Model Assignment

Assessment Material

OCR Level 1/2 Cambridge National Certificate in Science

R073: How scientists test their ideas - Electrolysis

Please note:

This OCR model assignment is to be used to provide evidence for the unit identified above. Alternatively, centres may 'tailor' or modify the assignment within permitted parameters (see Information for Teachers). It is the centre's responsibility to ensure that any modifications made to this assignment allow learners to show that they can meet all of the learning outcomes and provide sufficient opportunity for learners to demonstrate achievement across the full range of marks.

INSTRUCTIONS TO TEACHERS

The OCR administrative codes associated with this unit are:

- unit entry code R073
- certification codes J815

The accreditation numbers associated with this unit are:

- unit reference number M/503/6267
- qualification reference(s) 600/4790/2

Duration: Approximately 6 hours

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Assignment for the learner

Electrolysis

Metals, like copper, can be extracted from their ores and purified by electrolysis.

When an industrial process is designed, scientists must consider both the efficiency and the environmental impact of their design. The process of electrolysis uses a lot of electricity which may be made by burning fossil fuels. Scientists are continuously looking, to make the process of electrolysis: energy efficient, time efficient, and environmentally friendly.

Electrolysis must produce a metal which is pure enough to be useful and one that is easy to separate at the end of the process.

You are going to carry out an investigation on a condition that affects the production or purification of copper by electrolysis.

Read through all of the tasks carefully, so that you know what you will need to do to complete this assignment.

Your Tasks

Part 1 – Research and planning

You are going to carry out an investigation on a condition that affects the production or purification of copper by electrolysis.

The first step is to carry out suitable research to collect some information about the extraction and purification of copper. You should find out about:

How copper is extracted from its ore and is purified by electrolysis.

The chemistry of the electrolysis of copper(II) sulfate.

The factors that affect electrolysis.

The environmental impact of extracting and refining copper.

You should record your research.

To carry out your investigation, your teacher will provide you with copper(II) sulfate solution, and a suitable kit to carry out electrolysis.

You should produce a plan to collect high quality, valid data, and minimise measurement errors.

Part 2 – Collecting primary data

Prepare a full risk assessment before you begin any practical work.

Carry out your investigation and record your results to use in Part 3.

Part 3 – Analysis

In your analysis, you should:

- Process the data you have collected and either:
  - plot a graph to show the results of your investigation, **or**
  - carry out a mathematical or statistical analysis of your results;
- Describe any patterns or trends in your results.

Part 4 – Evaluation and Conclusion

In your evaluation and conclusion, you should:

- comment on any unexpected results
- evaluate your results, the method you used, and how well you managed the risks
- relate the information on the extraction and purification of copper from your research (Part 1) to the results of your own investigation (Part 2).

Information for Teachers

OCR Level 1/2 Cambridge National Certificate in Science

R073: How scientists test their ideas - Electrolysis

Guidance on using this assignment

1 General

1.1 OCR assignments are available to download free of charge from our website: www.ocr.org.uk/interchange

1.2 OCR assignments are intended to be used for formal summative assessment of learners and assessment must be conducted under supervision. The OCR specification for this qualification gives more information on the arrangements for assessing internally assessed units. There is also guidance on what supervision and authenticity means in the context of this assignment in section 3 below 'Producing evidence'.

1.3 This assignment has been designed to meet the full assessment requirements of the unit. Learners will need to take part in a planned learning programme that covers the underpinning knowledge, understanding and skills of the unit.

1.4 This assignment requires learners to:

- plan practical ways to answer scientific questions
- devise appropriate methods for the collection of numerical and other data
- assess and manage risks when carrying out practical work
- collect, process, analyse and interpret primary and secondary data including the use of appropriate technology
- draw evidence-based conclusions
- evaluate methods of data collection and the quality of the resulting data.

1.5 This assignment consists of one task divided into four parts. The task is centred on a particular idea that electrolysis must be carried out as efficiently as possible, but also so as to produce copper of the appropriate quality. Time, current and concentration of electrolyte will affect the process. This idea is investigated through Parts1, 2, 3 and 4. The parts should be taken in this order.

2 Before carrying out the assignment

2.1 Learners should be provided with a copy of the *Information for Learners* section of this assignment.

Learners may have access to the OCR marking criteria for the assignment, but not to adapted 'student speak' versions.

2.2 Learners will not need to carry out any preparations prior to undertaking the assessment task, such as collating resources to use in the assessment.

2.3 We have estimated that it will take approximately 6 hours to complete this assignment. This is the recommended time but centres can decide how the time can be allocated between each part or individual task in the assessment. Centres are also permitted to spread the overall assessment time across several sessions and therefore it is permissible for evidence to be produced over several sessions.

2.4 It is expected that before learners attempt this assignment task they will have received general preparation in their lessons. The details of practical techniques, the development of skills associated with these techniques, and the methods and choice of equipment for the task should be covered when teaching the particular part(s) of the specification which the assignment relates to, and should be completed prior to undertaking the task.

