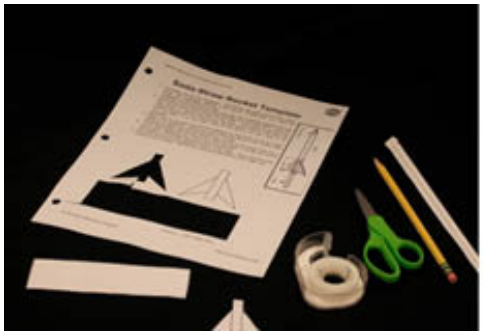
Lesson: Soda Straw Rockets

Grades: K-2nd Grade Prep Time: ~45 Minutes Lesson Time: ~90 Minutes



WHAT STUDENTS DO: Test a rocket model and predict its motion.

Curiosity about what lies beyond our home planet led to the first rocket launches from Earth and to many exploration missions since. Using simple materials (soda straws and paper), students will experience the processes involved in engineering a rocket. Conducting engineering tests, students will have the opportunity to answer a research question by collecting and analyzing data related to finding out the best nose cone length and predicting the motion of their model rockets.

NRC FRAMEWORK / NGSS CORE & COMPONENT QUESTIONS

HOW CAN ONE EXPLAIN AND PREDICT INTERACTIONS BETWEEN OBJECTS AND WITHIN SYSTEMS OF OBJECTS?

NRC Core Question: PS2: Motion and Stability: Forces and Interactions

How can one predict an object's continued motion, changes in motion, or stability?

NRC PS2.A: Forces and Motions

HOW DO ENGINEERS SOLVE PROBLEMS?

NRC Core Question: ETS1: Engineering Design

What is a design for? What are the criteria and constraints of a successful solution?

NRC ETS1.A: Defining and Delimiting an Engineering Problem

What is the process for developing potential design solutions?

NRC ETS1.B: Developing Possible Solutions

How can the various proposed design solutions be compared and improved?

NRC ETS1.C: Optimizing the Design Solution

INSTRUCTIONAL OBJECTIVES (IO)

Students will be able to

IO1: Plan and conduct an investigation through construction of a model rocket using soda straws and paper to test the effects of a push and of design changes of a rocket on the distance of the traveled

1.0 Materials

Required Materials

Please supply:

- 30 Sharpened Pencils (1 per person)
- 15 Scotch Tape Rolls – 1/4" tape if possible (2 per group)
- 30 Individually Wrapped Drinking Straws (1 per person)
- 15 Meter Sticks or Tape Measures (2 per group – 1st and 2nd grade ONLY)
- LCD projector and computer with internet access to find pictures or video of rockets on the following site: http://www.nasa.gov/centers/kennedy/launchingrockets/archives/elv_archive-index.html.
- OR pre-construct rockets prior to class (1 per person)

Materials Provided

Please Print:

From Lesson:

(A) Soda Straw Rocket Template – 1 per student
(B) Soda Straw Rocket Data Log Kindergarten – 1 per pair of Kinder students or
(B) Soda Straw Rocket Data Log – 1 per pair of 1st or 2nd grade students
(C) Soda Straw Rocket Safety Procedure – 1 per pair of students
(D) Soda Straw Rocket Results – 1 per student
(E) Apply to New Ideas – 1 per student
(F) Engineering Design Cycle – 1 per 1st or 2nd grade student

Optional Materials

From Alignment Document:

(G) "Soda Straw Rocket" Assessment Rubrics
(H) Alignment of Instructional Objective(s) and Learning Outcome(s) with Knowledge and Cognitive Process Types

