Mr. Willoughby
General Physics
The Pitch

Name: ________________

Date: ________________

Materials: two whiffle balls, 2 meter stick,

Procedure:

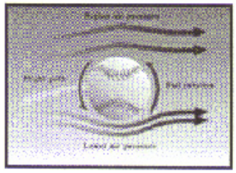
1. Obtain materials and one partner.
2. Stand approximately ten yards from your partner.
3. Place one meter stick on the ground as a refrence point for aiming the balls.
4. Throw the whiffle balls at the meter stick using the different methods for curving a ball.
5. Measure the distance the ball curved from the original line of throw. Accuracy will be different for every person. You should use the best approximation you can.
6. Repeat this ten times recording your information in a data chart.
7. Switch places and repeat the procedure.

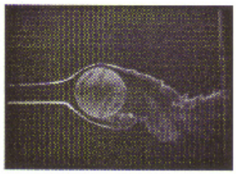
Questions:

1. Were you able to be accurate with your throws?
2. Did the balls curve as predicted?
3. Explain why the balls curved?
4. How do curve balls aid pitchers?
5. Draw out your data table and turn in with lab.

Does A Curve Ball Really Curve?

PREV NEXT





Spinning (Backspin) Baseball in a Water Tunnel
Note how the Flow Reacts When the Dye Hits the Baseball's Seams

Just before the outbreak of the American Civil War, a New England boy named Arthur Cummings became fascinated by a newly popular game called "base ball." On the beaches near his home he imitated his heroes by endlessly pitching clamshells. Soon he discovered that by holding and throwing the shells in a certain way, he could make them curve. Arthur, nicnamed "Candy" by his friends, daydreamed that one day he would play with his heroes and make a baseball curve like the clam shell.

In 1867, 18 year old Candy Cummings, pitcher for the Brooklyn Excelsiors baseball team, tried out the pitch he had been perfecting in secret for years. He wound and threw, snapping his wrist as he released the ball. He watched with delight as it made an arch and swept past the lunging batter into the catcher's glove. Again and again throughout the game, Cummings made batters fan the air swinging at his secret pitch. Today, in the Baseball Hall of Fame in Cooperstown, New York, there is a plaque that reads: Candy Cummings, inventor of the curve ball.

Yet for more than 100 years after Candy introduced his new pitch, people have doubted their eyes. Does a baseball really curve, or is it an optical illusion? Several attempts have been made through the years to settle the question. In an early test two large hoops were placed between the pitcher's mound and home plate. When the ball was pitched, it went past the first hoop and through the second one, seeming to indicate that the ball had curved inward. But skeptics remained. In 1941 both Life and Look magazines used stop-action photography to determine if curve balls really curve. Life concluded that they do not; Look claimed the opposite. As late as 1982, Science magazine commissioned both General Motors and the Massachusetts Institute of Technology to investigate the question. Their findings: A curve ball does curve, and can be explained by the laws of physics that are becoming familiar to you.

Throwing a curve ball is a snap - literally. A pitcher makes a finger snapping, wrist twisting movement as the ball is released. This creates a topspin of the ball as it travels, so that the top of the ball is moving forward against the air and meeting resistance while the lower half is spinning backward and moving in the same direction as the air. The air pressure above the ball is greater than the pressure below, causing the ball to curve downward. In the 60 foot 6 inch distance between major league pitcher and batter, this curving force can move a ball down a foot or more.

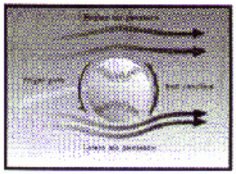
Combining with the effect of air pressure is gravity. A ball will eventually fall to earth as its velocity (speed) is reduced. A pitcher applies just enough force to his throw so that it is spent as it reaches the batter, allowing gravity to pull the ball down. Gravity makes objects move faster over time, so its effect on the ball is more pronounced as it reaches home plate. A pitch that drops half a foot in the first half of its flight falls another two feet in the second half. Add the fact that the pitcher is standing on a mound nearly a foot higher than the batter, and releasing the ball at head level, and we see that the arc of a curve ball is significant.

