Lesson 3 - Pre-Visit
Forces & Motion

Objective: Students will be able to:
- Explain Newton's Laws of Motion.
- State how Newton's Laws apply to baseball.
- Identify everyday activities that demonstrate Newton's Laws.

Time Required: 1 - 2 class periods

Materials Needed:
- A ball field, playground, or indoor gym
- Several baseballs
- Enough baseball mitts for all students (optional)

Vocabulary:
Acceleration - Change of speed or velocity
Action - The working of one thing on another so as to produce a change
Balanced Forces - Two or more forces act on a single object, completely canceling each other out
Force - A push or pull exerted by one object on another
Inertia - The tendency of an object to oppose a change in motion
Mass - The quantity of matter in an object
Motion - A change in position measured by distance and time
Net Force - The combined effect of all the forces acting on an object
Reaction - The force that opposes the action of a force applied to one thing by another
Unbalanced Force - When several forces are acting on a single object and the forces do not completely offset one another
Applicable Common Core State Standards:

**CCSS.ELA-Literacy.RI.3.3** Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

**CCSS.ELA-Literacy.RI.3.4, RI.4.4, RI.5.4** Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a *grade-appropriate topic or subject area*.

**CCSS.ELA-Literacy.RI.4.3, RI.5.3** Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

**CCSS.ELA-Literacy.W.3.7** Conduct short research projects that build knowledge about a topic.

**CCSS.ELA-Literacy.W.3.8** Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.

**CCSS.ELA-Literacy.W.4.7** Conduct short research projects that build knowledge through investigation of different aspects of a topic.

**CCSS.ELA-Literacy.W.4.8** Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.

**CCSS.ELA-Literacy.W.5.7** Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.

**CCSS.ELA-Literacy.W.5.8** Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.
Additional Relevant National Learning Standards:
(Based on Mid-continent Research for Education and Learning)

**Science. Standard 9. Level II [Grade 3-5].** Understands the sources and properties of energy

**Science. Standard 10. Level II [Grade 3-5].** Understands forces and motion

**Science. Standard 11. Level II [Grade 3-5].** Understands the nature of scientific knowledge

**Science. Standard 12. Level II [Grade 3-5].** Understands the nature of scientific inquiry
1. Begin by introducing force. A force is a push or pull exerted by one object on another. Forces affect how objects move.

2. As a class, discuss ways that forces can affect an object's motion. If possible, provide a demonstration of each, and explain the type of force acting upon the object.
   
   **Possible Answers:**
   
   - Forces can make objects start moving.
   - Forces can make objects move faster.
   - Forces can make moving objects slow down.
   - Forces can make objects stop moving.
   - Forces can make objects change direction.
   - Forces can make objects change shape.

3. Explain that more than one force can act on an object at a time. The forces can push or pull in any direction. Forces may work together or they may be opposite forces. When more than one force acts on an object, the forces combine to form a net force.

4. Any time two or more opposite forces act on a single object, completely canceling each other out, we say that they are balanced forces. You can tell when forces are balanced because the motion of the object is unchanged. It is as if no force was acting on the object. When the forces are balanced, the net force on the object is zero.

5. If the forces don't cancel each other, if one force is stronger than others, they are said to be unbalanced forces. Unbalanced forces cause a change in an object's speed, or direction.

6. Discuss that Sir Isaac Newton (1643 - 1727) was an English scientist who made many observations about forces and motion. Based on his observations, he wrote down three rules that apply to objects in motion. These rules have been tested and proven right in every test. We now refer to these ideas as Newton's Three Laws of Motion.
7. Review Newton’s Laws of Motion:

First Law - Law of Inertia
Newton's first law of motion says that an object in motion will stay in motion and an object at rest will stay at rest unless acted on by an unbalanced force.
- An object will not change its motion unless a force acts on it.
- An object that is not moving remains at rest until something pushes or pulls it.
- An object that is moving remains moving until something pushes or pulls it.
- All objects resist having their motion changed. This is called inertia.
- The more mass an object has, the greater its inertia. This means that the more mass an object has, the harder it is to move, stop, or change the speed or direction of the object.

Second Law - Law of Acceleration
The second law of motion states that the force of an object is equal to its mass times its acceleration.
- If you exert the same force on two objects of different mass, you will get different accelerations (changes in motion).
- It takes more force to move an object with a large mass than an object with a small mass.
- Objects accelerate more quickly when a greater force is used.

Third Law - Law of Action/Reaction
Newton's third law of motion states that for every action there is an equal and opposite reaction.
- Forces act in pairs.
- When one object exerts a force on a second object, the second object exerts an equal force in the opposite direction on the first object.
- The force exerted by the first object is the action force.
- The force exerted by the second object is the reaction force.

11. Introduce the activity.
1. If it is a nice day, go outside to a playground area or baseball diamond. Or, you can do this activity in a gym.

2. Set several baseballs on the field or the floor. Ask students why the baseballs are not moving. The force of gravity is holding the baseballs to the floor, but no other external forces have acted on the baseballs to make them move in any other direction.

3. Ask students to identify which of Newton's Laws of Motion is being demonstrated. Answer: 1st Law: "Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it."

4. Now roll one of the balls across the field or the floor. Ask students to identify forces that will stop the ball's movement. Friction, gravity, another object, etc. Ask students what would have happened if the ball had been set in motion somewhere without friction or gravity, such as outer space?

5. Discuss that the rolling baseball also demonstrates Newton's First Law. The ball was put into motion, and would have remained in motion, but it was acted upon by the force of friction.

6. Assign each student a partner. Give each pair of students a ball and a couple of mitts. Allow students to play catch for a few minutes.

7. Come back together as a class, and ask students why the ball stopped moving when it hit their mitts, and why the ball continued to travel in the same direction each time, instead of suddenly flying to the right or to the left?

8. Ask students to identify which of Newton's Laws of Motion is being demonstrated. Discuss that the baseballs are still demonstrating Newton's First Law. The mitts are now the "external force" stopping the motion of the ball. The ball continues traveling in the same direction because no external force is acting upon it that would cause it to move in another way.
9. Split the class into teams and have students play a few minutes of baseball. After several students have had a turn to bat, bring the class back together.

10. Ask students to think about the bat connecting with the baseball, and identify which of Newton's Laws of Motion they demonstrated in their game. 3rd Law

11. Discuss Newton's Third Law: "For every action there is an equal and opposite reaction." When the bat connects with the ball, the ball doesn't stop. It rebounds in the opposite direction. There is an exchange of energy when the bat hits the ball. The more energy a player puts into his swing, the more energy will transfer to the ball as it flies back into the field.

12. Now discuss Newton's second law of motion: "Force equals mass times acceleration."

13. Ask students to imagine that the pitcher has just pitched a fastball right over home plate (or you may demonstrate this). Was there a small force applied to the ball? Or a large force? Large force. What happened to the ball when the large force was applied? The ball traveled very quickly.

14. Now ask students to imagine that the pitcher tossed a slow underhand pitch (or demonstrate). Was there a small force applied to the ball? Or a large force? Small force. What happened to the ball when the small force was applied? The ball had barely enough speed to make it to home plate.

**Conclusion:**

To conclude the lesson and check for understanding, have students write a journal response in which they identify several everyday actions, or other sporting activities which would be good examples of each of Newton's Laws of Motion.