ADLER
EDUCATION

Fizzy Lifting Rockets

Purpose
This activity will demonstrate Newton's third law of motion through carbon dioxide powered rockets.

Objectives

- Students will explain Newton's third law of motion--for every action there is an equal and opposite reaction.
- Students will apply the scientific method to draw conclusions about rocket design.

Related Standards and State Goals
Illinois State Goals:

Middle/Junior High School

- *11.A.3a* Formulate hypotheses that can be tested by collecting data.
- *11.A.3b* Conduct scientific experiments that control all but one variable.
- *11.A.3c* Collect and record data accurately using consistent measuring and recording techniques and media.

Early High School:

- *11.A.4b* Conduct controlled experiments or simulations to test hypotheses.
- *11.A.4c* Collect, organize, and analyze data accurately and precisely.

Late High School:

- *11.A.5b* Design procedures to test the selected hypothesis.
- *11.A.5c* Conduct systematic controlled experiments to test the selected hypothesis.

Audience

- 6th-12th grade

Time Recommended
1 ½ -2 hours

Materials and Preparation:

- 1 or 2 film canisters per small group (with lids that attach on the inside of the canister)
- 1/2 Effervescing antacid tablet (ex. Alka Seltzer) per rocket launch
- Paper rocket template (at end of lesson)
- Various types of paper (computer, cardboard, tracing, typing etc.)
- Scissors
- Tape
- Eye protection
- Water
- Paper towels
- One plate per small group (to contain liquid from launch)
- Yard sticks
- Quadrant (at end of lesson, only for older students)
- "How High" worksheet (at end of lesson, only for older students)

Put an example rocket together. You may want to have a set of control data ready, from launches with no variables changed. This can serve for comparison for the students' findings.

Procedure:

1. Define Newton's third law of motion as: For every action, there is an equal and opposite reaction. Discuss how rockets demonstrate this law of motion.
    a. As the fuel in a rocket is ignited, pressure builds up within the fuel tank.
    b. The thrust from the escaping fuel leads to an imbalance of forces, which causes an action.
    c. The action is the burnt fuel pushing out of the rocket toward the ground.
    d. The reaction is the rocket being pushed in the opposite direction (toward space). Space shuttles use large amounts of fuel in order to escape Earth's gravitational pull.
2. To demonstrate this law, we will be making model rockets. The class' rockets will use a chemical reaction between an antacid tablet and water which creates CO_2. This reaction will take place in a film canister—our rocket. The CO_2 will build up inside the film canister until the pressure forces the cap off the canister (action). This results in the paper rocket shooting in the opposite direction (reaction).
3. Have students work in small groups to decide how to test the way different variables affect the rocket's launch height. Have the groups use the scientific method to write a hypothesis, test it, and draw a conclusion. Suggested strategies are:
    a. Have each group choose a variable to alter and observe. Possible variables include: weight of paper, amount of water, amount of antacid, presence/absence of fins, etc.
    b. Discuss variables in the rocket that may be altered for testing. Challenge the small groups to test the variables in order to find what will allow the rocket to go the highest. Make the students responsible for supporting their findings and relating them to the action or reaction component of the launch. Ex. If the fins are taken away, does it affect the action or the reaction of the rocket?
4. Have the students conduct their investigation. Be sure they come up with a systematic way to test their hypothesis and record their data. Launch height can be estimated with the yardstick. Alternately, students with a basic understanding of trigonometry can use the "How High" worksheet and the Quadrant Template to calculate their rocket's height.
5. As a class, compile a set of data and discuss which variables were tested and how they altered the action or the reaction of the experiment. You could also discuss the importance of doing many trials and calculating an average.

Directions/Tips for Rocket Assembly and Launch:
Cut out the template. Wrap the long paper around the film canister, canister top facing down, and tape together. Do not tape the paper to the canister before wrapping around! The rocket will have better lift when the canister is not taped directly to the rocket. Form the cone and tape to top of body tube. Finish with taping the fins to the base of the body, with the right angle of the fin perpendicular with the base of the rocket. Tape half of an effervescence tablet to top of film canister. Fill film canister half way with water and place in the bottom of the rocket. Fit the lid on the canister and flip over standing the rocket on the base. This will allow for the water and antacid to mix creating CO_2. The CO_2 will create pressure inside the tube and shoot the rocket.

Assessment:
Have the students write a conclusion about the design variables within the demonstration of Newton's Third Law of Motion. What were their findings and how can they apply them to real life situations? Their conclusions should be supported by data.

Have students compare their design process to the one NASA might use when designing a rocket. At what point in the design process would NASA launch a test model? Which steps would occur before building a test rocket to launch? Are the characteristics the students found most important also likely important in the design of full size rockets or are they unique to the model rockets? What are additional factors that need to be considered when designing a full-size rocket?

