Let's Go Fly a Kite!

Examples of Possible Academic Science Standards to Incorporate:

As you read the activities, keep in mind the specifics skills your students need to practice and master in the different grade levels and use them to guide your approach in how you present the activities and what you have the students do. We encourage you to add additional SPIs and Academic Vocabulary in your plans that are outside the specific ones listed below.

Kindergarten:

- 7.11.1 Use a variety of objects to demonstrate different types of movement. (e.g., straight line/zigzag, backwards/forward, side to side, in circles, fast/slow).
- 7.T/E.3 Use tools to measure materials and construct simple products.
- 7.1.3 Take apart an object and describe how the parts work together.
- 7.T/E.2 Invent designs for simple products.

1st Grade:

- 7.11.1 Use familiar objects to explore how the movement of an object can be changed [how forces (push, pull) can move an object or change its direction.]
- 7.T/E.3 Use tools to measure materials and construct simple products.
- 7.T/E.2 Invent designs for simple products.

2nd Grade:

- 7.12.2 Describe what happens when an object is dropped and record the observations in a science notebook. [Realize that things fall toward the ground unless something holds them up.]
- 7.T/E.3 Use tools to measure materials and construct simple products.
- 7.T/E.2 Invent designs for simple products.

3rd Grade:

- SPI 7.11.1 Identify how the direction of a moving object is changed by an applied force and explore how the direction of a moving object is affected by unbalanced forces.
- CU 7.11.1 Plan an investigation to illustrate how changing the mass affects a balanced system and recognize the relationship between the mass of an object and the force needed to move it.

4th Grade:

- 7.11.2 Design an investigation to identify factors that affect the speed and distance traveled by an object in motion. [ex. drag, thrust, gravity]
- 7.11.4 Plan and execute an investigation that demonstrates how friction [drag] affects the movement of an object.
- SPI 7.11.2 Identify factors that influence the motion of an object.

5th Grade:

- 7.11.1 Predict how the amount of mass affects the distance traveled given the same amount of applied force.
- 7.11.3 Design and conduct experiments using a simple experimental design to demonstrate the relationship among mass, force, and distance traveled.
- SPI 7.11.1 Explain the relationship that exist among mass, force, and distance traveled.
- SPI 7.12.1 Recognize that the earth attracts objects without touching them.
- SPI 7.12.2 Identify the force that causes objects to fall to the earth.

6th Grade:

- 7.T/E.5 Develop an adaptive design and test its effectiveness.
- SPI 7.T/E.1 Identify the tools and procedures needed to test the design features of a prototype.
- SPI 7.Inq.1 Design a simple experimental procedure with an identified control and appropriate variables.

7th Grade:

- SPI 7.T/E.1 Identify the tools and procedures needed to test the design features of a prototype.
- 7.11.4 Recognize how a net force impacts an object's motion.
- SPI 7.11.4 Identify and explain how Newton's laws of motion relate to the movement of objects.

8th Grade:

- 7.T/E.5 Develop an adaptive design and test its effectiveness.
- SPI 7.Inq.1 Design a simple experimental procedure with an identified control and appropriate variables.
- SPI 7.12.6 Illustrate how gravity controls the motion of objects. . .
- 7.12.6 Identify factors that influence the amount of gravitational force between objects.

High School: Physics

- 1.1.15 Relate inertia, force, or action-reaction forces to Newton's three laws of motion.
- SPI.1.1.3 Given Newton's laws of motion, analyze scenarios related to inertia, force, and action-reaction.
- 1.T/E.2 Apply the engineering design process to construct a prototype that meets developmentally appropriate specifications.
- SPI.1.1.11 Given a projectile launched at an angle, select the correct equation from a list for calculating: the maximum height of travel, time of flight and/or the maximum horizontal distance covered.

