



LESSON OF THE MONTH:

## PAPER ROCKETS (ROCKETRY)

### Title: Paper Rockets (Rocketry)

#### CONTENT AREA:

Physical Science - Engineering

#### GRADE LEVEL:

Middle School / High School

#### STANDARDS:

- Science as Inquiry
- Physical Science - Position and motion of objects
- Science/Technology - Abilities of technological design

#### PURPOSE:

Students will apply the four forces of flight by constructing a rocket that launches to a minimum altitude of 50 feet. Students will determine the altitude by using the maximum altitude formula.

#### LENGTH OF TIME:

45-60 minutes

#### MATERIALS:

Paper, Index Cards, 30cm length of PVC pipe or any tube with a  $\frac{1}{2}$  diameter, Clear Tape, Scissors, Markers, Student Sheet 1: Parts of the Rocket, Student Sheet 2: Paper Rockets, Resource Sheet 1: Rocket Launcher, Stop Watch, Calculator



#### Fast Facts Four Forces of Flight

- 1) **Thrust**- pushes the rocket through the air
- 2) **Lift**- keeps the rocket in the air (stability)
- 3) **Weight**- gravity tries to pull the rocket back to Earth
- 4) **Drag**- the amount of air that pushes back on the rocket as it flies

#### Parts of a Rocket

- 1) **Nose Cone**- shaped to offer minimum resistance
- 2) **Shaft**- main body of the rocket
- 3) **Fins**- provide lift and keeps the rocket stable as it flies through the air.



#### **Note to Teacher:**

Before class begins, construct the Rocket Launcher using the directions on Resource Sheet 1 and review the launching instructions. Determine a safe location to launch the paper rockets.

### **WHOLE GROUP:**

1. Introduce the four Forces of Flight using the information in the Fast Facts.
2. Pass out Student Sheet 1. Point out the three main parts of the rocket and explain why they are important. Also, point out the different fin shapes that a rocket may have (shown at the bottom).
3. Inform the students that they will be making their own paper rocket similar to the one shown on Student Sheet 1 with a goal of launching it to an altitude of at least 50 feet.
4. Pass out Student Sheet 2 to the students. Go over the directions and demonstrate how to make a paper rocket.
5. Remind the students of the four forces of flight and how each affects rocket altitude. They need to keep this in mind because they have to construct their rocket to reach an altitude of at least 50 feet.

### **INDIVIDUAL:**

1. Ask each student to construct their own rocket following the directions on Student Sheet 2.



#### **Note to Teacher:**

- **When students are designing their fins, mention that their fins should be identical. An easier way to make fins identical is to have students design one fin, cut it out, and then trace the remaining fins.**
- **When attaching fins emphasize the importance of having fins evenly spaced around the paper for lift (stability), and the importance of placing a piece of tape on the edge of the fins on both sides for strength.**

### **WHOLE GROUP:**

1. Once all students have finished constructing their rockets, gather the launcher and stopwatch, and take the class to the designated launching location. Students will need to bring their Student Sheet 2 and a writing utensil out to the launching area.
2. Before launching, designate one student to be a time keeper for all launches. See Resource Sheet 1 for timekeeping directions.
3. Demonstrate how to launch a paper rocket using Resource Sheet 1. Each student will be launching their own rockets.
4. Call up the first student to launch. After the launch, students should report to the time keeper for their launch time. Have students record their times (t) on Student Sheet 2.
5. Congratulate each student after his/her launch and ask students to retrieve their rocket.
6. Continue until each student has launched their rocket.
7. Following the same launching procedure, allow the students to launch their rocket one more time.

8. When the launching is finished, take the students back to the classroom and allow them time to complete Student Sheet 2. They will need to determine the altitude of their launches using the provided equation and answer the discussion questions.
9. After completing the activity, lead an open discussion with the students in which they share their responses to the discussion questions on the Student Sheet 2.

