Exploring Science and Math
Using Kites

Presented by the

Education Division
National Museum of the United States Air Force

www.nationalmuseum.af.mil

History of Kites

China is usually considered the place of origin of the kite. Although no one knows for certain when or how the world's first kite was flown, a favorite theory is that a Chinese farmer whose hat blew off in the wind was so fascinated to see that his hat could "fly" that he later attached a string to it and launched it as a kite. Silk, which was produced in China as early as 2600 B.C. may have been an important material from which early kites were made, as most likely was paper. Broad leaves and frames of sticks or bamboo strips may also have provided the makings for early kites.

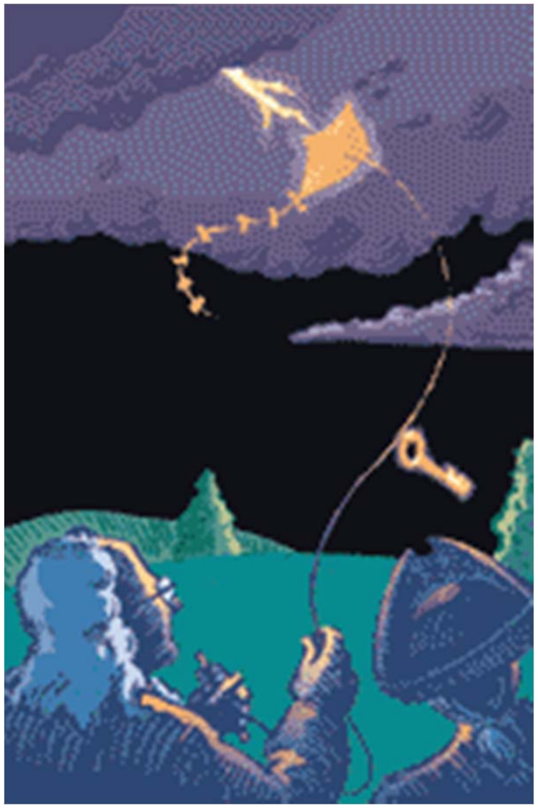
Chinese Dragon Kite

History of Kites

One of the earliest legends of kiting is that of General Han Hsin, who helped to establish the Han Dynasty as one of the most powerful dynasties in Chinese history. In 206 B.C., the general and a small band of soldiers camped outside the walls of an enemy palace. The problem facing Han Hsin was how to conquer the well-fortified palace with only a few soldiers. After some consideration, Han Hsin built a kite and sent it aloft until it flew over the palace walls. Then he carefully marked the length of line that had been required for the kite to go that distance. This told his soldiers how long a tunnel they would have to dig to get inside the palace walls and take the enemy by surprise -- which is exactly what they finally did! Thus Han Hsin won his battle and the kite victoriously entered recorded history.

History of Kites

In the United States, Benjamin Franklin is known for his experiments with electricity while flying a kite during a thunderstorm. Throughout history, kites have been used in many innovative ways:



History of Kites

Weather Watching

In 1749, in Scotland, Thomas Melville and Alexander Wilson attached thermometers to kites for meteorological purposes. Until 1933, in the United States, the Weather Bureau operated kite stations to obtain data on temperature, humidity, wind velocity, and altitude.

History of Kites

Towing

In 1826, George Pocock, an English schoolmaster, developed a method of pulling a carriage with kites. The carriage could travel at speeds of up to twenty miles an hour.

History of Kites

Military Use

An early Chinese legend tells of a general who attached lanterns and noisemakers to kites and flew them at night over his enemy’s camp. The enemy was so frightened by the mysterious “spirits of the night” that it fled without a battle. For many centuries, manlifting kites were used in Asia to send up spies to observe the enemy.

Much later, in the late 1800s, this method of reconnaissance was adopted in the West, when British Captain B.F.S. Baden-Powell began to build and fly “Levitor” kites. Baden-Powell’s system was capable of lifting a “spotter” about one hundred feet into the air to observe and photograph the enemy.

History of Kites

Military Use (continued)

Later, during World War II, U.S. Navy Lieutenant Paul Garber developed the “target kites” for use by the Navy and the Army. Manipulated by two flying lines and a rudder, these kites could be steered through all sorts of fancy maneuvers, such as loops, dives, and figure eights, thereby providing excellent practice targets for aircraft gunners.

Safety Guidelines

From the American Kitefliers Association

1) Gloves should be worn to protect your hands from cuts and burns by the kite line, especially when flying a hard-pulling kite.
2) Never fly a kite in wet or stormy weather. Keep your line dry.
3) Never fly kites around power lines, transmission towers or antennas. Should a kite get tangled with power lines, do NOT attempt to free it. Contact the local power company to report the situation.
4) Do not use wire or metal in kite construction or line.
5) Do not fly from or over public streets and highways.
6) Do not fly near airports and air traffic patterns.

Safety Guidelines

7) Do not fly maneuverable kites close to bystanders. This applies to the flying line as well as the kite.

8) Check the flying field for holes, gullies, rocks, broken glass, and other debris that might trip you.

9) Do not fly near trees. If your kite should get caught in a kite-eating tree, don't pull at it or climb the tree. Let the wind blow it out.

10) Use caution when launching, flying and landing large kites.

11) Do not fasten kite lines to yourself unless you have a quick release system

When to Fly a Kite

You can fly a kite any time of year when the wind is right and there are no storms. Although spring is the traditional kite flying season, the spring winds are often too strong or too gusty. The best conditions for flying kites are blue skies and gentle to moderate winds (about 8-18 mph).

Material	***Wind (mph)***	***General Range***
Light paper	4-12	Light to Gentle
Light plastic	8-24	Gentle to Fresh
Light cloth	8-31	Gentle to Strong
Heavy plastic	13-31	Moderate to Strong
Heavy cloth	13-31	Moderate to Strong
Kite Type	***Wind (mph)***	***General Range***
Fighter	4-12	Light to Gentle
Sled	6-18	Light to Moderate
Diamond	6-18	Light to Moderate
Delta	6-18	Light to Moderate
Box	13-31	Moderate to Strong

Beaufort Wind Scale

In 1806, British Admiral Sir Francis Beaufort devised a wind velocity scale. It measures how fast the wind is moving by how it is affecting the environment. This version is adapted for kite flying.

