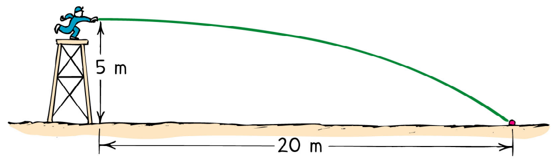
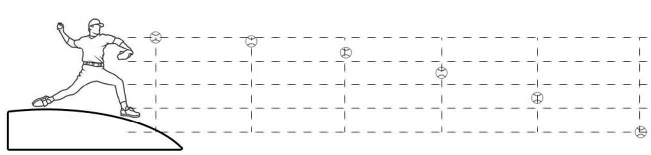
Anatomy of a Pitch



The basic idea of this activity is simple: the horizontal and vertical motion of a projectile—in this case a baseball—are independent of each other. If Timmy throws a baseball from a tower 5 meters tall that lands 20 meters downrange, how fast did he toss the pitch? Show your reasoning.

The key to good hitting is timing. The key to good pitching is throwing the batter's timing off. Even by the slightest amount will make a big difference. One of the main ways pitchers do this is by varying the speed of the pitch. Let's see how slight differences in speeds makes on the trajectory of the ball.

Assume the pitch is released level to the ground from the pitcher's mound. That means the initial speed of the pitch is purely horizontal. However, as soon as it leaves the pitcher's hand the ball begins to fall due to gravity and acquires a vertical component. The trajectory of the ball is a parabola. The slower the pitch, the more time it takes to get to the plate and the more time it has to drop vertically. However, since the horizontal and vertical components of the pitch are independent of each other, the ball crosses the plate with the same horizontal velocity the moment the pitcher released it.



The distance from home plate to the pitcher's mound is 60 feet (actually 60'6"), however since pitchers lean forward as they release the pitch, the release point is closer to 50 feet than 60 feet. Suppose the pitch is released at 85 mi/h. Find the following.

Remember, $g = 32$ ft/s^2. Neglect the effects of air friction and the spin of the ball. Rewrite the formula for the vertical drop using 32 ft/s^2.

$$d_y = \frac{1}{2}gt^2 =$$

1. First, convert 75 mi/h to ft/s. Remember 1 mi/h = 1.47 ft/s.

v_x = ______ft/s

2. Calculate the time *t* for the pitch to get to home plate.

t = ______

3. Calculate the vertical distance the ball drops due to gravity in this amount of time in feet.

d_y = ______ at 75 mi/h

4. Convert the vertical drop in feet to inches.

5. Repeat Steps 2 - 4 for 85 mi/h. v_x = ______ft/s d_y = ______ at 85 mi/h

6. Repeat Steps 2 - 4 for 95 mi/h. v_x = ______ft/s d_y = ______ at 95mi/h

Write the results of your calculations in the table below.ca

horizontal distance	**horizontal pitch speed**	**time**	**vertical drop**
d_x = 50	v_x	t	d_y

7. Carefully tape 2 pieces of graph paper together horizontally. Try to do so such that the don't over lap more than a square or so. Using the scale 1 cm = 1 ft, draw a line in the middle of your graph paper that represents 50 ft. This means the lines should be ____ cm long. Label the line "Trajectory of the Ball Without Gravity". Label the left side of the line, "Pitcher's Release Point" and "Home Plate" in the lower right hand corner

8. On the right hand side of the line over home plate, draw lines that represent how much the ball drops vertical due to gravity for 75, 85, and 95 mi/h. Draw a dark dot that represents the ball at this position.

9. At half the distance to the plate, how far will the ball have dropped compared to the distance to home plate? What about $1/4^{th}$ the way?

d_y = _____ at 25 ft

d_y = _____ at 12.5 ft

d_y = _____ at 37.5 ft

10. Draw lines the represent the fraction of the distance to home plate for each pitch.

11. Finally, preferable in different colors, sketch the parabolas for each pitch. Use pencil first to get a smooth parabola, then re-draw it using a different color for each pitch.

Analysis

1. Does the ball drop vertically from the straight line it would go without gravity very much half-way to home plate? If so, explain why so many people think the ball does not drop at all until it gets near home plate?

2. It is often said that baseball is a game of inches. Do your graph support that assertion? Explain.

2. What is the difference in time it takes the pitch to get to home plate between an 85 and 90 mi/h? Between an 85 and 95 mi/h?

3. Barry Bonds, one of the best hitters of all time, took about 1/3rd of the time it took the ball to get the plate to swing the bat and contact the ball. How much time, in seconds, does this give him to swing the bat to hit the ball for each pitch?

time to swing at 85 mi/h: t = ________ s

time to swing at 90 mi/h: t = ________ s

time to swing at 95 mi/h: t = ________ s

Extra for Experts

Create a spreadsheet that calculates the vertical drop of the ball when it reaches home plate. Make sure your columns are properly labeled. Print out your final working version with the calculated values. Attach your printout to this lab.