



Mathematics

The Sky's the Limit!

STEP 1

LEARN

(First class session: 15 minutes)

Objectives

- Students will discover what data should be collected when a model rocket is launched for a Longest Flight launch competition.
- Students will record the appropriate launch data for all model rockets that are launched for the competition.
- Students will review launch data to determine the rocket with the longest flight.
- Students will build a model rocket and participate in a rocket launch competition.

Materials

1. Generic E2X®, Alpha III® or UP Aerospace™ SpaceLoft™ 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 or plastic cement, scissors, modeling knife, ruler and masking tape for each student
6. Longest Flight Launch Data sheet for each student
7. Stopwatch - 2 or more
8. Model Rocket Flight Profile and Model Rocket Safety Code handouts for each student
9. *Ignite the Imagination* Video

Time

Two class sessions

NATIONAL STANDARD

Standard 6

Understands and applies basic and advanced concepts of statistics and data analysis

Benchmark 1

Understands that data represent specific pieces of information about real-world objects or activities



Background

Building and launching an Estes model rocket is an exciting activity for a Math class. In this lesson, the model rocket will be used for a launch competition that will require students to collect data at the launch field. Instead of just watching the rocket thrust upward and float back to the ground, students will launch their rockets with a specific goal. A rocket launch competition is a great way to motivate and keep students involved in the activity plus experience a different way to collect and use data.

Before students assemble and launch their rocket, they need to understand 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.

KEY WORDS

apogee
competition
data
decelerate
drag
ejection charge
gravity
igniter
nozzle
propellant
recovery system
thrust
time delay
tracking



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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

Activity

1. Introduce the lesson by showing Part I (Intro) and Rocketry 101 from the *Ignite the Imagination* Video.
2. Ask students to explain what a model rocket is and how it works.
3. Hand out Model Rocket Flight Profile and Model Rocket Safety Code sheets to all students. Review both sheets with the class.
4. Students will take these sheets home to review so they will be prepared for the next class.
5. Discuss with students how recording different launch data will help with a rocket launch competition.
6. Review with students what data points they will be collecting during the rocket launches.

STEP 2

BUILD

(First class session: 35 - 40 minutes)

Activity

1. Students will build an Estes model rocket to use in the Longest Flight launch competition.
2. Build the Alpha III®, Generic 2X® or UP Aerospace™ SpaceLoft™ together with students, using step-by-step procedures. E2X® rocket kits contain parts that are colored and easy to assemble. Glue the parts together as per the instructions, apply the self-stick decals, attach the recovery system and you are ready to launch.



3 STEP

LAUNCH (Second 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.
2. Launch rockets outside at a soccer field, football field, baseball field, green grass area or blacktop area.

LONGEST FLIGHT LAUNCH COMPETITION

This is a contest to see whose rocket has the longest flight time. Have one student time each launch with a stopwatch. Make sure every student gets a chance to time a rocket launch. If you have more than one launch pad, assign students to time a launch at a specific launch pad (e.g., Launch Pad 1, 2 or 3). After every launch, give students a chance to record the data for each rocket. Data to record for this contest: Student Name, Flight Number, Engine Type, Predicted Flight Time and Actual Flight Time. Make sure the Predicted Flight Time is filled in before each rocket launches. Students can base their predictions on correct rocket construction, looks aerodynamic, etc.

Students will start the stopwatch when the rocket lifts off and stop the stopwatch when the rocket touches the ground. After every launch (if three launch pads, after every three launches), students will record the data for each rocket. The rocket or rockets with the longest flight time is the winner.

Wrap Up - Touch Down & Recovery

1. Students will analyze the flight duration times to determine the rocket or rockets with the longest flight time and complete the Class Rank and Longest Flight Winner on the data sheet.
2. Students will use the flight duration times of all rocket launches to calculate the average rocket flight time for their class. (Add all rocket flight times. Divide the flight time total by the number of rockets.)
3. Why is the average flight time for the class useful information?



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Extensions

1. Students can plan a new flight competition that requires the use of data collection to determine the winner.
2. Students will conduct their new flight competition.

Evaluation/Assessment

- Students will successfully build and launch an Estes model rocket.
- Students will use a stopwatch to time a rocket launch.
- Students will record and analyze rocket flight time data.
- Students will calculate the average rocket flight time for their class.

References

- *Estes Educator™ - Guide for Teachers and Youth Group Leaders*
- Estes Educator™ Website - www.esteseducator.com
- NAR Model Rocket Safety Code - www.nar.org