FINDING THE PERFECT SHOT

PART TWO – SPIN CYCLE

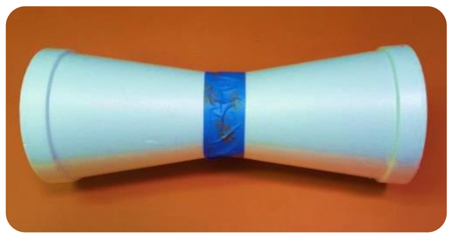
Most basketball players add backspin to the ball when they shoot. Does it really make a difference in their shot? Let's find out by investigating the effect spin has on the trajectory, or path, an object makes as it travels through the air.

HERE'S WHAT YOU'LL NEED:

- 3-4 thin rubber bands
- 2 Styrofoam cups
- Masking tape
- A variety of large and small plastic and paper cups
- A tape measure or meter stick
- A notebook
- An open area for flight testing
- Optional: LED and watch battery

WARM-UPS

Construct a test flyer by placing two Styrofoam cups together, bottom to bottom. Make sure the cups are lined up evenly and then tape them tightly together.



Prepare the test area by marking a launch line on the ground with tape.

Before you explore the effect spin has on the flyer's trajectory, observe how it behaves when it is launched without spin. Grasp the flyer around the taped area in the middle with one hand. Make sure both cup-openings are horizontal to the ground. Pull your arm back and then fling it forward, releasing the flyer as you straighten your arm and hand.

Mark the spot the flyer lands and record the distance in your notebook. Repeat the test four or five times.
Are your results similar each time? Why or why not? What can you do to get a more consistent result?

Draw a diagram of the flyer's flight path trajectory and use arrows to communicate the shape and direction.

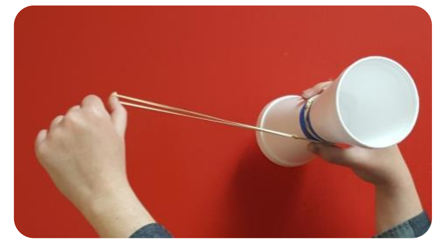
Now you're ready to introduce the variable of spin. How do you think the trajectory will change if you add backspin to the flyer's motion?

Before you start testing, construct a launch device by looping four smaller rubber bands together into one long chain. The band should help you produce a more consistent rate of spin for each test flight.

To launch your flyer, use your thumb to hold one end of the rubber band in the center, taped area.

Wrap the band tightly around the cups several times. Finish with the end of the band on the bottom pointing away from you.

Hold the flyer in one hand and the end of the rubber band in the other hand. Pull back the flyer and let go.



Observe the path the flyer takes and measure the distance it travels. Record the data in your notebook.

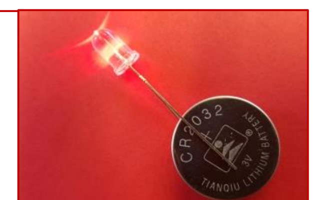
Repeat the backspin test four or five times.
How do the trajectories differ from the no-spin trials?

To get a more accurate picture of the trajectory, try using a little light!

Attach an LED and a watch battery to the inside bottom of the cups with tape.

Turn off the lights.

Launch the flyer and use a slow-shutter app or smart phone camera to record the path it takes.



GAME TIME

The direction the rubber band is wound around the cups and how the flyer is held when it's launched (cup openings vertical [up and down] or horizontal [side-by-side]) can affect the direction of the spin.

Design an experiment to test what impact different spin directions have on the trajectory of the flyer.

Create a data table to record your measurements and observations. They will help you look for patterns and analyze your results.

OVERTIME

Let's take it a step further

Now that you've tested how spin affects the flyer's trajectory, change a different variable to see how it affects the flight path.

Possible variables to change:

- the size of the cups
- the material the cups are made of
- the number of cups used
- using other types of containers
- using containers that are not identical
- the length of the rubber band chain
- the design of the launcher

Choose a variable and predict what will happen.

ANALYZE THE REPLAY

What happened?

Once you've finished testing, take the time to review and consider all of the information that you have collected through your tests and observations.

What surprised you the most?

Looking at your data, how does the spin affect the trajectory of an object? Think about what you have discovered and use your data to help you write a scientific explanation for your results. What type of spin would you recommend? Why?

What difficulties did you encounter during testing? How did you overcome them?

Think about what you've observed from your flyer trials and from watching others play basketball. How would adding spin to the ball help a player's shot success? What type of spin would you recommend? Why?