Scale Number	***Wind Speed***	***Forecast Description***	***Observable Effects***
0	0	Calm	Smoke rises vertically
1	1-3	Light air	Smoke drifts slowly
2	4-7	Light breeze	Leaves rustle
3	8-12	Gentle breeze	Small flags fly
4	13-18	Moderate breeze	Small branches move
5	19-24	Fresh breeze	Small trees sway
6	25-31	Strong breeze	Large branches sway

Building the Sled Kite

Grade Level: K-8

Subject Area: Math and Science

Time Required: Preparation: 1-½ hours; Activity: 1-2 hours

Summary: Students will construct a basic sled kite and make necessary adjustments (if needed) to insure a successful flight. Prior to the lesson, students will be given information about fundamental principles that contribute to successful kite flying.

Objectives: Students will:

1) Build the kites.
2) Use symmetry in building the kites.
3) Determine factors that made their kites successful or unsuccessful.
4) Fly the kites.

Building the Sled Kite

Background: The sled kite is a standard workshop kite that can be made in a variety of sizes and with a variety of materials. The kite is simple to make and is an excellent flyer. There are three main forces that affect the flight of a kite. They are: lift, gravity and drag. Lift causes the kite to rise. Gravity causes the kite to fall. Drag is the pull on the kite by the passing air. When all three of these forces are balanced, the kite will fly.

A kite has many parts that help keep lift, gravity and drag balanced. The flying line holds the kite so that it will not fly away in the wind. The bridle connects the flying line to the kite at two points. The actual flying line is connected to the bridle at its tow point. The bridle sets the angle of the kite in the wind. If the bridle is not set at the correct angle the kite will not fly properly. The spine (backbone) and struts of a kite provide the framework for the kite. The sail cover, or skin of the kite is the material that covers the rods and makes up the body of the kite. The best weather conditions for flying sled kites are light to moderate wind (approximately 6 to 18 miles per hour) and blue skies. Do not attempt to fly a kite in wet or stormy weather.

Building the Sled Kite

Symmetry is an important concept in kite building. If the kite is out of balance, it may not fly at all or may only fly for a short period of time.

Material List:

- (2) 1/8" diameter dowel rods (24" long)
- Plastic garbage bags (tall kitchen size) or brown craft paper
- String
- Scissors
- Reinforced packing tape
- Hole punch
- Markers (optional)

Building the Sled Kite

Safety Instructions:

See [Safety Guidelines]

Procedure:

Warm-Up:

1) Review the background information and have additional reading materials available for the students who wish to gather more information.
2) Review vocabulary words and their meanings (lift, drag, gravity, etc.).
3) Review symmetry.

Building the Sled Kite

Procedure (continued):

Activity:

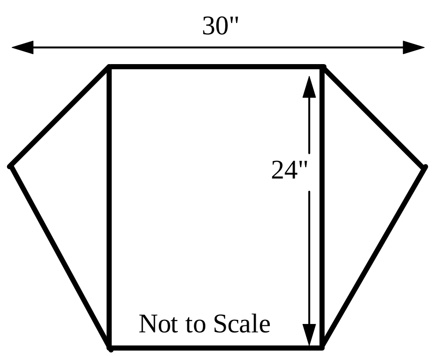
1) Have a sample available of a previously made sled kite as well as all the materials needed for kite building.
2) Create a pattern according to the following diagram. All sled kites follow the same proportions. If you fold the pattern lengthwise, you can place it along the side seams of a tall kitchen garbage bag and get two kites from one bag.

Building the Sled Kite

Procedure (continued):

Activity (continued):

3) Lay the plastic garbage bag flat. To tape the dowels in place, use about 1½"- 2" of strapping tape. It is very helpful to pre-cut the tape into 1½"- 2" pieces. Each student will need ten pieces. Place the dowels parallel to one another. Place tape on back of the kite skin (about half the length of a piece of tape) and fold it toward the front of the kite to secure the dowel. Press down firmly around the dowel and repeat at the other end. Once both dowels are taped in place, put one piece of tape (lengthwise) in the center of the dowel to hold the middle. By wrapping the tape from the back to front, the ends of the dowels are more secure.

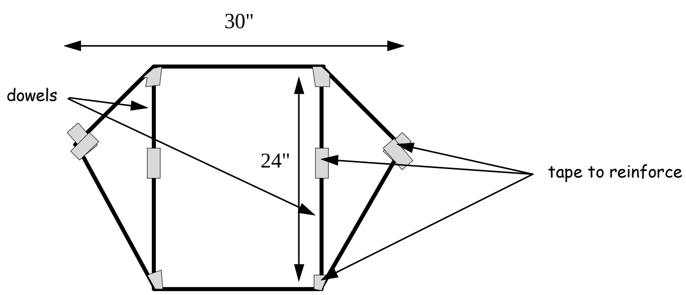


Building the Sled Kite

Procedure (continued):

Activity (continued):

4) At the outside corners, place tape on the back side (about half the length of a piece of tape) and fold toward the front of the kite. Use another piece of tape and repeat the procedure, but tape in the opposite direction to reinforce the corner.



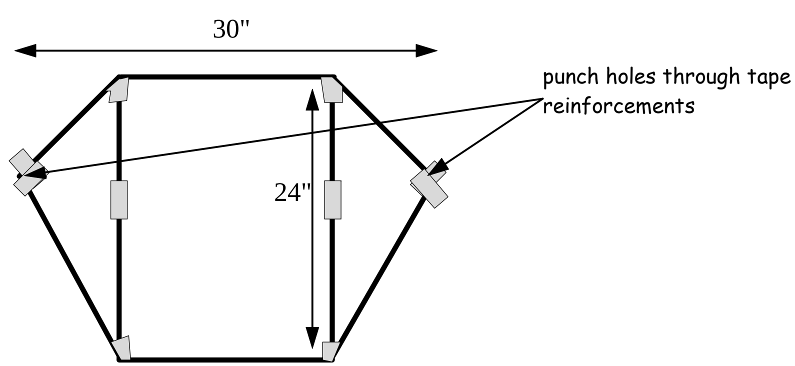
5) Fold the kite in half, match the reinforced corners and punch holes through the reinforced corners.

Building the Sled Kite

Procedure (continued):

Activity (continued):

6) To make the bridle, cut a piece of string that is five times the length of the dowel (about 10 feet). This proportion works for all sled kites. If this string is cut too short, the kite will not open wide enough to catch the wind. Tie one end of the string through each hole. Square knots work the best. Match the holes and find the exact midpoint of the string. This is a critical step. If the loop is not at the midpoint, the kite will dive to one side. Now tie a knot, leaving a small loop. Tie your flying line to the loop and you are ready to fly.



