# Electrolysis of aqueous solutions: supporting resources

### This resource supports the practical video Electrolysis of aqueous solutions, available here [rsc.li/3a7LS37](http://rsc.li/3a7LS37)

## Using the pause-and-think questions

Pause-and-think questions are supplied in two formats: a teacher version for ‘live’ questioning and a student version which can be used during independent study. The time stamps allow you to pause the video when presenting to a class, or learners to use for active revision.

The questions could also be used to support delivery of the experiment as a demonstration or class practical. Responses will help you to assess understanding and address misconceptions.

#### **Teacher version**

The questions are presented in a table and you can choose to use as many as appropriate for your class and the learning objectives.

Some questions have two timestamps to allow you to adapt the questions for different classes or scenarios. Pause the videos at the earlier timestamp to ask a question before the answer is given, useful for revision or to challenge learners. Pause at the later timestamp to ask a question reflectively and assess whether learners

have understood what they have just heard or seen. This would be useful when introducing a topic, in a flipped learning scenario or when additional support and encouragement is needed.

Think about how you will ask for responses. Variation may help to increase engagement – learners could write and hold up short answers; more complex questions could be discussed in groups.

Not all answers to questions are included in the video. Some of the questions will draw on prior learning or extend learners’ thinking beyond the video content.

#### **Student version**

The same questions are offered as a printable worksheet for learners. Use in situations where there is not a teacher present to guide discussion during the video, for example homework, revision or remote learning.

## **Pause-and-think questions**

### Teacher version

|  |  |  |  |
| --- | --- | --- | --- |
| **Timestamp(s)** | | **Question** | **Answer/discussion points** |
| 00:00 | 00:13 | What do you understand by the word electrolysis? | Electro = electricity.  Lysis = split, dissolve, break down.  Electrolysis = Using electricity to break down an ionic substance.  A Frayer model framework for this term is provided. |
| 00:13–00:40 | | Write down some applications of electrolysis in industry. | Production of aluminium, chlorine and sodium hydroxide. Chlorine and  sodium hydroxide are produced from the electrolysis of brine (concentrated sodium chloride solution).  Electroplating uses electrolysis to create a thin layer of metal on another metal. This is used for plating jewellery and in electronic devices - inside your phone will be circuitry that has been electroplated in order to make electrical contacts.  NB. Electroplating is slightly different process as it uses active electrodes one of which is the metal that you want to plate. |
| 01:04 | | What is meant by ‘aqueous solution’? | An aqueous solution is where the solute is dissolved in a solvent of water.  Answer is discussed at 02:10. |
| 01:07 | 01:10 | What is an electrolyte? Give a definition.  What is the electrolyte in this experiment? | A liquid or solution that conducts electricity and breaks down during electrolysis.  Copper(ii) sulfate solution. |
| 01:14 | | What does inert mean?  What are the electrodes that are used in this experiment made from? | Inert means unreactive.  The inert electrodes in this experiment are made from carbon (in the form of graphite). Sometimes platinum, an inert metal, is used. |
| 01:17 | 01:22 | Why do the electrodes need to be inert? | The electrodes in this experiment need to be inert so that they do not react with the electrolyte. |
| 01:27 | | Why must the electrodes not be allowed to touch? | This would create a ‘short circuit’ which can be hazardous. The current will flow directly from one electrode to the other and will not pass through the liquid. Electrolysis would not occur. |
| 01:31 | | Why does the current need to flow in one direction only? | If an alternating current was used then the anode and cathode would constantly swap. The positive and negative ions would be attracted to both electrodes alternately.  Deposition would occur unevenly at both electrodes. |
| 01:49 | 01:58 | What do you see at:   1. the negative electrode 2. the positive electrode | brown solid bubbles |

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| 02:10 | | What is an ion? | A positively or negatively charged particle. | |
| 02:17 | 02:28 | List the four ions present in copper(ii) sulfate solution. | Cu2+  SO 2-  4 | H+  OH- |
| **02:54** | | **The NEGATIVE electrode** |  |  |
| 02:54 | | Which two ions are attracted towards the negative electrode? | Cu2+ and H+ | |
| 02:57 | 03:02 | Which ion reacted at the negative electrode? | Cu2+ | |
| 03:10 | 03:30 | What is the rule for working out which positive ion reacts at the negative electrode? | If a metal is less reactive than hydrogen then that metal will appear at the negative electrode.  If the metal is more reactive than hydrogen then H2 hydrogen gas will form at the electrode. | |
| 03:30 | 03:38 | Which ion reacts at the negative electrode and why?  How do we know? | Cu2+ reacts because copper is less reactive than hydrogen.  We observe a brown solid of copper. | |
| 03:37 | 03:45 | Write a half equation for the reaction of Cu2+ at the negative electrode. | Cu2+ + 2e- → Cu | |
| **03:48** | | **The POSITIVE electrode** |  |  |
| 03:48 | 03:56 | Which two ions are attracted towards the positive electrode? | SO 2- and OH-  4 | |
| 04:00 | 04:02 | When you test the gas given off at the positive electrode, a glowing splint relights. What is this gas? | Oxygen | |
| 04:01 | 04:04 | Which negative ion is reacting at the positive electrode? | OH- | |
| 04:11 | 04:33 | State the rule for working out which negative ion reacts at the positive electrode. | If a halide ion (Cl-, Br- or I-) is present then you will get the halogen (Cl2, Br2 or I2) given off at the positive electrode.  If there is no halide or it is in a very low concentration, then oxygen gas will be given off at the positive electrode. | |
| 04:33 | 04:43 | Write a half equation for the reaction of OH- at the positive electrode. | 4OH- → 2H2O + O2 + 4e- | |
| **04:44** | | **Oxidation and reduction** |  |  |
| 04:55 | 05:01 | What does the mnemonic OILRIG stand for? | Oxidation Is  Loss of electrons Reduction  Is  Gain of Electrons | |
| 05:08 | | What do the white dots represent? | Electrons travelling in the electrodes. | |
| 05:08 | 05:19 | Is this oxidation or reduction?  Explain why. | Reduction  The Cu2+ has gained electrons. | |
| 05:24 | | What is the name of the electrode where reduction occurs? | Cathode | |
| 05:26 | 05:35 | Is this oxidation or reduction?  Explain why. | Oxidation  The OH- has lost electrons. | |

