Extensions

1. Language Arts: October Sky (Rocket Boys)
Depending on time, read then watch the movie "October Sky" or just watch the movie. This is the true story of Homer Hickam who grew up in a West Virginia mining town and dreamed of building a rocket. With the help of his teacher and friends, he overcomes impossible odds to reach his dream and eventually become a NASA engineer. This is an inspiring and motivating story to begin or use with any study of rocketry. Caution: Movie is rated PG for language and a scene with teen drinking and sensuality. You should get parental permission for each student to watch this film.

2. Science: Payload Experiment
Plan an experiment for a SpaceLoft™ space flight. What do you want to see, test, prove or compare with Space vs. Earth situations? For example: Will a space flight hinder the growth of a plant? Compare the growth of the same plants, one plant will stay on Earth and one plant will go to Space in the SpaceLoft™.

3. Social Studies and Science: Rocket Scientists and Designs
Read about rocket scientists or rocket designs. Prepare and present written reports or oral presentations. Each student should choose a different topic.

4. Art: Launch Poster
Students can create posters advertising their class rocket launch. Use crayons, magic markers, stickers, construction paper and old magazines for pictures. Each poster must have launch information like the date, time, place, etc. Posters can be hung around the school and classroom.

5. Science and Technology: Design Challenges
a. Private Rocket - Students can design the next generation of private space vehicles that will have Space tourists.
b. New ISS - Students can design and make a model of a new ISS.
c. Reusable Spaceships - Have student teams design reusable spaceships they think will be used in 100 years. Each group should explain how their ship is powered, where it flies, what it is called and how it is a more effective means of travel than current vehicles. Specific requirements for the reusable spaceship include the ability to a.) Fly once a week with a minimum of one person aboard; b.) Safely carry three adults who return in good health; and c.) Attain a 100 km altitude (62 miles).

6. Language Arts, Music, Science: Creative Thinking
a. **Space Music** - List songs that mention Mars, Martians, Moon, lunar, Space, rocket, spaceship or the Solar System in the title or lyrics.
b. **Alien Research** - Imagine a probe was sent to Earth from a distant planet by another species. Have the students list the "Top Ten" characteristics they would want these distant aliens to know about Earth. Students should explain how the aliens would learn about each characteristic and why the characteristics are important.
c. **Science Fiction vs. Real Rockets** - Compare rockets and space vehicles in science fiction movies and television shows to actual rockets, satellites and Space vehicles.
d. **ISS** - Research the International Space Station's design and purpose. Discuss how astronauts live and work on the Space Station and the experiments they are doing there.
1. How will these experiments benefit humanity and the Earth?
2. What other experiments do you think should be studied on the ISS? What would be their benefits?

e. **Future Space Station** - Write journal entries about what a day on a Space Station will be like in 25 years. Include information on activities such as eating, sleeping, working and playing. Read the entries aloud listening for similar ideas or for "far-out" different ideas.
1. What rockets/spacecraft will astronauts use to get personnel and supplies to the Space Station? Will civilians visit?
2. Will there be amazing scientific discoveries from experiments performed on the Station? What will they be?
3. Will the Space Station get bigger as time goes on? If so, what modules will be added? Describe their uses.
4. If the Space Station gets smaller, what modules will be taken away? Why will these modules be taken away?
5. What is the name of this Space Station?

Web Challenge

1. UP Aerospace™ - Go to the UP Aerospace™ website at www.upaerospace.com. Information to find:
a. What does the 'UP' in UP Aerospace™ stand for?
b. The peak altitude of the SpaceLoft™ rocket is up to ______ miles. It is ______ feet tall with a diameter of ______inches. _______ pounds is the payload capacity.
c. ______________________ is the workhorse of the UP Aerospace™ fleet.
d. Describe the STAR™ program.
e. How often does UP Aerospace™ conduct space flights?
f. Where do they conduct their space flights?
g. What is an orbital space mission?
h. How much does a space launch cost?
i. What kind of payloads do they fly?
j. Does this website give you enough information about UP Aerospace™ and their rocket fleet? What is the best part of the site and the weakest part of the site?

2. Private Spacecraft Companies - There are a number of private spacecraft companies. These private companies include many X PRIZE teams that have continued working on their rockets and spaceships for the X PRIZE Cup Competitions and there are several other companies similar to UP Aerospace™. Conduct a search on the internet to find at least two of these private spacecraft companies. Find out the company's name, information about their spaceship design, the company's service, when and where they plan to launch and any other interesting info about the company to share with the class.