From their work in R071 (LO7), learners should understand that metals can be extracted from their ores by heating with carbon or by electrolysis. They should be able to write word and balanced symbol equations for chemical reactions (and understand oxidation and reduction). They should be able to calculate yields and appreciate issues of sustainability, e.g. with regard to extraction vs. recycling, and environmental impacts, including production quantities and energy budgets.

From their work in R073, learners should be able to plan a scientific investigation (LO1), collect scientific data (LO2), analyse, evaluate and communicate scientific information (LO3-5).

2.5 Learners should be made aware of the: health and safety issues associated with this task; need to provide a quantitative evaluation of the data collected; sources of experimental errors.

2.6 Learners working at higher levels will need to be made familiar with the principles and use of statistics when assessing the significance of their results.

2.7 Learners should also be made aware of the marking criteria for this task.

3 When completing the assignment and producing evidence

3.1 Centre staff may give support and guidance to learners. This support and guidance should focus on checking that learners understand what is expected of them and giving general feedback that enables the learners to take the initiative in making improvements, rather than detailing what amendments should be made. However, where more specific support is provided so that learners are able to make progress with the task or to ensure safety, this must be reflected in the marks awarded. It is not acceptable for teachers/deliverers to provide answers or to work through answers in detail.

3.2

Part 1 – Research and planning

You are going to carry out an investigation on a condition that affects the production or purification of copper by electrolysis.

The first step is to carry out suitable research to collect some information about the extraction and purification of copper. You should find out about:

How copper is extracted from its ore and is purified by electrolysis.

The chemistry of the electrolysis of copper(II) sulfate.

The factors that affect electrolysis.

The environmental impact of extracting and refining copper.

You should record your research.

To carry out your investigation, your teacher will provide you with copper(II) sulfate solution, and a suitable kit to carry out electrolysis.

You should produce a plan to collect high quality, valid data, and minimise measurement errors.

Part 1 requires learners to carry out research using books/internet/surveys. Learners must be guided on the use of information from sources. They will need to plan how they are going to carry out the research and collect their results for use in Parts 2 - 4. The research may be carried out during lessons or as a homework exercise. Learners should be made aware of the time allowed for carrying out this part of the task. Their access to resources is determined by those available to the centre and/or to learners at home.

Learners' work and research should be available for Parts 2 and 3.

Part 1 is expected to take 1.5 – 2 hours.

3.3

Part 2 – Collecting primary data

Prepare a full risk assessment before you begin any practical work.

Carry out your investigation and record your results to use in Part 3.

Part 2 requires learners to plan and carry out an investigation to collect primary data. Learners need access to their individual work and research from Part 1.

Learners may work in groups of no more than 3 (2 is recommended) and may collaborate in the development of the plan and the conduct of the investigation. During planning learners may wish to trial procedures they plan to use, at the discretion of the centre. They should provide a risk assessment of the procedures they have planned. Learners must record their plan and results individually. The investigation should be planned and conducted in supervised lessons.

Teachers are responsible for ensuring appropriate health and safety procedures and all appropriate steps taken to reduce risks are carried out, including a risk assessment for the task, prior to learners attempting the practical work. It is the centre's responsibility to ensure the safety of all learners involved in any investigation.

The work of individual learners may be informed by working with others but each must provide an individual response. Learners should be made aware of the time allowed for carrying out this part of the task. Learners' access to resources is determined by those available to the centre.

In their investigations, learners will need to make choices about the possible methods/ factors to investigate, e.g. current, time and electrolyte concentration; choices about the range of independent variable; choice of electrodes (perhaps determined by the centre); how the yield of copper can be measured; how the quality of copper can be assessed qualitatively; the number of replicates; and the accuracy of measurements made of the dependent variable. Learners must not be instructed or advised in these areas except where they affect safety, use of resources or timescale.

Learners' work should be available for Part 3.

Part 2 is expected to take 2 hours.

3.4

Part 3 – Analysis

In your analysis, you should:

- Process the data you have collected and either:
  - plot a graph to show the results of your investigation, **or**
  - carry out a mathematical or statistical analysis of your results;
- Describe any patterns or trends in your results.

In Part 3, learners will process and analyse the results of their research and the investigation.

Learners will need access to their individual responses from Part 1 and Part 2.

Learners must complete all work independently. Learners should be made aware of the time allowed for carrying out this part of the task.

In processing data, learners will have opportunities to use mathematical and graphical skills: calculation of means; calculation of yields; for higher level candidates, calculation of theoretical yields and percentage yields; quantitative treatment of spread of data and thus level of uncertainty; graphs drawn with correct scales and accurate plotting to show the relationship between yield and current/time/concentration of electrolyte; a mathematical analysis of yields using different types of electrodes; mathematical analysis of the relationship between loss of mass of a copper anode, and increase of mass of a copper cathode. Learners must not be instructed whilst carrying out these analyses.

Part 3 is expected to take 1 - 1.5 hours.

3.5

Part 4 – Evaluation and Conclusion

In your evaluation and conclusion, you should:

- comment on any unexpected results
- evaluate your results, the method you used, and how well you managed the risks
- relate the information on types of fuel from your research (Part 1) to the results of your own investigation (Part 2).

