Let’s Bounce!

Common Core Standard

7.RP.2b Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams and verbal descriptions of proportional relationships.

The Task

You are watching your neighbor’s children one afternoon and need to help settle a dispute. The siblings want to play with a ball that is really bouncy. Jana says she wants to use a tennis ball because she read somewhere that a tennis ball will bounce 58 inches when you drop it. Jared thinks a basketball will bounce more.

You decide that you need to find out more and look up information about the 3 types of balls you saw on sale at the local store: a tennis ball, a basketball, and a lacrosse ball.

According to International Tennis Federation (ITF): A tennis ball is tested for bounce by dropping it from a height of 100 inches (2.54 m). A bounce between 53 and 58 inches (1.3462–1.4732 m) is required for official use in competition.
http://www.itftennis.com/technical/rules/

The National Collegiate Athletic Association (NCAA) requires a basketball to measure between 29.5 and 30 inches in circumference, and bounce between 49 and 54 inches when dropped from a height of 6 feet.

The National Collegiate Athletic Association (NCAA) requires a lacrosse ball to have a bounce of not less than 1.1m or more than 1.3m when dropped from 1.8m onto concrete.

Which of these balls is the ‘bounciest’? Develop a way to present your findings to Jana and Jared to help them understand which ball will bounce the most.
Facilitator Notes

1. Introduce the task to the students. Allow students a few minutes to read the task and dialogue about what it means for a ball have the ‘most bounce’ or be the ‘bounciest’.
2. It may be helpful to note that these parameters hold true for new balls, filled to the appropriate pressure, bouncing on a standard concrete surface. They should assume that the balls Jana and Jared could get from the store are new and inflated.
3. Have students work in pairs or small groups to discuss and develop strategies for solving the problem. The groups should chart their strategies.
4. Provide students with graph paper, calculators, or other useful tools. (If desired, actual balls, measuring tapes, meter and yard sticks could be provided.)
5. As groups work, circulate to monitor which strategies are being used to solve the problem. If groups are struggling, encourage them to model the situation using ratio tables, tape diagrams, graphs, etc.
6. Once groups have had an opportunity to solve the task, have groups compare solutions and strategies (either through a gallery walk, a jigsaw, or through group presentations).
7. Highlight key ideas and approaches that were used by the groups.

Follow-Up Questions

1. Did you use a different approach for the information given in inches vs. meters? Why or why not?
2. A small rubber bouncy ball advertised that it has a between an 88–92% rebound. What is a possible drop height and bounce that could represent the bounce of this ball?

Solutions

A basketball is the ‘bounciest’ and would have the highest relative bounce.

Possible strategies may include, but are not limited to, finding the decimal equivalent for the ratio, comparing equivalent bounces in a ratio table, diagramming the drop and bounce height, or graphing.

The bounce or rebound can be described by its “coefficient of restitution”, which is a constant of proportionality.

- Tennis ball = 0.53–0.58
- Basketball = 0.68–0.75
- Lacrosse ball = 0.61–0.72

Note: Students could argue that a lacrosse ball with a maximum rebound (0.72) is bouncier than a basketball with minimal rebound (0.68).
Solution #1
I pictured dropping the balls from the same place, so I drew 3 diagrams with 3 different scales that were the same physical height on the page but in fact represented the 3 actual heights that were given. I drew a vertical number line diagram of each ball and used the ranges 0 – 100in, 0 – 6ft, and 0 – 1.8m. I used equal intervals for each number line.
A basketball bounced up the highest, but the lacrosse ball could bounce higher than a low basketball.
Solution #2
I think I should compare the balls as if I was dropping them from the same height. I only want to look at the information for the highest bounce since I am only interested in the bounciest ball. I think it will be easy to work with 100, so I build a ratio table to find drop heights of 100.

So, a basketball is the bounciest since 75 > 72.2 > 58.
Solution #3
I think that bounciness is how much a ball comes back up after dropping it. This relationship can be written as a ratio comparing how high it bounces to the height it is dropped from.

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\text{bounce height : drop height or } \frac{\text{bounce height}}{\text{drop height}}
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I can divide to find the decimal equivalent and compare the values easier that way. A basketball would bounce back up the most. Maybe a lacrosse ball would be good, too. The information overlaps. Jana and Jared could test the actual balls to decide.
Solution #4
I thought I could graph the line of each ball. I know that if I drop a ball from a height of 0 in then it will also bounce 0 in, so all lines will start at the origin. The other point on the line would be (drop height, bounce height). I figured that each ball should bounce back at least as much as the low end of the range, so I use that point for each line. I used (100, 53) for the tennis ball, (72, 48) for the basketball, and (180, 110) for the lacrosse ball. The basketball would have the highest bounce.

Follow-Up Questions:
1. Students could have converted the meters to feet or inches if they were not comfortable using the metric system, but it is not necessary. Essentially, the units of measure do not matter because they would cancel out in a ratio.
2. Answers will vary. Any relationship that falls between 88-92% is acceptable.
   - Drop from 3ft; bounce of 33in (91.67%)
   - Drop from 100in; bounce of 89in (89%)
   - Drop from 2m; bounce between 1.76-1.84 (88-92%)