Balancing Equation Notes

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Balancing equations can seem a bit difficult and off putting at first glance, but once we get used to them, they are perfectly straight forward. It's the getting used to them that takes a bit of time. So, we will take our time and practise plenty of them to make sure we get them 😊 First, let's look at **three** key definitions.

Reactants: are the molecules that react together in a chemical reaction. They are always written on the left hand side of a chemical reaction.

Products: are the molecules that are produced in a chemical reaction and they are always written on the right hand side of a chemical reaction.

The Law of Conservation of Mass: states that mass cannot be created or destroyed in a chemical reaction. This means that the number and type of atoms in the reactants will be the same as the number and type in the products.

Balancing Equations Key Points

Below is a list of key points about how to understand and correctly complete questions involving balancing equations.

1. The number of atoms that go into a chemical reaction must be the same as the number of atoms that come out of a chemical reaction. This is the law of conservation of mass.

2. Reactants go on the left-hand side and products go on the right-hand side of a chemical equation.

3. Try to avoid working with odd numbers of atoms if you can.

   How do we do this? We could just pop a 2 in front of the molecule that we're working with. Take the example of H_2O. If we have one molecule of H_2O in the products this means we have 2 hydrogen atoms and 1 oxygen atom. This 1 oxygen atom can make balancing a bit tricky, or not, it depends on the equation. If it is a tricky one, just pop a 2 in front of H_2O.

   This gives us **$2H_2O$**. So we now have 4 hydrogen atoms and 2 oxygen atoms. This is much easier to balance.

4. We can add numbers (coefficients) in front of molecules but we cannot change the subscripts. Subscripts are the small numbers in the molecules. See the molecule of aluminium oxide (Al_2O_3) below as an example.

$$2Al_2O_3$$

Coefficients — These are the numbers that we **can** change.

Subscript — These are the numbers that we **cannot** change.

Now, let's have a look at a number of examples 😊

Example 1: A student reacts some hydrogen with oxygen to produce water. The equation for the reaction is:

$$H_2 + O_2 \rightarrow H_2O$$

Balance the equation for the reaction.

Solution: we notice that there are two hydrogen atoms on the left and two on the right. So, that's fine for the moment. We notice that there are two oxygen atoms on the left but only **one** on the right. We can make two oxygens be on the right by putting **2** in front of H_2O. This then makes two oxygens on the left and two on the right.

$$H_2 + O_2 \rightarrow 2H_2O$$

But, this change now means that there are four hydrogen atoms on the right but only two hydrogen atoms on the left. We can make four hydrogen atoms be on the left by putting a 2 in front of H_2. So the balanced equation is…

$$2H_2 + O_2 \rightarrow 2H_2O$$

Example 2: A student completed a combustion reaction of methane in oxygen. The equation for the reaction is:

$$CH_4 + 2O_2 \rightarrow CO_2 + H_2O$$

Balance the equation for the reaction.

Solution: we notice that there is one carbon atom on the left and one on the right. So, that's fine for the moment. We notice that there are four hydrogen atoms on the left but only two on the right. We can make four hydrogens be on the right by putting 2 in front of H_2O. This then makes four hydrogen atoms the right hand side.

Putting that 2 in front of H_2O now means that we have two oxygens from the H_2O molecules as well. This means that we have four oxygens in total on the right hand side. We look back and see that there are also four oxygens on the left hand side.

The equation is now balanced.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

Example 3: A student reacted some aluminium hydroxide with sulfuric acid. The equation for the reaction is:

$$Al(OH)_3 + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2O$$

Balance the equation for the reaction.

Solution: so there are clues here. We notice that three groups of SO_4 are on the right hand side. But only one group on the left. If we put a 3 in front of the H_2SO_4 that would balance the SO_4.

$$Al(OH)_3 + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2O$$

We next need to balance the aluminium. There are two on the right but only one on the left. We can balance this by placing a 2 in front of $Al(OH)_3$.This gives us…

$$2Al(OH)_3 + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2O$$

Lastly, we need to balance the hydrogen atoms. We can see that there are twelve individual hydrogen atoms on the left hand side. We can make twelve be on the right hand side by placing a 6 in front of the H_2O.

$$2Al(OH)_3 + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 6H_2O$$

The equation is now balanced.

Exam Trap 😊

Do you member earlier when we said that **mass** cannot be created or destroyed in a chemical reaction, yes, well… it **can change during a reaction**… In an open system, that's one where the reaction is just in contact with the air, the mass of the reaction might go increase or it might decrease.

We could see a question that asks us "**Why does mass sometimes seem to change during an experiment?"** Let's look at both increases and decreases.

Mass increases – this is due to one of the reactants reacting one of the gases in the air. This gas is usually oxygen 😊

Example: magnesium reacting with oxygen to form magnesium oxide. The mass of magnesium oxide is higher than just magnesium on its own.

Mass decreases – if one of the products is a gas it can be given off from the reaction. This means the mass will decrease.

Example: calcium carbonate thermally decomposing to produce carbon dioxide gas.