DOES MASS MATTER?

Duration: 315 minutes

STEM Connections

Science
- Mass vs Weight

Technology
- Use Pocket Lab to Collect Data

Engineering
- Design and Build a Straw Rocket
- Build an Estes Rocket
- Payload Planning

Math
- Calculation of Force
- Calculation of Velocity
- Graphing skills and Analysis
- Calculating Averages

21st Century Skills
- Communicate
- Creativity
- Collaborate
- Critical Thinking

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Storyline

In this lesson, students will answer the question, Does the mass of a model rocket affect the altitude, velocity and duration of the rocket's flight? Your students are part of a group of engineers working for Rockets R US which has been contracted to build rockets that will carry the PocketLab Data Analyzer to astronauts on the International Space Station (ISS). They must be sure that their rockets reach 200ft and contain a payload of no more than 10 pennies to reach the ISS. Students will determine which team member below is correct.

1. Martin Moneysaver wants the rocket to carry only the data payload (PocketLab) to the ISS because he feels that would save money for fuel.
2. Sha'Niece Supersupplier says the rocket needs to be packed with as many things as possible so that the astronauts on the ISS have fresh food, games, clothing, and comfort items from home. She doesn't think the amount of mass in the rocket really makes much of a difference.
3. Wes Wishywashy is afraid that if they don't send any supplies for the astronauts the rocket will be too light to fly.

Students will hypothesize how the mass of the payload will affect the rocket's final altitude. After a review of weight vs. mass, students will practice what they learned and build a straw rocket. After analyzing the data, students will apply those learnings to build the Green Eggs Rocket and plan their payload for their flight. They will state a hypothesis and identify the independent and dependent variables.

After the flight, the students will combine their data into a class data chart to allow better analysis. They will compare the results and determine the answer to the essential question, "Does Mass Matter?".

The student's final product will be to complete a Claims- Evidence- Reasoning writing piece supporting their final conclusions. A traditional multiple-choice quiz is included for use if needed.

Essential Question

Does the mass of a model rocket affect the altitude, velocity and duration of the rocket's flight?

I Can Statements

After this activity, students should be able to say I CAN…

- Articulate Newton's Second Law of Motion and provide examples.
- Conduct an experiment and display collected data to show the relationship between mass and speed.
- Define the criteria and constraints of a design problem with enough precision to ensure a successful solution.
- Evaluate competing design solutions to determine how well they meet the criteria and constraints of the problem.
- Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- Develop a model to generate data for repeated testing and modification of a proposed object, tool, or process to achieve an optimal design

Unit Vocabulary

- **Weight**
- **Mass**
- **Velocity**
- **Force**
- **Acceleration**
- **Velocity**
- **Payload**
- **Apogee**
- **Prototype**

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Content Standards

Targeted NGSS Performance Expectation(s):

MS-PS2-2
Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

MS-PS.2.4
Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

MS-PS.3.1
Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

MS-ETS 1-1
Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS 1-2
Evaluate competing design solutions based on jointly developed and agreed-upon design criteria using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS 1-3
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS 1-4
Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

NEXT GENERATION SCIENCE STANDARDS

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Equipment

This materials list outlines the core items needed to teach the activities within this challenge. Note that some materials are used across several activities.

Each Student Needs:

Description	Quantity	Notes
Student Design Portfolio	1	Available in .pdf for print or google doc / word doc for digital distribution
Safety Goggles	1	Highly recommended to ensure student safety
Tape	1	
Scissors	1	
Straw	1	
Ruler	1	
Paper Clips	5-10	
Paper 8.5" x 11"	1	

The Class Needs:

Description	Quantity	Notes
Weight vs. Mass PowerPoint	1 per class	Available as a .pdf, google slide or PowerPoint
Stopwatch	1 per group	Student could also use their phones if permitted
Meter Sticks	1 per group	
Green Eggs Rocket Kit	1 per group	Available for purchase in a 12 pack
C11-3 Engines	1-2 per group	Extra engines are great if you want students to launch more than once
PocketLab	1-3 per class	
Glue	1 per group	Recommend yellow wood glue like TiteBond of Elmer's carpenter glue
Exacto Knife	1 per group	
Pennies	5-10 per group	
Scale	1 per class	
Camera	Optional	Great if you want to take videos of student launches!

