Adhesives – Teacher Notes

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Introduction:

We see claims all the time that manufacturers make about their products. In this investigation, we will examine the packets of Blu-Tack and white tack, and put any marketing claims to the test! This investigation is simple, inexpensive and a great way to teach students the scientific method. While a basic framework is provided, students will have to think hard about how to conduct a fair-test.

This investigation has two parts. The first is at a prescribed level, while the second is at a guided open-inquiry level because students must write their own method and choose how to record and analyse their results. Various points for class discussion are suggested so that students are exposed to scientific theories that underpin their investigation, such as whether "stickiness" is a physical or chemical property.

Discussing the topics of material composition and adhesives will allow students to understand how these materials make our lives better in so many ways. Students will also see how associated industries stay innovative by working collaboratively with research scientists.

Question:

For **Part A**, the question has been set for students: *"To which surface does Blu-Tack stick best, wood or plastic?"* **Part B** gives students an objective to follow which is to compare two different types of adhesive tack. Students must write an Aim and Hypothesis for each part.

If teachers would like to include an examination of the product's marketing claims, then students should be provided with packaging. Students are advised to identify any claims, such as the tack being 'reusable', how it 'won't dry out' and can 'pick up dirt". Students can incorporate what they find in their predictions. If any claim is associated with the question, than they can also include 'testing this claim' in their Aim.

Plan:

Materials: Blu-Tack is the commercial name of a "reusable" adhesive made by Bostik. Other similar products can be used. Icy pole stick, paddle pop stick, and popsicle stick are alternate names for flat pieces of wood about 12cm long, 1cm wide, and 2mm thick. Any similar product can be used as the important thing is that they are uniform.

Safety: Provide students with a spongy mat to place below their apparatus in order to protect the table from any damage, and ensure students are keeping their fingers away from any falling weights.

Part A: Students are provided with a materials list. They are then instructed to read through the instructions and see what additional steps could be taken to make the experiment a fair-test. This is to prepare students for Part B, where they must devise a method from scratch. If required, students can set-up the equipment and perform practise tests to help them brain-storm. A good step is to identify the variables. Examples are provided below:

- **Independent Variable:** stick material
- **Dependent Variable:** shear strength

- **Controlled Variables:** amount of Blu-Tack used, whether the tack was manipulated by hand prior, pressure applied when sticking the tack, time taken for tack to set, time taken to release weight, temperature and humidity of the room.

There are many controlled variables that would have a significant effect on the results. Students will need to think of how they will control for them. For example, students can use a stop-watch to time certain processes. Another example is, instead of applying pressure by hand, students can set the sticks down on the table and put a heavy weight on top of the joint for an allocated time (i.e. 2 kilo kettle ball for 5 seconds).

Part B: Students will have to devise their own procedure for testing and comparing the competitor brand of adhesive tack. If students have thought hard about ways to improve the experiment in Part A, then they can easily transfer the same practises over when testing the different brand of adhesive tack. It would be beneficial if students tested the different tack on all three stick types, as the competitor tack may be better in some areas and not in others.

Extension activity: Adhesives are special polymers (long chain molecules) with sticky properties. Make your own adhesive with the proteins found in milk, vinegar and baking soda. First warm milk and add vinegar. This creates a chemical reaction which separates the milk into curds (casein) and liquid whey. Collect the curds and strain them. Then add the baking soda to neutralise the vinegar. This causes an acid and base chemical reaction, and it liquefies the curd enough to form a paste. Now students can explore what this glue can and can't hold together.

Conduct:

Students can commence the experiment once they have thought-out what their method is going to be. A results table is provided in Part A. A similar table can be used for Part B, or students may wish to make their own.

Students can be guided to make additional observations and record qualitative results. Allow students time to manipulate the Blu-Tack and the competitor tack with their hands and note any sensations and observations. Stretching the tack will show how the material acts while being stressed.