2.0 Vocabulary

Analyze	consider data and results to look for patterns and to compare possible solutions
Data	facts, statistics, or information
Empirical Evidence	knowledge gained through direct or indirect observation
Engineering	a field in which humans solve problems that arise from a human need or desire by relying on their knowledge of science, technology, engineering design, and mathematics (derived from NRC Framework, 2012).
Explanations	logical descriptions applying scientific information
Graph	a diagram representing the relationship between facts or statistics
Hypothesis	a suggested explanation that predicts a particular outcome based on a model or theory, to be shown true or false
Inquiry	a method of learning scientists use, which includes observing, **questioning**, examining what's already known, planning investigations, using tools to gather, analyze, and interpret data, proposing **hypotheses** and predicting results, and communicating findings (derived from NSES, 1996)
Mission	an operation designed to carry out the goals of the space program
Models	a simulation helps explain natural and man-made systems and shows possible flaws
Prediction	the use of knowledge to identify and explain observations or changes in advance (NSES, 1996)
Questions	scientists asks questions that can be answered using **empirical evidence**
Rocketry	a branch of science that deals with rockets and rocket propulsion

3.0 Procedure

PREPARATION (~15 minutes)

- Set up authorized target for rockets (globe, ball, a round circle on an easel, etc).
- Set up a masking tape line on the floor to establish the launch point
- Access pictures of rockets on the internet: http://www.nasa.gov/centers/kennedy/launchingrockets/archives/elv_archive-index.html

- Print:

  - Student Sheets (A-D) – 1 per student

Teacher Tips

1. If possible, use ¼" tape for taping the rockets. The smaller size works more easily and can be applied without over-taping areas.
2. Do not distribute the straws until all the students are finished with their rocket and you are ready to have the class begin the launches. Use wrapped straws for sanitary purposes.
3. Have the students line up in a horizontal line to launch the rockets. Depending on the number of students, you may have to have sequential launches take place. An outside venue, cafeteria or gym would work great, as you could spread the students out and allow them to make their measurements easily. Make sure you let them know that no unauthorized launches can be done! They must launch when given permission.
4. Having a launch countdown as a group is always fun! (e.g., 10,9,8,7…)
5. Always provide an authorized target (globe, ball, etc. for students to direct their aim).
6. If students take their rockets home, please advise that no rockets may be launched on the bus!
7. If you use Soda Straw Rockets for other venues (school space nights, open house, etc.), make sure you have a target for the students. Provide a small zip top bag in which students can place their rockets and ask them not to launch in other places.
8. To save time, it is very helpful if you have extra rocket pieces already cut for students who struggle with cutting.

STEP 1: ENGAGE (~20 minutes)

Research common rocket features

A. Blast off! Getting off Earth and toward a solar system destination is exciting. How do we know we can get where we want to go? Engineering design is important to helping us reach our goals. For this engagement, you will be modeling steps in the inquiry process for your students, from observation and questioning to testing and acquiring results, as well as engineering design. As students get older, they will be able to complete these steps on their own.

B. Show images of rockets. For initial engagement, you can also begin with "Mars in a Minute: How do we launch to Mars?" as a cartoon teaser for more in-depth content.

Research video and images of rockets that NASA sends into space. (http://www.nasa.gov/centers/kennedy/launchingrockets/archives/elv_archive-index.html). Ask students what they may notice about the rockets and the launches. Do they have something in common?

C. What do the students predict would happen to the distance a rocket will travel if changes were made to the amount of push (force of air) on the rocket?

D. Let's investigate that question! Record the class hypothesis on the board.

STEP 2: EXPLORE (~30 minutes)

Design and implement rocket investigation

A. Give students the *(A) Soda-Straw Templates* (or pre-cut pieces for very small children) and direct them to write their names, initials, or colorful designs on the fins of the rockets. Review the directions on how to construct their rocket.

Teacher Tip: Have students work in pairs to construct the rocket tubes. One student can hold the tube tight on the pencil and the other student can apply the tape to the paper tube. Students build the rocket on the pencil. Tell them not to remove it from the pencil until you are ready to distribute the straws.

B. Students should select a control for this investigation. Discuss that the purpose of a control is to have something to which you can compare the results. This control should be similar to what you are testing, but something that will be unaffected by the things you are changing. For this investigation, control will be launching from behind the same line and attempting to blow at the same rate.