Examples of Possible Science Academic Vocabulary to Incorporate:

Kindergarten:

- Air
- Change
- Observe
- Shape
- Size

1st Grade:

- Balance
- Property
- Push/Pull

2nd Grade:

- Observation
- similarities/differences
- Compare/Contrast

3rd Grade:

- Force
- Atmosphere
- Wind vane

4th Grade:

- Mass
- Friction

5th Grade:

- Gravity
- Dissipate

6th Grade:

- Cause and Effect
- Criteria
- Design Constraint
- Protocol
- Variable

7th Grade:

- Acceleration
- Momentum
- Phenomenon
- Speed
- Velocity

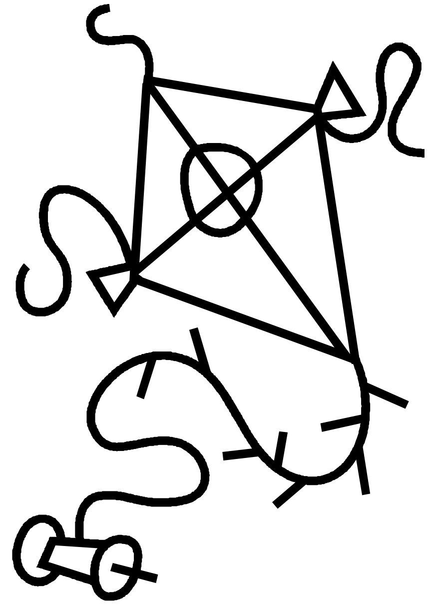
8th Grade

- Variation
- Gravitation

High School: Physics

- Friction
- Current
- Buoyancy

Let's Go Fly a Kite!



Note: There are a large variety of excellent books and resources that could be used in conjunction with this lesson, whether you use books with aerial photography taken by using kites, ex. *Hanging by a Thread* by Craig Wilson, children's literature, ex. *The Story of Kites* by Ying Chang Compestine, or online photo galleries of kite festivals and amazing kites around the world.

Challenge your students to come up with a definition for a kite. Ask, "Class, what is a kite?" Amazingly enough, this question will probably stump your class. Everyone knows what a kite is visually, but many have difficulty explaining it clearly and concisely in words. You can stimulate the discussion with the question, "If you had a friend that lived on the moon, and they had never seen a kite, how would you describe it?"

Your Students Might Say	You Can Ask Them
It's a toy	How is it different from a rubber ball?
It can fly	How is it different from an airplane?
It rises in the air	How is it different from a balloon?
It uses the wind	How is it different from a windmill?
It has paper or fabric	How is it different from your shirt?
It has sticks	How is it different from a fan?
It's lightweight	How is it different from a feather?

Look for the following key ideas that usually come from different students and can stimulate additional topics for discussion:
- Kites are tethered objects using one or more lines
- Kites depend on air moving across their surfaces to fly
- Kites generate lift and have an aerodynamic shape

Definition: According to the Drachen Foundation in Seattle, WA, "A kite is a heavier-than-air craft that depends on the wind to overcome gravity to fly. All kites have one or more surfaces to be acted upon by the wind, a bridle to hold the kite at an efficient angle into the wind, a flying line to keep the kite from blowing away.

Does that definition give students a good mental picture? What definition does your class decide best describes a kite?

Over the millennia, kites have been used to ward off evil, deliver messages, represent the gods, raise banners, discover natural phenomena, propel craft, drop propaganda leaflets, catch fish, spy on enemies, send radio signals, measure the weather, photograph the Earth, and lift passengers skyward.

Kites are used as a fishing aid in the Solomon Islands. In Javanese villages, kites are employed to drive away insects and wild birds in paddy fields. Kites are used by the Koreans to announce the birth of a child. Kites were used by the ancient Chinese during battles. They were made of bamboo and had the tendency to hum and shriek in the wind which frightened the enemy. Kites in the Chinese and Japanese cultures were capable of holding or "flying" a person in the air where the person could spy or act as a sniper using bows and arrows.

There is some debate about where kites originated. Some say China and some say, no, they originated in the South Pacific with the islanders there. Others say Indonesia because primitive paintings depicting people playing with airborne puppets were discovered on cave walls. They are estimated to date from over 3,000 years ago. The Balinese have their own story which explains the origin of kites. Regardless of where they began we are left with a heritage of wonderful stories, designs and techniques for flying kites.

Did You Know?

