



Lesson Plan: Up, Up and Away with the Montgolfier Balloon

Grade Level: 4-8
Subject Area: Science, Math
Time Required: *Preparation:* 1 hour per balloon
Activity: 3 hours

National Standards Correlation:

Science (grades K-4)

- Science as Inquiry Standard: Abilities necessary to do scientific inquiry.
- Unifying Concepts and Processes Standard: Evidence, models, and explanation.
- Unifying Concepts and Processes Standard: Change, constancy, and measurement.
- Physical Science Standard: Position and motion of objects.

Science (grades 5-8)

- Physical Science Standard: Motions and forces.
- Unifying Concepts and Processes Standard: Evidence, models, and explanation.
- History and Nature of Science Standard: Nature of science.
- History and Nature of Science Standard: History of science.

Math (grades 3-5)

- Data Analysis and Probability Standard: Understand and apply basic concepts of probability.
- Data Analysis and Probability Standard: Develop and evaluate inferences and predictions that are based on data.
- Measurement Standard: Understand measurable attributes of objects and the units, systems, and processes of measurement.
- Measurement Standard: Apply appropriate techniques, tools and formulas to determine measurements.

Math (grades 6-8)

- Data Analysis and Probability Standard: Develop and evaluate inferences and predictions that are based on data.
- Measurement Standard: Understand measurable attributes of objects and the units, systems, and processes of measurement.
- Measurement Standard: Apply appropriate techniques, tools and formulas to determine measurements.



Summary: Students will construct and launch a Montgolfier hot air balloon.

Objectives: Students will:

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



Materials:

You will need:

- Tissue paper-10 panels (each panel is 20" x 108") for each balloon
- Glue sticks
- String
- Aluminum wire
- Fan or hand-held hair dryer to inflate balloon
- Heavy-duty hair dryer or a camp stove with a section of duct pipe as the heat source
- Fire extinguisher
- Stop watch

Special Instructions:

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.

Background:

This activity was originally developed by Norm Poff (NASA Aerospace Education Project) and has become the standard for teaching about hot air balloons.

Procedure:**A. Warm-up**

1. Provide some background on the history of the hot air balloon and the principles which cause hot air to rise.
2. 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.
3. Students will work in teams of four to six to construct each balloon.

B. Activity

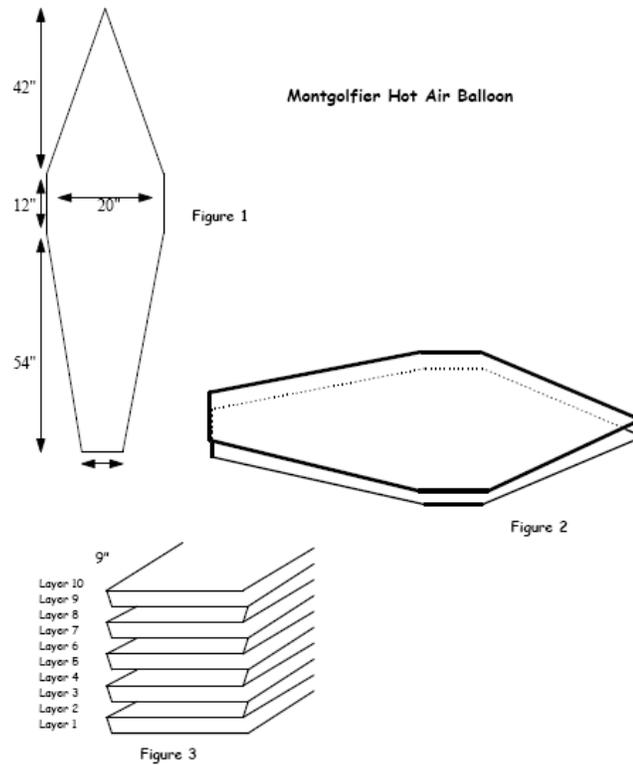
1. Using heavy paper or cardboard, draw and cut a template. (Figure 1)
2. Assemble tissue paper into 9 foot lengths or use a 9 foot length from a roll. (Each balloon requires 10 sheets of tissue paper, each 9 feet in length). This is the most time consuming portion of the activity.
3. Lay out 10 sheets 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. Spread a small amount of glue (glue sticks work the best) 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 it or 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.
12. 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.
13. Have a fire extinguisher available. Use a heavy-duty hair dryer as the heat source to inflate the balloon. Use caution not to ignite the balloon or to overload the electrical circuits. OR Have a fire extinguisher available. 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 below). 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 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.



14. Students will time the duration of the flight, and record the data.



C. Wrap-up

1. 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.

