

Student Guide

Adhesives & Solubility

Introduction:

Adhesives are used to hold all kinds of items and materials together. Objects may be constructed from multiple parts attached by adhesive. Broken fragments may also be re-assembled with adhesives. Adhesives can be natural or synthetic and have distinct properties including strength, viscosity, and solubility. In the conservation repair of art objects, the adhesive must be functional as well as reversible, allowing joins to be altered in the future. It is also often necessary to take apart repaired fragments that have been joined in the past. It is therefore important to conduct solubility tests in order to know which solvents will dissolve the adhesive without altering the original object or materials.

Objectives:

- Define solubility
- Demonstrate the effect of temperature on solubility
- Demonstrate the effect of surface area on solubility

Supplies:

100 mL beaker or jar with lid
Water, hot and cold
Mineral Spirits
Acetone
Super Glue GEL
Gorilla Glue
Gelatin (plain, unflavored)
Permanent marker
Plastic containers (large enough for one tile)
Thin tipped paint brushes
Droppers
Ceramic tiles
Large plastic zip-lock bags
Small glass jars or beakers
Hammers

NOTE: Gelatin, Superglue, and Gorilla Glue are NOT recommended for or used in the conservation repair of ceramics. These adhesives have been chosen for this activity because they are non-toxic, inexpensive, readily available, and demonstrate different solubilities.

Safety:

Acetone should be used under a fume hood. Gloves and goggles should be worn at all time, especially when handling Super Glue GEL.

Procedures:

Week 1

Preparing the tiles:

(Each student group will prepare three tiles: one repaired with each of the three adhesives.)

1. Break each tile into at least four pieces. Place individual tiles into transparent plastic bags. Working on a hard surface, hit the tiles with a hammer to create enough broken pieces.
2. Glue pieces of each tile together, using one adhesive per tile. Use a thin paint brush or the applicator tips to apply adhesive along the break edges. Also thinly smear a small amount of the adhesive on the surface of each piece of the tile. Be sure that the same adhesive is used for joining and smearing on one tile. Note: Before applying Gorilla Glue, the break edges and smear locations must be brushed with water first.
3. Label each tile: #1 gelatin, #2 Gorilla Glue, and #3 Superglue GEL.
4. Allow the tiles to dry for at least 1 week.

Week 2

Testing the solubility of the adhesives:

1. Draw one tile on the worksheet. Examine your joins and note your observations.
2. With a marker, label one smear on each tile with each of the solvents:
A – acetone, HW – hot water, CW – cold water, MS – Mineral spirits.
3. Using a dropper, apply a small drop of each solvent (acetone, cold water, hot water, mineral spirits) onto the corresponding surface smears. Apply only one solvent per smear. Be sure to apply all solvents to each of the three tiles.
4. Allow the solvent drops to sit at least 5 minutes.
5. Blot off remaining solvent with wipe or paper towel.
6. Test whether the smears are tacky by touching each smear with a gloved finger or a wipe. Note your observations.
7. Based on your observations, propose which solvent will solubilize each adhesive.
8. Expose the joins to the selected solvents. Using a dropper, apply a drop of the selected solvent onto the joins on one tile. The solvent will flow into the cracks. Repeat on other two tiles with the selected solvent for each.
9. Allow the solvent drops to sit for at least 5 minutes.

10. Blot off remaining solvent.

11. Carefully pick up each tile and observe whether joints are loose. Gently manipulate the pieces to see if any move or can be separated. Note your observations.

Steps 7-10 could be repeated to experience the effect of longer contact between solvent and adhesive.

Optional: Continue with steps 11-13 to experience the effect of more solvent action.

12. Expose the tiles to the selected solvent. Tiles may be completely submerged in hot or cold water in a plastic container. For acetone and mineral spirits, create a vapor chamber by enclosing the repaired tile and a small open container of the selected solvent in a sealed bag.

13. Allow the tiles to be exposed for at least 10 minutes.

14. Carefully remove the tiles and check the joints. Have any of the pieces separated or loosened? Are the effected joints the ones that have excess adhesive, gaps, or uneven alignment? Note your observations.

Steps 11-13 could be repeated to separate more joints.

Clean up:

Clean brushes. Properly dispose of solvents. Prepared glues may be stored in sealed containers.

Student Name _____ Date _____ Period _____

**Adhesives & Solubility
Answer Sheet**

1. Examine your joins.

Each student should draw one tile, indicating the joins. Did the pieces stick together? Are the joins level? Is there excess adhesive within or along the cracks? Are there gaps between the pieces? Mark uneven areas with S, excess adhesive with A, and gaps with G.

Do you think your repairs would be appropriate for a valuable old pot? Why or Why not?

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2. Test whether the smears are tacky. When the adhesives are solubilized they will become tacky.

Indicate "S" for soluble, "SS" for slightly soluble, and "I" for insoluble:

| | Acetone | Hot Water | Cold Water | Mineral Spirits |
|--------------------------|---------|-----------|------------|-----------------|
| TILE #1 (gelatin) | | | | |
| TILE #2 (Gorilla Glue) | | | | |
| TILE #3 (Super glue GEL) | | | | |

3. Based on your observations above, propose which solvent will best solubilize each adhesive.

Gelatin _____

Gorilla Glue _____

Superglue GEL _____

4. Note the effect of placing the solvents directly onto the repaired cracks.

Did any pieces separate? Did any pieces move or come apart with gentle manipulation?

Referencing your drawings, consider if the loose joins are the ones that had excess adhesive, gaps, or uneven alignment?

5. Note the effect of placing the tiles directly into the solvent baths and chambers.

Did any pieces separate? Did any pieces move or come apart with gentle manipulation?

Referencing your drawings, consider if the loose joins the ones that had excess adhesive, gaps, or uneven alignment?

6. Why might it be easier for the joints with gaps and uneven alignment to separate following solvent exposure?

7. Based on this exercise, list at least three factors that affect solubility:

1. _____

2. _____

3. _____