Redox reactions: oxidation, reduction and how to test for them

Lesson plan and teacher's notes · Form 2 Chemistry · 1 period of 40 minutes

School	(write school name)	**Teacher**	(write name)
Date	(date)	**Class**	Form 2
Subject	Chemistry	**Enrolment**	Boys ___ Girls ___ Total ___
Time	40 minutes	**Topic**	Redox reactions: oxidation, reduction and how to test for them

Learners explain that oxidation and reduction happen together in a redox reaction, say what oxidising and reducing agents do, and identify each by its colour change. The lesson starts from bleach and a vitamin C drink and ends with a test-tube identification of two unknown solutions.

Specific outcomes

By the end of the lesson, learners should be able to:

1. Explain that oxidation and reduction happen together in a redox reaction
2. Say what an oxidising agent and a reducing agent do
3. Identify an oxidising agent using potassium iodide and starch
4. Identify a reducing agent using acidified potassium dichromate and acidified potassium permanganate
5. Give everyday examples of oxidising and reducing agents

Prior knowledge

- Atoms and ions
- Electrons can be lost or gained
- Safe behaviour in a laboratory

Teaching and learning materials

- potassium iodide solution and starch solution
- acidified potassium dichromate and acidified potassium permanganate
- test tubes and droppers
- goggles and laboratory coats
- distilled water
- a lemon, water and a vitamin C tablet if available

References

Ministry of Education (CDC) Form 2 Chemistry syllabus and module; 25Schools learners' note: Redox reactions: oxidation, reduction and how to test for them.

Lesson development

Stage and time	Teacher activities	Learner activities
Introduction 5 min	Ask why bleach turns clothes white and why a vitamin C tablet stops a lemon drink from turning brown. Tell learners both involve electrons moving from one substance to another.	Suggest reasons and copy the lesson title.
Development: redox reactions 10 min	Teach oxidation as loss of electrons and reduction as gain of electrons. Explain that the electrons lost by one substance must be gained by another, so one cannot happen without the other.	Copy the meanings and say which substance loses and which gains in an example.
Development: oxidising and reducing agents 10 min	Teach the oxidising agent, which takes electrons and is reduced, and the reducing agent, which donates electrons. Give the everyday examples of bleach and vitamin C.	Match each agent with what it does and give one everyday example.
Development: testing 12 min	Show the potassium iodide and starch test (blue-black means oxidising agent) and the acidified dichromate (orange to green) and permanganate (purple to colourless) tests for a reducing agent. Stress goggles, a control with distilled water and safe disposal.	Record each colour change and say what it shows.
Conclusion 3 min	Ask which colour change shows which agent. Set the homework.	Answer orally and copy the homework.

Teacher's content notes

Read these before the lesson. They are what you need to know, not what to copy onto the board.

Redox reactions: electrons on the move

A redox reaction is a chemical reaction in which oxidation and reduction occur simultaneously. They happen at the same time because both involve the transfer of electrons: the electrons lost by one substance must be gained by another substance. A substance that loses electrons is oxidised. A substance that gains electrons is reduced. You cannot have one without the other.

Oxidising and reducing agents

An oxidising agent causes another substance to lose electrons, while the oxidising agent itself gains electrons. In the process it is reduced. A reducing agent does the opposite: it donates electrons to other substances. Bleach turns things white and disinfects surfaces. Vitamin C helps to stop a drink from turning brown and so helps to preserve food by preventing oxidation.

Testing for an oxidising agent

Place about 2 cm³ of potassium iodide solution in a test tube, add a few drops of the solution you are testing, then add a few drops of starch solution and shake gently. An oxidising agent takes electrons from the iodide ions and turns them into iodine, and the iodine reacts with the starch to give a blue-black colour. Examples to test include acidified potassium permanganate, chlorine water, hydrogen peroxide and dilute nitric acid. Always use distilled water as a control, wear goggles and a laboratory coat, and dispose of the chemicals safely.

Testing for a reducing agent

Use an acidified oxidising agent whose colour changes when it gains electrons. In Part A, place 2 cm³ of acidified potassium dichromate in a test tube and add a few drops of the test solution, such as iron(II) sulphate. If the orange colour turns green, the substance is a reducing agent. In Part B, use acidified potassium permanganate and add a few drops of a test substance such as ethanol. If the purple colour turns colourless or pale pink, the substance is a reducing agent. Waste containing chromium must be disposed of properly.

