Cambridge NATIONALS

Accredited

SCIENCE
LEVEL 1/2

UNIT R073 - HOW SCIENTISTS TEST THEIR IDEAS: ELECTROLYSIS

LEARNER STYLE WORK

LEVEL 2 PASS

OCR

CONTENTS

INTRODUCTION

This work has been developed to provide examples of the content and standard of work required to evidence the identified assessment criteria (Level 1, R073 Model Assignment). This is one approach that could be used but it must not be directly replicated or any part plagiarised by learners.

Teachers may choose to identify their own approach for learners to follow but evidence submitted must clearly meet the assessment criteria.

This is not real learner work; its purpose is to provide ideas and approaches.

The text in the blue boxes are examples of annotations teachers may add to work. The annotations are of good practice and are not a compulsory element of teacher marking.

All centres should complete a unit record sheet for each candidate. The unit record sheet should include comments related to the marking of candidates work. The unit record sheet should not be returned to candidates once work has been marked.

LEVEL 2 PASS
HOW SCIENTISTS TEST THEIR IDEAS: ELECTROLYSIS

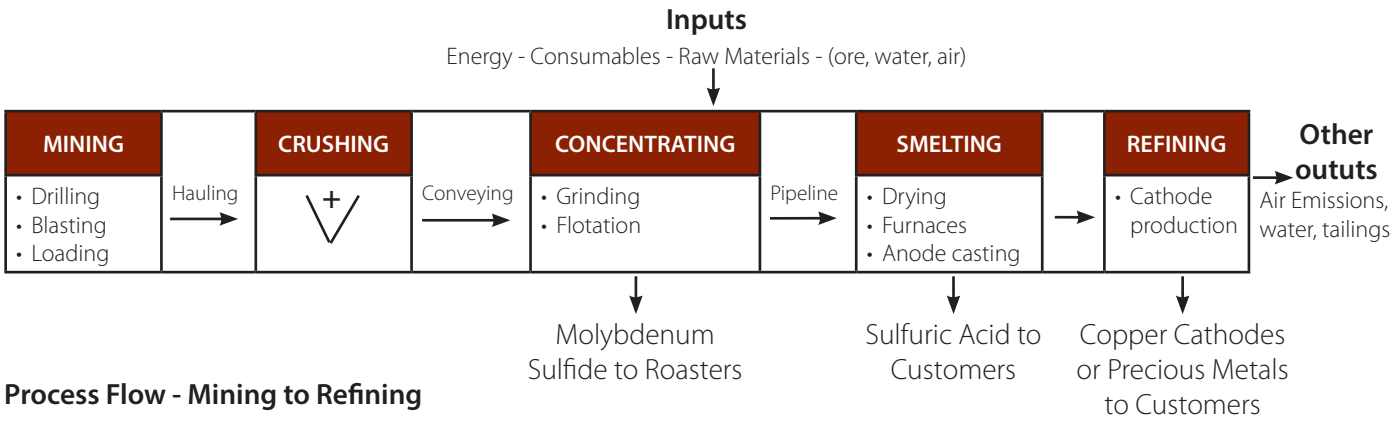
Research

The production: Production of Copper

Copper is important in producing electrical wires (60%), for roofing and plumbing (20%) and industrial machinery (15%). Copper is mostly used as copper metal, but when a higher hardness is required it is combined with other elements to make an alloy such as brass or bronze. About 5% of copper is used as an alloy. [1]

A small part of copper is also used in compounds for nutritional supplements and fungicides. [1]

This is a flow chart of copper production. [2]



Process Flow - Mining to Refining

The concentration of copper in ores averages only 0.6%, and most commercial ores are sulfides, especially chalcopyrite ($CuFeS_2$) and to a lesser extent chalcocite (Cu_2S). [1]

The ore is crushed and the minerals are concentrated by froth flotation. The copper content is mow 15%. When the're heated, the sulfides are converted to oxides. The cuprous oxide is converted to blister copper when its heated.

The copper is electrorefined by electrolysis to produce very pure copper.

Electrolysis

Electrolysis in chemistry and in manufacturing is a method of separating chemically bonded elements and compounds by passing an electric current through them. [3]

Source: http://en.wikipedia.org/wiki/Electrolysis

LO1 - MB1 References

Electrons as charge carriers:
- ✯ Electric charge is carried through wires and other conductors by electrons. Electrons do not travel through solids.

