Exploring Force and Motion with Stomp Rockets®

Teacher Lesson Plan #2

Key Questions

- How does the stomping force affect the rockets flight?

Grade Levels
3-12
40 - 50 minutes

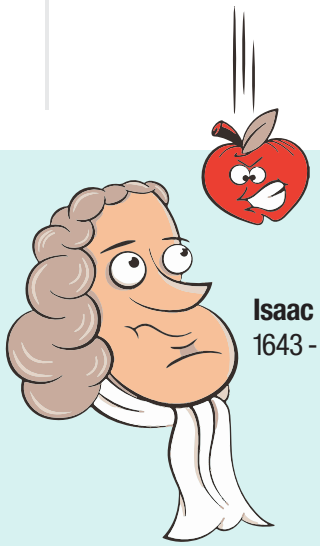
Objectives: Students will...

- Observe and describe the flight of an air pressure-powered rocket
- Use observations to make inferences regarding the reason for variations in rocket performances
- Measure the duration of an object's flight using a stopwatch
- Measure the distance an object travels due to an applied force
- Describe the relationship between force and motion

Background Information

Isaac Newton, born in England on Christmas day in 1642 (the year Galileo died) refined Galileo's Principle of Inertia in terms of unbalanced forces and made it his first law of motion.

Newton's First Law of Motion: In the absence of an unbalanced force, an object at rest remains at rest, and an object already in motion remains in motion with constant speed on a straight line path. **Newton's Second Law of Motion:** The relationship of inertia to force and acceleration is given in Newton's second law of motion. The greater the net force applied to an object, the greater its acceleration, but the more mass, the less it accelerates. (given the same applied force).



Isaac Newton
1643 - 1727

$$a = \frac{F}{m}$$

National Science Education Standards

Science as Inquiry

- Identify questions and concepts that guide scientific investigations
- Design and Conduct Scientific Investigations

Physical Science

- Motion and Forces

History & Nature of Science

- Science as a human endeavor
- Historical Perspectives

Stompin' Science Definitions

Force:
A push or pull, any influence that tends to accelerate or decelerate an object

Acceleration:
The rate at which velocity is changing

Preparation

Materials - per groups of 3

- 1 Ultra Stomp Rocket® Launch Stand and Tube Assembly (included in kit)
- 2 Ultra Stomp Rockets® 1 Stopwatch
- 1 Clipboard or hard writing surface

Materials - Supplemental

- Rope, 50 feet, one inch diameter, (designates firing line and safety zone)
- Rubber cones, 10 - 12 twelve-inch safety cones (designates groups' launching areas and distance measuring intervals)
- Long measuring tape

Getting Ready

Locate an area of the schoolground with a large open field. Stretch the rope out to form a firing line. Place rubber cones at equal intervals along the firing line for groups to place their Launch Stands. Assemble the Launch Stand for the younger students. Using the measuring tape, place additional rubber cones at equal intervals (ex. 10 meters) out from the firing line for students to estimate the distance traveled by the rocket.

Management

a. Students work in groups of three.
b. Limit each group to two rockets.
c. Have students rotate roles: Launcher, Timer, Recorder, Retriever.

Procedure

1. Use "Exploring Force and Motion with Stomp Rockets®" to introduce the activity.
2. Review how to launch rockets with the Launch Stand and Stomp Pad.
3. Review the safe launch procedure.
4. Divide students into groups of three and distribute the materials.
5. Help groups select Method #1 or Method #2 for their stomping procedure. If students design their own method, check their procedure for obtaining varying strengths of the stomping force .
6. Proceed to launch area. Review safety procedures.

   Launch away!
7. Complete as many trials (launches) as time permits. (Suggestion: Make each student responsible for recording five different trials. Total number of trials per group = 15.)
8. Upon returning to the classroom, discuss the teams' results and address the questions listed in their assignment.

Compare the time in the air and the distance traveled to the amount of stomp force used.

Do you see a relationship? Explain. (The greater the force the greater the total time in the air and therefore the rocket travels a greater distance. This relates directly to **Newton's Second Law of Motion**, a=F/m. Increasing the force on an object causes it to accelerate.)

Does the launch speed appear to increase or decrease as the force increases?