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Background Material For Teacher

Sir Isaac Newton

What is known about rocketry today can be traced back to the time of Sir Isaac Newton (1642 - 1727). Newton described the motion of objects falling to the Earth in his book Philosophiae Naturalis Principia Mathematica where he outlined three laws of motion. Although Newton was merely describing principles of nature, Newton's Laws apply to the physics of rocketry. His laws are simple statements regarding the physics governing motion and can be used to provide precise explanations of rocket flight.

Newton's First Law of Motion

Objects at rest will remain at rest and objects in motion will remain in motion in a straight line unless acted upon by an unbalanced force.

During a model rocket flight, forces become balanced and unbalanced all the time. A rocket on the launch pad is in a state of rest. This is called inertia. A rocket is balanced all the time because the surface of the pad pushes the rocket up while the force of gravity tries to pull it down. An unbalanced force must be exerted for a rocket to lift-off from the launch pad. A rocket blasting off the launch pad changes from a state of rest to a state of motion. It will keep moving in a straight line at the same speed unless it is acted upon by an unbalanced force (gravity and drag).

There are four forces (drag, gravity, thrust, lift) that act on all objects that travel through the air. Drag and gravity are the two unbalanced forces that act on a model rocket. Drag is the resistance or frictional force between the surface of a moving object and air. Drag increases with speed. Gravity is the force pulling an object back to the surface of the Earth. The amount of this force is proportional to the mass of the object.

When the rocket lifts off the launch pad it is guided by the launch rod in a straight line upward. The unbalanced forces (drag and gravity) cause it to arch and fall to the ground.

Newton's Second Law of Motion

Force is equal to mass times acceleration. (F = ma)

The amount of thrust (force produced by a rocket engine) will be determined by the mass of gases created and how fast the gas escapes the rocket. The greater the rate at which the rocket fuel is burned and the faster the velocity of the escaping gas, the greater the thrust of the rocket engine.

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Background Material For Teacher

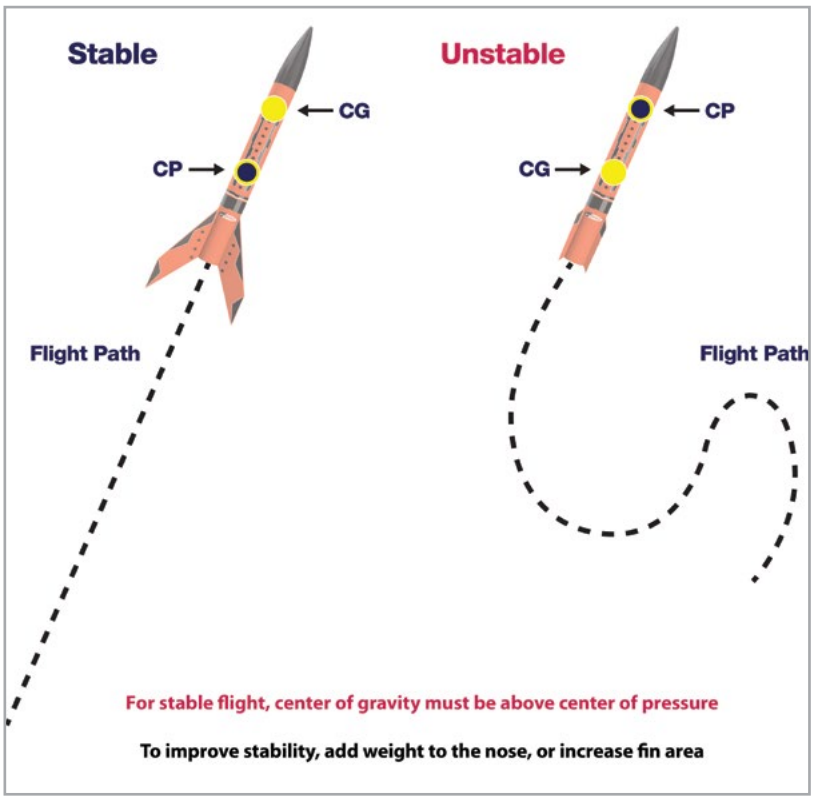
Newton's Third Law of Motion

For every action there is an equal and opposite reaction.