Adler Planetarium Field Trip Connections:
The following experiences* at the Adler can enhance the content covered in this lesson.

Guided Gallery Experiences:
- *In Our Solar System* (Grades 2-7) tour covers space travel and touches on astronaut Jim Lovell's childhood fascination with model rockets.

Exhibitions:
- Learn about rockets and the history of space flight in our *Shoot for the Moon* gallery.

* *Please note that shows, classroom programs, and guided gallery experiences are available for an additional cost.*

This activity is adapted from the Sun-Earth Connection curriculum. You may download the curriculum in its entirety at http://www.adlerplanetarium.org/educate/resources/curriculum.
This curriculum is also available along with supporting classroom materials for loan in the Sun-Earth Discovery Kit. Information about the Adler Planetarium's Discovery Kit program is available at http://www.adlerplanetarium.org/educate/resources/kits.

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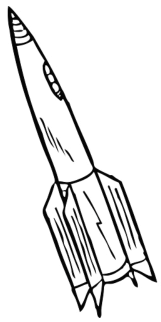
How High?

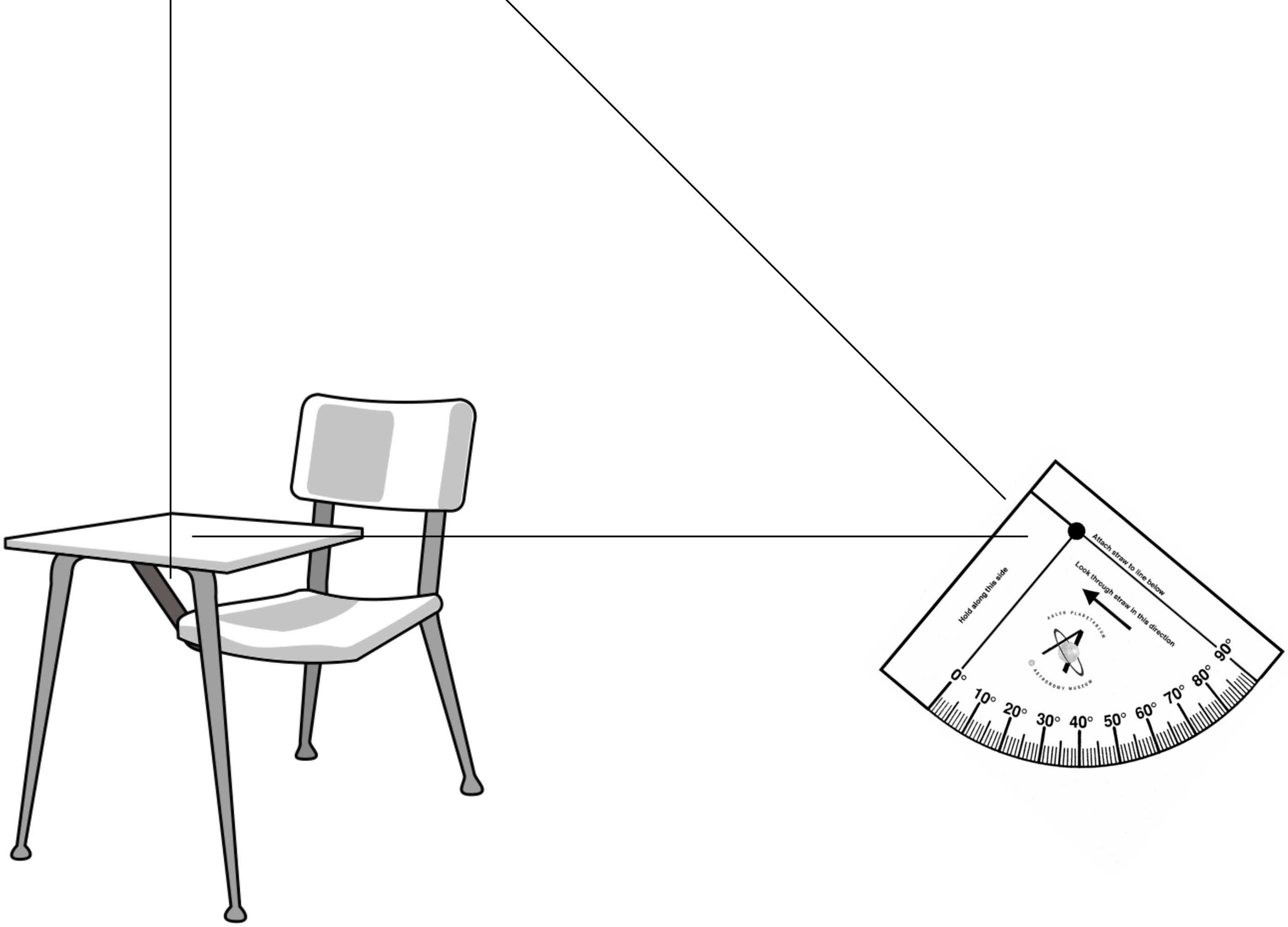


1. Launch rocket
2. Sight rocket through straw on quadrant. Your eye should remain level with the launch pad through the entire launch.
3. Record angle at highest point.
4. Measure the distance from your location to the launch pad.
5. Calculate height of launch using the formula below.

