



C I A!

Challenging Investigations in Art forgery

TASK SHEET

30th of April 2015

Challenge 2

Country:

Team:

Lab safety rules

- Lab coats and safety goggles must be worn all times in the laboratory.
- Eating and drinking is strictly prohibited in the laboratory.
- Disposable gloves are provided and should be worn while working with chemicals.

General instructions

- On completion of your work all papers including scribbling paper must be handed in. NOTHING must be taken from the laboratory.
- All results must be entered into the answer sheet (coloured paper).
- Graphs must be handed in together with the answer sheet.

Only the final answer sheet (coloured paper) and the supplemented graphs will be assessed!

Task A: 92 Marks

Task B: 92 Marks

Task C: 92 Marks

Task D: 06 Marks

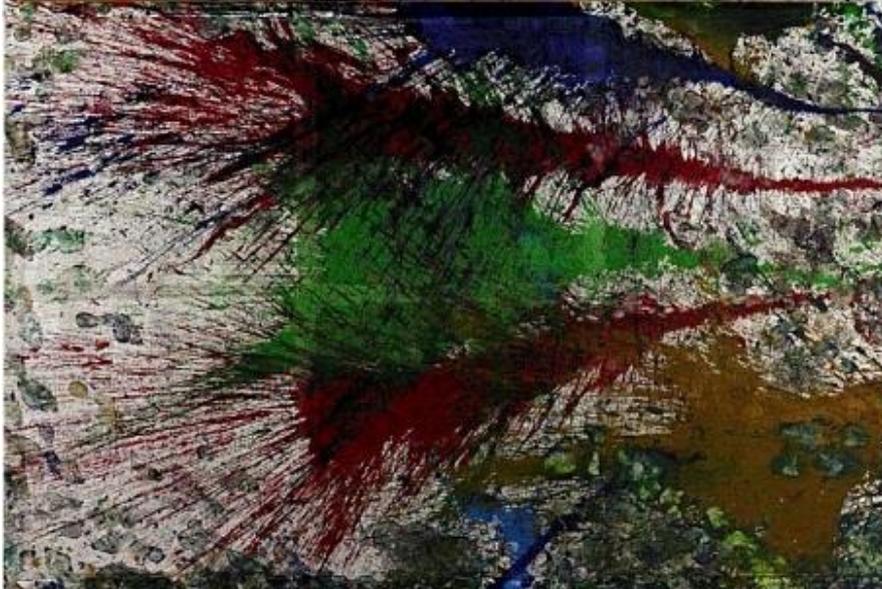
Task E: 24 Marks

You have **4 hours** to complete Challenge 2.

Please ensure that you allow enough time to complete tasks D and E

The Story

A burglary has been committed in a villa in Klagenfurt. During a vehicle inspection near the house a painting resembling the work of the Austrian actionist artist Hermann Nitsch was found in the trunk of a parked car. Nitsch is famous for using animal blood in his work and has always been under fire for that. After a consultation with the artist himself the painting was identified as forgery, although blood has been identified as a constituent in the colours, so further investigations have to be conducted.



Source: www.strabag-kunstforum.at/artcollection/kuenstlerinnen-und-kuenstler/?kid=30

The circle of suspects specialising in faking modern pieces of art has been limited to three persons. At least one of the suspects is known for using animal blood as paint, so the person who faked the painting might be among them.

In order to identify the art forger, investigations concentrate on:

- The painting itself.
- The car where the painting was found.
- The three artist studios (including the garden area and close surroundings).

At all three places different pieces of evidence were secured that - together with the evidence from the car should help identify the perpetrator. Materials and pieces of paintings stem from the three studios that have been secured at earlier investigations. However, during the transport some of the pieces of evidence were mixed up due to badly sealed containers. Luckily the three paint and canvas samples were labelled properly.

As part of this challenge, you as an up-coming science team are asked to investigate the present evidence using basic and straightforward methods and make a joint decision from which studio the painting has come from.

