19 - Oxidation and Reduction

Balancing Act: Mastering Redox Equations

Video 19 - Transcript

Hi everyone, Welcome to video number 19. Today we are going to be looking at the processes of oxidation and reduction. Now as we go through this topic, you will see that these two processes occur simultaneously. This is why we have come up with the term REDOX to exemplify these two processes. Essentially, we need to be able to define what oxidation means, and we need to be able to define what reduction means. Oxidation can be defined in many different ways, and we're going to list what these are. Firstly, we can define oxidation as an increase in what we call the oxidation number. We can simply calculate oxidation number by looking at the charge on a species. Let's say we had a Cu2+ ion. Then the oxidation number of this species is +2 When we're looking at charge we have the sign which is plus after the number. When we're looking at oxidation number, we have the sign which is plus before the number. Oxidation is an increase in oxidation number. At the same time, we can define oxidation as the addition of oxygen onto a molecule or a species. Alongside that, we can say that oxidation is the removal of hydrogen atoms from a molecule or species. Finally, we can define oxidation as the removal of electrons from a molecule or a species. If we are being converted from a low valency to a high valency, that is going to be an increase in oxidation number; if we are adding oxygen, if we're removing hydrogen, or if we're removing electrons, all of these are termed oxidation. Now on the other hand, if we want to define reduction, reduction is simply the reverse of oxidation. We can think of reduction as a decrease in the oxidation number. If let's say we had Cu2+ going to Cu+ this is a reduction. We are decreasing the valency. We're going from a high valency to a low valency. Similarly, we can define reduction as the removal of oxygen, as the addition of hydrogen. Finally, as by the addition of electrons to a species. It's very important to be able to remember these various definitions of oxidation and reduction. So that when you come across these situations in a chemical reaction, you can then identify this is being oxidized or this is being reduced. If we want to look at two very common reactions that we're going to meet as we explore biology: photosynthesis and respiration. Both of these are very important reactions that occur in living systems. We know that photosynthesis occurs in autotrophs, or otherwise known as organisms which produce their own food, like green plants for example; Respiration occurs in many organisms, whereby we take glucose or sugars, and we oxidize it to make energy. If we look at photosynthesis, we can see what is happening. We have a reduction of our carbon dioxide into our sugars. This here is a reduction. Notice what we're doing. We're taking carbon and we're adding hydrogen atoms. Based on our definition of reduction, converting CO2 into glucose is a reduction because we're adding hydrogen atoms. Okay? If we want to produce CO2 and water

from glucose, this is an oxidation reaction, for example. what we're seeing here is that we are essentially taking our oxygen. Okay? We're also looking at the carbons in our glucose molecule. And we're basically removing hydrogens to get CO2 - so removal of hydrogen is oxidation. Now it's really important for us to take into consideration the integral role that oxidation and reduction plays in the metabolic reactions which support life. Now, it was mentioned before that oxidation and reduction are simultaneous processes, so that they occur at the same time. Oxidation cannot occur without reduction, and vice versa. If you think about the species that is itself oxidized. Okay. If you think about here glucose being oxidized to CO2, the whole process of taking glucose and bringing it into carbon dioxide necessitates the removal of the hydrogen. If we think about a chemical reaction, it needs to be balanced on both sides. Where the atoms on the left hand side are equal to the atoms on the right hand side. If we remove hydrogen from glucose, there must be something that is taking up that hydrogen. And in this case, it's going to be our oxygen. If we notice we have oxygen taking up our hydrogen atoms and being converted to water. If we look at this reaction, our oxygen, which is being reduced to water, is actually going to become the reducing agent for this molecule. Essentially, the oxidizing agent is itself reduced. The reducing agent is itself oxidized. We should recall that when we write chemical reactions, all of the atoms must be the same on either side. Therefore, if a species loses an oxygen atom, then something else must be gaining that oxygen atom. If a species gains an electron, for example, and is reduced, addition of electrons is reduction, then there must be another species that would have donated that electron and therefore was oxidized. Oxidation and reduction occur simultaneously. And we have to remember that the oxidizing agent is itself reduced. The reducing agent is itself oxidized. That's all for this video. I'll see you guys in the next video, where we're going to look at the energy changes that occur during chemical reactions.