Lesson Plan 1
"The Greatest Distance is Sound"

Students will be able to:
- Make inferences from observation of phenomena.
- Predict the inferences of the motion of some objects on other objects.
- Evaluate a simple procedure to carry-out an exploration.
- Evaluate scientific investigations to formulate and revise scientific explanations.

Materials:
Hammer or piece of wood the size of a hammer, baseball bat (aluminum and/or wooden bat), ruler

Before the Game:
Hold the bat horizontally with one hand. With your other hand, pick up a hammer or piece of wood. Strike the bat at points that are one inch (2.5 cm) apart. Start at the heavier end of the bat. Listen to the sound the bat makes each time you hit it (note all changes of sound as you move from one end to the other).

1. What did you notice about the sound of the bat each time you hit it?
2. Where is the spot that makes the clearest, most solid sound?
3. Measure how far this spot is from the thick end of the bat (inches or cm).
4. Why do you think this spot is called the "center of percussion"? (Hint: Which band instruments are called percussion instruments?)

At the Game:
1. Observe the sound that Cubs players' bats make. Are these sounds different from the sounds of your bat? Do ground balls sound different than fly balls?
2. Have various students close their eyes for one half inning of the game. Have these students attempt to determine the distance that the ball travelled based on the sound off the bat. Have your students track the difference between their "guess" and the actual distance of the ball.

Beyond the Game:
1. Experiment with other sports equipment (e.g. tennis racket, racquetball racket, hockey stick, etc.) to find the "center of percussion." Graph your findings.
2. Why do professional players use wooden bats whereas collegiate players down through little league use aluminum bats? Note that collegiate baseball players are now slowly being required to switch from aluminum bats to wooden bats. Why?

Lesson Plan 2
"The Center of Gravity"

Students will be able to:
- Make predictions then inferences from observations of phenomena.
- Evaluate a simple procedure to carry out an exploration.
- Evaluate conclusions based on scientific data.

Materials:
Variety of baseball bats, 2 feet of string

Before the Game:
On every bat, there is a spot where the weight is concentrated. This spot is called the center of gravity. The students can find the spot by following the directions.

1. Instruct the students to predict where they think the center of gravity may be located.
2. Take the string and tie it to the bat somewhere around the middle. Make the knot loose because you may need to slide the knot up and down the bat.
3. Let the bat hang horizontally from the string so that the bat becomes balanced. This is the time when the knot should be adjusted to enable the bat to hang balanced.
4. When the bat becomes balanced, this spot is the center of gravity for the bat. Measure the distance from the thick end of the bat to the place at which the knot is balancing the bat.
5. How far off were students from their predictions?

At the Game:
Observe players' baseball bats as they step up to home plate. Which players appear to have the largest baseball bats? Does this players' personal and baseball statistics justify him using this size bat?

Beyond the Game:
Ask students about other careers that require materials that are perfectly balanced. List those materials. Discuss reasons why different players use different size bats.

Lesson Plan 3
"Galileo's Principles"

Students will be able to:
- Read, interpret, and use charts to identify patterns and draw conclusions.
- Use variables to describe mathematical process.
- Evaluate conclusions based on scientific data.

Materials:
Pencil, baseball, stopwatch

Before the Game:
Using the charts on the following page, find the rule or formula used in each chart. Allow students to experiment with formulas determined from the tables with a baseball.

SEE NEXT PAGE FOR CHARTS

Extended Ideas

Students will be able to:

- Predict the inferences of the motion of some objects on others.
- Make inferences from observations.
- Identify simple patterns in physical phenomena.
- Evaluate a simple procedure to carry out an exploration.
- Analyze the impact of human activity on the ecosystems of the earth.
- Demonstrate an understanding of the cycling of resources.
- Identify the positive impact of technology on human activity.

Examining Scientific Relationships

Using a baseball or a softball, have students determine the relationships between time, velocity, distance, and height.

a) Use your visit to Jackie Robinson Ballpark to determine the speed, velocity, or distance of a fly ball.
b) During your visit, determine the speed or velocity of a throw across the infield.

Relationship Between Distance And Angle

In baseball, the angle of the swing has a dramatic effect on the angle of the baseball and, therefore, the ball's distance. Experiments can be staged to emphasize the effect of the swing angle.

a) Have students swing a baseball bat off of a batting tee using different angles. Determine which angle allowed the greatest distance. Which angle produced the worst results in terms of distance? What factors do your students feel affected your results (either positively or negatively)?
b) Using videotape, examine the swing of home run champion Mark McGwire, Sammy Sosa or Barry Bonds versus the swing of one of your students or of a baseball "singles" hitter. What factors have caused McGwire, Sosa, and Bonds to be so successful?
c) Use the following web site to illustrate this concept (powerful computer likely needed to run these intense graphics): http://www.exploratorium.edu/baseball/

Determining The Effects Of Weather And Air Density On A Baseball

In class, discuss the differences during a baseball game between games played in ideal weather conditions versus games played in rain, cold, humidity, precipitation. Also discuss the effect that air density has on the distance that a ball will travel (e.g. in cities such as Denver).

a) What was the weather like at Jackie Robinson Ballpark on "Education Day"? Attempt to anticipate how well the ball will travel based on your class's earlier findings.

Using Levers

A baseball bat is a first-class lever. Using a baseball bat as an example, determine the fulcrum, the force, and the load. What are other examples of other first, second, and third-class levers? in baseball and in general?

Extended Ideas

- **Bernoulli's Principal**

Test the effects of lift, drag and thrust on ball movement. How does the pitcher's grip on a baseball or delivery motion affect ball movement?

- **Angle Of The Sun**

Using what students know about the sun and the lay-out of Jackie Robinson Ballpark, what seat would be the best if it was going to be a sunny, hot day? Which direction would you normally expect the wind to blow?

- **Machinery & Baseball**

In what way has the development of machinery improved/hurt the cultural experience of the game of baseball? How was the game played before machines such as hot dog warmers, pitching machines and scoreboards were invented?

- **Life Cycles**

Ask students to spend one inning recording all observable life. Create diagrams of the cycle that was observed.

- **Baseball Inventions**

Have students state which invention had the largest impact on professional baseball. Discuss. Research and list a number of inventions that have improved the game of baseball over the years. Ask them to create a new invention that would improve baseball.

- **Swinging The Baseball Bat**

Using Appendix R, determine the appropriate bat length and weight for each Cubs player (see Appendix E) as well as each student in class. Discuss why some players use larger or smaller bats than what is prescribed. Conduct experiments outside the classroom using a variety of baseball bat weights and lengths.