

Teaching The Scientific Method Using Adhesives

Developers

Ileen Green
Samson Freedman School
Philadelphia, PA

Kathleen Hughes
Judy Whitmire
Angela Campbell
Rohm and Haas Company
Spring House, PA

Discipline:

Middle School (6-7-8)

Goals:

General Science - Basic Teaching of the Scientific Method – Science Fair Projects

1. Students will learn the six step scientific method through experimentation.
2. Students will display knowledge of adhesives used in daily life and be able to measure the differences in adhesives based on testing for tack, shear, and peel.
3. Students will enhance their research skills.

Specific Objectives:

1. Students will learn testing procedures used in an industrial laboratory.
2. Researching information
3. History of adhesives
4. How to collect data using skills in mathematics
5. Charting and graphing skills (Teacher to do with the class with comparing group activities).
6. The difference between a chemical and physical change

Background:

Steps of the Scientific Method

1. Identify the problem and state it carefully.
2. Collect as much information as possible about the problem.
3. State a Hypothesis.
4. Test the Hypothesis.
5. Draw conclusions about the Hypothesis.
6. Report the conclusions so other scientists can test the Hypothesis.

Testing Adhesives - Glossary

Tack Enables an adhesive to form a bond with another surface under light pressure (How sticky is an adhesive?)
Shear How strong is an adhesive?
Peel How strong is the adhesive bond when the material bearing the adhesive is peeled away by force?

Materials

Rulers, plastic bags, pennies, spring scale, inclined plane or ramp, marbles, cardboard, hole puncher, stapler, weight

Materials to Test:

Band-aids®, masking tape, cellophane tape, first aid tape, packing tape, electrical tape, Post-It® notes

Prodedure:

1. Student is to write clear statement of problem - Do as a class with teacher guidance - Are some adhesives stickier than others?
2. Collect as much information as possible about the problem - Divide the students into groups to report on:
 - a) History of Adhesives (include biographies on Wallace Hume Carothers; Leo Hendric Baekeland; John Hyatt).
 - b) Types of Adhesives.
 - c) Uses of Adhesives.
 - d) Properties of Adhesives.
 - e) Tests for Adhesives (Tack, Shear, Peel).
3. State the Hypothesis - Define Hypothesis - Give materials (various tapes) to them and let them decide stickiest to least sticky.
4. Test the Hypothesis - each group to do one test only for tack, shear or peel - Tests described in attached sheet Testing Procedures for Adhesives.
5. Draw Conclusions - Have group draw conclusions based on testing.
6. Report the Conclusions - Groups cooperate to make one report - They divide the report and present orally to class - Reports are displayed.

Extensions:

1. Students can add materials to be tested.
2. Students can put materials in baggies and place in freezer to see what effect cold has on the adhesive.
3. Students can use lamps or hair dryer to heat the adhesive and then retest.
4. Students can use water to wet adhesives and then retest(chemical vs. physical change).
5. Students can make their own adhesives using skimmed milk and vinegar.

Testing Procedures For Adhesives

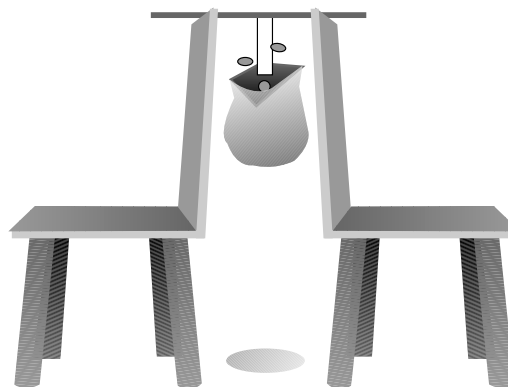
Tack

There are four tests scientists use to see how sticky an adhesive is. Choose only one for your experimentation.

1. **Polyken Probe Tack Test** - This test is done on equipment sometimes referred to as the “mechanical finger.” We can come to the same conclusions by using everyday materials.