(Launch speed increases as the force increases. Help students to realize that this is what Isaac Newton stated in his Second Law of Motion. He defined force as anything that can accelerate an object. The greater the force, the greater the acceleration it produces.)

Describe two examples where force and changes in speed are related.

(Answers will vary. Examples include: the harder kick on a ball the faster it accelerates, a bigger car engine produces a faster acceleration, bigger pushing force with your legs produces a faster running speed, etc.)

Going Further

1. Have students investigate other toys in which the force can be varied to produce a greater acceleration (e.g., wind-up rubber band toys, water-pressure rockets, fully charged battery powered toys versus weak batteries).
2. Encourage students to think of other variables that would affect acceleration (e.g., mass).

Stompin' Science Notes

Stompin' Science Notes

Name _____ Class _____ Date_____

Stompin' Science Lab #2

Exploring Force and Motion with Stomp Rockets®

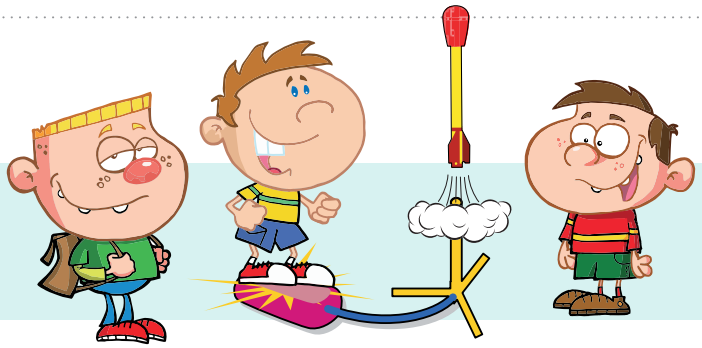
Key Question:

How does the stomping **FORCE** affect a rocket's flight? My Theory:

Materials:

For groups of 3 students:

- 1 Stomp Rocket® Launcher and 2 Stomp Rockets®
- 1 Clipboard
- 1 Stopwatch



1. Decide how your group will produce a **SMALL, MEDIUM,** and **LARGE** stomping force for your launch. You may choose from one of the methods below or you may write your own.

Select and (circle) a launch method: **Method #1** **Method #2** **Method #3**

Method #1: Three-Person Stomp - Each group member will take a turn stomping on the Launch Pad. One person must apply a light stomp, another person a medium stomp, and the last group member a large forceful stomp.

Method #2: One-Person Stomp - Pick one person to be the stomper. This person must be able to vary their stomping force. Have them practice jumping straight up to three different heights. Small height = small force, medium height = medium force, large height = large force.

Method #3: Design Your Own -

2. Using the stopwatch, **time** the rocket from the instant you stomp on the launching pad to when it hits the ground.
Using the data table of the back of this sheet, record the **time (t)** and the **stomp force (F)** used.

3. Estimate the **distance** your rocket traveled by comparing its landing spot to the marking cones or flags your teacher placed on the field (cones or flags are placed 10 meters apart). Record this **distance (d)** in the data table.

Exploring Force Data Chart

Key Question: How does the stomping force effect a rocket's flight?

Trial Number	**Force** small/medium/large	**Total Time** seconds	**Distance** meters	**d x 3.3** distance in feet

Stompin' Science Questions

1. Compare the **time in the air** and the **distance traveled** to the **amount of stomp force** used. Do you see a relationship? Explain.

2. Does the launch speed appear to increase or decrease (circle one) as the force increases?

3. Describe two examples where force and changes in speed are related.

Exploring Mass and Motion with Stomp Rockets®

Teacher Lesson Plan #3

Key Questions

- How does a rockets **mass** affect its flight?

Grade Levels
3-12
40 - 50 minutes

Objectives: Students will...

- Observe and describe the flight of an air pressure-powered rocket
- Use observations to make inferences regarding the reason for variations in rocket performances
- Measure the duration of an object's flight using a stopwatch
- Measure the distance an object travels due to an applied force
- Describe the relationship between force, mass and motion

National Science Education Standards

Science as Inquiry
- Identify questions and concepts that guide scientific investigations
- Design and Conduct Scientific Investigations

Physical Science
- Motion and Forces

History & Nature of Science
- Science as a human endeavor
- Historical Perspectives

Background Information

Acceleration occurs when force is applied to an object that is greater than the object's inertia (resistance to changes in motion, measured by an object's mass) and any frictional forces present. An ant jumping up and down on the Stomp Rockets® launch pad cannot cause it to accelerate. The force an ant can exert on a launch pad is too small to overcome the combination of the friction between the rocket and the launch tube and the rocket's inertia.

If an applied force does not change, then an object's acceleration (whether speeding up or slowing down) will decrease if the object's mass increases. The same force applied to twice as much mass results in only half the acceleration.

Stompin' Science Definitions

Two definitions of Mass:
The mass of an object is:
1) The quantity of matter in an object;
2) The resistance to change in motion of an object.

Preparation

Materials - per groups of 3

- 1 Ultra Stomp Rocket® Launch Stand and Tube Assembly (included in kit)
- 2 Ultra Stomp Rockets®
- 1 Ball of clay (45 grams)
- 1 Balance with measuring masses
- 1 Stool or chair
- 1 Clipboard or hard writing surface

Materials - Supplemental

- Rope, 50 feet, one inch diameter, (designates firing line and safety zone)
- Rubber cones, 10 - 12 twelve-inch safety cones (designates groups' launching areas and distance measuring intervals)
- Long measuring tape

Getting Ready

Locate an area of the school ground with a large open field. Stretch the rope out to form a firing line. Place rubber cones at equal intervals along the firing line for groups to place their Launch Stands.

Using the measuring tape, place additional rubber cones at equal intervals (ex. 10 meters) out from the firing line for students to estimate the distance traveled by the rocket.

Management

a. Students work in groups of three.
b. Limit each group to two rockets.
c. Have students rotate roles: Launcher, Timer, Recorder, Retriever.

Procedure

1

Use "Exploring Mass and Motion with Stomp Rockets®" to introduce the activity.

2

Review how to launch rockets with the Launch Stand and Stomp Pad.

- Make sure students realize the importance of trying to reproduce the same launching force for each trial. (See Methods #1 and #2 on student sheet.)

3

Help groups select Method #1 or Method #2 for their stomping procedure.
If students design their own method, check their procedure for obtaining the same stomping force for each launch.

4

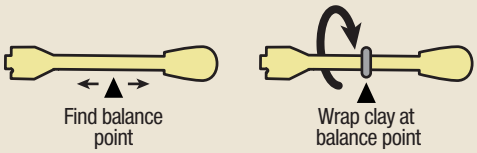
Distribute a large lump of clay (45 grams) to each group. Have students shape the clay into two balls. Clay Ball #1 should be about 2.0 cm in diameter with a mass of approximately 15 grams. Clay Ball #2 should be about 3.0 cm in diameter with a mass of approximately 30 grams.

5

Have students use the balance and masses to measure the mass of one rocket (approximately 15 grams).

6

To attach the clay to the rocket, have students find the balancing point of your rocket by balancing it horizontally on two fingers. Roll the clay balls into a longer cylinders about 10 cm long and wrap each of the clay cylinders around the balancing point of the rockets.



7

Proceed to launch area. Review safety procedures. **Launch away!**

8

Complete as many trials (launches) as time permits. (Suggestion: Make each student responsible for recording five different trials. Total number of trials per group = 15.)

9

Upon returning to the classroom, discuss the teams' results and address the questions listed in their assignment.

Compare the time in the air and the distance traveled to the amount of mass used.

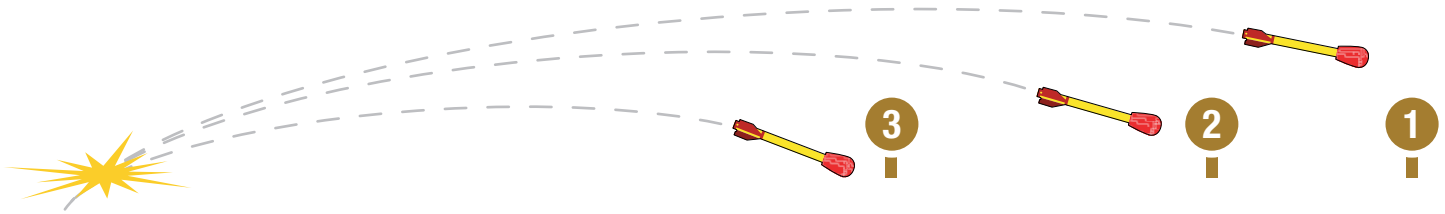
Do you see a relationship? Explain. (The greater the mass of the rocket the more force it takes to accelerate it. This relates directly to **Newton's Second Law of Motion**, a = F/m.)