C. Ask students

a. "*What is the difference between these rockets and the ones we were looking at in pictures and video*?" Ideally, the goal is to help students understand this is a model of rocket that we will use to test the effect of air (push) on the speed and distance.

D. Prior to launch, have students select the appropriate image/images from *(C) Safety Procedures* that reflect correct safety procedures for launching a soda straw rocket. Discuss which image is most appropriate and why.

E. Students will then place the straw in the opening of their rocket and launch their rocket. Students will then record the distance it traveled (by counting the number of floor tiles (K) or using meter sticks (1-2)) on the *(B) Data Log*.

F. Between each trial, ask students if they observed how hard they blew on the straw. Record if it is a soft launch or a hard launch by circling the appropriate graphic on the page.

G. Students should do a few trials of the investigation and record the results on their *(B) Data Log*.

H. As a class, create a bar graph to represent how the straw was blown and how far the rocket flew.

STEP 3: EXPLAIN (~10 minutes)

Drawing conclusions from data and evidence

A. Students will discuss which bars on the graph are bigger and what caused them to be bigger. Ask questions such as:

a. *Did you notice anything about the speed of the rockets in each one?*
b. *Is it possible the speed had something to do with the distance also?*

B. Give students *(D) Student Worksheet. Soda Straw Rocket Results.* Have them cut and paste the appropriate results demonstrating the difference in push vs distance the rocket flew.

STEP 4: ELABORATE (~10 minutes)

Consider other possible variables

A. Give students the opportunity to evaluate and explore other possible variables that could affect the flight pattern of a rocket. They may come up with examples such as: angle of launch, # of fins, length of the tube, weighted with paper clips, etc. This exercise helps to build your students to participation in a full inquiry model. They can report out their results to the class upon completion of their investigation.

B. Have students complete *(E) Student Worksheet. Apply to New Ideas*.

STEP 5: EVALUATE (~20 minutes)

Reflect on findings from rocket testing

A. Ask students to complete the *(F) Student Worksheet. Engineering Design Cycle* so that they can draw conclusions based on evidence from their tests.

B. Ask students to share their results with the class. What did they test? What worked, what didn't?

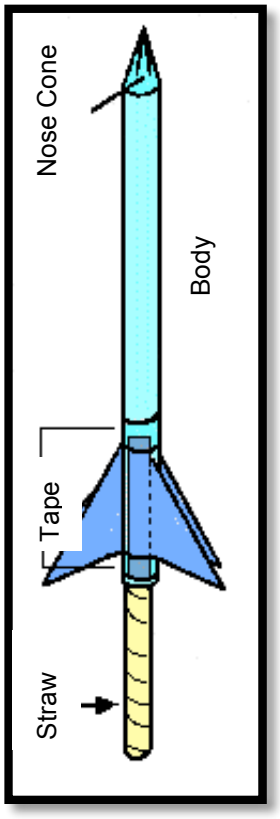
4.0 Extensions

In Step 4: Elaborate, investigate the purpose of nose cones (they hold the payload of rockets) and some of the changes that have to be made to accommodate launching larger payloads into space (e.g., larger rockets, strap-on boosters to add more thrust, etc.).

5.0 Evaluation/Assessment

In the Alignment Document Teacher Guide, use the *(E) "Soda Straw Rocket" Rubric* as a formative assessment that aligns with the NRC Framework, National Science Education Standards, and the Instructional objective(s) and learning outcomes in this lesson.

(A) Soda-Straw Rocket Template (1 of 2)



1. Carefully cut out the rectangle. It will be the body tube of the rocket. Wrap the rectangle around a #2 pencil, lengthwise, and tape the rectangle so that if forms a tube.

