# Producing ‘gold’ coins on a microscale

## Learning objectives

1 Understand that electroplating is an important industrial application of electrolysis.

2 Electroplate a coin.

3 Describe how to electroplate a metal.

4 Explain what happens at each electrode during electroplating.

## Introduction

Electroplating is the process of covering a metal object with a thin layer of another metal. The technique is often used to make cheap jewellery look expensive! For example, a ring made from a cheap metal like copper can be electroplated with either gold or silver. The result looks like a gold or silver ring without the high cost. Electroplating is also used to protect metals from corrosion. For example, the inside of a steel food can is electroplated with less reactive metal such as tin. The layer of tin provides a physical barrier protecting the steel from oxygen and water.

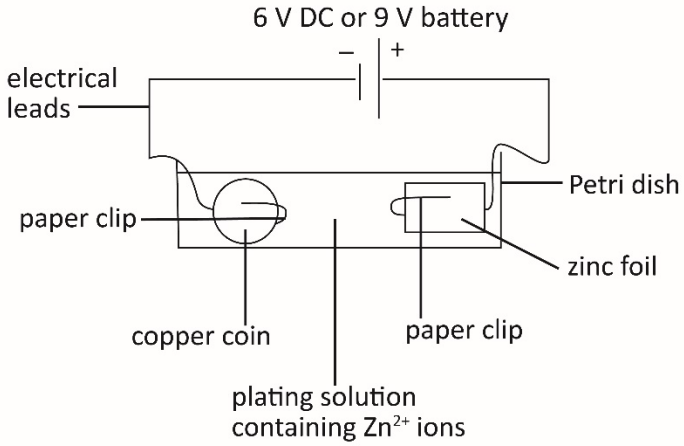
In this practical activity you are going to produce a ‘gold’ coin. First you will electroplate a copper coin with zinc. Then, by heating the plated coin in a flame, you will produce a brass layer giving it a ‘gold’ effect.

## Method

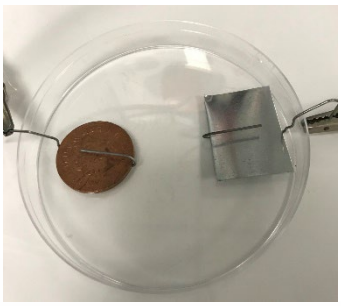
### Safety and hazards

- Wear safety glasses.
- Beware of sharp edges when manipulating the zinc foil.

- Take care not to get the electrolyte solutions on your skin.
- Work in a dry area. Make sure the power supply is switched off when you are putting the equipment together and that you switch it off again when you are dismantling the equipment.
- Hot coins can cause burns. Allow them to cool before you handle them.




## Set up the electroplating bath using a Petri dish and paper clips

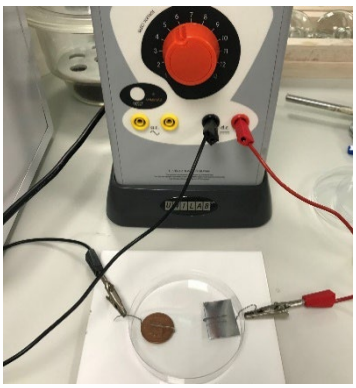


- Straighten out the long 'legs' of the paper clips and place the coin and the zinc foil in the paper clip holders.
- Place both electrodes into the Petri dish.
- Attach the 'long leg' of the paper clip to a crocodile clip.

## Make up the plating solution, which is an electrolyte containing $Zn^{2+}$ ions

- Measure 12 $cm^3$ sodium hydroxide ($NaOH$) and 2 $cm^3$ zinc sulfate ($ZnSO_4$) solutions using two different measuring cylinders.
- Add the sodium hydroxide and zinc sulfate solutions to a beaker.
- When all the white precipitate has dissolved pour the solution into the Petri dish.

## Do the electroplating



- Using an electrical lead, connect the paper clip attached to the zinc to the positive connection of a 6 V DC power supply (or 9 V battery).
- Using an electrical lead, connect the paper clip attached to the copper coin to the negative connection of a 6 V DC power supply (or 9 V battery).
- When the coin looks 'silver', turn off the power and disconnect the wire from the paper clip holding the coin.
- Remove the coin with paper clip from the petri dish using tongs.
- Rinse the coin with water, then remove the paper clip holder.
- Dry the coin and polish it with a cloth.

### Heat the coin

- Using tongs, gently pass the coin through a blue Bunsen burner flame until the coin looks golden.
- Place the coin on a heat proof mat and allow it to cool before handling.

## Questions

1. Electroplating is an important industrial process. Give **two** uses of electroplating.

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2. Give **two** reasons why objects are electroplated.

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3. Describe what you saw at the negative electrode.

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4. Explain why the object to become electroplated has to be the negative electrode. (You should refer to metal ions in your answer.)

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5. This question is about the electrolyte.

(a) What type of substance can be an electrolyte?

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(b) Explain why an electrolyte conducts electricity.

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(c) In this experiment, a layer of zinc metal forms on the copper coin. Explain how the zinc metal forms from the zinc ions in the electrolyte?

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**6.** Complete the equation for the reaction at the negative electrode.

$Zn^{2+}(\_\_\_) + \_\_\_e^- \rightarrow Zn(s)$

**7.** During the electrolysis, zinc ions are removed from the solution. Having a positive electrode made from zinc foil keeps the concentration of zinc ions in the electrolyte constant. Explain how. Write a half-equation for the reaction at the positive electrode.

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**8.** Suggest a reason why the 'silver' coin turned 'gold' when it was carefully passed through a Bunsen flame.

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**9.** Select the correct statements for the conditions required to silver plate a metal fork. Give a reason for your answer.

| Option | Negative electrode | Positive electrode | Electrolyte |
|---|---|---|---|
| A | Silver | Metal fork | Silver nitrate solution |
| B | Zinc | Metal fork | Copper sulfate crystals |
| C | Metal fork | Silver | Silver nitrate solution |
| D | Metal fork | Silver | Solid silver nitrate |

_____ is correct, because _____

_____

## Long-answer question

**10.** A student wants to electroplate a screw with nickel metal. Describe and explain the process of electroplating a screw with nickel. Include half-equations for the reaction at each electrode.
*Use the prompts in the table below to help structure your answer.*

| Electroplating an iron screw | |
|---|---|
| Define electroplating. | |
| State the meaning of electrolyte and name the ion that must be present for nickel plating. | |
| What is the negative electrode made from? | |
| What will you observe at the negative electrode? Write an equation. | |
| Explain why the positive electrode is made from nickel foil. | |
| Write an equation for the reaction at the positive electrode. | |