GRADES 3-5
Three Class Lesson Plan

Science

Screamin' Streamers/Parachutes

STEP 1 ■ LEARN (First Class Session)

Objectives

- Students will be familiar with a variety of recovery systems for model rockets.
- Students will conduct a scientific inquiry about model rocket streamers or parachutes.

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, carpenter's wood glue or white glue, scissors, modeling knife, ruler, masking tape, sandpaper and spray paint for each student
6. *Ignite the Imagination*™ Video
7. Model Rocket Flight Profile, Model Rocket Nomenclature (2) and Model Rocket Safety Code sheets for each student or overheads of each
8. Screamin' Streamers/Parachutes Project Form for each student
9. Stopwatch - 3 or more

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

NATIONAL STANDARD

Standard A
Science as Inquiry

Standard 12
Understands the nature of scientific inquiry

Benchmark 1
Knows that scientific investigations involve asking and answering a question and comparing the answer to what scientists already know about the world

Benchmark 3
Plans and conducts simple investigations

made of lightweight materials like paper, balsa wood and plastic. The body tube 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

Recovery Systems
Various recovery systems are used depending on rocket size and weight. The systems used in Estes model rockets include:

Break-Apart - Recovery is accomplished by the rocket separating in the middle and free falling back to the ground.

Featherweight - Used strictly for light rockets. When the ejection charge activates, the engine is ejected, and the rocket falls lightly to the ground.

Glide - The engine's ejection charge converts the rocket into a glider by separating the glider from the booster rocket. The glider's wings then generate lift, allowing it to settle slowly to the ground.

Helicopter - Vanes on the rocket are activated when the ejection charge fires. Lift is created when the vanes rotate and the rocket settles slowly to the ground.

Tumble - The center of gravity is shifted behind the center of pressure. (The center of gravity is the point where the rocket balances evenly. The center of pressure is the point where the aerodynamic forces are evenly distributed.) Tumble can be accomplished by allowing the ejection charge to push the engine casing backwards, but not out of the rocket. The rocket is unstable and tumbles end over end producing high drag which slows the rocket as it falls. This method is often used for recovering lower stages of multi-stage rockets.

Parachute - The parachute is the most common form of recovery. Drag is produced by the parachute to slow the rocket. The parachute is attached to both the nose cone and the body tube. Flame-resistant recovery wadding must be placed between the engine and the parachute. If wadding is not placed in the rocket, the engine could melt or burn holes into the parachute.
Streamer - A streamer is attached to the rocket and ejected by the ejection

charge. It whips through the air causing drag to slow the rocket. The larger the streamer, the slower the rocket descends.

The recovery systems used in the Space Shuttle vary for different components. In the Space Shuttle, the rocket boosters parachute back to Earth and land in the ocean. The boosters are recycled and used on future missions. The external tank tumbles back to Earth and burns up as it re-enters the atmosphere; it is not reusable. The orbiter re-enters the atmosphere, glides back to the Earth's surface, lands like a plane and deploys a parachute to stop. The orbiter is then refurbished for another mission.

Activity

1. Show the class the Rocketry 101 video segment from the *Ignite the Imagination*™ Video.
2. Use a model rocket, Model Rocket Nomenclature, Model Rocket Flight Profile (as overheads or individual handouts) to show students the parts of a model rocket and what happens when it is launched.
3. When discussing the parts of a model rocket, students will fill out the blank Model Rocket Nomenclature sheet.
4. Show the class the What Goes Up, Must Come Down video segment on the *Ignite the Imagination*™ Video.
5. Discuss the seven recovery systems used on model rockets.
6. Explain that streamers are used on smaller rockets to help them fall faster and to keep them from drifting away. They will be working with rockets that have streamer recovery (Viking™ or Wizard™) or parachute recovery (Alpha®). Parachutes are used for larger and heavier rockets, like the Alpha®, to return them to the ground without breaking the rocket.
7. For Viking™ or Wizard rockets, students will solve a PROBLEM about their rocket's streamer. The problem is to decide: What is the best streamer length for the rocket to drift the longest time (longest flight duration) when it is launched. To accomplish this, students will need to measure the length of the streamer in the rocket kit. They will decide to keep the streamer length as it is or change the length. If they add or shorten the length they will include the new length in their hypothesis.
8. For Alpha® rockets, the PROBLEM to solve about their rocket's parachute is: What can you do (if anything) to the parachute to make the rocket drift down quicker? Students can change their parachute or leave it as it is. There are two ways to alter the parachute to reduce the effects of drift:

KEY WORDS

body tube
ejection charge
engine holder assembly
featherweight
fins
glide
hypothesis
igniter
launch lug
nose cone
parachute
propellant
recovery system
reefing
scientific inquiry
shock cord
spill hole
streamer
tumble

Spill Hole
The top of the Estes plastic parachute has a dotted line circle (4.5 in. {114 mm} in diameter) and a smaller white circle (2.25 in. {57 mm} in diameter) inside the dotted line circle. Either circle can be cut out. This allows the air flow through the parachute quicker, increasing the descent rate. Students can also cut out smaller holes the size of a dime, penny, nickel, quarter or half dollar.

Reefing
Gather the parachute's shroud lines together at the mid-point and wrap a piece of tape around it. This prevents the parachute from opening fully which will increase the descent rate.

For their hypothesis, students can decide if they will cut a spill hole the size they think will work best, reef the parachute or do nothing to the parachute.

9. Students will complete the problem, hypothesis and procedure on the Screamin' Streamers/Parachutes Project Form.

STEP 2. BUILD (Second class session)

Activity

1. For many of your students, this will be the first time they have built and launched a model rocket. Explain when this project is completed, they will become a Model Rocket Scientist.
2. Build the Viking™, Wizard™ or Alpha® 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. Assembly will take one class session. If you have never built one of these rockets, it is a good idea to build and launch one before your students build and launch their rockets.
3. **Viking™ or Wizard™ Rockets**
   When students prepare their streamers, make sure they have adjusted the length according to their hypothesis. If they are increasing the length, they can use what other students have discarded when shortening their streamer length or bring in some plastic to add to the length.

4. **Alpha® Rockets**
   Make sure students have altered their parachutes according to their hypothesis. Students will choose to not change the parachute, cut a spill hole of a specific size or use the reefing technique.
5. Review the Model Rocket Safety Code with the class or assign this for homework.

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.
4. **Flight Times**
   Students will launch their rockets with a launch partner. When one student launches their rocket, their partner will use a stopwatch to time the flight. They will start the stopwatch when the rocket lifts off and stop the stop watch when the rocket touches the ground. They will record flight times after each launch.

Note: *Before going outside to launch, demonstrate how to use a stopwatch. Let students practice using the stopwatch.*

Wrap Up - Touch Down & Recovery

1. Students will analyze and record their results based on their rocket's flight time and their hypothesis.
2. Students will graph and compare their results with other students' results.
3. Students complete the project by writing their conclusion on their project form.

Extensions

1. Students will make a bar or line graph showing the flight times of all class rockets.
2. Class Blog - Students can write what they did and learned during the Screamin' Streamers/Parachutes Project.

Evaluation/Assessment

- Students will complete the Screamin' Streamers/Parachutes Project Form.
- Students will assemble a model rocket, modify the recovery system according to their hypothesis, launch and time the rocket's flight time.

References

- *Estes Educator™ - Guide for Teachers and Youth Group Leaders*
- Estes Educator™ Website - www.esteseducator.com
- Estes Educator™ - *Reproduction Masters for Model Rocketry*

Name_____ Date_____
Class_____

Screamin' Streamers/Parachutes Project

PROBLEM

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HYPOTHESIS

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PROCEDURE

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RESULTS

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CONCLUSION

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