2. Carefully cut out the two fin units and align the rectangle between the two fins with the end of your body tube. Tape it to the body tube. Tape the tube about ¼" above the end of the tube. That helps to prevent the taping of the fin to the pencil. Do the same thing for the other fin unit, but tape it on the other side of the pencil, so you have a "fin sandwich."

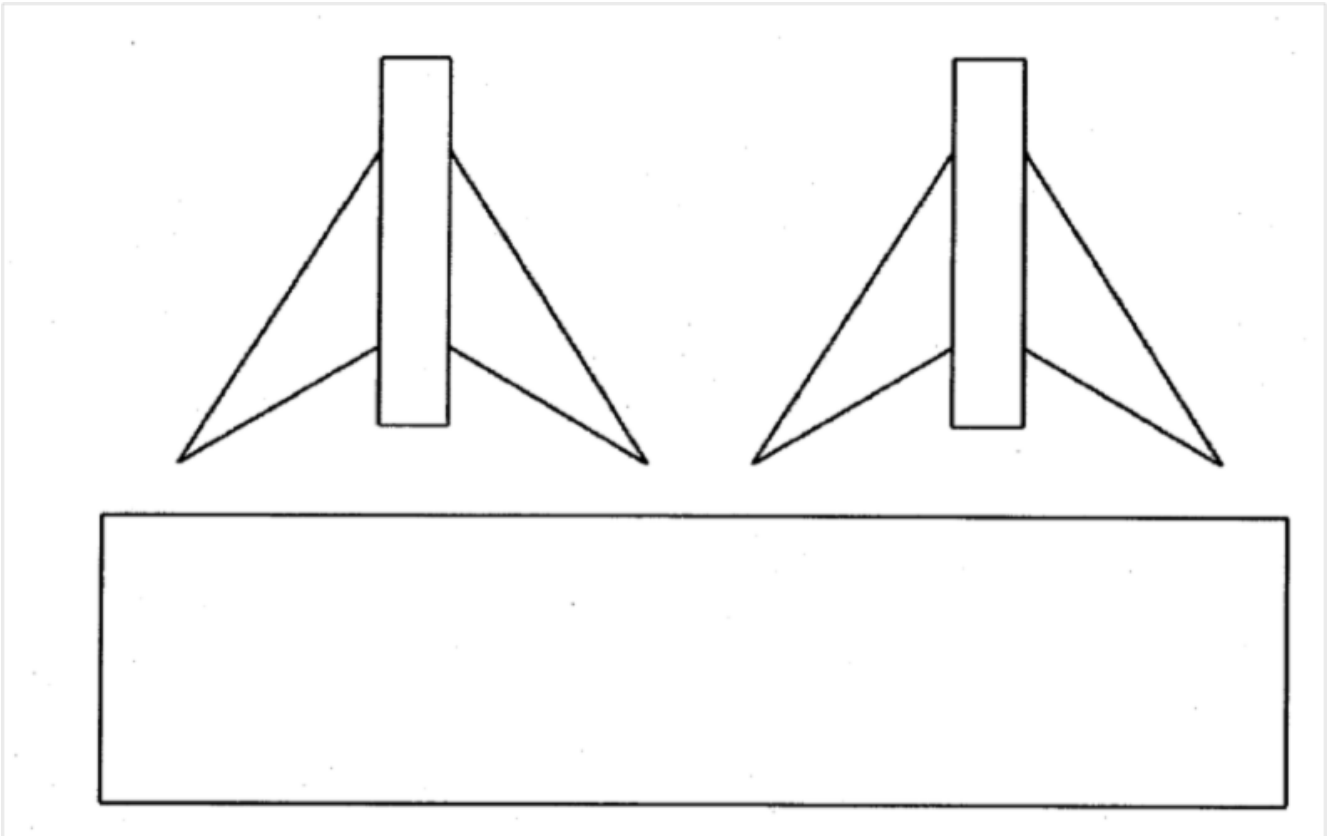
3. Bend one fin on each fin unit 90 degrees so that each fin is at a right angle to its neighbor. When you look along the back of the rocket (near the pencil eraser), the fins should form a "+" mark.