- In 1820, George Pocock connected several large kites to a carriage and pulled it from Southampton to London. Since road taxes were based on the number of horses used to pull a carriage, he was able to avoid any taxes!
- In the year 169 BC, the Chinese General Han Hsin used a kite to measure the distance between his camp and the wall of an enemy city. His soldiers then dug a tunnel the same distance in order to crawl under the wall and attack from inside. The city was conquered by a kite!
- The largest kites built in Japan are flown in Hoshubana every May. The kites are 36 feet wide and 48 feet tall with bridle lines more than 100 feet long. It takes fifty members of the O-dako (Giant Kite) Association of Hoshubana to launch this giant creation. Each team member is suitably uniformed in a traditional festival jacket that matches the kite. The kite is made from individual pieces of rice paper, each glued together at the edges.
- On February 28, 1889, in Milton Massachusetts, near the Blue Hill Observatory outside of Boston, a large box kite with about 86 square feet of sail are rose more than two miles over the earth's surface. The kite's flying line was piano wire with a breaking strength of 330 pounds. The flight was conducted by meteorologists Henry Helm Clayton and A.E. Sweetland. Eventually they determined that their kite had risen to an altitude of 12,471 feet. Over 100 years later, this record was broken by Richard Synergy at over 14500 feet in August 2000.
- On May 16, 1987, Troy Vickstrom decided to measure the speed of his kite across the beach in Lincoln City, Oregon. The kite’s speed of 108 miles per hour was measured using a police radar gun. Afterwards, the police issued a citation for exceeding the maximum speed in an area with a posted speed of 20 mph. (The ticket was a joke.)

Modern kites are flown mostly for pleasure and sport, in addition to being a folk form of artistic expression. Some interesting traditional International Kite Flying festivals are in Greece, India and

Pakistan. Greeks fly kites on the first Monday of Lent. This is known as Clean Monday. Yokaichi Giant Kite Festival is held every May in Higashiomi, Shiga, Japan. Millions fly kites all over northern India during the Indian festival of Makar Sankranti, a spring festival celebrated every January 14 and a public holiday in Gujarat. In neighboring Pakistan, kite flying is done in Basant -their spring festival. Bright kites fill the sky by the dozens — and sometimes the hundreds — in these worldwide kite festivals. There are single kites, single strings that fly tens of kites, and large, complex creations that require a whole team to get up in the air and flying.There are even kite dances, like aerial ballet, and kite fights, such as those in Afghanistan where the string of the tails of the kites are passed through a mixture of ground glass powder and glue to make them capable of cutting either the tails or the string controlling their opponent's kite .

The kite was the ancestral aircraft that launched manned flight. Wilbur and Orville Wright tested and built their first airplane designs as kites, then flew them as giant gliders. These experiments led directly to their successful 1903 aircraft. Today kites of all shapes and sizes are flown in competitive sports, for military or scientific purposes, and as a relaxing hobby or pastime. Kites are also used to power activities like kite surfing (on water), kite landboarding (on land, with wheels), kite fishing, kite buggying (in sand), and a new trend called snow kiting. Kites towed behind boats can lift passengers, which has had useful military applications in the past. Humans are sometimes bound to a large kite to fly, as many hang gliders are true kites. The first known example is of someone hang gliding on a kite happened over 1500 years ago. Kites are named after the kite bird, a graceful hawk. So, how do they stay up while gravity pulls them down?

A kite might seem pretty simple regardless of how large it is or what shape it may be. There are no wires or microchips, but they actually have a very special design that keeps them soaring, high off the ground.

The form and size of kites are remarkably varied. Some kites can fly in the lightest breeze, while other designs require steady winds. Kites can be made of two sticks covered with a sail material or be very large and have to have a complex framework. Until recently, the materials for constructing kites—bamboo or wood, fabric or paper, and string—had remained essentially unchanged for more than 2,000 years. Today, kites are often built with synthetic materials, manmade ones, like plastic.

How Do Kites Fly?

Show kids an open sheet of paper and another sheet crumpled into a ball. Point out that the two sheets of paper are identical, but that you made one into a ball. Before dropping each one, ask:

