Rocketry: An Introduction to Rocketry as a Science

Grade Level: Grade 3 (Age 8)

FEDERATION OF GALAXY EXPLORERS
MISSION PLAN: **Rocketry: An Introduction to Rocketry as a Science**
LENGTH OF LESSON: 1.5 Hour

1. GENERAL

This module will familiarize the Mission Team member with a basic overview of rockets. Mission Team Members will learn about the history of rockets and key rocketry pioneers, as well as develop a basic understanding of how rockets work, why we have so many different types of rockets, and why rockets are important in the exploration of space. This class is presented to expand the space knowledge of all Galaxy Explorers in order to enhance their competence and confidence of all aspects of space.

LEARNING OBJECTIVE:
Mission Team Members will learn basic rocket principles -- what rockets are, how they work, and why they are used in the exploration of space. They will also learn about the history of rockets, early rocketry pioneers, and different types of rockets.

2. LEARNING OBJECTIVES

#1

SUBJECT AREA: History of Rockets, Key Rocketry Pioneers, and How Rockets Work.

TASK: Familiarize the Mission Team Members with how the modern rockets of today came to be, who key rocketry pioneers were, and how rockets work. (Put here what you want them to get out of the subject area. Example: You must be able to understand essential ideas about the composition and structure of the universe and the Earth's place in it.)

CONDITIONS: Team leader will present a discussion. When discussing how rockets work, the team leader may want to use balloons to demonstrate. (Put here what you are giving the Mission Team member to perform the Task (e.g. handouts, book).

STANDARD: At the end of the discussion, team leader can ask questions of the Mission Team Members. Sample questions are provided below.

#2

SUBJECT AREA: Different Types of Rockets and their Role in the Exploration of Space

TASK: Mission Team Members use their critical thinking and logic skills to understand why there are different types of rockets. Mission Team Members will also use their inquiry skills to associate different types of rockets with different types of space missions (e.g., a space shuttle carries people and payloads into space and can also fly through air because it has wings).

CONDITIONS: Mission Team Members will be given a series of pictures in an attached Microsoft powerpoint file (rocket pictures and space mission pictures). These pictures will accompany questions to ask of the Mission Team Members and allow for open discussion and participation.

STANDARD: At the end of the discussion, team leader can ask questions of the Mission Team Members. Sample questions are provided below.

EVALUATION: This learning objective will not be evaluated.

MISSION TEAM LEADER'S NOTE
Mission Team Members will not be required to read any material prior to the lesson. The Mission Team Leader will read the lesson plan prior to giving the class to ensure he/she is familiar with the material and to ensure the lesson plan is complete to include required training aids. During the class, material will be covered in the sequence it is presented in the lesson plan.

3. **PRESENTATION GUIDE**

a. Introduction (2 minutes)

Good morning/afternoon, I am _____ and I will be your Mission Team Leader for **Rocketry: An Introduction to Rocketry as a Science**.

Example Opening Question: What are rockets? What do they do? (allow Mission Team members a few open responses to get them thinking)

Today we get to learn what rockets are, how they were invented, who invented them, how they work, and why they are so many different types of rockets that go into space.

b. Development (15 minutes) MAIN LECTURE

Brief History of Rockets

Did you know the first "rocket" was invented in Italy over 2000 years ago by man named Aulus Gellis? He made a pigeon out of wood that could fly! Mr. Gellis boiled water (just like you do over your kitchen stove at home), that became steam and escaped from inside the wooden pigeon. The escaping gas caused the pigeon to fly forward. The Chinese created the first real

rockets in the 1st century A.D. as fireworks to celebrate special events. They filled bamboo tubes with gunpowder and tossed them into fires. When the gunpowder was heated up it burned and produced fire, smoke, and the gas that escaped from the bamboo tube caused the tube to launch in the air. These early rockets were very small and did not travel very far. They were used primarily as fireworks and later used as weapons in wars.

This history of rocketry really began in the early 20th century, around the same time the Wright Brothers flew the first airplane. The key pioneer in American rocket design was Robert Goddard. He figured out much of the science behind rockets and launched the first small rockets ever fired, all during the 1930's, the years of the Great Depression and World War II. However, America was not the only country designing rockets. In Germany, a man named Werner von Braun worked for the German government and helped design the first ever large rocket, the V-2. Unfortunately, the V-2 was used as a weapon during WWII and terrorized the citizens of Great Britain, killing thousands of British citizens. The V-2 foreshadowed the use of rockets by both American and Soviet forces during the Cold War as a means of launching nuclear bombs.

On a brighter note, rockets are the only reason we have been able to explore space and visit the moon during the last 40 years. The Soviets were the first to design rockets suitable for getting to space (previous rockets, including the V-2, did not fly in space. They were launched into the air and would fall back to the earth). In 1957, they launched a rocket that carried the first ever satellite, Sputnik, into orbit. Today, all nations of the earth rely on satellites for such things as telephone communications. Additionally, the Soviets were the first to launch human astronauts, with Yuri Gagarin the first ever human being launched into space. The United States was also successful in rocket design. The United States began a program around 1960, called the Mercury program (named after the planet Mercury) that took a small group of United States Air Force and Navy airplane pilots and trained them to operate rockets. Among this first class of American astronauts (a word which means "space voyagers" in Greek) were Alan Shepard, the first American to reach space, and John Glenn, the first American to orbit the earth.

Perhaps the most exciting moment in the history of rockets and space exploration happened on July 20, 1969, when Neil Armstrong and Buzz Aldrin landed their spacecraft, Eagle, on the surface of the moon, marking the first time mankind had stepped foot on ground that was not Earth. Rockets have known no greater purpose than man's exploration of space.

Some other important milestones in the space program include the first American woman to orbit the earth, Sally Ride. Unfortunately, rockets have not always proven to be the safe and reliable vehicles we would want. In January of 1986 the Space Shuttle Challenger blew up a few minutes after liftoff, killing all 7 astronauts aboard including the first school Mission Team Leader ever sent into space, Christa McCaulliffe.

Since that time, however, rockets have proven invaluable to both science and commerce. Several scientific experiments – the Hubble space telescope, for example, which takes pictures of far away galaxies – have been launched by rockets, and today's communications systems are all launched into space by rockets. The history of rockets is bright, particularly as mankind contemplates a visit to our nearest planet, Mars.

Rocket Principles

From this discussion, Mission Team Members should understand the action-reaction principle that guides rocket motion. Mention that Sir Isaac Newton discovered the laws that explain how rockets work and how they get people and objects into space. Then explain the key principle of action-reaction – that for every action there is an equal but opposite reaction – and use a balloon to demonstrate.

Sir Isaac Newton, in the late 17th century studied how objects move and developed the basis for how rockets work and why they can fly through the air and far into outer space. He developed Newton's three scientific laws. Newton said that for every action there is an equal and opposite reaction. What does that mean? (Hand out balloons to the Mission Team Members to demonstrate Newton's Third Law of Action-reaction) Hold the balloon in your hand. The balloon does not move because we have not done anything to it, or given it a *force*. Now, blow air into your balloon and then release it. Does the balloon move? Why do you think it moves? It moves because there is air escaping the balloon. The air escapes one direction and the balloon moves in the opposite direction. The same thing happens in rockets. The rocket's engine produces gas that escapes one end of the rocket and it causes the rocket to move in the opposite direction, just like your balloon!

Practical Rocketry

From the discussion, Mission Team Members should have a basic understanding of what rockets are, how they work, and what goes into designing a rocket. The activity should extend the discussion to get them to think about why we use different types of rockets for different missions.

Show them pictures of different types of rockets (in the attached Microsoft powerpoint file) and discuss what they would be used for.

What were the first modern rockets that were used? Ask them who the first person who ever went into space was – Yuri Gagarin – and show them a picture of his rocket. Then ask them who the first American in space was – Alan Sheperd – and who the first American to orbit the earth was – John Glenn – and show them pictures of the Mercury rockets. You might also show them a picture of the V-2 rocket used by Germany in WWII, which was designed by the same man – Werner von Braun – who designed the Saturn V, which sent the first humans to the moon.

Why did we design big rockets (Saturn V)? We designed big rockets to send large objects into space – first people and their living quarters to the moon, then big satellites that are used to transmit communications through cell phones, television sets, and radios.

Why is the space shuttle a different shape than earlier rockets? The space shuttle is a different shape because it is the first rocket that was intended to be used over and over again. The Saturn V and all other rockets are only used once and then they are thrown away. The space shuttle has been used many, many times. You'll also notice that the space shuttle, unlike other rockets like Saturn V, looks like an airplane. This is because, in order to get the astronauts back to earth safely and be used again, the shuttle has to land like an airplane on a runway. Since it has to land like an airplane, it has to look like an airplane.

Why are rockets different sizes? Today, the size of the rocket depends on how big the object is that you want to send into space. The bigger the object, or payload, the bigger the rocket. The biggest determinant in the size of the rocket is the amount of fuel it has to carry – fuel is often 90% of the total weight of the rocket! The bigger the payload, the more fuel you need, and thus the bigger the rocket. So, if you want to get a really big satellite into space, you need a really big rocket. At this point, show the Mission Team Members a picture of several types of rockets – the original Gemini and Mercury rockets, Saturn V, the space shuttle, and modern Atlas rockets – next to a person, or something well-known like the Statue of Liberty, and show them the size comparison.

Why are rockets different shapes? Rocket shape is determined by whether or not there will be people on board, how much fuel is needed, and what size the payload is. But, actually, most rockets are generally the same shape. Why? Explain to the Mission Team Members that they should think of a rocket as a cart. There are two ways to make a cart move – push it from behind or pull it from the front. Most people would think of pulling the cart, like with horses. This would be a good idea, except for one problem – the fire created by the fuel that makes the rocket go would melt the rocket if it came out the top! That's why all those cars with rocket engines, like the Batmobile, have the rocket in the back – so you get the power of the rocket without destroying it! Besides putting the engine in the back, the other factor affecting rocket shape is called drag, or wind resistance. Imagine opening up the car window going 45 miles per hour and putting your hand out. You feel the air pushing on you, right? Now imagine doing that at 5000 miles per hour and faster! That's a lot of push, and that push is called drag. To minimize the drag, rockets are made tall and slender, so there is less surface area being affected. That's why all rockets have generally the same shape – engines on the bottom, tall and slender in the body.

What kind of rocket would we need to explore far away planets? The rocket would have to be really big since it would have to carry a lot of fuel for the large distances. Even though we could send people to other planets without a lot of fuel by using the earth's gravity as a slingshot (have them thing of a real slingshot and the distance you can throw a pebble with one – the earth's gravity is the sling and the rocket would be the pebble) we would need fuel to get them back to earth. Also, this rocket would have to be big enough to send people with enough food, water, medicine, and personal items on a long journey. (Ask them how long they think it would take to get a rocket to Mars, the planet right next door. The answer is almost 9 months)

What kind of rocket would we need to send humans into space? We have sent people into space on two types of rockets – Saturn V-type rockets and the space shuttle. One of the key differences is what the astronauts living quarters look like in each case (show pictures of the re-entry pod for the Apollo missions and the space shuttle main cabin). The biggest concern for NASA today is the safety of the astronauts. So, we need a really safe rocket. One of the key drivers is re-entry. When humans re-enter the atmosphere, there is a lot of heat generated because of the friction generated by the high speeds – the space shuttle re-enters the earth's atmosphere at over 18,000 miles per hour! The astronauts need to be kept safe from this heat, so there is a lot of protective shielding put on the space shuttle, just as there was a lot of shielding on the Apollo space module.

ACTIVITY:

Description:

Mission Team members construct a rocket powered by the pressure generated from an effervescing antacid tablet reacting with water.

Mission Team Leaders Notes:
For best results, Mission Team members should work in pairs. It will take approximately 40 to 45 minutes to complete the activity. Make samples of rockets in various stages of completion available for Mission Team members to study. This will help some Mission Team members visualize the construction steps.

A single sheet of paper is sufficient to make a rocket. Be sure to tell the Mission Team members to plan how they are going to use the paper. Let the Mission Team members decide whether to cut the paper the short or long direction to make the body tube of the rocket. This will lead to rockets of different lengths for flight comparison.

Film canisters for this activity are available from camera shops and stores where photographic processing takes place. These businesses recycle the canisters and are often willing to donate them for educational use. Be sure to obtain canisters with the internal sealing lid. These are usually translucent canisters. Canisters with the external lid (lid that wraps around the canister rim) will not work. These are usually opaque canisters.

Materials and Tools:
- Heavy paper (60-110 index stock or construction paper)
- Plastic 35 mm film canister*
- Mission Team member sheets
- Cellophane tape
- Scissors
- Effervescing antacid tablet
- Paper towels
- Water
- Eye protection
- The film canister must have an internal-sealing lid.

The most common mistakes in constructing the rocket are: forgetting to tape the film canister to the rocket body, failing to mount the canister with the lid end down, and not extending the canister far enough from the paper tube to make snapping the lid easy.
Some Mission Team members may have difficulty in forming the cone. To make a cone, cut out a pie shape from a circle and curl it into a cone.

Background Information:
This activity is a simple but exciting demonstration of Newton's Laws of Motion.
The rocket lifts off because it is acted upon by an unbalanced force (First Law). This is the force produced when the lid blows off by the gas formed in the canister. The rocket travels upward with a force that is equal and opposite to the downward force propelling the water, gas, and lid (Third Law). The amount of force is directly proportional to the mass of water and gas expelled from the canister and how fast it accelerates (Second Law).

Procedure:
Refer to the Mission Team member Sheet.

Discussion:

- How does the amount of water placed in the cylinder affect how high the rocket will fly?
- How does the temperature of the water affect how high the rocket will fly?
- How does the amount of the tablet used affect how high the rocket will fly?
- How does the length or empty weight of the rocket affect how high the rocket will fly?
- How would it be possible to create a two stage rocket?

Extensions:

- Hold an altitude contest to see which rockets fly the highest. Launch the rockets near a wall in a room with a high ceiling.
- Tape a tape measure to the wall. Stand back and observe how high the rockets travel upward along the wall. Let all Mission Team members take turns measuring rocket altitudes
- What geometric shapes are present in a rocket?
- Use the discussion questions to design experiments with the rockets. Graph your results.

COUNTDOWN:

1. Put on your eye protection.
2. Turn the rocket upside down and fill the canister one-third full of water.

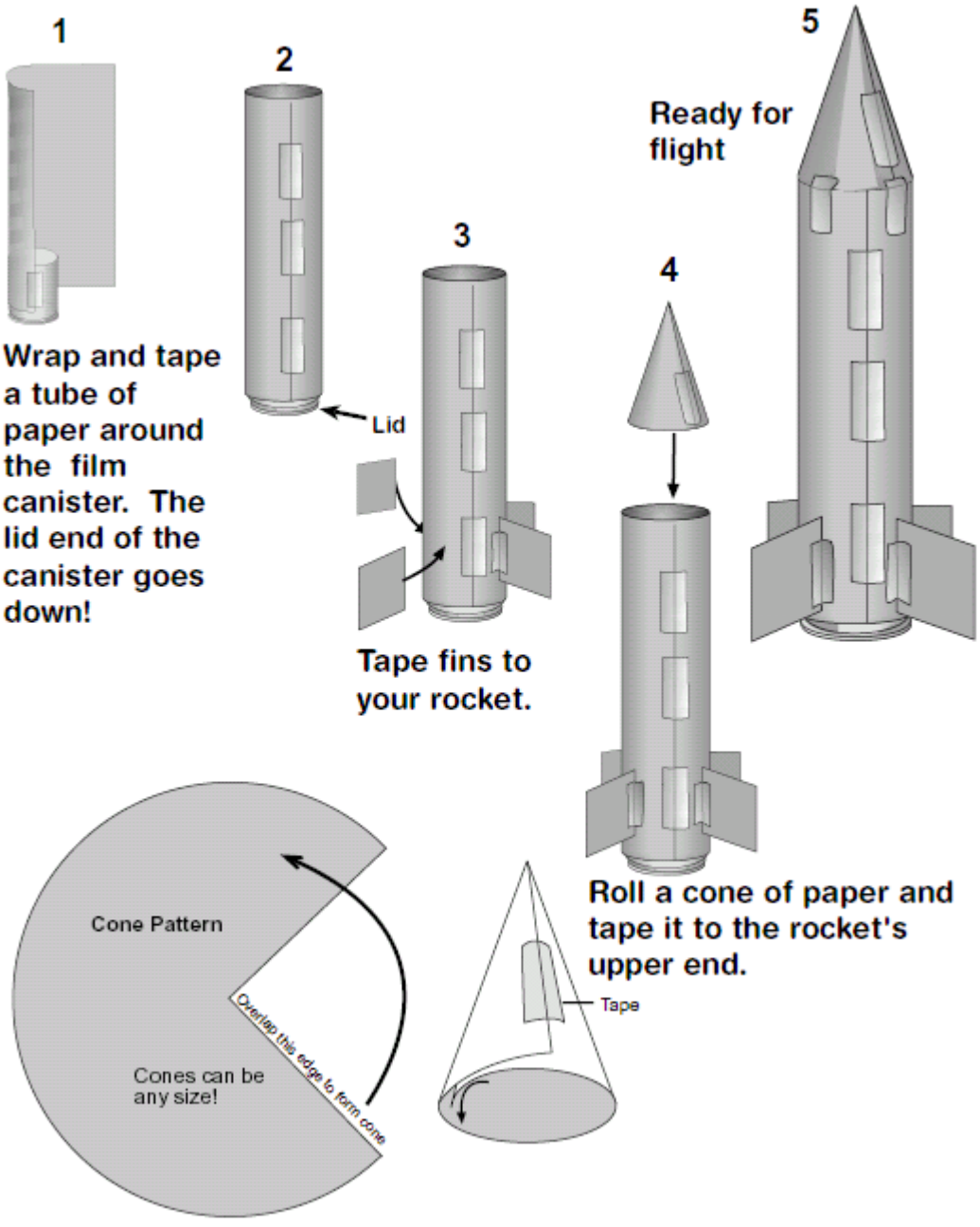
Work quickly on the next steps!

3. Drop in ½ tablet.
4. Snap lid on tight.
5. Stand rocket on launch platform.
6. Stand back.

LIFTOFF!

What three ways can you improve your rocket?

1.
2.
3.


1
2
3
4
5
Ready for flight
Wrap and tape a tube of paper around the film canister. The lid end of the canister goes down!
Lid
Tape fins to your rocket.
Roll a cone of paper and tape it to the rocket's upper end.
Cone Pattern
Overlap this edge to form cone
Cones can be any size!
Tape