



# Math and Science with a Hot Air Balloon I

*Students will practice math and physical science skills while building and launching a model hot air balloon.*

---

## LESSON PLAN

### Learning Objectives

The students will:

- Build and launch a hot air balloon
- Identify the physical science principles involved
- Identify the math principles involved
- Time the duration of the flight and compute averages

### Purpose

The purpose is for students to practice math and physical science skills while building and launching a model hot air balloon.

### Background

The teacher may choose to cover the history and science of hot air balloons based on the grade level of students. Suggested readings are included in the resources section below.

Grade Levels: 5-8

#### [Ohio Learning Standards/Science \(2018\)](#)

##### *Physical Science*

[5.PS.1:](#) Amount of change in movement of an object is based on mass and the amount of force exerted.

[6.PS.3:](#) Kinetic and potential energy. Objects and substances in motion have kinetic energy.

[8.PS.1:](#) Objects can experience a force due to an outside field

[8.PS.2:](#) Forces can act to change the motion of objects.

#### [Ohio Learning Standards/Mathematics \(2018\)](#)

##### *Statistics and Probability*

[6.SP.4:](#) Summarize and describe distributions.

Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

[6.SP.5:](#) Summarize and describe distributions.

Find the quantitative measures of center (median and/or mean) for a numerical data.

[7.SP.2:](#) Summarize and describe distributions  
Statistical problem solving. Formulate Questions, Collect and Analyze Data.

[7.SP.3:](#) Summarize and describe distributions.  
Summarize data and interpret the mean.

#### Materials Required:

- Heavy paper or cardboard, scissors, sharp utility knife, pencil, ruler or yard stick, glue sticks, string, aluminum wire, Stop watch
- Fishing Rod and reel (optional for outdoor launch)
- Tissue paper-10 panels (each panel is 20" x 108") for each balloon
- Fan or heavy duty hand-held hair dryer to inflate balloon
- A camp stove with a section of duct pipe as the heat source
- Fire extinguisher

## Procedure

- Before construction of the balloon, explain that the tissue paper is very delicate and can be easily punctured or torn. The glue must be applied heavily but carefully. It should be applied in the same direction along the edges of the paper.
- Students will work in teams of four to six to construct each balloon. Kits are available on line or students may choose to build their own. Model hot air balloon launch equipment is also available online.
- Build the hot air balloon. (*Instructions are at the end of the lesson plan*)
- Launching instructions: An indoor launch in a gymnasium or auditorium is preferred. If you decide to launch outdoors, remember that cool, calm weather is best. Also, you are urged to use a fishing rod and reel and attach the line to the metal ring, so the balloon may be retrieved. Free flights can carry the balloons for miles and result in several safety hazards.
- Have a fire extinguisher available. Use a heavy-duty hair dryer as the heat source to inflate the balloon to check for any tears or gaps in the seams before launching. Use caution not to ignite the balloon or to overload the electrical circuits. Light a camp stove and allow it to burn a few minutes. Place a piece of duct pipe over the heat source. Have an adult hold the top of the balloon, while the instructor holds the bottom of the balloon about 6 to 8 inches over the stovepipe (see diagram to the right). After the air is sufficiently heated, the balloon will stand on its own, and you will feel the lifting ability. Invite each student to come forward and carefully and briefly grasp the ring using the thumb and forefinger of one hand. After all team members have tested the lift, count down and let the balloon go.
- Students will time the duration of the flight and record the data.



## Safety

Use caution when operating the hair dryer; it can get very HOT and may ignite the paper balloon. Have a fire extinguisher available. Use caution when operating the camp stove. Make sure students stand away from the stove when the teacher is heating the balloon. When launching the balloon outdoors, use a fishing rod and reel and attach the line to the balloon's metal ring, so the balloon can be easily retrieved. Free flights can carry the balloons for miles and result in safety hazards. You can also tether the balloon by attaching a roll of fishing line to the balloon and allowing it to unroll as the balloon rises.

## **Wrap-up**

- Students will compile the data for all the teams and determine the longest and shortest flight and team average. Students may graph the results.

## **Assessment/Evaluation**

Students should be evaluated on their ability to work cooperatively in groups and the accuracy of mathematical calculations.

## **Extensions**

Have students determine the surface area of the balloon and compare the duration of the flight in relationship to the surface area.

## **Resources:**

<https://www.space.com/16595-montgolfiers-first-balloon-flight.html>

[https://www.nasa.gov/pdf/544372main\\_PS1\\_Bag%20Balloon\\_C1\\_Final.pdf](https://www.nasa.gov/pdf/544372main_PS1_Bag%20Balloon_C1_Final.pdf)

<https://www.britannica.com/video/164692/ballooning-brothers-Montgolfier>

[https://www.nasa.gov/pdf/205702main\\_Bag\\_Balloons.pdf](https://www.nasa.gov/pdf/205702main_Bag_Balloons.pdf)

<https://www.youtube.com/watch?v=ABsVP41-EeY>

<https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/196758/lighter-than-air-flight/>

