Sixth-Grade Aeronauts

Note: These instructions will create a balloon approximately 2' in height.

By Larry Flick and Ked Dejmal

The search for solutions often leads students to inquire beneath the surface of science activities. By identifying problems and determining solutions, children do more than follow instructions – they learn that scientific investigations have purpose. Combine scientific problem solving with the colorful history of hot air ballooning by allowing students to build and launch their own balloons. They'll determine the best design and production techniques to construct a tissue paper balloon and test its integrity. As they experience the dynamics of hot air and air currents and discover the function of symmetry in these balloons, they'll come to know the importance of collaborative work in science.

In the spirit of Galileo and his telescope, a middle school class can build balloons and then carry out investigations with them. Such active involvement in the complete scientific process produces a spirit of adventure that children rarely relate to science. We've conducted this activity with sixth graders, and both teachers and students greatly enjoyed themselves. Try it with your students and our results will most likely be replicated.

Making the Balloon

For each balloon, you will need:

- 4 standard-size pieces of tissue paper (50 cm x 75 cm) (20 in x 30 in),
- Scissors,
- Glue (preferably a glue stick),
- and thin, flexible wire (22-24 gauge).

The balloon is made of eight panels of tissue paper. A single sheet of tissue will make two panels. All eight panels can be cut at the same time. Stack four sheets of tissue and fold them twice lengthwise. The first fold gives you a stack of eight sheets that will become the eight panels. The second fold allows you to cut the curve necessary to provide the balloon shape.

After making two folds, you have a rectangle of about 12 cm x 75 cm (5 in x 30 in). Draw a lengthwise curve away from the second fold as if this were a stack of eight sheets of paper folded to make eight Valentine hearts. The curve you draw represents half the heart shape. When you unfold the cut tissue, you will have a stack of eight panels. The panels should be narrower (about 5 cm) at one end and wider (about 10 cm) at the other. The narrow ends will form the top of the balloons, which will be closed with a scrap piece of tissue cut into a circle. The wider ends will form the bottom, which will be held open by a piece of thin wire glued into a small fold along this wide edge.

The shape of the curve can vary quite a bit but should take advantage of the full width of the folded panel. The students can design these curves, or you may wish to provide a pattern for tracing. Our pattern was made out of heavy tag board.

After tracing the curve onto the top piece of tissue paper and cutting all eight sheets at one time, students can begin the gluing process. Students will encounter a variety of difficulties that they must overcome during this phase, so remind them to think through the process before beginning. One group in our class did not pay attention to the wide and narrow ends while gluing and produced a balloon that was hard to seal at the top and too small at the bottom to accept the hot air. News of the error spread quickly and resulted in the correction of all but one balloon. Since they learned from the error, the students agreed that this "mistake knowledge" helped their efforts.

The easiest way to assemble the balloon is to begin with the panels stacked on a table. Apply glue in a 1-cm wide strip along one side of the top panel (P1) with 1 cm of the second panel (P2) extending out from below the first to keep any stray glue off the table. A second group member immediately begins folding the underlapping portion of P2 over the glued area of P1. Work in 15-20 cm sections at a time. Wrinkling will occur along the seam as P2 conforms to the curve of P1.

Next, turn back P1 along the center fold, so that only P2 is showing, in order to glue panels 2 and 3. This not only gets P1 out of the way, but it also keeps the balloon flat until it is time to glue the last two edges. Repeat the process with the remaining panels. To form the last seam, open the flat stack of tissue paper and bring the final two edges together. Students will discover that it is best to begin gluing the top of the balloon and work down since the larger opening at the top of the balloon provides more room to finish the gluing. This step requires teamwork to complete, because all seams need to be tightly sealed for maximum performance. Seal off the top of the balloon with a circle of tissue cut from scraps. The more skillfully made balloons will only need a small piece at the top.

