Author	Adrienne Studd
Lesson Title	Balloon Ball Bounce
Grade Level	Grades 5-8
Lesson Source	Balloon Ball from: "That's the Way the Ball Bounces" written by Sandra Van Natta and Sue Hall for the Polymer Ambassadors http://www.polymerambassadors.org
Abstract/Description	In this activity, students will realize that different sports use balls with different amounts of rebound. Understanding this idea, the students will determine if the number of balloons in a balloon ball affect the rebound height. The students will then use the ball to discuss energy conversions.
Objectives **Should be measurable** • **What should the students know as a result of this lesson?**	Students will describe the energy conversions (potential and kinetic) as the balloon ball falls and rebounds. Students will describe why a ball rebounds. Students will explain the Law of Conservation of Energy. Students will analyze how the number of balloons in a balloon ball impacts the rebound of the ball.
• **What should the students be able to do as a result of this lesson?**	Students should be able to use the experimental design process to investigate the energy conversions and the rebound of a student-made balloon ball. Through the activity, the students should also be able to identify variables, collect data, and create an accurate graph of data and draw conclusions from the data.
Materials Needed	Meter stick 10-12 round balloons per group Scissors

	Websites for background information on bouncing balls and different sport balls as needed Computer/projector to show the websites
Procedures (Learning Cycle) • **Engagement / Assessment**	Use the following websites and their images to conduct a discussion about sports and the type of ball used. For example, ask the students why a tennis ball is not used in baseball games or why a ping-pong ball is not used in golf. (The balls are designed based upon the requirements of the sport and the rebound of the ball. A tennis ball would go too far in baseball and would not provide much challenge for the team on offense. On the other hand, a ping-pong ball does not have the same amount of rebound as a golf ball and would not travel the required distance when playing golf.) Ask the students to provide additional examples. http://www.exploratorium.edu/baseball/bouncing_balls.html http://www.exploratorium.edu/sports/ball_bounces/ballbounces3.html Tell students their challenge: As a group you will have 10-12 balloons (based upon teacher choice) to make a balloon ball. You are designing a ball for a sport that needs the greatest possible rebound when dropped from a height of 1.0 meter. Assessment: Monitor the students' understanding of the need for a specialized ball in sports by asking the students to provide additional examples. (whiffle ball vs. baseball, bowling ball vs. basketball) Before proceeding, be sure that students understand the challenge by asking one or two students to explain the challenge in their own words to the class. Correct any misunderstandings.
• **Exploration / Assessment**	Divide the students into groups of three. The job assignments could be the release person, distance observer and the recorder. All students should assist in the creation of the balloon ball. The students should decide how many balloons to use in their balloon ball. However, they will need to test at least three different balls. For example, students might want to make a ball with 3 balloons and then perform the test. Next they could add balloons to the ball to make a ball with 7 balloons and then perform the test. Finally, they could add balloons to make a 10-balloon ball and then perform the test. During the tests, the students should record their data in a data table. (Number of balloons in the ball and the height of the first rebound.) Remind students to conduct each test at least three times. Once all data has been collected, graph the results of the three trials. Find the average and the mode for each trial. Make a bar graph using the data. *To make the balloon ball: 1. Blow up a round balloon and tie it off so that it is slightly smaller than a fist. 2. Using a second balloon, cut it with scissors at the neck. 3. Open the balloon and place the blown up balloon inside. 4. Rotate the direction of the balloon ball and place another cut balloon around the balloon ball. 5. Repeat steps until the balloon ball has the desired number of balloons. Assessment: Monitor the students' work and adherence to the safety procedures. Check to see that all of the

	students are following the procedures, making accurate observations, and recording the data accurately using the metric system.
• **Explanation / Assessment**	Share the data and graph with the class. After the students have answered the following lab questions in their groups, discuss the questions as a class. Based on your data, what is the best number of balloons to use for a super bouncy ball? Why do you think this number of balloons make the ball bounce better? What is your definition of rebound? Once the students have shared data and discussed the questions, students should describe the forces and energy conversions that are taking place in the balloon ball. When the ball is dropped, the ball's energy is gravitational potential energy (GPE). The force of gravity causes the ball to fall towards the ground. During the fall, the ball's GPE is being converted into kinetic energy (KE). At the moment the ball hits the ground it momentarily stops. The KE has decreased and Elastic Potential Energy has increased to its maximum. Eventually the ball returns to its original shape and bounces back upward. The Elastic Potential Energy changes into KE. As the height of the ball increases, the KE changes into GPE. The rebound height of the ball will never be as tall as the drop height of one meter because some of the energy in this system becomes heat and sound energy. As more of the energy is changed to heat and sound, the ball will eventually come to a stop. Ask the students to draw the balloon ball and label the gravitational potential energy (GPE), the elastic potential energy (EPE), the kinetic energy (KE) and any other forms of energy or energy conversions observed during the trials. Assessment: Determine the students' understanding of their data and rebound by asking and discussing the lab questions. Based on your data, what is the best number of balloons to use for a super bouncy ball? Why do you think this number of balloons make the ball bounce better? What is your definition of rebound? (to attempt to return to the starting position) Ask the students to draw the bouncing balloon ball and label the gravitational potential energy (GPE), the elastic potential energy (EPE), the kinetic energy (KE) and any other forms of energy or energy conversions observed during the trials. (Before the ball is dropped (GPE) During the fall and rebound (KE) At impact (EPE, Sound, heat))
• **Elaboration / Assessment**	Ask the students to evaluate and predict: What do you think would happen in the balloon ball bounce if 100 balloons were used in the ball? What do you think would happen if the initial drop height were 2.0 meters? What do you think would happen if a balloon ball was made from Mylar? What do you think would happen if the medium inside the first balloon was changed from air to helium or water? Discuss the questions and answers as a class. Share ideas and possibly create a test to find the answer to one of the questions.