Steps

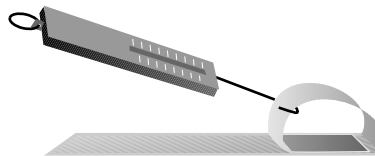
- a) Place two chairs of the same height back to back, 6" apart.
- b) Place the ruler in the center across the backs of both chairs.
- c) Cut a 6" piece of tape.
- d) Tape 2" of the tape to a plastic bag so that the bag hangs open when you hold the top of the tape.
- e) Tape 1" of the other end of the tape to the center of the ruler so the bag hangs down.
- f) Drop in pennies one at a time until the bag falls.
- g) Write number of pennies on data sheet and repeat experiment for each tape.



2. *Loop*

Steps

- Cut 10" piece of each tape.
- Attach the tape to the tabletop from left to right with the adhesive side down.
- Lift the tape from the right side to form a 2" loop.
- Attach a spring scale to the loop and with one hand, pull it back towards your left 2".
- Take a reading on the scale, and write it on your data sheet. Repeat experiment for each tape.



3. *Qualitative*

Steps

- Cut 6" piece of each tape, and place each one on the table side by side with adhesive side up.
- Have each member of the group feel each adhesive.
- Put the tapes in order from most sticky to least sticky.
- Put results on your data sheet.

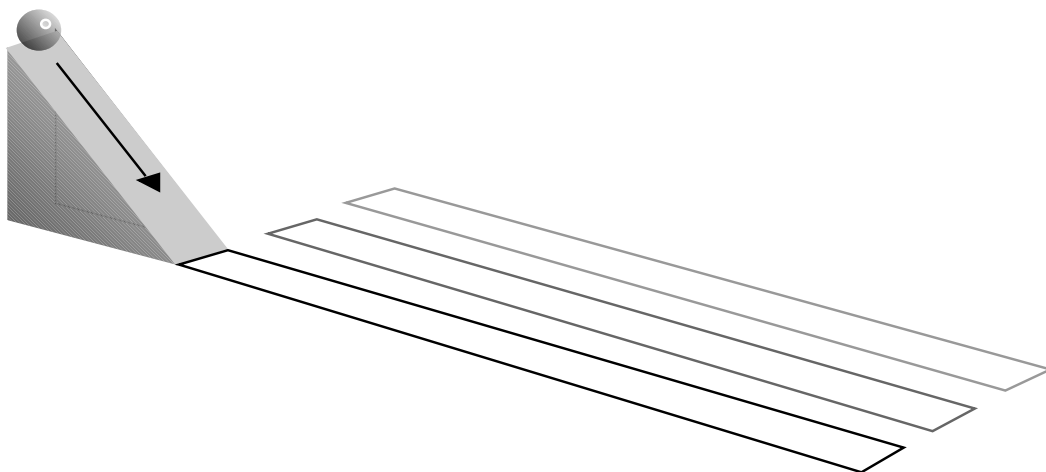
4. *Rolling Ball*

Steps

- Cut 10" piece of each tape.
- Place each tape on the table from left to right with the adhesive side up.
- Place the ramp on the right of the tape so the incline faces the tape.
- Roll the marble down the ramp by releasing and not pushing.
- Measure the distance from the end of the ramp to the marble.
- Repeat this step three times on each tape and use an average to get your result. Clean the marble between tests with rubbing alcohol.

$$\frac{a+b+c}{3} = \text{results}$$

- Put your results on your data sheet.

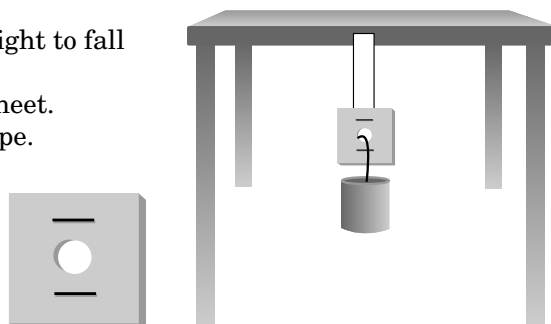


Shear

Use this test to determine how strong the adhesive is. Use cardboard 1" squares with a hole punched in the center and a staple above and below the hole to prevent tearing of the cardboard.

