GRADES 3-5
Three Class Lesson Plan

Mathematics

High Flight

STEP 1. LEARN (First Class Session)

NATIONAL STANDARD

Standard 1
Uses a variety of strategies in the problem-solving process

Benchmark 1
Uses a variety of strategies to understand problem situations

Objectives

- Students will record and analyze flight data for altitude tracking.
- Students will discover how to use the Estes Altitrak™.
- Students will experience what it is like to be a model rocket scientist while making and launching their own Estes model rocket.

Materials

1. Alpha®, Viking™ or Wizard™ 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. Visual/Overhead: Model Rocket Flight Profile
7. Model Rocket Safety Code, Rocket Launch Data and Table of Tangents for each student
8. Estes Altitrak™ - 3 or more
9. Tennis Balls - 5 or more
10. Launch Data Sheet for each student

Time

Three class sessions

Background

Making a model rocket, launching it and collecting altitude data is a great activity for Math class. Students will need to learn about how a model rocket launches and all safety procedures that are included in the Model Rocket Safety Code by the National Association of Rocketry (NAR).

A Typical Model Rocket Flight

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

Altitude Tracking at Rocket Launches

All students need to have a launch partner. When one partner launches their rocket, the other partner will use the Estes Altitrak™ to collect the launch data for their partner's rocket launch.

1. Measure and mark 500 feet (152 meters) from each launch pad. The partner (tracker) using the Altitrak™ will stand here.
2. The tracker will hold the Altitrak™ at arm's length, pointed at the rocket, pull and hold the trigger, then signal for the launch.
3. Tracker will track rocket through forward sight. When the rocket reaches maximum altitude (apogee), the tracker will release the trigger. This is usually when the ejection charge goes off to push out the parachute or streamer.
4. Partners will record the meters from the Altitude in Meters Scale.
5. Make sure the predicted altitude is filled in before each rocket launches.
6. Partners will switch places and repeat the launch procedure.

KEY WORDS

- apogee
- data
- drag
- ejection charge
- igniter
- nozzle
- propellant
- recovery system
- thrust
- tracking

Activity

1. Select the Model Rocket Flight Profile to show the class how a model rocket works and launches. This may be accomplished by using an overhead, PowerPoint or on an interactive whiteboard.
2. Demonstrate how to use the Altitrak™. Hold at arm's length, pull and hold the trigger, point at object upward like something on the ceiling and release the trigger. Students will practice doing this with the Altitrak™.
3. Explain to students how to use the Altitrak™ when launching the rockets.
4. Students will practice using the Altitrak™ and recording the data by going outside on the school grounds. Students will record data from the Angle Scale and the Altitude in Meters Scale for:
   a. flag pole
   b. school roof (one story high or two stories high or both)
   c. specific playground equipment
   d. trees (tallest and shortest)
   e. houses or buildings next to school (highest part of their roof)
   f. other objects suitable to use to record the height in meters
5. **Moving Objects**
   When students track the launched rocket, they will track a moving object. To practice tracking a moving object, students will use a tennis ball. One student will throw the ball up in the air while the other student tracks with the Altitrak™.

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. When they make and launch their rocket, they will be able to experience what it is like to be a rocket scientist working on solving a problem (data collection, analyzing and calculating results).
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.
4. Students will work with launch partners to record their predicted altitude and altitude in meters on the Launch Data Sheet. To help students with the predicted altitude, use a telephone pole which is 9 meters tall (30 ft.) for a reference guide.

Wrap Up - Touch Down & Recovery

1. Students will decide how to determine which rocket had the highest flight. They will figure out how to compile and analyze all rockets' altitudes.
2. For older or advanced students, they can also convert the meters recorded from the Altitude in Meters Scale into feet.

   CONVERT METERS TO FEET:
   1 meter = 3.28 ft.
   Feet = Meters times 3.28 ft.
   Example: 210 m X 3.28 ft. = 688.8 ft.

Extensions

1. Students will make a bar or line graph showing all the rockets' altitudes in meters.
2. A. For older or advanced students, when tracking their rocket's height, students can also record the angle in degrees from the Angle Scale on the Altitrak™. Students will calculate the altitudes of all rockets. The formula to use is:

   Altitude = Angle Tangent multiplied by Baseline Distance

   Example: 30° Angle = .58 (Tangent)
   Baseline = 500 ft.
   .58 X 500 ft. = 290 ft.

   The rocket went 290 ft. high.

   B. Students will compare the conversion to feet answer with the answer they got when they calculated the altitude by multiplying the angle tangent times the baseline distance.
   - Were the answers the same?
   - Determine which Altitrak™ method is more accurate – calculating with the launch angles or the altitude in meters reading on the Altitrak™.

Evaluation/Assessment

- Students will learn how to use the Altitrak™ by practicing with a partner.
- Students will record their rocket's altitude in meters (predicted and actual).
- Students will decide how to analyze the launch data to determine which rocket went the highest.
- Students will assemble and launch an Estes model 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™ *- Mathematics and Model Rockets Curriculum*