

Simple Solar Balloon Building

Mathew Lippincott



K.I.S.S. Balloon

simple construction, easy recovery

Stick to the K.I.S.S. Method

Keep It Simple and Stupid. Most solar balloon builders have settled on tetrahedrons (triangular pyramids) as the easiest balloon shape, because they can be taped up out of rectangles (make one out of this page!). I haven't seen anyone share plans on a good balloon recovery mechanism, so I designed one myself. After playing around with knots, custom pin releases, and fishing tackle, I think I've got a good, easy to make design from a binder clip. I've tried a bunch of harder designs for balloons, and they definitely don't work better. Enjoy!



Not simple—boat awaits a water landing
—Adventure Squad! Copenhagen 8/30/08

Not simple—Samantha Mitchell narrowly escapes an attack by an errant kite balloon.

—Great Berrington, MA, July 2008

On The Cover
Molly Danielsson prepares for overflight of the Danielsson farm, Beirhult, Sweden 8/16/08



Not simple—Jake Lemkowicz holds my spherical black HDPE balloon—Brooklyn, April 2008.

Absorbing Sunlight

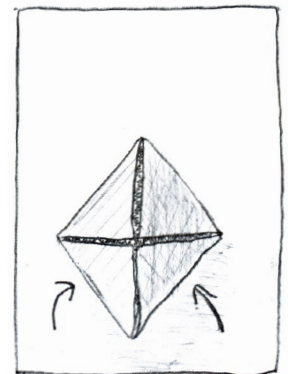
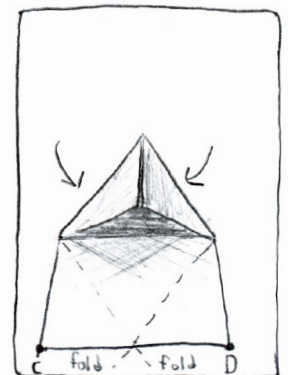
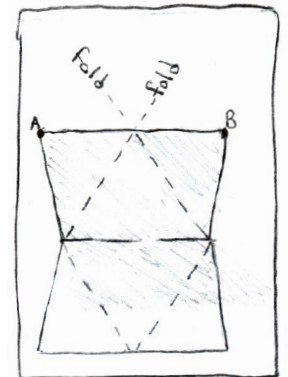
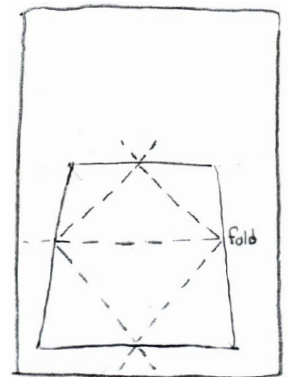
Translucent HDPE needs to be tinted black to absorb sunlight. For this you can use **black iron oxide tempera pigment** (don't buy "dust free" it won't cling). I think charcoal is cheaper, better, and less irritating if you accidentally get it in your eye or nose. But it is flammable, so you may want to use tempera (see the index in the back for details of the debate). You can buy powdered charcoal, or grind your own out of charred wood. Don't use grilling briquets! **use Bayferrox Iron Oxide Black 330**

Picking the Plastic

The best is thin HDPE, sold for drop cloths as "painter's plastic" at any hardware store. You want the thinnest stuff, roughly .3 mil (millionths of an inch). you can also use trash bags, but they will have to be seamed together. Black ones fly well but rip easily.

Make this page a paper prototype:

← Cut or tear here for a rectangle with a ratio of sides 1:√3 (2 1/8" off 8.5" x 11") and fold along the dotted lines.



Find space and get ready

A clear, clean space makes building easier and more fun. Thin plastic tears easily and picks up lint, so I suggest working on a smooth wood or tile floor, swept clean.

