Technology

Fins R Roots!

GRADES 3-5
Three Class Lesson Plan

STEP 1 ■ LEARN (First class session)

Objectives

- Students will learn the purpose of fins.
- Students will identify the different fin shapes and parts of a fin.
- Students will construct and launch an Estes model rocket to see how fins affect a rocket in flight.
- Students will determine if the rocket's fin design should be changed.

Materials

1. Viking™, Wizard™ or Alpha® Rocket Lab Pack™ (12 pack) - 2 or more
2. Rocket Engine Lab Pack™ (24 pack) - 1 or more
3. Electron Beam® Launch Controller - 1 or more
4. Porta-Pad® II Launch Pad - 1 or more
5. Paper, pencil, white glue or carpenter's wood glue, scissors, modeling knife, ruler, masking tape, sandpaper and spray paint for each student
6. Visuals/Overheads: Model Rocket Nomenclature, Model Rocket Flight Profile, Common Fin Shapes, Parts of a Fin, What is Drag?
7. Design Considerations for Fins worksheet for each student

Time

Three class sessions

Background

Parts of a Model Rocket

The main parts of a model rocket are the body tube, engine holder assembly, fins, launch lug, nose cone, shock cord and recovery system. Model rockets are made of lightweight materials like paper, balsa wood and plastic. The body tube

NATIONAL STANDARD

Standard 10
Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Benchmark E
Students will learn the process of experimentation, which is common in science, can also be used to solve technological problems.

is the main structure of the rocket. It determines the main shape of the rocket and is usually long and slender. All other parts are attached to the body tube. The engine holder assembly holds the engine in place inside the rocket. Fins give directional stability and help the rocket fly straight. The launch lug is the hollow tube that slips over the launch rod. The nose cone is attached to the top of the rocket and is tapered to cut through the air more efficiently and reduce drag. The rubber shock cord attaches the nose cone to the body tube so the rocket is recovered in one piece. The recovery system returns the rocket to the ground.

Model Rocket Flight Profile

Thrust is the upward force that makes a rocket move off the launch pad. This is a demonstration of Newton's Third Law of Motion: "For every action there is an equal and opposite reaction." The action of the gas escaping through the engine nozzle leads to the reaction of the rocket moving in the opposite direction.

The casing of a model rocket engine contains the propellant. At the base of the engine is the nozzle which is made of a heat-resistant, rigid material. The igniter in the rocket engine nozzle is heated by an electric current supplied by a battery-powered launch controller. The hot igniter ignites the solid rocket propellant inside the engine which produces gas while it is being consumed. This gas causes pressure inside the rocket engine, which must escape through the nozzle. The gas escapes at a high speed and produces thrust.

Located above the propellant is the smoke-tracking and delay element. Once the propellant is used up, the engine's time delay is activated. The engine's time delay produces a visible smoke trail used in tracking, but no thrust. The fast moving rocket now begins to decelerate (slow down) as it coasts upward toward peak altitude (apogee). The rocket slows down due to the pull of gravity and the friction created as it moves through the atmosphere. The effect of this atmospheric friction is called drag.

When the rocket has slowed enough, it will stop going up and begin to arc over and head downward. This high point or peak altitude is the apogee. At this point the engine's time delay is used up and the ejection charge is activated. The ejection charge is above the delay element. It produces hot gases that expand and blow away the cap at the top of the engine. The ejection charge generates a large volume of gas that expands forward and pushes the recovery system (parachute, streamer, helicopter blades) out of the top of the rocket. The recovery system is activated and provides a slow, gentle and soft landing. The rocket can now be prepared for another launch.

To summarize, the steps of the Flight Sequence of a Model Rocket are:

1. Electrical Ignition and Liftoff
2. Acceleration or Thrust Phase
3. Coast Phase and Tracking Smoke
4. Peak Altitude (Apogee) and Ejection
5. Recovery System Deployed
6. Touchdown

Model Rocket Fins

The primary purpose of fins on a rocket is to serve as the rocket's control system. Fins give directional stability and help the rocket fly straight. Model rocket fins may be made of plastic, balsa wood or stiff cardboard. Fins should be attached in a symmetrical form of three, four or possibly more. Model rocket fins are usually fixed; while some actual rockets have fins that have movable components that allow for the in-flight control of the rocket's guidance.

The four most common shapes of fins are rectangular, elliptical, straight-tapered and swept-tapered (Common Fin Shapes visual/overhead for the overhead projector, computer projection, a PowerPoint or interactive whiteboard). The four parts of a fin are leading edge, trailing edge, root edge and tip (Parts of a Fin visual/overhead).

