Sticking Together: Adhesion and How it Works

In this activity students will examine the stickiness of different kinds of tape. At the end of this activity students should be able to determine how well and which tapes should be used to hold materials on a wall due to its adhesive properties.

Objective

- Students will test the adhesive force of different sticky tapes, take measurements, record data and report their findings. Students will also conduct research into topics related to adhesives and product testing. The students would learn about how scientists often look to nature to invent products that are useful in our lives and how the usefulness of a product is contingent on its function for a particular purpose and can be connected to nature.
- By the end of this students will understand the importance of the global context of research and collaboration when making advancements and developing a deeper understanding of science.
    - Juniors from three Philadelphia, PA highschools (Paul Robeson High School. South Philadelphia High School and Thomas A. Edison High School) and Upper Secondary School students from three Florence, Italy high schools (International School of Florence, Lycee Victor Hugo, and Public School High School Niccolo Machiavelli) will compare their data and reported findings.
        - Students will find similarities and differences in the adhesion force data that they complete for the different tapes and brainstorm reasons for the irregularities in the data and ways to create consistency in the data globally.
- Students will answer the following:
        - How are tapes alike? How are tapes different? Will they all serve the function and have the ability to hold up the decorations? Are they made out of the same materials? Do they all have the same stickiness?
- Students will be able to differentiate between shear force and peel force

Powerpoint presentation link for students:

https://docs.google.com/presentation/d/1pw4nlK0yo2HXb_lAxx4_2eoFagLVFYjUobisa2d4E_w/edit?usp=sharing

Materials

Tapes to display in the opener and for testing: masking tape, clear packing tape, painters tape, and electrical tape

Testing track: marbles, measuring tape, books or blocks (for ramp), board approx. 12 in. by 24 in.

Graphing paper

Assignment Overview Given to Students

Engagement

- Before the school dance, the committee is in a rush to finish hanging decorations in the main hallway. While working on the job a committee member noticed that they were running out of tape to finish the job so they called the other members to help find more tape in order to finish decorating. The team returned with a variety of different tapes including masking tape, duct tape, clear packing tape, medical bandage tape, painters tape, and electrical tape. The group wishes to know the adhesive properties of these tapes so that the decorations would not fall down before the dance.
    - It is the students task to examine the stickiness of different kinds of tape and determine how well and which tapes should be used to hold materials on a wall due to its adhesive properties.

Demonstration

How to set up the equipment to make the apparatus for testing the stickiness

- https://youtu.be/mYDCSIVxTGI

Questions

- After completing the activity and recording the data students from each school will submit the data of the adhesive force recorded for the 6 tapes, and submit which tape they recorded to be the strongest.
    - All of their data will be compiled into an excel sheet where all students will be asked to make conclusions on their data and identify trends and inconsistencies in the data. Students will be asked to evaluate the importance of the data and the activity.
- Questions to be asked…
    - What surprised you about the data overall?
    - Did your data support your predictions?
    - Which tape was the stickiest in this test?
    - Which tape was least sticky in this test?

Elaboration

Adhesion in nature - highlight how scientists and engineers look at nature to help invent products that will be useful in our lives when creating a biologically-inspired design.

- Geckos

    - The hundreds of tiny microscopic hairs on Geckos bulbous toes allows them to stick to a variety of surfaces. To create a bond that is strong between their feet and the surface.
    - Researchers have been developing synthetic adhesives that are designed to mimic the bristly gecko toes. The gecko's setae are self-cleaning so that they have the ability to cling to surfaces over and over again. Will addresshow gecko-inspired adhesive tapes have great functionality since they are dry, reusable, not time-sensitive and can work in a vacuum (for space applications)
    - Video
        - https://youtu.be/qSMZkc4kw6U

Application

- Tests to see what surfaces the manufacturer has determined that the tape be used on effectively
    - Peel force: pulls in a direction perpendicular to the surface
    - Shear force: pulls parallel to the surface
- Want to tape an item to a wall → tape with a strong shear force
- Easily remove painters' tape in a home decorating job → low peel strength
- Post -it Notes
    - Moderate shear strength → won't fall off the bulletin board
    - Low peel strength → easily removed

Content Knowledge

- Shear force and peel force are the two kinds of forces that tend to break the bond between an adhesive and a surface. Shear force pulls parallel to the surface while peel force pulls in a direction perpendicular to the surface
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Safety

- Make sure that students dispose of all testing tapes in the wastebaskets and mind students to use all materials for their intended purpose

Procedure

** Experiment to be completed in pairs

Part 1: Setting up the testing board (materials needed: tape measure or ruler, permanent marker, testing board)

1. Lay testing board (approx. 12” x 24”) on a flat surface
2. Place the tape measure or ruler parallel to one edge of the board, making sure to align the "0 inch" mark with one end.
3. Using a ruler, place marks on the board every ½ inch on the entire length of the board
    a. Make sure to keep the ruler straight
4. Using a permanent marker, write down the corresponding distance that each mark represents ex. (0", 1⁄2", 1", 1 1⁄2", etc.).

Part 2: Attaching the testing tape to the board (materials needed: testing board, various kinds of tapes, scissors, stack of books to elevate the board)

1. Elevate the testing board using a stack of books
2. Make sure that there are roughly 4 inches on each sides that extend beyond the board
3. Extend a piece of tapes all the way across the board and extend for an extra 4-5 inches past the board.
4. Cut this piece of tape and make sure that it is laying face-up across the length of the board
5. Attach one of the short pieces of tape from Step 2 face-down onto one end of the long tape (make sure to keep about half of the sticky side of the short tape exposed). Secure the end of the long tape to the board by wrapping it around the end of the board and fastening it to the bottom of the board
6. Repeat step 5 using the second piece of short tape to attach to the other end of the long tape
7. Make sure that the adhesive (sticky side) of the tape is extended face up and level along the entire length of the board
8. Reapt steps 2-5 for additional tapes

Part 3: Testing the tapes (materials needed: marbles, computer)

*The further that the marble rolls down, the weaker the tape is

1. Open the google form and input which tape you and your believe will be the stickiest and how far you predict that the marble will run down the test track
2. Plave the marble at the 0 inch mark
3. The marble test should be repeated 3 times for each tape, at each elevation
4. Record the distance of the marble after each test, find the average distance
5. Input the data into the google form
    a. https://forms.gle/9RGjb8f1n5KkTGVw8

Data Collection

Have students input and submit data into google form

- https://forms.gle/9RGjb8f1n5KkTGVw8

IMP: Make sure the students understand that the farther the marble rolls down the testing tape, the weaker the tape is. **

References

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The University of Akron, Ohio. "Adhesives How Sticky Is Your Tape." *The University of Akron, Ohio*, 24 Oct. 2016, www.uakron.edu/polymer/agpa-k12outreach/lesson-plans/adhesives-how-sticky-is-your-tape.

*Idea developed from The University of Akron