Use the following hints:

- Your own investigation results and measurements.
- The collected pieces of evidence.
- The description of the artist studios and of the surrounding areas.

Information on the artist studios:

The artist studio at the Lake Woerthersee

A quartz-gravel road leads from the main street to the parking space of the premises. Within a few minutes the lakeside can be reached from the artist studio, the way leading through an alder swamp, partly covered with rush. Recently, an introduced aquatic animal has caused fauna and flora problems in the lake. On one hand it competes with rare endemic species for food sources, on the other hand it serves as a food source for ducks.

The artist studio in the forest

The old building, situated close to an old granite quarry, is made up of sandstone. Although the location of the studio is very quiet, the artist has planted a yew tree hedge to screen it from the neighbouring land plot. He sells honey from his own production on the farmer's market in Klagenfurt and fir trees from his own plantation at the Christmas market; this is additional income for him.

The artist studio at the sea

It is situated in a picturesque location on limestone at the Mediterranean Sea coast. The distance to the beach is only about 100 m, and the beach is lined with typical beach flora. However, the invasive neophyte *Mesembryanthemum crystallinum* is increasingly becoming a threat.

TASK A

In Task A it is possible to use jokers, but marks will be deducted.

Materials:

Contents of the bags:

- You will receive five bags with reference samples:
 - Bag "Forest": from the studio at the edge of the forest of Viktring, a part of Klagenfurt. (Samples labelled with "Forest 1", "Forest 2", "Forest 3").
 - Bag "Lake": from the studio and from the garden at the banks of the Lake Wörthersee (Sample labelled with "Lake 4").
 - Bag "Sea": from the studio at the Mediterranean coast (Samples labelled with "Sea 5", "Sea 6", "Sea 7").
 - Bag "Car": from the car where the painting was found (Samples labelled with "Car 8", "Car 9", "Car 10").
 - Bag "Mix": from all three studios, the content of which has accidentally been messed up (Samples labelled with "Mix 11", "Mix 12", "Mix 13", "Mix 14").
- Microscope slides
- Black paper as pad for the slide
- Cover slips
- Microscope
- Diluted hydrochloric acid labeled as "HCl"
- Silver nitrate solution labeled as "AgNO₃"
- Magnesia sticks (magnesia = magnesium oxide)
- Razor blade
- One piece of elder marrow
- Petri dishes
- Bunsen burner (on central lab bench)
- Forceps
- Manipulating needles

1. Assignments to be done with the pieces of evidence in the bags

1.1. Which pieces of evidence from bag "Mix" belong to which putative location?

Write the appropriate numbers of the pieces of evidence from the bag "Mix" in the table next to the corresponding studio location. (The pieces of evidence are labelled with numbers)

⇒ Answer sheet

1.2. Systematic assignment: Identify the pieces of evidence from Bag "Lake", Bag "Forest", Bag "Sea", Bag "Car" and Bag "Mix" and enter the numbers found on the pieces into the appropriate blanks in the tables "Systematics 1" and "Systematics 2"!

⇒ Answer sheet

The more precise the systematic assignment is done, the more marks can be achieved. **Watch out!** Some pieces of evidence can be assigned to one and the same organism. Also, some pieces of evidence may be assigned to more than one of the fields surrounded by bold lines, e.g. to both family and genus/species. Some boxes may be left blank.

2. *Mesembryanthemum crystallinum*

Leaves and stems of *Mesembryanthemum crystallinum*, a succulent plant from the family of Aizoaceae (fig-marigold family or ice plant family), were found in the car.

Mesembryanthemum crystallinum shows the following characteristics:

- As an adaptation to its environment it can undergo a stress-induced switch from C3 metabolism to CAM (**crassulacean acid metabolism**) as a consequence of salt or drought stress.
- *Mesembryanthemum crystallinum* is commonly known as 'ice plant' due to its leaves, stem, buds and seeds that are covered with epidermal bladder cells (filled with liquid). Thus, the plant appears as if it is fully covered with small frozen dewdrops. The epidermal bladder cells serve as a storage reservoir for some compounds, such as NaCl, which regulates the water balance.
- Crystals can be found in the vacuoles.

