STRAW ROCKET

GRADES 3-5

ELEMENTARY STEM ACTIVITY GUIDE

PITSCO EDUCATION

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STRAW ROCKET

Written by Dianna Green.

Content advising by Tammy Pankey.

Cover and document design by Christine Bennett.

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LESSON PLANS

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STRAW ROCKETS AND NEWTON'S LAWS

GRADE LEVELS
Grades 3-5

TIME REQUIRED
45 minutes

CONTENT AREAS
- Science
- Engineering

KEY WORDS AND CONCEPTS
- Force
- Newton's laws
- Rocketry

OVERVIEW
Students will individually construct straw rockets. Using the launcher, students will learn the concept of Newton's third law of motion: for every action, there is an equal and opposite reaction. Students will further understand the basics of rocketry.

STANDARDS ADDRESSED

Common Core State Standards – Mathematics

Mathematical Practice Standards

- **MP2** Reason abstractly and quantitatively.
- **MP5** Use appropriate tools strategically.

Mathematical Content Standards

- **3.MD.A** Solve problems involving measurement and estimation.
  - **3.MD.A.2** Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.

Next Generation Science Standards

- **3-PS2-1** Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
- **3-PS2-2** Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

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VOCABULARY

- **accelerate:** to speed up
- **acceleration:** the rate of change in speed of an object
- **decelerate:** to slow down
- **drag:** the force that resists the forward motion of an object as it moves through air
- **fins:** provide guidance to a rocket
- **gravity:** the force that pulls all objects toward the center of Earth
- **motion:** movement; a change of position in relation to an object's surroundings
- **rest:** not moving; without motion
- **thrust:** the upward force that pushes a rocket upward or forward

MATERIALS

- Pitsco Straw Rocket Class Pack
- Pitsco Straw Rocket Launcher
- Transparent tape (1/4" size works best)
- Scissors
- Rulers
- Pencils
- Colored pencils, crayons, or markers (optional)
- Masking tape or small repositionable notes (Post-It® notes)
- Fine-line marker for marking targets
- Small notebook (for any notes)

SAFETY

Eye protection should be worn by students while the straw rockets are being launched. General classroom safety should be observed during the construction of the rockets.

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INTRODUCTION OF ROCKETRY AND NEWTON'S LAWS OF MOTION

- If possible, decorate the classroom with pictures of different types of rockets that have been used throughout history.
- There are many good, short videos on the history of rockets and rocketry available on YouTube:
    - "Robert Goddard - The Father of Modern Rocketry" from Sigma Rockets (2:52 minutes)
    - "Robert Goddard - The American Pioneer of Rocketry" from Sigma Documentaries (15:12 minutes)
    - "Dr. Robert H. Goddard - Father of Modern Rocketry (1961)" from AIRBOYD (7:07 minutes)
    - "A Brief History of Rocket Flight" from Sigma Rockets (5:08 minutes)
- Additionally, you may access NASA for videos of rocket launches and galleries of rockets and launches. Any pictures on NASA's gallery pages may be printed for use in the classroom.
    - Search www.nasa.gov/education.
- To introduce the subject matter, you might wish to engage your students with questions such as:
    - How long do you think people have used rockets?
    - Who do you think were the first people to have used rockets?
    - How do you think rockets get into space?
    - What makes a rocket able to fly?
- Any of these questions lend themselves well to student research. This could be used as an additional lesson leading up to the actual building of the rockets.

TEACHING TIPS

- Make sure you have a completed rocket to show students. This is especially useful when explaining fin placement and nose cone shape.
- When you start to assemble the straw rockets, it is important that the students have the same amount of modeling clay with which to build their nose cones. The shape is not important at this time, but the weight of the nose cone needs to remain uniform at this initial stage of the program. To ensure that the amount of clay is uniform, slice the bar of clay into 1/4" slices using a plastic knife. Then, cut each slice into two equal parts. Each student will use one piece of clay to model his or her nose cone.
- If you have a student or students in your class who might have trouble using scissors, it might be a good idea to have a few rocket fins already cut out and ready to be attached to the straw.

