TEACHERS Serving TEACHERS!®

Educational Innovations Inc.®

# Rocket Balloons

RKT-135, RKT-140, RKT-145

## Some background:

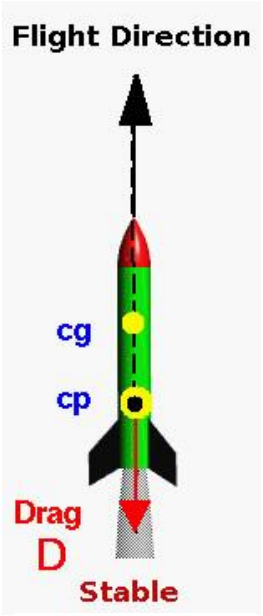
Newton's Three Laws of Motion are essential to rocket science. Exploring the many variables related to the Rocket Balloon's pre-launch, launch, flight, and recovery will give your students a chance to appreciate these important laws in a tangible and engaging way. When a real rocket is launched, the burning fuel and expansion of gases cause the rocket to move in a direction opposite from the thrust coming from the engines. In this activity, the thrust for the balloon is caused by the air being propelled out of its neck. What makes our Rocket Balloons so special is their stability. In fact, our Rocket Balloons have everything to do with real rocket science.

## How does it work?

Students will conduct trials launching the Rocket Balloons in the safety of the classroom. Among other things, they will learn that the stability of a rocket in flight is paramount.

The **Center of Pressure** (CP) is the point at which the aerodynamic forces on a rocket in flight are centered. However, the Center of Pressure should not be confused with **Center of Gravity** (CG).

CG is the center of the mass or weight of the rocket. For a rocket to be stable, the CP must be behind the CG. The nose of the Rocket Balloon is perfectly weighted in such a manner that the balloon is much more stable due to the forward position of the CG. This design gives the balloon a straight and true flight. The drag of the balloon and its weight, after all the air is expelled, is what slows the Rocket Balloon and returns it back to Earth.




A stable rocket has its center of pressure (cp) behind the center of gravity (cg).

**Image Credit: NASA**

When a rocket is in flight, four forces act on it: **weight**, **thrust**, **lift** and **drag**.

1. The amount of **weight** depends on the mass of all the parts of the rocket and gravity.
2. The rocket's propulsion system causes **thrust**.
3. **Lift** is not as significant a force on a rocket as it is on an airplane.
4. **Drag** is the aerodynamic force that works against the movement of a rocket caused by the friction of the air.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# Rocket Balloon Experiments

## Get to know Newton's Three Laws of Motion

**Newton's First Law of Motion** states that an object at rest will remain at rest unless acted on by an unbalanced force. An object in motion continues in motion with the same speed and in the same direction unless acted upon by an unbalanced force.

***How does it relate to rocket science?*** *A rocket will stay on the launch pad until a force blasts it off. Once in space, a rocket will continue to move unless retrorockets are fired to slow the rocket down.*

**Newton's Second Law of Motion** states that acceleration is produced when a force acts on a mass. The greater the mass (of the object being accelerated), the greater the amount of force needed (to accelerate the object). This is also expressed using the equation F = ma.

***How does it relate to rocket science?*** *The main forces acting on a rocket in flight are the weight of the rocket, the thrust of the rocket engines, and drag as the rocket moves through the air. At any time, the sum of these forces is equal to the current mass of the rocket times the current acceleration of the rocket, or F=ma. We say "current mass" because as a rocket burns off its fuel, the mass of the rocket will decrease.*

**Newton's Third Law of Motion** states that for every action force there is an equal and opposite reaction force. This law is also known as "the law of action and reaction."