Questions to ask during the lesson

Question	Expected answer
A learner sees bleach turn a stained cloth white and wants to know what is happening. (a) Say what a redox reaction is. (b) Say what happens to a substance that is oxidised. (c) Say what happens to a substance that is reduced.	(a) A chemical reaction in which oxidation and reduction occur at the same time because electrons are transferred. (b) It loses electrons. (c) It gains electrons.
A teacher adds an unknown solution to a test and the substance takes electrons from another substance. (a) Say what an oxidising agent is. (b) Say what happens to the oxidising agent itself. (c) Say what a reducing agent does.	(a) A substance that causes another substance to lose electrons while it gains electrons. (b) It is reduced. (c) It donates electrons to other substances.
A learner mixes potassium iodide, a few drops of a test solution and starch, and sees a blue-black colour. (a) Say what the blue-black colour shows. (b) Say what the oxidising agent does to the iodide ions. (c) Name the substance that reacts with the starch.	(a) The test solution is an oxidising agent. (b) It takes electrons from them and turns them into iodine. (c) Iodine.
A learner uses acidified potassium dichromate to test two solutions. One stays orange and the other turns green. (a) Say which colour change shows a reducing agent. (b) Name the second test that uses acidified potassium permanganate. (c) Say what colour change shows a reducing agent in that test.	(a) Orange to green. (b) Adding the test substance, such as ethanol, to acidified potassium permanganate. (c) Purple to colourless or pale pink.

Worked examples for the board

Example 1: permanganate turns colourless

A few drops of a test solution are added to acidified potassium permanganate and the purple colour turns colourless. What can you say about the test solution? Purple to colourless means the permanganate has lost its purple colour. This colour change is the test for a reducing agent. So the test solution is a reducing agent, and it donated electrons.

Example 2: blue-black with starch

A learner adds starch to potassium iodide and a test solution and sees a blue-black colour. The test solution took electrons from the iodide ions and turned them into iodine. The iodine reacted with the starch to give the blue-black colour. So the test solution is an oxidising agent.

Example 3: orange to green

A few drops of iron(II) sulphate are added to acidified potassium dichromate and the orange colour turns green. This colour change is the test for a reducing agent. So the iron(II) sulphate is a reducing agent.

Board plan

Write the title and the key words. Left: the meaning of oxidation and reduction with the electron arrow from the reducing agent to the oxidising agent. Right: the table of tests and colour changes.

Test reagent	Colour change	What it shows
Potassium iodide and starch	Blue-black colour	Oxidising agent
Acidified potassium dichromate	Orange to green	Reducing agent
Acidified potassium permanganate	Purple to colourless or pale pink	Reducing agent

Colour changes used to identify agents

Mistakes to expect

Learners often think	Put it right
Oxidation can happen on its own without anything else changing.	Oxidation and reduction happen together. The electrons lost by one substance must be gained by another, so you cannot have one without the other.
A substance that is oxidised gains electrons.	A substance that is oxidised loses electrons, and a substance that is reduced gains electrons.
An oxidising agent is itself oxidised.	An oxidising agent takes electrons from another substance, so the oxidising agent gains electrons and is reduced.
A blue-black colour with potassium iodide and starch shows a reducing agent.	A blue-black colour means the substance is an oxidising agent, because it turns iodide ions into iodine and the iodine reacts with starch.

Differentiation

Learners who struggle

Give learners a card with the colour changes in a table and a sentence frame: it loses electrons, so it is oxidised. Do the first test slowly, naming each step before it is carried out.

Learners who finish early

Ask learners who finish early to explain in three sentences how the iodide ions in the potassium iodide and starch test show that the tested substance is an oxidising agent.

Hearing or visual impairment

For learners with hearing impairment, write each step and colour change on the board and point to the test tube while naming it. For learners with visual impairment, read the colour changes aloud and let learners say the result of each test before it is written down.

No projector, no printing

If the chemicals are not available, the teacher draws each test on the board with coloured chalk showing the colour before and after, and learners record the changes. Use the lemon and vitamin C tablet example, which needs only water and a tablet.

If time is short

Teach the meaning of a redox reaction, the two agents, and the potassium iodide and starch test. Leave the dichromate and permanganate tests for the next lesson.

