Lesson Plan for Stomp Rockets

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Teaching Plan:

Introduction (5 min)

Discuss the science/teaching strategies (10 min)

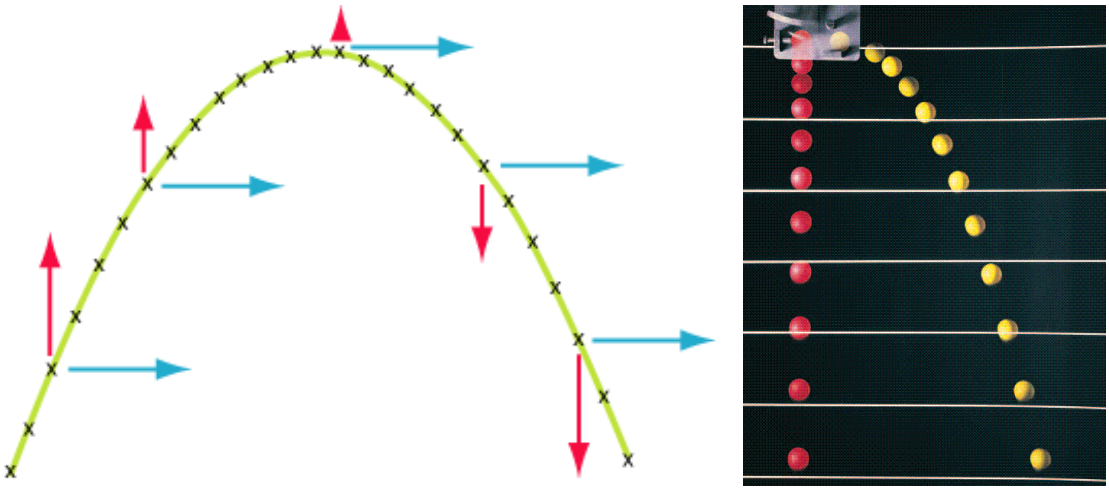


Figure 1: After a projectile is thrown, it follows a path called a *parabola* Notice that only the vertical motion, drawn with red arrows, changes as the projectile travels along the path (left image).[1] A ball dropped from a certain height will hit the ground in the same time as one thrown horizontally from the same height. The vertical position of the balls is independent of the horizontal motion (right image).[2]

- **Projectile:** When you throw a ball, that ball is a *projectile*. In this activity, our *rocket* is a projectile.
- **Projectile motion:** Once launched, all projectiles follow a frown-shaped path known as a *parabola*, due to the effects of gravity. Gravity, which acts *downward*, only influences the *vertical* motion of the projectile. The initial velocity of an object determines its *horizontal* motion, which remains the same (constant) throughout its flight.
- **Velocity:** The *direction* and *speed* of an object together tell us the object's *velocity*.
- **Newton's 3rd law:** *For every action, there is an equal and opposite reaction.* Our rocket's initial velocity comes from the air pressure that builds up in the pipe when you step on the bottle. When the rocket is fitted onto the end of the pipe, it forms an airtight seal. When you step on the bottle, air is forced out of the bottle into the pipe, which pushes the rocket off the pipe so the air can escape. The "push" that the air gives the rocket determines the initial *speed* of the rocket. The direction of the pipe determines the initial *direction* of the rocket.

Build the Rockets (20 mins)

Test the Rockets (15 mins)

Conclusion (10 mins)

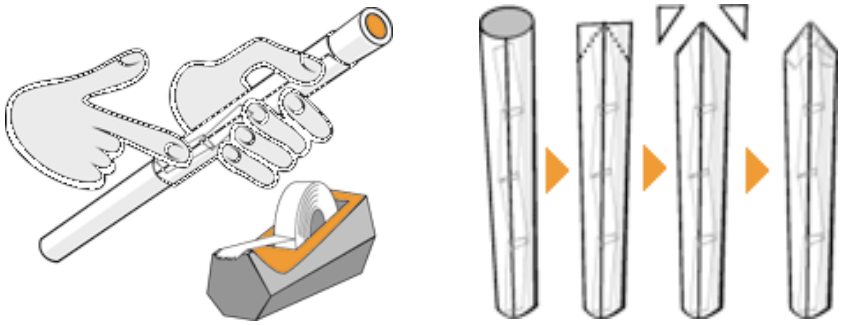
Introduction for the Mentees (5-10 min)

- Discuss how a ball travels through the air when we throw it.
- Discuss projectiles, showing that they travel along a frown-shaped curve called a “parabola”.
- Today’s topic: Making rocket projectiles
- Launch a demonstration rocket.
- Challenge: Who can build and launch a rocket to go the furthest?
- Discuss how direction and speed might affect the distance of the rocket’s flight.