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TEACHER PROCEDURE

1. Set up a target for the straw rockets. If possible, hang a large balloon or beach ball from the ceiling to serve as a target. Inflatable globes are great for this; you could also use a target drawn on the white board or even mounted to a wall. Choose a large, open area, such as the gymnasium, for your launch.
   - A. Set up launcher and make sure area around it is clear of all obstructions.
   - B. Make sure each student has a pencil and data-collection sheet.
   - C. Make sure each student is wearing eye protection.
2. Make sure each student has completed a straw rocket.
   - A. If possible, use 1/4" width tape when attaching fins so that you are not as likely to over-tape.
   - B. For this initial lesson, each student will use the same amount of modeling clay when forming the nose cone for his or her rocket.
   - C. Students will also use uniformity in size, shape, and placement of fins. Templates for fins are included in the kit.
3. Before launch, each student should check his or her rocket for stability.
   - A. Hold the rocket horizontally at eye level and drop the rocket. It should land nose first. If it lands on its side or fins first, it is unstable and the fins might have to be adjusted.
   - B. Adjust the fins by making them slightly larger or by moving them forward on the straw fuselage.
4. Prepare to launch your rocket as the initial trial.
   - A. Before launch, ask the students which safety rules should be used: all present should be wearing eye protection and only those directly involved in the launching of a particular rocket should be in the launch zone. Say the word "clear" when retrieving a rocket from the launch area.
   - B. It always adds some extra fun and excitement when everyone joins in to count down the launch.
5. Explain to the students that by launching their rocket, they will be demonstrating Newton's third law of motion: for every action, there is an equal and opposite reaction.
   - A. The action is the thrust that will be caused by the air being forced into the straw from the launcher.
   - B. The reaction is the actual propulsion of the rocket toward the target.
6. Put students in groups of two.
   - A. One will launch his or her rocket while the other retrieves it.
   - B. A small piece of masking tape or a small Post-It® note with the student's name will be placed on the location of the target where the rocket made contact.
   - C. Partners will then switch jobs so that each one gets to launch and also retrieve.
   - D. Students complete the "Straw Rocket Launch Test Report."

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7. Using the "Rocket Data Tracking Sheet," each student will input the data on each rocket that is launched.
    A. For example, students might wish to name their rockets. If this is the case, each rocket's name should be used on the data sheet. If not, use each student's name.
    B. Points may be assigned to different locations on the target. Students might wish to determine which area on the target merits the most points.
    C. Have the class determine how many times each rocket is to be launched. They can then choose to either use each person's best score for performance points or average the points.

TROUBLESHOOTING

- If a rocket fails the stability test, have the student make an adjustment on the fins. Make sure they are attached in the correct spot and that the student has followed the template when creating his or her fins.
- Make sure that all rockets are launched using the same angle of launch. Any variance could cause a difference in performance as far as targeting a specific area.
- Keep extra transparent tape, card stock, and scissors on hand at the launch site in case of any mishaps involving loss of or accidental damage to the rocket fins. You might also wish to have modeling clay available in the event of damage to or loss of a nose cone.

EXTENSION ACTIVITIES

- Expand the lesson to include some mathematics by having the students graph the class's launch results.
- The students might be interested in finding out more about the history of rockets. They might wish to do some research on Robert Goddard or Werner von Braun.
- Some of your more advanced readers might wish to read *Rocket Boys* by Homer Hickam, which chronicles the story of four Appalachian boys from a small coal-mining town whose experiments with model rockets eventually send them to the National Science Fair in Washington, D.C. The movie *October Sky* is based on this book.

ASSESSMENT

1. What gives the straw rocket its stability?
2. What serves as the thrust in the launch?
3. Explain Newton's third law of motion.

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OVERVIEW

You will build straw rockets. You will learn about of Newton's third law of motion. You will learn about the basics of rocketry.

VOCABULARY

- accelerate
- acceleration
- decelerate
- drag
- fins
- gravity
- motion
- rest
- thrust

MATERIALS

- Pitsco Straw Rocket Class Pack
- Pitsco Straw Rocket Launcher
- Transparent tape
- Scissors
- Ruler
- Pencil
- Colored pencils, crayons, or markers (optional)
- Small notebook (for any notes)

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STUDENT PROCEDURE

1. Build a straw rocket.
2. Before launch, check your rocket for stability.
   A. Hold the rocket horizontally at eye level and drop the rocket. It should land nose first. If it lands on its side or fins first, it is unstable and the fins might have to be adjusted.
   B. Adjust the fins by either making the fins slightly larger or moving them forward on the straw fuselage.
3. Prepare to launch your rocket as the initial trial.
   A. Review safety rules.
4. By launching your rocket, you will be demonstrating Newton's third law of motion: for every action, there is an equal and opposite reaction.
   A. The action is the thrust that will be caused by the air being forced into the straw from the launcher.
   B. The reaction is the movement of the rocket toward the target.
5. Get into groups of two.
   A. One of you will launch his or her rocket while the other retrieves it.
   B. Use a small piece of masking tape or a small Post-It® note with your name and place it on the location of the target where the rocket made contact.
   C. Switch jobs so that each of you gets to launch and also retrieve.
   D. Complete the "Straw Rocket Launch Test Report."
6. Using the "Rocket Data Tracking Sheet," add the data on each rocket that is launched.
   A. If you named your rocket, each rocket's name should be used on the data sheet. If not, use each student's name.
   B. Points may be assigned to different locations on the target. Decide which area on the target scores the most points.
   C. Launch each rocket three times. Use each rocket's best score or an average.

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ROCKET DATA TRACKING SHEET

	Name	Flight 1	Flight 2	Flight 3
1.				
2.				
3.				
4.				
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8.				
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STRAW ROCKET LAUNCH TEST REPORT

Name ____

1. Launch your rocket three times at the same launch angle. Each time, record how many points were scored on the target.
2. Try to estimate how many points your rocket will score on the second launch. Record your estimate and the actual points scored. What was the difference?
3. Try to estimate how far the rocket will fly. Record your estimate and the actual distance flown. What was the difference?
4. On the back of this paper, write a short paragraph about your rocket and how it flew. Draw a picture of your rocket.

Launch 1

How many points were scored? ________

Launch 2

My prediction of points scored ________

Actual points scored ________

Difference (if any) ________

Launch 3

My prediction of distance flown ________

Actual distance flown ________

Difference ________

<u>Notes</u>

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ROCKET STABILITY INFORMATION PAGE

Why must a rocket be stable? Why is stability so important in a space launch? NASA scientists could tell you that accuracy is what makes a launch successful. Just imagine what might happen if one of the rockets got into the wrong orbit and was unable to make a connection with the *ISS*, the Moon, or another target. The mission would be a failure.

Stability gives a rocket the ability to have a smooth flight path. Can you imagine what might happen if the rocket was unstable? The flight would probably be rough. The astronauts would need extra fuel to get back on the right path. Instability could cause the rocket to spin off into space. That would be a disaster!

It's a good thing that it is pretty easy to keep a rocket stable when it is traveling through space. The rocket scientists must keep two important things in mind: the center of mass and the center of pressure.

The center of mass is the point where an object balances. If you hold a stick on your finger and balance it, you are modeling the center of mass. If the stick is balanced on your finger, the center of mass is right above your finger. If it should tip to the right, the center of mass is to the right. Likewise, if it tips toward the left, then the center of mass is to the left.

Center of pressure is the point on the surface of the rocket where pressure is exerted by the air hitting it. The rocket needs to have more air pressure on the end. That is why fins are so important. The fins catch more air pressure and keep the rocket from spinning around the center of mass.

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GRADE LEVELS

Grades 3-5

TIME REQUIRED

90 minutes

CONTENT AREAS

- Science
- Engineering

KEY WORDS AND CONCEPTS

- Force
- Gravity
- Mass
- Newton's laws

OVERVIEW

Students will construct straw rockets. Using varying amounts of modeling clay, students will construct different sizes and shapes of nose cones to experiment with during the launch of a straw rocket. Students will understand how gravity and mass affect thrust in a rocket launch.

STANDARDS ADDRESSED

Common Core State Standards – Mathematics

Mathematical Practice Standards

- **MP2** Reason abstractly and quantitatively.
- **MP4** Model with mathematics.
- **MP5** Use appropriate tools strategically.

Next Generation Science Standards

- **3-PS2-1** Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
- **3-PS2-2** Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
- **3-5-ETS1-1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- **3-5-ETS1-2** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

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- **3-5-ETS1-3** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

VOCABULARY

- **acceleration:** the rate of change in the speed of an object
- **data:** facts, statistics, or information
- **drag:** the force that resists the forward motion of an object as it moves through air
- **engineering:** a field in which humans solve problems by relying on their knowledge of science, technology, engineering design, and mathematics
- **force:** a push or pull on an object
- **gravity:** the force that pulls all objects toward the center of Earth
- **mass:** the amount of matter contained in an object
- **thrust:** the upward force that pushes a rocket upward or forward
- **weight:** the force exerted on an object by gravity

MATERIALS

- Pitsco Straw Rocket Class Pack
- Pitsco Straw Rocket Launcher
- Transparent tape (1/4" size works best)
- Modeling clay
- Scissors
- Rulers
- Pencils
- Colored pencils, crayons, or markers (optional)
- Masking tape
- Small set of balance scales
- Meterstick or measuring tape
- Small repositionable notes (Post-It® notes)
- Fine-line marker for marking targets/distances flown
- Graph paper
- Small notebooks

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SAFETY

Eye protection should be worn by students during the launching of the straw rockets. General classroom safety should be observed during the construction of the rockets.

TEACHING TIPS

- Because this is the second lesson in the series, the students should now have a general idea of how rockets work.
- There are some very good short videos available on Youtube that help explain more fully Newton's second law of motion.
  - "Newton's Second Law of Motion" from MacMillanSpaceCentre (3:08 minutes)
  - "Newton's 2nd Law of Motion" from makemegenius (1:36 minutes)
- Make sure the students are familiar with using a balance scale.
- Make sure you have a completed rocket to show the students. You will also need two or three nose cones of varying sizes and shapes as you explain the lesson.

TEACHER PROCEDURE

1. Prepare for the launch.
   - A. Choose a large, open area, such as the gymnasium, for your launch.
   - B. Tape a line of masking tape along the floor. It should be at least 30 feet long.
   - C. Mark the tape in increments of one foot. (This would be a good job for a couple of students.)
   - D. Set up launcher and make sure area around it is clear of all obstructions.
   - E. Make sure each student has a pencil, notebook, and data-collection sheets.
   - F. Make sure each student is wearing eye protection.
2. Make sure each student has completed a straw rocket.
   - A. If possible, use 1/4" width tape when attaching fins so that you are not as likely to over-tape.
   - B. Students will shape three nose cones of varying sizes and shapes for this lesson.
   - C. Students should keep uniformity when designing fins because the primary focus of this lesson is weight and mass.
   - D. Each time a nose cone is changed, the rocket needs to be weighed and the weight recorded on the student's rocket data sheet.
3. Each rocket should be tested for stability before launching.
   - A. Hold the rocket horizontally at eye level and drop the rocket. It should land nose first. If it lands on its side or fins first, it is unstable and the fins might have to be adjusted.
   - B. Fins might need to be moved forward or backward on the rocket's fuselage.

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4. Each student will formulate a hypothesis and test his or her hypothesis with rocket launches.
    A. For example: I think the large, blunt nose cone will cause the rocket to go farther because it weighs more.
    B. After the launches, students will evaluate their hypotheses.
    C. Students complete the "Straw Rocket Launch Test Report."
5. Explain to the students that they will be modeling Newton's second law of motion with the launch of their rockets.
    A. Explain the law.
    B. Show how the law is generally written as a formula: $f = m \times a$.
    C. Explain how the experiment with the nose cones of varying weights will demonstrate that more force is needed to accelerate a heavier object.
6. Put students in groups of two.
    A. One will launch his or her rocket while the other retrieves it.
    B. A small piece of masking tape or a small Post-It® note with the student's name will be placed on the location of the target where the rocket made contact.
    C. Partners will then switch jobs so that each one gets to launch and also retrieve.
7. Using the data-tracking sheet, each student will enter the data for each launch.
    A. The weight should be noted before each launch.
    B. Students will then use the data to support or refute their hypotheses.
    C. You might wish to give a certificate to the student whose rocket flies the farthest or to students who best prove their hypotheses. Perhaps you would like to give certificates for the funniest nose cone or the heaviest rocket to still be able to fly. Use your imagination!

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TROUBLESHOOTING

- If a rocket fails the stability test, have the student make an adjustment on the fins. Make sure they are attached in the correct spot and that the student has followed the template when creating his or her fins.
- Make sure that all rockets are launched using the same angle of launch. With the additional weight of the nose cones, a good rule of thumb is to choose an angle less than 45 degrees at which to launch. Use your judgment. You might wish to experiment with your own rocket first to ascertain which angle of launch will work best for your students.
- Keep extra transparent tape, card stock paper, and scissors on hand at the launch site in case of any mishaps involving loss of or accidental damage to the rocket fins.
- Keep extra modeling clay available in the event of damage to or loss of a nose cone.

EXTENSION ACTIVITIES

- Expand the lesson to include some mathematics by having the students graph the class's launch results.
- It might be fun to average the weight of all the rockets that were launched.
- Discuss ways in which engineers might test their designs for new rockets.
- Research what new rockets are being developed.

ASSESSMENT

1. Generally speaking, did the rockets with the heavier or lighter nose cones fly farther?
2. Explain Newton's second law of motion.
3. Demonstrate Newton's second law of motion.

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OVERVIEW

You will build straw rockets. You will build different sizes and shapes of nose cones by using different amounts of clay. You will learn how gravity and mass affect thrust in a rocket launch.

VOCABULARY

- acceleration
- data
- drag
- engineering
- force
- gravity
- mass
- thrust
- weight

MATERIALS

- Pitsco Straw Rocket Class Pack
- Pitsco Straw Rocket Launcher
- Transparent tape (1/4" size works best)
- Modeling clay
- Scissors
- Rulers
- Pencils
- Colored pencils, crayons, or markers (optional)
- Masking tape
- Small set of balance scales
- Meterstick or measuring tape
- Small repositionable notes (Post-It® notes)

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- Fine-line marker for marking targets/distances flown
- Graph paper
- Small notebooks

STUDENT PROCEDURE

1. Complete your straw rocket using the materials and instruction sheet from the kit.
    A. Try not to over-tape when attaching the fins to the rocket.
    B. You will be designing three nose cones of varying sizes and shapes. Use your graph paper to draw out your designs, being careful to measure each one. Please let your teacher know if you need more clay.
    C. For this first rocket, you must use the pattern for your fins, but you may decorate them as you wish.
2. Check your rocket for stability.
    A. Hold your rocket horizontally at eye level and drop the rocket. It should land nose first. If it lands on its side or fins first, it is unstable and the fins might have to be adjusted.
3. With your partner, decide who will launch first and who will retrieve first. Make sure to wear your eye protection.
    A. One of you will launch his or her rocket while the other retrieves it.
    B. Use a small piece of masking tape or a small Post-It® note with your name and place it on the location of the target where the rocket made contact.
    C. Switch jobs so that each of you gets to launch and also retrieve.
    D. Complete the "Straw Rocket Launch Test Report."
4. Using your tracking sheet, record the data of each launch, noting which nose cone was used, the weight of your rocket, and the distance traveled.
5. Be sure to take any notes that might help you with the launch of your next rocket.

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6. Fill out your data sheet and determine if you were able to prove your hypothesis.
7. Write a short paragraph about your launches, the nose cones, and your hypothesis. Be sure to include pictures of what each one looked like. Using your own words, explain how Newton's laws were used in your rocket launch.

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ROCKET DATA TRACKING SHEET

	Name	Flight 1	Flight 2	Flight 3
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STRAW ROCKET LAUNCH TEST REPORT

Name ______________________________

1. Launch your rocket three times at the same launch angle. Each time, attach a different nose cone. Record the distance flown with each nose cone.
2. Try to estimate how far your rocket will travel on the second launch. Record your estimate and the actual distance. What was the difference?
3. Try to estimate how far the rocket will fly. Record your estimate and the actual distance flown. What was the difference?
4. On the back of this paper, write a short paragraph about your rocket and how it flew. Draw a picture of each of the nose cones you designed.

Launch 1

Nose cone shape __________

Nose cone mass __________

Distance flown __________

Launch 2

Nose cone shape __________

Nose cone mass __________

Distance flown __________

Launch 3

Nose cone shape __________

Nose cone mass __________

Distance flown __________

Notes

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A TASTE OF ROCKET SCIENCE INFORMATION PAGE

It doesn't matter if it is a small straw rocket or a very large *Saturn V* rocket, the principles of rocketry are the same. The same forces are at work for all rockets.

Galileo was one of the first people to conduct experiments about the theory of motion. During the course of his work, he learned that an object in motion didn't need to have force continually applied to it. It would keep moving as long as drag and friction did not act upon it. He learned a truth that we know as *inertia*. All things, regardless of their mass, will resist changes in motion.

Sir Isaac Newton built on Galileo's ideas and came up with his three basic laws of motion. If you know Newton's laws of motion and how they work, then you can probably design a rocket that will fly well. If you understand these laws and can use them, then you are on your way to being a true rocket scientist.

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CHALLENGE: THE GREAT ROCKET FIN CAPER

GRADE LEVELS
Grades 3-5

TIME REQUIRED
180 minutes

CONTENT AREAS
- Science
- Engineering

KEY WORDS AND CONCEPTS
- Force
- Gravity
- Mass
- Newton's laws
- Rocketry

OVERVIEW

Students will design and attach fins to one of their already-constructed straw rockets. Using the launcher, students will learn how drag affects acceleration and distance in flight.