3. Space Images - The SpaceLoft™ has windows on it to attach cameras. These cameras take pictures of the Earth below. There are websites that will show you satellite images of addresses you request. Let students find one of these sites and then find a satellite image of their home and school. If possible, students can print out the 'bird's eye view' of their home. (Check this out at Google [www.google.com] – click on MAPS.)

Bonus Activity

Estes Space Images – To simulate a satellite image of your school property, launch with your students an Estes SnapShot™ or AstroCam® 110 camera rocket. Both of these rockets use 110 film that is included with each rocket. Every time you launch each rocket, the camera snaps a picture when the engine's ejection charge activates. Since the film is 110, you do need to have it developed. To 'Space map' the school grounds, change the position of the launch pad for every launch.

Let students 'grid' the area to decide where the launch pad should be placed for each launch. When the film is developed, have the pictures enlarged to 8" x 10". Students can put together a giant satellite poster of the school's grounds. This looks great as a wall in your classroom or as a hall poster. With the Estes Oracle™ rocket, you can take digital videos of this rocket's entire flight. After the launch, download the videos to your computer for some spectacular viewing!

Evaluation

- Students participation in class discussions.
- Students successfully build a SpaceLoft™ rocket.
- Students 'launch' their rocket.
- Students have a complete Rocket Lab Folder.
- Student teams Mission Patch design or participation in the class Mission Patch design.
- Students complete the 'before' and 'after' WEBBING activity.

Each student will compare both activities and list what they have learned from the Estes Rocket LAB.

Internet Resources

Estes Educator – www.esteseducator.com (PUBLICATIONS & CURRICULUMS)
Estes Rockets – www.estesrockets.com
Mission Patches – www.hq.nasa.gov/office/pao/History/shuttle_patches.html
UP Aerospace™ - www.upaerospace.com
The National Science Digital Library – http://nsdl.org
NASA – www.nasa.gov
Space.com – www.space.com
Ansari X PRIZE – www.xprize.org
Rockets Away! – http://rocketsaway.net
Beyond-Earth Enterprises – www.beyond-earth.com
SpaceX – http://www.spacex.com
Homer Hickham – www.homerhickham.com
Scaled Composities (SpaceShipOne) – www.scaled.com
Virgin Galactic – www.virgingalactic.com
The Space Fellowship – www.spacefellowship.com
Masten Space Systems – www.masten–space.com
Space Services Inc.– www.spaceservicesinc.com
ZG Aerospace – www.zerog–space.com

By Ann Grimm - Director of Education

ESTES ROCKET LAB™

ESTES EDUCATOR

SUCCESSFULLY COMPLETED THE ESTES ROCKET LAB™ BY STUDYING, BUILDING AND LAUNCHING THE SPACELOFT™ ROCKET

YOU ARE NOW A MODEL ROCKET SCIENTIST!

Date ____________________ Teacher ____________________

PN 61596 (06-06)

ESTES ROCKET LAB™ SPACELOFT™ LESSON GUIDE

THE NEW ERA OF PRIVATE SPACECRAFT EXPLORATION

Grade Level(s)

5th – 8th grades (Adaptable for upper grade levels.)

National Standards Addresssed

Science Standards

1. **Science as Inquiry**
   Abilities necessary to do scientific inquiry
   Understandings about scientific inquiry
2. **Physical Science**
   Motions and forces
   Properties and changes of properties in matter
3. **Unifying Concepts and Processes**
   Change, constancy and measurement
   Evidence, models and explanation
4. **Science and Technology**
   Abilities of technological design
   Understandings about science and technology
5. **Science in Personal and Social Perspectives**
   Science and technology in society

Mathematics Standards

1. Problem Solving
2. Communication
3. Reasoning
4. Connections
5. Number and Number Relationships
6. Computation and Estimation
7. Patterns and Functions
8. Statistics
9. Geometry
10. Measurement
11. Trigonometry

Subject Areas

Physical Science
Mathematics
Language Arts
Social Studies
Art
Technology

Timeline

One – five class sessions

Science Process Skills

1. Observing
2. Communicating
3. Measuring
4. Collecting Data
5. Inferring
6. Predicting
7. Making Models
8. Making Graphs
9. Hypothesizing
10. Interpreting Data
11. Controlling Variables
12. Investigating

Materials

#1793 – Estes Rocket LAB Pack™ – SpaceLoft™ Rocket (12 pack)
#1788 – Estes Engine Rocket LAB Pack™ – 1/2A3-4T (24 pack)
#302220 – Estes Electron Beam® Launch Controller
#302215 – Estes Porta-Pad® Launch Pad
#302232 – Estes Altitrak™ (2 or more)
NASA Mission patches or printed examples
Blank paper (for patch design)

Hobby knives
Plastic cement
Scissors
Pencils
Markers or colored pencils
Ruler
Masking tape
Folder

Objectives

- Students will understand the new era of private spacecraft exploration.
- Students will learn about UP Aerospace™, Inc. and the SpaceLoft™ rocket.
- Students will work together to design a mission patch for their SpaceLoft™ rocket launch.
- Students will build and launch their own SpaceLoft™ rocket.
- Students will learn how to calculate how high and fast their rocket launched.
- Students will use technology to learn about other private rocket companies.
- Students will become 'Model Rocket Scientists'.