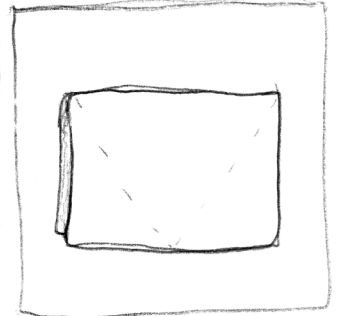
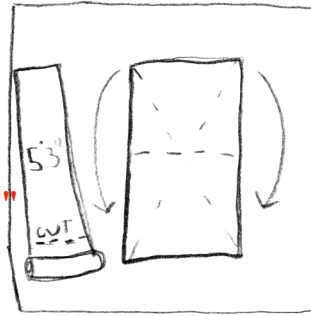
buy 12' roll of painters plastic. Make a balloon with a 12' x 20'10"

You will need:

get a kite reel with 100lb+ line

optional for rigging

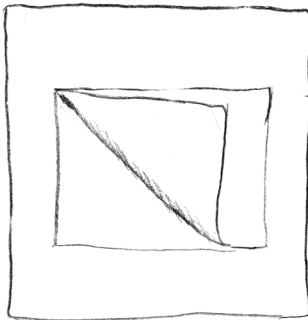
- ~~9' x 5'3"~~ of thin (0.3 mil) HDPE plastic
- tape (Scotch® Utility Tape works well)
- generic or brand name Super® glue
- fishing line (10lb test, or 10lb thickness)
- white Bic Stic® pen
- binder clip with 3/4" mouth
- thin rag
- craft knife (Olfa®, X-Acto®) or scissors
- yard stick or measuring tape
- big mixing bowl (about 12") or compass



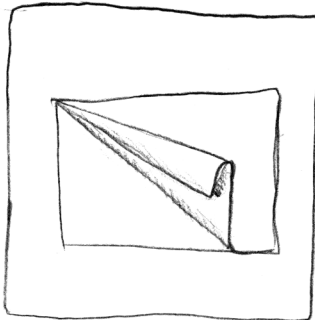
Roll out 5'3" of plastic, or cut a 9' x 5'3" sheet.

Use a straight edge and don't cut directly on the floor. Make a nice straight cut and spread the sheet flat.

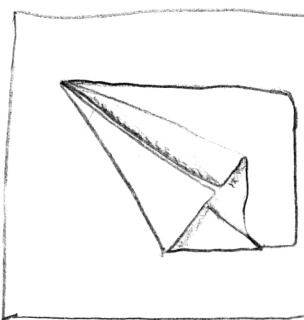
Fold length-wise. We're going to tape up the sides. Each seam will join 2 right triangles into two full equilateral triangles— but this requires some folding.



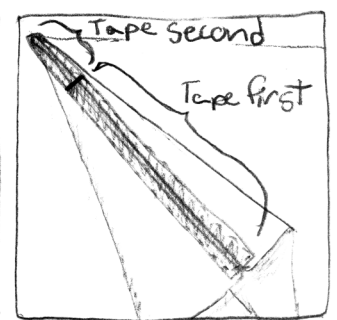
Grab a corner on the top sheet and fold diagonally upwards.



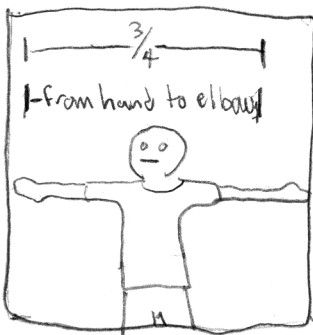
Fold corner back down. All folds meet at the same vertex.



Fold the bottom sheet up and flush with the top sheet.



Tape seam close to the vertex, then patch the corner.



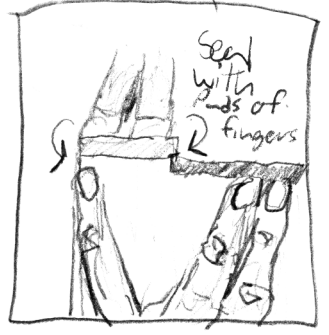
If you line the seam up really straight and take care laying tape down, then you can use a single piece of tape up to 3/4 of the length of your arm-span.



Place the tape down in a single movement. Pat down along the length before you smooth the tape out, otherwise the plastic bunches up and you get leaks.

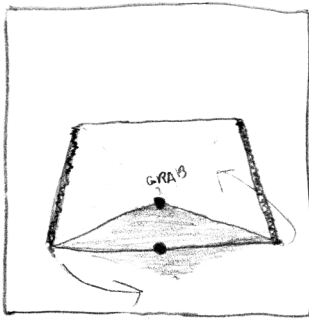


To tape up the last 3 inches of a corner, fold the tape along the seam and pin it between your thumb and forefinger. apply tape to one side, lay down sticky side up.

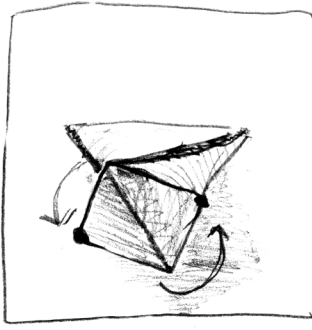


Hold the corner down with one hand, and carefully fold the tape over with the other. Immediately press down the seam.

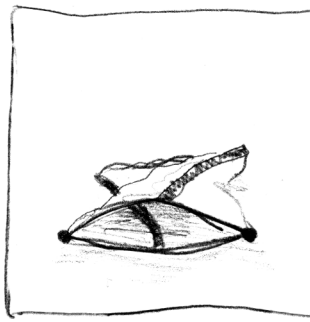
Patch only one corner, the other will be cut.



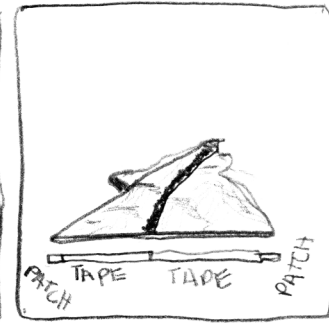
Now to fold the final edge into position, grab the middle of the opening on both sides, these two points will become the corners.



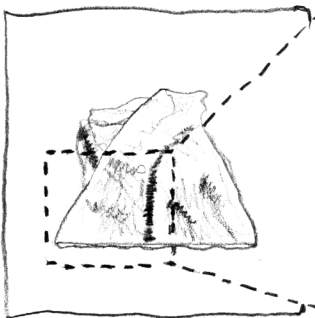
Pull the two points out towards the corners, rotating the opening 90° while lining up the first two seams you made to meet in the middle of the new edge.



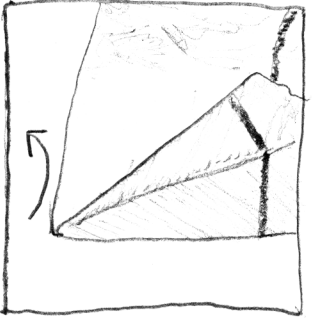
Pull from the new corners and flatten the edge so that it isn't wrinkled.



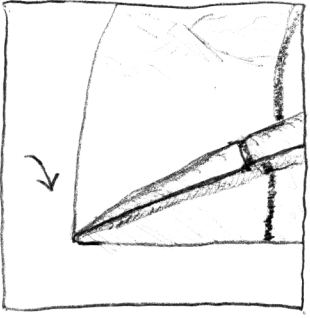
This seam won't be as easy to tape as the last two, but we'll use similar folding techniques.



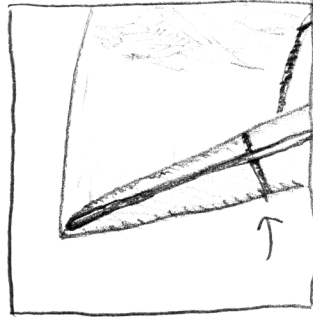
Smooth out the highlighted area so that there are no wrinkles. We're going to fold it up and tape the left side of the seam, then the right.



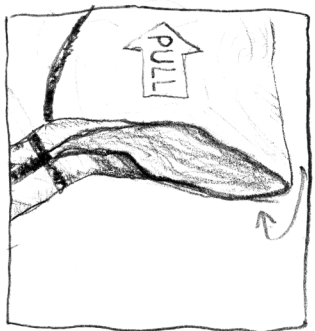
Lift up the top sheet and fold over, smooth flat up to the middle (marked by a seam).



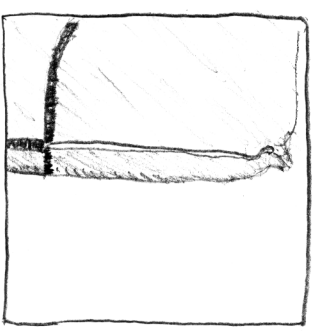
Now Fold the top edge down and smooth flat.



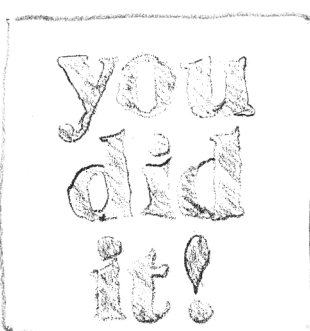
Bring the bottom edge up to meet the top edge, line up using the perpendicular seams. Tape up the length but don't patch the corner till after the next step.



Grab at points above and below the end of the finished seam.



Pull up and lay flat. Pull the seam up towards the corner. Tape up.



You've made a tetrahedron. Congratulate yourself.

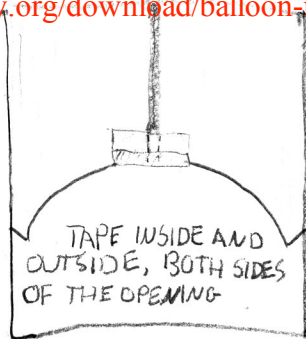
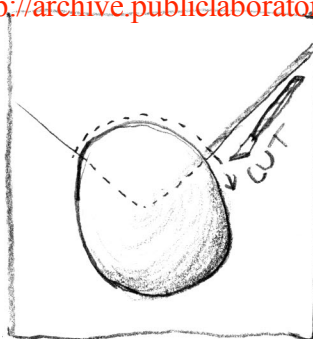


Now we'll cut the unpatched corner, so it spread flat.

don't cut it. you're done.

This is totally optional, and is only useful if you want to do a really quick takedown. the line can also be attached rigidly, using the same system PLOTS uses for sealing helium balloons. Doing so will save a lot of time rigging.
<http://archive.publilaboratory.org/download/balloon-mapping-quickstart-1.0-en.pdf>

Recovery!

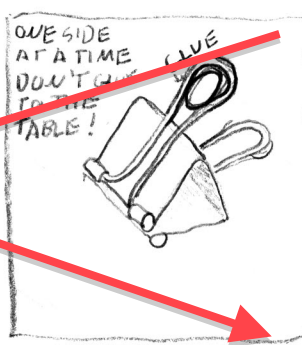
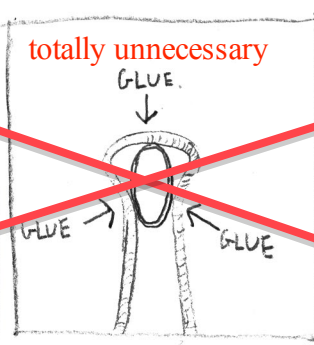
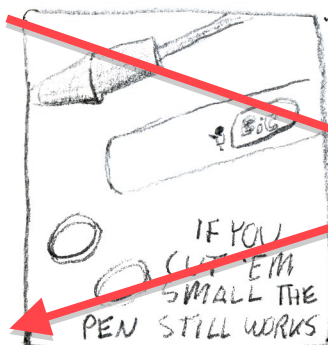
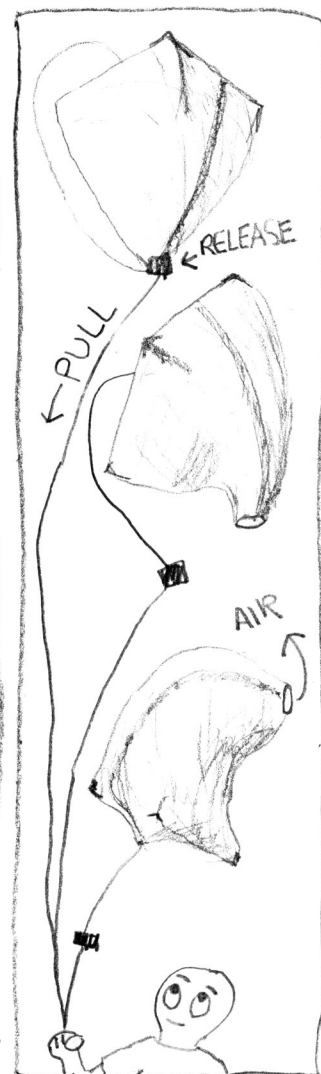


YOU WANT TO GET YOUR BALLOON BACK WHEN YOU FLY IT. THE RECOVERY SYSTEM CLIPS TO THE BOTTOM OF THE BALLOON. WHEN YOU PULL THE STRING, THE BALLOON FLIPS UPSIDE DOWN.

Use the bowl or compass to mark a circular opening. Place the bowl over the corner and cut.

Tape up two spots for the clip on both sides of the opening, taping the inside and outside of the plastic.

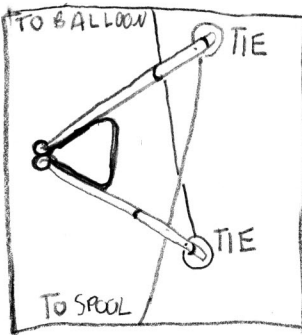
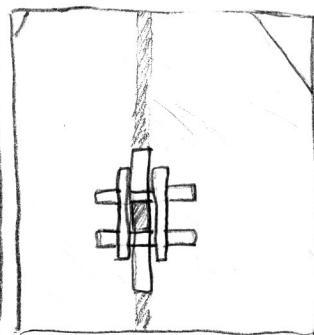
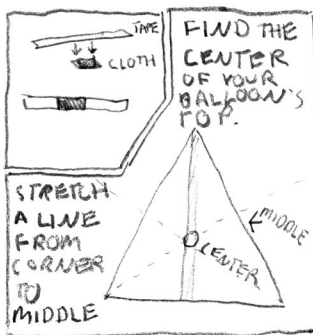
Your tetrahedron has now become a balloon. We're going to make the recovery system now.



To make the release clip, pull the tip out of a Bic pen and cut two small rings. The pen should still work.

Place the binder clip down with the wire flat and squeeze the bic ring in. Flip the other way up for...

The gluing! Place little dabs where the ring meets the wire, do one side at a time, off the table.



almost done

While the glue dries, stretch out the un-cut points to expose the balloon's top. find the middle. cut a tiny square out of a rag, place in the center of 12" of tape.

Tape your 12" of tape down to the seam on the top of the balloon so the little piece of fabric is right in the center. Re-enforce on all sides.

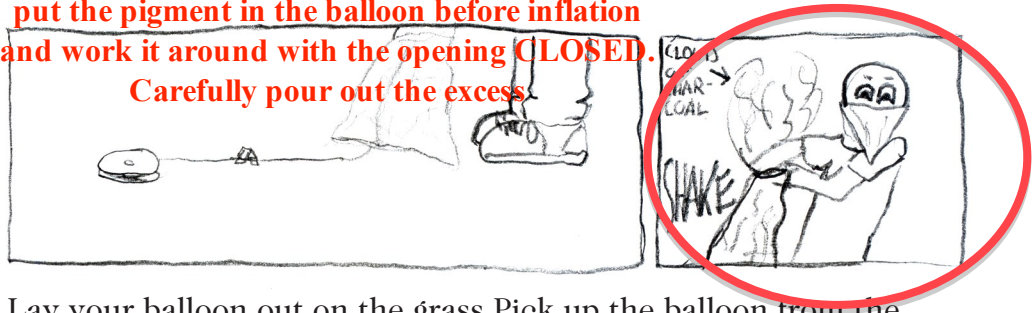
To rig the clip up, tie 6' of line to one side, run it through the opposite loop, and tie it to the square of fabric on top. Tie your spool of line to the other side.

