# *Nose Cone Aerodynamics*

**LESSON DESCRIPTION**
Students compare the aerodynamic features of different nose cone designs.

**OBJECTIVES**
Students will
• Experiment with different nose cone shapes to determine the advantages and disadvantages of each type. Conic, parabolic and flat shapes will be tested to determine which is most aerodynamic.

## NASA SUMMER OF INNOVATION

**UNIT**
*Engineering*
**GRADE LEVELS**
*7th -9th*
**CONNECTION TO CURRICULUM**
*Physical Science, Engineering/Technology, Mathematics*
**TEACHER PREPARATION TIME**
30 minutes
Rocket Wind Tunnel construction greatly increases this advance time requirement. Additional, 2 hours
**LESSON TIME NEEDED**
1 hour Complexity: Moderate

**NATIONAL STANDARDS**

**National Science Education Standards (NSTA)**
Science as Inquiry
•Abilities necessary to do scientific inquiry
Physical Science
•Position and motion of objects
•Motions and forces
Science and Technology
•Abilities of technological design

**Principles and Standards for School Mathematics (NCTM)**
•
Math as Problem Solving
•Measurement
•Number and Operations
•Data Analysis and Probability
• Reasoning and Proof
•Communication
•Connections
•Representations

**National Technology Standards (ITEA)**
•Creativity and Innovation
•Research and Information Fluency
•Critical Thinking, Problem Solving, and Decision Making

## MANAGEMENT

***Nose Cone Experts:*** Other than the collection of materials the original design of this activity requires minimal advance preparation. The teacher should identify an area where the wind tunnel testing can take place with a leaf blower to minimize the disturbance of other classes. Students should work in teams.

If the instructor wishes to pursue this series of tests with a more quantified measurement of the drag resulting from each design, a simple yet effective ***vertical wind tunnel design*** exists in the NASA Educator Rocket Guide on p. 97 of this guide. This piece of equipment will be too involved for younger students to construct and will fall to the teacher, but once constructed middle grade students should be very capable of making the measurements using the device.

Student activity forms for the ***Rocket Wind Tunnel*** will appear on p. 101 of the guide for duplication. This wind tunnel design make be used for other small model rocket designs with a variety of engineering variables.

## CONTENT RESEARCH

**Aerodynamics** is the branch of science that deals with the motion of air and the forces on bodies moving through the air. There are four forces that act on a rocket. They are **weight, lift, drag and thrust**.

- **Weight** is a force that is always directed toward the center of the earth
- To overcome the weight force, aircraft generate an opposing force called **lift**. Lift is generated by the motion of the aircraft through the air. Most of the lift is generated by the wings. In most rocket designs, **fins** are more engaged to steer or direct the air flow for flight stability, instead of providing lift.
- Drag is a force that opposes the upward movement of the rocket. It is generated by every part of the rocket. Drag is a sort of **aerodynamic friction** between the surface of the rocket and the air.
- To overcome drag, aircraft and rockets use a **propulsion system** to generate a force called **thrust**.**

## LESSON ACTIVITIES

Student teams will construct predesigned card stock nose cones from patterns provided in the *Adventures In Rocket Science Activity Guide*. The wind tunnel simulation is one of the most basic and can be easily modified to create improved air flow, etc…
Drag is measured here as a result of the differing distances the rocket body travels in opposition to the air flow.

## RELATED RESOURCES

NASA Educators Aeronautics Guide:
http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Aeronautics.html
NASA Rocket guide - Heavy Lifting:
http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Heavy_Lifting.html
Rocket Wind Tunnel design from the NASA Educator Rocketry Guide:
http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Rocket_Wind_Tunnel.html p.97
Our World: Wind Tunnels in Action:
http://www.nasa.gov/audience/foreducators/nasaeclips/search.html?terms=aeronautics

## MATERIALS

***Nose Cone Experts:***
*http://www.nasa.gov/pdf/265386main_Adventures_In_Rocket_Science.pdf The original lesson is found on p.90 of this guide. The chart and patterns to be duplicated appear following p. 92.*

*•Nose Cone Distance traveled Table*
*•Group Procedures and Questions*
*•Paper towel Tube*
*•Nose Cone Patterns Worksheet*
*•Yard or Meter Stick*
*•Several 2-Liter Plastic Bottles*
*•Modeling Clay*
*•Card Stock*
*•Leaf Blower or Vacuum set to exhaust/blow*
*•Books to make pathway*
*•Long Hallway or Open Area*
*•Tape*

**Rocket Wind Tunnel Design:**
*•Paper concrete tube form (8 " or 2" by 4' )*
*•Beam balance or electronic scale (sensitive to 0.1 grams)*
*•Balance or some other weight*
*•Thin wire coat hanger*
*•Nail (about 16D by 3" )*
*•2 small screw eyes*
*•String*
*•Duct tape*
*•Transparency paper or clear cellophane*
*•Small electric fan*
*•Needle-nose pliers and wire cutter*
*•Box cutter*
*•Ruler*
*•Toilet paper roll tubes - about*

ARC Wind Tunnels: http://www.windtunnels.arc.nasa.gov/
GRC Wind Tunnel Resources:
http://www.grc.nasa.gov/WWW/k-12/WindTunnel/windlist.html
LaRC Wind Tunnels http://www.nasa.gov/centers/langley/news/factsheets/windtunnels.html
GRC Forces of Flight:
http://www.grc.nasa.gov/WWW/K-12/airplane/forces.html

**DISCUSSION QUESTIONS**

1. What do you think of when you hear the word aerodynamic?
    a. Where have you heard the term before? *Student answers will vary*.
2. Using the resources on the Internet or in your library, find information on aerodynamics and the importance of the use of wind tunnels.
    a. Give several examples. *Student answers will vary*
3. What is drag as it relates to aerodynamics? *Drag is the friction of a design against the flow of air*
    a. What are some things that can be a done to an object to decrease its drag? *Decrease the profile of the object as it attacks the air.*
    b. What are the parts of a rocket that may result in drag? *All of the exterior facing pieces of the rocket create drag*

*4.* List the variables that need to be controlled in this activity. *Speed/force of the air used to test rocket for drag, design of the rocket body, conditions related to the leaf blower or wind tunnel testing areas, etc…*

**ASSESSMENT ACTIVITIES**

With multiple tests, students will compare their results and discuss the questions above as they relate to the procedures and results of the tests. The activity's original design lacks a series of rubrics for student performance in the activity. Possible rubrics may be related to the details provided in the summary results of the tests presented either in writing or orally.

**ENRICHMENT**

Obvious extensions of this experiment is to permit the students to design their own variety of nose cones for comparison on the same rocket body or tube. Another consideration might be to include centimeter graph paper as the material for the construction of the nose cones. Students will be able to quickly determine the square centimeter surface area of one design over another and it this variable has an effect on the outcomes.

Utilizing the Rocket Wind Tunnel device permits the using of fin designs, body tube variations and a host of variables.