Ions as charge carriers:
- ✯ The moving particles in solutions are ions. Cations travel to the Cathode.

- ✯ Anions travel to the Anode.
  Anions being negatively charged deposit electrons on the anode. - oxidised
  Cations being positively charged pick up electrons from the cathode. – reduced
- ✯ Other electrons move round the circuit to replace them.
  So in the circuit electrons are flowing, just as if the entire circuit was made of conducting wires.
  This explains how a solution conducts electricity.

This means electrolysis is a redox reaction

LO1 - MB1 Variables

Making it a fair test

To make it fair, I will change only one variable during my investigation. The factor I have chosen is

CURRENT

I must keep the other factors that might affect the electrolysis CONSTANT. These will be:

- The length of time
-
- The same type and size of electrodes
-
- The distance between the electrodes
- The temperature
- The concentration of copper sulfate solution

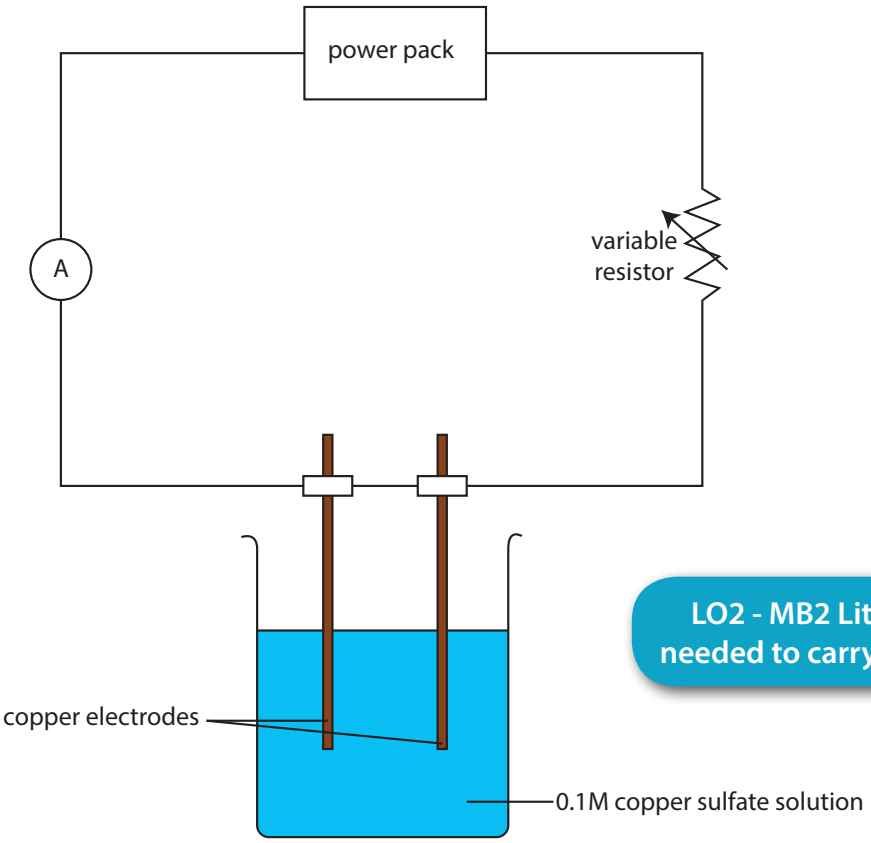
LO1 - MB2

My plan:
I am going to set up my equipment to use for this experiment. I will start with my first current, and measure the mass of the anode and cathode after 5 minutes electrolysis. I will then change the current and do the experiment again.

- I will use a balance that weighs to the nearest 0.01 g. This will increase the accuracy.
- I will wash and dry carefully the electrodes before weighing them.
- I will repeat the experiment three times at each current to give me accurate results.
- I will put the electrodes the same distance apart each time.

My method

1. I will pour some of the copper sulfate solution into the beaker (50 ml).
2. I will weigh the anode and cathode using a balance.
3. I will support the electrodes in a stand and clamp and connect up the circuit.
4. I will the turn on the power pack and make adjustments to get the correct current.
5. I will leave the power pack on for five minutes.
6. I will remove the electrodes from the copper sulfate (one at a time so that I don't get them mixed up) and weigh them.