The investigators found different subspecies of *Mesembryanthemum crystallinum* at each artist's location:

- within the vegetable garden at the lake
- as indoor plant at the forest studio
- as a proliferating neophyte in the vicinity of the studio at the seaside

On initial observation the plants cannot be distinguished from each other. They all look very similar. However, subspecies can clearly be distinguished from one another according to the following criteria:

- Shape of the embedded crystals in mesophyll cells
- Material of the embedded crystals
- Capability of NaCl storage within the epidermal bladder cells
- Optical properties of the bladder cell liquid → **Task C**

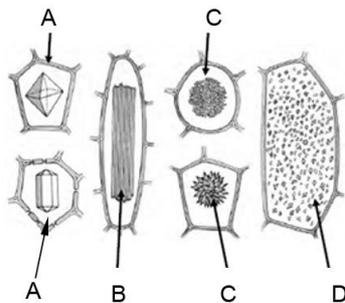
Location	Plants	Shape of crystals	Material of crystals	NaCl in bladder cell liquid	Optical activity
Lake studio (vegetable garden)	<i>Mesembryanthemum c. subsp.zzz</i>	Druse	Calcium carbonate	Storage of NaCl	Optical activity
Forest studio (indoor plant)	<i>Mesembryanthemum c. subsp.yyy</i>	Needle-shaped crystals (Raphides)	Calcium oxalate	No storage of NaCl	No optical activity
Sea side studio (invasive neophyte)	<i>Mesembryanthemum c. subsp.xxx</i>	Needle-shaped crystals (Raphides)	Calcium oxalate	Storage of NaCl	Optical activity

For the investigation it is important to determine which studio the plant found in the car comes from. Use the characteristics mentioned in the table above for your investigations. The following experiments should help you to answer this question!

2.1. Shape of the embedded crystals in mesophyll cells

Make a cross section of the plant's leaf. (Take a leaf at least 2 cm long.) If you need instructions ask a laboratory assistant. Be aware: By using a joker you will have 2 marks deducted.

With the help of a microscope, look for embedded crystals in the cross section of the leaf. Identify the shape of crystals present in that plant!



Possible crystal shapes:

- Single crystals
- Needle-shaped crystals in bundles (Raphides). If the cells are destroyed they can fall apart into single crystal needles.
- Crystal druses - asteroidal aggregates of crystals
- Crystal sand

2.1.1. Fill in the appropriate letters into the answer box!

⇒ Answer sheet

2.2. Distinction between Calcium oxalate- and Calcium carbonate

You have to work very carefully in doing this experiment and you must wear gloves!!!!

Step 1: Add one drop of diluted hydrochloric acid onto in a new microscopic slide.

Step 2: Place a new thin cross section on the drop of hydrochloric acid.

Step 3: Cautiously place a cover slip on top of it.

If you have liquid coming out from below the slip, remove it with tissue without wetting the slide or slip any further. Take care that your skin does not come into contact with diluted hydrochloric acid!

Step 4: Investigate whether the crystals react with the hydrochloric acid. For observation use the 10x objective. Monitor your experiment carefully and patiently for up to 10 min to see whether or not you observe any changes.

2.2.1. Tick the result of your investigation in the Table "Reaction of crystals"

⇒ Answer sheet!

2.2.2. The conclusion of your investigation.

Choose the appropriate letter and write it into the answer box!

⇒ Answer sheet!

E: The crystals are made of calcium carbonate

F: The crystals are made of calcium oxalate.

2.3. Investigation of NaCl in bladder cells.

Analysis of chloride ions

You must wear gloves!

