Friction

Teacher Notes

Purpose

The purpose of this assessment probe is to elicit students' ideas about friction between solid objects. The probe is designed to determine (a) whether students recognize friction as an interaction between two objects or materials that rub against/slide over each other and (b) whether they limit this interaction to a particular type of matter or contact.

Related Concepts

contact force, friction, interaction, kinetic friction, rolling friction, sliding friction, static friction

Explanation

All of the choices are examples of friction with the exception of E (box sitting on a flat table). A wheel rolling on a surface is an example of "rolling friction." A magnet is attracted to the refrigerator with a magnetic force, but it is the frictional force that prevents the magnet from sliding down the front of the refrigerator. A box would slide down a hill if there were no friction between the box and the hill. Although an ice rink provides a low friction surface, there is still some friction between an ice skate and the ice rink (the skater will eventually slow down and stop if she does not push off). Even a clothespin can only work because of the friction force between the clothes and the surface of the clothespin. In all of the examples except for A and F, which are examples of rolling friction, the friction force acts parallel to the two surfaces that are in contact with each other. Because the surfaces are sliding past each other, C and G are examples of what is called "kinetic friction." The other examples (except for A and F) are called "static friction" because the surfaces are not moving relative to one another.

Administering the Probe

This probe is best used with middle school and high school students. It can also be used with upper elementary students by removing the

static friction distracters that don't involve a visible rubbing or sliding (i.e., B, D, H, and I).

Related Ideas In *National Science Education Standards* (NRC 1996)

5–8 Motions and Forces

★ Unbalanced forces will cause changes in the speed or direction of an object's motion.

9–12 Motions and Forces

- Objects change their motion only when a net force is applied.

Related Ideas In *Benchmarks for Science Literacy* (AAAS 1993, 2009)

3–5 Motion

- Changes in speed or direction of motion are caused by forces.

6–8 Motion

★ An unbalanced force acting on an object changes its speed or direction of motion, or both.

9–12 Forces of Nature

★ Electric forces hold solid and liquid materials together and act between objects when they are in contact—as in sticking or sliding friction.

Related Research

- In a study by Stead and Osborne (1981), 50% of 13-year-olds in their sample group of 38 12- to 16-year-olds associated friction with rubbing (Driver et al. 1994).
- Some students thought that if a box is motionless on a slope, there is no friction (because there is no rubbing, heat, or wearing down of surfaces) (Stead and Osborne 1980).
- In a group of 47 secondary students, the following ideas about friction were held: Friction occurs only between solids (12 students) and friction occurs with liquids but not with gases (10 students). Only 16 students called friction a force (the responses of 9 students were in an "other" category) (Stead and Osborne 1980).

Suggestions for Instruction and Assessment

- Ask students to recall times when they easily slid down a slide on a playground and other times when they were slowed down on the slide. Ask them to compare the interaction between themselves and the slide that occurred in each case.
- It is important to develop the concept of interactions when teaching about friction.
- Encourage students to come up with examples of friction involving moving and stationary objects.
- Consider extending the probe to examples that include fluid friction, such as the drag on an object in air or water.
- Research shows that some students may benefit from the introduction of an intermediate model of friction, similar to the bridging analogies used by Clement (1993) (Besson and Viennot 2004). For example, have students try to slide two hairbrushes across each other. Students will see the bristles pushing against each other.

References

American Association for the Advancement of Science (AAAS). 1993. *Benchmarks for science literacy.* New York: Oxford University Press.

American Association for the Advancement of Science (AAAS). 2009. Benchmarks for science literacy online. *www.project2061.org/publications/bsl/online*

Besson, U., and L. Viennot. 2004. Using models at the mesoscopic scale in teaching physics: Two

★ Indicates a strong match between the ideas elicited by the probe and a national standard's learning goal.

experimental interventions in solid friction and fluid statics. *International Journal of Science Education* 26 (9): 1083–1110.

Clement, J. 1993. Using bridging analogies and anchoring intuitions to deal with students' preconceptions in physics. *Journal of Research in Science Teaching* 30 (10): 1241–1257.

Driver, R., A. Squires, P. Rushworth, and V. Wood-Robinson. 1994. *Making sense of secondary science: Research into children's ideas.* London: RoutledgeFalmer.

National Research Council (NRC). 1996. *National science education standards.* Washington, DC: National Academies Press.

Stead, K., and R. Osborne. 1980. Friction. LISP working paper 19. Hamilton, New Zealand: University of Waikato, Science Education Research Unit.

Stead, K., and R. Osborne. 1981. What is friction? Some children's ideas. *New Zealand Science Teacher* 27: 51–57.