NEWTON'S APPLE

Show Number 908

SLINKY PHYSICS

How Do Toys Work?

David discovers that the slinky and many other toys aren't as simple as they may look.

- Who invented the Slinky?
- How does it walk down stairs?
- Is it as simple as it looks?
- What other kinds of tricks can a Slinky perform?
- Are there other toys that work the same way?

DISCUSSION

When the Slinky's inventor Richard James, a naval engineer, and his wife decided to demonstrate their new toy at Gimbels Department Store in Philadelphia in the early 1940s, they feared that no one would buy it because it was so simple. They were so worried they gave a close friend a dollar to buy one. An hour and a half after the first demonstration, they had sold a total of 400 Slinkys!

The Slinky, whose design has been modified only once to crimp the ends for safety, remains the same today as it did at Gimbels. Not only is the Slinky an excellent toy, its action also demonstrates a variety of physical forces and principles.

The Slinky, like all objects, tends to resist change in its motion. Because of this inertia, if it were placed at the top of the stairs it would stay at rest without moving at all. At this point it has potential or stored energy. But once it is started down the stairs and gravity affects it, the potential energy is converted to the energy of motion or kinetic energy and the Slinky gracefully tumbles coil by coil down the stairs.

The physical properties of the slinky determine how quickly it moves under the influence of gravity. Although its movement may look simple, from a scientific point of view the motion is quite complex. As the slinky moves down the steps, energy is transferred along its length in a longitudinal or compressional wave, which resembles a sound wave that travels through a substance by transferring a pulse of energy to the next molecule. How quickly the wave moves depends on the spring constant and the mass of the metal. Other factors, such as the length of the slinky, the diameter of the coils and the height of the step must be considered to completely understand why a slinky moves as it does.

James originally developed the Slinky for the Navy as an anti-vibration device for ship instruments. When the Slinky failed to work for the Navy, it became one of the most successful toys of all time!

Things to Talk About

1. Why can't a Slinky go upstairs? Would it work on a circular staircase? Is there any difference between plastic and metal Slinkys?

2. What are all the factors that might make one slinky move faster than another? Which factors are the most important? How would you test your answers?

Vocabulary

Longitudinal Wave--A wave in which the vibration is in the same direction as that in which the wave is traveling, rather than at right angles to it. Sound waves are longitudinal waves.

Transverse Wave--A wave in which the vibration is at right angles to the direction in which the wave is traveling. Waves in the stretched strings of musical instruments, upon the surfaces of liquids, and the electromagnetic waves which make up radio waves and light are transverse.

Inertia--A property, or quality, that tends to keep objects in motion in a straight line, or to keep objects at rest motionless, unless either one is acted upon by an outside force.

Friction--The force that acts when two surfaces rub against each other. Friction always acts to slow movement and if no other force is applied, it will bring motion to a stop.

Resources

- Ardley, Neil. Muscles to Machine. New York: Glouchester Press, 1990.
- Hewitt, Paul. Conceptual Physics, 2nd Edition. New York: Addison-Wesley, 1991.
- Milgrom, Harry. First Experiments with Gravity. New York: E.P. Dutton & Co., 1966.
- Panati, Charles. Extraordinary Origins of Everyday Things. New York: Harper & Row, 1987.

Additional Sources of Information

- Toys in Space Program
- NASA CORE
- Lorain County Joint Vocational School 15181 Route 58 South Oberlin, OH 44074

Activity Page

Let 'em Roll

Find out how you can convert potential energy into kinetic energy!

Main Activity

You can overcome an object's inertia and watch physical forces act on it as it moves. You will also be able to create energy transfers.

Materials:

- Empty spool of thread
- Small rubber band about the same length as the spool
- Metal washer
- Tack or pin
- Match stick
- Paper

Pencil

1. Slip the rubber band through the hole of the empty spool.

2. Attach the end of the rubber band to the end of the spool with the tack or pin.

3. Pull the loose end of the rubber band through the metal washer.

4. Slip the match stick through the open end of the rubber band. Wind the rubber band around the match stick several times until there is no slack left in the rubber band.

5. Let go of the match stick and watch what happens!

Questions

1. Does the number of twists in the rubber band affect how far the model goes? What would happen if you used a longer rubber band?

2. Can you modify the design of your toy so that it can travel faster? Could you design it to go around corners?

3. What happens if you run the toy on a sloped surface? Does this affect the speed of the toy?

Collect as many dominoes as you can. Line them up in some creative patterns. Push the first domino to start a chain reaction of falling dominoes. How is the energy transfer similar to the operation of a Slinky? Can you find information about domino competitions? Draw some examples of the elaborate designs used in these competitions.

Select five of your favorite toys. These might include yoyos, hula hoops, roller skates, tops, marbles or any toy balls. The Slinky is an example of energy moving along a spring, but other toys transfer momentum from one object to another. Experiment with the motion of each and examine how potential energy is converted into kinetic energy.

United States soldiers who used radios during combat in Vietnam tossed the Slinky into trees to act as a makeshift antenna. Pecan harvesters used the Slinky to help collect the pecans and increase production. How do you think they did it? Find other ways Slinkys have been used by industry. What uses can you find for your Slinky?

With your hands held horizontally, hold each end of the Slinky so that it forms an arch. Move one of your hands up. What happens to the coils of the Slinky? If you repeat that action but quickly return your hand to its original position the coils move very quickly. How do the connections from one coil to another affect the speed a Slinky moves?

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