Newton’s Hovercrafts
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Grade Level: 8th grade

Class Size: 30-40 students in groups of 2

Class Session: 3 (2 hours each)

Summary:
Students will engineer a hovercraft using everyday materials to demonstrate Newton’s laws of motion. Students will power their hovercrafts using a PC fan and two 9 volt batteries. The hovercrafts will be put through three tests that exhibit Newton’s three laws on motion. Groups will have to design their hovercrafts to pass the three tests or they will not get full credit for the activity.

Objective:
  a. Students will demonstrate their understanding of Newton’s first law of motion by testing their hovercrafts on different surfaces.
  b. Students will demonstrate their understanding of Newton’s second law of motion by testing their hovercraft with different weights attached.
  c. Students will demonstrate their understanding of Newton’s third law of motion by testing their hovercrafts against other student’s hovercrafts.

Background/Introduction:
Newton’s law of motion describes the relationship of a moving body and the forces that are acting upon it. These laws provide the explanation for a variety of physical phenomena such as the orbit planets in space. With their wide implications, Newton’s law of motion serves as a foundation for the engineering and mathematical feats of modern society.

  • **Newton’s 1st law of motion**: An object at rest will remain at rest unless acted on by an unbalanced force. An object in motion continues in motion with the same speed and in the same direction unless acted upon by an unbalanced force. (Law of Inertia)
  • **Newton’s 2nd law of motion**: The relationship between an object’s mass $m$, its acceleration $a$, and the applied force $F$ is $F = ma$. Acceleration and force are vectors.
  • **Newton’s 3rd law of motion**: For every action there is an equal and opposite reaction

Sources:
www.ehow.com/how_8657927_make-mini-hovercraft-computer-fan.html
www.instructables.com/id/small-hovercraft/
**Key Words:**

**Hovercrafts:** air-cushioned vehicle that is capable of traveling over different types of surfaces

**Forces:** any influence that causes an object to undergo a change

**Friction:** the force resisting the relative motion of solid surfaces, fluid layers, and material elements sliding against each other

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**Eight Grade Science Standards:**

**Physical Science:**

1. Students know when an object is subject to two or more forces at once, the result is the cumulative effect of all the forces.
2. Students know how to identify separately the two or more forces that are acting on a single static object, including gravity, elastic forces due to tension or compression in matter, and friction.
3. Students know the greater the mass of an object, the more force is needed to achieve the same rate of change in motion.

**Investigation and Experimentation:**

1. Plan and conduct a scientific investigation to test a hypothesis.
2. Construct appropriate graphs from data and develop quantitative statements about the relationships between variables.
3. Apply simple mathematic relationships to determine a missing quantity in a mathematic expression, given the two remaining terms (including speed = distance/time, density = mass/volume, force = pressure × area, volume = area × height).

**Materials:**

Plates, Styrofoam cups, construction paper, plastic bags...etc.
9 volt batteries
12 volt PC fans (90mm)
Scissors
Electrical Tape

**Day 1:**

Present Newton’s laws of motion and introduce hovercrafts (attached ppt)

Hand out **Laws of Motion worksheet**

Have students fill out this worksheet during the presentation

Present the challenge of making hovercraft to students
Give students time to think about what materials they want for their hovercrafts

**Day 2:**

Go over how to operate fan with students using 2 9v batteries

Allow students to get materials and build their hovercrafts

**Procedure for making a hovercraft:**

1. Students will work in **groups of two** to build a hovercraft
2. Each group will be given a PC fan, tape, 2 9 volt batteries, scissors, and materials to build a hovercraft
3. Trace the outline of the fan on the plate or base of the hovercraft
4. Attach the fan to the base of the hovercraft with tape
5. Attach the skirt to the hovercraft (**optional**)
6. Attach the 9 volt batteries on one end (leave the other end for the wires)
7. Attach the ends of the wires to the ends of the batteries using tape

When groups are done making their hovercrafts, they will be put through Newton’s tests for hovercrafts. There will be different modules where the teams will go and procedures will be given to the students. They will be making predictions and writing observations during these tests (**Newton’s test for hovercrafts worksheet**). If their hovercraft fails the tests they can modify their hovercrafts.

**Newton’s test for Hovercrafts:**

1. **Newton’s First law of motion test:** have the students hover their hovercrafts over different surfaces such as tile floors, carpet, gravel...etc.
2. **Newton’s Second law of motion test:** have the students hover their hovercrafts with different weights attached
   a. Have the students weigh their hovercraft with and without the weights
3. **Newton’s Third law of motion test:** have the students battle their hovercrafts against another team’s hovercrafts in an area marked with tape. First team to be out of the designated area will lose.

**Day 3:**

Finish Newton’s tests for hovercrafts

Class discussion about hovercraft

- Discuss the elements that were strong examples of Newton’s laws
- Highlight things that everyone did well or even elements that non-winning designs did well
- Talk about some issues that students had and how they were resolved or how they could be resolved

Assess students understanding (**Newton, Hovercraft, and Motion worksheet**)

Announce the winners of Newton’s test for the third law of motion
Laws of Motion

1. Write a brief explanation of Newton’s laws of motion and give some examples:

   a. Newton’s first law of motion:

      Examples:

   b. Newton’s second law of motion:

      Examples:

   c. Newton’s third law of motion:

      Examples

2. How does a hovercraft work?
Team Name:

Team members:

1. What is your design for your hovercraft?

   a) How might your design represent Newton’s first law of motion?

   b) How might your design represent Newton’s second law of motion?

   c) How might your design represent Newton’s third law of motion?
Newton’s Tests for Hovercrafts

Newton’s First test
Prediction: How do you think your hovercraft will be affected by different surfaces? Will it glide smoothly over rough surfaces?

Observation: What happen to your hovercraft on a **Smooth** surface? **Describe** the hovercraft movement and **draw** the force diagram.

Observation: What happen to your hovercraft on a **Rough** surface? **Describe** the hovercraft movement and **draw** the force diagram.

Conclusion: Was your prediction correct? Do you need to make adjustments to your hovercraft? If so, what are they?
Newton’s Second test

Prediction: How do you think your hovercraft will perform with weights on it?

<table>
<thead>
<tr>
<th>Mass of your hovercraft</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Mass of your hovercraft with weights</td>
<td></td>
</tr>
<tr>
<td>Mass of the weights</td>
<td></td>
</tr>
</tbody>
</table>

How much **force** is needed to accelerate your hovercraft with the weights on it? \( a = 9.82 \, \text{m/s}^2 \)

Observation: **Describe** the movement of your hovercraft with weights on it. **Draw** the force diagram of the hovercraft.

Conclusion: What happen to your hovercraft when different weights were attached to it? Was your prediction correct?
Newton’s Third Test (Knockout Round!!!)

Prediction: Do you think your hovercraft will be able to knockout your opponent’s hovercraft? Why?

Observation: Describe what happened to your hovercraft in the knockout round. Draw the force diagram of what happened to your hovercraft in the knockout round.

Conclusion: Do you need to make modifications to your hovercraft to make it a killing machine? If so, what are they? Did you modifications help your hovercraft defeat your opponent?
Newton, Hovercrafts, and Motion

1. Write a brief explanation of how hovercrafts demonstrate Newton’s laws of motion:

a) Newton’s first law of motion:

b) Newton’s second law of motion:

c) Newton’s third law of motion:

2. Do you think a second fan would improve the performance of your hovercraft? How will you use your second fan to represent Newton’s second law?