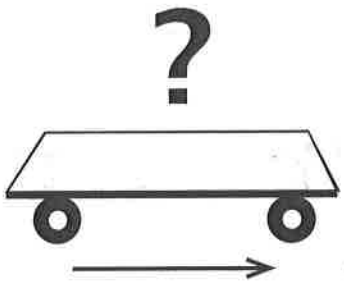
Riding in the Parade

Cindy is very excited—she has been asked to ride in a parade! During the parade, she stands in the middle of the float and waves to the crowd while the float is moving down the street at a constant speed. While she is waving, she sees her friend standing on the sidewalk. She jumps straight up as high as she can so that her friend will see her.



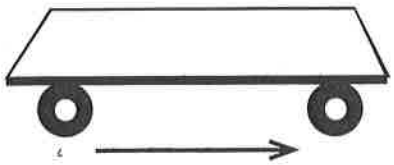
When Cindy lands back on the float, where will she land?

A She will land in the same place on the float from where she jumped.

B She will land closer to the front of the float than where she was before she jumped.

C She will land closer to the back of the float than where she was before she jumped.

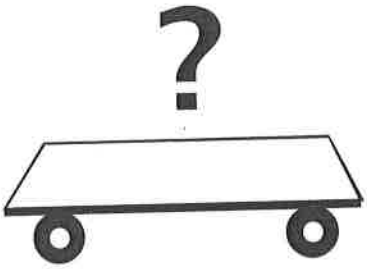
Draw where Cindy will land on the float (below).



Explain your thinking. Describe the reasoning you used to make your prediction.

Riding in the Parade

Teacher Notes



Purpose

The purpose of this probe is to elicit students' ideas about relative motion. The probe is designed to reveal whether students use Newton's first law of motion to predict where a person would land on a moving object if he or she jumped straight up while the object was moving.

Related Concepts

Newton's first law

Explanation

The best answer is A: She will land in the same place on the float from where she jumped—that is, she will land in the middle of the float. She and the float are both moving with the same speed. She will continue her forward motion even though she is no longer in contact with the float. Another example of this motion is when a person jumps up inside an airplane that is moving very fast. This person will land back down directly where he or she jumped from, even though the airplane is moving while the person is up in the air. Newton's first law says that objects in motion continue in motion unless acted on by a force. The float pushes Cindy up to allow her to jump. Nothing is pushing Cindy sideways, so her sideways motion will continue to be the same, that is, she will have a steady sideways speed. More advanced students may try to take air resistance into account and will predict that she lands slightly in back of the center line. This is also a correct statement if accompanied by the correct explanation.

Administering the Probe

This probe is best used with middle school and high school students. Be sure students know that the float is not speeding up, slowing down, or changing direction. It is moving at a steady speed in one direction.

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

5–8 Motions and Forces

★ An object that is not being subjected to a force will continue to move at a constant speed and in a straight line.

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 Motion

★ Any object maintains a constant speed and direction of motion unless an unbalanced outside force acts on it.

Related Research

- Everyday experiences from birth onward result in firmly established ideas called "gut dynamics." These "gut dynamics" underlie most people's ability to interact with moving objects and to play sports. In addition, people appear to generate for themselves a set of explanations and rules for why things move the way they do. These rules have been termed "lay dynamics" (Driver et al. 1994, p. 154).
- Several researchers have found that computer simulations can help students to understand relative motion (Monaghan and Clement 2000; Morecraft 1985).

Suggestions for Instruction and Assessment

- Students can sit on a rolling skateboard or other moving object and throw a ball straight up into the air to see what happens. (*Note:* It is difficult to toss a ball straight up. Before sitting on a rolling skateboard or other moving object in the classroom, have students practice "pushing" the ball off their palms so it rises up slightly in a straight line and lands back on their palms.) Some science supply companies sell a cart that contains a spring-loaded launcher that will shoot a ball straight up into the air. This common demonstration shows that when the cart is moving at constant speed in a straight line, the ball will land directly back into the launcher.
- A useful resource is the DVD movie collection called *Physics Cinema Classics*. These film clips show a wide variety of motions, including visual evidence of Newton's first law. The DVD can be ordered from the American Association of Physics Teachers: *www.aapt.org/Store/cinemaclassics.cfm*.

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*

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

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

Monaghan, J. M., and J. Clement. 2000. Algorithms, visualization, and mental models: High school students' interactions with a relative motion simulation. *Journal of Science Education and Technology* 9: 311–325.

Morecroft, L. E. 1985. A relative-motion microworld. Technical Report 347. Cambridge, MA: Massachusetts Institute of Technology.

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