Step 1: Place the glass slide on the black paper.

Step 2: Carefully (do not squeeze the bladder cells) take one leaf of *Mesembryanthemum crystallinum* and cut it off with the razor blade.

Step 3: Take the side of the leaf with the bigger bladder cells and put it face down on the glass slide. Gently press the leaf on the glass to make the bladder cells burst so that they leave some fluid film on the glass. Remove the leaf from the microscope slide!

Step 4: Add 1-2 drops of readily prepared AgNO_3 (silver nitrate) on the fluid film

Step 5: Observe the reaction and note down the result!

2.3.1. Tick the appropriate conclusion in the table "Analysis of chloride ions"

⇒ Answer sheet!

Analysis of sodium ions

Step 1: Carefully take a magnesia stick with forceps and let one end touch the (big) bladder cells of another leaf. Hold the magnesia stick in place to draw up some fluid. The flame test must only be carried out at the designated bench in the laboratory!

Step 2: Ask a laboratory assistant to help you with the Bunsen burner. Ensure you use a working flame and not the safety flame.

Step 3: Hold the magnesia stick with the probe into the flame for up to one minute.

Step 4: Carry out the flame test at least twice. Let the magnesia stick cool in between, snap off the end carefully (Caution! It might still be HOT) and repeat steps 1 and 3.

Investigate the reaction!

2.3.2. Tick the flame colour and then the appropriate conclusion in the table “Analysis of sodium ions”! ⇒ Answer sheet!

2.3.3. The flame test for sodium can be tricky. Which of the mentioned mistakes can have an effect on the result? Tick the appropriate answers in the table “Possible sources of error during flame test”. ⇒ Answer sheet!

2.4. The results from the investigation of *Mesembryanthemum* from the car

2.4.1. Summarize your results from your investigation in the checklist “*Mesembryanthemum*”! ⇒ Answer sheet!

2.4.2. Write the correct name of the plant (subspecies!) found in the car into the answer box! ⇒ Answer sheet!

3. Graphical presentation of epidermal cells and cells of the stomata.

Draw a biological scientific sketch of a surface section of *Mesembryanthemum crystallinum* of about 20 epidermic cells with cells of stomata in plane view! For observation use the 10x objective ⇒ Answer sheet!

Prepare a surface section of the leaf. If you need instructions ask a laboratory assistant. Be aware: By using a joker you will have 2 marks deducted.

Pay attention to the correct labelling and provide all relevant information on the sketch!

4. Crude examination of the small stone from the car

Recall what you might know about hardness of stones and which of the materials might show visible effects when they come in contact with hydrochloric acid.

The following materials are provided:

- Water
- A glass plate = Microscope slide

- A dropper bottle with diluted hydrochloric acid

Carry out relevant experiments to find out whether the stone could be quartz, granite or limestone!

4.1. Tick the appropriate answers!

⇒ *Answer sheet!*

4.2. Result of crude determination: Write the appropriate letter into the answer box!

⇒ *Answer sheet!*

A = quartz

B = limestone

C = granite

5. Bag from the Car

After having finished all the practical experiments, it should be possible to match the pieces of evidence from the car to the forger's art studio.

5.1. Tick from which studio the pieces of evidence found in the car might be!

⇒ *Answer sheet*

Watch out! You should now be able to add evidence piece number 10 to the table "systematics 1" as well!

6. Who is responsible for the art forgery?

After your investigation you should be able to identify the fraudulent.

6.1. Tick the most likely location, from which the fraudulent painting could have come from.

⇒ *Answer sheet!*

7. Plant metabolism

Crassulacean acid metabolism, also known as **CAM photosynthesis**, is a carbon fixation pathway that evolved in some plants, eg. *Mesembryanthemum crystallinum*, as an adaptation to arid conditions. Plants using full CAM can reduce the loss of water by several anatomical and physiological adaptations (modified from Wikipedia).