Let’s Go Fly a Kite!

To fly the kite, stand with the wind at your back and ask someone to lift your kite up (the dowels should be on the ground side) and let the wind carry it. No running is needed.

Here are some trouble shooting hints for successful kite-flying:

- If the kite does not rise, there may not be enough wind or the bridle may be too short.
- If the kite flies and then crashes, you may need to lengthen the bridle.
- If the kite tends to spin or wobble, you may need to check the midpoint of the bridle.

Extensions

For Younger Students:

Identify various geometric shapes found in a sled kite. Draw a model of the kite using exact dimensions.

For Older Students:

Determine the perimeter and surface area of the kite. Determine the altitude of the kite.

Using a spring scale, measure the force on the kite.

Kite Math

Review these terms and relate them to various kites:

Similar
Congruent
Symmetric
Parallel
Perpendicular

Polygon
Quadrilateral
Parallelogram
Diamond
Triangle
Rectangle
Rhombus
Trapezoid
Square

Diamond Kite Train

NATIONAL MUSEUM
OF THE UNITED STATES AIR FORCE ™

Parafoil Kite

Flexifoil Kites

Kite Math

Using various kites, discuss these terms and have the students identify examples of each term.

Practice finding perimeter, surface area and aspect ratio using a Sled Kite.

What is aspect ratio?
An airplane's wingspan divided by its standard mean chord or more easily span squared divided by wing area.

AR=b2/S
Aspect ratio is a powerful indicator of the general performance of a wing. High performance gliders have very long, thin wings

Aspect Ratio

High aspect ratio indicates long, narrow wings as in the U-2 reconnaissance aircraft.

Aspect Ratio

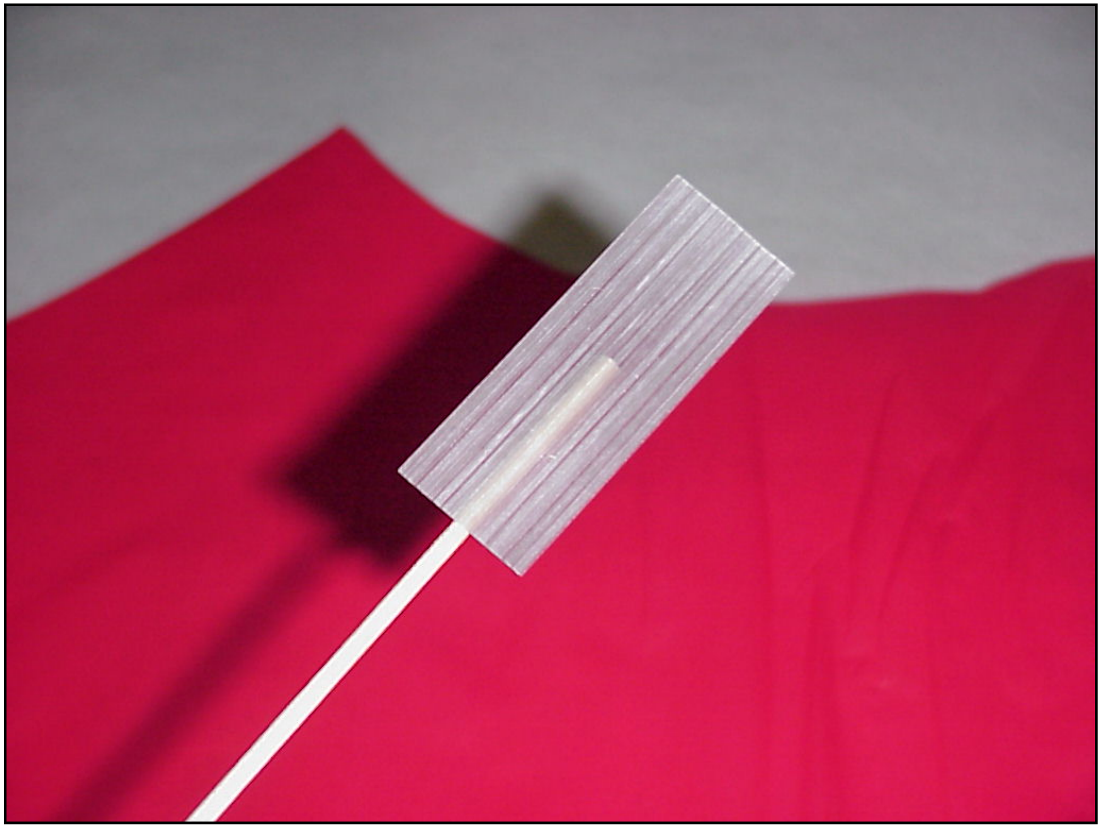
Low aspect ratio indicates short, stubby wings as in the F-117 stealth fighter.