	Remind the students that in sports, the ball is specially designed for the rules of the sport. Brainstorm some games that might benefit from the newly constructed balloon ball with the greatest rebound. Show the students the video clip of a bouncing basketball. Ask the students to draw the basketball at its highest point, when it is falling, when it is at its lowest point, when it is rebounding, and when it is at its highest rebound height. Label the energy conversions taking place in each picture. Identify the pictures with the greatest potential energy and the greatest kinetic energy. Assessment: Use the remaining lab questions to determine the students' understanding rebound, energy conversions, and the interpretation of data. Review and re-teach any misconceptions. What do you think would happen in the balloon ball bounce if 100 balloons were used in the ball? (students should use their own data to make a prediction) What do you think would happen if the initial drop height were 2.0 meters? (students should use their own data to make a prediction) What do you think would happen if a balloon ball was made from Mylar? (Mylar is the common shiny or silver helium balloons. Mylar is not elastic, this would not work. Check to see that the students understand that the type of material influences the rebound height.) What do you think would happen if the medium inside the first balloon was changed from air to helium or water? (accept all reasonable answers) Show the students a video clip of a bouncing basketball. Ask the students to draw the basketball at its highest point, when it is falling, when it is at its lowest point, when it is rebounding, and when it is at its highest rebound height. Label the energy conversions taking place in each picture. Identify the pictures with the greatest potential energy and the greatest kinetic energy. (highest point = greatest GPE, falling = GPE to KE, hitting the ground = KE to Elastic Potential, Sound, and heat, rebound = PE to KE)
Prerequisites	Students should have previously discussed potential/kinetic energy and energy conversions during class. Students should be able to measure accurately using metric measurements. Students should be able to calculate averages and find the mode of a data set. Students should be able to create a bar graph.
Best Teaching Practice(s)	Students need to perform hands-on/minds-on activities. These activities make concepts tangible for students, meet the needs of multiple learning styles, and help to keep students engaged. Probing questions push students beyond simple recall and encourage them to extend their knowledge. This promotes critical thinking and higher level thinking skills.

Alignment with Science Standards • **National**	**Science 5 – 8 Transfer of Energy:** Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways. **Science 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. **Science 5-8 Science as Inquiry:** use appropriate tools and techniques to gather, analyze, and interpret data.
• **Ohio**	**Scientific Inquiry – Doing Scientific Inquiry Grade 6-8** A. Explain that there are differing sets of procedures for guiding scientific investigations and procedures are determined by the nature of the investigation, safety considerations and appropriate tools. **Physical Science – Nature of Energy Grade 6-8** D. Describe that energy can take several forms, some forms represent kinetic energy and some forms represent potential energy; and during energy transformations the total amount of energy remains constant,
Content Knowledge (include any connections to technology)	Potential energy is stored energy due to an objects position or chemical bonds. Kinetic energy is the energy of motion. When a ball is dropped, the ball's energy is gravitational potential energy (GPE). The force of gravity causes the ball to fall towards the ground. During the fall, the ball's GPE is being converted into kinetic energy (KE). At the moment the ball hits the ground it momentarily stops. The KE has decreased and Elastic Potential Energy has increased to its maximum. Eventually the ball returns to its original shape and bounces back upward. The Elastic Potential Energy changes into KE. As the height of the ball increases, the KE changes into GPE. The rebound height of the ball will never be as tall as the drop height of one meter because some of the energy in this system becomes heat and sound energy. As more of the energy is changed to heat and sound, the ball will eventually come to a stop.
Safety/disposal	Use of scissors (sharp object) when making the balloon ball. Students with latex allergies should not handle the balloon ball. These students could conduct the measurements. Explain expectations and requirements for the use of the balloon ball once they are made. There are no disposal concerns.
Applications (where is this content applied in the "real world?")	Energy conversions between GPE and KE take place in the real world in places such as a swinging pendulum, a teeter-totter, or any dropped object. In sports, the amount of elasticity and rebound of the ball affect the players' abilities and therefore the rules of the game.
Assessment (overall)	Show the students the video clip of a bouncing basketball. Ask the students to draw the basketball at its highest point, when it is falling, when it is at its lowest point, when it is rebounding, and when it is at its highest rebound height. Label the energy conversions taking place in each picture. Identify the pictures with the greatest potential energy and the greatest kinetic energy.
Additional	Divide the students into groups of three. The job responsibilities could be the release person, rebound observer and the recorder. All students should help in the creation of the balloon ball.

