“BUILD A BETTER WORLD”
ROCKETS PROGRAM

MONTANA LIBRARIES
SUMMER READING PROGRAM 2017

MUSEUM OF THE ROCKIES
MONTANA STATE UNIVERSITY

Updated March 10, 2017
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Dear Montana Libraries,

The Museum of the Rockies would like to invite you to experience a free Summer Reading Kit that contains materials and lesson plans about the physics and benefits of rocketry and space exploration, for the theme “Build a Better World.”

The kit will provide detailed lessons, activities, and materials for a 90-minute program that you can do in your hometown. The kit will include materials for interactive observations, hands-on experiments, and group discussions. Activities are designed to be adaptable for different time constraints, ages, and attention levels.

All lessons for this Summer Reading Program Kit are in this Activity Guide. The kit’s contents are also listed, in addition to materials that each library is responsible for providing.

Museum of the Rockies will ship your kit to you. To reserve a kit, please contact Angie Weikert at angela.weikert@montana.edu or call 406-994-6618.

We hope you enjoy this new outreach kit from Museum of the Rockies, and your summer reading programs!

Sincerely,

Education Department
Museum of the Rockies
“Build a Better World” Rockets Program

PROGRAM AND KIT OVERVIEW

Age levels: K-5
Number of Participants: 25-50 children and their caregivers
Length: 90 minutes

LESSON OUTLINE

Welcome and Introduction to Museum of the Rockies (5 minutes)
What is a Rocket? (15 minutes)
Demonstrating the Physics of a Rocket (25 minutes)
Rocket Building: Soda-Straw Rockets (20 minutes)
Living on the International Space Station (15 minutes)
Reading about Rockets (10 minutes)

PRE-PROGRAM PREPARATION

- Inflate three balloons, one a little bit less than the others. Using the duct tape provided, attach 6-8 washers to one of the balloons.

- Set up a computer, projector, and screen for the YouTube video

- Make photocopies of the soda-straw rocket template, ruler template, and the recording sheet

- Set up brochures and tattoos for students to take home at the end of the class
LEARNING OBJECTIVES

Part One: What is a Rocket?
- To gain an understanding of the shared characteristics of all rockets
- To consider the value of space travel and rockets to our world

Part Two: Rocket Demonstration
- To observe that a greater mass of gas used for takeoff will result in greater thrust
- To understand that a heavier rocket will travel less distance if the amount of gas used for takeoff is not sufficient
- To understand the greater force needed to propel a rocket further into space
- To understand the way in which gravity and momentum work together in order for a shuttle to remain in orbit
- To consider what would happen if the forces were to become unbalanced
- To consider how a rocket could become slower or faster depending on how much drag is present in its design

Part Three: Rocket Building Experiment
- To apply principles from the Rocket Demonstration in order to build a successful soda-straw rocket
- To identify the ways in which aspects of the rocket’s design impacted its flight

Part Four: Living Away from Earth
- To gain a basic understanding of why the International Space Station is important
- To consider what types of activities take place at the International Space Station
- To brainstorm about how a space station can contribute to a better world
“Build a Better World” Rockets Program

MATERIALS

Disposable materials
Museum of the Rockies brochures
Museum of the Rockies temporary tattoos
Soda-straws
Soda-straw rocket template
Ruler template

Kit materials
5 laminated rocket posters: Saturn V, Space Shuttle, Space Launch System, Antares, Sputnik
Laminated NASA logo poster
Balloons (12)
Duct tape (for adding weight to one balloon)
6 washers (for adding weight to one balloon)
Laminated diagram of different rocket speeds
A length of twine
A large straw
Soft Space Shuttle model
Twine and handle
PVC pipe
Laminated diagram illustrating momentum and gravity
“Draw a rocket” activity sheet
Laminated diagram illustrating the main parts of a rocket
Pre-assembled rocket car
Laminated picture of an arrow
Template for soda straw rockets
Large diagram explaining how to construct a soda-straw rocket
Soda-straw rocket recording sheet
Straws (100)
Large space station “map” with velcro
Space station object cards with velcro
There’s No Place Like Space (Cat in the Hat’s Learning Library) by Tish Rabe
Roaring Rockets by Tony Mitton and Ant Parker
The Moustronaut by Mark Kelly