***How does it relate to rocket science?*** *A rocket can lift off from a launch pad only when it expels gas from its engine. The rocket pushes against the gas, and the gas in turn pushes against the rocket. Thrust is the force that causes the rocket to lift. In space, rocket engines are usually called "reaction engines" because the law of reaction causes the spacecraft to move in a direction opposite to the direction of the engine's thrust plume, which is the expanding gas coming from the back of the rocket.*

## Preview Our Rocket Balloons in Action

Our Rocket Balloons can be used by students of all ages and abilities. Check out a recent launch at an Educational Innovations workshop in this YouTube video:

***Watch our YouTube to see the Rocket Balloons in action!***

**https://youtu.be/nhOSubhUf9I**


## Activity 1: Blast Off!

Insert the straw or nozzle of the pump into the opening at the neck of the balloon. Pump or blow air into the balloon. Use a permanent marker to write a name on the side of the balloon. To build on prior knowledge, you might ask students to use historic names like Redstone, Titan, Delta, and Atlas —or let them be original and make up their own rocket name! Fly the Rocket Balloons and enjoy a class full of enthusiasm and wonder.

### Guiding questions for this lab:

*What makes the Rocket Balloon fly?*
*What causes the noise emitted from the Rocket Balloon?*

## Activity 2: Say It Like Newton?

After students have experimented with the Rocket Balloons, have them draw its phases of flight (pre-launch, launch, flight, and recovery). Ask students, "How would Sir Isaac Newton explain this rocket based on his three Laws of Motion?" For younger learners, you may want to spend time helping them with interpretation. Have them label their diagram with Newton's Three Laws of Motion. After completing their diagrams, students in middle and upper grades can collaboratively create a chart as a class. They should fill in the laws and the observations that support the laws, following this diagram:

| Newton's Laws | Brief Description of the Law | What did you observe in the pre-launch, launch, flight, and recovery of the Rocket Balloon that supports this law? |
|---|---|---|
| **First Law** | | |
| **Second Law** | | |
| **Third Law** | | |

## Activity 3: Motion, Fuel, and Flight Duration

Students can investigate how different volumes of air affect their Rocket Balloon's motion and duration of flight. Remind students of Newton's Third Law. Can students prove this by changing variables? **Prep Work:** This is best done outdoors in a field or empty parking lot. If you can't bring your class outside, use your school's gymnasium or the empty lunchroom. Work in teams of three. Use a permanent marker to write the rocket's name on one side. On the other side, use a meter stick to measure the length and divide the length into equal quarters. Make big marks that will be easy to see from a distance. Distribute the ***Motion, Fuel, and Flight Duration Lab*** worksheets on pages 4-5. The detailed lab instructions and their data collection during the investigation will give your students independence for this hands-on lab. It is intended for use with middle school students but can be modified for younger or older students.

### Guiding question for this lab:

*How does the amount of air in a Rocket Balloon affect the path and duration of flight?*

Name: _____

# Motion, Fuel, and Flight Duration Lab

## GUIDING QUESTION FOR PREDICTION:

How does the amount of air in a Rocket Balloon affect the path and duration of flight?

My prediction is: _____

_____

## MATERIALS:

1 Rocket Balloon per team (NOTE: You may need more than a single balloon.)
1 straw for each student or 1 balloon pump per team
Timer

## PROCEDURE:

1. Divide into groups of three. Each person will have a key responsibility for the lab. Agree upon which team member will perform which tasks:
   - Rocket Balloon Filler / Launch Specialist
   - Timer / Data Specialist
   - Rocket Balloon Spotter / Recovery Specialist
2. Gather materials and get ready to go to the launch site. When at the launch site, listen for instructions, stay with your group, and follow all school safety rules.

