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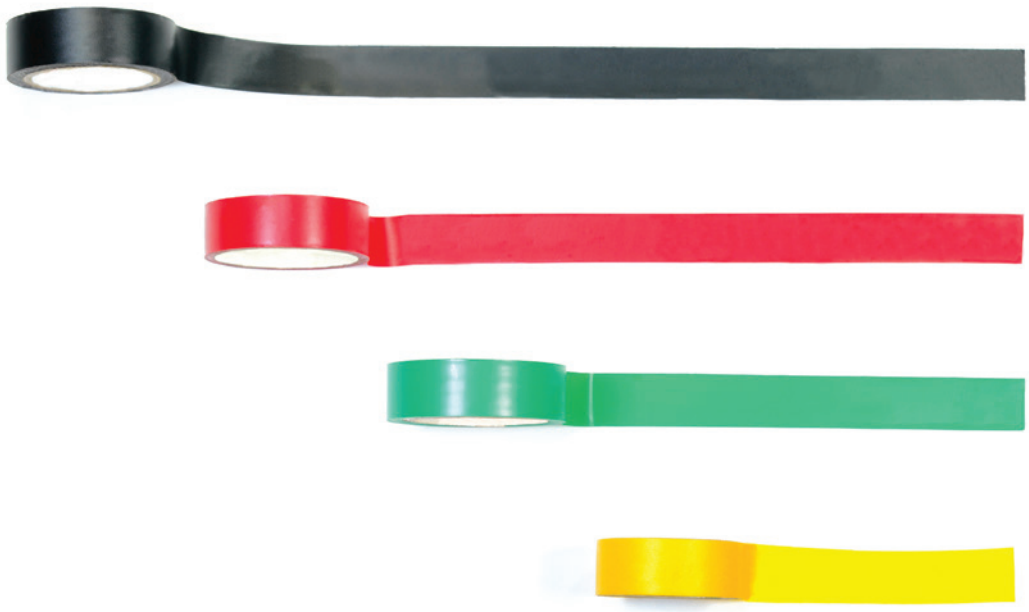
Sticky Buisness

Read the article about the science of sticky stuff:

https://education.australiascience.tv/sticky-business

In this, we learn about why substances are sticky.



Activity.

This article explained the science of why things are sticky. In this activity, you will be a scientist testing the tackiness of different tapes. Adhesive scientists around the world use tests just like this!

We can describe stickiness in different ways. As you have already learned, adhesion describes how strongly the tape and the surface bond to each other. Cohesion describes how strongly the adhesive molecules on the tape attract and hold on to each other. Tack describes how quickly a bond forms between the tape and the surface.

Scientists customise tapes for specific uses by balancing adhesion, cohesion, and tack. For example, high-tack tape sticks quickly to a surface, but it may be difficult to move later.

How can we measure how sticky an adhesive tape is? This question is more complicated than it seems!

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Apparatus.

- Roller Ball Test Track
- Ruler
- Scissors for cutting tape
- Marble, ball bearing
- Book/Blocks
- Several different kinds/brands of tape, such as duct tape, masking tape, cellophane tape, or packing tape, etc.
- Protractor or smartphone app to measure angle of ramp
- Wipes to clean the test marble
- Cloth/rag to dry marble
- Measuring tape
- A4 piece of cardboard
- Cardboard tube (cut in half lengthways)

Method.

1. Use a rolling ball test track (see Fig 2) or build your own ramp following steps 2 and 3 below.
2. The ball needs to roll easily down the incline. Make an incline out of A4 cardboard folded lengthways into a 'V' shape or a carboard tube from a roll of paper towels.
3. Make a test tape surface by securing a 30cm strip of tape (sticky side up) to the work bench or the inside of a cardboard tube (cut in half lengthways) to create a trough. The sticky surface should begin at the lower end of the incline. Repeat for each type of tape tested.

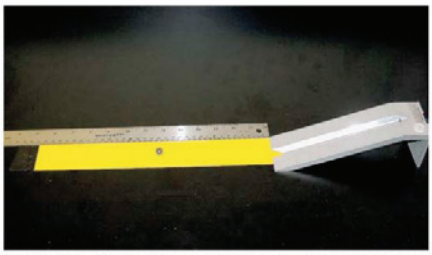


Figure 2. Rolling ball test apparatus and specimen showing distance of roll that is measured.

4. Place the ramp on the right of the tape so the incline faces the tape. Use books or blocks to raise one end of the incline until the slope is about 10°. Use a protractor or smartphone app (such as Protractor+) to measure the angle. There should be little to no drop between the incline and the start of the test tape surface.

NB: Ensure you perform a 0° (control) elevation before adjusting the incline.

5. Mark the ball's starting point at the top of the incline with a pencil or sticky tab. It is important to release the ball at the same point for each test.
6. Roll the ball down the ramp by releasing and not pushing. Allow it to roll down the incline onto the test tape surface.
7. Measure the distance from the end of the ramp to the point where the ball stops, enter this distance into your data table.
8. Repeat the trial a minimum of three times for each type/brand of tape. Clean and dry the ball after each trial. You also need to use a new piece of tape each time you repeat the test.

What did you observe?

Table of results:
Complete the data table for each type of tape tested.

Type of tape	Angle	Predicted Distance Rolled (cm)	First Distance (cm)	Second Distance (cm)	Third Distance (cm)	Average Distance (cm)
Cellophane	0°					

Evaluation

What surprised you most about the results?

Did your data support your predictions?

Does a high-tack tape let the ball roll a short or a long distance?

Based on your measurements, which tape had the highest tack? Explain your answer.

Did the same tape have the highest tack for all the different balls/masses you rolled?