With rockets, the action is the expelling of gas out of the engine. The reaction is the movement of the rocket in the opposite direction. The rocket is pushed by the escaping gases produced by the chemical reaction of fuel and oxidizer combining in the combustion chamber.

Center of Gravity / Center of Pressure

The basic principle is that the center of gravity must be ahead of the center of pressure for the rocket to be stable. The **center of gravity (CG)** is the point at which the mass of the rocket is balanced because the weight forward from this point is equal to the weight to the rear of this point. (Think of this as balancing a pencil on your finger. The pencil will balance when there is an equal amount of mass on both sides of your finger.) The **center of pressure (CP)** is the point on the rocket at which half of the aerodynamic surface area is located forward and half to the rear.



Fins make the rocket fly straight. A rocket without fins will tumble around its CG (also called the balance point) when flying through the air like a balloon that is inflated and then let go. The balloon will fly erratically because it is uncontrolled. With fins, a rocket has more surface area behind the CG than in front. When the rocket is flying through the air, the air has more surface area to push against behind the balance point than in front because of the greater surface area provided by the fins. Therefore, the rocket tends to stabilize itself. The rocket will rotate until the nose is pointing forward in the air and the fins are pointing backward.

If you point a rocket straight up, the CP should be below the CG. This will allow the rocket to have a stable flight. You can accomplish this by adding fins (as noted above) or by adding mass to the front of the rocket. meaning if the rocket is pointed upward, the CP should be below the CG. Neutral stability is when the CG and CP are at the same point and the rocket's flight will be random. If the CP is in front of the CG (in other words, the surface area is greater towards the front or top of the rocket), then the flight will be unstable.

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Additional Resources

1. Power Points

- Mass vs. Weight Introduction PowerPoint

2. Student Design Portfolio

- PDF
- Google Doc
- Microsoft Word Doc

3. Videos

- NASA's Perseverance Rover Launch
- PocketLab Voyager

4. Links

- Green Eggs Instructions
- Instruction Manual for Pocket Lab Voyager
- NAR Rocket Safety Code
- Launch Day Guidelines
- Teaching Students to Interpret Graphs

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Preparation

Before the Activity

1. Prepare the Student Design Portfolios – print one per student or make available electronically.
2. Gather the materials needed for the straw rocket with enough supplies for each group.
3. Mark on the floor a "starting line" for testing.
4. It is highly recommended that you create and test your own straw rocket. This will allow you to problem solve any difficulties that may arise and will also allow you to have a 3-D model of the rocket for students to reference.
5. Assemble and display a Green Egg rocket and place it on a launch pad in a prominent place in your classroom.
6. Gather the materials needed for the model rocket with enough supplies for each group and have students prepare the rockets.
7. Find a safe launch site. Be sure to check with local and state regulations before launching. Contact Estes if you are unsure where to launch. **educator@estesrockets.com**
8. Review Launch Day Guidelines
9. Gather materials for launch, pennies for each group, an optional camera

Tips

- The primary goal of this project is to empower students to apply the Engineering Design Process.
- STEM learning offers open-ended solutions. Promote wild ideas!
- If some students have difficulty with their rockets, ask other students who are more successful to help.
- Be enthusiastic! The excitement you bring each day will help your students connect to the lesson.

Project Schedule Core Lesson (225+ minutes)

This lesson is based on 45-minute sessions and is designed to be highly adaptable to meet the needs of any program.

Step	(1) 45min	(2) 45 min	(3) 45 min	(4) 45min	(5) 45min	(6) 45min	(7) 45min
Ask							
Imagine							
Plan							
Create							
Test							
Improve							
Communicate							

Flightpath B = There are optional learning extensions for your students included. Within the daily lessons you will see options for extended learning under the Flightpath B activities. These are not required in order for your students to have successful STEM learning experiences.