**FOLLOW-UP QUESTIONS:**

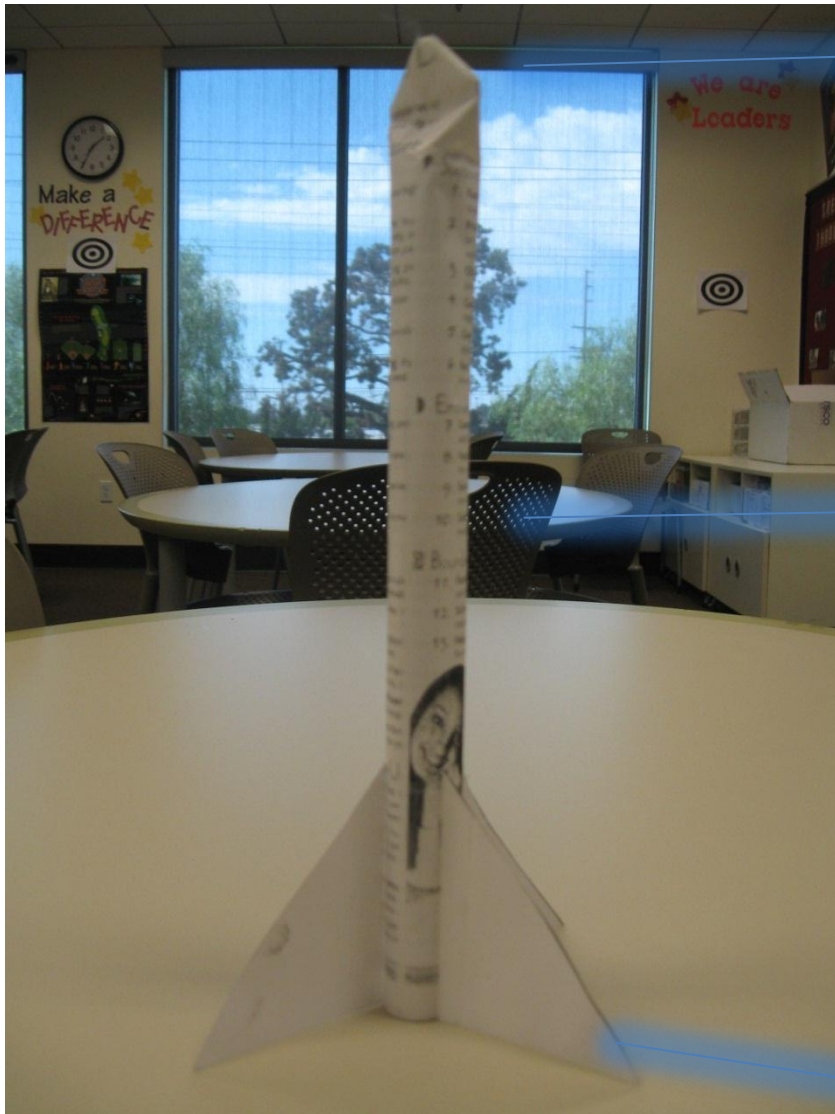
1. How do the four forces of flight affect the launch of a rocket?
2. Which part of rocket is most important in gaining altitude and why?

**EXTENSION ACTIVITIES:**

1. Have students make a second rocket for competition. Students can experiment with their rockets by varying the: shape, size, and number of fins/ rocket's center of gravity/ length of the rocket body/ shape of nose cone. The competition is to see which student can launch their rocket to the highest altitude.

**STUDENT SHEET 1:**

Parts of the Rocket

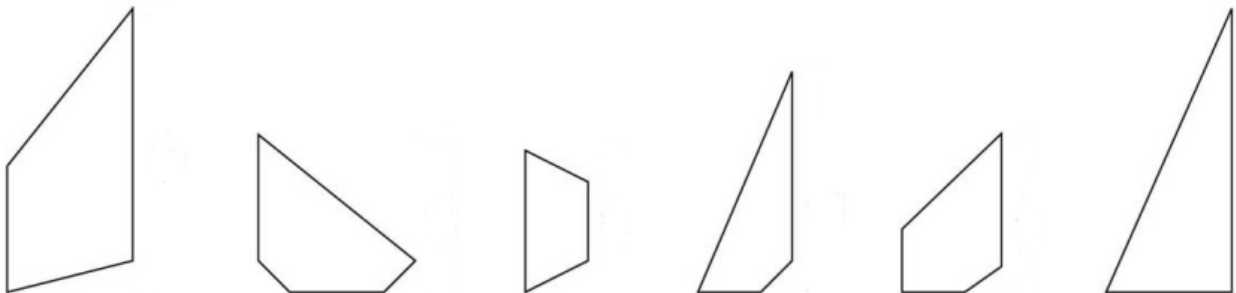


Nose Cone- shaped to offer minimum resistance

Shaft- main body of the rocket

Fins- Provide lift and keep the rocket stable as it flies through the air.