4. At the sharpened end of your pencil, twist the top of the body tube into a nose cone. Measure your nose cone from the base to its tip and record the length on your (B) Data Log and on the rocket itself.

5. Remove the pencil and replace it with a soda straw. Blow into the straw to launch your rocket. Remember launch safety! Never point your rocket at a person. Your goal is to get to your target destination! Record the distance it travels on your (B) Data Log.

(A) Soda-Straw Rocket Template (2 of 2)

Soda Straw Rocket Template – Cut these three pieces out carefully.



(B) Student Worksheet. Soda-Straw Rocket Data Log - Kindergarten

Name: _____

Color the number of floor tiles

13	13	13
12	12	12
11	11	11
10	10	10
9	9	9
8	8	8
7	7	7
6	6	6
5	5	5
4	4	4
3	3	3
2	2	2
1	1	1

(B) Student Worksheet. Soda-Straw Rocket Data Log

Name: _____

Using a meter stick or ruler, measure the distance of the soda straw rocket from the launch line.

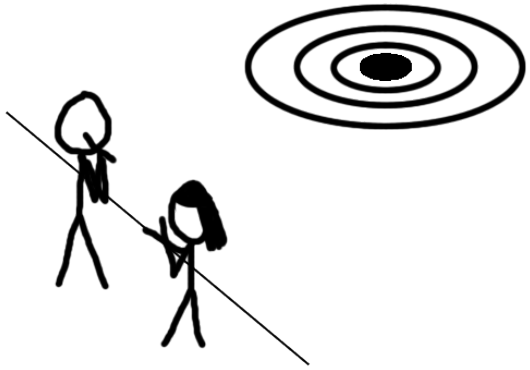
	Distance Trial #1	Distance Trial #2	Distance Trial #3	Observations?
Small				
Medium				
Big				

(C) Student Worksheet. Safety Procedure

Name: _____

Circle the safest example of how to launch the soda straw rocket:

1.



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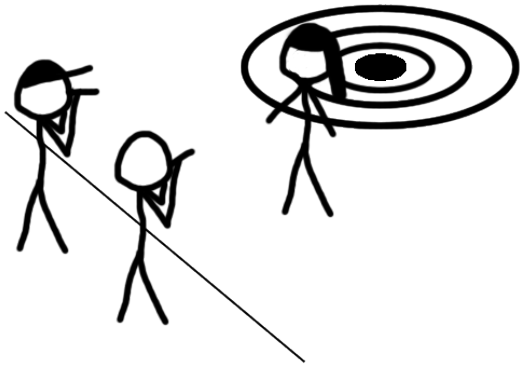

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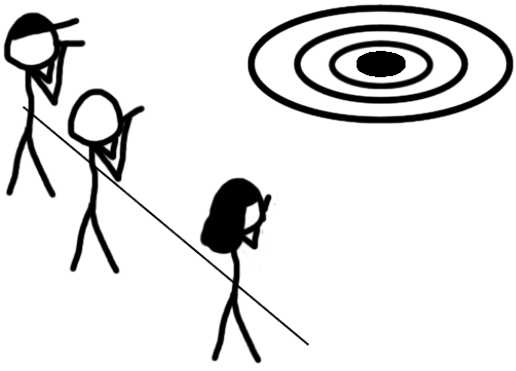