LO2 - MB2 Little support needed to carry out practical

7. I will repeat the experiment three times.

8. I will then repeat the experiment using the next current I want to test.

Health and safety

LO2 - MB2

Copper sulfate: an irritant that is harmful if swallowed; irritant to eyes and skin; toxic to aquatic organisms.

Risk: swallowing; getting on skin or in eyes; putting in water with aquatic wildlife in.

Those at risk: me and others around me.

Control measures:

- ✯ Wearing goggles.
- ✯ Do not drink the copper sulfate.

Training: Doing previous experiments.

Emergency action:
- ✯ Seek medical attention
- ✯ Seek first aid

Other risks:
- ✯ Keep the power pack away from water and the copper sulfate solution.
- ✯ Make sure that your using a power pack that has been tested recently.

Results

LO2, LO3 - MB2 Processing

0.2A

Test	Start mass of cathode, g	End mass of cathode, g	Change in mass, g	Average change in mass, g
1	60.15	60.17	+0.02	+0.02
2	60.17	60.19	+0.02	

0.4A

Test	Start mass of cathode, g	End mass of cathode, g	Change in mass, g	Average change in mass, g
1	60.19	60.23	+0.04	+0.04
2	60.23	60.27	+0.04	

0.6A

Test	Start mass of cathode, g	End mass of cathode, g	Change in mass, g	Average change in mass, g
1	60.27	60.33	+0.06	+0.055
2	60.33	60.38	+0.05	

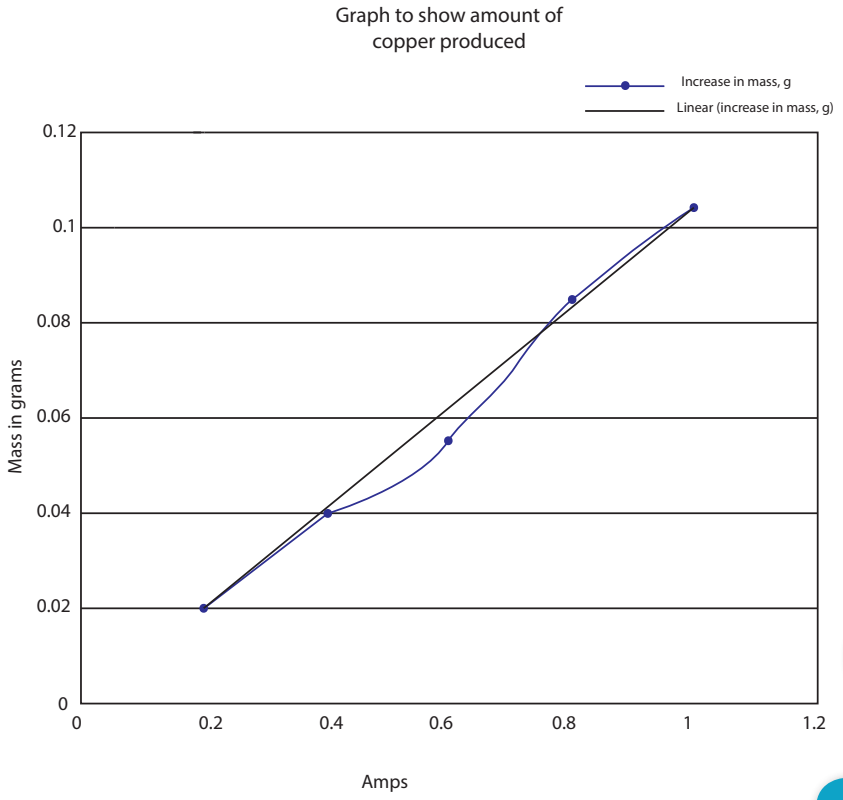
0.8A

Test	Start mass of cathode, g	End mass of cathode, g	Change in mass, g	Average change in mass, g
1	60.38	60.47	+0.09	+0.085
2	60.47	60.32	-0.15	
3	60.32	60.40	+0.08	

1.0A

Test	Start mass of cathode, g	End mass of cathode, g	Change in mass, g	Average change in mass, g
1	60.40	60.50	+0.10	+0.105
2	60.50	60.61	+0.11	

I then plotted a graph of these results: Discussion of results



LO3 - MB2

LO3 - MB2 Trend

Discussion of results

From the graph, you can see that as the current increases the amount of copper added to the cathode increases. This is because as the current increases, more electrons flow and the more copper produced at the cathode. The mass of copper is directly proportional to the current.