Materials provided by each library
Tape
Scissors
Photocopies of soda-straw rocket template (original provided by MOR)
Photocopies of soda-straw rocket recording sheet
Photocopies of ruler template
Additional straws, if necessary
Blank white paper
Pencils
Yardstick

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WELCOME AND INTRODUCTION

Welcome your group to the Summer Reading Program. Tell the participants that today’s program is brought to them by the Museum of the Rockies (MOR). Ask the participants if they have ever been to the Museum of the Rockies in Bozeman, Montana. Show the group where Bozeman is on the state map.

Tell the group that today they are going to learn about rockets, space travel, and physics. Give students an age-appropriate definition of physics:

Physics is a type of science where we study how different things move, and how the world around us works. Physics can explain why a heavy object moves at the same speed as a light one if they are dropped out of a window at the same time, or why objects and people stay on the surface of the Earth instead of floating out into space. Physics can also explain how cars, airplanes, and rockets work.

Tell the group that we are going to learn about some of the physics that make rockets possible, and that they will get to make their own rocket!

Tell your group that at the end of the program, the Museum of the Rockies has sent brochures and tattoos for each person to take home.

BACKGROUND INFORMATION:

The Museum of the Rockies (MOR) is a world-class museum located in the heart of the Rocky Mountains in Bozeman, Montana. Known for its vast collection of dinosaur fossils, the Museum houses some of the most famous dinosaur specimens in the world including Tyrannosaurus rex and Triceratops.

MOR features permanent exhibits on dinosaurs, regional and American Indian history, as well as changing exhibits that focus on “bringing the world to Bozeman.” A planetarium features shows on the night sky, and a living history farm on the Museum grounds is home to magnificent Heirloom Gardens. In 2010, the new Explore Yellowstone: Children’s Discovery Center opened as a permanent exhibit designed for children up to 8 years old.

The Museum of the Rockies is both a college-level division of Montana State University and an independent 501(c)(3) nonprofit institution. Accredited by the American Alliance of Museums, MOR is one of just 775 museums to hold this distinction from the more than 17,500 museums nationwide. The Museum is a Smithsonian Affiliate and a Federal Repository for fossils.

For more activities about astronomy, space and astronauts visit:
http://nasawavelength.org/
WHAT IS A ROCKET?

Explain to the group that a rocket is an object that has the following characteristics:

1. It is usually tall, thin, and round
2. It can travel very far and very fast
3. It’s engine doesn’t need air in order to move (unlike a jet engine)
4. It turns the fuel inside of it into hot gas, which then pushes out of one end of the rocket in order to make it move forward.

Tell the group that later we will be doing some experiments that will show them how this works.

Ask students if they have heard of NASA (National Aeronautics and Space Administration), show them the NASA logo poster, and ask them if they know what NASA does. Explain that NASA builds many rockets, and uses them for different things. Show students the rocket posters, and give a brief explanation for what each rocket might do:

- **Sputnik 1**: This satellite (an object that moves around another object) was NOT built by NASA. It was the very first satellite, built in Russia, and was launched into orbit 60 years ago. This means that it left the Earth’s surface and then went around and around the Earth. There were no people aboard Sputnik 1, but satellites help scientists learn about the Earth and the solar system by sending information back to Earth, including pictures. Select a student to demonstrate how a satellite moves (have them “orbit” you several times in front of the class)

- **Saturn V**: This kind of rocket launched humans to the moon for the very first time! It was so big that it needed three different sections to help it leave the Earth’s atmosphere and get all of the way to the moon. It was as tall as a 36-story building - look at the ceiling, and imagine 36 more rooms on top of this one! Inside the rocket were spaces for humans to live while they travelled to the moon.

- **Space Shuttle**: NASA uses space shuttles to carry astronauts into outer space so that they can repair satellites, orbit Earth, or work on the International Space Station. We will learn more about the Space Station later! Astronauts also do science experiments on space shuttles, since it is different than doing them on Earth. Other rockets are attached to space shuttles when they launch, to help the shuttle get into space.
● **Space Launch System**: One of NASA’s recent projects, the Space Launch System, is even bigger and more powerful than Saturn V. It will be able to carry astronauts very far into outer space - maybe even to Mars! The Space Launch System will be powerful enough to take very heavy loads into space.

● **Antares**: This is a small rocket, used to carry things to the International Space Station. There are no humans on board of this rocket. In 2014, this rocket had trouble launching - it fell back onto the launch pad and exploded!

*Ask students to quickly sketch the rocket that they would like to own if they could have one.*
DEMONSTRATING THE PHYSICS OF A ROCKET
Part 1: Thrust and Takeoff

Ask students if they have any ideas about how something as big as a rocket could be launched into space. Then, tell them that rockets are launched using thrust, a force that is explained by Newton’s Third Law of Motion. This law says that for every action, there is an equal and opposite reaction. Tell the students that we can see how this law works by using a balloon.

Ask students what will happen if the air in a balloon is released. Will the balloon go forwards or backwards? Once they determine that it will go forwards, ask if the amount of air in the balloon might affect how far it goes.

Thread the twine through the straw on the first balloon. Ask a student to stand where the balloon “launches,” and another to stand where the balloon ends up. Measure the distance and record it on a piece of paper. Repeat this with the less full balloon.

Ask students what they think will happen if the weight of the rocket increases, but the amount of “fuel” stays the same. Then, repeat the experiment with the heavy balloon. Explain that when the weight of a rocket increases, the mass of the gas inside must also increase.

Show students the diagram of rocket speeds. If you have any extra time, show students the YouTube video of the NASA Atlantis launch.

ACTIVITY LENGTH:
25 minutes (for Parts 1-3 combined)

KIT MATERIALS:
- One very full balloon with a straw attached to the top with duct tape (see diagram)
- One less full balloon with a straw attached to the top with duct tape (see diagram)
- One balloon, with a straw, duct tape and washers attached
- Laminated diagram of different rocket speeds

MATERIALS FROM YOUR LIBRARY:
- Pencils
- Paper
DEMONSTRATING THE PHYSICS OF A ROCKET
Part 2: Orbit and Gravity

Ask students if they remember what a satellite is from the “What is a Rocket” activity. Explain that many satellites orbit around Earth, and that one of the biggest satellites is the International Space Station, where people live and work. Have one student pretend to be the Earth, and have another student “orbit” around them. Ask students if they have an idea as to how a space shuttle stays in orbit.

If possible, go outdoors for this demonstration. Swing the space shuttle around your head on the rope. Do this at a high speed, so that the shuttle remains “in orbit.” Show students the diagram illustrating momentum and gravity. Explain that when an object is moving as fast as a rocket, it wants to go in a straight line. However, gravity pulls the rocket in towards the Earth, making sure that the rocket stays in orbit.

Do the demonstration again, and reduce the momentum of the shuttle (slow down the swinging motion). Ask students if they can describe why the shuttle falls to the ground (if momentum is reduced, gravity wins!)

Tell students that you are going to do the experiment one last time, but this time we are going to see what happens if we take away gravity. Once the shuttle is orbiting, release the string. Explain that if there were no gravity, rockets would leave orbit and shoot off into space!
DEMONSTRATING THE PHYSICS OF A ROCKET
Part 3: Design and Drag

Show students the “parts of a rocket” diagram. Go over the following elements, asking students each time what they think each part does. As students learn about each part, they can draw it onto the outline of the rocket frame on the activity sheet.

- **Fins**: these make sure that the rocket stays on a stable path and does not wobble around as it moves forward. Fins work the same way that the feathers on an arrow work - they create drag on the bottom of the rocket, so that it always goes nose first.

- **Nose cone**: this is the very tip of a rocket, and is designed in a pointed shape so that the rocket can move without too much resistance.

- **Payload**: the payload is what a rocket can carry into space. This usually consists of cargo, scientific supplies, or astronauts! What would your rocket carry into space?

- **Guidance system**: this controls the movement and steering of the rocket.

- **Propulsion system**: this system is the engine of the rocket, and includes the fuel that is needed to launch the rocket into space! Most of the space in a rocket is taken up by the propulsion system.

Have students gather in a semicircle so that they can all see the rocket car. Have them make a few observations about the car. What differences and similarities does it have compared to a rocket?

