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BASIS Lesson Plan

Lesson Name: Sail Cars: Newton's 2nd Law of Motion

Grade Level Connection(s)

NGSS Standards: Grade 3, Physical Science
FOSS CA Edition: Grade 2, Physical Science

**Note to teachers: Detailed standards connections can be found at the end of this lesson plan.*

Teaser/Overview

What happens when a force is applied to an object? In this hands-on lesson, students will explore and experience Newton's second law of motion through several examples, illustrating the relationship between force, mass and acceleration. The students will build and race their own "sail" cars to demonstrate this concept.

Lesson Objectives

- Students will be introduced to the concept that when a force is applied to an object, that object will accelerate (Newton's 2nd law of motion)
- Students will make predictions and hypotheses how forces will impact the motion of objects
- Students will make predictions and hypotheses about how the weight of objects and magnitude of force impacts their motion.

Vocabulary Words

- **Force:** a push or a pull
- **Motion:** movement of a body
- **Acceleration:** increase in speed
- **Hypothesis:** a testable prediction of what will happen; an educated guess
- **Model:** a simple version of something that we can easily study
- **Newton's Second Law of Motion:** forces cause objects to accelerate (F=ma)

Materials

Scientist Volunteers will bring:
Skateboard
Laminated images of action/reaction
Marshmallow wheels (130, enough for 32 cars)
Index cards (32)
Small pieces of straw (64)
Short skewers (64)
Masking tape (3 rolls)
Sail structure (bendy straw)
Sails (Paper)

Materials teachers should provide:
Students should have pencils and will need surface and desk space in order to build their sail cars.

Classroom Set-Up

Students should be seated at the central carpet are for the introduction to the lesson. Students should then be divided into three groups and each group will build their sail cars, so if there are three somewhat cleared desk spaces where one third of the class and a BASIS volunteer can comfortably fit, that would be ideal. An open space of 4ft x 12ft for racing the sail cars is needed. At the end of the lesson, students should then go back to the central carpet area. It would be helpful if students wear name tags during the lesson.

Classroom Visit

1. Introduction (15 minutes)

Role Model Introduction:
Being a role model for students is an important part of being a BASIS volunteer. Begin your lesson by introducing yourselves! Every team member should take a moment to explain who they are and what they study/do as a scientist. A bonus will be to tell your "story," as if giving an elevator pitch to 8-year-olds: Why did you become a scientist? What made you interested in your topic? Why should students relate to you, or be interested in you? Feel free to draft a script of what you will

say, here. And remember, you can also weave your story throughout your lesson through examples from your own life, and/or return to it with Q&A at the end.

Topic Introduction:
After you introduce yourselves as role models, take some time to introduce the topic of this lesson: *Newton's Second Law of Motion – forces accelerate massive objects (F=ma)*
It may be helpful to keep the suggested take-away in the back of your mind throughout the lesson.

Your topic introduction should follow the outline below. As much as possible, try to frame this information as questions posed to the class, rather than as a lecture. This helps activate students' prior knowledge and facilitates student-guided discussion.

- Drop an item on the ground (apple or anything else will do). Do any of you know what caused the object to fall to the ground? [Gather ideas, answer: gravity]
- Gravity is one type of force. Can anyone tell me what a **force** is? [a push or a pull; write this on the board]
- A long time ago, in the 1600s, a scientist named Isaac Newton saw an apple fall to the ground. This inspired him to think about all the kinds of forces that push and pull around us. He made several rules to explain this. Today, we're going to talk about one of these forces, which explains what happens when a force is applied to an object.
- Ask for two volunteers. One student will sit on the skateboard and the other will push on their back. Then a BASIS teacher will sit on the skateboard. Ask the class what will happen when the student pushes on the BASIS teacher. Each student should make a **hypothesis** about what will happen [define, write on board]
- Encourage students to use the word "force" in their hypothesis
- Write Force = Mass x Acceleration on the board
- Discuss **mass** and how it is different from weight
- Discuss **acceleration** and ask class for examples.
- Lead a discussion on real world examples of the interaction between force, mass, and acceleration.
- Discuss sail boats and how they work. What is the force that makes the boats move?

2. Learning Experience (35 minutes)

Students will be split into three groups. Each group will experience the same demonstration and build their sail cars with a BASIS volunteer leader. Once the sail cars are constructed, then the three groups will come together to race their cars in an open area of the classroom. Students will then come back to the central carpet area for a wrap-up discussion.
Show students a completed sail car so they have an idea of what they will be constructing.

Directions:

1. Distribute 1 Index card to each student. Have student write their names, draw something to identify their car
2. Distribute 2 straight straws and 2 wooden skewers to each student. Instruct students to thread skewers through the straight straws.
3. Distribute 4 marshmallow wheels to each student. Instruct students to push marshmallow wheels onto all four ends of the skewers. Be careful of the pointy skewers!
4. Distribute two pieces of masking tape to each student. Instruct students to tape the straws to the index card such that it connects the two sets of straws as the body of the car. (Help the students make sure that the axles of the wheels are as parallel as possible)
5. Distribute the “mast” structure, paper, and tape and demonstrate how to attach the sails.
6. Make the sails and attach them to the “mast”
7. Blow on the sail to make car move forward
8. After the students are finished building their cars, they can race their cars against the students in the other groups in an empty area of the room.
9. Experiment with placing pennies on cars to see how weight impacts their motion.
10. Lay the measuring tape down along the “race track”.
11. Talk about what made a car move better or worse and students (e.g., “lessons learned”).

3. Wrap Up: Review and Discuss the Learning Experience (5 minutes)

Have students rejoin you on the carpet for a wrap-up discussion.

- What was the action in our sail cars?
- Draw a force diagram with arrows to illustrate this.
- What were some good methods for building the best sail car?
- Reiterate Newton’s Second Law once again.
- Ask what would happen if they made their cars heavier.
- Ask what would happen if they blow harder on their cars.

4. Connections & Close (5 minutes)

Connections to the real world around students:
If possible, tie lesson back into your research or role model story.

Close:

- Reiterate for students that science helps us learn about forces and motions
- Ask students if they have any questions about science or being a scientist
- Close with a good bye and a thank you, and encourage the kids to keep thinking about Newton's Second Law in their everyday lives. Think about actions and reactions!
- Don't forget to help clean up!

Follow Up: After the Presentation

Teachers who wish to extend the impact of this lesson may find the following CRS web pages useful:

- http://www.crscience.org/educators/helpfulreports
- http://www.crscience.org/educators/treasuretrove

Standards Connections

NGSS:

- Connections by topic
  Physical Science: 3. Forces and Interactions
- Connections by disciplinary core ideas
  Physical Science: 3-PS2. Motion and Stability: Forces and Interactions
- Connections by scientific & engineering practices
  2. Developing and using models
  3. Planning and carrying out investigations
- Connections by crosscutting concepts
  2. Cause and Effect: Mechanism and explanation
  5. Energy and matter: flows, cycles, and conservation
- Connections by performance expectation
  3-PS2-1. Plan and conduct investigations to provide evidence of the effects of balanced and unbalanced forces on the motion of an object
  3-PS2-2. Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion