

## RATE OF ELECTROLYSIS MEMO

### Purpose

- Learners design, perform, and report on an experimental investigation using readily-available equipment.

### Structure

- During the first part of the worksheet and movie learners explore numerous investigation possibilities, and think through the design of these possible experiments. During the last part of the movie, learners observe how to perform a specific investigation. After this, they should preferably practically perform this investigation, or any of the other variations they had previously planned. Alternatively, they could complete the worksheet by referring to what was done in the movie.

### Suggested teaching approach

Estimated time	Description	Resources
Class time: 1 lesson	<ul style="list-style-type: none"> <li>Explore planning possibilities.</li> <li>Discuss set-up and theory.</li> <li>Set up electrolytic cells. Either prescribe a specific investigation to perform, e.g. that performed in the movie, or give learners the freedom to investigate any feasible question from those previously discussed.</li> </ul>	Rate of electrolysis movie Electrodes, $\text{CuCl}_2$ , cells, wires, scale
Homework: $\frac{1}{2}$ lesson	<ul style="list-style-type: none"> <li>Learners answer questions 1-7 in writing.</li> </ul>	Worksheet (pp.43-46)
Overnight	<ul style="list-style-type: none"> <li>Allow to stand for about 2 hours.</li> <li>Remove cathodes from the electrolytes. Allow to dry overnight.</li> </ul>	Well ventilated area
Class time: 1 lesson	<ul style="list-style-type: none"> <li>Collect data.</li> <li>Learners answer questions 8-12 in writing.</li> </ul>	Scale Worksheet
Class time: $\frac{1}{2}$ lesson	<ul style="list-style-type: none"> <li>Go through answers.</li> </ul>	Memo

### Practical preparation and tips

- You need: carbon rods (you could get these from dismantled batteries), copper chloride solution electrolyte in a beaker, a power supply (e.g. battery) and connective leads.
- If you cannot get copper chloride, use blue window cleaner.
- To measure electrode mass, you need a mass scale. Be sure to measure each cathode's initial mass and to mark each one clearly. Be careful not to dislodge any copper from the cathodes during or after the experiment. Allow to dry thoroughly before measuring the final masses.
- Electrolyte colour change is a poor practical indicator of rate of electrolysis of  $\text{CuCl}_2(\text{aq})$ , since it is very difficult to see the difference between most colour changes which might occur.

### Suggested answers to questions

#### Planning possibilities

Watch the movie introduction about the planning possibilities of the investigation.

You want to investigate how various factors affect the rate of electrolysis.

- Suggest various factors which might affect the rate of electrolysis, which you could alter in this investigation. These are possible **independent** variables.  
**temperature of solution, concentration of solution, time left in solution, potential difference used, surface area of electrodes, distance between electrodes, volume of solution**
- Rate of electrolysis** is the **dependent** variable for this investigation.  
Give possible **focus questions** for this investigation.  
These can be written in the form:  
How does [independent variable] affect [dependent variable]?  
**How does temperature of solution affect rate of electrolysis?**

- How does concentration of solution affect rate of electrolysis?  
 How does time left in solution affect rate of electrolysis?  
 How does potential difference used affect rate of electrolysis?  
 How does surface area of electrodes affect rate of electrolysis?  
 How does distance between electrodes affect rate of electrolysis?  
 How does volume of solution affect rate of electrolysis?

3 Complete for three possible indicators of the dependent variable (rate of electrolysis):

Indicator of electrolysis rate	If I see _____, I would deduce that the rate of electrolysis was high	If I see _____, I would deduce that the rate of electrolysis was low
colour of solution after a certain time	pale blue after e.g. 2,5 hours	still dark blue after e.g. 2,5 hours
volume of chlorine gas formed in a certain time	much chlorine gas would be formed in e.g. 5 minutes.	little chlorine gas would be formed in e.g. 5 minutes.
mass of copper precipitated on electrode in a certain time	electrode would have gained a lot of mass, due to copper precipitation, in e.g. 2,5 hours.	electrode would have gained little mass, due to copper precipitation, in e.g. 2,5 hours.

Watch the rest of the movie.

### Focus question

- 4 Give the focus question of the investigation performed on the movie.  
 How does **potential difference** affect **rate of electrolysis**?

### Treatments

- 5 Describe the treatments.

**Four electrolytic cells are used, with the following potential differences across their electrodes:**

A: 1,5V

B: 3V

C: 4,5V

D: 6V

- 6 In which variable do they differ from one another? (Choose:) [Dependent / **Independent**]

### Controlled variables

- 7 List variables which must be the same between the different treatments for a fair test:  
**temperature of solution, concentration of solution, time left in solution, surface area of electrodes, distance between electrodes, volume of solution**

### Tables

- 8 Tabulate the results either shown in the movie, or, preferably, from your own experiment.

**Note: if learners use data from their own experiment, then their values will differ from those given here.**

Raw data table: The effect of potential difference on rate of electrolysis

Potential difference (V)	Electrode mass (g)		
	Initial	Final	Change
1,5	6,50	6,90	0,40
3	6,50	7,33	0,83
4,5	6,51	7,93	1,42
6	6,57	8,17	1,60

Processed data table: The effect of potential difference on rate of electrolysis

Potential difference (V)	Change in electrode mass due to copper deposition (g)
1,5	0,40
3	0,83
4,5	1,42
6	1,60

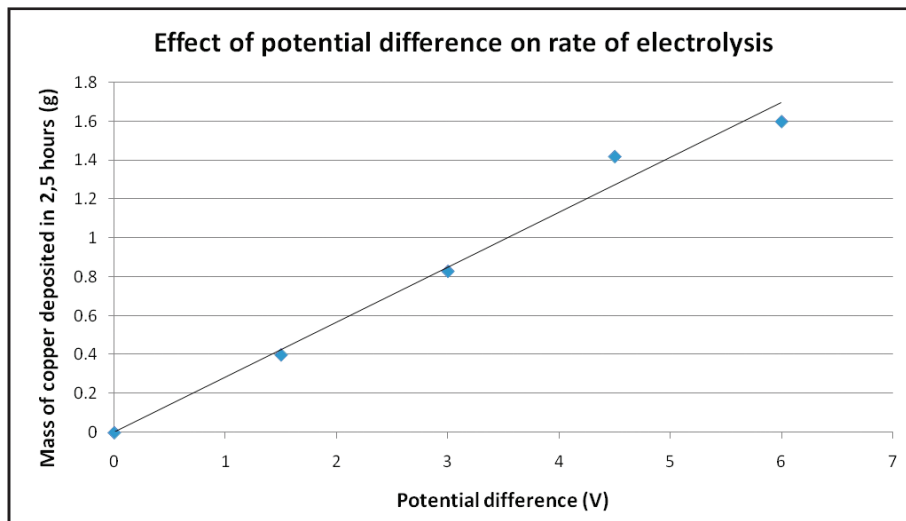
Check. Has the learner:

- completed the table headings suitably?
- headed the first columns with the independent variable?
- given units, where appropriate, in the headings, not body, of the table?
- filled in all treatment details in the first column?
- filled in initial and final mass readings (processed data table)
- correctly calculated and recorded mass change values (raw and processed data tables)?

Tick if done:

### Graph

9 Represent the findings graphically.



Check. Has the learner:

- given a suitable graph heading?
- plotted the independent variable on the x ( — ) axis?
- plotted the indicator of the dependent variable on the y ( | ) axis?
- labelled each axis and given units where appropriate?
- accurately plotted data and drawn a smooth trend line?

Tick if done:

### Conclusion

10 Answer the focus question in your own words.

**A higher potential difference causes the electrolytic reaction rate to be higher.**

11 Complete for a shorter way of writing the conclusion:

Increasing **potential difference** [increases / decreases / doesn't affect] **rate of electrolysis**.  
 [independent variable] [dependent variable]

### Discussion

12 Suggest a reason for your findings, referring to the background theory.

**A higher potential difference is associated with a greater delivery of electrical energy to the circuit. In an electrolytic cell electrical energy is converted into chemical energy. A higher rate of delivery of electrical energy to the cell results in a higher rate of chemical reaction. Therefore the rate of electrolysis increases with an increased potential difference.**