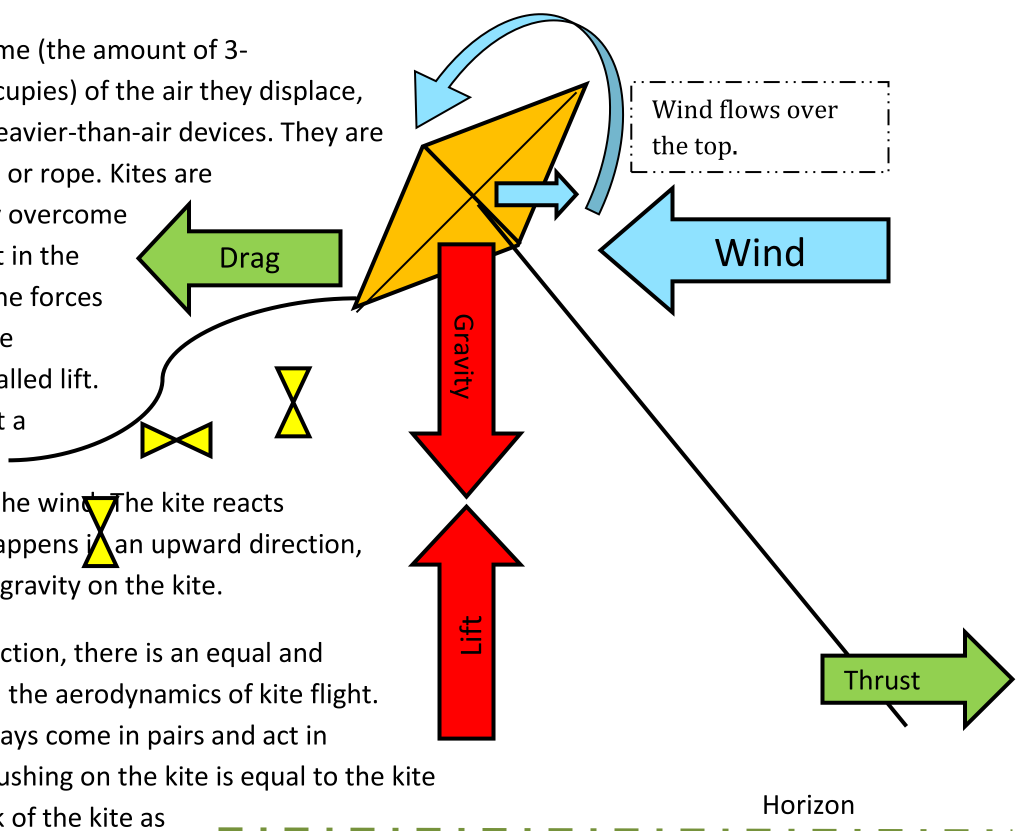
- How will the ball of paper fall when I drop it? (It will fall straight to the ground.)
- How about the flat sheet of paper? (It will drift to the ground.)
- What is the name of the force that pulls the paper down? (Gravity)
- Why did the pieces of paper act so differently when I dropped them? (Air is something! It is made of gas particles, such as oxygen, nitrogen, and carbon dioxide. The open sheet hits **more** of these particles, which slows it down.)

The Aerodynamics of Kites

Three main forces control kite flight: lift, gravity, and drag. One kite may look different than another kite, but the forces acting on all the kites are exactly the same. In fact, with the exception of thrust (The force that propels an object in a given direction, especially when generated by the object itself, as by an engine), the forces acting on a kite are also the same forces which act on an airliner or a fighter plane. Like an aircraft, kites are heavier than air and rely on aerodynamic forces to fly.