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Ask: Identify & Define the Problem

Overview

- Activity 1: Pre-Assessment
- Activity 2: Read the Problem

Flightpath B (Optional learning Extensions)

- Activity 3: Vocabulary Presentation

Time	Materials Needed	Performance Expectations	Activities
45 Min.	Student Design Portfolio Mass vs. Weight Introduction PowerPoint	Articulate Newton's Second Law of Motion and provide examples.	**Introduce the project using the Mass vs. Weight Introduction PowerPoint** • Use the PowerPoint to instruct students on the difference between mass and weight and introduce Newton's Laws • This video is a great rocket launch example to show students. It is also imbedded in the PowerPoint • Video: NASA's Perseverance Rover Launch • Promote class discussions and use additional internet resources to help students understand these concepts. **Assign the Ask section of the Student Design Portfolio** **Activity 1: Pre-Assessment** • In the middle of the Mass vs. Weight Introduction PowerPoint, students will be prompted to complete this section. • They may not know all the answers yet. Encourage them to try their best and work with a partner/group if needed. **Activity 2: Read the Problem** • Students will read the problem that they are trying to solve and participate in a Think, Pair Share exercise to determine what fictional team member they agree with. • Lead a class discussion so students can share their answers.
45 Min. (Optional)	Student Design Portfolio Vocabulary Presentation	Students will create a presentation to learn unit vocabulary.	**Flightpath B (Optional Learning Extensions)** **Activity 3: Vocabulary Presentation** • Students will complete the Vocabulary Presentation. • Circulate and check in with student progress. • If students do not complete the assignment in class, you can chose to give students a workday or assign it for homework.

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Imagine: Brainstorm Solutions & Research Ideas

Overview

- Activity 1: Build a Straw Rocket
- Activity 2: Make a Prediction
- Activity 3: Collect Data
- Activity: 4: Reflect and Apply

Time	Materials Needed	Performance Expectations	Activities

90 Min.	Student Design Portfolio
	
	Classroom Spreadsheet Template
	
	Safety Goggles
	
	Paper, 8 ½ x 11
	
	Tape
	
	Scissors
	
	Straws
	
	Stopwatch
	
	Meter sticks
	
	Paper Clips
	
	Scale
		Conduct an experiment and display collected data to show the relationship between mass, and speed.
		
		Develop a model to generate data for repeated testing and modification of a proposed object, tool, or process to achieve an optimal design.
			Assign the Imagine section of the Student Design Portfolio
			• Ensure students have a good understanding of Newton's Laws.
			
			Activity 1: Build a Straw Rocket
			• Students will build and test straw rockets as part of their research on the effect of mass on a rocket's altitude, velocity and duration.
			• Show students the straw rocket you have built and demonstrate the safe way to fly the rocket.
			• Explain the instructions in the Student Design Portfolio thoroughly.
			• Encourage students to decorate their rocket if time permits.
			
			Activity 2: Make a Prediction
			• Guide the students in their development of a hypothesis and determination of their variables.
			• Be sure to stress to students that breath size is a hard variable to control but that you are asking them to attempt to blow the same amount each time.
			
			Activity 3: Collect Data
			• Before testing, ask students why it is important to have multiple trials (to ensure that the results are accurate, etc.).
			• Review the safety guidelines:
			  • Students will wear goggles when testing.
			  • Students will stand behind the line established by the teacher. Rockets are ONLY launched in one direction and only after the teacher gives instructions.
			  • While a student is blowing into the rocket, his/her partner is responsible for timing the duration of the flight and marking where the rocket lands.
			  • All rockets will be launched at 180* - straight.
			  • Students will not share rockets!
			• Launch 1
			  • Students will work through the instructions and record their data on the Launch 1 page in the Student Design Portfolio
			  • Classroom Management Tip: Ideally, only one student would test at a time, however, this is difficult to manage in a single class period. More than one student can test at a time if they are carefully distanced.
			• Add Mass
			  • Students will modify their straw rocket designs to increase the weight of the rocket

