Title: Bouncing High

Brief Overview:

Students will apply their knowledge of measuring, problem solving, and teamwork to design a new and better bouncing ball. They will work in small groups and utilize their skills to create a size for maximum bouncing and fun. They will graph the rebound bounce of their ball and compare the results with the rebound bounce of other balls.

NCTM 2000 Principles for School Mathematics:

- **Equity:** *Excellence in mathematics education requires equity - high expectations and strong support for all students.*
- **Curriculum:** *A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated across the grades.*
- **Teaching:** *Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well.*
- **Learning:** *Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge.*
- **Assessment:** *Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.*
- **Technology:** *Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning.*

Links to NCTM 2000 Standards:

- **Content Standards**

<u>Measurement</u>
Mathematics instructional programs should include attention to measurement so that all students understand attributes, units, and systems of measurement. Students will apply a variety of techniques, tools, and formulas for determining measurements.

<u>Data Analysis and Probability</u>
Mathematics instructional programs should include attention to data analysis, statistics, and probability so that all students pose questions and collect, organize, and represent data to answer those questions. They will interpret data using methods of exploratory data analysis. They will develop and evaluate inferences, predictions, and arguments that are based on data. They also will understand and apply basic notions of chance and probability.

- **Process Standards**

  <u>Problem Solving</u>
  Mathematics instructional programs should focus on solving problems as part of understanding mathematics so that all students will build on new mathematical knowledge through their work with problems. They will apply a wide variety of strategies to solve problems and adapt the strategies to new situations. They also will monitor and reflect on their mathematical thinking in solving problems.

  <u>Communication</u>
  Mathematics instructional programs should use communication to foster understanding of mathematics so that all students organize and consolidate their mathematical thinking to communicate with others and express mathematical ideas coherently and clearly to peers, teachers, and others. They will extend their mathematical knowledge by considering the thinking and strategies of others and use the language of mathematics as a precise means of mathematical expression.

  <u>Connections</u>
  Mathematics instructional programs should emphasize connections to foster understanding of mathematics so that all students can recognize and use connections among different mathematical ideas and understand how mathematical ideas build on one another to produce a coherent whole. They will recognize, use, and learn about mathematics in contexts outside of mathematics.

  <u>Representation</u>
  Mathematics instructional programs should emphasize mathematical representations to foster understanding of mathematics so that all students can create and use representations to organize, record, and communicate mathematical ideas and use representations to model and interpret physical, social, and mathematical phenomena.

Grade/Level:

Appropriate for Grades 4-6

Duration/Length:

Three to four one hour class periods

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- Measurement in centimeters
- Writing a business letter
- Making predictions
- Some background knowledge of graphing

Student Outcomes:

Students will:

- understand different ways to display data: line plot, bar graph, and scatter plot.
- work in a group to solve a problem by graphing and analyzing a data set.
- use a graph to interpret data and write a paragraph analyzing the results.

Materials/Resources/Printed Materials:

- Rubber bands
- Graph paper, or one inch grid paper
- Yardsticks and measuring tape
- Variety of balls in various diameters
- Masking tape
- Geoboards
- Student and Teacher Resource sheets

Development/Procedures:

Day 1

Opener – Guessing Game

1. Place a rubber band inside of a paper bag. Have the students ask yes and no questions as they guess what is inside the bag.

Activity – Rubber Band Throwing

2. Take the students out to a place with a large area that is at least 30 ft long (i.e., outside, the gym, cafeteria, or a hallway).
3. Place a large piece of masking tape on the floor or ground to serve as a starting line.
4. Choose 1 or 2 students to measure each throw with a tape measure or meter stick to the nearest centimeter. Appoint another student who will record all data.
5. Give each student a rubber band. Have students predict how far their rubber bands will travel when thrown.
6. Students will stand on the starting line and shoot their rubber bands.
7. Students will measure and record the distance each rubber band traveled.
8. Instruct the class to return to the classroom and display the class data on a line plot.
9. Discuss the significance of the class data.
10. Discuss what factors or variables might have affected the distances the rubber bands traveled.

Day 2

Opener – Amazing Rubber Bands Worksheet (Student Resource #1)

1. Distribute Student Resource #1 and have students answer the questions.
2. After allowing sufficient time for students to make an educated guess to complete Student Resource #1, have students share their answers (Teacher Resource #1). Encourage them to explain their answers with examples. For example, the rubber band may weigh as much as three bricks, etc.
3. Discuss size relevance of the megaball and show a transparency of (Teacher Resource #2).

