

Bounce It Like Westbrook

Explore the advantages in the design of different sports balls

Have you ever wondered why a basketball is made the way it is? What are the advantages of its shape, size, and make up? Why are soccer balls or baseballs so different from basketballs, and do these differences matter? Experiment to discover these answers!

HERE'S WHAT YOU'LL NEED:

- Baseball
- Basketball
- Soccer ball or kickball
- Bouncy ball
- Meter stick
- Stopwatch, clock with second hand, or timer
- Paper and pencil
- White school glue
- Sodium tetraborate solution
(See Coach's Corner for directions!)
- Cornstarch
- Shaving cream (optional)
- Disposable bowls
- Craft sticks
- Marbles
- Small balloons (water balloon-sized is perfect)
- String
- Small Styrofoam balls, small pieces of cork, etc.
- Access to an internet-enabled computer for research



WARMUPS

Get started by examining how different balls from various sports behave when put through a series of tests. Grab a friend, your assortment of sports balls, meter stick, stopwatch, and pencil and paper to get started. Begin by making a chart to record how high and how long each ball bounces.

Which ball do you think will bounce the highest? Which one do you think will bounce the longest? Have your friend hold the meter stick upright so you can measure the height of bounces. Begin by dropping the first ball from the top of the meter stick. (You're probably going

to want to put some effort behind the bounce for the ball, but try to fight that temptation! For this test you want to just drop the ball without any extra energy from you. Let gravity do all the work!) **How high did the ball bounce? Record this data in your chart.** Repeat this drop/bounce test with each one of your other sports balls. **Record the bounce height for each ball in your chart, and then look at the data. How did the results differ from your original prediction of which ball you thought would bounce the highest?**

Next, test how long each ball bounces. Have your friend be in charge of the stopwatch or timer. Drop the first ball from the top of the meter stick like you did in the first test, but this time, time how long it takes for the ball to completely stop bouncing. **Record this information in your table.** Then, repeat the timed bounce test for each one of your other balls. **Again, record the information for each ball's bounce endurance in your table. How did these results compare to what you expected would happen?**

What did you notice about the control with which each ball bounced? When you dropped the bouncy ball, did it bounce up and down in a straight line, or did it bounce off at an angle? How about the basketball or the baseball? Why do you think each ball bounced the controlled (or uncontrolled) way that it did?

Based on your experiments, what explanation can you develop regarding why certain balls are designed the way they are for certain sports? What advantage does a baseball have to being smaller and firm?

What athletic benefit does a soccer ball serve by being large, flexible, and bouncy? Did you know that sports balls have actually been continually re-engineered throughout the history of each sport to be better and more efficient? You might not even recognize some famous sports balls from their first creations! For instance, the first game of basketball was reportedly played with a soccer ball!

Do some research on the internet or in the library at this point to discover what each of your sports balls is made out of, and how they're each constructed. Make a new chart to record the data that you find. **Which balls are simply full of air? Which have cores or are solid? What are some differences between the balls filled with air?**



GAME TIME

Now that you've discovered what certain sports balls are made of, try constructing your own ball out of a few different materials and see if you can create one that will bounce the highest and with the most control. To begin, gather together the materials you've collected as possible cores for your ball (small Styrofoam balls, marbles, water balloons inflated with air, ping pong balls, small balls of string, small pieces of cork, and whatever else you have on hand). Choose the core of your ball that will best suit your need. You're going to make a smaller ball in this experiment (as opposed to something the size of a basketball). Remember, you're looking to create a ball that will bounce as high as possible and with good control. When choosing your core, think back on your tests with the various sports

balls done earlier. Which ball(s) bounced the highest and with most control? What were they made out of?

Now that you've chosen or created your core, make the material you'll use to cover your ball.

- **Start by pouring about ½ cup of Elmer's Glue into your disposable bowl. This will be your mixing bowl.**
- **Add a small spoonful of cornstarch to your glue and mix it together.**
- **Now, squirt or pour a little bit of the sodium borate mixture into your glue. Mix it together. Slowly add more sodium borate until you are left with a nice blob that is pliable and non-sticky. This hunk of glue slime will be the covering of your ball.**
- **Flatten your piece of glue slime out into a sheet that you can wrap around your core, rolling the entire thing into a nice ball.**

Once you've completed making your ball, it's time to test it. Using a friend's help, perform the same bounce height activity that you did in the previous activity. With a meter stick being held upright, drop your ball from the top of the meter stick. Write down how high your ball bounced and whether the bounce was controlled or more wild. Repeat this test a few times to gain a good sample of how your ball behaves, and then switch places and help your friend test the ball that they have created.



ANALYZE THE REPLAY

What happened?