LO3 - MB2 Conclusion

Evaluation

My graph showed that I had some good results, but I had one anomalous result. I did an extra test to make up for this. My graph had a good line of best fit (which I added to my graph).

The reason for my anomalous result was that some of the copper fell off of the rod and into the beaker. Not all of the copper deposited on the electrode. Also I could have given the $CuSO_4$ a stir so that we made sure that all of the copper sulfate stayed dissolved. But I do not think that this would have helped it stick to the electrode.

Improvements:

LO4 - MB2

Our group could have improved on the experiment by getting more copper on the electrode and less in the bottom of the beaker, we could have done this by having a bigger electrode meaning that there's a bigger surface area for the copper to stick to. We could have also had a lower voltage, and made it more gradual.

Some of the yields of copper we got were very low, and difficult to messure on the balance, so we could have done the experiment for 10 minutes.

My experiment showed that you don't get much copper with a small current. When copper is produced on a bih scale, a lot of electricity is needed.

References

[1] http://en.wikipedia.org/wiki/Copper

[2] Rio Tinto
http://www.kennecott.com/sites/kennecott.com/files/files/Copper_Environmental_Profile-2006.pdf

[3] http://en.wikipedia.org/wiki/Electrolysis

UNIT RECORDING SHEET

OCR
RECOGNISING ACHIEVEMENT

Science

OCR J815 Unit R073 Level 1/Level 2
Cambridge National Certificate in Science
Unit Recording Sheet

Please read the instructions printed at the end of this form. **One** of these sheets, suitably completed, should be attached to the assessed work of **each** candidate.

Unit Title	**How scientists test their ideas**	**Unit Code**	**R073**	**Session**		**Year**	
Centre Name						**Centre Number**	
Candidate Name	**Electrolysis L2 Pass**					**Candidate Number**	

Criteria			**Teacher Comments**	**Mark**	**Page No**
LO1: Be able to plan a scientific investigation			Good plan, with enough detail to repeat it. Good coverage of variables involved, replicates, and comments on reducing error. A good introduction, referenced appropriately.	10	
MB1: 1 – 6 marks	**MB2: 7 – 11 marks**	**MB3: 12 – 15 marks**			
• **Limited** plan includes equipment and techniques to be used • Plan provides a 'fair test' • Identifies how **some** errors will be minimised • **Some** sources of secondary data/information identified **[1 2 3 4 5 6]**	• Plan gives **sufficient detail** for investigation to be repeated, including choices of: o equipment, including instrumentation o range and number of data points o number of replicates o control of variables to result in the collection of data of an appropriate quality • **Some** explanation of how errors will be minimised • **Range** of **relevant** sources of secondary data/information identified **[7 8 9 (10) 11]**	• **Comprehensive** plan shows scientific understanding in making appropriate choices of: o equipment, including instrumentation o range and number of data points o number of replicates o control of variables to result in the collection of accurate data to address the scientific problem • **Detailed** explanation of: o how errors will be minimised o variables which cannot be controlled • **Wide range** of **relevant** sources of secondary data/information identified and selection of **appropriate** sources justified **[12 13 14 15]**			

<table>
<tr><th colspan="3">Criteria</th><th>Teacher Comments</th><th>Mark</th><th>Page No</th></tr>
<tr><td colspan="3">LO2: Be able to collect scientific data</td><td rowspan="3">Risk assessment at MB2.

Little support needed to set up and carry out practical work safely.