Activity – Geoboard Measuring

4. Give each group of 4 students a geoboard and a rubber band. Students will receive rubber bands of varying thickness.
5. Students will see how far the rubber band can stretch across the geoboard. Students will count the area (number of squares) inside the rubber band to the nearest half square.
6. The data, the number of squares enclosed by the rubber band, will be recorded on a class bar graph. (Student Resource #2)
7. Discuss the results together, especially noting the different variables. (i.e., thickness of rubber bands)

Day 3

Activity – Bouncing Balls

1. Collect various balls of different sizes.
2. Tape metersticks on walls around the room. Make sure that there are enough for each group of 4 students. Also make sure that the metric side is visible.
3. Have students guess which ball will bounce the highest and why.
4. Have each group pick 2 balls of various sizes. Give each group a worksheet (Student Resource #3).
5. Have each group appoint someone to drop the ball, someone to record the data, and 1 or 2 people to spot the bounce of the ball.
6. Each group will drop (emphasize dropping not throwing) the ball from 30 cm, 40 cm, 50 cm, 60 cm, 70 cm, 80 cm, 90 cm, and 100 cm. The students will check to see how high each ball bounces back. Advise students to measure from the bottom of the ball. The ball will be dropped from each measurement 3 times. The data will be recorded on the worksheet.
7. Record the data from each group on a class scatter plot. (Teacher Resource #3)
8. Have a class discussion about the results emphasizing the difference size might make, compared to megaball.

Performance Assessment:

Day 4

Rubber Band Ball

1. Show the students a transparency of Teacher Resource #4.
2. Have students work in the same groups they were in on Day 3.
3. Give each group a large bag of rubber bands and Student Resource #4.
4. Each group will make a ball out of rubber bands. Remind students to use the data they collected with the activities on ball size and elasticity.
5. When finished, each group will test the rebound height of its ball from a 60-cm drop. The groups will drop their ball five times and then plot the median on the class chart (Teacher Resource #5).
6. Students will write letters to the Wicomico Toy Company telling them about the rebound height of their ball. (Teacher Resource #6)

Extension/Follow Up:

- Develop and create an advertisement for your "new" product.
- Create inventive ways to utilize unused rubber bands.

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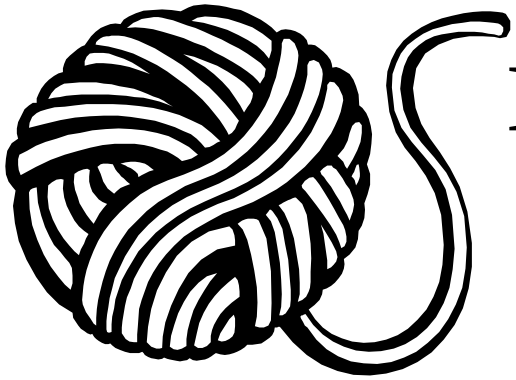


Mega Knowledge of Megaball

1. What is the megaball made of? _____
2. How much does the megaball weigh? _____
3. How long of a piece of string would you need to go around the entire megaball?