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			• Students should only add the paper clips to the nose of the rocket. This is a control. Explain to them how the Center of Gravity and the Center of Pressure must be situated to allow for a stable flight.
			• Launch 2
			  • After modification of the rockets has occurred, have students repeat the procedure from the previous activity and complete the questions on the worksheet.
			  • Allow students to make any adjustments they need (paper clips may fall off, etc.) and retest as time allows.
			• Graph
			  • Students will graph their data. If time permits, have students share their average velocities with you and enter these into a class spreadsheet.
			  • Conduct a class discussion about the results - what trends do they see? Was the flight of the rocket different? How? Encourage them to share their qualitative and quantitative data. Were there any outliers to the data- what caused these? How did the experiment connect to Newton's Second Law?
			
			Activity 4: Reflect and Apply
			• Students will complete the questions in their Student Design Portfolio

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Plan: Select & Sketch Idea

Overview

- Activity 1: Learn About the Pocket Lab
- Activity 2: Write a Hypothesis

Time	Materials Needed	Performance Expectations	Activities
30 Min.	Student Design Portfolio	Define the criteria and constraints of a design problem with enough precision to ensure a successful solution.	**Assign the Plan section of the Student Design Portfolio** • Remind students of their previous lesson with the straw rockets and its connection to Newton's Second Law. **Activity 1: Learn About the PocketLab** • Introduces students to the Pocket Lab through this video: YouTube video • Students can read the Instruction Manual for Pocket Lab Voyager if needed. **Activity 2: Write a Hypothesis** • Show students the example Green Eggs Rocket and identify the part of the rocket so student become familiar with the rocket they will be making. • Students will write their hypothesis and identify variables in their Student Design Portfolio • Remind students that their final Green Eggs rocket will need to carry the PocketLab so they will need to understand how mass will affect the rocket. • Students should be reminded that the mass of the Pocket Lab Voyager is a control. Their hypotheses will ALL be about increasing the mass adding pennies; therefore, the students should be specific about the amount of mass they will test compared to other groups.

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Create: Build a Model or Prototype

Overview

- Activity 1: Build Rocket
- Activity 2: Prep Rocket for Flight
- Activity 3: Review NAR Safety Code

Time	Materials Needed	Performance Expectations	Activities

90 Min.	Student Design Portfolio
	
	NAR Safety Code
	
	Green Eggs Rocket Kit
	
	C-11 3 Engines
	
	Exacto Knife
	
	Glue
		Develop a model to generate data for repeated testing and modification of a proposed object, tool, or process to achieve an optimal design.	**Review Constraints and Criteria Criteria**
			The Green Egg Rocket must
			• Reach a minimum altitude of 200 feet
			• The payload must include between 1 and 10 pennies.
			Constraints
			• The Green Egg Rocket may not be altered in any way other than the addition to the payload.
			• The Pocket Lab must be included in the payload
			• No more than 10 pennies may be added to the payload
			• Students will be limited in the amount of time to build the Green Egg Rocket up to teacher discretion (about 2 45-minute class periods.)
			• Students must follow the NAR Safety Guidelines during the launch.
			Client
			• International Space Station
			End User
			• Astronauts on the International Space Station
			
			Assign the Create section of the Student Design Portfolio
			Activity 1: Build Rocket
			• Students will work in small groups and follow the instructions to build their rocket
			
			Activity 2: Prep Rocket for Flight
			• All groups MUST add some mass to the payload area - the only rocket without additional mass will be the teacher rocket.
			• Students will weigh their rocket and payloads, including the Pocket Lab.
			  • Warn students that not all pennies have the same mass!
			  • Remind students that the Pocket Lab Voyager will require some padding around it to keep it stable and this padding is also part of their mass.
			• Students will them prepare their rocket for flight by adding recovery wadding, folding their parachutes and putting an engine in the rocket
			• Collect all finished rockets and put them in a safe place (we recommend a box) so they are ready for flight!
			