Evaluation

Question or task	A correct answer shows
A learner at a school in Luangwa is given two unlabelled solutions, X and Y. When starch and potassium iodide are added to X, a blue-black colour appears. When Y is added to acidified potassium permanganate, the purple colour disappears. (a) Say what X is. (b) Say what Y is. (c) Explain the results.	(a) X is an oxidising agent. (b) Y is a reducing agent. (c) X takes electrons from the iodide ions, turning them into iodine. Y gives electrons to the permanganate, so the purple colour is lost.
At home a girl squeezes lemon into water and notices that the drink goes brown when left out, but a drink with a vitamin C tablet stays clear. (a) Say which of the two is acting as a reducing agent. (b) Explain what a reducing agent does. (c) Say why this property is useful in food.	(a) The vitamin C. (b) A reducing agent donates electrons to other substances. (c) It helps prevent oxidation, which helps to preserve food.
A learner adds a few drops of iron(II) sulphate to acidified potassium dichromate and the orange colour turns green. (a) Say what the colour change shows. (b) Say what the iron(II) sulphate does to the electrons. (c) Say what happens to the dichromate.	(a) The iron(II) sulphate is a reducing agent. (b) It donates electrons. (c) It gains electrons and is reduced.

Homework

A shopkeeper uses bleach to clean a floor and notices that it also disinfects surfaces, while his wife adds vitamin C to a fruit drink to stop it from turning brown. (a) Say whether bleach is an oxidising or a reducing agent. (b) Say what vitamin C does in the drink. (c) Explain which colour change with potassium iodide and starch would show an oxidising agent.

Extra practice with answers

Question	Answer
1. A learner at a school in Luangwa adds a few drops of ethanol to acidified potassium permanganate and the purple colour turns colourless. (a) Say what the colour change shows. (b) Say what the ethanol did to the electrons. (c) Say what the colour change would have shown if the colour had stayed purpl	(a) The ethanol is a reducing agent. (b) It donated electrons. (c) The ethanol is not a reducing agent in this test, because the colour did not change.
2. A learner adds chlorine water to potassium iodide and starch and sees a blue-black colour. (a) Say what the blue-black colour shows. (b) Say what the chlorine water took from the iodide ions. (c) Say what it turned them into.	(a) Chlorine water is an oxidising agent. (b) Electrons. (c) Iodine.
3. A boy says that a substance can be oxidised without anything being reduced, because only one substance seems to change. (a) Say whether he is right. (b) Explain what happens to the electrons. (c) Say what the word redox shows.	(a) No. (b) The electrons lost by one substance must be gained by another substance. (c) That oxidation and reduction happen together.
4. A mother adds a vitamin C tablet to a lemon drink and the drink does not turn brown, while another lemon drink without it turns brown. (a) Say what vitamin C does to the electrons. (b) Name the type of agent it is. (c) Say how this helps to preserve food.	(a) It donates electrons. (b) A reducing agent. (c) It prevents oxidation.
5. A learner must test a solution safely in the school laboratory before sharing the results with the class. (a) Say what to wear. (b) Say what to use as a control. (c) Say how to treat waste containing chromium.	(a) Goggles and a laboratory coat. (b) Distilled water. (c) Dispose of it properly.

Answers to the learners' check-yourself questions

1. What is a redox reaction?
   A chemical reaction in which oxidation and reduction occur at the same time because electrons are transferred.
2. What happens to a substance that is oxidised?
   It loses electrons.
3. What is an oxidising agent?
   A substance that causes another substance to lose electrons while it gains electrons, so it is reduced.

4. What colour change in the potassium iodide and starch test shows an oxidising agent?
   A blue-black colour.
5. What colour change shows a reducing agent when acidified potassium dichromate is used?
   Orange to green.
6. You are a learner at a school in Luangwa. Your teacher gives you two unlabelled solutions, X and Y. When you add starch and potassium iodide to X, a blue-black colour appears. When you add Y to acidified potassium permanganate, the purple colour disappears. (a) What is X? (b) What is Y? (c) Explain
   (a) X is an oxidising agent. (b) Y is a reducing agent. (c) In the first test X takes electrons from the iodide ions, turning them into iodine. In the second test Y gives electrons to the permanganate, so the purple colour is lost.
7. At home you squeeze lemon into water and notice that the drink goes brown when left out, but a drink with a vitamin C tablet stays clear. (a) Which of the two is acting as a reducing agent? (b) Explain what a reducing agent does. (c) Say why this property is useful in food.
   (a) The vitamin C. (b) A reducing agent donates electrons to other substances. (c) It helps prevent oxidation, which helps to preserve food.

Teacher's reflection

What went well:

What I will change next time:

Learners who need follow-up: