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**Suggested Grade Level:** 4th – 6th Grade, but can be used for any grade with very small modifications

**Title:** Hero’s Engine

**Behavioral Objective:**

During the expansion portion of the lesson, the students will be able to create a hero’s engine that will spin the fastest for the longest amount of time with 95% accuracy.

**Concept Statements:**

Force equals mass times acceleration. (Newton’s Second Law of Motion)

Every action has an equal and opposite reaction. (Newton’s Third Law of Motion)

**Supplies**:

Empty Coke Cans (enough for each student, plus one for each group)

3 Feet of Fishing Line (enough for each can)

3 – 4 different sizes of nails

Large tub of water

**Prep for Lesson:**

1. Be sure you have 3 to 4 different sizes of nails for each group of students.
2. Tie a 3-foot piece of fishing line to the tab of a coke can. Be sure you make enough for each student. Please make sure the tabs of the coke cans are facing straight up.
3. Find a safe area to set-up a large tub of water.

**Procedures:**

*Exploration*

1. All of the students will be placed in groups of 3 to 4 students.
2. Each student will be given an empty coke can with a 3-foot piece of fishing line attached to the tab. Please make sure the tabs of the coke cans are facing straight up.
3. Each table will be given 3 to 4 different sizes of nails.
4. The groups will be instructed that each student should take a different size nail.
5. As the teacher demonstrates, the students will poke four holes using the same size nail at an equal distance near the bottom of the can. As they poke in each hole, be sure they push the nail to the right.
6. The teacher will then explain how the students will place the cans in the water. You should place one hand directly over the top of the can while your fingers hold onto the side. Your other hand should hold the fishing line at the very end. As you place the can in the tub of water, be sure you can feel the bubbles hit your hand. When the bubbles stop coming up, let go of the can and stand straight up. Your string should be as tight as possible.
7. Before you lift the can out of the water, ask the students what they think will happen. Have a student write the predictions on the board. Be sure to accept all predictions!
8. Lift the can out of the water. Compare the predictions to what actually happened.
9. Let the students experiment. Have the students gather information to answer all of these questions:
   1. Which direction are the holes facing?
   2. Which direction is the can spinning?
   3. Why?
   4. Which nail hole spins the fastest?
   5. Which nail hole spins the slowest?
   6. Which nail hole spins the longest amount of time?
   7. Which nail hole spins the shortest amount of time?

# *Concept Invention*

1. In a class discussion, talk about the students’ answers to the questions in number 9 of the Exploration. Be sure that all answers are accepted. If any of the answers are incorrect, be sure to redemonstrate and have the students look very closely. The answers are as follows:
   1. The holes are facing to the right.
   2. The can spins to the left.
   3. The water coming out of the can creates the “fuel” to spin the can.
   4. The biggest nail spins the can the fastest.
   5. The smallest nail spins the can the slowest.
   6. The smallest nail hole spins the longest.
   7. The biggest nail spins the can the shortest.
2. Have each group write a concept statement for their experiment. The statement should be one or two sentences long and state what they saw happen. Have each group write their concept statement on the board.
3. When all of the groups have written their concept statements on the board, have each group share their answer aloud with the group.
4. When each group has shared, underline every word that gives away part of Newton’s Second and Third Laws. For example:

If the student writes: The can with the biggest nail holes spun for a very short time and the fastest. The holes faced to the right and the can spun to the left.

I would underline: The can with the biggest nail holes spun for a very short time and the fastest. The holes faced to the right and the can spun to the left.

1. Explain how each word the students used relates to the language Newton used. This is the first time you will introduce the concept statements.
2. Have the students tell you 5 examples of Newton’s Second and Third Laws in everyday life.

## *Expansion*

1. Give each group of students one more can.
2. Create a class challenge. Give a prize to the group that can create a can that spins the fastest and the longest duration. Give the students 5 to 10 minutes to create their prize-winning can. They can only use 4 holes and they must be as close to the bottom as possible. The holes must all face the same direction. However, they can interchange the sizes of nails used.
3. Put all of the cans into the water at the same time. The teacher should signal to the students as to when to pull out the cans, so they all pull out at the same time.

*Anticipated Difficulties:*

1. It is best to do this activity outside so that water does not get on the floor and create a dangerous environment for the students. If inclement weather requires the activity to be done inside, be sure to lay plenty of shower curtains or trash bags below the tubs of water.
2. The students could tear their holes too big causing the cans not to spin correctly. Be sure to check for this on faulty engines. Make sure you have plenty of cans so students can try again.

**Evaluation:**

I will observe whether or not my students are able to create a can that spins the fastest and the longest duration with 95% accuracy. If this is not met, then we will repeat the experiment.





