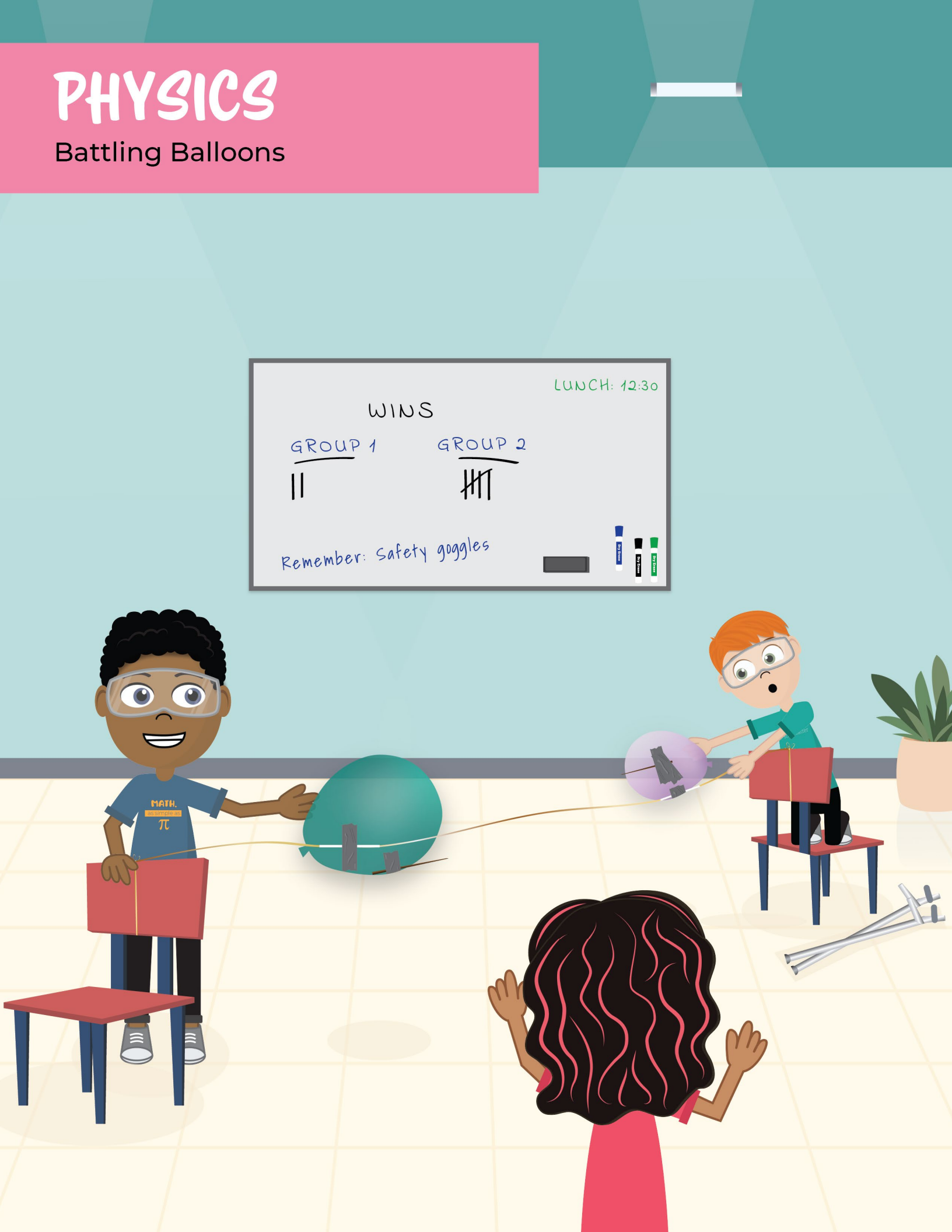
PHYSICS

Battling Balloons



Battling Balloons

NGSS

3-PS2-1; MS-PS2-1

Objective

The student will understand the basic physics of rocketeering and the engineering design process.

The student will be able to design a balloon popper using the engineering process.

Vocabulary

Force: Strength or energy as an attribute of physical action or movement.

Thrust: The propulsive force of a jet or rocket engine. This is explained by Newton's Third Law of Motion.

Newton's Third Law of Motion: For every action, there is an equal and opposite reaction. The statement means that in every interaction, there is a pair of forces acting on the two interacting objects. The size of the force on the first object equals the size of the force on the second object.

Pressure: Force per unit area.

Potential Energy: The energy possessed by a body by virtue of its position.

Kinetic Energy: Energy that a body possesses by virtue of being in motion.

Engineering Design Process: A series of steps that engineering teams use as a guide to solve problems. The design process is cyclical, meaning that engineers repeat the steps as many times as needed, making improvements along the way.

Background

Sir Isaac Newton first presented his three laws of motion in the " Philosophiæ Naturalis Principia Mathematica" in 1686. His third law states that for every action (force) in nature

there is an equal and opposite reaction. In other words, if object A exerts a force on object B, then object B also exerts an equal and opposite force on object A. Notice that the forces are exerted on different objects.