7.1. Fill in the appropriate numbers in the table "Plant metabolism"!

⇒ *Answer sheet!*

1 = appropriate statement

0 = not applicable!

TASK B

1. Investigation of paint samples

1.1. Detection with luminol

1.1.1. Record your observations in the table.

(6 Marks)

Fill in the table. Write "P" for a positive test and "N" for a negative test.

S 1	S 2	S 3

1.1.2. What colour of light do you observe, if the test is positive?

(1 Mark)

Tick the appropriate answer.

- blue
- green
- red/orange

1.1.3. What is the reason for the light emission?

(1 Mark)

Tick the appropriate answer.

- phosphorescence
- fluorescence
- chemoluminescence

1.2. Spot plate

(19 Marks)

1.2.1. Show the finished spot plate to the laboratory assistant who will take a photo.

For the laboratory assistant:

Spot plate has been photographed.

Signature of laboratory assistant: _____

1.2.2. Which of the samples contain Fe(III)? Record your findings in the table. (6 Marks)
Fill in the table. Write “P” for a positive test and “N” for a negative test.

S 1	S 2	S 3

1.2.3. Based on the tests you have conducted so far, which sample(s) might contain blood? (6 Marks)
Fill in the table. Write “P” if you assume it contains blood and “N” if you assume it does not.

S 1	S 2	S 3

1.3. Detection of haemoglobin with Teichmann test

1.3.1. Which samples contain Teichmann crystals? (6 Marks)
For reference, use the picture of what Teichmann crystals look like next to the microscope.
Fill in the table with “P” if it contains Teichmann crystals or “N” if it does not contain them.

S 1	S 2	S 3

1.3.2. Show one sample that contains Teichmann crystals to the laboratory assistant. (4 Marks)

Get the laboratory assistant’s signature for confirmation.

Put the labelled slides into the envelope and make sure that you hand it in with the answer sheet.

For the laboratory assistant:

Teichmann crystals present

not present

Slides submitted.

Signature of the laboratory assistant: _____

2. Investigation of canvas

2.1. Calculate the R_f-value for chloride.
(Marks)

(13

Calculation:

Attach the chromatogram!

Chromatogram:

2.2. In which of the samples have you found chloride?

(6 Marks)

Fill in the table. Write "P" for a positive test and "N" for a negative test.

A	B	C

COUNTRY:

Version 19.04.2015

TEAM:

2.3. Summarize your findings.

2.3.1. The origin of the painting can only be a studio where blood is used. (2 Marks)

Tick "yes" or "no".

- Yes, blood was used
 No, blood was not used

2.3.2. The origin of the painting can only be a studio with an increased concentration of chloride.

(2 Marks)

Tick "yes" or "no".

- yes
 no

2.3.2 Based on your findings, which of the studios might the painting originate from?

(6 Marks)

Fill in the table. Write "P" if the studio is possible and "N" if the studio is not possible.

Studio in the forest	Studio at the Lake	Studio at the sea

3 Theoretical assignment

3.1 Tick the appropriate answers. (8 Marks)

		correct	incorrect
3.1.1.	The R _f -value changes depending on the time the plate is left in the TLC-chamber.		
3.1.2.	In order to achieve luminescence, electrons always have to be excited by a chemical reaction.		
3.1.3.	The iron in the haem complex acts as a catalyst in the luminol reaction performed in this task.		
3.1.4.	In the reaction of iron ions with SCN ⁻ the iron ions are being oxidized.		

3.2 At a 40-fold magnification a crystal appears to be 2 cm long. How big is it in reality?

(6 Marks)

Calculation:

2. Investigation of textures**(10 Marks)****2.1. Determination of the diffraction angle of textures A – E**

texture	distance L	distance X	angle α (degree)
A			
A			
A			
B			
B			
B			
C			
C			
C			
D			
D			
D			
E			
E			
E			

textures	mean value of the angle (degree)	standard deviation (degree)
A		
B		
C		
D		
E		

2.2. Diagram: texture A - E – diffraction angle**(10 Marks)**

Paste your diagram!

