www.pbs.org/saf/1206

On the Ball

Activity 3: Grades 5-8

Bouncing Back

When a bat strikes a baseball, both objects change. At the moment of the collision, the energy of the impact gets stored as the physical deformation of both the bat and the ball. If the ball strikes a wooden bat, the ball undergoes most of the "squishing." If an aluminum bat is used, the deformation of the bat becomes the main reservoir for storing this potential energy. As the ball and bat return to their original shape, the stored energy is transformed back into the energy of the ball's movement. This difference in shape deformation accounts for the variance in the action of wooden and aluminum bats.

But you don't have to go out on a ball field to explore the relationship between potential energy and its conversion to kinetic energy. A similar energy transfer occurs when a ball rebounds off a surface such as a floor or wall.

In this activity, you will explore how the height from which a ball is dropped affects its rebound. Is there an optimal height for observing the greatest rebound? How does temperature affect the ball's rebound?

This activity page will offer:

- Insight into the storage of potential energy within a disfigured rubber ball.
- A hands-on experience in energy transformation.
- An opportunity to manipulate variables and observe effects.
- An exploration of the physics of rebounds.

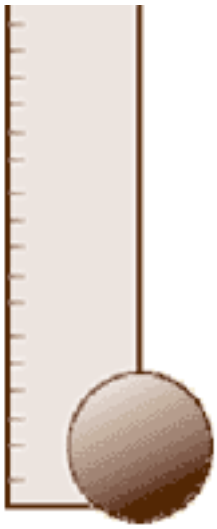
MATERIALS

- Hollow ball*
- Solid ball *
- Measuring stick
- Adding machine paper
- Tape

*Composed of rubber or other elastic material.

PROCEDURE

Part 1- Obtaining a Baseline



1. Work with a partner to tape a length of paper along a wall so that it extends upwards from the floor to a height of around 6 feet.
2. Use a measuring stick to create a scale along the length of the paper.
3. One team member holds a solid ball at a height of 6 inches. The other member marks this point as the release height.
4. The team member holding the ball releases it. The other team member observes and marks the rebound height on the chart. The person observing the ball should note any change in the ball's appearance as it hits the ground and rebounds.
5. The ball is then released from a height of one foot. Again, its release and rebound heights are recorded and marked on the chart.
6. Keep elevating the release point until you are dropping the ball from the top of the chart.
7. Repeat steps 1-6. This time substitute a hollow ball for the solid one. The same person should continue to drop the ball, and the same person should continue to observe and record it.

QUESTIONS

1. How did the release height affect the rebound height?
2. Did you observe a difference in the ball's shape as it struck the ground? If so, what happened?
3. Was the relationship between release height and rebound height constant? In other words, did the ball bounce highest when released from the highest point?
4. CRITICAL ANALYSIS: At a certain point, further increases in height do not produce a higher rebound height. Explain.

Part 2- Cooling Off

ADDITIONAL MATERIALS

- Golf ball
- Baseball

PROCEDURE

1. Determine the average rebound height for a golf ball kept at room temperature and dropped from a height of about 3 feet.
2. Refrigerate the golf ball for several hours.
3. Again, determine the average rebound height from a 3-foot drop.
4. Repeat steps 1-4, substituting a baseball for the golf ball.

QUESTIONS

1. Did the rebound height change when the golf ball and baseball were refrigerated?
2. Which ball's rebound was affected most by the change in temperature?
3. How would you find the percentage of the bounce lost due to refrigeration?
4. What percentage of the bounce is lost when a baseball is refrigerated?
5. What percentage of the bounce is lost when a golf ball is refrigerated?
6. Why does the change in temperature affect the bounce?

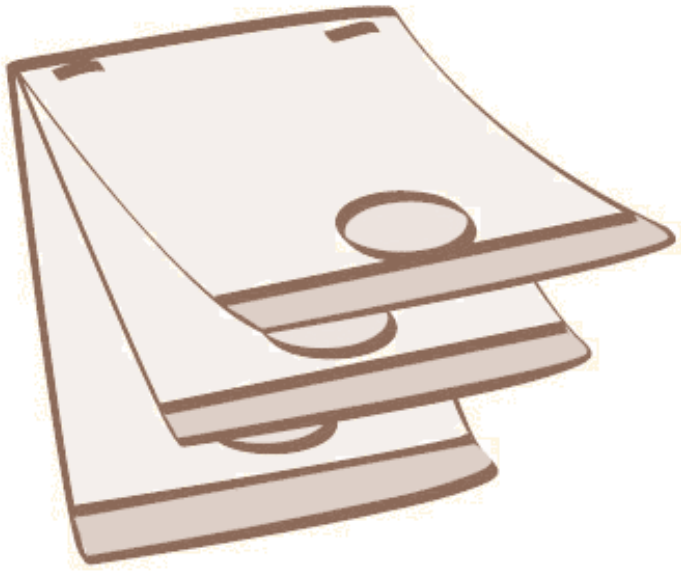
EXTENSIONS

Transfer of Energy

Beginning with the sun, identify all of the energy changes responsible for a basketball's rebound. To simplify matters, assume that the basketball is already manufactured.