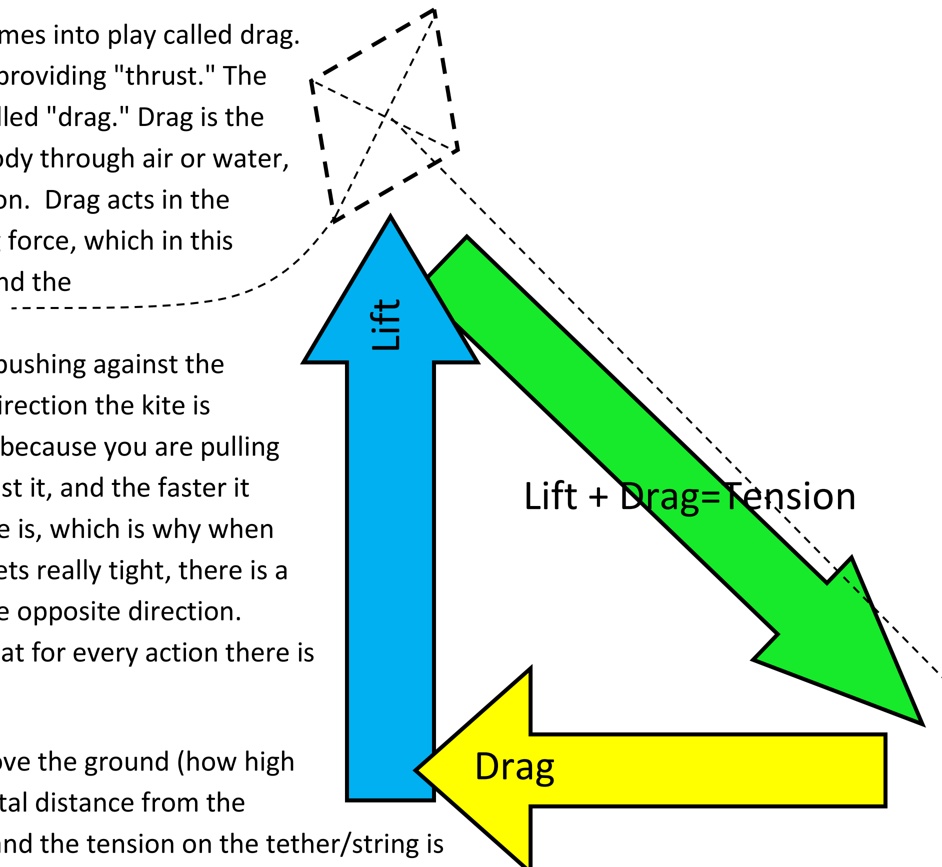
Forces come from something that physically exists. Most of the time, we don’t notice air. Have kids hold up their hands, keeping them still. Then have them wave their hands back and forth. Ask kids what they feel when they move their hands. (They feel the air making contact with their hands.) Have them blow onto their hands and feel how forceful moving air can be.

Kites weigh more than the volume (the amount of 3-dimensional space an object occupies) of the air they displace, that’s why they are called are heavier-than-air devices. They are flown at the end of a string, line or rope. Kites are aerodynes. In other words, they overcome the force of gravity and are kept in the air by the force of the wind or the forces of wind pressure on the kite. The aerodynamic force involved is called lift. Lift on a kite is perpendicular (at a 90 degree angle) to the actual direction of wind and speed of the wind. The kite reacts to the wind pushing on it. Lift happens in an upward direction, opposing the downward pull of gravity on the kite.



Newton's Third Law (for every action, there is an equal and opposite reaction) helps explain the aerodynamics of kite flight. The law predicts that forces always come in pairs and act in opposite directions. The wind pushing on the kite is equal to the kite pushing back on the wind. Think of the kite as flying on an inclined plane (at an angle to the horizontal or horizon) and flying in one spot. The kite exerts a downward force (pushes down) upon the air. The air current created when the wind hits the kite passes over the top edge of the kite and goes down the upper surface of the kite. Remember that air is relatively heavy. As the kite pushes downward on the air, it gets an equal push upward from the air, and it flies! We can think of it as a bit similar to what happens to you on a trampoline. If you stand on a trampoline and don't move, you are in equilibrium, it's pushing up the same amount you're pushing down. In order for you to go up, you have to push down harder on the trampoline, the harder you push down, the harder it pushes you up, and the higher you go.

Now, there is another force that comes into play called drag. As you pull on a kite string you are providing "thrust." The resistance of the kite to thrust is called "drag." Drag is the resistance to a force propelling a body through air or water, basically, drag is resistance to motion. Drag acts in the opposite direction to the propelling force, which in this case is the line pulling on the kite and the wind. Another way to think of it is that drag on a kite, is wind friction pushing against the kite in a direction opposite to the direction the kite is moving, the kite is moving forward because you are pulling on it and drag is pushing back against it, and the faster it travels, the more friction/drag there is, which is why when your kite is flying quickly, the line gets really tight, there is a lot of drag trying to push back in the opposite direction. Remember, Newton's Law states that for every action there is an equal and opposite reaction.



The vertical distance of the kite above the ground (how high it is) is due to lift, while the horizontal distance from the operator to the kite is due to drag and the tension on the tether/string is the direct result of the combined forces of lift and drag.

So, what features help a kite fly? (Key features include being lightweight to minimize the pull of gravity; big enough to catch a lot of air and exert force; strong enough to handle the wind; and flying at an angle so the kite can push on the air and the air can push back on the kite and lift it up.)

