

HOW TO GET UNSTUCK: TEACHER GUIDE

Subject: Physical Science or Chemistry

Grade Level: High School, 9th -12th grade. May be adapted for middle or elementary classes.

Case Summary

Conservators must use a wide variety of tools and materials to repair broken pottery. Adhesives and glue are vital components that conservators will use to repair pottery. Understanding the solubility of the adhesive along with the adhesives strength and viscosity can help conservators determine how to repair art objects. Adhesives many times also have to be functional and reversible so that the object can be altered in the future. In this case study, the students are asked to use specific adhesives to adhere broken tiles and then are asked to use specific solvents to remove the adhesive from the tile. A lab report will be written by the student team as a method of assessment.

Credits

This case was written by Shannon K. Watkins (M.Ed., North Paulding High School, Dallas, GA). Author may be contacted at kaitlynwatkins@yahoo.com

This case was adapted from *Solubility of Adhesives lab* (Smith, et al., 2013).
Smith, T., Commander, J., Etre, K., and Stein, R. (2013). *Solubility of Adhesives lab*.
Presented at the Science Behind Art Conservation Teacher Workshop, Emory University, July 8-12, 2013.

Learning Objectives

1. Define the term solubility, solution, solvent, and solute
2. Demonstrate the effect of temperature on solubility
3. Demonstrate the effect of surface area on solubility

Georgia Performance Standards

SPS6. Students will investigate the properties of solutions.

- a. Describe solutions in terms of solute/solvent, conductivity, or concentration
- b. Observe factors affecting the rate a solute dissolves in a specific solvent.
- c. Demonstrate that solubility is related to temperature by constructing a solubility curve.

Assessment

- Student learning will be assessed using both a box chart and a written report from the lab teams. The student lab handout includes the information that is necessary in the written report. The report should include answers to the questions in the lab.
- The students should identify that the students in scene 2 had accidentally used gelatin to glue the tile back together based upon the data that they collected in their lab. Scientific evidence should be given to support their lab report findings.
- The lab and report can be assessed using both the self/group evaluation and the grading rubric given below.
- The students could make a presentation of their findings to the class as another form of assessment.

Self & Group Evaluations

Name: _____ Teacher: _____ Period: _____

Reflect on how you and your group members did at working as a team. Be specific and be fair. Scores range from "0" (unacceptable), "1" (good), "2" (better), "3" (best), "4" (excellent). Place a score for yourself and each of your team members. This will only be read by your teacher so please be honest with your evaluation.

SELF (score): _____

What I did well: _____

What I can improve: _____

Group Members:

(score)

comments

What did your group do well? _____

What can your group do to improve your results for next time? (Be very specific)

1. _____

2. _____

3. _____

Grading Rubric for Lab Assessment

Adhesives Lab Group Paper

1. Correct Grammar, Punctuation, and Spelling _____/20 points
2. Minimum 1 page with 12 Font Times New Roman
Names and Date in right hand corner _____/10 points
3. Answers each question and gives data to support (10 pts each) _____/70 points
 - a. Which glue was dissolved by water?
 - b. Which glue was dissolved by acetone?
 - c. Which glue was dissolved by ethanol?
 - d. Which glue was not dissolved by any solvent?
 - e. Did the temperature of the water speed up or slow down the solubility of the glue?
 - f. Notice the difference in the amount of time or success to reverse good and bad joins.
Do those joins that are uneven, gapped, or stepped respond differently to the solvents used to remove the glue? Why is this a factor?
 - g. Based upon the team's findings from scene 2, which glue did the students probably use and why?

4. Total points for report _____/100 points

Implementation Strategy

Prelab:

- The teacher needs to make the gelatin adhesive ahead of class time and keep it warm. Directions are given in the Teacher guide on how to make gelatin adhesive.
- The case is designed for a two to three class periods on a block schedule. The teacher needs to have purchased all supplies and set up all lab supplies prior to completing the lab.

Day 1:

- The students can be grouped into teams of three students (but teams of two or four also work). The students can be assigned the following roles: leader, recorder, and organizer.
- Scene 1 and the box chart will take about 20 to 30 minutes to complete.
- Scene 2 will take about 10 minutes to read.
- Give the students an opportunity to add items to their first box chart and make adjustments.
- Day one of the lab will take about 30 minutes for students to break the tiles and use the adhesive to glue the tiles together. The tiles need to dry for a minimum of a week.

Day 2:

- Day two testing for solubility should take about 50 minutes to complete.
- The rest of the class period should be dedicated to the student groups completing the assessment lab report.

Day 3:

- The third day should be used for all student groups to complete the written lab report and make sure they have answered all questions about the lab.
- If desired, the students can leave their tiles in the solvent chamber and/or water baths overnight and these tiles (and the joins) can be evaluated first thing.

