NES: Newton’s Laws of Motion: Lunar Nautics

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Newton’s Laws of Motion

LUNAR NAUTICS

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Presentation Outline

Lunar Nautics Overview

NASA Connection

Featured Activities:
- Rocket Staging: Balloon Staging
- Lunar Landing: Swinging Tray
- Lunar Base Supply: Egg Drop

More Force and Motion Activities

NASA Explorer Schools
Lunar Nautics Overview

• Grade Level: Middle School
• Hands-on curriculum
• Correlates to National Science and Math Standards: Physical Science
• Total project length: 6 – 30 hours
• Day camp / After-school programs
• Classroom unit
• Includes master supply
Featured Activities

- Rocket Staging: Balloon Staging
- Lunar Landing: Swinging Tray
- Lunar Base Supply: Egg Drop
Poll Audience

Have you ever done similar activities before?

A - yes
B - no
C - unsure
Let’s Pause for Questions.
Review Newton’s Laws of Motion

[Use the chat room to respond]
First Law of Motion

An object at rest will stay at rest, and an object in motion will stay in motion at constant velocity, unless acted upon by an unbalanced force.
Second Law of Motion

- The greater the force, the greater the acceleration
- The greater the mass, the greater the force needed for the same acceleration
- Calculated by: $F = ma$
  ($F = \text{force}$, $m = \text{mass}$, $a = \text{acceleration}$)
Third Law of Motion

Whenever an object exerts a force on another object, the second object exerts an opposite but equal force on the first.
Students will conduct investigations that will include investigation data, results, and how the investigations relate to NASA.
Poll Audience

Which object will hit the ground first if dropped from the same height?

A. Textbook
B. Sheet of paper
C. Both
Poll Audience

What do you think will happen if the same experiment was done on the moon? Which object will hit the ground first?

A. Textbook
B. Sheet of paper
C. Both
David Scott: Apollo 15 Astronaut

Geologic hammer

Falcon feather
Newton’s First Law

An unbalanced force is needed to start the rocket moving.

Once moving, the rocket will keep moving in a straight line unless it is acted upon by another unbalanced force.
Newton’s Second Law

The strength of the force is determined by the equation:

\[ F = ma \]

The faster a rocket burns its fuel mass and the greater the acceleration of the gases, the greater the thrust (force).
Newton’s Third Law

The force will produce an action (exhaust gases) and a reaction (movement of rocket) that are equal but opposite.
Let’s Pause for Questions.
Featured Lessons

Expected Outcomes

Increase student ability to apply science, technology, engineering, mathematics, and geography concepts and skills in meaningful ways.
Balloon Rocket

Learn how rockets can achieve greater distance by using the technology of staging.

Rocket Staging: Balloon Staging

Overview
Traveling into outer space takes enormous amounts of energy. This activity is a simple demonstration of rocket staging that Johannes Schmied first proposed in the 16th century.

Purpose
Through participation in this demonstration, students will:
• Learn how rockets can achieve greater distances by using the technology of staging.

Preparation
• Gather all materials.

Materials
Per class:
• Student Data Sheets
  (CD Location: Educator Resources/Guides/Student Guide)
• 2 long, party balloons
• Non-combustible fishing line (any weight)
• 2 plastic straws (latex tubing size)
• Styrofoam coffee cup
• Masking tape
• Scissors
• 2 spring clothespins

Procedure
1. Thread the fishing line through the two straws. Stretch the fishing line snugly across a room and secure its ends. Make sure the line is just high enough for people to pass safely underneath.
2. Cut the coffee cup in half so that the lip of the cup forms a continuous ring.
3. Stretch the balloons by pressing them. Inflate the first balloon about three-fourths full of air and squeeze its nozzle tight. Pull the nozzle through the ring. Twist the nozzle and hold it shut with a spring clothespin. Inflate the second balloon. While doing so, make sure the front end of the second balloon extends through the ring a short distance. As the second balloon inflates, it will press against the nozzle of the first balloon and take over the clip’s job of holding it shut. It may take a bit of practice to achieve this. Clip the nozzle of the second balloon shut also.
4. Take the balloons to one end of the fishing line and tape each balloon to a straw with masking tape.
5. The balloons should point parallel to the fishing line.
6. Remove the clip from the first balloon and untie the nozzle. Remove the nozzle from the second balloon as well, but continue holding it shut with your fingers.
7. If you wish, conduct a rocket countdown as you release the balloon you are holding. The escaping gas will propel both balloons along the fishing line. When the first balloon released runs out of air, it will release the other balloon to continue the trip.
8. Distribute design sheets and ask students to design and describe their own multistage rocket.
9. Collect and display student designs for multistage rockets. Ask each student to explain his/her rocket to the class.
Materials per Team

- 2 long party balloons
- Nylon monofilament fishing line
- 2 plastic straws (milkshake size)
- Styrofoam coffee cup
- 2 spring clothespins
- Scissors
- Masking tape
Balloon Staging
Discussion Questions

Which Newton’s laws of motion are demonstrated by this?
A. 1  B. 2  C. 3  D. All

How might other launch arrangements such as side-by-side balloons and three stages work?
Let’s Pause for Questions.
Learn that gravity acts as a centripetal force that keeps satellites in orbit and controls the path of the moon.
Materials

- Metal pizza tray
- String
- Duct tape
- Plastic cup
- Water
- Food coloring
- Hard hat
- Safety glasses
Swinging Tray

Swinging Bucket

Give it a Whirl
Discussion Questions

What do we call the path that the tray moves in?

If the strings are held at a shorter distance to the tray, shortening the tray’s orbit, what happens to the speed of the tray?
Let’s Pause for Questions.
Lunar Base Supply Egg Drop

- Eggs
- Scissors
- Cups
- Straws
- Paper towels
- Cotton balls
- Plastic bags
- Bubble wrap
- String
- Drop cloth
- Role Cards
- Masking tape
- Round balloons
Discussion Questions

- What structures worked well?
- What structures did not work well?
Poll Audience

Do you plan to use these activities in your classroom?

<table>
<thead>
<tr>
<th>Balloon Staging</th>
<th>Swinging Tray</th>
<th>Egg Drop</th>
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More Force and Motion Activities

- Pop Bottle Rocket — Investigates designing, building and testing a model rocket.
- Spacesuits: Potato Astronaut — Investigates how the layers of a spacesuit protect an astronaut.
More Activities

🔗 Bending Under Pressure: How pressure affects astronauts’ movements in their spacesuits.

🔗 Microgravity/Come-Back Bottle: How toys act on Earth and in free fall.
Let’s Pause for Questions.
Collaboration
NEWTON'S LAWS OF MOTION: LUNAR NAUTICS

Featured Lesson(s)
- Rocket Staging: Balloon Staging
- Lunar Landing: Swinging Tray
- Lunar Base Supply Egg Drop

 Essential Question
How do Newton's Laws of Motion apply to space exploration?

Description
Lunar Nautics is a hands-on module for students in grades 5-8. Lunar Nautics featured lessons are linked to exploring the moon, human presence on the moon and enabling future exploration. The lessons feature design challenges focusing on conceptual, real-world understanding of Newton's laws and address common misconceptions associated with the laws.

- Rocket Staging: Balloon Staging -- Traveling into outer space takes enormous amounts of energy. This activity is a simple demonstration of rocket staging first proposed by Johann Schmiaid in the 16th century. Students learn how rockets can achieve greater distances through rocket staging.
- Lunar Landing: Swinging Tray -- Since gravity is responsible for keeping satellites in orbit, why do astronauts appear to float in space? The answer is simple, as students learn in this featured lesson.
- Lunar Base Supply Egg Drop -- Although attempts will be made to make any future lunar base as self-sufficient as possible, it will likely need periodic resupply from Earth. The purpose of this activity is for student teams to design a method of packaging "supplies" and getting them safely to a "lunar base."

Lesson Information
Subject(s) Covered: Physical science
Topic(s) Covered: Newton's Laws of Motion, Gravity, Centripetal force
Activity Type: Student investigation
Grade Level: 5-8

Instructional Objective: Students explain Newton's Laws of Motion and apply them to space exploration.

Time to Complete the Activity: One to three 45 minute classes

Materials Needed:

Connection to NASA:

Extension Activities:

Professional Development:

Click here to find the live web seminars scheduled for this featured lesson. Web seminars are led remotely by NASA subject matter experts and education specialists.

Click here to access the teacher video collection for this featured lesson.

NES Video Collections:
Newton's Laws of Motion

Video 1 of 6: Lunar Nautics introduction
(04:39) Posted: 09/03/2010

Video 2 of 6: Newton's Laws of Motion
(05:24) Posted: 09/03/2010

Video 3 of 6: Activity 1: Balloon staging Rocket
(07:43) Posted: 09/03/2010

Video 4 of 6: Activity 2: Lunar Landing Swinging Tray
(08:52) Posted: 09/07/2010

Video 5 of 6: Lunar Base Supply Egg Drop
(07:53) Posted: 09/07/2010

Video 6 of 6: More Force and Motion Activities
(03:09) Posted: 09/07/2010

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