Project (30-40 min)

Building the Rockets:

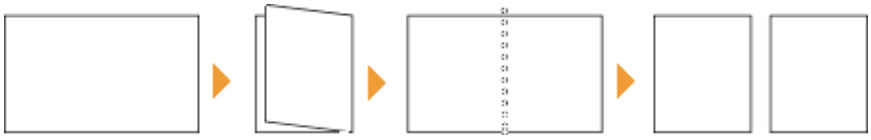
1. Wrap paper loosely around the PVC pipe (if you wrap the paper too tightly around the pipe, friction will keep the rocket stuck on the pipe during launch)



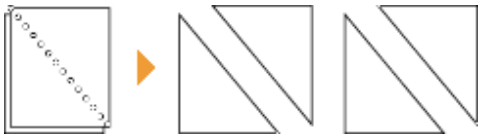
2. Tape the seam, then slide the paper off the pipe
3. Flatten the tube at one end, use scissors to cut the flat edge into a sharp point
4. Tightly tape the point so air does not escape

Adding Fins:

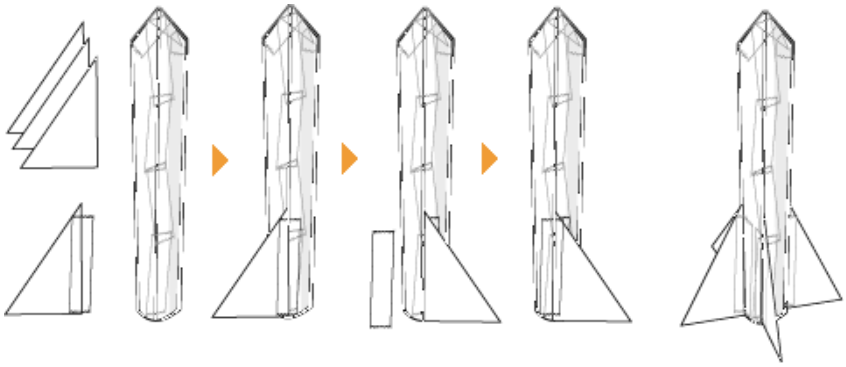
1. Fold a 3 x 6 index card in half, open at fold and cut along the fold



2. Cut along the diagonals of the half cards



3. Tape the fins on the rocket, spaced equally apart from each other



Flying the Rocket:

1. Slide the rocket halfway down the PVC pipe
2. Put the bottle on the ground
3. Point the PVC pipe away from people
4. Step on the bottle
5. Use your hands to make a mouthpiece over the end of the PVC pipe and blow into the pipe to reinflate the bottle

Closing Activity and Discussion.

- How did the direction of the pipe affect the distance travelled by the rocket?
- Did the distance of your rocket flight depend on how hard you stomped on the launcher?
- What combination of direction and speed launched the rocket the furthest?

Materials

- To build two rocket launchers:
  - Empty 2-liter plastic soda bottles; recycled if possible (2) [$1/bottle; http://moourl.com/g5grq]
  - Clear flexible vinyl tubing with ½ inch inner diameter and 5/8 inch outer diameter (~ 3 feet long) [$0.38/foot; McMaster-Carr #5233K66 http://www.mcmaster.com/#tubing/=bn35xq]
  - Duct tape [$5/roll; http://moourl.com/z573o]
  - PVC pipe with ½ inch inner diameter (~ 2 feet long) [$12.53/8 feet; McMaster-Carr #49035K83 http://www.mcmaster.com/#pvc-pipe/=bn3aho]
  - Hacksaw; try to borrow one [$14; http://moourl.com/6php4]
- To make and launch rockets:
  - 8.5" x 11" paper; recycled paper if possible (2 sheets per person) [$4/500 sheets; http://moourl.com/020sp]
  - PVC pipe with ½ inch inner diameter (~ 1 foot length for each group of 5 people) [cost for 6 lengths of 1 foot pipe included above with PVC pipe for launchers]
  - Clear scotch tape [$4/3 dispensers; http://moourl.com/ka4mt]
  - Scissors; try to borrow these (~ 1 pair for each group of three) [$2/each; http://moourl.com/eur2e]
  - 3" x 5" index cards (1 card per person) [$2/100 cards; http://moourl.com/eur2e]
  - Pens or pencils; try to borrow these [$2/12 pencils; http://moourl.com/q6mr5]

Total cost for a class of 30 students (including everything): $68.67
Total *reduced* cost for 30 students: $28.67 (excludes hacksaw, paper, scissors, pens/pencils)

References

1. Projectile motion: http://www.elec-intro.com/projectile-motion
2. Acceleration of projected and dropped balls: http://fphoto.photoshelter.com/image/I0000aqiKPtSPYw0
3. Projectile motion: http://en.wikipedia.org/wiki/Projectile_motion
4. Projectiles, gravity: http://www.physicsclassroom.com/class/vectors/u3l2a.cfm
5. Bottle Blast-Off! (The Exploratorium): http://www.exploratorium.edu/math_explorer/BBO_makingRockets.html