Building the Sled Kite

Position of the dowel rods

Building the Sled Kite

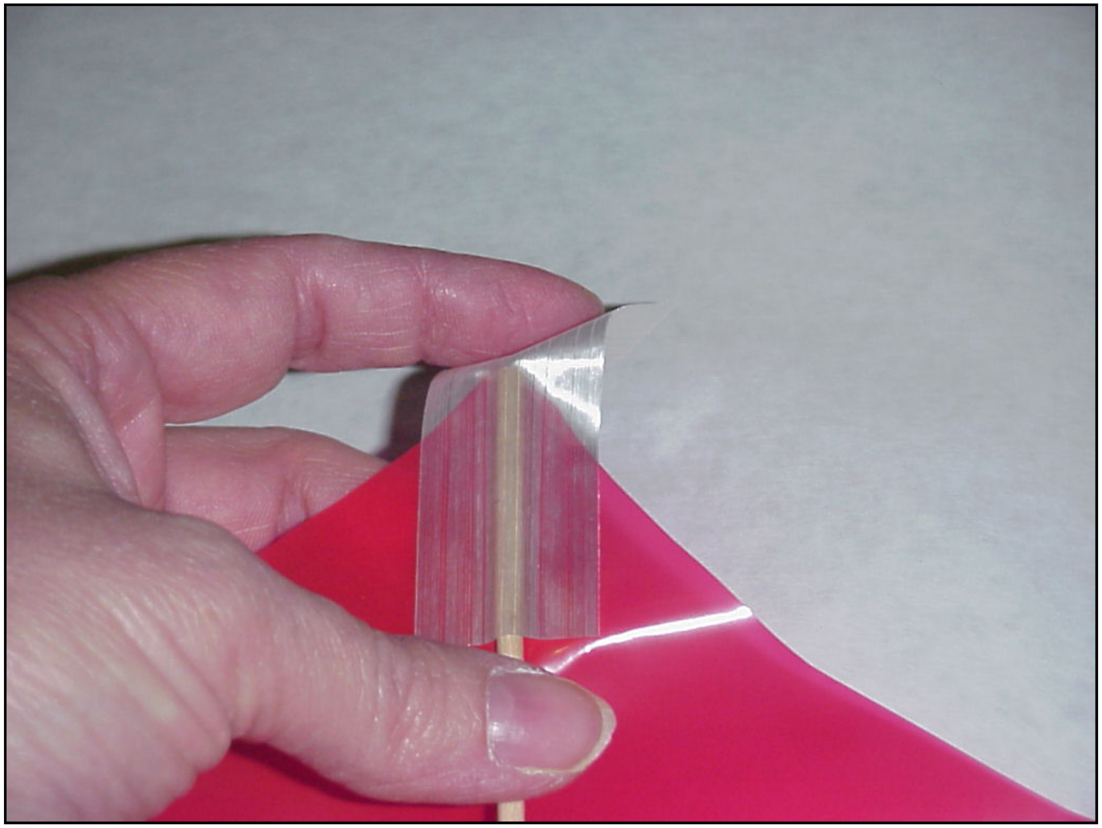
Preparing to attach the dowel rod



NATIONAL MUSEUM
OF THE UNITED STATES AIR FORCE ™

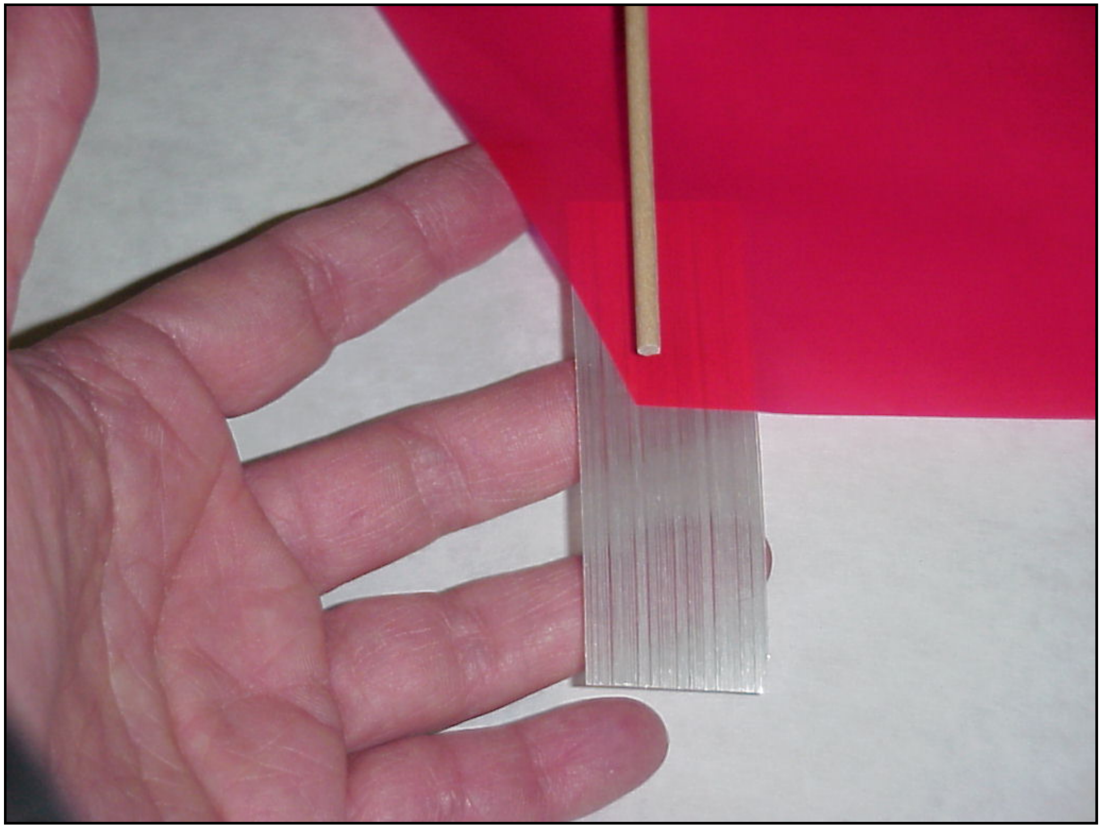
Building the Sled Kite

Attaching the dowel rod



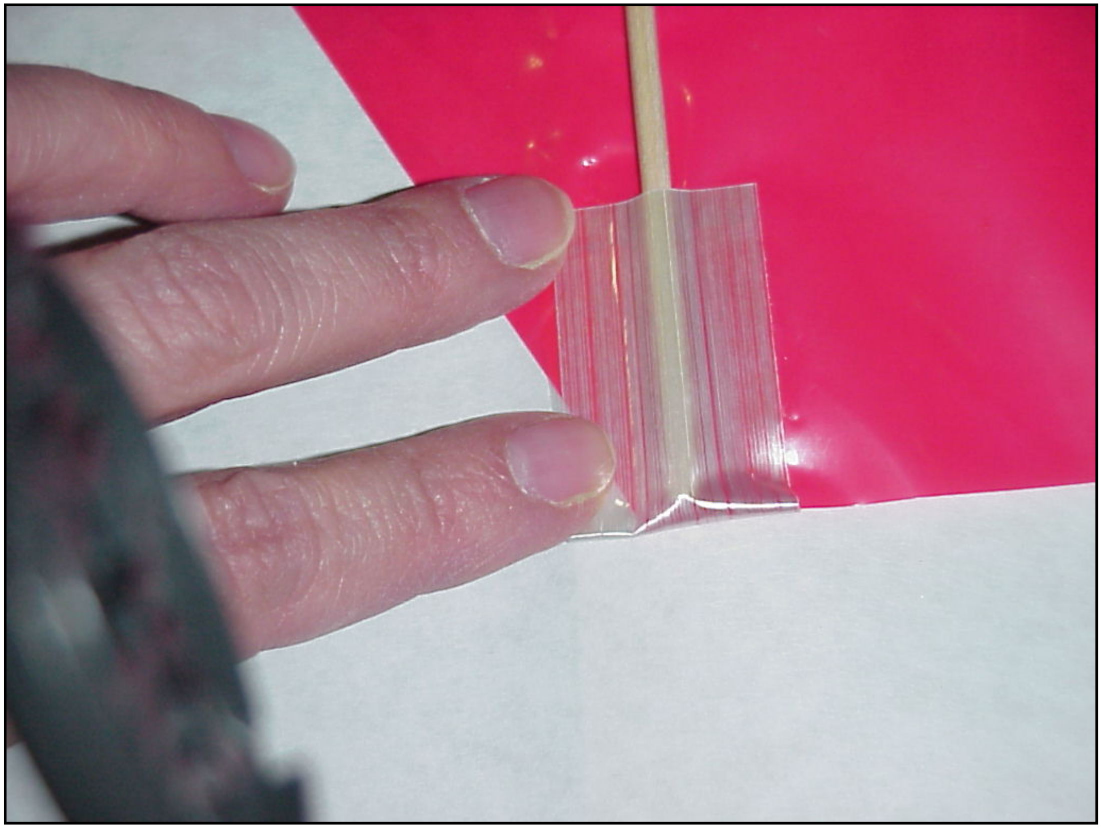
Building the Sled Kite

Attaching the dowel rod