Estes Rocket LAB™ Organization

When your students have participated in the "Rocket LAB" activities, they will become 'Model Rocket Scientists'. You decide the appropriate lessons/activities in this Lesson Guide your class will do. At the completion of these lab activities, each student (if they have successfully completed their rocket lab activities) will be certified as a 'Model Rocket Scientist'.

While you are conducting the "Rocket LAB" you, the teacher, are and can be called the 'Master/Head Model Rocket Scientist' and the students will be called your 'Rocket LAB Technicians', 'Rocket LAB Techs', 'ROC LAB Techs' or 'LAB Techs'.

The 'LAB Techs' should keep a Rocket LAB Folder for all their lab records and completed lab work. This lab folder can be used for evaluating each student's rocket lab work to determine if they have completed enough research activities to become a 'Model Rocket Scientist'.

Background

What is the new era of private spacecraft exploration? This is the time of private spacecraft companies that are making access to Space affordable and it is happening now. The catalyst for the new era began when the Ansari X PRIZE contest was announced on May 18th, 1996. This contest was a $10 million prize to "jump–start the space tourism industry through competition among the most talented entrepreneurs and rocket experts in the world." The Ansari X PRIZE was awarded to the privately financed team that designed the first private spaceship to successfully launch three humans to a sub-orbital altitude of 100 km (62 miles) on two consecutive flights within two weeks. There were 27 international teams competing to win this prize. The $10 million prize was won on October 4th, 2004 by Burt Rutan and the Mojave Aerospace Ventures team. Their SpaceShipOne™ spacecraft climbed to 367,442 feet (112 kilometers) – 70 miles high. The definition of Space is 62 miles (100 kilometers). This flight showed that private industry can build a workable vehicle for sending paying passengers to Space.

UP Aerospace™ is a private spacecraft company in the U.S. that was officially founded in on October 21st, 2004. The two founders (rocket scientist from Lockheed-Martin and a professional inventor) had been working on their SpaceLoft™ rocket's design for seven years before the company was founded. UP Aerospace™ is America's affordable space launch resource. It has a fleet of space-flying sounding rockets that they use to provide low-cost space access to businesses and the educational/collegiate sector. Never before has it been affordable to launch significant-size payloads and sophisticated experiments into space. UP Aerospace™ provides complete payload recovery and a wide range of tracking, telemetry and avionics options.

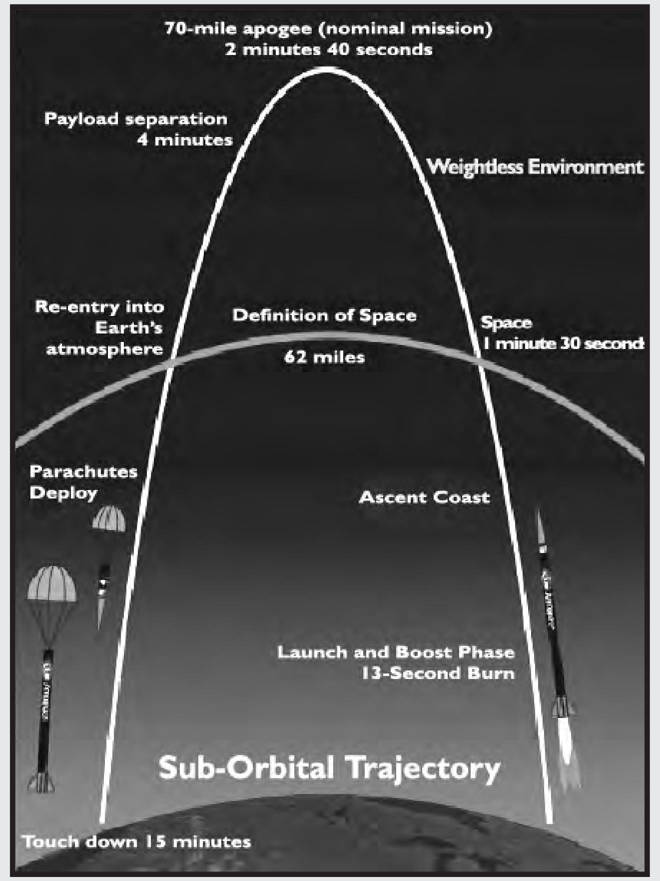
UP Aerospace's space flights with their SpaceLoft™ rocket provide the following:

- 110-pound payload capacity
- 10,500 cubic-inches payload volume
- Payloads up to 10 inches in diameter and 7 feet long
- Space flight profiles up to 140 miles with a wide range of microgravity experimentation time options

The Connecticut Center of Advanced Technology (CCAT) and the National Aerospace Leadership Initiative (NALI) partnered with UP Aerospace™ to offer students the opportunity for their own science and technology investigations to be conducted on a rocket launched into space. The students create their own experiments and use the CCAT's exclusive LaunchQuest™ software to ask scientists questions, summarize their experiments and talk to other student teams. UP Aerospace™ also uses The STAR™ (Space Technology & Academic Research) education initiative to provide schools with "ultra-low-cost" access to Space.

The UP Aerospace™ rockets are named the SpaceLoft™ and the SpaceLoft™ XL. The company will be launching these rockets at New Mexico's Southwest Regional Spaceport (SRS). The SRS was built from January - August 2006.

The inaugural launch of the SpaceLoft™ XL rocket is scheduled for September, 2006. The company has the capability to launch up to 30 flights annually. The first launch will include more than 40 experiments from middle schools, high schools and NASA Explorer Schools across the United States (Connecticut, Pennsylvania, Ohio, California, Arkansas, Alabama, Tennessee, New York). Some of the universities that have payloads are the University of Colorado, Central Connecticut State University and Brown University.



THE SPACELOFT'S FLIGHT PROFILE

(Material courtesy UP Aerospace™. Used with permission.)

Facts about the SpaceLoft™ XL rocket:

- Single-stage, solid–propellant rocket
- Accelerates to 5 times the speed of sound – nearly 3,400 miles per hour in13.5 seconds
- Will reach space (62 miles up) in just 1 1/2 minutes
- Flight apogee (top altitude) will be 70 miles up
- During its recovery the rocket will separate into 2 sections: an upper nose cone/payload section and a lower rocket booster section

Activity

1. Introduction - Rocket Webbing

Ask students "What do you know about rockets and spacecraft?"

Students should fill out a blank webbing worksheet, label it "BEFORE" and keep it in an 'Estes Rocket LAB™' folder or their science folder. At the end of the lab, students should fill out another webbing worksheet, label it "AFTER" and then compare the "BEFORE" and "AFTER" worksheets.

This can also be done as a whole class discussion with the teacher using an overhead transparency or interactive whiteboard to record student's answers. Students can copy the overhead answers and label the sheet "BEFORE". At the end of the rocket lab, students can fill out their own "AFTER" webbing worksheets and then compare with the whole class "BEFORE" responses.

Another way to do this webbing activity is to make it a class poster that can be added to by the teacher and students when new subjects and facts are discovered.

2. The New Era of Private Spacecraft Exploration and UP Aerospace™

Describe what a rocket is and how it works.

Ask students:

a. How rockets are used today?
b. What do you think the new era of private spacecraft exploration is?
c. Do you know of any private spaceship companies?

Discuss who Up Aerospace™ is, what they do and their SpaceLoft™ rocket.

Student questions:

a. What do you think a payload is? (An experiment on a rocket)
b. If you designed an experiment for Space, what would it be?

3. Design a SpaceLoft™ Mission Patch

The class can work together or in pairs to design a Mission Patch for their SpaceLoft rocket mission. All missions for NASA have a Mission Patch. This patch is a graphics logo that depicts some important aspect of the mission. It is also used as a way of identifying the mission and making it unique. Show students NASA patches you have printed out or let them go to the NASA website to see them.

Up Aerospace™ designed a mission patch for their inaugural launch.

SPACELOFT™ MISSION PATCH FOR INAUGURAL FLIGHT

Show it to the class and ask students:

a. Why is this mission patch designed with this shape?
b. What are the objects in the patch?
c. What is the significance of each object in the patch?
d. Would you change the colors in this patch? If you would, what colors would you use?

After the class has their design completed, make copies of the patch for students to color and cut out. Students should wear their Mission Patch on launch day. If the students worked in pairs, the class can vote on the best design for the class. Older students can make a class mission patch poster.

4. Build the Estes SpaceLoft™ Rocket

a. It is a good idea to make your own SpaceLoft™ rocket before you have your students build their rocket. This will make it easier for you to direct your students during the building process.
b. Check the instructions to see what materials you will need to make the rocket. Get all building materials.
c. Students build their rockets. All students should make the rockets together one step at a time while you show them each building step.

