Balancing Reaction Strategies

Balancing Reaction Basics

There are two basic rules for balancing reactions.

1. There must be the same number of atoms for each element in the reactants and in the products.

2. We can adjust the number of atoms on a side by adding coefficients, numbers in front of an element or compound.

- Coefficients multiply the number of atoms of whatever it is in front of.
- The coefficient cannot go in the middle of a compound or change the formula of a compound.

The following is a step by step look at balancing a reaction.

Step 1: Count the number of atoms for each element on both sides of the reaction. It is important to list the elements in the same order on both sides of the reaction.

$K_2S_{(aq)}$	+	$BaBr_{2(aq)}$	→	$BaS_{(ppt)}$	+	$KBr_{(aq)}$
K = 2				K = 1		
S = 1				S = 1		
Ba = 1				Ba = 1		
Br = 2				Br = 1		

Step 2: Starting at the top, add coefficients to make each element balanced. Notice that when you place a coefficient in front of a compound, it will multiply every element in the compound.

___ $K_2S_{(aq)}$	+	___ $BaBr_{2(aq)}$	→	___ $BaS_{(ppt)}$	+	_2_ $KBr_{(aq)}$
K = 2				K = ~~1~~ = 2		
S = 1				S = 1		
Ba = 1				Ba = 1		
Br = 2				Br = ~~1~~ = 2		

We now have the same number of atoms on both sides for each element. If there is not a coefficient written in front of an element or compound, then it is understood to be 1. We could say that this reaction balanced as 1, 1, 1, 2 by listing all of the coefficients. The coefficients must be reduced to the lowest possible ratio. If the coefficients where 2, 2, 2, 4, then it would be incorrect until reduced.

Balancing Strategies

Strategy One: If an element appears more than once on one side of a reaction, then do it last. When an element appears more than once, then the amount in all of its appearances will be added together.

___ $C_4H_{8(l)}$	+	___ $O_{2(g)}$	→	___ $CO_{2(g)}$	+	___ $H_2O_{(g)}$
C = 4				C = 1		
H = 8				H = 2		
O = 2				O = 3 (2 in CO_2 & 1 in H_2O)		

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Do the carbon atoms first, and save the oxygens for last since they are in CO_2 & H_2O.

___ $C_4H_{8(l)}$	+	___ $O_{2(g)}$	→	_4_ $CO_{2(g)}$	+	___ $H_2O_{(g)}$
C = 4				C = ~~1~~ = 4		
H = 8				H = 2		
O = 2				O = ~~3~~ = 9		

The hydrogens are next. Continue to save the oxygens for last.

___ $C_4H_{8(l)}$	+	___ $O_{2(g)}$	→	_4_ $CO_{2(g)}$	+	_4_ $H_2O_{(g)}$
C = 4				C = ~~1~~ = 3		
H = 8				H = ~~2~~ = 8		
O = 2				O = ~~3~~ = ~~9~~ = 12		

Finally, the oxygens can be balanced.

___ $C_4H_{8(l)}$	+	_6_ $O_{2(g)}$	→	_4_ $CO_{2(g)}$	+	_4_ $H_2O_{(g)}$
C = 4				C = ~~1~~ = 3		
H = 8				H = ~~2~~ = 8		
O = ~~2~~ = 12				O = ~~3~~ = ~~9~~ = 12		

Strategy Two: If a polyatomic ion is unchanged on both sides of a reaction, then it can be treated as a single item instead of being broken down into its elements.

In this reaciton, the carbonates are the same on both sides, so keep it together when you count.

___K_2CO_3	+	___$MgCl_2$	→	___$MgCO_3$	+	___KCl
K = 2				K = 1		
CO_3 = 1				CO_3 = 1		
Mg = 1				Mg = 1		
Cl = 2				Cl = 1		

___K_2CO_3	+	___$MgCl_2$	→	___$MgCO_3$	+	_2_KCl
K = 2				K = ~~1~~ = 2		
CO_3 = 1				CO_3 = 1		
Mg = 1				Mg = 1		
Cl = 2				Cl = ~~1~~ = 2		

If the polyatomic ion is broken up in the reaction, then you must count the individual atoms. For example, in $H_2CO_3 \rightarrow H_2O + CO_2$ the carbonate is not the same on the right side.

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Strategy Three: If you are having a hard time balancing a reaction, then start over and put a two as the first coefficient.

Note that hydrogen should be balanced last since it shows up twice on the product side. However, it is the only element out of balance. This makes this reaction difficult to balance the first time through, but putting a 2 as the first coefficient makes it fairly simple.

___ $Na_{(s)}$ + ___ $H_2O_{(l)}$ → ___ $NaOH_{(aq)}$ + ___ $H_{2(g)}$	
Na = ~~1~~ = 2	Na = 1
H = 2	H = 3
O = 1	O = 1

_2_ $Na_{(s)}$ + ___ $H_2O_{(l)}$ → _2_ $NaOH_{(aq)}$ + ___ $H_{2(g)}$	
Na = ~~1~~ = 2	Na = ~~1~~ = 2
H = 2	H = ~~3~~ = 4
O = 1	O = ~~1~~ = 2

_2_ $Na_{(s)}$ + _2_ $H_2O_{(l)}$ → _2_ $NaOH_{(aq)}$ + ___ $H_{2(g)}$	
Na = ~~1~~ = 2	Na = ~~1~~ = 2
H = ~~2~~ = 4	H = ~~3~~ = 4
O = ~~1~~ = 2	O = ~~1~~ = 2

Strategy Four: It is possible for a reaction to be balanced without adding any coefficients.

In this case, simply write "already balanced" after the reaction.

$NaHCO_{3(s)}$ + $HC_2H_3O_{2(aq)}$ → $NaC_2H_3O_{2(aq)}$ + ___ $H_2O_{(l)}$ + $CO_{2(g)}$			
Na = 1		Na = 1	
H = 2		H = 2	
C = 1		C = 1	already balanced
O = 3		O = 3	
$C_2H_3O_2$ = 1		$C_2H_3O_2$ = 1	