As they open their balloons and let them fill with air, the students' enthusiasm creates intense activity. Remind them that they must be gentle with their creations. As they discover unglued seams or small tears, fits of inventiveness produce a variety of techniques for gluing a hollow, tissue–paper object. Tape can fix small holes, but too much adds unwanted weight. Solutions must be carefully planned with the light-weight symmetrical balloon in mind.

Once the balloon is sealed and ready for flight, a thin wire is attached to the bottom rim to keep it open. Fold the bottom edge of the balloon around the circle of wire and add glue. For a final test, fill the balloons with air from a hair dryer. Loosely sealed seams that were not thoroughly repaired will become visible, and airtight balloons will actually fly.

The completed balloons inspire many questions. How does a hot air balloon work? How can it lift heavy cargo, like people? Have students weight their balloons, and come up with a class list of questions to try and answer on flight day.

Out to Launch

Launching the balloons requires a source of hot air and little or no breeze. Make sure that you have a repair kit with plenty of tape, glue, wire, scissors, and tissue paper.

The launcher that we devised was built by the school custodian with material lying around his shop. It worked well for us, but such a tool can always use structural improvements. As well, your available materials may differ from ours, or perhaps you will come up with a better design. Just remember, *safety* should be your primary concern.

Our model was made from a large metal bucket (20 L or 5 gallon) with a round hole cut on the side for a 15 cm diameter chimney pipe. One piece of pipe is welded to the hole and a second piece of pipe added to the first extends the chimney about 1.5 meters. A piece of wire mesh wedged over the opening inside the bucket keeps large ashes from escaping. A metal angle-iron is welded to the bottom of the bucket to keep the chimney balanced and upright. Although a slow, even-burning fire will send hot air out of the chimney and not readily burn fingers when it is controlled, warnings must be given to the students to prevent accidents. The launcher should not be touched and this exercise should only be done in an open area.

Our launcher provides a large quantity of hot air quickly. This means a balloon can be launched in less than 30 seconds. Most sixth graders can handle launches by themselves with adult supervision. A camp stove could be substituted on a calm day, but the launch process would be much slower. *Caution: Launch techniques which inflate the balloon slowly may result in the balloon collapsing on the heat source.* The chimney on our launcher places the balloon a safe distance away from the fire. If you come up with a better model, share it with S&C and we'll pass it along.

Instruct students to hold a balloon over the hot air source until it inflates. On a calm day, this should take about 5 seconds. Students will notice an initial rush of cool air as the warm air rises to take its place in the balloon. When the escaping air becomes warm, the launch can take place.

The ascent of symmetrically balanced balloons is dramatic. Even with a slight breeze they remain round as they gain altitude. Slight variations in wind currents become obvious when balloons shift directions. Breezes do not stay constant. It would be interesting to plot the location of each balloon landing on a grid representing the launch area.

Top-heavy balloons wobble to one side and allow the hot air to escape before they reach a high altitude. Balloons that are balanced but heavy with extra paper and tape stay aloft for a while but never attain much altitude. Others fly high above the trees and are lost to the upper air currents. One group of sixth graders chased their large balloon for about 200 meters before giving it up to the wind. Groups who don't lose their balloons should be able to repeat the launch several times, each time becoming more sensitive to wind currents and the temperature of the air around the inflated balloon.

Once students have had practice in launching the balloons, initiate a balloon race to see whose balloon travels farthest and whose stays aloft for the longest time. A each group's balloon lands, measure the distance from the launcher and record the time with a stopwatch. Record both scores and determine categories for awards – perhaps fastest (distance divided by time), longest time aloft, and longest distance traveled. These and other activities you may think of will motivate observation and speculation.

After they have observed several balloons in flight, students can begin forming tentative answers to the list of questions they made earlier.

Experiencing Science

In order to form ideas in science, students must do more than manipulate materials. They must manipulate the problem mentally in order to form connections between physical events and their understanding of the problem. Once students reflect on the goal of an activity and take purposeful action – guided by a knowledge of the materials – the science activity will become a meaningful experience.

Resources

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