BALL DROP

AT A GLANCE

Students observe energy transfer as they experiment with three types of bouncing balls.

OBJECTIVES

Students will:

- Observe energy transferring between potential and kinetic.
- Learn that energy can not be created or destroyed, but can change its form.
- Participate in an experiment comparing rebound heights of different types of balls

KEY VOCABULARY

Gravitational potential energy, potential energy, kinetic energy, Law of Conservation of Energy, inelastic collision

SUGGESTED GRADE LEVELS: 4—8

ILLINOIS STATE LEARNING GOALS

Late Elementary

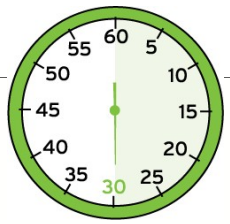
6: A; 10: A, B; 11:A,; 12.C, D; 13.A, B

Middle/Junior High

10:A; 11: A; 12: C, D; 13: A, B

PACE YOURSELF

30 MINUTES



ADVANCE PREPARATION

1. Make copies of the "Height of Rebound" student activity sheet.
2. Collect materials needed for the activity

MATERIALS

Per Group:
Meter stick
3 balls: golf, rubber, tennis
Optional: calculator

Per Student:
"Height of Rebound" student activity sheet

WHAT YOU NEED TO KNOW

The Law of Conservation of Energy states that energy cannot be created or destroyed, but can be transformed**.** In Ball Drop, we see energy being transformed, although the total amount of energy remains the same.

Before dropping a ball, you must lift it up from its' resting surface. When you do this, you are transferring energy from your muscles to the ball. You are giving the ball **potential energy**, specifically **gravitational potential energy**. Gravitational potential energy (GPE) is the energy gained by an object as its height above ground level increases. An object's GPE is determined using this formula:

GPE = height x weight

Objects that are the same weight will gain more GPE the higher they are positioned. If one object is heavier than the other at the same height, the heavier object will have more GPE.

As the ball falls towards the ground, its gravitational potential energy is transformed into **kinetic energy**. The kinetic energy of an object is the energy it possesses due to its motion. The kinetic energy of the ball will continue increasing as the ball gains momentum, until it finally collides with a surface.

When the ball collides, the kinetic energy is transformed into other forms of energy. When a ball hits a surface, some energy is transformed into sound energy, some is transformed into thermal energy from the friction created, and some becomes elastic potential energy resulting from the instantaneous deformation of the ball when it collides.

This elastic potential energy is why the ball is able to bounce, or rebound.

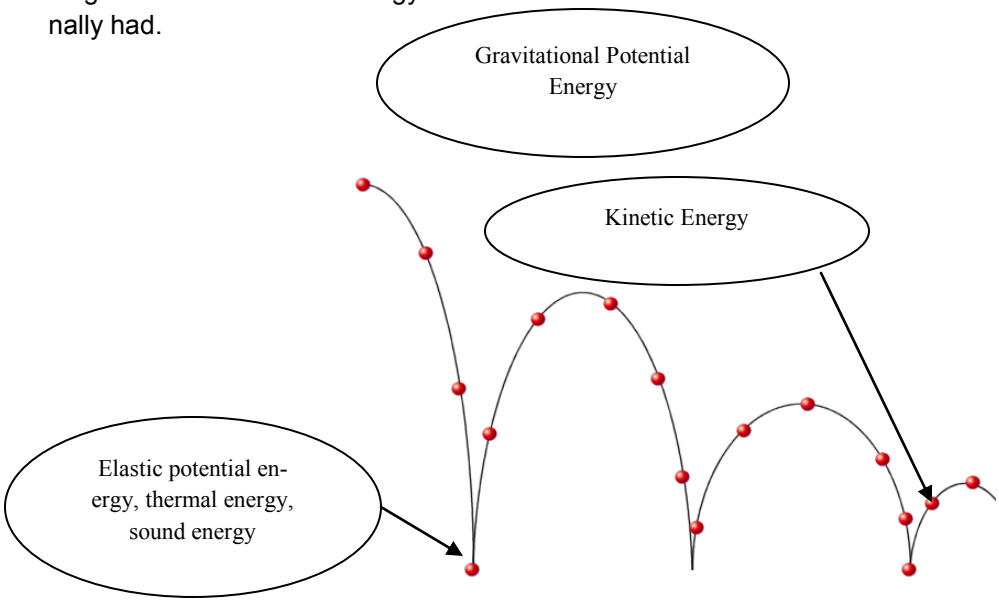
After the ball rebounds, the elastic potential energy is transformed into kinetic energy, but it will never possess as much kinetic energy as during its original fall. The ball will never be able to rebound to its original height. This is because some of the original kinetic energy has been transformed into sound, friction, and deformation of the ball.

