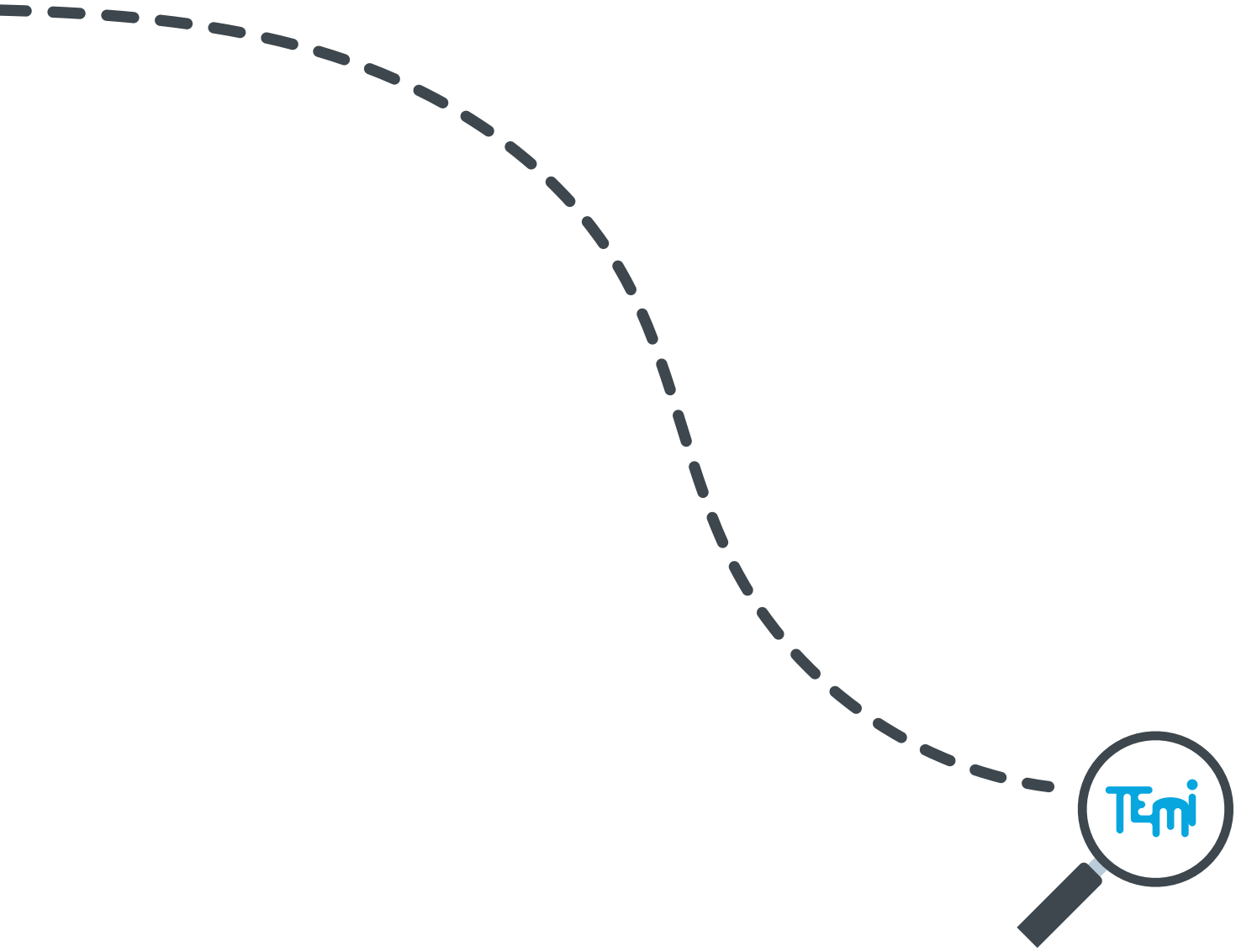
The murder of the jeweller Beketov

CLASSROOM SCIENCE ACTIVITY TO
SUPPORT STUDENT ENQUIRY-BASED LEARNING



This classroom-tested teaching plan uses the four innovations of the TEMI project, as detailed in the Teaching the TEMI Way (TEMI, 2015).

