A Guide to Redox Reaction

Teaching Approach

In this series we explain reduction-oxidation reactions, called redox for short. We start with looking at redox in real life, such as rusting. We point out that redox is the transfer of electrons from one substance to another and is made up of two half reactions which together make the complete reaction. The rules for assigning oxidation numbers are taught and it is important that the students learn these rules and then do lots of practice to ensure that they can use them easily. This is important as not only does this help the students identify which substances are being oxidised and which are being reduced, but also is essential in balancing redox reactions using oxidation numbers. We also look at different types of reactions and learn to identify displacement, synthesis and decomposition reactions.

In the last lesson we investigate the oxidising action of potassium permanganate and the reducing action of hydrogen sulfide. Please note the safety information for the reaction of potassium permanganate with hydrochloric acid and caution needs to be taken as well, for the reaction of hydrogen sulfide.

Video Summaries

Some videos have a 'PAUSE' moment, at which point the teacher or learner can choose to pause the video and try to answer the question posed or calculate the answer to the problem under discussion. Once the video starts again, the answer to the question or the right answer to the calculation is given.

Mindset suggests a number of ways to use the video lessons. These include:

- Watch or show a lesson as an introduction to a lesson
- Watch or show a lesson after a lesson, as a summary or as a way of adding in some interesting real-life applications or practical aspects
- Design a worksheet or set of questions about one video lesson. Then ask learners to watch a video related to the lesson and to complete the worksheet or questions, either in groups or individually
- Worksheets and questions based on video lessons can be used as short assessments or exercises
- Ask learners to watch a particular video lesson for homework (in the school library or on the website, depending on how the material is available) as preparation for the next day's lesson; if desired, learners can be given specific questions to answer in preparation for the next day's lesson

1. Introduction to Redox Reactions

In this lesson we introduce redox using real life examples. We explain that redox reactions occur when there is a transfer of electrons between substances.

2. Assigning Oxidation Numbers

In this lesson we go through the rules used to assign oxidation numbers and then use these to determine the oxidation numbers in some examples.

3. How to use Oxidation Numbers in Redox Reactions

In this lesson we briefly revise the rules for assigning oxidation numbers. We explain that redox reactions always involve changes in oxidation numbers.

4. Various Types of Redox Reactions

In this lesson we investigate various redox reactions. We use the reaction between copper and silver nitrate to show a displacement reaction.

5. Using Oxidation Numbers to Balance Reaction Equations

In this lesson we demonstrate how to balance equations using oxidation numbers by working through an example step by step.

6. Examples of Redox Reactions

In this lesson the reducing action of hydrogen sulfide is shown by demonstrating an experiment with hydrogen sulfide and potassium dichromate. Colour changes and the formation of a solid precipitate are pointed out.

Resource Material

1. Introduction to Redox Reactions	http://www.slideshare.net/guest53e1dff/redox-reactions-everyday-examples	This website gives every day examples of redox reactions.
	http://www.scienceclarified.com/everyday/Real-Life-Chemistry-Vol-2/Oxidation-Reduction-Reactions.html	This page defines the concept of oxidation-reduction reaction.
	http://www.ask.com/question/redox-reactions-in-real-life	Redox reaction in real life.
2. Assigning Oxidation Numbers	http://www.slideshare.net/guest53e1dff/redox-reactions-everyday-examples	Redox reactions everyday examples
	http://www.scienceclarified.com/everyday/Real-Life-Chemistry-Vol-2/Oxidation-Reduction-Reactions.html	Oxidation reduction reaction.
	http://www.ask.com/question/redox-reactions-in-real-life	Redox reactions in real life.
3. How to use Oxidation Numbers in Redox Reactions	http://www.files.chem.vt.edu/RVGS/ACT/notes/oxidation_numbers.html	Oxidation numbers and redox reactions.
	http://www.youtube.com/watch?v=lxEvuJPTvew	A video on how to assign oxidation numbers.
	http://www.youtube.com/watch?v=PNaZqnFwIIQ	A video on single replacement reaction.
	http://www.youtube.com/watch?v=Fz9eV-EWtpY	A video on magnesium burning oxygen.
	http://chemwiki.ucdavis.edu/Wikitexts/Development_Details/xApproaches/VVV_Demos/Burning_Magnesium	Burning magnesium
	http://chemistry.bd.psu.edu/jircitano/KClO3decomp05.pdf	The decomposition of potassium chlorite.
	http://www.youtube.com/watch?v=Fcr7UDHRa0Y	A You tube video on the decomposition of potassium chlorite.
	http://people.ku.edu/~matt915/projects/chloratedecomp.html	Decomposition of $KClO_3$.