Good results tables.</td><td rowspan="3">6</td><td rowspan="3"></td></tr>
<tr><td>MB1: 1 – 4 marks</td><td>MB2: 5 – 7 marks</td><td>MB3: 8 – 10 marks</td></tr>
<tr><td>• Basic understanding of risks in procedures with only standard laboratory safety precautions identified
• Significant teacher intervention required to ensure safety or help set up equipment
• Results recorded clearly

[1 2 3 4]</td><td>• Some risks in procedures identified and some specific responses suggested to reduce risks
• Most risks managed successfully with no significant incidents or accidents and no requirement for teacher intervention
• Little support required to set up equipment
• Results tabulated to include all data collected, including use of correct headings

[5 (6) 7]</td><td>• All significant risks in the plan evaluated and reasoned judgements made to reduce risks by use of appropriate specific responses
• All risks managed successfully with no incidents or accidents and no requirement for teacher intervention
• Measurements taken and recorded to appropriate accuracy and precision using an appropriate format, including use of correct units

[8 9 10]</td></tr>
<tr><td colspan="3">LO3: Be able to analyse scientific information</td><td rowspan="3">Appropriate processing of data (calculation of means).

Graph drawn on Microsoft Excel. Axis titles and line of best fit added by candidate. No gridlines provided.

Main trend in data described.</td><td rowspan="3">7</td><td rowspan="3"></td></tr>
<tr><td>MB1: 1 – 5 marks</td><td>MB2: 6 – 9 marks</td><td>MB3: 10 – 13 marks</td></tr>
<tr><td>• Some evidence of processing of quantitative data:
o data presented as simple charts or graphs
o use of a simple mathematical technique where appropriate
• Some trends/patterns in the data identified

[1 2 3 4 5]</td><td>• Graphical and mathematical techniques used to reveal patterns in data:
o charts or graphs used to display data in an appropriate way
o correct use of simple mathematical techniques where appropriate
o appropriate qualitative treatment of the levels of uncertainty in the data, including identification of any anomalous results
• Main trends/patterns in the data described with reference to quantitative data

[6 (7) 8 9]</td><td>• Appropriate graphical and mathematical techniques used to reveal patterns in data:
o appropriate scales and axes used in graphs and data plotted accurately, including where appropriate, use of lines of best fit
o correct use of complex mathematical techniques where appropriate
o appropriate quantitative treatment of levels of uncertainty in the data
• Main trends/patterns in the data described in detail and interpreted correctly with reference to quantitative data and relevant scientific understanding

[10 11 12 13]</td></tr>
</table>

<table>
<tr><th colspan="3">Criteria</th><th>Teacher Comments</th><th>Mark</th><th>Page No.</th></tr>
<tr><td colspan="3">LO4: Be able to evaluate scientific information</td><td rowspan="3">Brief but pertinent conclusion.

Make extra measurement to compensate for outlier.

Limitation of the method used for data collection and some suggestions for improvement given.

Applies knowledge of electrolysis from Unit 1 to discussion.</td><td rowspan="3">7</td><td rowspan="3"></td></tr>
<tr><td>MB1: 1 – 5 marks</td><td>MB2: 6 – 9 marks</td><td>MB3: 10 – 13 marks</td></tr>
<tr><td>• Limited comments made about the quality of the data and the methods used
• Simple conclusion given which is consistent with the data collected and shows limited scientific understanding
• There is limited application of skills/knowledge/understanding from other units in the specification

[1 2 3 4 5]</td><td>• Some relevant comments made about the quality of the data including accuracy and sources of error, linked to the methods of collection:
o limitations in the methods of data collection identified and suggestions for improvements given
• Conclusion given and justified based on an analysis of the data, showing sound understanding of the underlying science
• Applies skills / knowledge / understanding from other units in the specification in a way which is mostly relevant

[6 7 8 9]</td><td>• Detailed and critical consideration given to the data and methods used to obtain them:
o sources of error and quality of data discussed and explained, including accuracy, repeatability and uncertainty
o limitations of the method identified and suggestions for improvements justified
• Conclusion given and justified based on critical analysis of primary and secondary data, clearly linked to relevant scientific understanding
o identification of conflicting evidence
o what further evidence is needed to make the conclusion more secure
• Applies skills / knowledge / understanding from other units in the specification in an effective relevant way

[10 11 12 13]</td></tr>
<tr><td colspan="3">LO5: Be able to communicate scientific information</td><td rowspan="3">Good structure to report.

Occasional errors in SPG.