2.3. Possible forger studios

Insert the diffraction angle (3 Marks)

Table 2.3			
sample	distance L	distance X	angle α (degree)
P			
P			
P			

Diffraction angle of sample P: $\alpha =$ degree (mean value and standard deviation)

Possible studios of the forgery:

3. Identification of a fluid

3.1. Adjustment of the experiment

Write down the value of the zero reference mark! (1 Mark)

Value of the zero reference mark: degree

3.2. Which fluid shows optical activity?

Insert your result in the table 3.2! (3 Marks)

Table 3.2		
fluid sample	yes	no
A		
B		
C		

Confirmation by the lab assistant:

3.3. Measurement of the optical activity at different concentrations (8 Marks)

Table 3.3a		
dilution	concentration [g/100ml]	rotation angle α [degree]
original	50	
original	50	
original	50	
1	25	
1	25	
1	25	
2	12,50	
2	12,50	
2	12,50	
3	6,25	
3	6,25	
3	6,25	

Calculate the mean value and the standard deviation.

Table 3.3b			
dilution	concentration [g/100 ml]	mean value of the rotation angle α [degree]	standard deviation [degree]
original	50		
1	25		
2	12,50		
3	6,25		

3.4. Set up of a calibration graph for the optical rotation**(10 Marks)**

Draw a diagram on a millimeter paper, in which the rotation angles α are plotted in relation to the concentration. Insert this diagram here! Be sure to include mean values, error bars and a line of best fit!

3.5. Determination of the specific rotation angles**(8 Marks)**

Table 3.5			
dilution	concentration [g/100 ml]	specific rotation angle [α] [degree.ml/dm.g]	standard deviation [degree.ml/dm.g]
original	50		
1	25		
2	12,50		
3	6,25		

3.6. Diagram: Specific rotation angle in relation to the concentration (10 Marks)

3.7. Interpretation of the results**(9 Marks)****Tick the appropriate answers for your experiment!**

Table 3.7	Correct	Wrong
The constant function is based on the fact that the specific rotation angle of a substance is independent of the concentration.		
The increase of the concentration leads to smaller values of the specific rotation angle.		
The uncertainties of the measured values arise from inaccurate measurements of the angle.		
The uncertainties of the measured values arise from inaccurate dilutions.		
The uncertainties of the measured values arise from varying intensities of the laser.		
The uncertainties of the measured values arise from the wavelength of the laser.		
The uncertainties of the measured values arise from the measuring process.		
The uncertainties of the measured values can be reduced in drawing a line of best fit.		
The uncertainties of the measured values can be reduced by additional measurements.		

3.8. Determination of the substance**(6 Marks)****3.8.1. The specific rotation angle $[\alpha]$ = degree****3.8.2. Select the substance which has a specific rotation angle closest to your result! Tick the appropriate answers!**

Table 3.8		
material	yes	no
fructose		
glucose		
saccharose		
tartaric acid		
ascorbic acid		

Possible studios of the forgery**(2 Marks)****3.9. Identification of the studio/s**

Possible studio/s of the forgery:

TASK D**1. The investigator team's conclusions**

Which are possible places of origin of the fraudulent painting? Summarize your results as a team in the table "Investigator team's summary" to help you come to a common statement in the table "Conclusion"!

1.1. Fill in "Y" (appropriate statement) or "N" (not applicable/incorrect) in the table.

⇒ *Answer sheet!*

1.2. Indicate your common statement in the table "Investigator team's conclusion" with an "X" in the relevant field!!

⇒ *Answer sheet!*

TASK E**1. Facts about....**

After you finished your individual work, your team will finally have to answer some tricky questions. It might be necessary to discuss each of them.

1.1. Tick the appropriate statements in the table „Facts about....“!

⇒ *Answer sheet!*