tan (Angle) X (Distance from launch pad) = Height of rocket launch

For example, if our rocket was 37 degrees at the peak of its launch and the launch pad was 29 inches from our sight, then our calculation would be:

tan 37° X 29 inches = 21.85 inches



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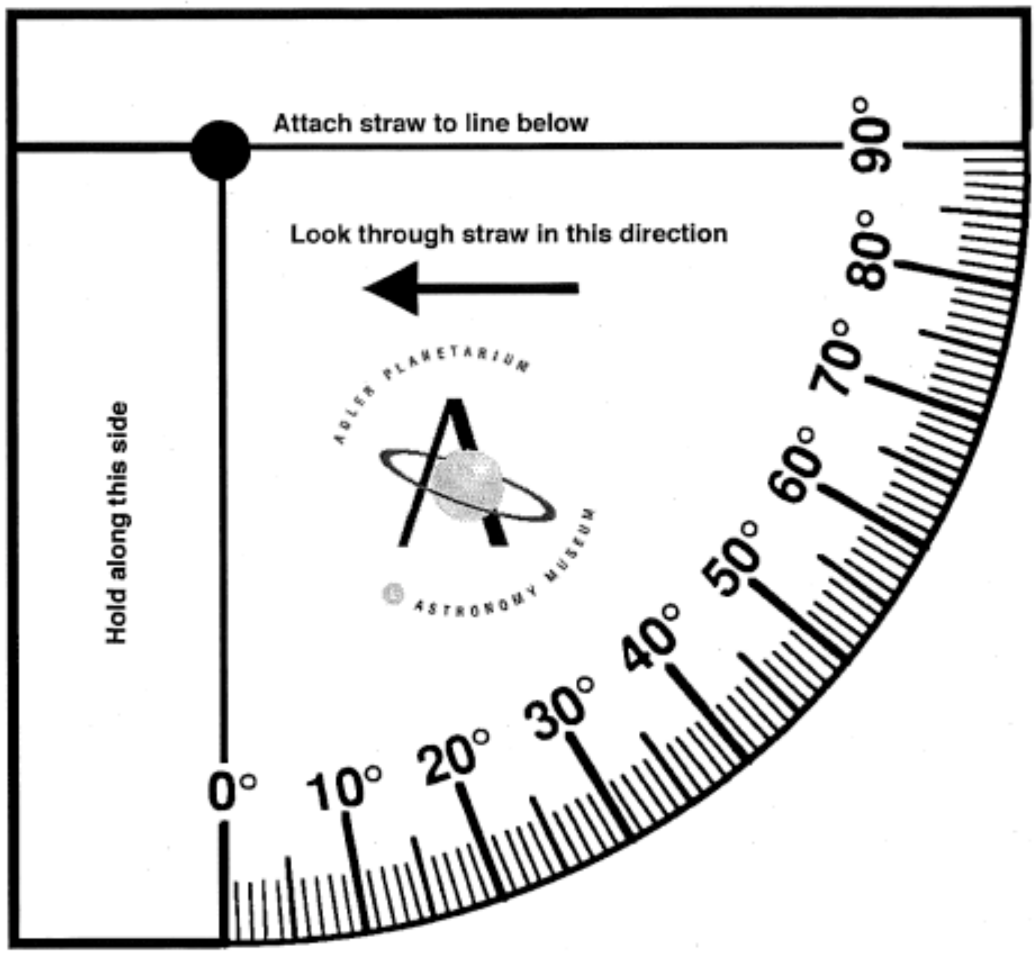
Quadrant Template



To construct:

1. Use scissors or a hole punch to make a hole on the big black dot.
2. Tie a 20 cm length of string to the quadrant, going through the hole you just made and over the top of the quadrant.
3. Tie a small weight to the other end of the string. You can use a large bead or washer as a weight.
4. Attach a drinking straw to the line at the top of the quadrant with tape. One end of the straw should align with the hole and the other end should extend towards the 90 degree mark.

To use:

Hold the quadrant along the edge labeled, “Hold along this side.” Look through the straw, in the direction indicated and locate the object that you are trying to find the height of. Use your finger and thumb to pinch the string where it has swung along the quadrant scale. Use the string’s position to measure the angle.