Does the launch speed appear to increase or decrease as the mass increases?

(If the launch force remains constant, launch speed will decreases as the mass increases.)

Describe two examples where changing the mass of an object affects it's acceleration.

(Answers will vary. Examples may include: increasing the mass carried by a pick-up truck decreases it's ability to accelerate, carrying a heavy backpack reduces someone's ability to accelerate, etc.)



Going Further

Have students investigate other toys or games where changing the mass affects an object's acceleration (e.g., water-pressure powered rockets, mass of chosen bowling ball, baseball versus a softball).

Stompin' Science Notes

Name _____ Class _____ Date_____

Stompin' Science Lab #3

Exploring Mass and Motion with Stomp Rockets®

Key Question:

How does the stomping **MASS** affect a rocket's flight? My Theory: .....

.....

.....

Materials:

For groups of 3 students:

- 1 Stomp Rocket® Launcher and 2 Stomp Rockets®
- 1 Balance with measuring masses
- 1 Ball of clay (45 grams)
- 1 Stool or chair
- 1 Clipboard
- 1 Stopwatch

1. Decide how your group will produce the **SAME** stomping force for your launch. You may choose from one of the methods below or you may write your own.

Select and (circle) a launch method: **Method #1** **Method #2** **Method #3**

Method #1: One Person Jump & Stomp - Pick one person to be the stomper. This person must be able to use the SAME stomping force for each launch. Have them practice jumping straight up to the same height each time to achieve the same landing or launching force.

Method #2: One Person Drop & Stomp - Pick one person to be the stomper. This person must be able to safely step off of a small stool or chair and land on the launch pad. Have them practice stepping straight off the chair and landing on the launch pad (WITHOUT jumping up).

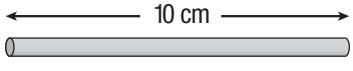
Method #3: Design Your Own - .....

.....

2. **Shape the clay into two balls.**
   Clay Ball #1 should be about 2.0 cm in diameter with a mass of 15 grams.
   Clay Ball #2 should be about 3.0 cm in diameter with a mass of 30 grams.

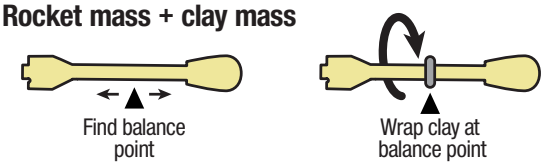
3. Measure the mass of one rocket. **Mass of** Stomp Rocket® = ...

4. **Rolling the Clay:** Roll the clay balls into long cylinders about 10 cm long.



5. **Attaching Clay to the Rocket**: Balance the rocket horizontally across two fingers. Wrap each of the clay cylinders around the balancing point of each rocket and press the ends together to form a clay ring.

6. Using the stopwatch, **time** the rocket from the instant you stomp on the launching pad to when it hits the ground. **Using the data table below,** record the **time(t)** and the total **mass (m)** of the rocket. **Total mass = Rocket mass + clay mass**



6. Estimate the **distance** your rocket traveled by comparing its landing spot to the marking cones or flags your teacher placed on the field. Record this **distance (d)** in the data table. (Multiply your distance in meters by 3.3 to convert it to feet.)

Stomp Rocket® Mass Data Table

Trial Number	**Total Mass** grams	**Total Time** seconds	**Distance** meters	**d x 3.3** distance in feet

Post-Launch Questions

1. Compare the **time in the air** and the **distance traveled** to the **total mass of the rocket** launched. How does a rocket's **mass** affect it's flight? Explain.

2. Does the launch speed appear to increase or decrease as the **mass** increases?

3. Describe two other examples where changing the **mass** of an object affects it's acceleration. (Hint: Check out the picture below.)