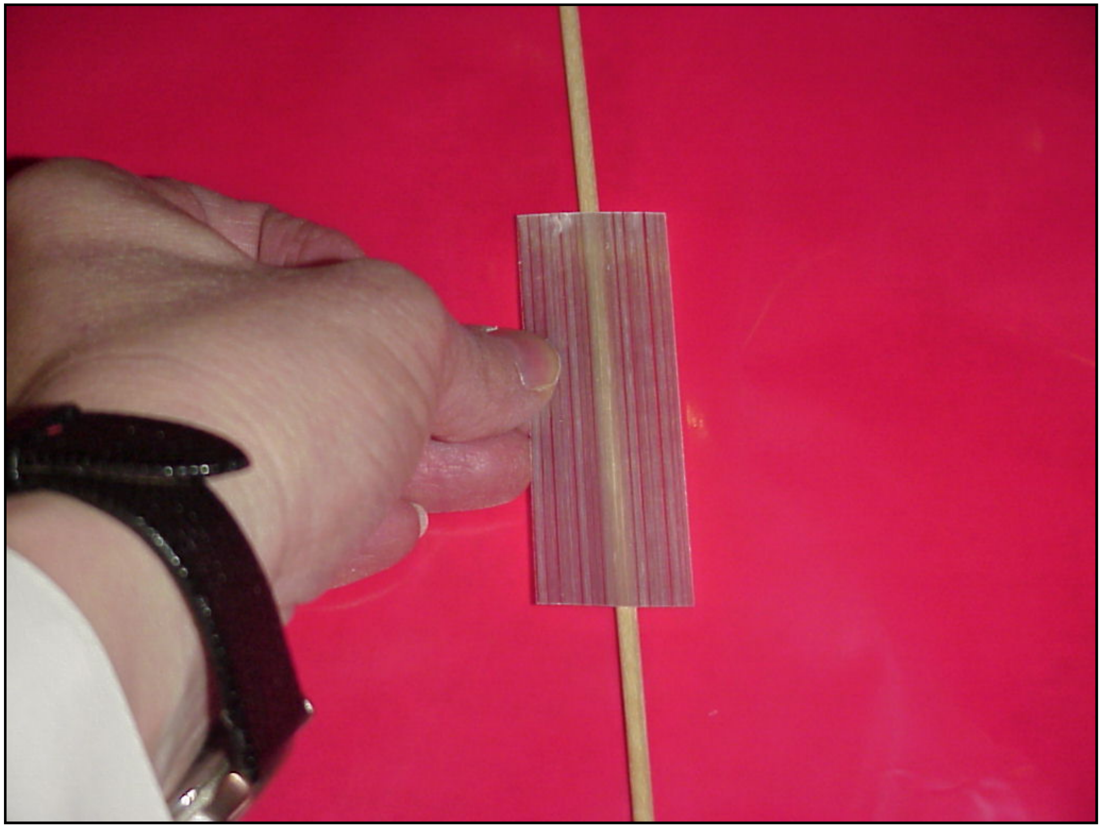
Building the Sled Kite

Attaching the dowel rod



Building the Sled Kite

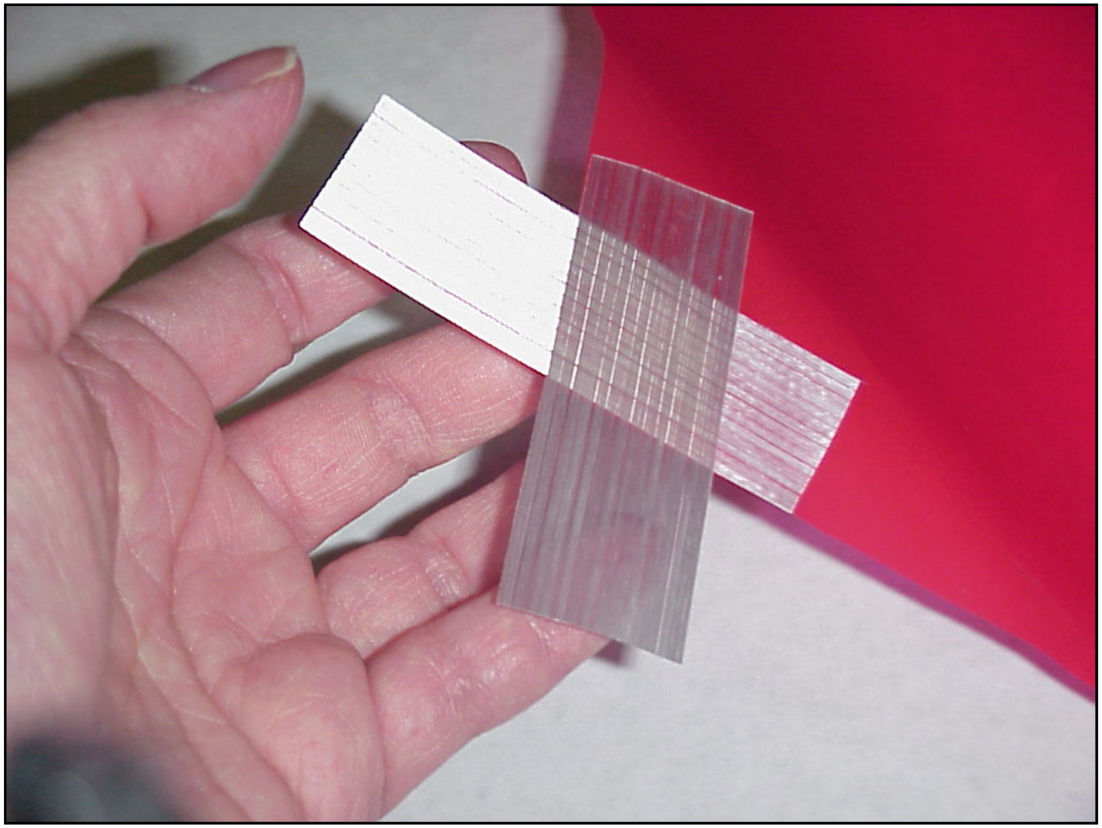
Tape at midpoint along the dowel rod



NATIONAL MUSEUM
OF THE UNITED STATES AIR FORCE ™

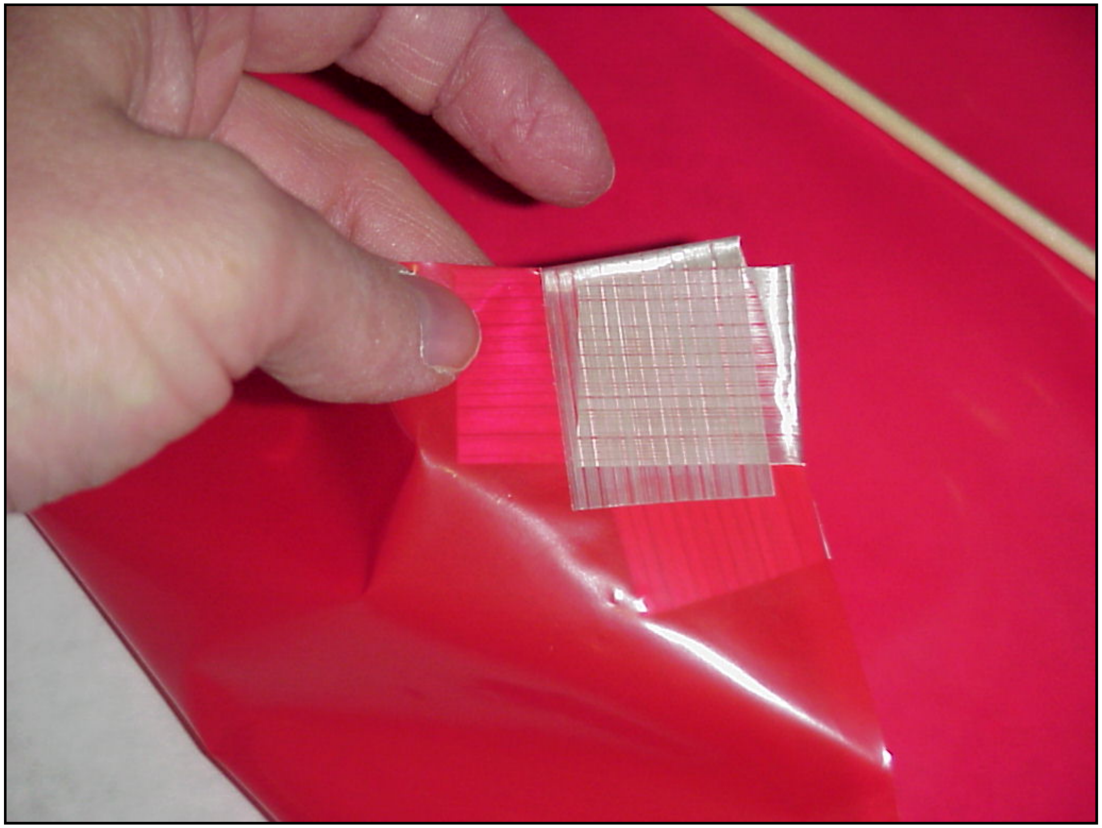
Building the Sled Kite

Tape position to reinforce the corners



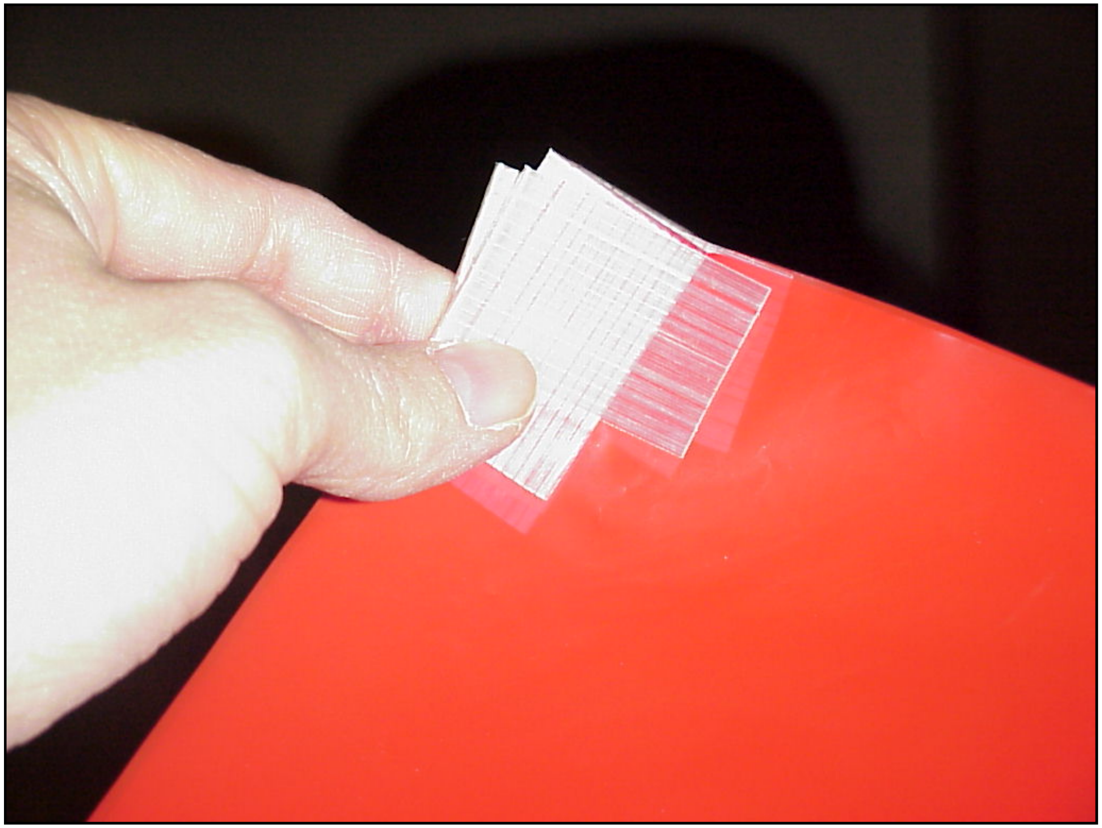