Doing it for themselves

Knowing the basic principles can help us learn how to fly a kite and how to design a kite. Also, knowing the strength of the wind and wind direction are useful in developing a knowledge of the basic moves and tricks in kite flying.

The tail of a kite adds to its stability and balance and keeps the kite's nose pointed into the wind. It also acts as a drag. In designing kites one must consider the pros and cons to each element of design. For example, one can eliminate the tail, but bow out the design for stability and possibly achieve greater altitude. Other ways to achieve stability may be in the cover material, the sticks or frames, addition of wings or keels or using shaped wing surfaces. Rudders, airfoil-shaped surfaces and tapering are some other design possibilities.

Explain that today's challenge is to make kites that catch enough air to fly (indoors or out.)

Show the students a sample kite. Point out the sail (body), crosspiece (support bar), tail, and string attachment point. Ask kids to predict how each part helps a kite to fl y. Record their ideas. (Air pushes on the sail. The crosspiece keeps the sail stiff when the air pushes on it. The tail and attachment point keep the sail at an angle so the push of the air lifts the kite up.)

Build kites

Have kids make their kites, following the directions. Give a two-minute warning before the end of the building time. As an alternative, lead the group step by step through the instructions. Doing each step together can minimize confusion and everyone will finish at nearly the same time.

If possible Gather a variety of kites to show the children for ideas in making and modifying their own kites after testing the following design. After the students complete the kite they will go outside and fly their kites to experience the wind lifting their kite and keeping their kite in the air. Encourage your class to make different types and shapes of kites so that as a class you can experience the various aerodynamic forces that impact a kite when it is flown.

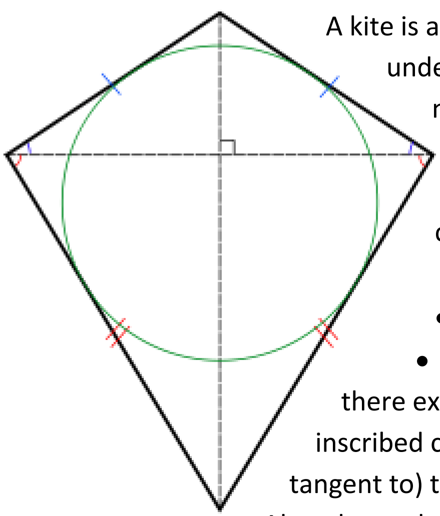
Practice Math Skills:

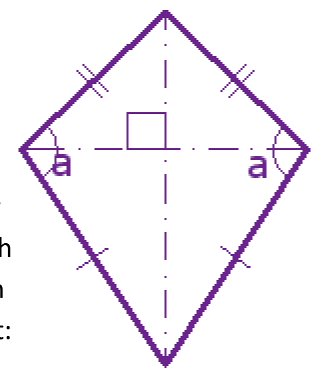
It's all about symmetry, area, and angles. Learning soars as students use mathematical applications when they build, fly, and estimate altitudes of different types of polyhedral kites.

As they test and build their own kite designs or the included designs have students find the perimeters, areas, sides and angles of their kites and convert measurements using the information and techniques below. Which kite design works the best? The one with more area? Which degree of angles are the most effective?

In addition, have students:

- Estimate altitude
- Estimate cost of materials
- Calculate the ratio of weight to sail area for a variety of kite styles.
- Change the size of a kite, scaling all pieces proportionately.
- Measure the size of a kite and calculate its aspect ratio.
- Discuss symmetry and geometry using kites.
- Convert the measurements from English to Metric





A kite is a member of the quadrilateral family, and while easy to understand visually, is a little tricky to define in precise mathematical terms. It has two pairs of equal sides. Each pair must be adjacent sides (sharing a common vertex) and each pair must be distinct. That is, the pairs cannot have a side in common. A kite is a 4-sided flat shape with straight sides that:

- Has two pairs of sides.
- Each pair is adjacent sides (they meet) that are equal in length.
- Has an inscribed circle. Every convex kite has an inscribed circle; that is, there exists a circle that is tangent to all four sides. In geometry, the incircle or inscribed circle of a triangle is the largest circle contained in the triangle; it touches (is tangent to) the three sides.

Also, the angles are equal where the pairs meet.