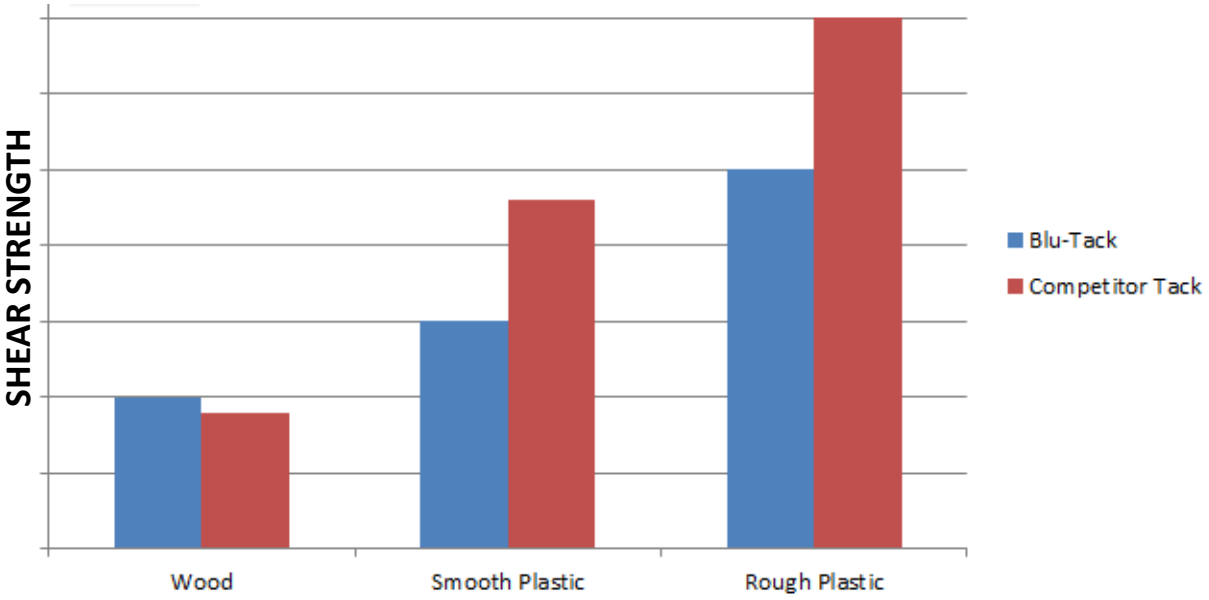
If time allows, students can compare joints made with manipulated tack versus joints made with tack that has been sitting idle. Additionally, students can set a joint and leave it overnight. They can then compare the shear strength of this joint compared to joints that have just been set.

High speed video camera can be set up to record the point of failure. By playing it back in slow motion, students will be able to see exactly how the failure occurs and be more likely to pinpoint the forces at play.

Extension: Does the temperature have an effect on shear strength? Provide students with hair-dryers and coolers containing ice so that they can test the shear strength of Blu-Tack and other tack adhesives while being put under these extremes.

Analyse:

For Part B, students are asked to express their results graphically. Students can use the plot paper to draw a bar graph, comparing results for the Blu-Tack with the results for the white-tack. By doing this, it will become obvious which adhesive tack is superior for a glued joint. Example is provided below:



Extension: Students can be asked to make a graph in excel to present to a board meeting. Because they want to convince the board members to switch from one product to another, they must try to make the graph colourful and visually appealing.

Problem-Solving:

Evaluate: At this stage students can evaluate whether their experimental design was satisfactory. Did they test the correct things in order to obtain an answer to their question? Did they conduct a fair-test? Did students identify the main control variables, and were they able to implement strategies to keep them consistent throughout? Where there any forms of human error? Discuss these issues with students as they assess the reliability of their results.

Apply key ideas: Students can refer to their drawings on what the tack looked like at point of failure. Did the tack break apart so that both sticks were left with residual tack? This would mean that the failure was with the tack's **cohesion** (binding force between two of the same materials).Was the tack ripped off one stick completely? This would mean that the failure was with its **adhesion** (binding force between two different materials). It is possible that both cases were seen, depending on the various stick surfaces.

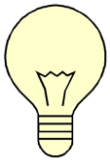
Real-world problem: Often when you sign a lease to a rental property, the contract will state that you are not allowed to use Blu-Tack, or other tack materials. Students can be asked why this is the case? This is because if the adhesive force is stronger than the cohesive force when pulling the Blu-Tack off the wall, then the wall paint can be stripped off as well.

What is Blu-Tack? Blu-tack is a 'pressure-sensitive' adhesive. It acts like a liquid with very high viscosity and has elastic characteristics. The technical term for this is '**viscoelastic**'.

Similar to a liquid, Blu-Tack will slightly 'wet' a surface that it is pressed onto. Students may have noticed this on their fingers when playing with the Blu-Tack. It is this property which allows Blu-Tack to move efficiently into the tiny crevices that form the texture of the surface. It creates a strong grip, as witnessed when sandpaper is used to make a surface more rough.

Blu-Tack is also very elastic and resists separation when stressed (being pulled apart). These inherent properties of a 'sticky' or 'tacky' polymer are physical and not chemical.[i]

Is Blu-Tack a liquid or a solid? Blu-Tack is what is called a non-Newtonian fluid, which behaves as a liquid and a solid under different conditions, such as when stress and force are applied. This gives Blu-Tack unusual properties, such as being able to be moulded into various shapes, as well as shattering when hit with a hammer after being left out. This can make an interesting class demonstration.



In the kitchen: We use non-Newtonian fluids all the time. When corn-starch is added to water and other ingredients and continuously stirred it thickens the mixture and makes a sauce. But, it takes effort as you can't stop stirring the pot!

STEM application: One of the stickiest 'viscoelastic' materials known to man has been created by mother-nature! Frogs actually have very sticky saliva, which allows them to grab their prey (insects) with tremendous speed and accuracy. See what scientists are researching in order to advance technology in this interesting video here:

https://www.youtube.com/watch?v=cFWIrfzYVV0

Conclusion:

In this section students will be able to answer their initial question, making a short statement about what their overall findings were.

Were students successful in answering their question? How many groups were able to show that their hypothesis was correct?

[i] Louis H. Sharpe (editor in chief of the Journal of Adhesion), Scientific American, https://www.scientificamerican.com/article/what-exactly-is-the-physi/