3-2-1 POP!

How do scientists use the inquiry process in their testing?

Teacher Overview:
Students determine the best combination of water temperature and effervescing tablet to launch a rocket powered by the pressure generated from the tablet reacting with water.

Objective:
To demonstrate how rocket liftoff is an application of Newton's Laws of Motion.

Next Generation Sunshine State Standards:
SC.6.N.1.1: Define a problem from the sixth grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
SC.6.N.1.4: Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.
SC.6.N.3.4: Identify the roles of models in the context of the sixth grade science benchmarks.
SC.6.P.11.1: Explore the Law of Conservation of Energy by differentiating between potential and kinetic energy. Identify situations where kinetic energy is transformed into potential energy and vice versa.
SC.6.P.13.1: Investigate and describe types of forces including contact forces and forces acting at a distance, such as electrical, magnetic, and gravitational.
SC.6.P.13.2: Explore the Law of Gravity by recognizing that every object exerts gravitational force on every other object and that the force depends on how much mass the objects have and how far apart they are.
SC.6.P.13.3: Investigate and describe that an unbalanced force acting on an object changes its speed, or direction of motion, or both.

Materials and Tools:
Student sheets
Paper plates
Coffee stirrers
Paper towels
Eye protection
Plastic 35 mm film canister* or Steve Spangler Science graduated film canisters
Effervescing antacid tablet
Hot and cold water
Pipettes
** The film canister must have an internal-sealing lid, i.e. Fuji. Canisters with a lid that wraps around the canister rim) will not work. These are usually opaque canisters.*

Management:
For best results, students should work in pairs. It will take approximately 40 to 45 minutes to complete the activity. Film canisters are available from camera shops and stores where film processing takes place. These businesses recycle the canisters and are often willing to donate them for educational use. Be sure to obtain canisters with the internal sealing lid. These are usually translucent canisters.

Space Knowledge:
This activity is a simple but exciting demonstration of Newton's Laws of Motion. The rocket lifts off because it is acted upon by an unbalanced force (Newton's First Law). This is the force produced when the lid blows off by the gas formed in the canister. The rocket travels upward with a force that is equal and opposite to the downward force propelling the water, gas, and lid (Third Law). The amount of force is directly proportional to the mass of water and gas expelled from the canister and how fast it accelerates (Second Law).

Discussion:

- How does the amount of water placed in the cylinder affect how high the rocket will fly?
- How does the temperature of the water affect how high the rocket will fly?
- How does the amount of the tablet used affect how high the rocket will fly?
- How does using a whole tablet versus breaking up/crumbling the tablet affect how high the tablet will fly?

Assessment:
Ask students to explain how Newton's Laws of Motion apply to this rocket.

Teacher Suggestions:

1. Use Fuji brand film canisters or Steve Spangler Science film canisters.
2. Ask your local film developer to save canisters for you; they are getting harder to come by now that most people use digital cameras.
3. Make sure effervescing antacid tablets are fresh.
4. Plan to have enough antacid tablets and time for several trials.
5. Using denture cleaning tablets have produced mixed results.
6. Launch rockets in an open area (i.e., outside) where film canisters will have enough room when they are launched.

Directions:
Tell students that their job is to determine the best combination of fuels needed to launch a rocket.

1. *Note: Students must wear safety goggles throughout this activity.*
2. Students will be given three effervescing tablets along with hot and cold water. Pipettes will be used to add drops of cold and hot water onto the effervescing tablets. Paper plates can be used as a testing surface for each student.
3. Direct students to test combinations of hot and cold water with large pieces of the tablet, broken pieces of the tablet, and pieces crushed into powder. Students should observe the differing reaction times.
4. Students will determine the best combination of water temperature and tablet condition to use to launch their rockets.
5. Students will use their fuel choice to launch their rockets. *Note: Students may incorrectly choose the fastest reacting fuel combination. Discuss why that combination would not be the best choice for launching a rocket.*
6. Ask students to explain how Newton's Laws of Motion apply to this rocket.

Extensions:

- Students can create a table in their notebooks and use timers to measure the time it takes for reactions to occur.
- Students can record their explanations of Newton's Laws of Motion in their notebooks.
- Use card stock to add a cone and fins to the film canister.
- Assign monetary value to the tablets and water. Give the students play money and charge them for extra supplies. Discuss the importance of careful testing and budgeting.