DO YOU WANT TO LEARN MORE?
Research:
Projectile motion/Rotation motion/Magnus effect/Newton's Third Law

CHECK OUT THESE WEBSITES AND VIDEOS:

See how backspin affected a basketball when dropped from 140m up off of the Gordon Dam.
https://youtu.be/2OSrvzNW9FE

How to Get Backspin on a Basketball
http://www.livestrong.com/article/467883-backspin-basketball/

Background and practical uses for the Magnus Effect
http://www.youtube.com/watch?v=Fk2xU8pEIIl&sns=em

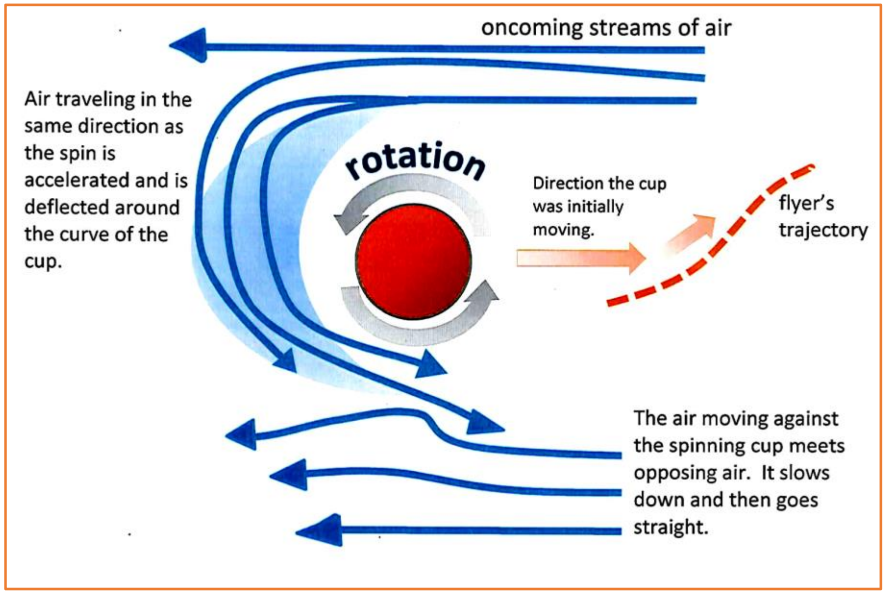
Physics Girl's The Physics Behind a Curveball - The Magnus Effect
http://www.youtube.com/watch?v=YIPO3W081Hw&sns=em

Veritasium's What Is The Magnus Force?
http://www.youtube.com/watch?v=23f1jvGUWJs&sns=

COACH'S CORNER

Additional information and explanations for parents and educators

In warmups, the flyer was launched with backspin. The rubber band was stretched around the cups and pulled back. When the flyer was released, the cups traveled forward, spinning in a counterclockwise direction. As it flew forward through the air, the oncoming air moved around the cups from front to back. The cups were spinning the same direction as the air flow at the top of the cups, but at the bottom, the cups were moving in the opposite direction.



Because of friction between the oncoming air and the surface of the flyer, the air at the top was pulled around the top of the cups and downward around the curve.

At the bottom of the flyer, the airflow and the cups were traveling in opposite directions. Instead of being deflected upward, the air slowed down before it returned to its flight's original path.

As a result, more air was deflected downward. Newton's Third Law now came into play and the air exerted an equal and opposite force on the cups, pushing the flyer upward. Eventually, friction slowed the rotation and the flyer falls back down.

If the flyer is launched with topspin, the cups rotate in a clockwise direction. More air is deflected upward and, because of Newton's Third Law, the flyer is pushed sharply downward. Likewise, cups that are given sidespin produce a trajectory that curves either to the right or left.

This phenomenon, known as the Magnus effect, was first described in the 1850's by Heinrich Gustav Magnus while he was investigating the trajectories of cannonballs. The Magnus effect is often used by athletes in many different sports. Bending a soccer ball around a group of defenders, using topspin to drop a tennis ball just over the net and curveballs that quickly drop just out of a batter's reach are all examples.

In basketball, a ball shot with backspin tends to be a softer shot with a higher arc. The friction between the air and the ball reduces the ball's velocity and the equal and opposite reaction of the Magnus Effect pushes the ball higher into the air. Additionally, if the player misses the shot and hits the backboard, the ball will bounce in the direction of the spin and back toward the net.

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