You should read this companion book to get the most from your teaching. The **TEMI** techniques used in this teaching plan are: **1)** productive science mysteries, **2)** the **5E model** for engaged learning, **3)** the use of presentation skills to engage your students, and **4)** the apprenticeship model for learning through gradual release of responsibility. You might also wish to use the hypothesiser lifeline sheet (available on the **TEMI** website) to help your students document their ideas and discoveries as they work.

To know more about **TEMI** and find more resources **www.teachingmysteries.eu**

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teachingmysteries.eu

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The murder of the jeweller Beketov

What's the mystery?

The mystery revolves round a detective story which the students gradually solve. A jeweller has been murdered: the suspects are his metal suppliers but the motive and the culprit are initially unknown.

DOMAIN(S)

Chemistry.

SUBDOMAIN KEYWORDS

Electrochemical series of metals, properties and reactions of metals, periodic system of the elements.

AGE GROUP

14 to **18** years old.

EXPECTED TIME FOR THE MYSTERY

Approximate time for teacher preparation:
30 min.

Approximate time in classroom:
two 45 min. lessons.

SAFETY/SUPERVISION

The experiments use a five per cent solution of HCl: this is an irritant. Caution and protective gloves are needed.

Disclaimer: the authors of this teaching material will not be held responsible for any injury or damage to persons or properties that might occur in its use.

PREPARATION AND LIST OF MATERIALS

- Text of a detective story for each group of students
- Common chemical equipment (test tubes, pipettes, petri dishes and pincers)
- Solutions ($AgNO_3$, $Al_2(SO_4)_3$, $ZnSO_4$, HCl: everything is diluted at, for example, five per cent concentration)
- Solid metals (Zn, Al, and some silvery metal with a look and shape similar to silver, possibly Sn or Fe).

LEARNING OBJECTIVES

Students learn about the redox properties of metals, which are the base of the electrochemical series of metals. This series of metals was first assembled by the Russian chemist N. N. Beketov in the 19th century, which is why it is sometimes called the Beketov's series of metals, and it is also why we used his name in our story. V. V. Markovnikov was also an important Russian chemist of the 19th century.

Guidance notes for teachers

THE 5E MODEL

Engage

CAPTURE STUDENTS' ATTENTION

Students look for papers with parts of a detective story and arrange them to make sense. It is a murder mystery: why were the jeweller, Beketov, and the investigator, Markovnikov, murdered?

Explore

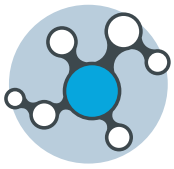
COLLECT DATA FROM EXPERIMENTS

Students have samples of the various metals with which the jeweller worked. They find out the metals' properties by looking at the chemical reactions between them and their salts. They present their results in the worksheet.

Explain

WHAT'S THE SCIENCE BEHIND THE MYSTERY?

Metals are divided into two groups according to their reactivity. More reactive metal reacts with the salt of a less reactive metal and becomes a part of the salt, while the less reactive metal comes out of the salt pure. Through the experiments, the students should find that Beketov found out that his supplier gave him tin (Sn) instead of silver and the supplier killed him. The investigator was coming close to finding out about this deception so he too was killed.



Extend

WHAT OTHER RELATED AREAS CAN BE EXPLORED?

This topic is a part of the curriculum (electrochemical series of metals/Beketov's metal series). It is connected with the common usage of metals (iron corrodes fast while gold doesn't corrode for thousands of years). This redox reaction is also the principle behind some kinds of batteries.

Evaluate

CHECK THE LEVEL OF STUDENT SCIENTIFIC UNDERSTANDING

Students should fill in the table correctly according to the results of their experiments. These will show them a part of the series of metals. The teacher fills in the rest of the series and continues by explaining and discussing the applications of this knowledge.

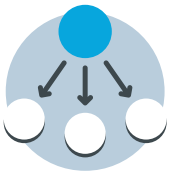
THE 5E MODEL

Showmanship

TIPS ON HOW TO TEACH AND PRESENT THIS MYSTERY

Students can pose their questions on the basis of the detective story (see below). The story is cut into pieces and scattered around the lab, classroom, corridor etc. Students need to find the pieces of the story and put them together. They then need to conduct experiments and assess the evidence. On the basis of this, they should explain the sequence of events in the murder. The teacher is there to supervise their hypotheses and maybe nudge them in the right direction if they seem lost.