A ball dropping is an example of an **inelastic collision** where part of the kinetic energy is changed to some other form when colliding with a surface. Another example of an inelastic collision is a car crash. When two cars collide, the kinetic energy transfers to sound energy (crash!), thermal energy, and energy used to crumple the cars, or change their shape.

WARM UP

As a demonstration, drop a ball onto a table where all of your students can see it. Discuss the types of energy.

1. When the ball is held at its highest point, it has potential energy, specifically gravitational potential energy.
2. When the ball is falling towards the table, it has kinetic energy. It has the most kinetic energy at the very end of its descent when it is moving the fastest.
3. Even though we can't see it, as the ball hits the table, it changes shape for a split second. This requires energy. There is a transfer of energy from kinetic to sound (in the noise it makes upon impact) and thermal energy (friction with the table.)
4. Without other forces, such as air resistance, the ball is still not be able to bounce to its original drop height because of these energy transfers. The ball will never have as much kinetic energy as it originally had.



BALL DROP

ACTIVITY

1. Give each group a golf ball, tennis ball and rubber ball. Set a timer, and let them "experiment" with the bouncing of each ball for one minute.
2. Have each group set up a testing station and follow the directions on their "Height of Rebound" worksheet. They will be dropping each type of ball 5 times from 100 cm and 200 cm and measuring their rebound heights.

CHECK FOR UNDERSTANDING

Discuss with students the results from their "Height of Rebound" worksheet. Ask, "What type of energy did you observe in this activity?" *Potential, kinetic, thermal, sound.*

DIFFERENTIATED INSTRUCTION

- Provide students less skilled in math with a calculator to determine the averages.
- Make directions clear for students, that it is a ball *drop.* They should drop the ball exactly the same way each time to isolate variables and should not throw the ball.

WHAT'S HAPPENING

Gravitational potential energy is the energy stored in an object by lifting it to a certain height above the Earth. When a tennis ball is dropped from 2 m, it possesses a certain amount of gravitational potential energy because of its mass and its height above the ground. As the ball falls, that energy is converted to kinetic energy. When the ball collides with the floor, some of this kinetic energy is transferred to the floor and converted to thermal energy (friction) and elastic potential energy (ball deformation.) Some of the kinetic energy is also transferred to sound energy, in the "boing" noise we hear during the collision. The remainder of the energy is used to bounce the ball back up – but not as high as where it started from because some of its energy has been transferred to the floor. The same is true for the golf and rubber balls.

INQUIRY WHEEL OPPORTUNITY

Show students how to design an experiment using the Inquiry Wheel! Examples of *independent variables* (inside the circle): temperature of ball, height ball is dropped from, surface ball is dropped onto, material of ball. Examples of *dependent variables* (outside the circle): how many times the ball bounces, the height of the first bounce.

INDEPENDENT VARIABLES ***How does the….***	**DEPENDENT VARIABLES** ***Affect ...***
Temperature of the ball	How many times the ball bounces
Height the ball is dropped from	How many times the ball bounces
Surface the ball collides with	The height of the first bounce
Material of the ball	The height of the first bounce

EXTENSIONS

LANGUAGE ARTS

Have students work in groups to brainstorm a list of onomatopoeia words; words that reflect, imitate or suggest the source of the sound that it describes. Examples are: meow, tic-tock, boing, zap, hiccup and zoom.

MATH

- Have students create a bar graph to compare the results of their ball drop.
- Have students determine the mean, median and mode for each ball.

DIGITAL RESOURCES

Check out this website, which has great physics articles for students in 6th-8th grade:

http://www.kids.gov/6_8/6_8_science_physics.shtml

RELATED EXHIBITS

Science Storms
Live Science Experience: *Ball Drop*

Height of Rebound Student Activity Sheet

Directions: Stand your meter stick up vertically and hold each ball type at the drop heights in the table below. Drop (do not throw) the ball directly beside the meter stick and observe how high the ball rebounds. Record your observations in the data table below. When you finish with all of the drops, calculate the average rebound height for each ball type.

Golf Ball						
Height of Drop	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average
100 cm						
200 cm						
Rubber Ball						
Height of Drop	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average
100 cm						
200 cm						
Tennis Ball						
Height of Drop	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average
100 cm						
200 cm						

Activity Questions

1. It has been stated that a ball will not bounce back to the starting height no matter what the starting position might be. Using evidence from the investigation, explain whether you think this statement is true.

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2. What kind of energy did the ball have when it was held at 100 cm. Explain your answer.

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3. When did the ball have kinetic energy?

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