Math Tutor BALANCING CHEMICAL EQUATIONS

A chemical equation is a written expression of an actual chemical reaction in which certain atoms, ions, or molecules become rearranged in a specific way. Therefore, the equation must represent exactly what happens in the reaction. Recall that atoms are never created or destroyed in chemical reactions. A balanced chemical equation shows that all of the atoms present in reactants are still present in products.

Problem-Solving TIPS

- First, identify reactants and products. (You may find it helpful to write a word equation first.)
- Using correct formulas and symbols, write an unbalanced equation for the reaction.
- Balance atoms one element at a time by inserting coefficients.
- Identify elements that appear in only one reactant and one product, and balance the atoms of those elements first.
- If a polyatomic ion appears on both sides of the equation, treat it as a single unit.
- Double-check to be sure that the number of atoms of each element is the same on both sides of the equation.

SAMPLE

When an aqueous solution of ammonium sulfate, $(NH_4)_2SO_4(aq)$, is combined with an aqueous solution of silver nitrate, $AgNO_3(aq)$, a precipitate of solid silver sulfate, $Ag_2SO_4(s)$, forms, leaving ammonium nitrate, $NH_4NO_3(aq)$, in solution. Balance the equation for this reaction.

As before, first write an equation with correct formulas for all reactants and products.

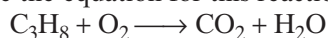$$(NH_4)_2SO_4(aq) + AgNO_3(aq) \longrightarrow NH_4NO_3(aq) + Ag_2SO_4(s)$$
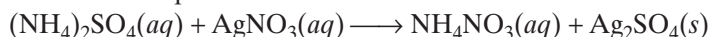
If you compare the number of silver atoms on each side, you can see that the equation is not balanced. This equation may look very complex, but it is really fairly simple. In many reactions involving polyatomic ions such as sulfate, nitrate, and ammonium, the ions do not change. In the equation above, you can see that NO_3 is present on both sides, as are SO_4 and NH_4. You can balance the equation by treating the groups as if they were single atoms. To balance the NH_4 groups, place a 2 in front of NH_4NO_3. This gives you two ammonium groups on the left and two on the right. Now, because you have two nitrate groups on the right, place a 2 in front of $AgNO_3$ to give two nitrate groups on the left. Finally, check silver atoms and sulfate groups, and you find that they balance.

$$(NH_4)_2SO_4(aq) + 2AgNO_3(aq) \longrightarrow 2NH_4NO_3(aq) + Ag_2SO_4(s)$$
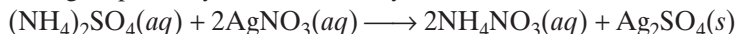
PRACTICE PROBLEMS

1. When propane burns completely in air, the reaction forms carbon dioxide and water vapor. Balance the equation for this reaction.
$$C_3H_8 + O_2 \longrightarrow CO_2 + H_2O$$

2. Balance the following chemical equations:
   a. $KI(aq) + Cl_2(g) \longrightarrow KCl(aq) + I_2(s)$
   b. $Al(s) + H_2SO_4(aq) \longrightarrow$
   $$Al_2(SO_4)_3(aq) + H_2(g)$$