Considerations Grouping Suggestions	
Additional Considerations Pacing / Suggested Time	This activity should take approximately 2 class periods.
Worksheets	See attached worksheet.
Credits/References	Polymer Ambassadors: http://www.polymerambassadors.org

See worksheet below

Balloon Ball Bounce

Problem: How many balloons will a balloon ball need to have the greatest rebound?

Hypothesis: _____

_____

Procedure:

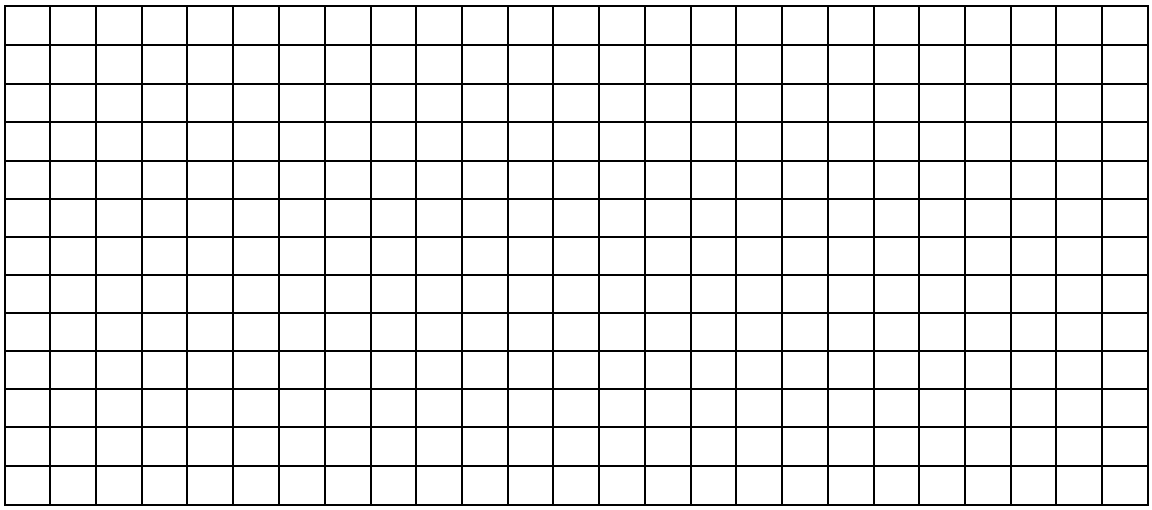
1. Using 10 balloons determine how many balloons a balloon ball needs to have the greatest rebound when dropped from a height of 1.0 meter.
2. Make the balloon ball.
3. Blow up a round balloon and tie it off so that it is slightly smaller than a fist.
4. Using a new balloon, cut the balloon with scissors at the neck of the balloon.
5. Open the balloon and place the blown up balloon inside.
6. Rotate the direction of the balloon ball and place another cut balloon around the balloon ball.
7. Repeat steps until the balloon ball has the desired number of balloons.
8. Drop the balloon ball from a height of 1.0 meter and record the height of the ball from the first rebound.
9. Record the results in the data table.
10. Repeat steps 4-9 two more times (change the number of balloons used).
11. Graph the results and share the data with classmates.

Data:

Number of Balloons in balloon ball	Height of balloon ball rebound in centimeters	Height of balloon ball rebound in centimeters	Height of balloon ball rebound in centimeters	Average height in centimeters	Mode of balloon ball rebound

Graph:
Create a bar graph to show all of your results for the three trials. The y-axis = height in centimeters (dependent variable). The x-axis = the number of balloons (independent variable).

Title: _____



Conclusion: Use your data to help you answer these questions.

1. What is the best number of balloons to use for the bounciest balloon ball?

2. Do your findings support your hypothesis? Explain why or why not.

3. Why do you think this number of balloons makes the ball bounce better?

4. What is your definition of rebound?

5. What do you think might happen to the height of the balloon ball rebound if 100 balloons were used to make the ball?

6. What do you think would happen if the initial drop height were 2.0 meters?

7. What do you think would happen if a balloon ball was made from Mylar?

8. What do you think might happen if the medium inside the first balloon was changed from air to helium or water?

9. Draw the balloon ball and label the gravitational potential energy (GPE), the elastic potential energy (EPE), the kinetic energy (KE) and any other forms of energy or energy conversions observed.