Example Fin Shapes:



## **STUDENT SHEET 2:**

### Paper Rockets

Introduction: Using the concepts of the forces of flight you will construct a rocket made of paper that will be launched to a minimum altitude of 50 feet.

#### Materials And Tools:

- 8 ½ x 11 paper
- 30cm length of PVC pipe or any tube with a ½ diameter
- Scissors
- Clear Tape
- 3x5 index cards
- Markers
- Stop Watch
- Calculator

#### Directions: Part I - Constructing the Rocket

1. Wrap a sheet of paper around a PVC pipe so it fits snugly. The sheet of paper can be wrapped lengthwise or widthwise. Be careful not to make it too tight or too loose because the rocket will have to fit back on the PVC pipe for launching. Once the paper is wrapped around the pipe, apply tape down the seam of the rocket so there are no gaps. Remove the rocket from the PVC pipe.
2. Flatten top of rocket and cut at an angle on both sides of the rocket to form the nose cone. The top of the rocket should look like a triangle. Apply tape to the top of the rocket so there are no holes in the nose, making it airtight.
3. Choose a fin shape and decide how many fins you want your rocket to have. Using an index card, draw the desired fins and cut them out. Make sure all of the fins are the same shape and size.
4. Using tape, attach the fins to the bottom of the rocket, making sure they are evenly spaced. Check that both sides of the fins are attached securely to the rocket.
5. Design your rocket to your liking using markers.
6. Launch rocket.

Part II - Measuring Altitude

1. After launching your rocket, report to the time keeper to obtain your time (t). Record the times of both launches in the table below.
2. Calculate the altitude of both launches using the formula below. Record your results in the table below.
3. The formula for calculating altitude is:

$$H = \frac{1}{2}gt^2$$

H= Altitude (Height)

g= 32ft/sec<sup>2</sup>

t= Time in seconds

Launch	Seconds to Maximum Altitude (t)	Altitude in Height (H)
1		
2		

Discussion Questions:

1. What was your highest altitude that your rocket launched?
2. What affected your rocket in flight?
3. How would you improve your rocket to make it launch to a higher altitude?

## RESOURCE SHEET 1:

### How to Build And Use a Paper Rocket Launcher



#### Materials:

- 2-liter plastic bottle
- 3 feet of clear flexible vinyl tubing with 1/2 inch inner diameter and 5/8 inch outer diameter (can be found at hardware store)
- Duct tape
- 2 feet of PVC pipe with 1/2 inch inner diameter

#### Build Instructions:

1. Remove cap from 2 liter bottle.
2. Insert 1 inch of flexible tubing into the bottle opening. Tape it in place with duct tape. Make sure the connection between the tubing and the bottle is airtight.
3. Insert the PVC pipe into the tube, by shaping the PVC pipe or heating up the tube. Tape the tubing and the PVC pipe together. Try to make the connection airtight.

## Launching Instructions:

### Time Keeper

Select a student volunteer to be the time keeper. This person will be responsible for timing all of the rocket launches. After each launch, the time keeper will need to report the times to the student launching and that student will need to record the information in the table on Student Sheet 2. Explain the steps below to the time keeper.

### Measuring Altitude with a Stopwatch

1. Reset stopwatch.
2. Start time when rocket is launched.
3. Stop time when rocket reaches its maximum altitude (when rocket starts curving down). Time should be in seconds.

### Launching the Rocket

1. Hold the PVC pipe straight in the air. One student at a time will insert their rocket on the PVC pipe. That same student will slam one foot on the 2 liter bottle to launch the rocket.
2. Reinflate the soda bottle after each launch by putting your hand around the end of pipe creating a mouthpiece and blowing into the PVC pipe.
3. Continue until each student has launched their rocket.