   _____
4. How many rubber bands are in the whole megaball?

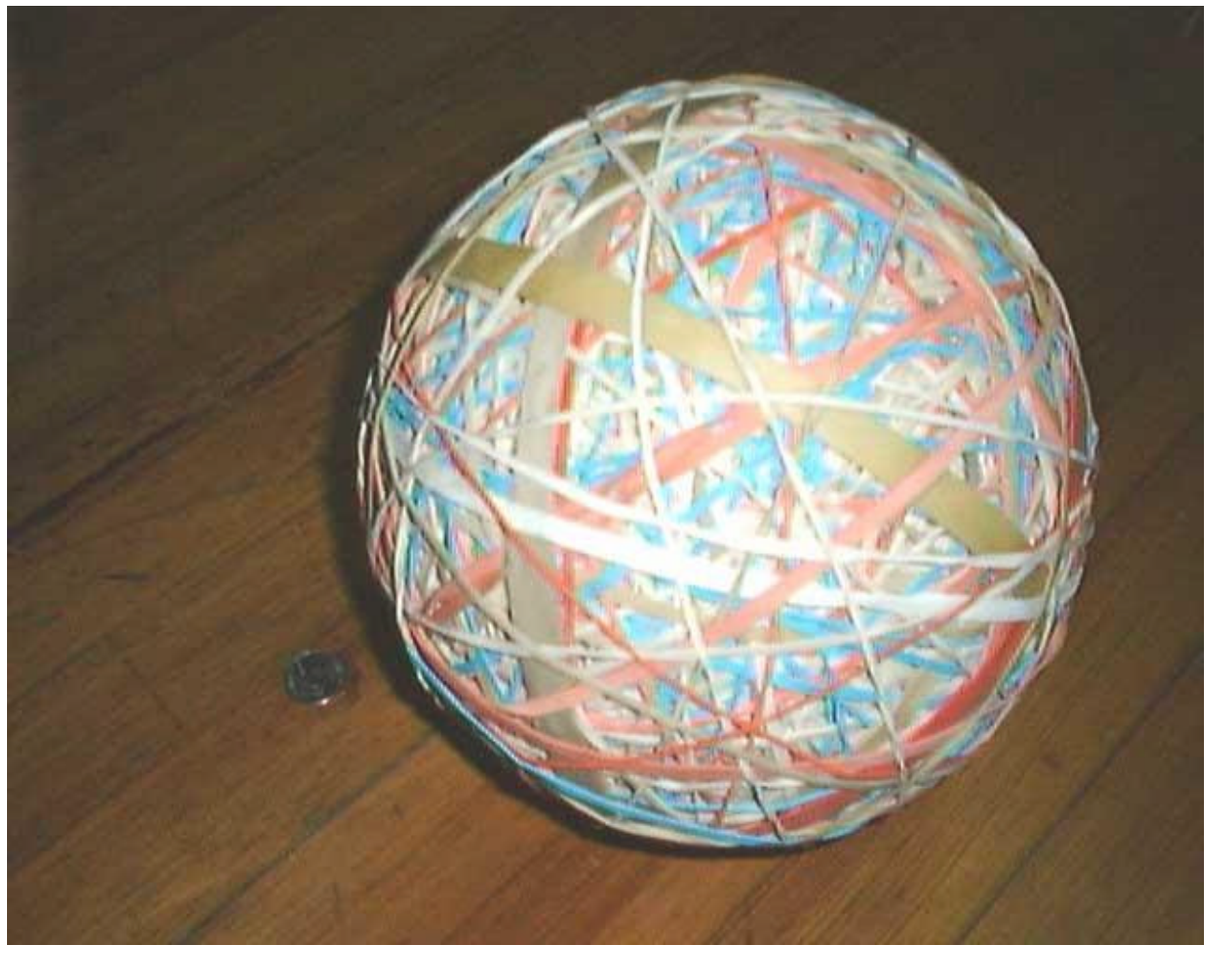
   _____
5. If megaball was dropped from the 10^{th} floor of a building predict how far would it bounce back up (in feet)?

   _____
6. When was the megaball invented? _____

Answer Key to Megaball Worksheet

1. Rubber bands
2. 12.69 pounds
3. 27.3 inches around
4. 6,200 rubber bands
5. 60 feet (answers will vary)
6. October 1993

