Lesson Title	Forces of Motion: Newton's Laws
Length of Lesson	100 minutes (two consecutive 50 minute classes)
Created By	Claire Babineaux
Subject	General Science
Grade Level	8^{th}
State Standards	2.c, f
DOK Level	2 (skill/concept)
DOK Application	Cause/effect, Infer, organize, construct, compare, make observations, predict
National Standards	B: Physical Science
Graduate Research Element	The size of the sand on a beach dictates how far it moves along the beach with the currents that affect the beach.

Student Learning Goal:
The goal of this lesson is to present Newton's Laws of Motion in a manner that the students can understand. This lesson will help the students to put into perspective what the laws of motion are and how they can be applied.

State Standards:
2.c: Distinguish the motion of an object by its position, direction of motion, speed, and acceleration and represent resulting data in graphic form in order to make a prediction

2.f: Recognize Newton's Three Laws of Motion and identify situations that illustrate each law (e.g., inertia, acceleration, action, reaction forces).

National Standards:
B: Motion and Forces: the motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph. An object that is not being subjected to a force will continue to move at a constant speed and in a straight line. If more than one force acts on a n object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.

Materials Needed (supplies, hand-outs, resources):
Marbles, small paper cups with an opening cut out (the width of a marble), wooden rulers, large drawing paper, books, pendulum, soccer ball, toy car

Lesson Performance Task/Assessment:
Formative: To begin, the teacher/fellow leads an inquiry based discussion on:
1. What is motion?
2. What is energy?

3. What are the types of energy involved with motion (potential & kinetic)?
4. What is acceleration?
5. Who is Isaac Newton?
6. What are Newton's Laws?
7. How do his laws apply to the motion of everyday objects (wheels, cars, trains, pendulums, etc.)?

For this lesson, the teacher will perform demos for Newton's Laws of motion. The lab associated with this lesson plan focuses on Newton's Second Law.

Demos:
Newton's First Law of Motion states "For every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it. To demonstrate this, the teacher may bring in a ball (a soccer ball works nicely here), or a toy car. In order to adequately demonstrate this law, the teacher should place the item (ball or toy car) on a level desk and ask the students if the item is in motion (they should say no, unless the item moves). Once they answer, the teacher lightly nudges the item until it moves. The teacher then asks the students again if the item is in motion. Once the students respond "yes", the teacher should then explain the law again to effectively show how the law relates to the item and its movement.

Newton's Second Law of Motion states "the relationship between an objects mass (m), its acceleration (a) and the applied force (f) is F = ma. Acceleration and force are vectors. In this law, the direction of the force vector is the same as the direction of the acceleration vector. The following lab will demonstrate this law.

Lab: this lab is the main part of this lesson plan and explains Newton's Second Law of Motion.

Part one:
Procedure:

1. Assemble the book and ramp (ruler) as shown in the diagram on the student worksheet.

2. Place the empty paper cup right side up at the end of the ramp and mark its position on the paper under it.

3. Roll one marble down the track so that it hits and moves the paper cup. Mark the ending position of the cup on the paper and measure the distance it moved in centimeters.

4. Put one marble in the cup and repeat step 3.

5. Repeat step 3 with 2 marbles in the cup.

6. Repeat step 3 with 3 marbles in the cup.

7. Place the results from the precious steps in the following table:

# of marbles in cup	Distance the cup moves (cm)
0	
1	
2	
3	

Part two:
Procedure: Use the ramp set up in part one and turn the paper cup upside-down.
1. As in part one, mark the starting position of the cup on the paper.
2. Roll one marble down the track and allow it to go into the cut-out part of the cup. The cup will catch the marble.
3. Repeat this procedure rolling 2 marbles together down the track making sure the marbles stay together as they go down the track.
4. Repeat the procedure rolling 3 marbles together down the track. Record observations from these steps in the following table:

# of marbles	Distance (cm)
1	
2	
3	

The students will fill out their worksheet as they go through the lab. These tables are also on the worksheet, along with questions associated with the tasks they are completing.

Newton's Third Law of Motion states "For every action, there is an opposite and equal reaction." The teacher may use a pendulum to demonstrate this law.

Lesson Relevance to Performance Task and Students:
This lesson works well with middle school science classes but can be altered to fit nicely into a high school physics class. It aims at introducing Newton's Laws through lecture and then demonstration.

Anticipatory Set/Capture Interest:
In order to capture the interest of the students, the teacher will do a short recap of what the students have previously covered with motion, acceleration, energy, etc. Then, the teacher will perform a demo of a balloon rocket. See teacher notes for directions.

Guided Practice:
The teacher will provide instructions for the lab and setup.

Independent Practice:
Students are allowed to continue with the lab and answer questions on the worksheet about the tasks associated with the lab.

Remediation and/or Enrichment:
Remediation: Teacher may specify groups for the students to be a part of
Enrichment: If the students complete the activity, the lesson may be extended. For example, they can vary the amount of books as in part 3 on the student worksheet.

Check(s) for Understanding:
What is motion?
What are the laws of motion?
How are they applied in everyday life?

Closure:
A student/teacher led discussion about what was covered in this lesson should bring closure to this lesson. An integration/introduction into graphing lessons can be linked here..

Possible Alternate Subject Integrations:
Math- graphing motion, acceleration over time and distance
Geology- the movement of sediments in beach, fluvial, and desert environments
Physics- Motion

Teacher Notes:
Instructions for Balloon Rocket demo:
Materials: yardstick, drinking straw, scissors, string, balloon, two chairs, masking tape
Procedure:

1. Cut the drinking straw down to approximately 4in.
2. Cut about 3.5 feet of string.
3. Thread the string through the straw piece.
4. Position the chairs about 4 feet apart, back to back.
5. Tie the string to the backs of the chairs. The string should be as tight as possible.
6. Inflate the balloon and twist the open end and tape to the straw.
7. Move the balloon and straw to one end of the string.
8. As you are explaining the law, release the balloon.
   The balloon will jet across the string to the opposite chair. The movement will stop when the balloon hits the second chair or when the balloon completely deflates.