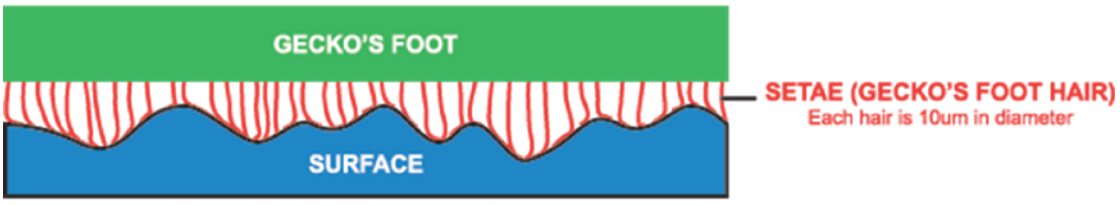
The theory.

Pressure-sensitive adhesive tapes are coated with an adhesive made of large molecules called polymers. Pressing the tape on a surface causes these large polymers to spread out. The spread-out adhesive now interacts and bonds with the surface, causing the tape to stick.
The tack of a tape depends on how easily the adhesive can spread out and interact with the surface.

Adhesion in Nature
Scientists and engineers look to nature to invent products that are useful in our lives. They call their work biologically inspired design. Geckos can stick to surfaces without any liquid and the bond is strong between their feet and the surface. The microscopic hairs (setae) on its feet can bend to fill in the uneven spaces on a surface (see diagram below), resulting in a very strong adhesive force.

But this adhesive force releases easily when the gecko lifts its foot. Generally, the stronger the adhesive, the harder it is to keep clean (have you ever used a piece of packing tape to take lint or pet hairs off your clothing?).
The gecko's setae are self-cleaning, so they cling repeatedly. Gecko-inspired adhesive tapes, have great functionality. They are dry, reusable (unlike most commonly available tapes), not time-sensitive (they will stick indefinitely, unlike cellophane tape which gets brittle over time), and work in a vacuum (applications for use in the space program).

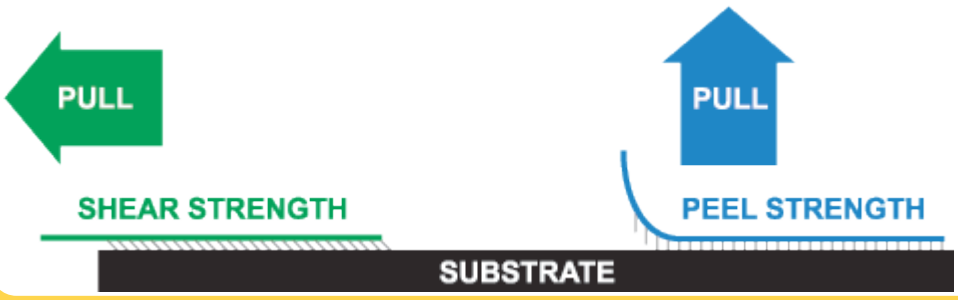
GECKO ADHESION DIAGRAM



(diagram viewed at 400 times magnification)

The gecko foot has thousands of microscopic hairs called setae which further divide into hundreds of smaller hairs called spatula. When the gecko puts its foot on any surface those hairs bend and take the configuration of the surface, thus allowing a very large area of contact. This bending helps in translating weak van der Waals force interactions into tremendous adhesive forces. The above diagram shows how these hairs bend and take the configuration of the substrate.

Adhesion forces
There are 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 (see diagram below). If you want to tape an item to a wall, you will choose a tape with a strong shear force. If you choose painters' tape in your home decorating job, you will want to easily remove the tape after painting, so the tape should have low peel strength. Post-it Notes™ should have moderate shear strength so they won't fall off your bulletin board and low peel strength so that they can be easily removed.



Want more?.

Manufacturers of the tape would have to test other materials adherence to the tape before marketing the tape as effective on wood, plastic, paper, and other surfaces.

1. Read the label of the tapes chosen for the class tests. Find out what surfaces the manufacturer has determined that the tape should be used on effectively.

How do you think these surfaces were determined?

2. Explore more variables:

- Try rolling balls made of different materials/surface textures e.g., plastic, wood, glass, metal (golf ball, ping pong, tennis ball, marble, ball bearing etc)

How does the roughness of the ball affect how quickly (distance ball travelled) a tape will stick?

What happens to the tack of the tape if you reuse it for several tests?

Did you observe any differences on the tape surface?

- Try rolling balls with different masses.

If you roll a heavy ball and a light ball down the tape, which one do you think exerts more pressure?

How did the mass of the ball affect how far it rolled on the tape?

3. Watch Adhesion tests in industry: https://youtu.be/z5dUBC7Iruw
4. Learn how to make edible slime: https://youtu.be/n2Zh0YCr81Y

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YEAR	LINKED TO SCIENCE AS A HUMAN ENDEAVOUR	CURRICULUM CODE
Yr 7	**Nature and development of science**	
	1. Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available.	ACSHE119
	Use and influence of science	
	2. People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity. **a.** *performance.*	ACSHE121
Yr 8	**Nature and development of science**	
	1. Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available.	ACSHE134
	2. Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures.	ACSHE226
	Use and influence of science	
	3. People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity.	ACSHE136
Yr 9	**Nature and development of science**	
	1. Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries.	ACSHE158
	Use and influence of science	
	1. People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities.	ACSHE160
	2. Values and needs of contemporary society can influence the focus of scientific research.	ACSHE228
Yr 10	**Nature and development of science**	
	1. Scientific understanding, including models and theories, is contestable and is refined over time through a process of review by the scientific community.	ACSHE191
	2. Advances in scientific understanding often rely on technological advances and are often linked to scientific discoveries.	ACSHE192
	Use and influence of science	
	1. People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities.	ACSHE194