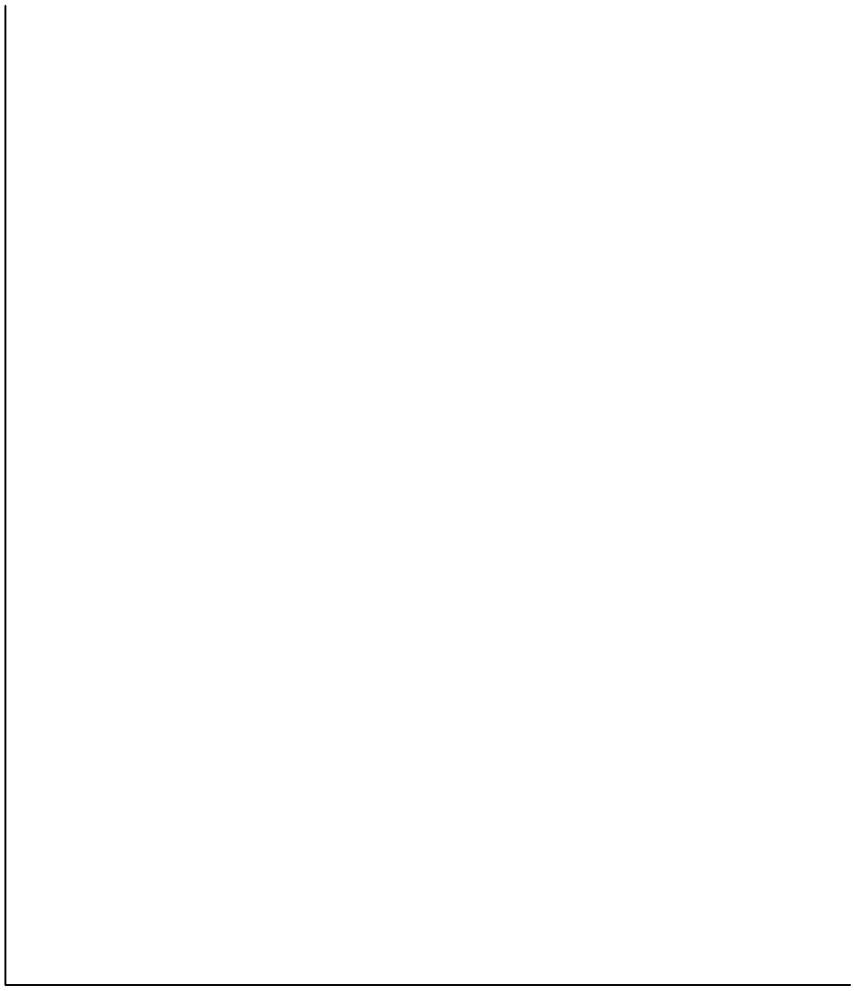
THE MEGABALL
VERSUS
THE QUARTER



“Stretchy, elastic, beautiful band,
I pull you gently with my hands.
Now you go to join your brothers,
In a unified ball made of rubber.” ~ Carole

San Francisco, California, a rubber band donor

Area of Stretchability

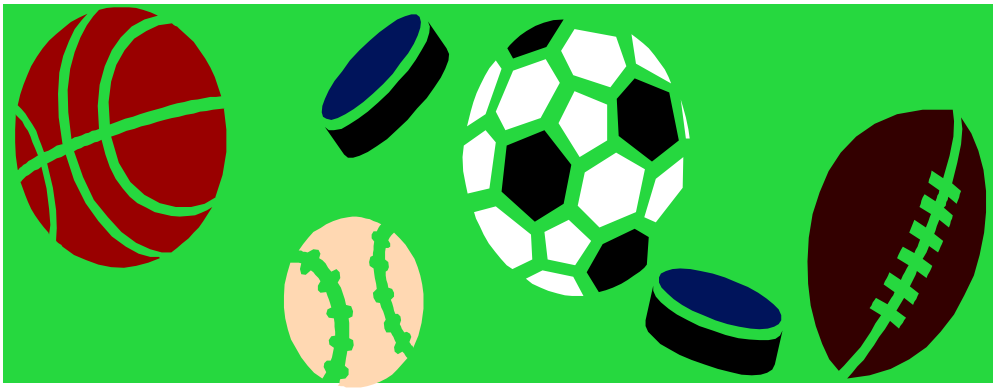


Groups

Student Resource #3

BALL REBOUND RECORDING SHEET

Kind of Ball _____ Type of Surface _____



Height of Drop (cm)	30	40	50	60	70	80	90	100
Height of Bounce (cm) – Trial 1								
Height of Bounce (cm) – Trial 2								
Height of Bounce (cm) – Trial 3								
Median Height of Bounce								

Rubric for Scatter Plot

To receive a score of 3, students must have the following:

- Title for scatter plot
- Labels on x and y-axis
- Correct number sequencing on x and y-axis
- Dots plotted in the correct places
- Show correct interpretation of data

To receive a score of 2, students must have the following:

- Title for scatter plot
- Label on x or y-axis
- Incorrect number sequencing on x and y-axis
- Some dots plotted in the correct places
- Show some incorrect interpretation of data

To receive a score of 1, students must have the following:

- No title for scatter plot
- No labels on x or y-axis
- Incorrect number sequencing on x and y-axis
- Some or most dots plotted in the correct places
- Show no understanding of data

Vignette

A local toy company, Wicomico Toys, has asked our class to design a new super, duper bouncy ball. Design one that would have more bounce and be fun for all ages. In a small group, design the new bouncing ball using rubber bands. Using your knowledge of rubber bands and balls, your goal is to create the highest bouncing ball.

