Rockets, for elementary sites [Fall 2011]

The Idea

Establish what beam is and have fun shooting rockets! Also, assess students preconceptions and hand out parent packets.

Teaching Goals

- Students will fill out the 'What is an engineer?' activity sheet
- Students will work together in teams to achieve a common engineering goal.
- Students will understand how geometry, weight and launching conditions affect projectile motion

Materials

Consumables:

- Paper
- Tape

Nonconsumables:

- stands for launching stomp rockets
- stand for launching the water rocket
- 2 liter bottle (the actual water rocket)
- scissors

Agenda/Lesson Plan

Setup (5 min, before session begins)

- Based on the number of available stomp rockets, one person can decide how you are going to split teams up and create stations, each with a stand, scissors, tape and some paper
- Another person can make prefill the water rocket bottle so that when the lesson starts things can run smoothly.
- Someone should quickly make a couple of different stomp rockets (one basic with no add-ons, one with fins, one that is shorter) to be used later.

Introduction (10 min)

- Have one person (maybe the site leader?) explain what is going on and what BEAM is about.
- Have each mentor introduce themselves and say a little about themselves.

Break into small groups (25 min)

- Break the students up into groups of 3-4, with at least one mentor to each group. If it's possible, leave the site leader free to move amongst the groups and make sure things are running smoothly. With each small group, do an ice breaker of your choice (possibly use examples discussed in the DeCal).
- Once the ice breaker is done, grab as many "What is an engineer?" worksheets as you need and help the students in your group fill them out. Explain why you are having them answer these questions. Remember to encourage them to express their ideas in words or pictures.
- Once everyone in your group is finished with the worksheet, hand the sheets off to the site leader; continue to hang with and get to know the kids in your group.

Reconvene (5 min)

- When everyone has completed their worksheet, briefly discuss how rockets fly when launched (projectile motion) and discuss the how the different changes in design (as seen in your pre-

made examples) effects how a rocket flies. Also discuss what happens when you change the launch angle. Give them the simple challenge of trying to launch their rocket the farthest.

Divide Class into Teams (5 min)
Allow mentees to choose their own teams when possible, but if there is a large age distribution try and make teams with equal ability levels. Try and divide the mentors evenly amongst the teams.

Experiment (25 min)
- After the teams are chosen, allow everyone to build a stomp rocket to their own personal specifications. Guide them in adding additional structures like fins.
- When everyone in your group has made a rocket, let each student load their rocket onto the launcher and then determine the angle they want to launch at. A mentor should be holding the launcher during the launch. Each student will get to "stomp" on the bottle to launch their rocket.

Demonstration(10 min)
- After everyone has had a chance to launch their rocket at least once, gather everyone up for the water rocket demonstration.
- Explain that you are going to launch two times, one with a lot of water in the rocket and one without a lot of water. Ask the students which one they think will go higher. Try to pump the same amount of air into each so that the desired results are achieved.
- Launch the rockets.
- Explain why one rocket went higher than the other (in truth, so many things affect the flight of a coke bottle upwards through the air that no matter what the result is, you can come up with a reasonable explanation).

Departing (5 min)
- Make sure to pass out and explain the parent packets to the students as the leave.

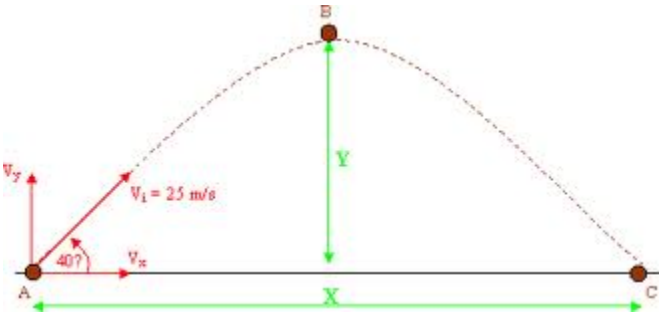
Background

Projectile motion: A projectile is any object that once projected or dropped continues in motion by its own inertia and is influenced only by the downward force of gravity. In the case of the water rockets, they are given an initial thrust by the expelled water, but once that direct force runs out; its path ideally follows that of projectile motion.

How the water bottle rocket works: Compressed air is added via a pump which creates a bubble that floats up through the water and then pressurizes the air volume in the top of the bottle. Once the bottle is released from the pump, the water is pushed out the nozzle by the compressed air. The bottle moves away from the water because of Newton's Third Law; for every action there is an equal and opposite reaction.

As the propellant (water) level in the rocket goes down, the center of mass initially moves backwards before finally moving forwards again as the propellant is depleted. This initial movement reduces stability and can to cause water rockets to start tumbling end over end, greatly decreasing the maximum speed and thus the length of glide. To lower the center of pressure and add stability, fins are added which bring the center of drag further back, well behind the center of mass at all times, ensuring stability.

- <u>Projectile motion: Anytime you drop or throw something it follows the following path due to gravity.</u>

- 

- “A projectile is an object upon which the only force acting is gravity. There are a variety of examples of projectiles. An object dropped from rest is a projectile (provided that the influence of air resistance is negligible). An object that is thrown vertically upward is also a projectile (provided that the influence of air resistance is negligible). And an object which is thrown upward at an angle to the horizontal is also a projectile (provided that the influence of air resistance is negligible). A projectile is any object that once *projected* or dropped continues in motion by its own intertia and is influenced only by the downward force of gravity.”
- Gravity and horizontal forces: “Gravity acts to influence the vertical motion of the projectile, thus causing a vertical acceleration. The horizontal motion of the projectile is the result of the tendency of any object in motion to remain in motion at constant velocity. Due to the absence of horizontal forces, a projectile remains in motion with a constant horizontal velocity. Horizontal forces are <u>not</u> required to keep a projectile moving horizontally. The only force acting upon a projectile is gravity!”

Projectiles, gravity: http://www.physicsclassroom.com/class/vectors/u3l2a.cfm
Reliability: http://en.wikipedia.org/wiki/Reliability_engineering
Building the Rockets: The Exploratium Stomp Rocket lesson plan guide