<https://www.nationalballoonmuseum.com/about/history-of-ballooning/>

<https://www.explainthatstuff.com/how-hot-air-balloons-work.html>

## **Buoyancy:**

<https://www.real-world-physics-problems.com/hot-air-balloon-physics.html>

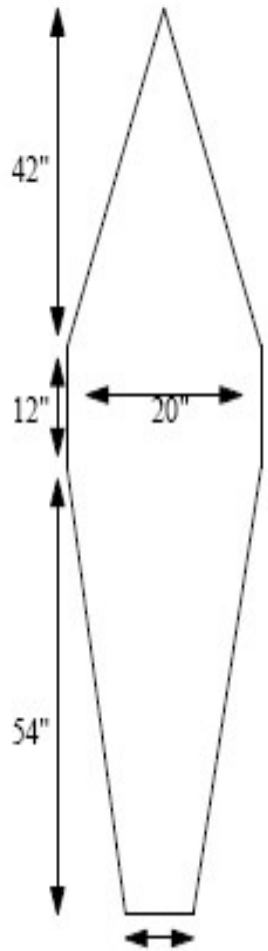
<https://www.ck12.org/physics/buoyancy/lesson/Buoyancy-MS-PS/>



## Instructions: Build a Hot Air Balloon

*Hot air balloon kits made from tissue paper are available at several different vendors searchable online. If not using a kit, following the instructions below:*

1. Using heavy paper or cardboard, draw and cut a template. (Figure 1)
2. Assemble tissue paper into 9 foot lengths or use a 9 foot length from a roll. (Each balloon requires 10 sheets of tissue paper, each 9 feet in length). This is the most time consuming portion of the activity.
3. Lay out 10 sheets of the 9 foot long tissue paper, placing each sheet exactly on top of the other. These sheets will become the panels of the balloon. Using the template and a sharp utility knife, cut all the panels at once. (A sharp knife is critical as the tissue paper will tear easily.) If possible, pre-cut the balloons for the students.
4. To begin construction, take two of the panels. Lay one panel on top of the other so that the bottom panel has  $\frac{1}{2}$ " or  $\frac{3}{4}$ " margin sticking out along the farther side of the top panel. (Figure 2)
5. Using a glue stick, spread a small amount of glue on the margin of the bottom panel, folding the margin over the top panel as you go along.
6. Place panel 3 on panel 2, letting the nearer margin of panel 2 stick out about  $\frac{1}{2}$ " to  $\frac{3}{4}$ " from beneath panel 3. Glue and fold the margin of panel 2 over panel 3. (Figure 3)
7. Using this method, alternate gluing the farther and nearer margins together. (Make a giant accordion.)
8. When all 10 panels are glued together, join the unglued edge of panel 1 with panel 10 and glue together in the same manner. (Be careful, as it is easy to glue all the edges together.) You now have a tissue-paper balloon with 10 panels.
9. Tie off the tissue paper balloon with a string about 5" from the top to hold the panels together. Tie securely, but avoid "snapping" it tight as it is possible to cut through the paper.
10. Gently open the balloon and make a ring out of lightweight aluminum wire to fit inside the bottom of the balloon. Hold it in place by folding the bottom of the balloon over the ring and gluing the paper in place.
11. Hold the balloon by the top and inflate it with a fan or a hand-held hair dryer so you can check for any tears or loose seams. Make any necessary repairs with glue and left-over tissue paper. (Hint: Tear a piece of paper for a patch, put glue on the patch, and then attach the patch to the balloon surface). Let the repair dry thoroughly. Now you are ready to launch.



Montgolfier Hot Air Balloon

Figure 1

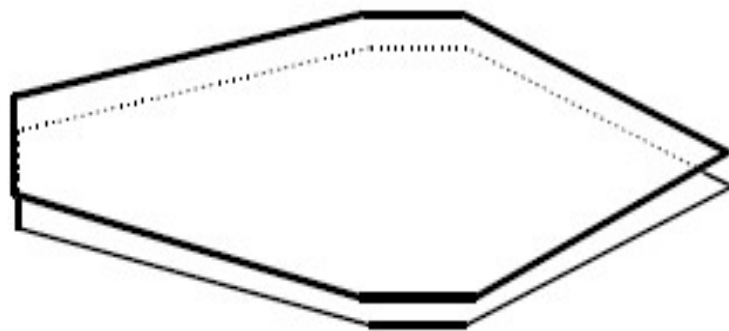


Figure 2

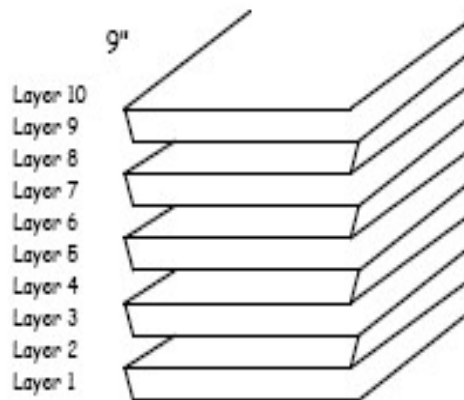


Figure 3