1. At 3PM, the police are called to the murder of the jeweller Beketov.
2. The policemen discover the jeweller, Beketov, in his shop on the main street with his skull bashed in.
3. The eyewitnesses claim that Beketov was provably alive and well at 1PM.
4. After questioning Mr. Beketov's helper, it was found that one of the suppliers arrived to the shop around 2PM.
5. It is not known which supplier arrived on that fateful afternoon: all three suppliers to the jeweller have an alibi for that time.
6. The police decide to give the newspapers the information that one of the suppliers is the murderer, believing this will scare him and make him confess.
7. In the morning after the newspaper article about the suspected suppliers comes out, the dead body of the policeman, Markovnikov, is found in the jeweller's workshop surrounded by chemicals and equipment.
8. It was found that the policeman, Markovnikov, was killed by a blow to the head during a chemical experiment which, according to his colleagues, was supposed to reveal the murderer.



GRR

TEACHING SKILLS USING GRADUAL RELEASE OF RESPONSIBILITY

Setting up the mystery: tell the students that a jeweller has been murdered and their help is needed to solve the mystery.

Demonstrated enquiry (level 0): the teacher reads out the murder story to the students and suggests a way to continue the experiments. The teacher says that some metals react differently than others and maybe the supposed silver is some other metal. Students record their thinking onto their hypothesiser lifeline worksheet.

Structured enquiry (level 1): students then use their Hypothesiser Lifeline sheet to record their own alternative ideas about the murder and to record their tests and conclusions regarding these other explanations.

Solving the mystery: students are led towards the explanation by using ideas about the electrochemical series of metals derived from their experiments. They will thus find out that the supposed silver was in fact tin. The jeweller found out and that was why he was murdered. The investigator was very close to finding out the culprit so he was killed too.

Resources

You can find examples of reactions between reactive metals and salts of less reactive metals in the videos on the TEMI Youtube Channel:
www.goo.gl/tUDaq5

Reaction between copper and silver nitrate:
playlist> Silver Tree
playlist> Silver Christmas Tree

Reaction betwenn iron and copper sulphate:
playlist> Chemistry Revision - Iron & Copper Sulphate solution

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STUDENT WORKSHEET

Initially, familiarise yourself with the story about the murders of the jeweler, Beketov, and the police commissioner, Markovnikov. Then, work out the experiments which will help catch the murderer by discovering which metal supplier killed Beketov and Markovnikov using the chemical experiment you devised.

Engage

WHAT'S INTERESTING?

Task: Work in pairs. Go outside the lab in turns with your partner and find strips of paper with pieces of the story. Put the pieces together so that the story makes sense.

Explore

WHAT'S HAPPENING?

Task 1: Suggest ideas to help solve the murder.

Task 2: Explore the behaviour of various metals (zinc, aluminium, and silver) in small test tubes with various solutions (salts of metals in water). You may use the following solutions: $AgNO_3$, $Al_2(SO_4)_3$, $ZnSO_4$, HCl. What experiments would be useful in providing evidence to assist you in solving the murder? Write your results into the table in the worksheet.

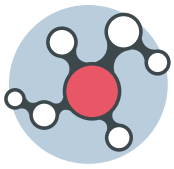
Explain

WHAT'S CAUSING IT?

Task 1: Sort the metals into a series according to the table.

Task 2: Explain why the metals are in this order. Note the various reactions of the metals with HCl: would silver react with HCl?

Task 3: Solve the murder!



Extend

WHAT'S SIMILAR?

Task: Try the same experiments with other metals and solutions of these metals' salts (for example, Mg and $MgSO_4$, Fe and $FeSO_4$, or Cu and $CuSO_4$). What do you find?

Write your results into the table on the next page and add these metals into the series.

Markovnikov's advice:

- Metal reacts – **2 points**
- Metal is in the solution of the same element's salts – **1 point**
- It didn't even perform the reactions – **redundant**
- Metal doesn't react at all – **0 points**
- After that, add up the points and form the metal series in ascending order.

Evaluate

WHAT'S MY UNDERSTANDING?

Task: Find some practical examples for using this series of metals in real life; for instance, what metal would you use for making long-lasting jewellery?

	$AgNO_3$ Name:	$Al_2(SO_4)_3$ Name:	$ZnSO_4$ Name:	HCl Name:
Ag				
Al				
Zn				
Total Points:	Silver	Aluminium	Zinc	Hydrogen