A curve ball, therefore, for the reasons given, is indeed no optical illusion. Anyone who has stood in a batter's box and tried to hit one has never doubted that the curve ball curves. But batters who claim the ball seems to make a sharp bend away from the bat as they swing, as if wood repelled leather, are somewhat the victims of an illusion. Studies show that a curve ball makes a smooth, circular path from pitcher to batter; but because of the increasing gravitational pull on the ball, and the difference in height between release and arrival, the ball appears from a batter's point of view to "fall off a table."

To add to a batter's dilemma, a good pitcher develops a variety of curving pitches, each with a descriptive name. The "round house" curve ball is thrown by a right handed pitcher to a right handed batter with both a topspin and a twist of the wrist, as if turning a door handle; this creates a high pressure area not only above but to the right of the ball, causing movement both down and to the left. The ball arrives lower and farther away than it would if it had been thrown in a straight path. Turn the handle in the opposite direction and the ball curves toward the batter rather than away - the "screwball." A curve ball thrown with more force, thereby allowing less gravitational pull, drops little or not at all, and seems to slide to the right or left on the same plane as it was thrown; hence the name, "slider." A ball thrown with topspin but with less force than the slider, and without the handle turning motion, doesn't move left or right but simply sinks as it arrives - the "sinker." And then there's the "knuckleball," held and released with little velocity or spin; the aerodynamics of this pitch are left entirely to random effects of air pressure and currents of the moment. Not only does the batter guess where it's going - so do the pitcher and catcher.

Consider: A ball travels from the pitcher to the catcher in about half a second. In order to hit the ball the batter must be swinging before the ball arrives. That means the batter has about a quarter of a second to decide where the ball will be and how soon it will be there, and swing (or not swing) accordingly. Batting is considered the most difficult task in sports. And on the mound is the task master, the pitcher, who is often likened to an artist with a palette of choices. Considering what we now know is involved - velocity, air pressure, gravity - one might call a pitcher not baseball's artist but its scientist.

The Aerodynamics of the Knuckleball page 1



Knuckleball

This is perhaps the hardest pitch to master. Not just for a pitcher, but for an aerodynamicist as well. Some believe that a knuckleball thrown without any spin will be at the mercy of any passing breeze. An thus, dances through the air in an unpredictable fashion. However, the most likely reason for the "dance" of a knuckleball is a very slow spin. Researchers have learned that a slight change in the orientation of the ball with respect to the flow of air results in dramatic changes in the forces acting on the ball. Not only does the magnitude of the force change, but the direction also changes. This is why the ball appears to "dance".

The mechanism by which the forces change magnitude and direction is not known. However, one can theorize that the stitches play a key role. The stitches will most likely cause the boundary layer to trip to a turbulent state. As we know, turbulent flow will stay attached longer than laminar flow. In fact, once the boundary layer becomes turbulent, a separated flow tends to reattach. This reattachment will dramatically alter the forces on the ball. Similarly, as the ball rotates, a region that was turbulent due to the position of the stitches, might now become laminar. The laminar flow will separate earlier than the turbulent flow. This altering of the state of the flow from laminar to turbulent, separated to attached, would cause the forces on the ball to fluctuate as shown by the experiments.

Furthermore, it is important to note that even if the pitcher throws the ball with no rotation, the flow asymmetry will cause the ball to rotate. The flow asymmetry is developed by the stitch pattern on a baseball.

The Spitball and the Vaseline ball

As previously mentioned, the knuckleball is very difficult for a pitcher to learn much less control. A simpler and more effective method is to use a lubricant such as saliva or vaseline. This causes the pitch to slide through the fingers and thus have little spin. Therefore, the ball moves like a knuckleball, but at the speeds of a fastball. This makes a spitball next to impossible to hit.

Other dirty tricks employed by pitchers involve scuffing the surface and/or polishing the surface. Just as a rough surface promotes turbulent and, therefore, attached flow, a polished surface will maintain laminar flow and hence separated flow. By roughening one side and polishing another, the effects of various pitches will be exaggerated. So, in reality, a pitcher is not just a ball player, but an amateur aerodynamicist as well.