Iron: a fiery future

Education in Chemistry
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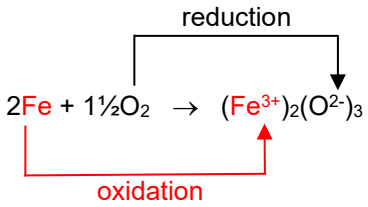
Displacement reactions as examples of redox reactions

Researchers at Eindhoven Technical University (TU/e) in The Netherlands are investigating the redox reaction between iron and oxygen to form iron oxide as a way of storing renewable energy.

This reaction is an example of a **redox reaction** because as the iron is **oxidised** the oxygen is simultaneously **reduced**.

This is easier to see if we show the charges on the ions in iron oxide.



The Fe atom has lost three electrons to become a 3^+ ion and so has been **oxidised**.

We show this in a **half equation** in which an electron is represented by e^-.

$$Fe - 3e^- \rightarrow Fe^{3+}$$

Each oxygen atom has gained two electrons to become a 2^- ion and so has been **reduced**.

$$\tfrac{1}{2} O_2 + 2e^- \rightarrow O^{2-}$$

A displacement reaction is another example of a redox reaction. In this task you will look at displacement reactions and identify the oxidation and reduction processes occurring.

For each of the displacement reactions listed below:

- explain why the displacement reaction occurs
- identify the metal that is **oxidised** and write a half equation for the oxidation process
- identify the metal that is **reduced** and write a half equation for the reduction process

1. sodium + silver(I) chloride → sodium chloride + silver

   $Na + Ag^+Cl^- \rightarrow Na^+Cl^- + Ag$

   Explanation: _____

   Metal that is **oxidised**: _____

   Metal that is **reduced**: _____

2. magnesium + iron(II) chloride → magnesium(II) chloride + iron

   $Mg + Fe^{2+}(Cl^-)_2 \rightarrow Mg^{2+}(Cl^-)_2 + Fe$

   Explanation: _____

   Metal that is **oxidised**: _____

   Metal that is **reduced**: _____

3. zinc + copper(II) bromide → zinc(II) bromide + copper

   $Zn + Cu^{2+}(Br^-)_2 \rightarrow Zn^{2+}(Br^-)_2 + Cu$

   Explanation: _____

   Metal that is **oxidised**: _____

   Metal that is **reduced**: _____

For these two final examples you will also need to write the symbol equation for the displacement reaction.

Remember, if a metal is a transition metal (or has a different charge to the group it's in) the charge on its ion is shown in roman numerals after the metal in the compound's name, eg iron(III) chloride contains iron as an Fe^{3+} ion and has the formula $Fe^{3+}(Cl^-)_3$.

4. zinc + lead(II) iodide → zinc(II) iodide + lead

   Symbol equation: _____

   Explanation: _____

   Metal that is **oxidised**: _____

   Metal that is **reduced**: _____

5. aluminium + copper(II) nitrate → aluminium nitrate + copper

   Symbol equation: _____

   Explanation: _____

   Metal that is **oxidised**: _____

   Metal that is **reduced**: _____

What do you notice about the more reactive metal in all the examples above?