Once all testing has been concluded, collaborate with your fellow classmates to create a master chart of all the bounce heights and ball materials for each student in your class.

- **What was the highest any of the glue balls bounced?**
- **What material was used in the core of the highest bouncing one?**
- **Which balls didn't bounce very high at all?**
- **What material was used in the core of those?**
- **Did the difference in core materials lead to a great variance between bounce height, or a more subtle variance?**
- **Which ball bounced with the most control, and what was its core?**
- **What was the most surprising discovery in the glue ball bounce test?**



OVERTIME

Let's take it further

Want to add in an extra variable to the glue ball test? Try making another batch of glue slime, but this time add shaving cream to your glue instead of corn starch, and then bind it together the same way with sodium borate. **How does this batch of glue slime feel different from the cornstarch one? What difference do you think this shaving cream/glue slime coating will make in the "bounceability" of your ball?** Wrap this glue slime around the same type of core you used previously, and conduct the same tests. **How did the results differ from your cornstarch/glue slime ball? If the shaving cream changed the results, why do you think it did?** To take it even further, you could also change the amount of cornstarch you add to the glue, or even add water to the glue before mixing in the sodium borate. You can also explore with trying different cores!

COACH'S CORNER

Additional information and explanations for parents and educators

In the “Warm-up” portion we tested the bounce height and bounce endurance of several different sports balls.

Balls made of an elastic material shell and an air-filled center, like a basketball or soccer ball, have the ability to stretch and then return back to their original shape. The more malleable the material, the more it can stretch.

A ball held in the air has potential gravitation energy. When it is dropped, the energy is transformed into kinetic energy or the energy of motion. As the falling ball makes contact with the floor, some of that energy moves to its elastic shell, momentarily causing the ball to flatten out. As the ball regains its original shape, most of the energy transfers back into movement and the ball bounces upward. This up/down cycle repeats until gravity, heat, and friction slow the movement down entirely.

Balls with less flexible coverings or heavy solid centers, like a baseball, lack as much ability to distort their shape to conserve energy. Instead, more energy is lost through heat and friction reducing their ability to bounce.

Basketballs and soccer balls are very similar in their composition, as the students likely discovered through their bounce tests. There are some important differences between soccer balls and basketballs, though, as one can visually tell. Soccer balls are more flexible than basketballs so players can hit them with their heads and not injure themselves. Though both balls have a leather-like cover, the smooth surface of the leather on a soccer ball creates less friction. Basketballs used to have a similar surface, but they proved to be too slippery as the players got sweaty throughout the game. Those little dimples all over a basketball are specifically engineered to create more friction for players’ sweaty hands to be able to properly grip the basketball even in the middle of the most high stakes game.

In the “Game Time” section we explored the actual makeup of balls and what makes one especially bouncy by creating a chosen core for the ball (cork, Styrofoam, small balloon to simulate the rubber bladder found in basketballs, etc.) and covering it in a glue slime coating. This test allowed students to experiment with different materials in making their ball, as well as the variability of discovering which one bounced the highest or with the most control.

TO MAKE THE SODIUM TETRABORATE SOLUTION

Add 1 cup of water and 1 tablespoon of 20 Mule Team Borax powder to a bowl or beaker. Stir until the powder is completely dissolved.

Prefer not to make your own borate solution?

Substitute contact solution instead.

The Science of Glue Slime

The white glue is made up of polymers, long flexible chains of polyvinyl acetate molecules. These chains flow easily past each other allowing the glue to pour from one container to another. However, when the borate solution is added to the mix, the borate ions cross-link with the polymer chains connecting the strands together, hampering their ability to move easily. The result is a non-Newtonian fluid that has the properties of a solid when under pressure, but those of a liquid when not.

The amount of water mixed in with the glue or the concentration of the borate solution affects the cross-linking abilities. The less water in the mix, the more links are formed, resulting in a stiffer slime consistency.

While the slime coating used to cover the cores in the “Game Time” activity won’t retain its spherical shape indefinitely, it should provide an elastic covering for the test balls for the duration of the activity.

DO YOU WANT TO LEARN MORE?

Research: Kinetic energy, potential energy, elasticity, non-Newtonian fluid,
Newton's First Law of Motion, Newton's Third Law of Motion

OKLAHOMA ACADEMIC STANDARDS - SCIENCE

STANDARD		3 RD GRADE	4 TH GRADE	5 TH GRADE
PS4-1	Matter and Its Interactions			●
PS2-1	Motion and Stability: Forces and Interactions	●		●
PS2-2	Motion and Stability: Forces and Interactions	●		
PS3-1	Energy		●	
PS3-2	Energy		●	
PS3-3	Energy		●	