

Forces on a baseball

By NASA.gov, adapted by Newsela staff on 10.20.16

Word Count **642**

Level **1050L**



TOP: Baseball. Pixabay.

When a baseball is thrown or hit, its resulting motion can be described by certain physical laws. These laws were discovered by Isaac Newton in the 17th century. According to Newton's first law of motion, a moving baseball will keep moving in a straight line unless it's affected by an external force.

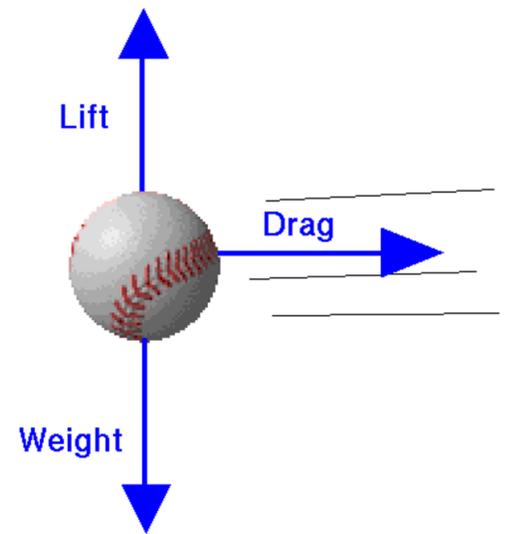
A force may be thought of as a push or pull in a specific direction. It is a vector quantity, which is a type of measurement that refers to both a direction and a magnitude, or strength. The three forces that act on a baseball in flight are weight, drag and lift.

Weight

Weight is a force that is always directed toward the center of the Earth. The magnitude of this force depends on the mass of the object it is acting on. Mass is a measurement of the amount of matter that an object contains, while weight is the measurement of the pull of gravity on that object.

The weight of a major league baseball is 5 ounces. The weight is distributed throughout the ball, but we can simplify the picture and think of the weight as acting through a single point called the center of gravity. Since a baseball is almost a sphere, its center of gravity is exactly in its center. In flight, the ball rotates around its center of gravity.

Strictly speaking, the weight of the ball should not be specified in ounces. The ounce is a measure of mass, while weight, a force, is measured in pounds. On Mars, where gravity is weaker than on Earth, the mass of a baseball would be the same as on Earth, but the baseball's weight would be less than on Earth.



Drag

As the ball moves through the air, it meets with resistance. The force of the air against the ball is called drag. Drag is directed against the baseball's flight direction, so it slows down the ball.

There are many factors that affect the magnitude of the drag force, including the shape, size and speed of the ball, and the conditions of the surrounding air. Determining the strength of the drag force is difficult because it depends on how the flow of air interacts with the object's surface. This is particularly tricky on a baseball, because the stitches are not symmetrically distributed around the ball.

Researchers have figured out an experimental way to measure the drag on a baseball. They have someone throw the ball, and then they measure the change in velocity, the speed of something in a given direction, between two points. As long as they know the distance between those two points, they can determine the drag force on the ball.

Lift

Lift is a force that is directed upward from the direction an object is flying in. Airplane wings use lift to overcome the weight of the airplane and allow the airplane to fly. Like drag, the magnitude of the lift force depends on the conditions of the air and the object, and the difference in speed between the air and the object.

The stitches on a baseball add some difficulty in calculating the lift force. As with the weight force, the lift force acts on the entire body of an object, but we imagine it at a single point. This point is called the center of pressure.

For an ideal, perfectly smooth ball, the center of pressure is at the center of the ball, along with the center of gravity. But a baseball in flight is not smooth or symmetric, because of its stitches. So the center of pressure for a baseball moves slightly over time, depending on how the stitches are placed. This change causes the ball to move around in mid-air. The motion is the source of the "dancing" knuckleball that confuses batters and catchers alike.

Quiz

- 1 Jupiter has much greater mass than Earth. How would the weight of a baseball change if Jupiter had a greater gravitational force?
- (A) It wouldn't. An object's weight is the same everywhere.
 - (B) It would increase because an object's weight is a measurement of the pull of gravity on it.
 - (C) It would decrease because an object's weight is a measurement of the pull of gravity on it.
 - (D) It would increase and then decrease because of the impact of space.
- 2 Select the paragraph from the "Weight" section that explains how weight affects the way a baseball spins in motion.
- 3 Forces can be attractive (they pull objects together) or repulsive (they push objects apart). Which of the following is true regarding the gravitational force?
- (A) Gravitational forces are always attractive.
 - (B) Gravitational forces are sometimes attractive.
 - (C) Gravitational forces are repulsive.
 - (D) Gravitational forces are neither attractive nor repulsive.
- 4 Which section from the article BEST explains how the resistance of air affects the speed of the ball in flight?
- (A) Introduction [paragraphs 1-2]
 - (B) "Weight"
 - (C) "Drag"
 - (D) "Lift"
- 5 Forces are sometimes described as being either contact or non-contact forces. Contact forces are forces that act on objects that touch, while non-contact forces act over a distance. Given this, which of the following are examples of non-contact forces?
1. the gravitational force pulling a person who has jumped
 2. the force of tension on a yoyo as it hangs from a string
 3. the force on a wagon by a person pushing it
- (A) 1 only
 - (B) 2 only
 - (C) 1 and 2
 - (D) 1, 2, and 3
- 6 Which of the following answer choices are two main ideas of the article?
- (A) Laws of motion were discovered by Isaac Newton in the 17th century; an ounce is a measure of mass while pounds measure weight
 - (B) A baseball is a sphere which rotates around its center of gravity in flight; drag or resistance of air against the ball can slow it down.
 - (C) Weight is a force always directed at the center of the Earth; researchers have found a way to measure drag on a baseball.
 - (D) When a baseball is thrown or hit, its movements can be described by physical laws; a vector is a type of measurement that refers to both direction and strength.

- 7 Newton's first law tells us that a moving ball will stay in motion in a straight line unless it is acted on by external forces. The motion of an object is determined by the sum of the forces acting on it. Given this, which of the following is true of a ball traveling through the air?
- (A) After a baseball is thrown or hit, it travels through the air in a straight line because there are no external forces acting on it.
 - (B) After a baseball is thrown or hit, it travels through the air in a straight line because there are no unbalanced forces acting on it.
 - (C) After a baseball is thrown or hit it does not travel in a straight line because there are unbalanced forces acting on it.
 - (D) After a baseball is thrown or hit it does not travel in a straight line because there are no external forces acting on it.

8 Which sentence from the article would be MOST important to include in a summary of the article?

- (A) The three forces that act on a baseball in flight are weight, drag and lift.
- (B) The weight of a major league baseball is 5 ounces
- (C) Airplane wings use lift to overcome the weight of the airplane and allow the airplane to fly.
- (D) The motion is the source of the "dancing" knuckleball that confuses batters and catchers alike.