Physics Invention Sequences Users' Guide: Friction

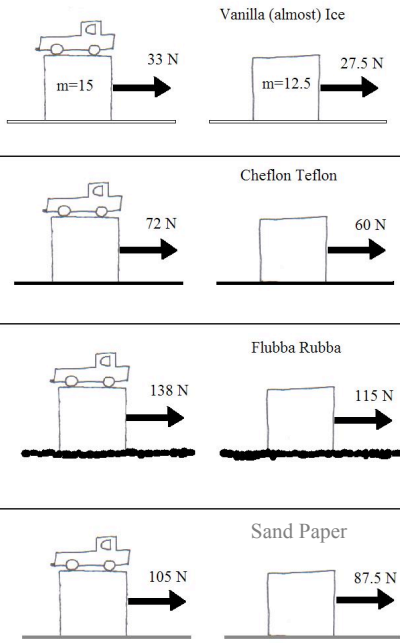
FRICTION INVENTION SEQUENCE

Includes: *stickiness index (coefficient of friction), challenge level (involves knowledge of calculating the normal force on an incline)*

Teacher Notes: When the object is on a horizontal surface, the normal force and the weight have the same value so there is no reason for students to think about the normal force. (they have a better sense of weight) It is important to have a dialog about mechanism for resisting motion. Even if the students are not able to get a numeric value for the normal force on an incline, the challenge level is worth a visit as they can reason about what happens if the angle is 90 degrees, does friction matter and if not, is that result consistent with their model?

Levels: This sequence is most appropriate for all levels that discuss a coefficient of friction mathematically.

Stickiness Index



You're working in a lab trying to determine how well a new material you've created grips other surfaces. The experiment is simple: you pull on a block (whose mass you can easily measure with a scale) of the new material over several different surfaces, while measuring the amount of force required to make it start to move (the block is initially at rest). Unfortunately, after you've taken the first trial's data, you realize your lab partner foolishly left a heavy piece of equipment on top of the block. You give your partner a stern talking-to and take another round of data; both trials are shown to the right.

Can you create an index that shows how well the new material grips other surfaces, a kind of "stickiness index?"

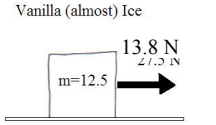
Block on…	**Vanilla Ice**	**Cheflon Teflon**	**Flubba Rubba**	**Sand Paper**
Stickiness index				

Reasoning Questions:

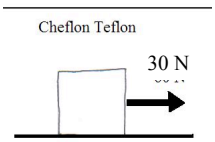
1. What effect does the extra weight left on top of the block have? Why?

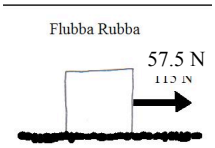
2. Which surface did the block grip the best? The worst?

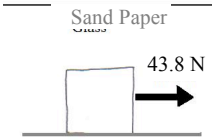
3. If you pulled a 50 kg block of the new material over rubber, what would you expect the required pulling force to be?



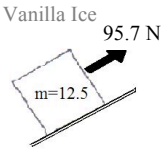
Your colleagues in the international space station have a *half-g* lab where the gravitational force is half of its value that it is on the surface on the earth. They decide to replicate your experiment, and their data are shown at the left. Do they measure the same stickiness index that you do? If they don't, since the stickiness is a characteristic of the surfaces only, you should look for a new stickiness index that is the same for them as it is for you. Revise your method if necessary.



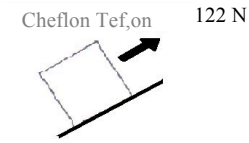


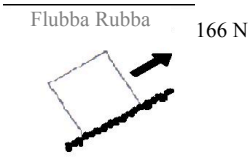


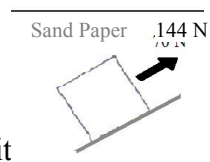
4. What are the units of a stickiness index that you all agree on? Explain.



CHALLENGE: Your colleague in the Himalayas decides to try and replicate your experiment. Unfortunately, her lab table is very slanted (at 37 degrees from the horizontal) due to the fact that there's no even ground in the Himalayas. Her data are shown at the right. Based on your method from above, does she measure the same stickiness index that you do. Explain why or why not. Revise your method so that you, your space station and Himalayan colleagues all measure the same stickiness index.







5. What effect does the incline have on the normal force (i.e. How is the normal force different from the first two trials? Why?)

6. Explain how you came up with your stickiness index, and how it is consistent with all of your colleagues. If you pulled a sled across snow, and the stickiness index between the snow and the sled is 0.25, what does the number 0.25 tell you?