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BASIS Lesson Plan

Lesson Name: Balloon Rocket Cars: Newton's 3rd 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 forces can cause objects to move? In this hands-on lesson, students will explore and experience Newton's third law of motion through several examples of balloon "rockets", and will build and race their own balloon-rocket cars to demonstrate this concept.

Lesson Objectives

- Students will be introduced to the concept that for every action there is an equal and opposite reaction (Newton's 3rd law of motion)
- Students will make predictions and hypotheses about actions and reactions
- Students will learn about how models are used to understand scientific phenomena

Vocabulary Words

- **Force:** a push or a pull
- **Motion:** movement of a body
- **Hypothesis:** a testable prediction of what will happen; an educated guess
- **Model:** a simple version of something that we can easily study
- **Action/Reaction:** the application of force and the response to that force
- **Newton's Third Law of Motion:** for every action, there is an equal and opposite reaction

Materials

Scientist Volunteers will bring:
Skateboard
String with balloon attached
Laminated images of action/reaction
Marshmallow wheels (130, enough for 32 balloon rocket cars)
Index cards (32)
Small pieces of straw (64)
Short skewers (64)
Masking tape (3 rolls)
Balloons tightly taped to bendy straws (32)
Balloon pump
Tape measure

Materials teachers should provide:
Students should have pencils and will need surface and desk space in order to build their balloon rocket 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 balloon rocket 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 balloon rocket 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)

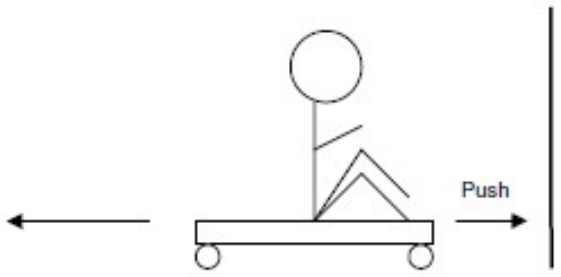
Role Model Introduction:
Being a role model for students is an important part of being a BASIS volunteer. Begin your lesson by introducing yourselves! Every team member should take a moment to explain who they are and what they study/do as a scientist. A bonus will be to tell your “story,” as if giving 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 Third Law of Motion – for every action, there is an equal and opposite reaction*
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 a volunteer to sit on a skateboard next to a wall. Ask the class what will happen if the student pushes off the wall with their feet. Each student should make a **hypothesis** about what will happen [define, write on board]
- Encourage students to use the word "force" in their hypothesis
- Ask the student on the skateboard to push off the wall. Were student hypotheses supported? Why or why not? What was the force applied? Was there motion? What was the action? What was the reaction? Draw a simple diagram of what happened on the board. Use arrows to show the directions of the force and the opposite force.



- Lead a discussion to explain Newton's Third Law such that the class understands action and reaction. Explain with real-world examples, like swimming, paddling, being thrown back on a

rollercoaster, rockets. Ask the students for their own examples, and ask them to identify the action and reaction in every example.

You can use a table like this on the board for this brainstorming session:

Example	Action	Reaction
Swimming	Stroke of arm forward	Resistance of water backwards
Rocket	Engine propelling downward	Rocket goes upward
Child and skateboard	Pushing feet off wall forward	Skateboard goes backward

- Compare a rocket to a balloon with the air escaping. In a rocket, the burning fuel and expanding gas shoots downward (action) and propels the rocket up (reaction). Likewise, in a balloon, the released air shoots in one direction (action), and the balloon flies in the opposite direction (reaction).
- Draw other force diagrams on the board to illustrate some of the other examples (if colored markers are available, use one color for the action and another color for the reaction)

2. Learning Experience (35 minutes)

Students will be split into three groups. Each group will experience the same demonstration and build their balloon rocket cars with a BASIS volunteer leader. Once the balloon rocket 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.

Activity 1: Balloon on a string

1. Thread a string through a straw and tape the end of the string so that the string is taught on both sides (alternatively, tape one end and hold the other end taught.
2. Blow up a balloon
3. Hold the end of the balloon closed and tape a piece of straw to it, parallel to the opening of the balloon.
4. Before releasing the balloon, ask the students for their hypotheses on what the balloon will do once you release it
5. Let go of the balloon. Were student hypotheses support? What was the action? What was the reaction? Draw a force diagram on a piece of paper, emphasizing the action and reaction of the balloon.

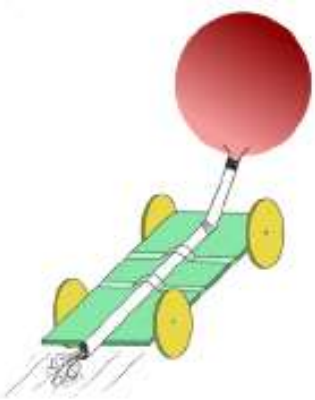
Activity 2: Balloon Rocket Cars

Show students a completed balloon rocket 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 straw with the balloon attached to each student. Distribute another piece of making tape to each student. Tape the straw with the balloon on top of the piece of cardboard. This will be the "rocket".
6. Blow up the balloon through the straw and plug the hole of the straw with a finger. When you let the balloon deflate, the car will be propelled forward. (If students have difficulty blowing up the balloons, you can help them with a balloon pump)

   Representation of completed car:



- 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.
- Lay the measuring tape down along the "race track".
- As students propel their cars, this can be used to measure how far the cars will go. These results can be charted or graphed if time permits.
- Engage students in a discussion about other experiments and hypotheses they could make with their balloon rocket cars: Does the degree of inflation on the balloon matter in how far the car will go? Why? Emphasize that if you change the degree of action, the reaction will also change.

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 rocket cars? What was the reaction?
- Draw a force diagram with arrows to illustrate this.
- Reiterate Newton's Third Law once again.
- How is our rocket car like rockets in real life?
- If time allows, you can watch recorded shuttle launches by NASA using downloaded movie files.

Prompt students to think about what other questions they would investigate in the future to figure out what affects how far the balloon rocket cars go. Degree of inflation, type of wheels, balloon size/shape?

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 Third 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