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| 05:39 | What is the name of the electrode where oxidation occurs? | Anode |
| 06:00 | What carries the electricity in the wires?  What carries electricity in the electrolyte solution? | Flow of electrons. Movement of ions. |
| 06:20 | Write a summary to explain what happens at the positive and negative electrodes. | At the positive electrode the negative ions lose electrons and become oxidised. The electrode where oxidation occurs is called the anode.  At the negative electrode positive ions gain electrons to become reduced. The electrode where reduction occurs is called the cathode. |
| 06:44 | Please see the separate resource for a structure strip and suggested response to the long- answer question: | |
| *A student has a beaker containing 50 cm3 sodium chloride solution. They are going to apply a direct electrical current to the solution using inert carbon electrodes.*  *Using your knowledge of reactivity, predict what substance will be produced at the positive and negative electrodes. Write a half equation for each reaction, identifying whether oxidation or reduction has occurred.*  *What tests could you carry out to show that your prediction is correct?* | |

## **Pause-and-think questions**

### Student version

*Pause the video at the time stated to test or revise your knowledge of these practical experiments.*

**Time Question**

00:33 What does the word ‘electrolysis’ mean?

00:40 Write down some applications of electrolysis in industry.

00:44 What is meant by the term ‘aqueous solution’?

01:07 What is an electrolyte? Give a definition.

What is the electrolyte in this experiment?

01:14 What does inert mean?

What are the electrodes that are used in this experiment made from?

01:22 Why do the electrodes need to be inert?

*01:27 Challenge: Why must the electrodes not be allowed to touch?*

*01:31 Challenge: Why does the current need to flow in one direction only?*

01:49 What do you see at the negative electrode?

What do you see at the positive electrode?

02:10 What is an ion?

02:28 List the four ions present in copper(ii) sulfate solution.

**H2O**

**CuSO4**

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| --- | --- | --- | --- |
|  |  |  |  |

02:54 Which two ions are attracted towards the negative electrode?

and

03:30 Complete the sentences:

If a metal is reactive than then that metal will appear at the negative electrode.

If the metal is reactive than then gas will form at the electrode.

03:38 Which ion reacts at the negative electrode and why?

How do we know?

03:37 Write a half equation for the reaction the reaction of Cu2+ at the negative electrode.

+ →

03:56 Which two ions are attracted towards the positive electrode?

and

04:00 When you test the gas given off at the positive electrode, a glowing splint relights. What is this gas?

04:33 Complete the sentences:

If a ion (eg ) is present then you will get a halogen

(eg ) given off at the positive electrode

If there is no ion, or it is in a very low concentration, then gas will be given off at the positive electrode

04:33 Write a half equation for the reaction the reaction of OH- at the negative electrode.

+ →

04:55 Fill in the expression below to describe what happens to electrons during oxidation and reduction O

I L R I G

05:08 What do the white dots represent?

05:19 Is this oxidation or reduction? Explain why.

05:24 What is the name of the electrode where reduction occurs?

05:35 Is this oxidation or reduction? Explain why.

05:24 What is the name of the electrode where oxidation occurs?

05:50 What carries the electricity in the wires?

What carries the electricity in the electrolyte solution?

06:20 Fill in the gaps to complete the summary:

At the electrode the negative ions electrons and become

. The electrode where oxidation occurs is called the .

At the electrode the positive ions electrons to become

. The electrode where reduction occurs is called the .

06:44 Now try writing a longer answer to this question using the structure strips:

A student has a beaker containing 50 cm3 sodium chloride solution. They are going to apply a direct electrical current to the solution using inert carbon electrodes.

Using your knowledge of reactivity, predict what substance will be produced at the positive electrode and the negative electrode. Write a half equation for each reaction, identifying whether oxidation or reduction has occurred.

Which tests could you carry out to show that your prediction is correct?

**This question has a structure strip. Find more resources to support you here** <rsc.li/3a7LS37>.