In Part 4, learners will evaluate their data and the methods used to collect it. They will then draw and justify a conclusion. They will be asked to comment on any issues of safety within the practical work.

Learners will need access to their individual responses from Parts 1 - 3.

Learners must complete all work independently. Learners should be made aware of the time allowed for carrying out this part of the task.

In evaluating their investigation, learners will assess the quality and validity of the evidence, identify conflicting evidence, or weaknesses in the evidence, which lead to different interpretations. Learners will link the data to scientific explanations, using ideas of correlation and cause. Learners will suggest how improvements in methods of data collection would improve the quality of the data, and suggest what further evidence would help to make a conclusion more secure.

Learners must not be instructed whilst carrying out the evaluation.

Part 4 is expected to take 1-1.5 hours.

3.6 We have specified what evidence the learner is expected to produce, but it is important to note that if it is possible to generate the evidence in a variety of formats, then the learner is free to use the format that is most appropriate for them. The section *Evidence Summary* at the back of this document will guide you on evidence and formats for evidence. Centres must advise learners as to the most appropriate format of evidence. Format must not be confused with the content or the type of datafile to be produced. Guidance on suitable formats of the evidence is provided in the section *Evidence Summary*.

4 Presentation of work for marking and moderation

4.1 Centres wishing to produce digital evidence in the form of an e-portfolio should refer to the appendix in the specification on guidance for the production of electronic assessment.

4.2 Centres may wish to discourage learners from excessive use of plastic wallets for presentation of their evidence as this may hinder the assessment process. Instead, centres may wish to encourage learners to present their work so that it is easily accessible, e.g. spiral bound, stapled booklet, treasury tag.

5 Scope of permitted model assignment modification

The model assignment is very self-contained in its present form. The set of tasks form a coherent whole addressing all the learning outcomes and allowing access to the full range of marks.

You **must not** change the following:

- the learning outcomes
- the marking criteria
- the requirements for supervision and authentication as described in the specification (section 'The internally assessed units').

Permitted changes:

The model assignment can be modified in terms of the areas described below at the permission of OCR but centres must be sure that learners still have the opportunity to cover all of the learning outcomes and to access the full range of marks:

- The learner's assignment, which can be contextualised or amended to suit local needs.
- To allow for differences in the materials, equipment and facilities at different centres; for example, in choice of electrodes.

OCR has ensured that in the language used and the tasks and scenario provided we have avoided discrimination, bias and stereotyping and support equality and diversity. In the development of qualifications and assessments we use the guidance given in the Ofqual publication *Fair access by design,* notably this includes:

- using language and layout in assessment materials that does not present barriers to learners
- using stimulus and source materials in assessment materials (where appropriate) that do not present barriers to learners.

If centres wish to adapt the model assignment we strongly advise that staff responsible for modifying the model assignment and quality assuring it refer to the publication *Fair access by design*.

If modifications are made to the model assignment, whether to just the scenario or to both the scenario and individual tasks, it is up to the centre to ensure that all learning outcomes can be met and that learners can access the full range of marks.

Evidence summary

When completing this assignment it may be possible to generate evidence for completing a task in a variety of formats. This list is not exhaustive.

Part number	What do learners need to produce (evidence)
Part 1	Evidence is likely to be in the form of a written report, with associated tables of data. Sources will be referenced using standard formats.
Part 2	Evidence is likely to be in the form of a written report with associated diagrams, pictures or flowcharts, to include an account of the problem to be investigated and the methods used to collect the data (including a risk assessment for the practical work involved). Data collected will be tabulated in appropriate formats. There will be opportunities to use ICT in the collection of data. Witness statements will be required for the practical elements of LO2.
Part 3	Evidence is likely to be in the form of a written report. Data will be analysed using appropriate mathematical and graphical techniques. There will be opportunities to use ICT in the analysis of data.
Part 4	Evidence is likely to be in the form of a written report. There will be opportunities to use ICT in the presentation of conclusions.

Apparatus and materials

- Stock solution of copper(II) sulfate, e.g. 1 mol dm^{-3} for use or dilution (if electrolyte concentration under investigation)
- Top pan balances, including one that records to 0.01 g

For each learner or group of learners:

- Beakers, 250 cm^3
- Stand, clamp and boss
- Measuring cylinders, including 100 cm^3
- Graphite electrodes, 5 mm, and/or copper strips
- Suitable DC power supply e.g. 6 V
- Leads and crocodile clips
- Rheostat
- Ammeter
- Stopclock
- Bulb, e.g. 6 V, 5 W (optional: to indicate flow of current)
- Pieces of emery paper
- Propanone (for removing water from cathode prior to weighing).

Learners plan their own investigation and may therefore require access to other apparatus at the discretion of the centre.

Notes to help teachers and technicians with this assignment

Teachers are advised to try out the experiment prior to candidates undertaking the task.

References

To ensure safe working, please consult:

http://www.cleapss.org.uk - see the Hazcards and Laboratory Handbook