Graph drawn and flow chart of copper extraction.</td><td rowspan="3">7</td><td rowspan="3"></td></tr>
<tr><td>MB1: 1 – 4 marks</td><td>MB2: 5 – 7 marks</td><td>MB3: 8 – 9 marks</td></tr>
<tr><td>• Limited use of scientific, technical and mathematical language, conventions and symbols
• Some errors in grammar, punctuation and spelling
• Limited use of diagrams, graphs, flow charts and pictures

[1 2 3 4]</td><td>• Information is presented in a structured format
• Sound use of scientific, technical and mathematical language, conventions and symbols
• Occasional errors in grammar, punctuation and spelling
• Some appropriate use of diagrams, graphs, flow charts and pictures

[5 6 7]</td><td>• Information presented is clear, well organised and structured, and in a coherent format
• Scientific, technical and mathematical language, conventions and symbols are used effectively
• Few, if any, errors in grammar, punctuation and spelling
• Diagrams, graphs, flow charts and pictures are used appropriately and accurately

[8 9]</td></tr>
<tr><td colspan="4">Total/60</td><td>37</td><td></td></tr>
</table>

URS143 Devised July 2012 **R073/URS**

Oxford Cambridge and RSA Examinations

MODERATORS COMMENTS

<table>
<tr><td colspan="3">R073 How Scientists test their ideas: Antimicrobials L1 Pass</td></tr>
<tr><td colspan="3">LO1: Be able to plan a scientific investigation</td></tr>
<tr><td>MB1: 1 – 7 marks</td><td>MB2: 8 – 13 marks</td><td>MB3: 14 – 18 marks</td></tr>
<tr><td>• Limited plan includes equipment and techniques to be used
• Plan provides a ‘fair test’
• Identifies how some errors will be minimised
• Some sources of secondary data/information identified</td><td>• Plan gives sufficient detail for investigation to be repeated, including choices of:
- equipment, including instrumentation
- range and number of data points
- number of replicates
- control of variables to result in the collection of data of an appropriate quality
• Some explanation of how errors will be minimised
• Range of relevant sources of secondary data/ information identified</td><td>• Comprehensive plan shows scientific understanding in making appropriate choices of:
- equipment, including instrumentation
- range and number of data points
- number of replicates
- control of variables
- to result in the collection of accurate data to address the scientific problem
• Detailed explanation of:
- how errors will be minimised
- variables which cannot be controlled
• Wide range of relevant sources of secondary data/ information identified and selection of appropriate sources justified</td></tr>
<tr><td colspan="2">An effective, repeatable plan has been produced, including a relevant method with diagram and comments on repeats and variables.

The range of currents has provided a (just) suitable number of data points for collection. The number of replicates, however, is limited, as is the comment on ‘fair testing’.

The limited number of information sources has been identified, but not in full detail (full URLs have been given, but no authors or titles of articles). The introduction is brief, but covers the pertinent points.
[10]</td><td></td></tr>
</table>

<table>
<tr><th colspan="3">LO2: Understand the risks and benefits related to the applications of nuclear radiation</th></tr>
<tr><th>MB1: 1 – 4 marks</th><th>MB2: 5 – 7 marks</th><th>MB3: 8 – 10 marks</th></tr>
<tr>
<td>• Basic understanding of risks in procedures with only standard laboratory safety precautions identified
• Significant teacher intervention required to ensure safety or help set up equipment
• Results recorded clearly</td>
<td>• Some risks in procedures identified and some specific responses suggested to reduce risks
• Most risks managed successfully with no significant incidents or accidents and no requirement for teacher intervention
• Little support required to set up equipment
• Results tabulated to include all data collected, including use of correct headings</td>
<td>• All significant risks in the plan evaluated and reasoned judgements made to reduce risks by use of appropriate specific responses
• All risks managed successfully with no incidents or accidents and no requirement for teacher intervention
• Measurements taken and recorded to appropriate accuracy and precision using an appropriate format, including use of correct units</td>
</tr>
<tr>
<td colspan="2">A reasonable risk assessment has been produced, covering pertinent hazards and risks but in variable detail.

The centre has indicated that the practical activity has been carried out safely and competently.