Steps

- a) Cut a 5" piece of tape.
 - b) Attach the 1" cardboard square to one end of the tape by putting 1" of the tape across the square over the staples and the hole. Repunch the hole.
 - c) Tape the other end (1/2") to the side of a tabletop. Place foam rubber or polyurethane (or a pillow) under the tape to prevent damage to the floor by the weight.
 - d) Place a 1 kg weight through the hole in the cardboard, and let it hang.
 - e) Time how long it takes the weight to fall when the tape releases.
 - f) Enter the time on your data sheet.
- Repeat experiment for each tape.



Peel

Use this test to determine how strong the adhesive is when it is peeled away by force. Various materials may be used such as plastic, cardboard, glass, and wood.

Steps

- a) Place 10" strip of tape adhesive side down on the material which is lying on the tabletop.
- b) Roll a rolling pin one time over the tape.
- c) Repeat this for each tape.
- d) Lift each tape off of the tabletop to determine which is stronger.
- e) Put the tapes in order from strongest to least strong.
- f) Put your results on your data sheet.

Making Your Own Adhesive

Slowly heat 1 cup of skim milk with 2 tablespoons of white vinegar. Keep stirring until the mixture thickens and lumps form. Take it off the stove. Keep stirring as long as lumps are forming. The lumps called curds are casein. Strain them out and throw away the liquid. Now you can use the curds to make a plastic. The plastic you make from casein is liquid. It's so sticky you can make glue from it. Put the curds in a jar. Add 2 tablespoons of water and 1/2 teaspoon of baking soda. The mixture bubbles and changes into a gooey white liquid (glue). Paste two sheets of paper together to test the glue. Let it dry. The glue is strong.

Adapted from: Science Fun with a Homemade Chemistry Set

Author: Rose Wyler

Publisher: Simon & Schuster Inc., New York, 1987

DATA SHEET

	Material A _____	Material B _____	Material C _____	Material D _____	Material E _____	Other Material Optional Name _____	Other Material Optional Name _____
TACK (use only 1 test) <i>Polyken Probe</i> # of pennies							
<i>Loop</i> Reading on spring scale							
<i>Qualitative</i> Most sticky to least sticky use 1=most sticky to 5= least sticky							
<i>Rolling Ball</i> Measure in inches							
SHEAR Minutes to fall							
PEEL Strongest to least strong Use 1= strongest to 5= least strong							
OPTIONAL TESTING							
OPTIONAL TESTING							
OPTIONAL TESTING							

References

Plitt, Karl F. Adhesives for Everyday Use. A Consumers Guide from the National Bureau of Standards Series 3. Washington, DC: U.S. Commerce Department, 1970

Brann, Donald R. Complete Guide to Glueing, Briarcliff Manor, NJ: Directions Simplified, Inc. 1962

Daniels George. Glue and Adhesives. New York: Harper and Row, 1979.

Green, Carla. Let's Meet the Chemist. New York: Harvey House, Inc., 1966.

Whyman, Kathryn. Chemical Changes. New York: Gloucester Press, 1986

Wyler, Rose. Science Fun with a Homemade Chemistry Set. New York: Simon and Schuster, Inc. 1987

Kohn, Bernice. The Scientific Method. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1964.

Ruchlis, Hy. Discovering the Scientific Method. New York: Harper and Row, 1963

Moorman, Thomas. How to Make Your Science Project Scientific. New York: Atheneum, 1979.

Stepp, Ann. Setting Up A Science Project. Englewood Cliffs, NJ: Prentice-Hall, 1966.

Webster, David. How to do a Science Project. New York: Franklin Watts, 1974

Kessler, James H. Wonder Science, Vol. 4, Number 1. American Chemical Society/American Institute of Physics, January 1990.

Strongly advise students to use encyclopedias as that is where the majority of information is contained. Have them look up: Adhesives, Polymerization, Glue, Resins, Plastics