Airboats
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Subject: Physics, Engineering
Level: Middle School
Standard 1 - Analysis, Inquiry and Design
Standard 4F – Use concrete materials and diagrams to describe the operation of real-world processes and systems.
Standard 7 - Interdisciplinary Problem Solving
Schedule: One 60-minute class period

Objectives:
Students will be introduced to Newton’s Laws of Motion. Students will understand the effect of a force on an object’s motion and gain an understanding of how an airboat works.

Students will:
- Use their understanding of Newton’s Laws of Motion to build an airboat.
- Students will identify the forces and direction of the forces involved in the movement of the airboat.
- Students will collect and record data.
- Communicate their findings both in writing as well as verbally to demonstrate understanding.
- Students will design improvements to their airboats with Newton’s Laws in mind.

Vocabulary:
Action
Reaction

Materials:
For Each Student: Activity Sheets 1-3
1 Balloon
1 Stiff Drinking Straw
Sheets of Writing Paper*
1 Small Rubber Band
Sticky Tape

For the Class: Construction Paper* Paperclips Different Balloons

*Provided by teacher

Safety:
This activity does not involve any safety precautions.
Science Content:

An airboat is basically a boat propelled by a giant fan. Since an airboat does not rely on an outboard motor and a rudder for propulsion and control, the base of an airboat can be made completely flat. This allows the airboat to travel over places where normal boats cannot go, such as shallow rocky water, swamps, ice and sometimes—even grass.

How does a giant fan push an airboat forward? Newton's Laws of Motion will help us answer that question.

Sir Isaac Newton, an English mathematician and scientist, wrote three Laws of Motion to describe how objects move and interact with each other:

First Law: An object that is still will remain still, and an object that is moving in a straight line will continue moving in a straight line, unless a force acts upon it.

Second Law: The acceleration of an object is proportional to the force that acts on it.

Third Law: If one object exerts a force on a second object, the second object will exert an equal and opposite force on the first object.
Let's look at a few examples to see how Newton's Third Law works.

**Action and Reaction - Newton's Third Law**

Suppose you are wearing a pair of roller skates, and you're standing still next to a wall. One way of getting yourself to move is to push against the wall. How does this work?

When you push against the wall, Newton's Third Law says that the wall must exert an equal and opposite force on you. That is, the wall pushes on you just as hard as you did on the wall.

Now suppose there isn't a wall, but instead you have a ball. You still can get yourself moving by throwing the ball away!
This works in the same way. You exert a force on the ball, and the ball exerts an equal and opposite force on you.

And if you had a box of balls, you could keep throwing balls and pick up more speed.

Airboats work the same way. Instead of throwing balls, they throw air molecules backwards. Each molecule only pushes the airboat by an extremely small amount, but if zillions of molecules push, that adds up to quite a considerable force!

Also, unlike a person on roller skates with a box of balls, an airboat doesn't have to carry the air molecules it tosses out. The giant fan on the airboat collects the air molecules in front of it and tosses them out the back of the airboat.

Rockets work the same way, but since there's no air in space, they have to carry their own air (vaporized rocket fuel) to throw out.
**Preparation:**

1. Photocopy print materials (*Activity Sheets 1 and 2*).
2. Distribute materials evenly to each student.

**Classroom Procedure:**

*Engage (Time: 10 mins)*

Show students an example of Newton’s Laws of motion, perhaps using a skateboard and asking students to brainstorm different methods of propelling it. Allow them to test their ideas, then explain how this is a direct example of Newton’s Laws of Motion.

*Explore (Time: 30 mins)*

Distribute materials and allow students to work on building their airboats either individually or in pairs. Once they’ve completed construction of the boat, allow them to experiment and refine their designs.

*Explain (Time: 15 mins)*

Have students discuss their design process and explain the principles that were learned during the activity. Encourage critical thinking and ask students to apply Newton’s Laws of Motion to real life situations.
**Assessment:**

The following rubric can be used to assess students during each part of the activity. The term “expectations” here refers to the content, process and attitudinal goals for this activity. Evidence for understanding may be in the form of oral as well as written communication, both with the teacher as well as observed communication with other students. Specifics are listed in the table below.

1= exceeds expectations
2= meets expectations consistently
3= meets expectations occasionally
4= not meeting expectations

<table>
<thead>
<tr>
<th>Engage</th>
<th>Explore</th>
<th>Explain</th>
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<tbody>
<tr>
<td>1 Shows leadership in the discussion and offers creative ideas reflecting a good understanding of Newton’s Laws.</td>
<td>Completes work accurately while providing an explanation for what is observed. Works very well with partner.</td>
<td>Provides an in-depth explanation of findings. Makes excellent and thoughtful comparisons to real-life situations. Fills out worksheet clearly.</td>
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<tr>
<td>2 Participates in the brainstorm and shows an understanding of Newton’s Laws.</td>
<td>Completes work accurately and works cooperatively with partner.</td>
<td>Provides clear explanation of findings. Makes good comparisons to real-life situations. Fills out worksheet clearly.</td>
</tr>
<tr>
<td>3 Contributes to the brainstorm, but shows little understanding of Newton’s Laws.</td>
<td>Works cooperatively with partner, but makes some mistakes with the procedure.</td>
<td>Provides a limited explanation of findings. Struggles to make comparisons to real life. Fills out some of the worksheet.</td>
</tr>
<tr>
<td>4 Does not participate in brainstorm. Shows no understanding of Newton’s Laws.</td>
<td>Has trouble working with partner. Does little to complete the procedure.</td>
<td>Is not clear in explanation of findings. Does not make comparisons to real life. Does not fill out worksheet.</td>
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Extension Activities:

- The model airboat
  1. What determines how far the model airboat travels?
  2. Can you improve the model airboat so that it travels (a) faster, or (b) further?

- Actual airboats
  1. How do airboats change direction?
  2. Why is the fan mounted at the rear of the airboat instead of in front?

Safety:

- This activity does not involve any safety concerns.

Acknowledgments:

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