Building the Sled Kite

Reinforcing the corners



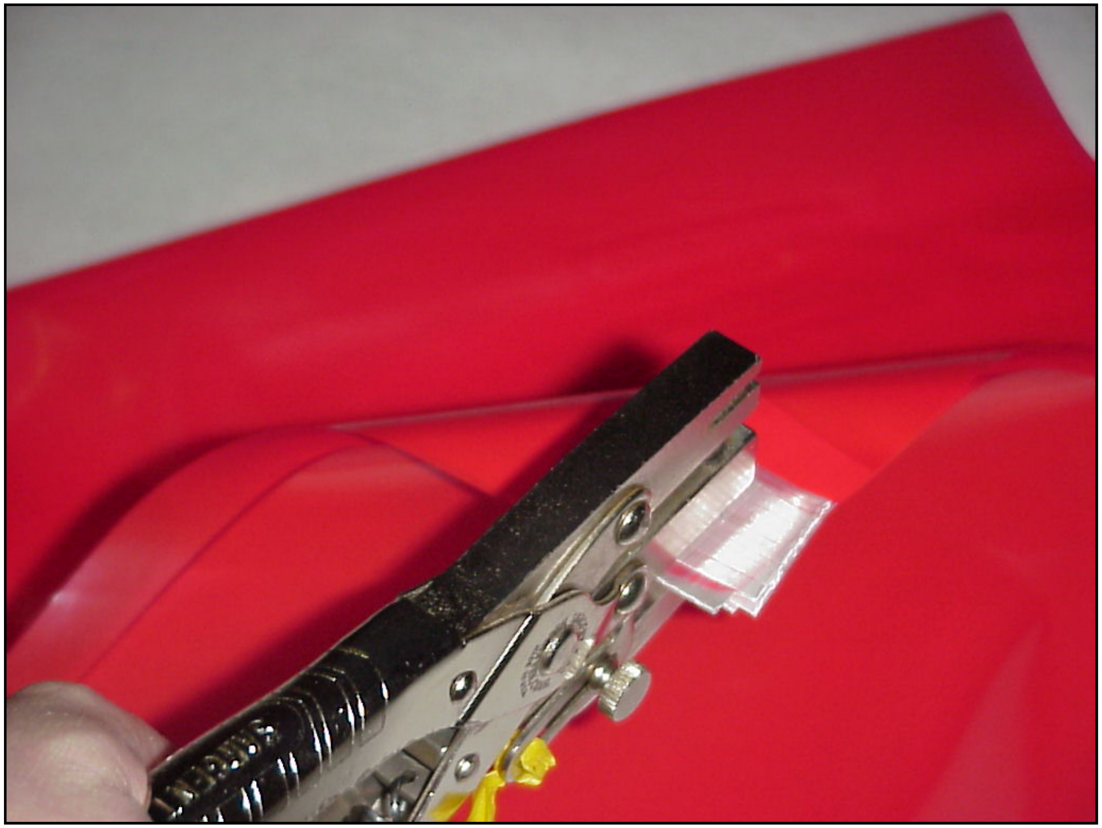
Building the Sled Kite

Lining up the two corners



Building the Sled Kite

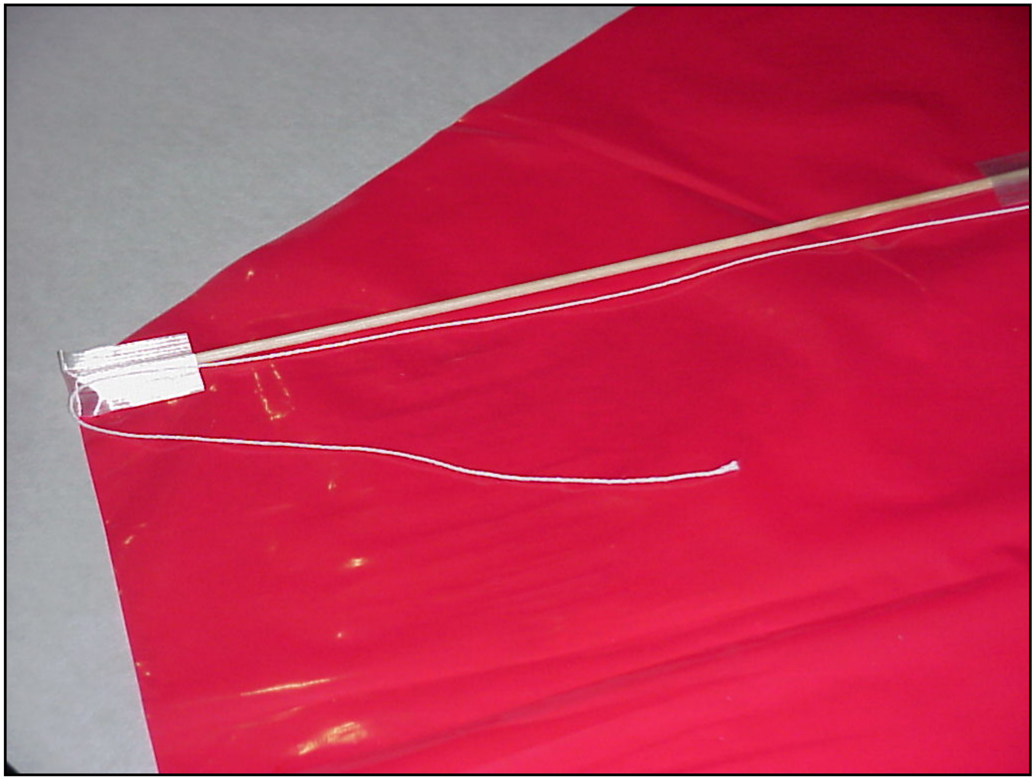
Punching both holes at the same time



Building the Sled Kite

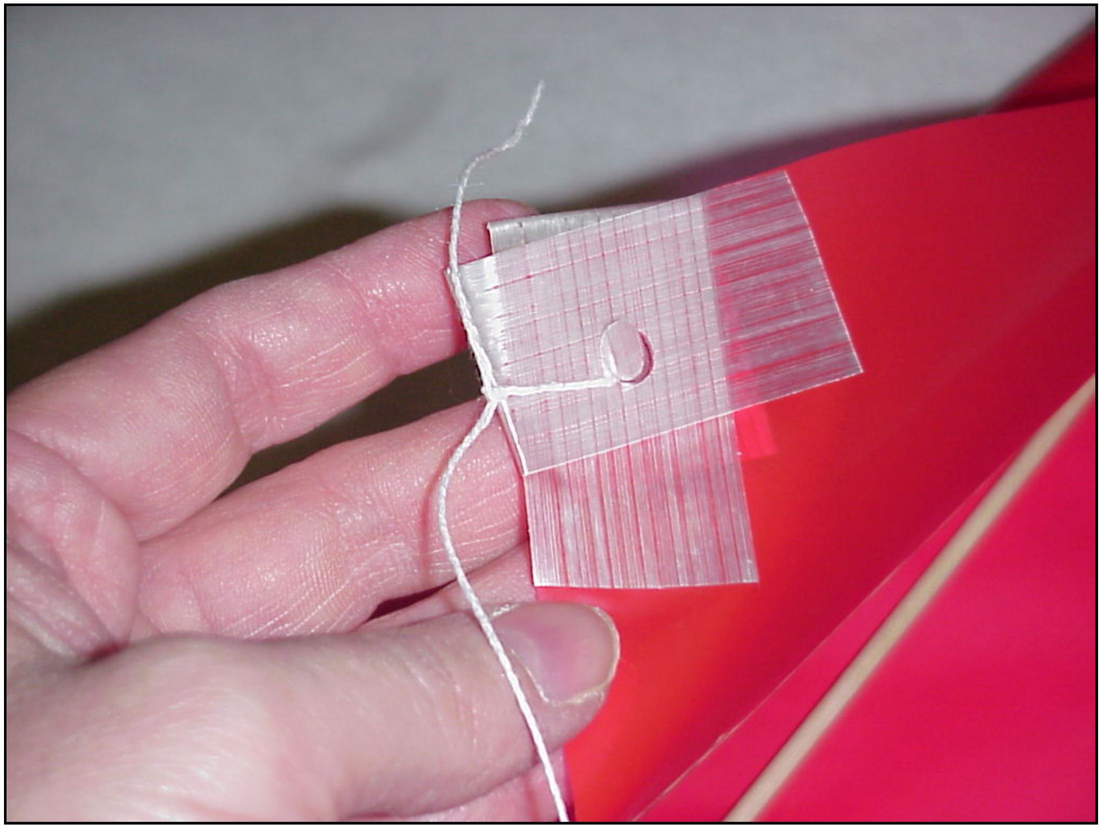
Measuring the length of the bridle

5 times the length of the dowel rod



