the equation is balanced. If your answer is no, continue to step 4.

Step 4: *In general* it will help to start with the element that is most dissimilar in count between the reactant and product side.

Reactants

Element	# of atoms
A	5
B	5
C	2

Products

Element	# of atoms
A	10
B	5
C	4

In the example above, the most dissimilar element is A (difference of 5) (B – no difference, C - difference of 2) You will fix A first!

Step 5: Decide which side you need to fix A on. You will fix the side with the *least* amount of A: reactant side.

Step 6: Determine what number you can multiply the number of A on the left side (5) by in order to equal the number of A on the right side (10).

$X * 5 = 10 ; X = 2$

2 is your coefficient in front of the formula containing that element.

You are not at liberty to change the subscripts.

Step 7: Re-count! The coefficient gets multiplied by everything in the formula. By adding this coefficient you may have fixed the difference in C as well, but you may have created additional problems that now need fixing. If the first fix does not balance C we must continue back to step 6.

Check your work! There is no reason to ever get a balancing problem wrong! Always check yourself by making sure that in the end you have the same number of atoms for each element on both the reactant and product side. If the numbers are different, redo the problem.

Sometimes…

- you will insert a coefficient but later determine that it is wrong, so you will have to take it out and reinsert a new coefficient
- it will appear that there is no possible solution using whole number coefficients. If you are in this predicament, multiply the entire equation by 2
- coefficients are not in the lowest whole number ratio. For example, if you have an order of coefficients that is 4-2-2, divide all numbers by 2 to get 2-1-1

Exercise A. Explain in words each of the symbols.

$Mg\ (s) + 2HCl\ (aq) \rightarrow MgCl_2\ (aq) + H_2\ (g)$

1.	Mg	_____	6.	(aq)	_____
2.	(s)	_____	7.	→	_____
3.	+	_____	8.	$MgCl_2$(aq)	_____
4.	2	_____	9.	H_2	_____
5.	HCl	_____	10.	(g)	_____

Exercise B. Identify the following parts in each chemical formula by circling the subscripts and drawing a square around the coefficients.

H_2 2 HCl 4 O_2 CH_4 3 CO_3 2 NaOH

Exercise C. List the symbols for the atoms in each formula and give the number of each. The coefficient gets distributed to everything in front of it. Therefore, you multiply the coefficient by the subscript number. If there is no coefficient, it is implied to be a "1."

C_2H_6	2MgO	$4P_4O_{10}$
C =	Mg =	P =
H =	O =	O =
NH_3	$3Al(OH)_3$	$2H_2O_2$
N =	Al =	H =
H =	O =	O =
	H =	
$Zn_3(PO_4)_2$	$Al_2(SO_4)_3$	$Mg(CN)_2$
Zn =	Al =	Mg =
P =	S =	C =
O =	O =	N =

Exercise D. Balance each of the following equations following the step-by-step procedures outlined in class.

____P + ____O_2 → ____P_4O_{10}

P =	P =
O =	O =

____Mg + ____O_2 → ____MgO

Mg =	Mg =
O =	O =

____HgO → ____Hg + ____O_2

Hg =	Hg =
O =	O =

____Al_2O_3 →____Al + ____O_2

Al =	Al =
O =	O =

____$BaCl_2$ + ____H_2SO_4 → ____$BaSO_4$ + ____HCl

Ba =	Ba =
Cl =	Cl =
H =	H =
S =	S =
O =	O =

Exercise E. Balancing Act

1. _____Ca + _____O_2 → _____CaO
2. _____N_2 + _____H_2 → _____NH_3
3. _____Cu_2O + _____C → _____Cu + _____CO_2
4. _____H_2O_2 → _____H_2O + _____O_2
5. _____Na + _____MgF_2 → _____NaF + _____Mg
6. _____Mg + _____HCl → _____$MgCl_2$ + _____H_2
7. _____Cl_2 + _____KI → _____KCl + _____I_2

8. _____$NaCl \rightarrow$ _____Na + _____Cl_2

9. _____Na + _____$O_2 \rightarrow$ _____Na_2O

10. _____Na + _____$HCl \rightarrow$ _____H_2 + _____$NaCl$

11. _____K + _____$Cl_2 \rightarrow$ _____KCl

12. _____ $P(s)$ + _____ $O_2(g) \rightarrow$ _____ $P_2O_5(s)$

13. _____ $Fe(OH)_3(s) \rightarrow$ _____ $Fe_2O_3(s)$ + _____ $H_2O(g)$

14. _____ $Na_2CO_3(aq)$ + _____ $Ca(OH)_2(aq) \rightarrow$ _____ $NaOH(aq)$ + _____ $CaCO_3(s)$

15. _____ $K_3PO_4(aq)$ + _____ $MgCl_2(aq) \rightarrow$ _____ $Mg_3(PO_4)_2$ (s) + _____ KCl (aq)

16. _____ $Mg(HCO_3)_2$ + _____ $HCl \rightarrow$ _____ $MgCl_2$ + _____ H_2O + _____ CO_2

17. _____ $Bi(NO_3)_3$ (aq) + _____ CaI_2 (aq) $\rightarrow$ _____ BiI_3 (s) + _____ $Ca(NO_3)_2$ (aq)

18. _____ Cu (s) + _____ H_2SO_4 (aq) $\rightarrow$ _____ $CuSO_4$ (aq) + _____ H_2O (l) + ____ SO_2 (g)

19. _____C_2H_6 + _____$O_2 \rightarrow$ _____CO_2 + _____H_2O

Exercise F. Write the balanced equation on the line for each reaction.

20. $KClO_3 \rightarrow KCl + O_2$ _____

21. $NaCl + F_2 \rightarrow NaF + Cl_2$ _____

22. $H_2 + O_2 \rightarrow H_2O$ _____

23. $AgNO_3 + MgCl_2 \rightarrow AgCl + Mg(NO_3)_2$ _____

24. $AlBr_3 + K_2SO_4 \rightarrow KBr + Al_2(SO_4)_3$ _____

25. $CH_4 + O_2 \rightarrow CO_2 + H_2O$ _____

26. $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$ _____

27. $C_8H_{18} + O_2 \rightarrow CO_2 + H_2O$ _____

28. $FeCl_3 + NaOH \rightarrow Fe(OH)_3 + NaCl$ _____

29. $Na + H_2O \rightarrow NaOH + H_2$ _____

30. $Ag_2O \rightarrow Ag + O_2$ _____

31. $S_8 + O_2 \rightarrow SO_3$ _____

32. $CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$ _____

33. $K + MgBr_2 \rightarrow KBr + Mg$ _____

34. $HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$ _____

Exercise G. Is the equation balanced? Write yes on no on the line. If it is not balanced properly, fix it!

1. _____ $2\ K + 2\ H_2O \rightarrow 2\ KOH + H_2$

2. _____ $HCl + NaOH \rightarrow H_2O + NaCl$

3. _____ $KNO_3 \rightarrow KNO_2 + O_2$

4. _____ $2\ C_2H_2 + 5\ O_2 \rightarrow 4\ CO_2 + 2\ H_2O$

5. _____ $C_4H_8 + 6\ O_2 \rightarrow 4\ CO_2 + 4\ H_2O$

6. _____ $Hg + O_2 \rightarrow HgO$

7. _____ $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$