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Mathematics of Hitting a Baseball

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### The Mathematics of Hitting a Baseball

Hitting a baseball is one of the hardest things to do in sports today. Hitting a spherical object with a cylinder object is no easy task. There are many different aspects that build up to hitting the ball in the correct way. The four factors of hitting are reaction time, how far the ball travels, the hitter being able to hit different types of pitches, and the batters bat speed and the angle the bat hits the ball. To be a good hitter, you must have great reaction time and bat speed. When the pitchers throws a fast-ball down the middle, you must be able to hit that pitch with the best bat angle and let the ball supply the power.

#### Reaction Time

Having good reaction time is a key attribute in a good hitter. The hitter as only a fraction of a second to determine four things: how fast the ball is being pitched, where it is located, and what kind of pitch is it, then swing. Reaction time is easily figured out by a simple conversion factor. Say that we only know how far away the mound is and how fast the pitch is coming. We need to find how much reaction time we have before the ball crosses the plate into the catcher's glove.

The regulation mound distance is 60.5 feet. If the pitcher throws a 90 mile/hour fast-ball, what is the reaction time for the batter? Because we know that the mound is measured in feet and inches, we would like to find the 90 miles/hour in feet/second.

$$90\text{miles}/1\text{ hour} \times 1\text{ hour}/60\text{ min} \times 1\text{ min}/60\text{ sec} \times 5280\text{ft}/1\text{mile} = 132\text{ft}/\text{sec}$$

We found the feet/second in a simple mathematical way. Everyone is familiar with all of the mathematical equations above. Now that we have found that 90 miles/hour is

132 feet/second, we can now set what we found equal to the distance from the mound to home plate.

$$132\text{ft}/1\text{ sec} = 60.5\text{ft}.$$

When we divide both sides by 132 ft/sec, the "ft" cancels out and we are left with our answer:

$$t = .458\text{ sec to react}$$



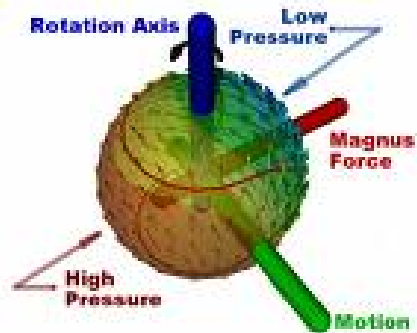
### Hitting certain types of pitches

Pitchers use many different types of pitches to throw a hitter out of his/her rhythm at the plate. The most popular types of pitches are the curveball, fastball, and changeup. All of these pitches have a different way of confusing the batter.

#### -The Curveball-

The Curveball is thrown with a lot of spin. The ball tends to drop at the last second away, or into, the batter. The ball is not thrown with a lot of velocity. It is usually thrown right after a fastball because the speed of the pitch changes greatly. When a curveball is thrown, it is exploiting the Magnus Effect. “The **Magnus effect** is the phenomenon whereby a spinning object flying in a fluid creates a whirlpool of fluid around itself, and experiences a force perpendicular to the line of motion and away from the direction of spin” (The Magnus Effect Wikipdia.com)

(How to hold a curveball)



-The Fastball-

The fastball is a pitch that is thrown at a high velocity. This pitch is used to catch the hitter off guard. If the batter has slow reaction time, a fastball will go by them for a strike most of the time. A fastball can be thrown in a variety of ways, also. The most common ways are a 2-seam fastball and a 4-seam fastball. The 2-seam fastball tends to move, or tail, with a sharp-quick type of motion. The 4-seam fastball tends to go straight towards the spot the pitcher has chosen to throw to.

(How to hold a 2-seam fastball)



(How to hold a 4-seam fastball)



### -Changeup-

The changeup is a pitch that is used to throw the hitter off guard with its slow velocity. This pitch is designed to look as if the pitch is coming in like a fastball, but is slow enough to have the hitter swing too early. The changeup, like the fastball, can be thrown in a variety of ways. All of the different ways still have the same effect for the batter.

(How to hold a changeup)



The amount of spin and velocity determines how far the ball will travel. The average fastball comes to the plate with backspin up to 1800 rpm. To hit the ball out of the park, the hitter must reverse the rotation of the ball so that it leaves the bat with backspin. By creating a lot of backspin, the ball will have lift and travel farther. A curveball can carry topspin of 1900 rpm. When the batter is able to hit a curveball on the right part of the bat, backspin is created from the front spin of the pitch, thus producing 45 percent more backspin off the bat.

Curveballs are usually hit farther than a fastballs. Studies by “Mont Hubbard of the University of California, Davis, found that a 94-mph fastball leaves the bat 3 mph faster than a 78-mph curveball, but it travels 442 ft. compared to the curve’s 455 ft” ([www.popularmechanics.com](http://www.popularmechanics.com)).

The ball will travel farther if the batter makes perfect connection with a curveball. A fastball and curveball have the largest amount of spin. The fastball travels at a high rate of speed and will go farther with contact. Pitches with less spin will not allow the ball to travel a far length. A pitch called a knuckleball is thrown with no spin at all. Hitters are able to get base hits but usually do not hit this pitch out of the park.

Bat speed and the bat’s angle are other big factors that go into being a great hitter. Bat speed is how fast the hitter can get the bat from the loaded position to the instance of contact with the ball. A good hitter is able to get the bat to the ball quickly and accurately. The angle of the bat will determine if the ball will be a groundball, liner, or pop fly. A few millimeters can decide whether you hit the ball out of the park, or if you hit a weak ground ball back to the pitcher.

Hitting a baseball is no easy task. Having good mechanics is vital if you want to be one of the best. By doing reaction time exercises and working on bat speed, it will maximize your chances of hitting the ball out of the park. When a hitter steps up to the plate, they think about hitting that ball as hard as they can. When a mathematician or physicist step up to the plate, they are thinking of all types of factors and equations that will help them succeed. It is really amazing to see all that goes into a sport, like baseball. If you really look at the mathematics of hitting, it will better your approach at the plate and make you a better baseball player.

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