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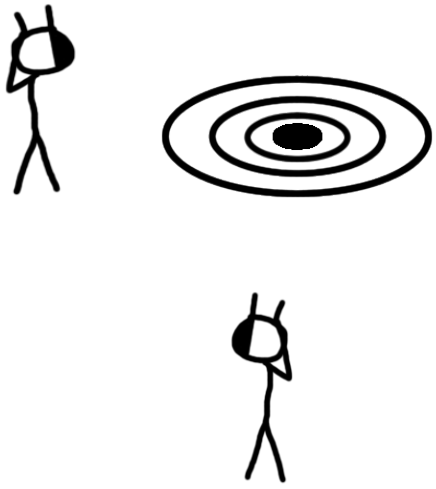
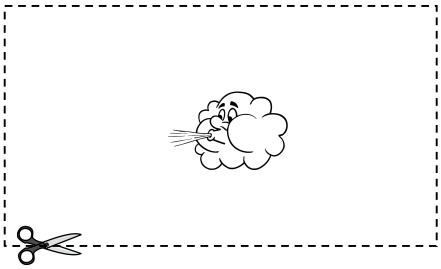
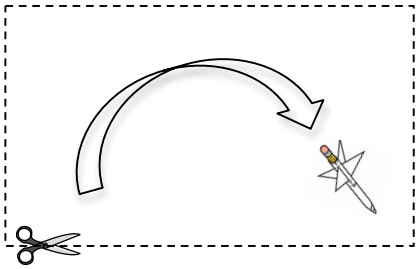
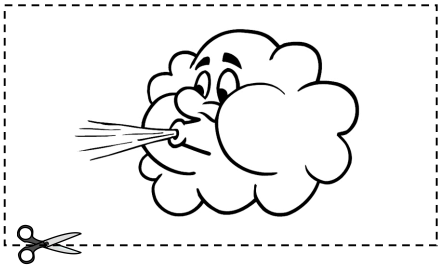


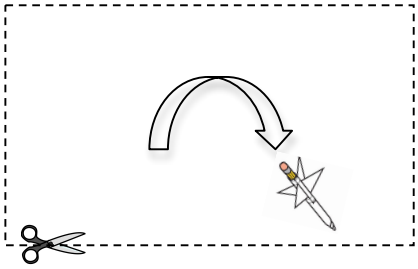
(D) Student Worksheet. Soda-Straw Rocket Results (1 of 2)

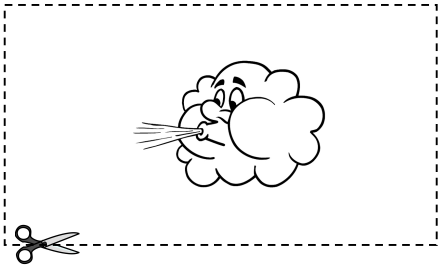
Cut pieces out below

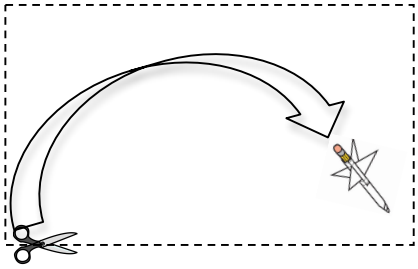






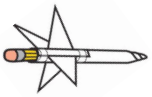






(D) Student Worksheet. Soda-straw Rocket Results (2 of 2)