4. Various Types of Redox Reactions	https://www.boundless.com/chemistry/aqueous-reactions/oxidation-reduction-reactions/types-of-redox-reactions/	This page looks at the five main types of redox reactions.
5. Using Oxidation Numbers to Balance Reaction Equations	http://www.youtube.com/watch?v=YZJt2TikFow	Balancing reactions with oxidation number 1.
	http://www.youtube.com/watch?v=mvbPtQfAfUQ	A video on redox balancing.
	http://www.chemistry.co.nz/chemequa.htm	Adjustable 2 gas mixer.
6. Examples of Redox Reactions	http://www.youtube.com/watch?v=Tj5DMYgsW_A	A look at the reducing agents sulfur dioxide and hydrogen sulfide.
	http://entrancechemistry.blogspot.com/2012/09/properties-uses-potassium-permanganate.html	Properties and uses of potassium permanganate ($KMnO_4$).

Task

Question 1

What is oxidation?

Question 2

2.1 Determine the chemical that is oxidised in this reaction:
$4Fe + 3O_2 \rightarrow 2Fe_2O_3$

2.2 Determine the chemical that acts as the oxidising agent in this reaction:
$2Cu + O_2 \rightarrow 2CuO$

Question 3

State which substances are being oxidised. Label the reaction as a synthesis or displacement reaction:

3.1 $Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$

3.2 $4K(s) + O_2(g) \rightarrow 2K_2O(s)$

Question 4

Use the rules for oxidation numbers to find the oxidation number of the atom indicated in bold:

4.1 NH_3

4.2 $K_2Cr_2O_7$

4.3 $Ca(OH)_2$

Question 5

Identify the chemicals that are oxidised and reduced in these reactions, and state the change in their oxidation numbers.

5.1 $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$

5.2 $2H_2O + CrO_4^{2-} + 3Fe(OH)_2 \rightarrow CrO_2^{-} + 3Fe(OH)_3 + OH^{-}$

Question 6

Balance these equations using oxidation numbers

6.1 $NO_2^{-} + MnO_4^{-} \rightarrow NO_3^{-} + Mn^{2+}$

6.2 $Cl_2(g) + S_2O_3^{2-}(aq) \rightarrow Cl^{-}(aq) + SO_4^{2-}(aq)$

Task Answers

Question 1

Oxidation is the loss of electrons.

Question 2

2.1 Fe → Fe^{3+}, Fe has lost electrons and is therefore oxidised.

2.2 The oxidising agent is reduced, which means that it gains electrons. O_2→ $2O^{2-}$ therefore oxygen is reduced and is the oxidising agent.

Question 3

3.1 $Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$

$Zn \rightarrow Zn^{2+}$

$2H^+ \rightarrow H_2$

Therefore the zinc is oxidised and the hydrogen is reduced. This is a displacement reaction because the sulfate has exchanged ions.

3.2 $4K(s) + O_2(g) \rightarrow 2K_2O(s)$

$K \rightarrow K^+$ therefore potassium is oxidised, which means that oxygen is reduced. This is a synthesis reaction since a new product, potassium oxide, is made by combining two substances.

Question 4

4.1 NH_3

(Oxidation number of N) + 3(+1) = 0, therefore Oxidation number of N = -3

4.2 $K_2Cr_2O_7$

2(+1) + 2(oxidation number of Cr) + 7(-2)= 0,

therefore oxidation number of Cr = +6

4.3 $Ca(OH)_2$

(oxidation number of Ca) + 2(-1) = 0 therefore oxidation number of Ca = +2

Question 5

5.1 0 +1 -2 +1 -2 +1 0

$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$

Sodium's oxidation number changes from 0 to +1 so it is oxidised to sodium hydroxide.

Hydrogen's oxidation number changes from +1 to 0 so water is reduced to hydrogen gas.

5.2 +1 -2 +6 -2 +2 -2 +1 +3 -2 +3 -2 +1 -2 +1

$2H_2O + CrO_4^{2-} + 3Fe(OH)_2 \rightarrow CrO_2^- + 3Fe(OH)_3 + OH^-$

Chromium's oxidation number changes from +6 to +3 therefore it is reduced.

Iron's oxidation number goes from +2 to + 3 therefore it is oxidised.

Question 6

6.1 $5\ NO_2^- + 6\ H^+ + 2\ MnO_4^- \rightarrow 5\ NO_3^- + 2\ Mn^{2+} + 3\ H_2O$

6.2 $S_2O_3^{2-}(aq) + 5\ H_20 + 4\ Cl_2(g) \rightarrow 2\ SO_4^{2-}(aq) + 10\ H^+(aq) + 8\ Cl^-(aq)$

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