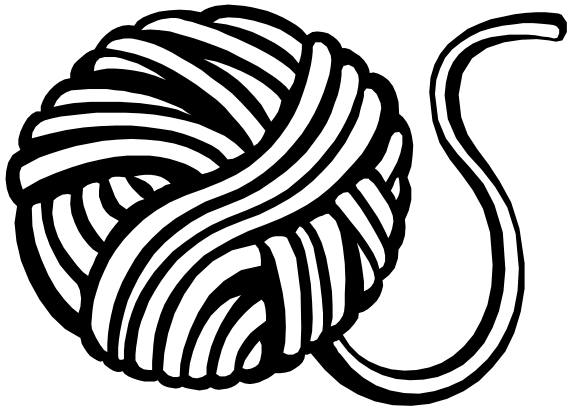
Plot each group's results and interpret the data. Using a business letter format, write a letter to Wicomico Toys telling them why one group's ball worked better than the balls designed by other groups and why the company should use it.

Student Resource #4

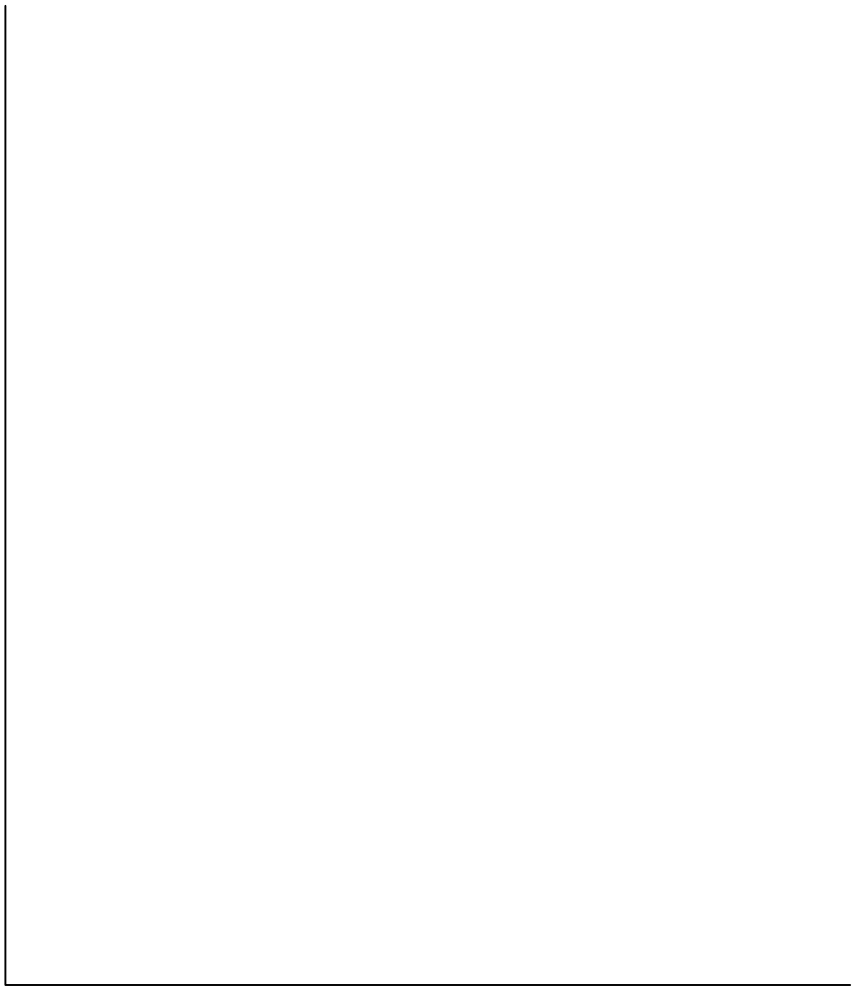
RUBBER BAND BALL REBOUND RECORDING SHEET

Names _____

Trials	Height of Bounce (cm)
1	
2	
3	
4	
5	



Rubber Band Ball Bounce



Groups

Rubric for Letter to Company

To receive a score of 4, students must have the following:

- Describe the winning ball using details from the graph
- Give a reason why that ball may have been the winner
- Construct complete sentences and proper grammar
- Have a proper business letter format

To receive a score of 3, students must have the following:

- Give some description of the winning ball
- Two reasons why that ball is the best
- Write a letter with most details of a proper business letter
- Complete sentences

To receive a score of 2, students must have the following:

- Name and some description of ball
- One reason why the ball is the best
- Missing some parts of proper letter format
- Some sentences incomplete

To receive a score of 1, students must have the following:

- No name and minimal description of ball
- No reasons why the ball is best
- Not in proper letter format
- All or most sentences incomplete and disjointed