Results have been recorded clearly in appropriate tables (column headings and recording of data is good).
[6]</td>
<td></td>
</tr>
</table>

<table>
<tr><th colspan="3">LO3: Be able to analyse scientific information</th></tr>
<tr><th>MB1: 1 – 5 marks</th><th>MB2: 6 – 9 marks</th><th>MB3: 10 – 12 marks</th></tr>
<tr>
<td>• Some evidence of processing of quantitative data:
• data presented as simple charts or graphs
• use of a simple mathematical technique where appropriate
• Some trends/patterns in the data identified</td>
<td>• Graphical and mathematical techniques used to reveal patterns in data:
- charts or graphs used to display data in an appropriate way
- correct use of simple mathematical techniques where appropriate
- appropriate qualitative treatment of the levels of uncertainty in the data, including identification of any anomalous results
• Main trends/patterns in the data described with reference to quantitative data</td>
<td>• Appropriate graphical and mathematical techniques used to reveal patterns in data:
- appropriate scales and axes used in graphs and data plotted accurately, including where appropriate, use of lines of best fit
- correct use of complex mathematical techniques where appropriate
- appropriate quantitative treatment of levels of uncertainty in the data
• Main trends/patterns in the data described in detail and interpreted correctly with reference to quantitative data and relevant scientific understanding</td>
</tr>
<tr>
<td colspan="2">(Simple) means have been calculated. The graph has been drawn, using Microsoft Excel, with appropriately labelled axes. There are no gridlines. A trendline has been added, and the candidate has added a computer-drawn line of best fit.

The main pattern in the data has been described.

[7]</td>
<td></td>
</tr>
</table>

<table>
<tr><th colspan="3">LO4: Be able to evaluate scientific information</th></tr>
<tr><th>MB1: 1 – 5 marks</th><th>MB2: 6 – 9 marks</th><th>MB3: 10 – 13 marks</th></tr>
<tr>
<td>• Limited comments made about the quality of the data and the methods used
• Simple conclusion given which is consistent with the data collected and shows limited scientific understanding
• There is limited application of skills/ knowledge/ understanding from other units in the specification</td>
<td>• Some relevant comments made about the quality of the data including accuracy and sources of error, linked to the methods of collection:
• limitations in the methods of data collection identified and suggestions for improvements given
• Conclusion given and justified based on an analysis of the data, showing sound understanding of the underlying science
• Applies skills/knowledge/understanding from other units in the specification in a way which is mostly relevant</td>
<td>• Detailed and critical consideration given to the data and methods used to obtain them:
- sources of error and quality of data discussed and explained, including accuracy, repeatability and uncertainty
- limitations of the method identified and suggestions for improvements justified
• Conclusion given and justified based on critical analysis of primary and secondary data, clearly linked to relevant scientific understanding
- identification of conflicting evidence
- what further evidence is needed to make the conclusion more secure
• Applies skills/knowledge/understanding from other units in the specification in an effective relevant way</td>
</tr>
<tr>
<td colspan="2">The candidate has identified an outlier and collected an additional piece of data to compensate for this.

There are some (limited) comments on the quality of data, and comments on sources of error, along with suggestions for improvement.

There is a brief but pertinent comment to explain the results obtained.

There is some application of knowledge and understanding of electrolysis and metal extraction and purification from Unit 1.

[7]</td>
<td></td>
</tr>
</table>

LO5: Be able to communicate scientific information		
MB1: 1 – 4 marks	**MB2: 5 – 7 marks**	**MB3: 8 – 9 marks**
• **Limited** use of scientific, technical and mathematical language, conventions and symbols • **Some** errors in grammar, punctuation and spelling • **Limited** use of diagrams, graphs, flow charts and pictures	• Information is presented in a **structured** format • **Sound** use of scientific, technical and mathematical language, conventions and symbols • **Occasional** errors in grammar, punctuation and spelling • **Some appropriate** use of diagrams, graphs, flow charts and pictures	• Information presented is **clear**, well organised and structured, and in a **coherent** format • Scientific, technical and mathematical language, conventions and symbols are used **effectively** • **Few**, if any, errors in grammar, punctuation and spelling • Diagrams, graphs, flow charts and pictures are used **appropriately** and accurately
There is some use of scientific, technical and mathematical language. There are some 'typos' resulting from the careless use of ICT, but grammar, punctuation and spelling and grammar are generally sound. The flowchart of copper extraction purification is a useful inclusion, but the graph could have been improved. [7]		

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Telephone 02476 851509

Email cambridgenationals@ocr.org.uk

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