STANDARDS ADDRESSED

Common Core State Standards – Mathematics

Mathematical Practice Standards

- **MP2** Reason abstractly and quantitatively.
- **MP4** Model with mathematics.
- **MP5** Use appropriate tools strategically.

Next Generation Science Standards

- **3-PS2-1** Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
- **3-PS2-2** Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
- **3-5-ETS1-1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- **3-5-ETS1-2** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

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- **3-5-ETS1-3** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

VOCABULARY

- **acceleration:** the rate of change in speed of an object
- **data:** facts, statistics, or information
- **drag:** the force that resists the forward motion of an object as it moves through air
- **engineering:** a field in which humans solve problems by relying on their knowledge of science, technology, engineering design, and mathematics
- **force:** a push or pull on an object
- **gravity:** the force that pulls all objects toward the center of Earth
- **mass:** the amount of matter contained in an object
- **thrust:** the upward force that pushes a rocket upward or forward
- **weight:** the force exerted on an object by gravity

MATERIALS

- Straw rocket from the previous lesson
- Card stock
- Pencil
- Graph paper
- Tape
- Markers or crayons for decoration
- Scissors

SAFETY

Eye protection should be worn by all students during the launching of the rockets. General classroom safety should be observed during the construction of the rockets.

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TEACHER PROCEDURE

1. Prepare for the launch.
    A. Choose a large, open area, such as the gymnasium, for your launch.
    B. Tape a line of masking tape along the floor. It should be at least 30 feet long.
    C. Mark the tape in increments of one foot. (This would be a good job for a couple of students.)
    D. Set up launcher and make sure area around it is clear of all obstructions.
    E. Make sure each student has a pencil, notebook, and data-collection sheets.
    F. Make sure each student is wearing eye protection.
2. Students will design a new set of fins for their straw rockets.
    A. There is no limit as to size, number, or placement of fins.
    B. There will be some instability, but let the students try their hands at this engineering feat.
3. Students will launch their rockets three times, recording distance, altitude, and accuracy.
    A. Use the target from Lesson 1 for accuracy and the taped distance marker on the floor for distance. Make a measured altitude target.
    B. As before, students will be in groups of two, taking turns launching and retrieving.
4. Prizes could be awarded for most accurate, rocket that goes the farthest, rocket that flies the highest, and perhaps some comic awards such as largest fins or most artistic fins.

TROUBLESHOOTING

- Keep extra transparent tape, card stock paper, and scissors on hand at the launch site in case of any mishaps involving loss of or accidental damage to the rocket fins.
- Keep extra modeling clay available in the event of damage to or loss of a nose cone.

EXTENSION ACTIVITIES

- This lesson might spur some of the students on toward some independent study on the history of rocketry or some of the new developments that NASA is working on – making a manned trip to Mars, traveling back to the Moon, or developing manned space vehicles.

ASSESSMENT

1. What is the minimum number of fins a rocket must have in order to have stability?
2. Did the size of the fin make a difference in the distance that the rocket could fly?
3. Did the size of the fins make a difference in the rocket's altitude?

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OVERVIEW

You will design and attach fins to one of your straw rockets. You will learn how drag affects acceleration and distance in flight.

VOCABULARY

- acceleration
- data
- drag
- engineering
- force
- gravity
- mass
- thrust
- weight

MATERIALS

- Your straw rocket from the previous lesson
- Card stock
- Pencil
- Graph paper
- Tape
- Markers or crayons for decoration
- Scissors

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STUDENT PROCEDURE

1. You will design a new set of fins for your straw rocket.
2. There is no limit as to size, number, or placement of fins.
3. Launch your rocket three times, recording distance, altitude, and accuracy.
4. Use the target from Lesson 1 for accuracy and the taped distance marker on the floor for distance. Make a measured altitude target.
5. Work in groups of two, taking turns launching and retrieving.

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ROCKET DATA TRACKING SHEET

Name	**Flight 1**	**Flight 2**	**Flight 3**
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			
19.			
20.			

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GODDARD INFORMATION PAGE

Doctor Robert H. Goddard is often called the father of modern rocketry. When he was a young man, Dr. Goddard was thrilled by science fiction books.

He patented a liquid-fuel rocket and a two-stage solid-fuel rocket in 1914. By 1920, he wrote that he believed it was very possible that one day a rocket would reach the Moon.

Goddard was one of the first to add fins, or vanes, to a rocket for guidance.

March 16, 1926. Robert H. Goddard and his first liquid-fuel rocket.
Photo courtesy of the NASA Goddard Space Flight Center.

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