			Activity 3: Review NAR Safety Code
			• Prior to the launch be sure to review the launch safety requirements and describe how the launch will run.

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			Classroom Tips • Each group will be responsible for recording qualitative observations and the altitude data from their Pocket Lab Voyager. • Remind students that they will be timing their flights as well. • If available, taking a slow-motion video of the flight is a great way to analyze the flight afterwards

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Test: Collect Data & Evaluate the Solution

Overview

- Activity 1: Rocket Launch
- Activity 2: Review Data
- Activity 3: Evaluate Against Criteria

Time	Materials Needed	Performance Expectations	Activities
90+ Min	Student Design Portfolio Completed Green Eggs Rockets Lifetime Launch Systems Pocket Labs Stopwatches	Conduct an experiment and display collected data to show the relationship between mass, and speed. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success	**Assign the Test section of the Student Design Portfolio** **Activity 1: Rocket Launch** • Students will launch their rockets outside. • We recommend that you set up your launch site the day before launching. • It is helpful to have an alternate day chosen for rocket launching if weather conditions (wind, precipitation, etc.) require you to cancel the launch. **Activity 2: Review Data** • Students will calculate the average velocity once they return to the classroom. • They can then share their average velocities with you and enter these into a class spreadsheet. • Create a graph (A line graph is preferred) of the data. This will help students to better visualize and analyze the data.

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Improve: Optimize & Redesign the Solution

Overview

- Activity 1: Plan an Adjustment

Flightpath B (Optional learning Extensions)

- Activity 2: Relaunch!

Time	Materials Needed	Performance Expectations	Activities

5 Min.	Student Design Portfolio	Evaluate competing design solutions to determine how well they meet the criteria and constraints of the problem.	**Assign the Improve section of the Student Design Portfolio**
			
			Activity 1: Plan an Adjustment
			• Students will complete the Improve section in their Student Design Portfolio.
			• Conduct a class discussion about the results
			  • What trends do they see?
			  • How were the flights of the rockets different?
			  • How were they similar?
			  • What mass is best for altitude, length of time and velocity?

45 Min. (Optional)	Completed Green Eggs Rockets C11-3 Engines Lifetime Launch Systems Pocket Lab		**Flightpath B** **Activity 2: Relaunch!** • Students may redesign and relaunch their rockets. However, given the possible time constraints, this step may be skipped. • If you choose to do this step, students can fill out the additional questions included in the student portfolio.

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Share: Communicate the Results

Overview

- Activity 1: Claims-Evidence Reasoning

Flightpath B (Optional learning Extensions)

- Activity 2: Your Choice!

Time	Materials Needed	Performance Expectations	Activities
20 Min.	Student Design Portfolio	Evaluate competing design solutions to determine how well they meet the criteria and constraints of the problem.	**Assign the Share section of the Student Design Portfolio** **Activity 1: Claims-Evidence-Reasoning** • Students complete the final question using the Claims-Evidence-Reasoning template. This may also be assigned as homework.
45+ Min. (Optional)			**Flightpath B** **Activity 2: Your Choice!** • Review some extensions on the next page. If time permits, challenge your students to another activity!

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Extensions

- Instead of class discussions, you may have students' partner for a think, pair, share assignment.
- The link to the spreadsheet can be given to the students and they can enter the data themselves.
- Instead of having students add to a class spreadsheet, ask each group to present their own findings
- Have students create a skit or make a video that explains the findings
- Ask students to create an advertisement that highlights why their rocket is the one to choose for the best results
- Have students write up an interview with a fictitious astronaut who explains all the things they need the rocket to carry up to the ISS
- Have students graph the data themselves from each of the groups.

Differentiation

For students who need additional assistance

- Click on Closed Captioning in the Pocket Lab video to increase understanding
- You may wish to pre-cut the materials to eliminate the need for measuring and the fine motor skills required for cutting.

For students who wish to further investigate

- Encourage them to try different positions for the paper clips to see the effect of mass on different parts of the straw rocket. Remind them that this will affect the Center of Gravity (see Teacher Background information)
- Have them conduct additional tests that alter the CG and CP of the rocket. If they are unable to test this, have them write out their procedure and rationale.