Note: The real SpaceLoft™ is a payload rocket, the Estes one is not a payload rocket.

d. When rockets are completed, review the NAR Model Rocket Safety Code and launch procedures with students. The Safety Code and 'Launch Site Preparations' can be found in the Estes Educator™ "Guide for Teachers and Youth Group Leaders". You can find and download this guide at www.esteseducator.com in the PUBLICATIONS section. The instructions also include how to stage your rocket engine and launch the rocket.

5. SpaceLoft™ Rocket Launch

a. Give students launch jobs that are covered in 'Launch Site Preparations' in the "Guide for Teachers and Youth Group Leaders". You can also use parent helpers and local NAR club members for help at launches.

b. Launch the rockets. Prepare the launch field before the launch. Decide on the students' launch order before the launch (boy-girl, alphabetical order, reverse alphabetical order, by teams of five, by height or age, by color of shirts wearing, drawing names, seating rows, etc.). Have a 'range box' that contains glue, tape, batteries for controllers, igniters, igniter plugs, engines, sandpaper, needle nose pliers and anything you might need to repair the rockets if needed. Make sure the launch rod and alligator clips on the launch controller are clean. Follow the launch procedures in the instructions or the "Guide for Teachers and Youth Group Leaders".

Launch Activities

Rocket Math

1. How high did it go?

Students can use the Estes Altitrak™ to measure the launch angle of their rocket. Pace off 500 feet from the launch pad at a right angle to the wind. Hold the Altitrak™ at arm's length, pointed at the rocket. Pull and hold the trigger then signal for launch. Track the rocket through the forward sight. When the rocket reaches apogee (maximum altitude), release the trigger. Read the angle indicated on the swing arm. You will need a Table of Tangents (included with Altitrak) to calculate the height using this formula:

Altitude = Angle Tangent x Baseline Distance

Example: 30 degree Angle = .58, Baseline = 500 ft. (150 m)
Altitude = .58 x 500 = 290 ft. (84 m)

Altitrak Practice: Practice using the Altitrak before the launch. Go outside and let students take turns using the Altitrak on flag poles, trees, playground equipment, school building, etc. Calculate the height of these school yard objects using the altitude formula.

Helpful Hint: Whenever you have two students using the Altitrak™ or stopwatch, have them average their results. This makes the readings and results more accurate.

2. How fast did it go?

The formula is: **Average Speed = Distance traveled ÷ Time of travel**

You will need a student or two to time the total flight from liftoff until touchdown. This formula will give you the feet per second. To get miles per hour, multiply the answer by 0.682.

Example (using height above): 290 ft. ÷ 5.1 seconds = 56.86 feet per second, 56.86 x 0.682 = 38.79 miles per hour

For more details, see "Elementary Mathematics of Model Rocket Flight" at **www.esteseducator.com** – PUBLICATIONS.

Launch Competitions

1. Accuracy Competition – This is a competition to see whose rocket can land closest to the Launch Pad. Launch in groups of five. Take the winners of each group of five and have a "Launch Off" for the Grand Champion. Students can test their powers of prediction by guessing who will win for each group and who will be the Grand Champion.

2. Target Shooting – Place a target (a hula hoop works great) on the launch field. The student's rocket that lands in the target or closest to the target is the top "sharp shooter". Launch in groups of five and conduct a "Launch Off" like in the Accuracy Competition. Students should record launch data for their own group of five.

3. Longest Flights – This is a contest to see whose rocket has the longest flight time. You, a parent volunteer or a student or two can time each launch with a stopwatch. Start the stopwatch when the rocket lifts off and stop the stopwatch when the rocket touches the ground. Launch in groups of five and conduct a 'Launch Off' like in the previous activities. Students can record data for their own group of five.

4. Highest Flier – Which rocket is the Highest Flier? Use an Estes Altitrak™ to track how high each rocket goes up. You, a parent volunteer or a student or two can operate the Altitrak™. Launch in groups of five and conduct a "Launch Off' for the Grand Champion. Students can record data for their own group of five. If you did the "How high did it go?" activity, all you need to do is compare the results. Use a line or bar graph to show the launch heights. Graphing is a good way for students to see and compare the results.

5. MORE! – Older students can measure the results of the Accuracy Competition and the Target Shooting. For the Accuracy Competition, students will measure and record the distance between each rocket and the launch pad. Students will measure and record the distance from the target and each rocket for Target Shooting. Students can decide what type of graph will work best to graph their results.