Congratulations, you're done building! All that's left is to blacken the balloon and fly it. This is messy and ought to be done outside.

Tinting The Balloon

This is always messy. Wear something that can get dirty, take your balloon outside, and tie a bandana around your mouth and nose, unless you like black snot (impress your friends!).

**this technique is a terrible idea
put the pigment in the balloon before inflation
and work it around with the opening CLOSED.
Carefully pour out the excess**

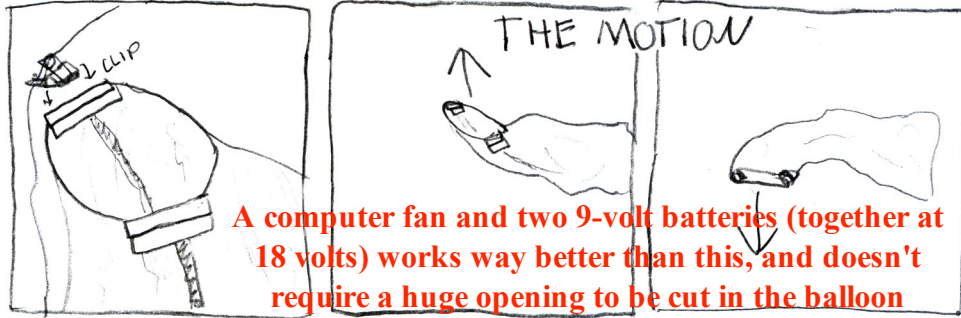


Lay your balloon out on the grass Pick up the balloon from the two taped points at the entrance, and pour about 1/4 cup of finely ~~ground charcoal~~ into the balloon. shake around to coat the inside until it is grey all over, then pour out any excess. Now go wash up. **again, use bayferrox iron oxide 330 pigment, they'll send you a free sample.**

Flying

Pick a calm sunny day, and head to big open field. Figure out which way the wind is going, and pick a spot near the edge of the field so that your balloon will blow the longest distance. After inflating the balloon, hold the entrance closed with your hand, and keep the balloon in the sun. it will probably take 5-10 minutes to heat up. You can tell that it is hot by a bubble of air that is constantly trying to stay at the top of the balloon. it will pull towards one corner, and then the next, reaching towards the sky.

Now let your balloon go and hold the spool loosely so it can pull line out, and run after your balloon. When it gets near a tree or building, pull the line taught, and it will come down.

