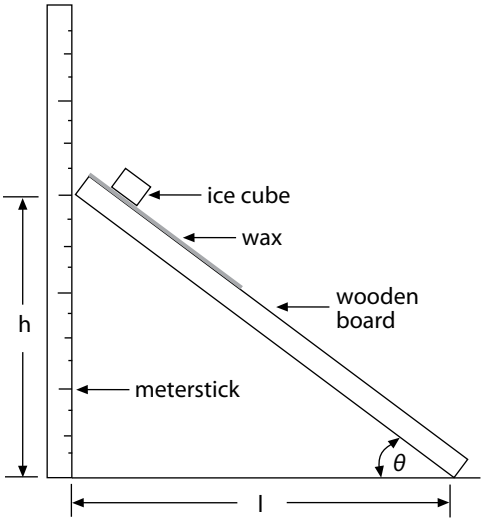
Effects of Wax on Sliding



Position of wooden board as ice cube begins to slide.

FYI...

In the figure above, the coefficient of static friction (μ_s) is the force of friction at the area of contact divided by the force of gravity normal to the board. It's expressed mathematically as:

$\mu_s = \tan \theta = h/l$

Sample data table

Test Surface	Height (h)	Length (l)	μ_s
plain wood			
paraffin wax			
ski wax			
surfboard wax			
floor wax			

Why do skiers put wax on their skis? In this activity, you'll explore how wax reduces friction between ice and wood.

Stuff You'll Use:

▸ice cubes ▸unfinished wooden planks or boards (Make sure both sides of the board are equally smooth.) ▸block of paraffin canning wax (Crayons will also work.) ▸meterstick ▸(optional) a variety of waxes, such as ski wax, surfboard wax, and floor wax

What to Do:

1. Apply wax to one side of the board by rubbing the block of paraffin or the crayon over the surface until the coating is thick and even. It's not necessary to coat the entire length of the board, just the end where you will be placing the ice cube. (See figure at left.)
2. Place an ice cube on one end of the non-waxed side of the board. *How high do you think the board can be lifted before the ice cube slides?* Holding the meterstick vertically next to the end of the board, slowly lift the end of the board until the ice cube begins to slide. Do at least three trials. Record the average height (h). *How do your results compare to your prediction? Do you notice much variation in the heights between trials? What factors could cause any observed variation?* Hint: Allow the ice cube to sit for several minutes on the board before lifting the end of the board. *How high can you lift the board?* Place the board down flat and gently pick up the ice cube. *What do you notice when you pull the ice cube off the wood?*
3. Repeat step 2 using the waxed side of the board. Compare the results.
4. (Optional) Repeat step 3 with boards that have been coated with other types of wax. *Which wax allows the ice to slide the best?*
5. (Optional) Determine the coefficient of static friction (μ_s) for each of the experimental conditions you tried: for example, ice on plain wood, ice on paraffin wax, ice on ski wax, and so forth. (See box at left.) Record the data in a table. *Look at your results. What is the relationship between the ease of sliding and the coefficient of static friction?*

How It Works:

Friction is the force that resists motion between two materials in contact with each other. Friction can occur between two solid materials (such as a book on a table), two fluid materials (air moving over water), or a solid and a fluid (for example, water moving through a pipe). Friction depends on many factors, including the forces pressing the surfaces together, the types of surfaces rubbing together, temperature, the relative speed of the two surfaces, and the presence of lubricants.

Skis and snowboards are able to glide smoothly over snow because a thin film of water (melted snow) between the bottom of the skis and the surface of the snow acts as a lubricant to reduce friction. The friction between skis and snow (or wood and ice, in this activity) is more complicated than the dry friction between other solids. If too little water is present between the snow and the skis, then dry friction will slow the skier down. On the other hand, too much water from the melted snow creates "wet drag," which can also slow down the skier. The purpose of putting wax

on skis is to help achieve a fine balance between friction and drag so that the glide is optimal. Different ski waxes are available for different snow conditions.

Physicists and engineers are still uncertain exactly how friction works. One model attributes friction to the tendency of materials in close contact with each other to stick together because of attractions between the atoms and molecules that make up the two surfaces.

You were probably able to lift the plain-sided board fairly high before the ice cube started to slide. After the ice cube had melted slightly, you may have noticed a small attraction between the ice and the wood when you pulled the ice cube off the board. Attractions also occur between the ice and water and the water and wax, but much less so than on the plain wood surface. Consequently, the ice cube on the waxed side of the board consistently slid down the board at a much lower angle (height) that it did on the non-waxed side of the board.

More Fun?

Learn more about the properties of waxes and fats. Terrific Science Press (www.terrificscience.org/bookstore) offers the following book that includes activities involving the science of lipids:

- *Fat Chance: The Chemistry of Lipids*