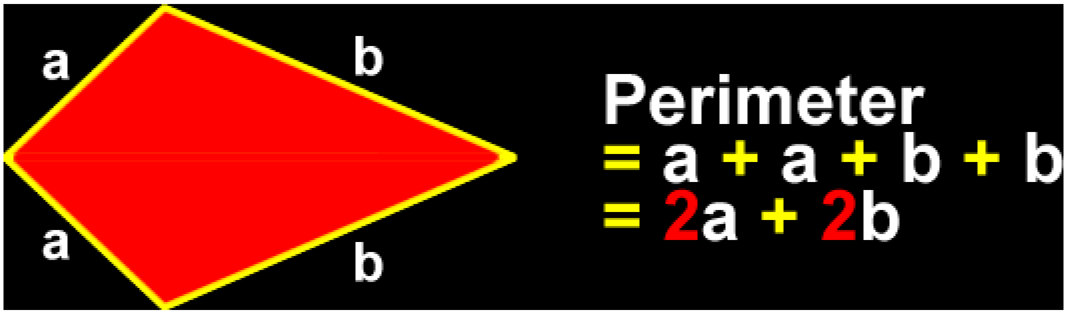
Diagonals (dashed lines) meet at a right angle, and one of the diagonal bisects (cuts equally in half) the other.

FYI: Did you know a kite can become a rhombus?

In the special case where all 4 sides are the same length, the kite satisfies the definition of a rhombus. A rhombus in turn can become a square if its interior angles are 90°.

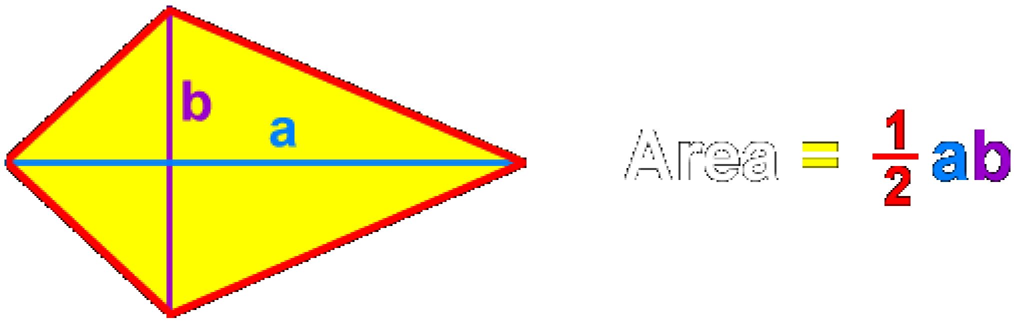
The perimeter of a kite:

To find the perimeter of their kites, teach students to just add up all the lengths of the sides:

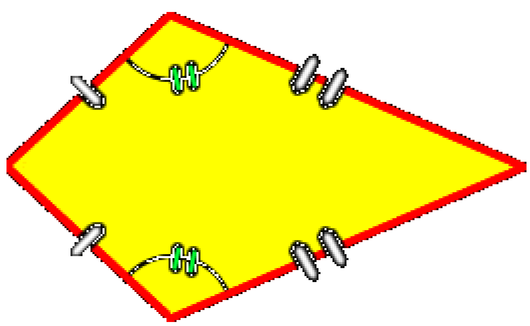


The area of a kite:

To find the area of their kites, have students multiply the lengths of the two diagonals and divide by 2 (same as multiplying by 1/2):



The sides and angles of a kite:



There are two sets of adjacent sides (next to each other) that are the same length (congruent.)
There is one set of congruent angles. These are opposite of each other and are between sides that are different lengths.
On this one, it's kind of hard to put this stuff into words that aren't confusing... So, look at the picture!

Altitude

There are several techniques for estimating/measuring altitude. Older students can calculate the altitude of a kite given the length of the line and the angle of elevation.
altitude = string_length * cosine(angle_of_elevation)

Aspect Ratio

Compare the aspect ratio of different kites, even kites with the same area can have different aspect ratios. An example of this is turning a rectangular kite on its side. The aspect ratio is the comparison of the height to the width of a kite.
aspect_ratio = height / width

Conversion

Convert measurements from English to Metric or Metric to English.