Flipping Fun

Have you ever made an animated flipbook? Here's your chance to create one that shows the deformation of a ball as it bounces against the ground. Using scraps of square or rectangular paper and a large fastening clip, assemble a blank flipbook. Draw a sequence of image frames that shows a bouncing ball that deforms as it strikes the ground and rebounds. Don't forget to show the ball's return to its spherical form and the associated rebound.



Hot Stuff

Suppose a golf ball was heated instead of chilled. How might additional thermal energy affect the rebound height? Make a prediction. Then, develop a method for inquiry that would uncover this relationship. Share your experimental design with your instructor. With his or her permission, perform your experiment, gather the data, analyze your results, and draw conclusions based on your data.

Web Connection

Bouncing Balls
http://www.exploratorium.edu/baseball/bouncing_balls.html
A comprehensive reference on the physics of ball bouncing.

Rebound Differences During Play
http://www.lightlink.com/sedgar/squash/drivetest.html
An article describing the effects of temperature on the bounce of squash balls.

The Energy of a Bouncing Ball
http://www.phys.virginia.edu/Education/outreach/8thgradesol/EnergyBallFrm.htm
A University of Virginia activity on investigating the energy of a bouncing ball.

The activities in this guide were contributed by Michael DiSpezio, a Massachusetts-based science writer and author of "Critical Thinking Puzzles" and "Awesome Experiments in Light & Sound" (Sterling Publishing Co., NY).

Academic Advisors for this Guide:
Corrine Lowen, Science Department, Wayland Public Schools, Wayland, MA
Suzanne Panico, Science Teacher Mentor, Cambridge Public Schools, Cambridge, MA
Anne E. Jones, Science Department, Wayland Middle School, Wayland, MA

On the Ball

Activity 3: Grades 5-8

Bouncing Back

ANSWERS

PROCEDURE

Part 1- Obtaining a Baseline

QUESTIONS

1. How did the release height affect the rebound height?
   (The greater the height of the drop, the greater the rebound height.)
2. Did you observe a difference in the ball's shape as it struck the ground? If so, what happened?
   (The shape deformed and temporarily stored the energy of the collision. Instantly, it "popped back" into its spherical shape, driving the ball's upward rebound.)
3. Was the relationship between release height and rebound height constant? In other words, did the ball bounce highest when released from the highest point?
   (No. At a medium drop height, the ball bounced back the greatest percentage of its release height.)
4. CRITICAL ANALYSIS: At a certain point, further increases in height do not produce a higher rebound height. Explain.
   (At a certain release height, the ball will undergo its maximum disfiguration upon contact with the ground. Additional increases in drop height will not increase the disfiguration. Therefore, there is a limit to the amount of energy that can be stored and the shape change produced by the impact.)

Part 2- Cooling Off

QUESTIONS

1. Did the rebound height change when the golf ball and baseball were refrigerated?
   (Yes. They did not bounce as high.)
2. Which ball's rebound was affected most by the change in temperature?
   (The golf ball.)
3. How would you find the percentage of the bounce lost due to refrigeration?
   (Subtract the height of the "cooled" bounce from the initial bounce height. Then, divide this difference by the initial bounce height. Multiply by 100 to obtain a percentage.)
4. What percentage of the bounce is lost when a baseball is refrigerated?
   (About 15-20%)
5. What percentage of the bounce is lost when a golf ball is refrigerated?
   (20-30%)
6. Why does the change in temperature affect the bounce?
   (When cooled, the material doesn't disfigure as easily. Since its shape "squishes" less, it stores less potential energy. Since less energy is stored, the bounce is not as great).

EXTENSIONS

Transfer of Energy

Beginning with the sun, identify all of the energy changes responsible for a basketball's rebound. To simplify matters, assume that the basketball is already manufactured.

(The sun's energy is absorbed by green plants. Green plants are eaten by herbivores, and energy is transferred and stored in the animals. Herbivores are eaten by humans, and energy is transferred and stored in the body. Stored body energy is changed into muscle movement. Movements increase the potential energy in the lifted ball. The falling ball exhibits the change of physical energy to kinetic energy. Upon striking the surface, kinetic energy is changed into the physical energy of the deformation. Physical energy is changed back to kinetic energy with the rebound bounce.)

CURRICULUM LINKS

Physics :
Motion, Forces, Potential and Kinetic Energy
General Science :
Observation and Inference

NATIONAL SCIENCE STANDARDS (Grades 5-8)

Science as Inquiry- Content Standard A

Students will learn to formulate questions, design an investigation,, execute this investigation, interpret the data and use the evidence to generate explanations.

Physical Science- Content Standard B

The student will observe the motion of an object and learn how this motion can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph.

The student will further their understanding of the transfer of energy and the notion that energy is a property of many substances.