Balloon Explorium

Ballooning As a Science Project

By the editors of Balloon Life

Introduction:

This report is designed to answer a number of frequently asked questions about ballooning, provide some additional resources for information, ask some thought provoking questions, and otherwise supply some ideas about how to make a science project out of aerostation.

Suggested books:

"Ballooning, The Complete Guide to Riding the Winds" by Dick Wirth, ISBN 0-934-51338-X published by Random House. The book was originally published in 1980 in hardback. In 1990 it was reissued with a soft cover and 16 pages were updated. Both versions are basically the same, and the information is a little old. Still, the book is the best general reference that you can use for explaining the various aspects of ballooning. It is an excellent general introduction.

"The Aeronauts" by Donald Jackson, ISBN 0-8094-3268-8. This book is more a history book and is part of the Time/Life "Epic of Flight" series on aviation.

"Just Wind" by William G. Armstrong, Jr., ISBN 0-595-28705-0. The adventures of two dramatic stratospheric balloon expeditions - to be first across the Atlantic, and first around the world - are chronicled with wit by a true insider. For more information, see www.JustWind.net

"The Eagle Aloft" by Tom Crouch, ISBN 0-87474-346-X published by The Smithsonian Institution. This is a 200 year history of the balloon in America. If you want US history of ballooning this is the book.

"Hot Air Balloons" by Christine Kalakuka and Brent Stockwell, ISBN 1-56799-620-5, published by Friedman/Fairfax in 1998. This is a modern up to date coffee table style book on the sport of ballooning.

"The Pre-Astronauts" by Craig Ryan, ISBN 1-55750-732-5, published by The Naval Institute Press.

Questions and Answers about Hot Air Balloons

What are hot air balloons made of?

The bag-or envelope, as it's more properly called-is made of a reinforced fabric called rip-stop nylon (some balloons are made of dacron). The material is very light weight, but is very strong. The fabric is coated on the inside to prevent leaks.

How is it inflated?

During the inflation process, ballooning becomes a group sport. Since a balloon is quite unwieldy on the ground, especially in gusty winds, it takes about four people to get the balloon inflated. Of course, the more people there are, the more fun you can have. To start off, the envelope is stretched out on the ground and attached to the basket, which is lying on its side. A small gasoline-powered fan blows air into the balloon. Then the burner is turned on, and the air in the balloon is heated. The hot air rises, lifting the balloon upright.

What are the baskets made of?

The baskets are made from rattan or wicker and each one is individually woven by hand.

How big are hot air balloons?

The typical sport balloons range in size from 65,000 to 105,000 cubic feet in volume and stand around 70 feet tall.

How do you steer the thing?

Strictly speaking you don't. The balloon goes where the wind takes it. However, the winds at varying altitudes may blow in different directions and at different speeds, so the trick is to climb or descend to an altitude where the wind is blowing in the direction you want to go.

How fast does it go?

As fast as the wind. Or as slow. Since the balloon has no forward propulsion system, its speed is determined entirely by the speed of the wind. That's why balloon races are events of accuracy not speed.

When is the best time to fly a balloon?

Usually just after sunrise and one or two hours before sunset. This is the time of day when winds are calmest and the air most stable.

How high do balloons fly?

Most balloon flights occur between 500 and 1,000 feet above the ground. But balloons can fly at treetop level or go much higher. The world record for altitude in a hot air balloon is 65,000 feet.

How long can it stay up?

It depends. Normally, the balloon carries enough fuel to remain aloft for 2 hours, but factors like outside air temperature, weight being carried in the basket, and weather determine the duration of the flight.

What kind of fuel is used?

Propane, kept in pressurized tanks on the floor of the basket. The balloon carries 30-40 gallons of liquid propane. It is carried under pressure and passes to the burners through flexible hoses. When the valves are opened, the propane atomizes and is ignited by a pilot light in the burners. The flame may shoot out as much as ten or twenty feet, making a loud "whoosh."

How do you get it back?

With the help of friends who drive a van or pickup truck. This chase crew follows the flight of the balloon (as well as the existing roads allow) and should be on hand to make the recovery when the balloon touches down.

What is the difference between a gas balloon and a hot air balloon?

A gas balloon is completely enclosed and is filled with helium or hydrogen. A hot air balloon gets its lift from heating the air within it.

Do you need a license to pilot a balloon?

Yes. A Balloon Pilot Certificate is issued by the Federal Aviation Administration. You must pass an FAA written examination, obtain a prescribed number of hours in a balloon, make a solo flight and a flight to altitude, pass a flight test and submit a medical statement.

Brief History of Balloon Flight

The first recorded balloon flight occurred in France in June 1783 when two brothers, Jacques Etienne and Joseph Michel Montgolfier, sent a large, smoked-filled bag 35 feet into the air. Three months later, a duck, rooster and sheep became the first passengers in a balloon, since no one knew whether a human could survive the flight.

Finally on November 21, 1783, before a vast throng of on-lookers that included the King and Queen of France, Marquis d'Arlandes and Pilatre de Rozier piloted man's first aerial voyagemore than a century before the Wright brothers' historic flight at Kitty Hawk!

Ballooning became quite popular for over half a century in Europe. Ten days after the first manned hot air flight, a French physicist named J.A.C. Charles made the first manned flight in a hydrogen-

filled balloon. Eighteenth century farmers, frightened by these strange objects descending from the heavens, attacked the balloon with pitchforks.

With the advent of powered aircraft, ballooning became a less practical mode of flight, practiced by only a few enthusiasts. The modern day sport of hot air ballooning evolved through research for the U.S. Navy in the 1960's and has enjoyed a remarkable comeback due to the development of a durable, inexpensive nylon for the envelope in combination with an improved and efficient propane burner system. Today there are more than 5,000 balloon pilots in the U.S. alone.

Suggestions for getting started on a science project using ballooning as a theme:

- What are the basic principles of physics apply to hot air ballooning?
- Build a "trash bag" or "tissue paper" hot air balloon to demonstrate the science of lighter-than-air flight.
- Demonstrate "Boyle's Law of Gasses."
- Discuss Archimede's Principle of Buoyancy Force. The greater the difference of temperature between the air inside the envelope (the balloon) and the air outside - the greater the lifting capacity.
- Discuss weights and balances.
- Mathematical calculations.
- Venturi Effect.
- Discuss the effect of weather on balloons.
- Effects of the jet stream in relation to the recent around-the-world by balloon attempts.
- Since geometry is a really basic field of science, go through the system of projections to develop the shape of a balloon. Start with a simple sphere. Then do a sphere on cone. Then approximate the "Natural Shape" balloon.
- To do a simple natural shape, there are lots of sources for computer programs such as the LTA Builders groups and the CD ROM (Balloons! IBM compatiable, http://kumo.swcp.com/balloons/) by Ojo Magic. Make a tailored balloon to the computer program and then make a plain cylinder with the same gore length and excess material circumferentially. Inflate them side by side to show they end up the same shape! (The plain cylinder will have a lot of wrinkles, but the same silhouette.)
- An analysis of the radius of curvature at any elevation showing that it is directly related to the internal pressure at that point and the vertical load there (total payload divided by the circumference at that point) will likely blow away his comment that everyone knows how they work, as most high school science teachers I have met would not know.
- Try a "Solar" hot air balloon made of black tissue paper, inflated by a very small fan (like from a computer ventilation system) and buoyed up by infra red heat lamps. If it does not rise, that may be all the better because then you can theorize on why it doesn't rise and your electric toaster supported hot air balloon does. This shows that a "Scientific Experiment" is a success if the results are properly observed, especially when they are different from the hoped for results. The scientist will be able to explain why one works and the other didn't and propose modifications to make it work (Bigger balloon, lighter tissue

paper, and more radiant heat - maybe with parabolic reflectors so the lamps can be farther away and so there is room for more of them.)

- Make a model balloon that is filled with plain air, but is submerged in an aquarium. (Tissue paper won't work for that one.) Measure the lift as compared to the bigger hot air one. Call that unit of the project "Eureka". Why? Who was Archimedes? What was the difference between Archimedes and Montgolfier? What was the difference between the Stratosphere Balloon and the Bathyscaph? Which one was invented first and which one was an adaptation of the other?
- Validate the balloon project as an important scientific venue by citing Craig Ryan's book "The Pre-Astronauts," The Naval Institute Press, ISBN 1-55750-732-5.
- Tape a couple of telephone interviews with college physics professors.
- Make a video of an actual hot air balloon flight, especially showing the inertia, momentum and heat loss reactions not easily demonstrated indoors.

Internet resources:

A few suggestions for exploration:

Balloon Life magazine: http://www.balloonlife.com

Team RE/MAX, a great education site built around ballooning provided by RE/MAX International http://www.remax.com/inside_remax/corporate_information/the_balloon/index.aspx

Larry and Anne Nelson in Redmond, Washington have created some links to history ballooning and a few other resources. Take a look at their web page at www.nwlink.com/~lwnelson/index.htm

A complete, or least as complete as it can be, listing of pages related to ballooning on the World Wide Web: www.euronet.nl/users/jdewilde/index.html