GRADES 3-5
Two Class Lesson Plan

Science

Early Rocket Scientists

STEP 1 LEARN (First class session: 15 minutes)

Objectives

- Students will learn about the origins of rockets, their uses and some people in their development.
- Students will see what it is like to be a first-time rocket scientist while making and launching an Estes model rocket.

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. History of Rockets PowerPoint

Time

Two class sessions

Background

Where It All Began (Slide 2)

The origins of modern rocketry can be traced back to Greece and China. One of the first devices to utilize the principles of rocket flight was a wooden bird. Aulus Gellius, a Roman, told the story of a Greek named Archytas from Tarentum, an area that is now part of southern Italy. Around 400 B.C., Archytas entertained the townspeople by flying a wooden pigeon. The bird was suspended on wires and was propelled by escaping steam (action-reaction principle).

NATIONAL STANDARD

Standard G
History and Nature of Science

Standard 13
Understands the scientific enterprise

Benchmark 1
Knows that people of all ages, backgrounds, and groups have made contributions to science and technology throughout history.

Around three hundred years after the pigeon, another Greek, Hero of Alexandria, built a similar rocket-like object called an aeolipile which used steam for propulsion. After attaching a sphere on top of a water kettle, a fire was built below the kettle to heat the water and turn it into steam. The steam would travel through pipes to the sphere and pass through two L-shaped tubes on either side of the sphere causing it to turn around. Today, we call this a Hero Engine.

(Slide 3) The historical records of various cultures show that rocket-like devices appeared from time to time. It is unclear when the first real rockets were developed and, in fact, the first true rockets might have been accidents. In the first century A.D., the Chinese often used a simple form of gunpowder for religious and other festive celebrations. They filled bamboo tubes with the gunpowder mixture and tossed them into fires to create explosions. Some of the tubes didn't explode and jumped out of the fires. They were pushed by the sparks and gases produced from the burning gunpowder. The Chinese started experimenting with the gunpowder-filled tubes and eventually attached these bamboo tubes to arrows and launched them with their bows. Later they found out that these tubes could launch themselves by the power created from the escaping gas. The modern rockets' ancestor was born.

In 1232, the Chinese began using their rockets in a war against the Mongols. In the battle of Kai-Keng, they drove back the Mongols with a barrage of arrows of flying fire. The fire-arrows were a simple form of a solid-propellant rocket. The rocket was a tube that was attached to a long stick and was capped at one end and filled with gunpowder, leaving the opposite end open. The powder was ignited and the quickly burning powder produced fire, smoke and gas that escaped out of the open end producing thrust. The stick became a simple guidance system that provided stability for and kept it going in one direction in the air. While these fire arrows may have inflicted little physical damage, they had to have imposed much psychological damage on the Mongols.

(Slide 4) After the battle of Kai-Keng, the Mongols made rockets of their own and might have been the people responsible for spreading rockets to Europe. There are many records that describe rocket experiments from the 13th to the 15th centuries. During this period in England, Roger Bacon, a monk, worked on improved forms of gunpowder that increased the range of rockets. In France, Jean Froissart launched rockets through tubes to increase the accuracy of the flights. Froissart's design was the forerunner of the modern bazooka. In Italy, Joanes de Fontana used a surface-running, rocket-powered torpedo to set enemy ships on fire.

In the 16th century, rockets weren't commonly used as weapons of war because of their inaccuracy. Instead, rockets were used for fireworks displays. A German fireworks innovator, Johann Schmidlap, designed the step rocket. The step rocket was a multi-staged rocket that propelled rockets to higher altitudes. A large sky rocket (first stage) carried a smaller sky rocket (second stage). When the larger rocket burned out, the smaller one continued to a higher altitude before it showered the sky with glowing cinders. This idea is basic to all rockets today that go into outer space.

(Slide 5) Up to this time, rockets were used for fireworks or warfare. An old Chinese legend shows that rockets were used for transportation. According to this legend, a lesser-known Chinese official named Wan-Hu and his assistants made a rocket-powered flying chair by attaching two large kites and 47 fire-arrow rockets. On flight day, Wan-Hu sat in the chair and signaled 47 assistants to light the rockets. All the assistants, each with a torch, rushed forward to light the fuses at once. A loud roar and huge billowing clouds of smoke filled the air. When the smoked cleared, Wan-Hu and his chair were nowhere to be found. No one knows for sure what happened to Wan-Hu. If this really happened, Wan-Hu and his chair probably didn't survive the explosion.

The Science of Rocketry (Slide 6)
The foundations for modern rocketry were established in the late 17th century by the English scientist Sir Isaac Newton (1642-1727). He organized physical motion into three scientific laws (Newton's Laws of Motion). These laws explain how rockets work both in Earth's atmosphere and in the vacuum of outer space.

Newton's laws soon began to influence many rocket designs. In 1720 a Dutch professor, William Gravesande, built model cars propelled by jets of steam. Rocket experimenters in Russia and Germany worked with rockets with a mass of more than 45 kilograms. Some of these rockets were so powerful that the escaping gases from them left deep holes in the ground even before liftoff.

Rockets experienced a short revival as weapons of war in the late 18th century and early 19th century. Indian rocket barrages against the British in 1792 and 1799 were so successful that an artillery expert, Colonel William Congreve, began designing rockets for the British military to use. The Congreve rockets were very successful in battle. These rockets were fired from British ships to pound Fort McHenry in the war of 1812. This inspired Francis Scott Key to include "the rockets' red glare" in his poem that later became *The Star-Spangled Banner*.

Even with the Congreve rockets, rockets were not very accurate. Many researchers around the world worked on improving accuracy. In England, William Hale developed a technique called spin stabilization. The escaping exhaust gases struck small vanes at the bottom of the rocket, causing it to spin like a bullet does in flight. Many rockets still use variations of this method today.

Activity

1. Ask students if they know who the first rocket scientists were.
2. Use the History of Rockets PowerPoint (Hero Engine through Rocketry Becomes a Science) to show the first rocket scientists and the rockets they created.

KEY WORDS

aeolipile
cultures
guidance system
hero engine
launch
multi-staged
sphere
thrust

STEP 2 - BUILD (First class session: 35 - 40 minutes)

Activity

1. For the majority of your students, this might be the first time they have built and launched a model rocket. When students make and launch their rocket, they will be able to experience how some of the first-time rocket scientists felt as they gained knowledge about rockets.
2. Build the Alpha III®, Generic E2X® 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.

STEP 3 - 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.
3. Launch rockets outside at a soccer field, football field, baseball field, green grass area or blacktop area.

Wrap Up - Touch Down & Recovery

1. Discuss with students the diversity of the first rocket scientists emphasizing that everyone can contribute to science, regardless of age, race/ethnicity, personal interests, etc.
2. Students will write a summary of who the first rocket scientists were, their rockets and how their discoveries contributed to the designs of today's rockets.
3. Students will write in their science journals their observations of the rocket launches, tell how it felt to make and launch their first model rocket and include a drawing of their rocket.

Extensions

1. Give the students some other names of early rocket scientists and some of today's scientists. Let them discover 3 or 4 important facts about each one to present to the class in skits, news casts, dioramas, etc.
2. Students can do a web search to see how rockets affected battle outcomes and developed structures to withstand rocket attacks. (The fall of the castle culture.)
3. Students will do research or a web search to find the 20th century pioneers of space.

Evaluation/Assessment

- Students will write a summary about who the first rocket scientists were, what their rockets were used for and how their rockets influenced the designs of today's rockets.
- Students will write their observations in their science journals that includes a drawing of their rocket.
- 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*

www.estesrockets.com