Name: _____

How does  **affect the**  **of the**  **?**

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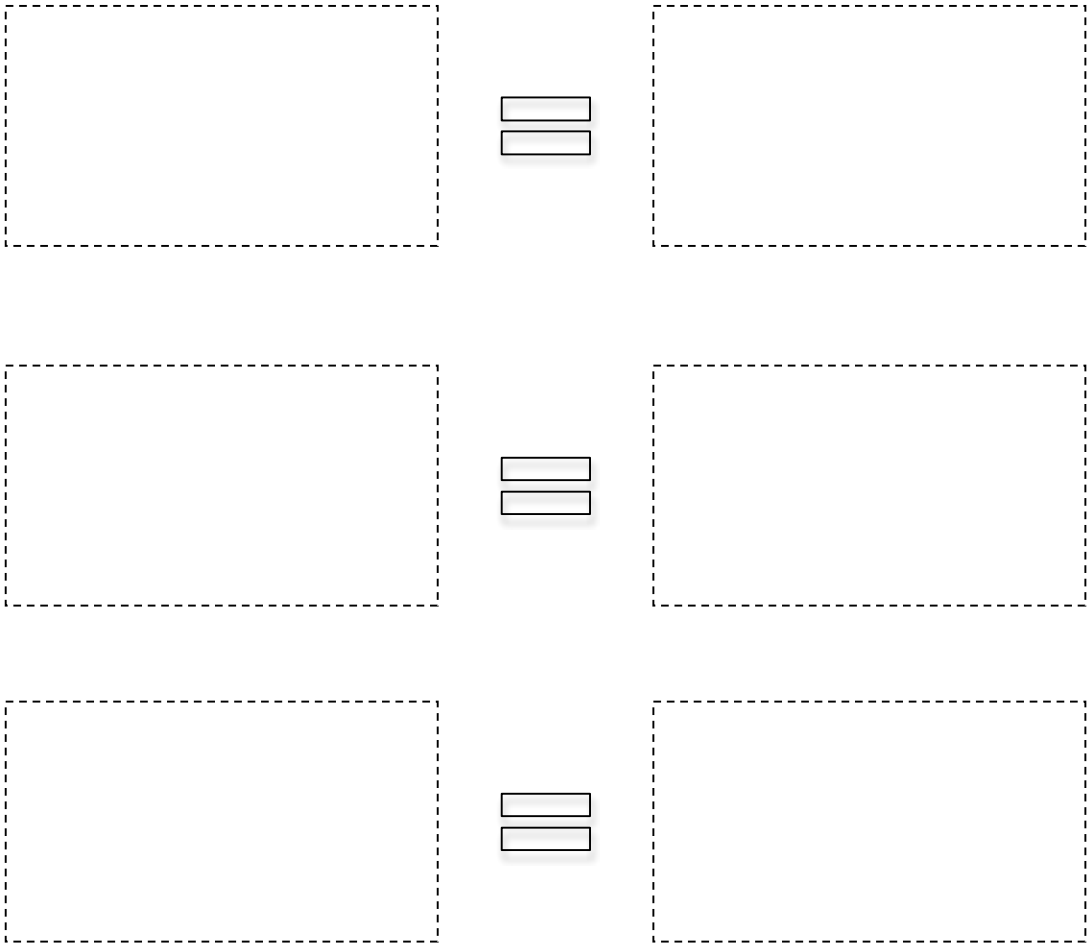
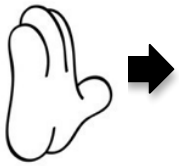
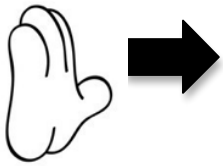


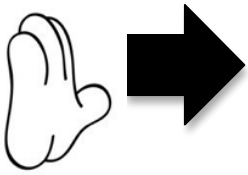
(E) Student Worksheet. Apply to New Ideas

Name: _____

Draw a line to match the amount of push to the car distance:

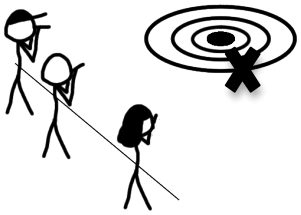
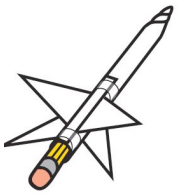
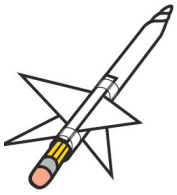
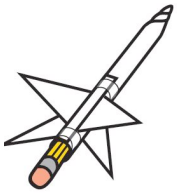
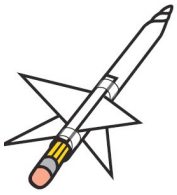






(F) Student Worksheet. Engineering Design Cycle

Name: _____

What rocket part did you change? Circle it.	Did it work? Circle one	How close to the target? Mark with an X
Example: 	Yes / No	
	Yes / No	
	Yes / No	
	Yes / No	
	Yes / No	