## AT THE LAUNCH SITE

3. The **launch specialist** inserts the straw or nozzle of the pump into the opening at the neck of the balloon.
4. Pump or blow air into the balloon to the ¼ mark on the Rocket Balloon. Pinch the opening tight with your fingers to prevent air from leaking out.
5. Hold the Rocket Balloon directly in front with the opening faced downward. Count down "5, 4, 3, 2, 1... ignition!" Release the Rocket Balloon. The **timer/data specialist** starts the timer at the "ignition" command.
6. The **spotter/recovery specialist** carefully follows the Rocket Balloon and yells "Touch Down" when it lands on the ground.
7. The **timer/data specialist** halts the timer when Touch Down occurs.
8. The **spotter/recovery specialist** brings the Rocket Balloon back to the team.
9. Data is recorded on the data sheet (on the next page). The team can discuss the movement of each launch and record qualitative data with pictures or brief descriptions in the trajectory box on the Motion, Fuel and Flight Duration data sheet.
10. Repeat step 3-9 two more times, so you have a total of three flights for the different fuel amounts.
12. Calculate the average time for each fuel amount.
13. Graph the data on a bar graph. Your data analysis and conclusion should include evidence from your investigation and show knowledge of Newton's Laws of Motion.

Name: _____

# Motion, Fuel, and Flight Duration Lab

**Data Collection:**

**1.** Fill in the time from each of your flights in the Data Table.

| Amount of Air | Trial 1 | Trial 2 | Trial 3 | Average Time | Trajectory of Rocket Balloon |
|---|---|---|---|---|---|
| ¼ full | | | | | |
| ½ full | | | | | |
| ¾ full | | | | | |
| full | | | | | |

**2.** Make a bar graph comparing the average amount of time the Rocket Balloon was airborne to the amount of air fuel in the Rocket Balloon.

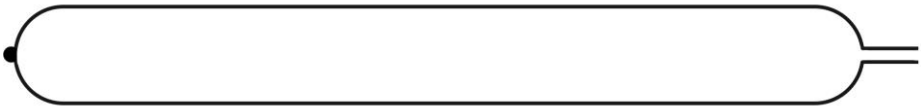
| Time Aloft | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | ¼ | ½ | ¾ | Full |

**Amount of Air**

**Data Analysis:**

**3.** On the back of this page, describe how the amount of air fuel in the Rocket Balloon affected the amount of time it was airborne.

**4.** Below is a diagram of the Rocket Balloon. Use arrows to show the action and reaction forces that caused the Rocket Balloon to fly.



**Conclusion:**

**5.** On the back of this page, describe how the science of a Rocket Balloon's flight is similar to a "real rocket."

**6.** On the back of this page, describe a real life experience where you saw the action and reaction forces in action.

# Take Your Lesson Further

**As science teachers ourselves, we know how much effort goes into preparing lessons. For us, "*Teachers Serving Teachers*" isn't just a slogan—it's our promise to you!**

**Please visit our website for more lesson ideas:**

**TeacherSource.com/lessons**

**Check our blog for classroom-tested teaching plans on dozens of topics:**

**http://blog.TeacherSource.com**

To extend your lesson, consider these Educational Innovations products:

**Mighty Seltzer Rocket** (RKT-555)
Five, four, three, two, one, LIFT OFF! This cleverly designed rocket with nose cone and fins will travel 20 to 30 feet into the air. Simply pour in water, drop in a seltzer tablet, replace the end cap, and the rocket is prepared for launch. To activate, simply invert the rocket, place it on a flat surface and move away. The rocket is 10 cm (4 in.) long. Adult supervision and eye protection required. Not for indoor use.

**Seismic Accelerator** (SS-150)
Several balls are threaded on a wire. When the apparatus is dropped straight downward onto a hard surface, the top ball can rebound to a height equal to five times the original drop. WOW! Leads into an interesting discussion of what has happened due to the Law of Conservation of Energy. Comes with safety glasses.

**Reaction Rocket** (RKT-625)
Appearances can be deceiving. This rubber ball launcher and foam rocket may look simple, but they're a sure-fire way to provoke a WOW reaction—and introduce students to Newton's Laws. Hold the launcher by its straw and drop straight down onto a hard surface. The rocket shoots up dramatically higher than its original drop height. Explaining energy conversion was never this easy... or this much fun! Comes with one launcher, two rockets. Class Kit includes 15 launchers and 40 rockets.