Example of How to get unstuck - Adhesives Box Chart

Facts – What we know from the scenario, data, or observations	Questions – What we want to ask the characters in the scenario to gather more information (but not things we could look up the answer to)
<p>MCCM conservators have a puzzle.</p> <p>Ancient Greek collector has sent pottery to MCCM to analyze and study.</p> <p>Collector believes incorrect adhesive has been used and could damage the pottery.</p> <p>Conservator has been tasked to determine the adhesive used on the pottery and to take down those joins.</p> <p>Adhesives have different properties that include strength, viscosity, and solubility.</p>	<p>Where did the pottery come from in Greece?</p> <p>How did the collector acquire the specific piece of pottery?</p> <p>How was the pottery originally damaged?</p> <p>Why was the pottery glued back together?</p>
Hypothesis – What we think is going on; possible diagnosis; predictions	Learning Issues – What we need to know to address the problem; Questions we could find the answer to in our texts, on the web, from an expert, etc.
<p>A conservator must pick an appropriate adhesive.</p>	<p>What are the properties of adhesives that the curator needs to consider to make the best adhesives?</p> <p>What are strength, viscosity, and solubility?</p> <p>How does temperature affect glue? (this can be added after reading scene 2.</p> <p>How does solubility affect glue? (this can be added after reading scene 2.</p> <p>Why would a conservator be unlikely to choose any of the three adhesives used in class?</p>

How to Get Unstuck: Scene 1

The conservators at the Michael C. Carlos museum in Atlanta, Georgia have a puzzle to solve. A collector of ancient Greek artifacts has sent the museum curator one of his pieces of ceramic pottery to analyze and study. The collector believes that the piece of pottery has been glued together using an adhesive that will damage the pottery. The museum curator has asked the conservator to determine the type of adhesive used on the Greek pottery and allow it to be taken apart again if necessary. A conservator will use the best adhesive to use on the pottery that will not damage the pottery. The conservator must use an adhesive with distinct properties including strength, viscosity, and solubility to ensure that the pottery will be held together.



Example of an ancient pottery piece

Wine Jug

Greece, 620 BC

MCCM Collection

Session # 1984.001.003

How to get unstuck - Adhesives Box Chart

Facts – What we know from the scenario, data, or observations	Questions – What we want to ask the characters in the scenario to gather more information (but not things we could look up the answer to)
Hypothesis – What we think is going on; possible diagnosis; predictions	Learning Issues – What we need to know to address the problem; Questions we could find the answer to in our texts, on the web, from an expert, etc.

How to Get Unstuck: Scene 2

After reading the information from scene 1 and creating a box chart, the students in Mrs. Watkins' chemistry class are excited to design an experiment to test adhesives to determine which type of adhesive works well on pottery and also which adhesive can be removed easily without damaging the pottery. During the experiment, a student team accidentally glued their ceramic tile using an unknown adhesive. The students were not sure whether they had used the super glue, the Elmer's multi-purpose glue, or the plain gelatin to glue their ceramic tile together.

Student 1: Oh no man!

Student 2: What happened?

Student 1: I forgot which glue I was using to glue the tile together.

Student 2: Oh, that is ok.

Student 1: What do you mean that it is ok. I do not know which glue I used.

Student 2: Well, when we do the second part of the experiment, we can figure out which glue you used by testing the different solvents on the glue to see if the glue dissolves.

Student 1: You mean we can unglue the tile by using a chemical.

Student 2: Have you not been paying attention to Mrs. Watkins?

Student 1: I have been sleeping most days.

Student 2: Mrs. Watkins has been discussing solvents, solutes, and solubility all week. We can use that information along with temperature and surface area to determine which glue you put on the tile.

Student 1: Well what are we waiting for! Lets get to un-gluing some tiles!

After conducting the adhesive experiment, the student group discovered that the acetone and ethanol could not dissolve their glue but the hot water worked the best to dissolve the glue they had used on the tile. The cold water also worked to dissolve the glue but was very slow.

Self & Group Evaluations

Name: _____ Teacher: _____ Period: _____

Reflect on how you and your group members did at working as a team. Be specific and be fair. Scores range from "0" (unacceptable), "1" (good), "2" (better), "3" (best), "4" (excellent).

Place a score for yourself and each of your team members. This will only be read by your teacher so please be honest with your evaluation.

SELF (score): _____

What I did well: _____

What I can improve: _____

Group Members:	(score)	comments
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

What did your group do well? _____

What can your group do to improve your results for next time? (Be very specific)

1. _____

2. _____

3. _____

Grading Rubric for Lab Assessment

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 - g. Based upon the team's findings from scene 2, which glue did the students probably use and why?

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4. **Total points for report** _____/100 points