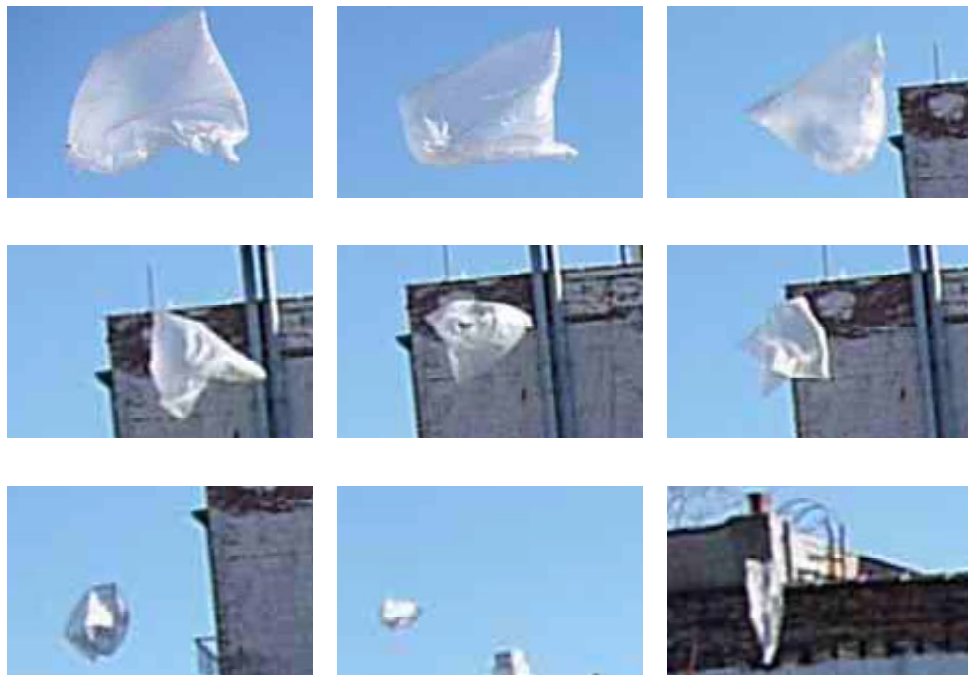


A computer fan and two 9-volt batteries (together at 18 volts) works way better than this, and doesn't require a huge opening to be cut in the balloon

Get your balloon ready to inflate. Clip the recovery clip to one side of the balloon's opening so that the line running to the balloon's top is facing outward.

Now grab the taped squares, and cupping the clip in the palm of one hand, scoop the opening up and down rapidly for the length of your upper body.

It will take a minute to fill with air. The balloon doesn't have to be taught with air, but it ought to hold its shape. Leave room for the air to heat up and expand.



The Balloon Tinting Controversy

This is a summary of contributions from the Solar Balloons Yahoo Group and personal observations. **No controversy-- charcoal stinks. Use Bayferrox iron oxide black 330**

There are two main ways to get a balloon to absorb sunlight- use black plastic, or tint the balloon somehow. Black plastic actually contains carbon black, which isn't much different than charcoal, in concentrations of up to 30% of the plastic's volume. This heavy pigment loading definitely weakens the plastic, so you can't make the balloon as thin as you can using clear plastic. My black plastic balloons have all ripped easily.

Alternately, you can use clear plastic and tint the inside. A layer of paint will be heavier and thicker than the plastic, so you have to depend on static cling of the pigment. Robert Rochte, who has had amazing success with science class, believes that charcoal has the risk of exploding in a particle-air explosion, as occasionally happens in grain elevators. No one has reported this happening with a solar balloon yet, but some people regularly make 50ft balloons, and an explosion at that size would do more than take your eyebrows off. I say don't smoke or use electrical devices around your balloon while you coat it with charcoal. Rochte says use black tempera pigment.

My girlfriend Molly is a painter who sources her own pigments, and so I know that black pigment is iron oxide, which is non-flammable and non-toxic. But it does irritate your nose and eyes a lot. While blackening a balloon with iron oxide, I found it extremely irritating, while I hardly notice the charcoal as it coats my face and makes me look like a coal miner.

Some people claim performance differences between tempera and charcoal, and between tinted balloons and black plastic balloons, but there is no hard data on this yet. My tinted balloons have flown just as well as my black plastic balloons, despite being many shades of grey paler. My unsubstantiated theory, based on observation of heat waves on the surface of my black plastic balloons, is that the outside of the black plastic is being heated, and that heat is lost to convection. Early solar balloon pioneers (manned balloons) have tried black plastic balloons inside clear balloons, and black nylon balloons, but no one seems to have any comparative data to share on the subject.

I hope my instructions for a quick, easy to recover balloon will help the collection of data. It is a simple project, and given instructions, a classroom of students could easily put together 10 or so balloons to run tests on materials and tinting.

Thanks for reading! This guide is Creative Commons Share Alike With Attribution licensed, feel free to republish with credit under the same license.

Special thanks to Bill Boyd, Robert Rochte, and the Yahoo Solar Balloons Group

Links:

Robert Rochte and Gross Pointe Academy: <http://arhab.blogspot.com/>

Steve Griffith has good volume equations:

<http://www.flymetothemoon.com.au/homebuilding/solar.htm>

The most comprehensive- and French- solar ballooning site (where I started):

<http://pagesperso-orange.fr/ballonsolaire/essais-autres1.htm>

Great equations on lift:

<http://www.ent.ohiou.edu/~et181/balloon/balloon.html>

headfullofair.com, publiclaboratory.org

You can follow me:

~~www.WhereTheSummerCalmOfCharityPerpetuallyReigns.com~~