One of the major concerns when designing fins is the effect of drag. Drag is the frictional force or resistance between the surface of a moving object and air. The visual/overhead What is Drag? illustrates the effects of drag on a hand placed into wind. The amount of drag is directly proportional to the amount of surface area that comes into contact with the leading edge of the rocket as it cuts through air. Because the palm of he hand has a greater surface area coming in contact with the moving air, it produces greater drag than the edge of the hand.

The shape of a fin is one factor that determines the amount of drag produced. Fin characteristics such as the total surface area, total span and sweep angle all help to determine the amount of drag produced by a rocket's fins. When viewing the fin from the fin's tip, the sectional shape is a determiner of the amount of drag produced by a rocket's fin.

Fins R Roots

For students to understand fins, compare a model rocket to a tree. A tree has a trunk, a model rocket has a body tube. A tree has roots, a model rocket has fins. The roots of a tree anchor the tree and give it stability to help it stand up straight. The fins of a model rocket give it guidance and stability so it flies straight.

Activity

1. Review the parts of a model rocket. Discuss how the rocket's flight profile. Use the visuals/overheads Model Rocket Nomenclature and Model Rocket Flight Profile. These visuals/overheads may also be used as student handouts, PowerPoint Presentation or interactive whiteboard.
2. Determine if students know why rockets have fins. Ask them if they know of any guidance systems on other types of transportation.
3. Use the What is Drag? visual/overhead to explain drag.
4. Show the class the most common fin shapes and the parts of a fin using the visuals/overheads - Common Fin Shapes and Parts of a Fin.
5. Students will discuss which fin shape will create the least amount of drag and make the rocket more aerodynamic.
6. Students will complete Design Considerations for Fins and label the parts of a fin on one of their sketches.

KEY WORDS

apogee
body tube
drag
ejection charge
elliptical
engine holder assembly
fins
friction
gravity
igniter
launch lug
nose cone
nozzle
propellant
recovery system
rectangular
shock cord
stability
symmetrical
tapered

STEP 2 BUILD (Second class session)

Activity

1. To show fins guide a rocket's flight, students will make and launch an Estes model rocket.
2. Build the Alpha®, Wizard™ or Viking™ model rocket together with students, using step-by-step procedures. Skill Level 1 rocket kits require some cutting, gluing, sanding and painting. Features to make building easy include step-by-step instructions, balsa or card stock fins, plastic nose cones and self-stick decals. The Viking™ and Wizard™ rockets are streamer recovery and the Alpha® rocket is recovered by parachute. Assembly will take one class session. If you have never built one of these rockets, it is a good idea to build one before your students do so you can assist them during the building and launching activities.
3. Review the Model Rocket Safety Code with the class.

STEP 3 LAUNCH (Third class session)

Activity

1. Assign and post launch jobs for students. Launch jobs are in the *Estes Educator Guide for Teachers & Youth Group Leaders*.
2. Prepare rockets for launching in your classroom before going outside to launch. Follow the Engine Preparation steps located in the rocket instructions.
3. Launch rockets outside at a soccer field, football field, baseball field, green grass area or blacktop area.

Wrap Up - Touch Down & Recovery

1. Ask students what fin shape did their rocket have and was this fin shape effective in reducing drag. If the rocket launched in a straight line upward and went higher than expected, the fin shape was probably correct for the rocket and the fin was glued straight on the body tube. If it did not launch straight, students will hypothesize why.
2. Students will make sketches of their rocket with a fin shape they think will produce less drag and a fin shape that will create more drag for the rocket. Students will explain by writing under each sketch why they chose each fin's shape.

Extensions

1. Use the Estes Designer's Special Kit to let students design other shapes of fins for their rocket, launch the rocket and decide if their fin design was better than the fin in the original kit.
2. Students can brainstorm on other fin designs, their good points and their bad points. Working in groups, each group could create a PowerPoint presentation of their new fin designs.

Evaluation/Assessment

- Students will complete the worksheet Design Considerations for Fins.
- Students will assemble and launch an Estes model rocket.
- Students will draw their rocket with fin shapes that will create less and more drag and for their rocket.

References

- *Estes Educator™ - Guide for Teachers and Youth Group Leaders*
- Estes Educator™ Website – www.esteseducator.com
- *NASA – Rockets - A Teacher's Guide with Activities in Science, Mathematics, and Technology*
- Estes Educator™ - *Industrial Technology and Model Rockets Curriculum*

www.estesrockets.com