On a Roll

VIRTUAL Field Trip to the California Science Center

Focus Question:

How can we make something move?

Buzzword:

Force

NGSS Standards

Performance Expectations:
3-PS2-1, 3-PS2-2

SEP: Planning and Carrying Out an Investigation

CCC: Cause and Effect, Patterns

OBJECTIVE:

Students will be challenged to investigate balanced and unbalanced forces as they create and play their own shuffle-board inspired physics game. They will plan and carry out an investigation to determine how changing the strength and direction of the forces on a cardboard tube affects its motion. Students will use their understanding of forces to predict the pattern of motion and earn a high score in the game.

MODIFICATIONS:

- Cardboard tubes can be replaced by sturdy paper that is rolled and taped to form a tube, cans, or any uniform cylindrical object.
- Game boards can be printed or recreated on notebook paper. Alternatively, a larger scale game board can be recreated on the ground or in an outdoor area. Different surfaces will affect the results of the game.
- If time is limited, students can pause after part 1 of the experiment and resume with the game in part 2 on another day.
- Students may play the game as individuals, teams, or as paired opponents.

Math integration: There are many ways to earn 20 points! Challenge students to explain multiple strategies to earn more than 20 points on the gameboard.

FACILITATING THE EXPERIMENT

1. **Before the Experiment:** It may be helpful to send a notice home to students ahead of this lesson to have them save cardboard tubes from toilet paper rolls or paper towel rolls. Discuss the situation as a class. Allow students to share prior knowledge of playing shuffleboard or similar games.

2. **Set Up the Experiment:** Print data tables and game boards for each student or team, or direct students to recreate them on paper or in a notebook. Allot 5-10 minutes for students to tape weights to the tubes as shown in the student guide. Students can work individually or in teams during parts 1 and 2 of the experiment. Have a discussion with the students about rules that come up while playing, so the class can have a consistent investigation.

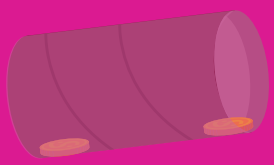
3. **During the Experiment:**

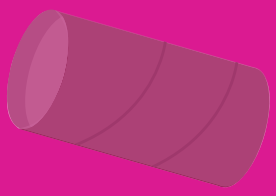
   PART 1: Encourage students to decide how they will plan and carry out an investigation which will help them understand how the tubes move. Students should consider the questions in the student guide part 1, step 3 on their own or with peers. Allow students to determine what variables they may change (i.e. how hard and where they push the tube, and which tube they use), things that must stay constant to keep the test fair (i.e. starting point, method of pushing tubes), and how many trials they should complete in order to make a good prediction. Encourage students to record data and observations as they test. Before moving on to part 2, discuss student answers to “What’s Going On?”.

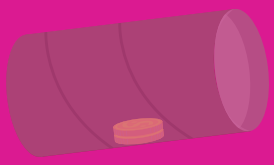
   PART 2: Before they begin the game, encourage students to make a hypothesis about which tube will help them to beat the high score. Remind students to look for patterns from their data in part 1 that might help them to predict their tube’s motion. As students play the game, encourage them to keep score and be mindful of how their results compare to their partner’s results.

4. **Wrap Up:** Allow students to share whether or not their experience in the game supports their hypothesis. Use student responses to facilitate a conversation about how they were able to use balanced and unbalanced forces to predict the motion of the tubes.

Students may have noticed that the tube with weight stacked in one place had a little more “get-up-and-go”--once it got going it continued to roll for longer. Scientists call this **momentum.**







WHAT’S GOING ON?

1. **What do you think caused the tubes to move?** Students should observe that they needed to provide a push forward to start the tubes moving. Label the push a **force** and note that the force and the tube both moved in the same direction: forward. In addition to direction, forces also have different strengths. Changing the strength of the force on the tube can cause it to travel further or less far. There are forces working on the tubes and each force has a strength and a direction. When the forces are balanced (before the push, or once the tube stops), the object doesn’t move. When the forces are unbalanced, the object will move in predictable ways.

2. **What do you think caused the three tubes to move differently from each other?** Students may point out variations in each tube’s pattern of motion, such as their speed, direction, stability, or distance. The tubes move differently because of the unbalanced forces working on them. The strength and direction of the students’ initial push can affect the speed and distance the tube travels. A second unbalanced force at play is the amount of weight on the tubes. Weighted tubes needed a bigger push, or stronger force, to start moving. This is because the pull of gravity is stronger on heavier objects, therefore a greater force is required to unbalance them. Finally, the placement of the weights--whether weight is spread across the tube or stacked in one place, affects how the tube rolls. If the weight is stacked in one place, it may have traveled further or in a different direction compared to the tube with weights spread across it.

Additional Resources

CONNECT WITH US

Visit the California Science Center virtually or in person to explore this standard and extend the activity with related content.

- **Watch a free Virtual Field Trip video episode:** Join our educators as they lead you in exploring the static electricity and magnetic forces around the California Science Center.
- **Reserve a live interactive Virtual Field Trip experience:** Our educators will take your class on a virtual field trip to find out how forces are applied in everyday scenarios to how they work to launch a shuttle, like our Endeavour Space Orbiter!
- **Visit us in-person:** Feel the thrill of balanced forces in action when you take a ride on the High Wire Bike suspended 43 feet above ground level in the Mark Taper Foundation Sky Court.

Website: www.californiasciencecenter.org

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Share your students' experiments with us on social media for a chance to be featured!

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EXTENSIONS

Make it your own: There are many more possibilities for customizing the cardboard tube. Allow students to design their own tubes and see the effect of changing variables, such as amount and placement of weight, length of the tube, or anything else they can think of.

Friction: Allow students to gather more evidence about the effects of balanced and unbalanced forces by introducing a new variable: friction. Students can compare their results when playing the game on differently textured surfaces, such as carpet, asphalt, rubber mats, or tile. Students can also vary friction by adding sand or other obstacles along the game board.