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Assessment 1:
Claims-Evidence-Reasoning

Using this Claims- Evidence-Reasoning template below, answer the question, 543

Does the mass of a model rocket affect the altitude, velocity and duration of the rocket's flight?

Claim A conclusion that answers the original question		• Scientifically accurate • Completely answers the question • Common inaccurate claim(s) are clearly addressed.
Evidence Scientific data that supports the claim		• The data are scientifically appropriate to support the claim. • The data are thorough and convincing – enough details and evidence provided. • Proper units are used in data • Shows with evidence why alternate claims do not work
Reasoning A justification that links the claim and evidence		• Reasoning clearly links evidence to claim • Shows why the data count as evidence by using appropriate scientific principles • There are sufficient scientific principles to make links clear between claim and evidence

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Assessment 2:
Does Mass Matter Quiz

Name: _____ **Class:** _____ **Date:** _____

1. **Newton's 1st Law states?**
   a. For every action there is an equal and opposite reaction
   b. Force = mass times acceleration
   c. For every action, there is an equal and opposite reaction

2. **Which of the following is true about Newton's 2nd Law?**
   a. If something has a greater mass, but the same acceleration, the force will increase.
   b. If something has a greater mass, but the acceleration decreases, the force will increase.
   c. If the mass of something decreases and the acceleration decreases, the force will increase.
   d. If the mass of something stays the same and the acceleration increases, the force will increase

3. **Which of the following correctly explains the difference between mass and weight?**
   a. Mass and weight will not change if you travel to the Moon
   b. Mass will stay the same, but weight will decrease if you travel to the Moon.
   c. Weight will stay the same but mass will decrease if you travel to the Moon.
   d. Mass will stay the same but weight will increase if you travel to the Moon.

4. **How is the launching of a rocket demonstrate Newton's 3rd Law?**
   a. There is a force that propels the rocket upwards and it is related to the mass and velocity of the rocket.
   b. There is no movement of the rocket until it is acted on by an unbalanced force.
   c. A rocket needs to have fuel in order for it to launch into space.
   d. The engine is the ACTION and the rocket launching is the REACTION.

5. **Which of the following statements is true?**
   a. Inertia is how likely an object is to start moving, but once the object starts to move it is no longer called inertia.
   b. Acceleration = force time mass
   c. Action / Reaction forces are always equal.
   d. Newton's 4th Law is about the conservation of momentum.

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Assessment 2:
Answer Key

Name: _____ **Class:** _____ **Date:** _____

1. **Newton's 1st Law states?**
   a. For every action there is an equal and opposite reaction
   b. Force = mass times acceleration
   c. For every action, there is an equal and opposite reaction

2. **Which of the following is true about Newton's 2nd Law?**
   a. If something has a greater mass, but the same acceleration, the force will increase.
   b. If something has a greater mass, but the acceleration decreases, the force will increase.
   c. If the mass of something decreases and the acceleration decreases, the force will increase.
   d. If the mass of something stays the same and the acceleration increases, the force will increase

3. **Which of the following correctly explains the difference between mass and weight?**
   a. Mass and weight will not change if you travel to the Moon
   b. Mass will stay the same, but weight will decrease if you travel to the Moon.
   c. Weight will stay the same but mass will decrease if you travel to the Moon.
   d. Mass will stay the same but weight will increase if you travel to the Moon.

4. **How is the launching of a rocket demonstrate Newton's 3rd Law?**
   a. There is a force that propels the rocket upwards and it is related to the mass and velocity of the rocket.
   b. There is no movement of the rocket until it is acted on by an unbalanced force.
   c. A rocket needs to have fuel in order for it to launch into space.
   d. The engine is the ACTION and the rocket launching is the REACTION.

5. **Which of the following statements is true?**
   a. Inertia is how likely an object is to start moving, but once the object starts to move it is no longer called inertia.
   b. Acceleration = force time mass
   c. Action / Reaction forces are always equal.
   d. Newton's 4th Law is about the conservation of momentum.

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