In aerospace engineering, the principal of action and reaction is very important. Newton's third law explains the generation of thrust by a rocket engine. In a rocket engine, hot exhaust gas is produced through the combustion of a fuel with an oxidizer. The hot exhaust gas flows through the rocket nozzle and is accelerated to the rear of the rocket. In re-action, a thrusting force is produced on the engine mount. The thrust accelerates the rocket as described by Newton's second law of motion.

Materials

***** Students will be in groups of 2-3 depending on class size. (Up to 5 groups)**

- 26 large balloons, minimum 12 inches (limit 5 per group, 1 for demonstration)
- 25 straight drinking straws (5 per group limit)
- ~30 feet of string (Make two ~15 ft strings... smooth line, like fishing line, strong thread, or kite string)
- 10 barbeque skewers (limit 1 per jouster)
- Duct tape
- Clear tape or masking tape
- 10 styrofoam cups (limit 2 per group)
- 10 plastic cups (limit 2 per group)
- 25 popsicle sticks (limit 5 per group)
- 5 scissors (1 per group)
- Assorted color sharpies
- 25 pieces of white printer paper (5 per group)
- Pencils (1 per student)

Note: Additional supplies can be added, but this is a good start. Students can brainstorm about other materials they could use to design a better popping mechanism (i.e. for protection, stability, etc.) Get creative!

Procedure

1. Introduce the topic and the scientific concepts related to balloon rockets.
2. **Balloon Rocket Demonstration**
    a. Thread a 15ft piece of string through a straw.
    b. Blow up a balloon and tape it to the straw.
    c. Two student volunteers should hold the string up tight between them and release the balloon so it rockets over to the other side.
    d. Discuss the physics concepts at work here.
        i. Newton's Third Law, Thrust, Kinetic and Potential Energy, etc.
3. **Balloon Popper Battling**
    a. Split students into groups of 2-3 (no more than 5 groups).
    b. Tell the students that they will design and build balloon jousters and then compete against other groups to determine the best design.
    c. IMPORTANT: Limit supplies consistently for each group. Either assign flat limitations for each item (refer to the "materials" section) or use other creative methods such as allocating a set budget for each group and assigning prices to the materials available.
    d. There are no restrictions on how each supply is used. Materials can be used for protection, extension, stability, increased attacking abilities... anything the students can imagine. Limit of one barbeque skewer per balloon is recommended, but not required.
    e. Tie the ends of a string to two stable objects (chair, table, etc.), at an even height above ground to allow the balloons to pass freely. Then, place the objects far enough apart to remove any slack in the string. IMPORTANT: To avoid eye injury, students should wear safety glasses and string should be tied at a height below the students' eye level.
    f. <u>BRAINSTORM & DESIGN (~5 min)</u>
    g. Display materials on a table and allow each group to come up one at a time and look at the available materials.
    h. Each group must then draw up a blueprint design and list the proposed materials for their first jouster.
    i. <u>BUILD, TEST, EVALUATE, and REDESIGN (~40 min)</u>
    j. Each group will build their first balloon jouster and then challenge another group.
    k. Instructors, keep track of wins and losses for each group. A bracket is

recommended for easy tracking!

l. After each round, groups can redesign, rebuild, and compete again. Groups are limited to 5 balloons, so they will have a maximum of 5 attempts.
m. Using a smart phone, try filming the jousts in slow motion so students can watch what happened in greater detail.
n. DISCUSS WHAT HAPPENED (~5 min)
o. Between each round and at the end of the lesson, take some time to talk about which designs worked and why.
p. Come back to the basic physics concepts involved in the lesson.

4. Clean up as a group. Save and return as many of the supplies as possible.

Optional extension activities:

1. Darts:
    a. Make a "dart" by attaching a balloon, skewer, and straw together, just like in the balloon joust.
    b. Make a target by inflating a second balloon, but tie this one closed, and tape it at one end of the string. Alternatively, draw/print a bullseye on a piece of paper or cardboard.
    c. Launch the dart balloon at the target.
2. Push over:
    a. Place two straw-balloon combos on a single line, aimed at each other (NO SKEWERS).
    b. Mark the center-point of the string with tape, marker, etc.
    c. Launch the balloons.
    d. The balloon that pushes the other beyond the center line is the winner.
3. Race:
    a. Set up two long lines, side by side.
    b. Race the two balloons.
    c. Which balloon travels the farthest? Which balloon crosses the finish line first?

Guiding Questions

What makes a rocket ship move? Why did some balloon poppers travel farther and faster than others? What are ways that you could protect your balloon popper?

Career/Future Application

The engineering design process is a valuable model for daily and occupational life regardless of career. You can find the importance of problem solving in just about everything!

Sources

http://pbskids.org/designsquad/build/balloon-joust/

https://www.physicsclassroom.com/class/newtlaws/Lesson-4/Newton-s-Third-Law