Building the Sled Kite

Tying the bridle at the corners

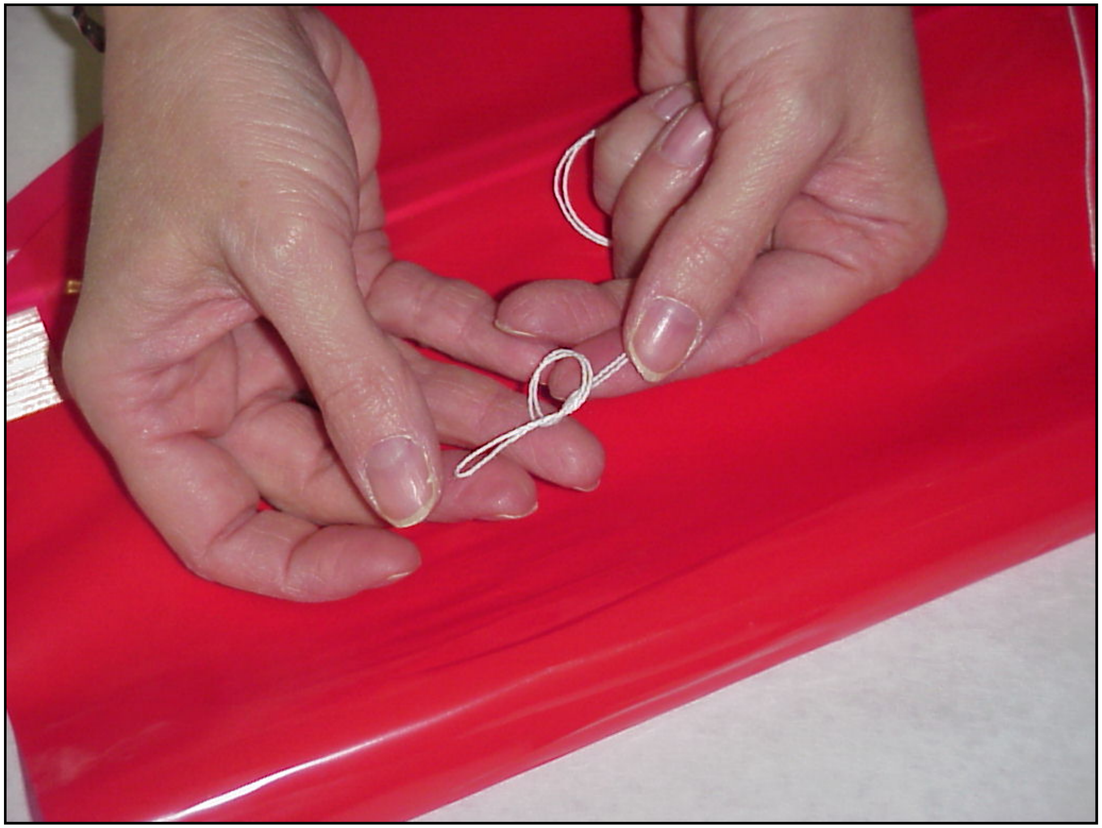


Building the Sled Kite

Locating the mid-point of the bridle

Building the Sled Kite

Tying the loop for the tow point



References

Belsky, Nancy Ann. Building Kites - Flying High with Math. Palo Alto, California: Dale Seymour Publications, 1995.

Greger, Margaret. Kites For Everyone. Winona, Minnesota: Apollo Books, Inc., 1984.

Hosking, Wayne. Flights of Imagination. Washington, D.C.: National Science Teachers Association, 1990.

Michael, David. Step -By- Step Making Kites. New York: Kingfisher Books, 1993.

www.grc.nasa.gov – Beginner's Guide to Kites

More Resources

Additional Teacher Resources
are available online at
http://www.nationalmuseum.af.mil/education/educators/index.asp