Measure the distance that the car travels. Divide the students into groups and have each group think of a way to make the car slower by creating drag, using objects around them. Add these elements to the car and measure the new distance.
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PARTS OF A ROCKET
Image credit: NASA

Rocket Parts

- Nose Cone
- Payload System
- Guidance System
- Fuel
- Frame
- Oxidizer
- Pumps
- Nozzle
- Fin
- Structure System
- Propulsion System

ROCKET CAR
Image credit: NASA
**ROCKET BUILDING**

Explain to students that we are going to use some of the things we learned about how rockets move to make their own rocket. Although their rocket won’t have fuel inside of it, and therefore won’t have thrust, they can work on designing the fins and nose in order to make their rocket go as far as possible, in a straight line.

Using the attached instruction sheet, assemble a soda-straw rocket as a group. Have a student help measure the nose cone, and have the group make some observations about the fins. Are they wide or narrow, long or short? How do they think this will affect the rocket’s flight?

“Launch” the rocket by blowing into the straw, and have the students measure the distance. Tell them that now, they can try to make a rocket that goes farther than that one!

There are a few options for how this activity can be implemented:

1. Give each student some scissors, tape, a straw, a photocopy of the template, and a recording sheet. Let them assemble their own rocket, and have them measure the distance it goes with the printed ruler template. Encourage them to record the first “trial,” then adjust the nose cone or fins and do another. If this option is chosen, it can be beneficial to have some adults helping with construction.

2. Have students divide into small groups and construct a rocket as a group, then have a competition to see which rocket goes the furthest.

3. Another option is to hand out pre-assembled rockets to small groups, and to have them adjust and add to the rocket, or decorate it. This can be a more efficient way of conducting a competition between groups.

**ACTIVITY LENGTH:**
25 minutes (for Part 1 & 2 combined)

**KIT MATERIALS:**
- Template for soda straw rockets
- Large diagram explaining how to construct a soda-straw rocket
- Soda-straw rocket recording sheet
- Straws (100)

**MATERIALS FROM YOUR LIBRARY:**
- Copies of soda-straw rocket template
- Copies of ruler
- Scissors
- Tape

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STRAW ROCKET TEMPLATE

Image credit: NASA
LIVING AWAY FROM EARTH

Give students some brief background about the International Space Station:

The International Space Station is an amazing example of many different people working together to make something happen! 16 countries collaborated to create the International Space Station, including the United States.

It is a huge object that orbits the Earth - the Space Station is so big that you can see it from the Earth! It can go around our planet 16 times every day because it moves so quickly.

People live on the Space Station! There are places for living, places for working, and parts of the Station that just exist to keep its structure strong. The Station also has many huge solar panels on it, which turn sunlight into electricity. There are sections called “modules,” where astronauts live, exercise, and do experiments.

What are some of the things that happen on the Space Station?

- Satellites can help find water sources in countries experienced drought
- The Space Station is essentially a laboratory in which scientists research things like robotics, proteins, disease prevention, and bone density loss
- Scientists also use the Space Station to observe how different plants and living things react to living in space. This is important, in case humans try to go to Mars in the next century.

The International Space Station provides us with information that helps us build a better world!

Split students into 4 teams, and split the object cards evenly between the teams. Explain that each team should pretend that they are on a space shuttle, delivering supplies to the International Space Station. This is how the Station gets things that it has run out of or needs. Tell them that we will have a relay race to put all of their supplies in the right areas of the space station.
CONCLUSION & READING ABOUT SPACE

Ask students if they can think of some ways in which rockets and space travel could help our world. How could we use the physics of rockets to build other things that contribute to a better world? How might the Space Station be used in the future? This can be a fun brainstorming section, and a chance to discover what they have learned.

Read one or more of the books in the kit. If there is extra time, students can make their own illustration, either about the book or about using rockets to build a better world.

ACTIVITY LENGTH:
Varies

KIT MATERIALS:
- “There’s No Place Like Space” (Cat in the Hat’s Learning Library) by Tish Rabe
- “Roaring Rockets” by Tony Mitton and Ant Parker
- “The Moustronaut” by Mark Kelly
Images Cited