1 foot = .3048 meters

1 inch = 2.54 centimeters

Estimation

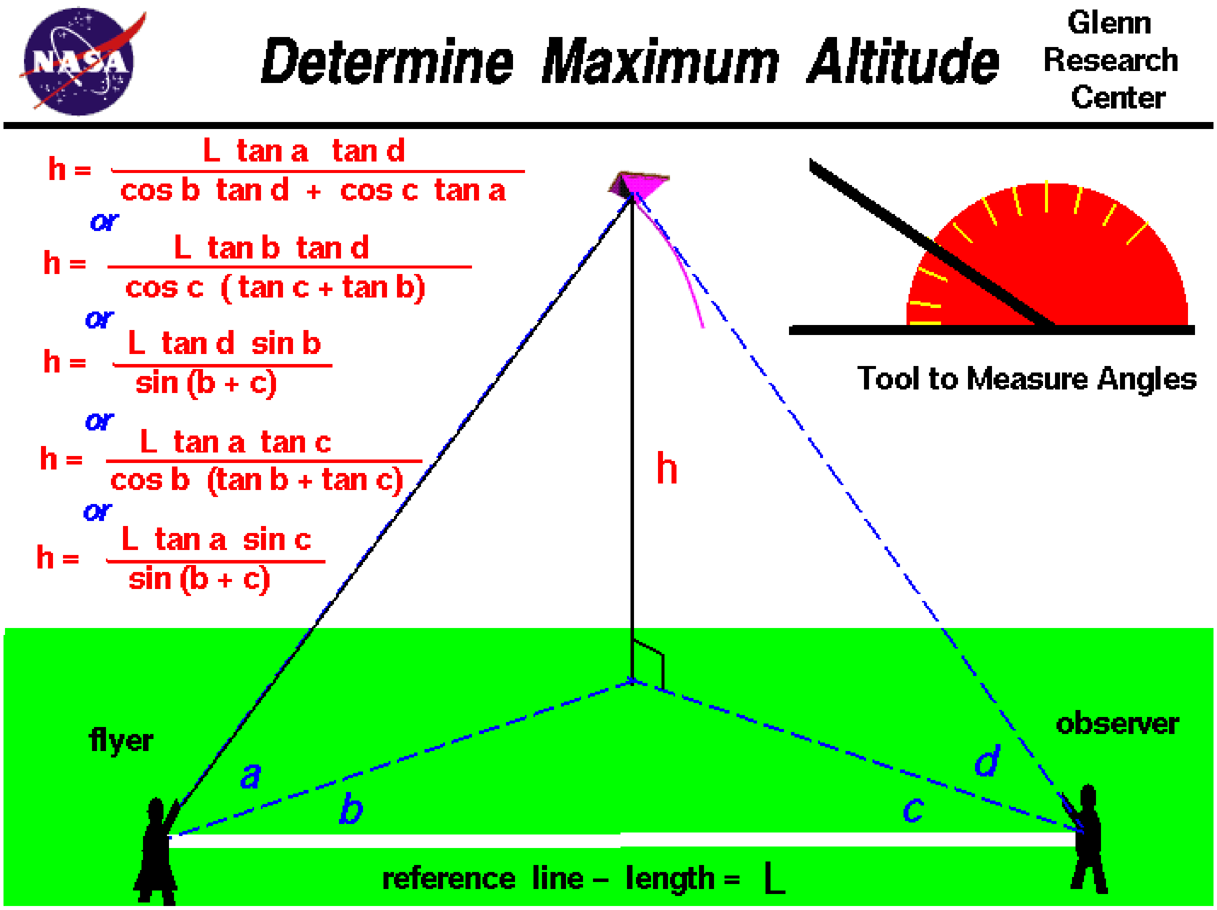
Estimate the cost of the kite based on the amount of materials needed.

Doubling the size of a kite gives four times the area.

Sail Loading

Sail loading is a ratio of the weight of a kite to the size of the kite (area). This tells us how well the kite will fly in light winds. You may wish to calculate the sail loading for a variety of kites. Calculate the sail loading for a single kite, then add heavy tape such as duct tape. Next, recalculate the said loading and try to fly it.

sail_load = weight / area


Determine Maximum Altitude
Glenn Research Center
h = L tan a tan d / (cos b tan d + cos c tan a)
or
h = L tan b tan d / (cos c (tan c + tan b))
or
h = L tan d sin b / sin (b + c)
or
h = L tan a tan c / (cos b (tan b + tan c))
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h = L tan a sin c / sin (b + c)
h
Tool to Measure Angles
flyer
observer
a
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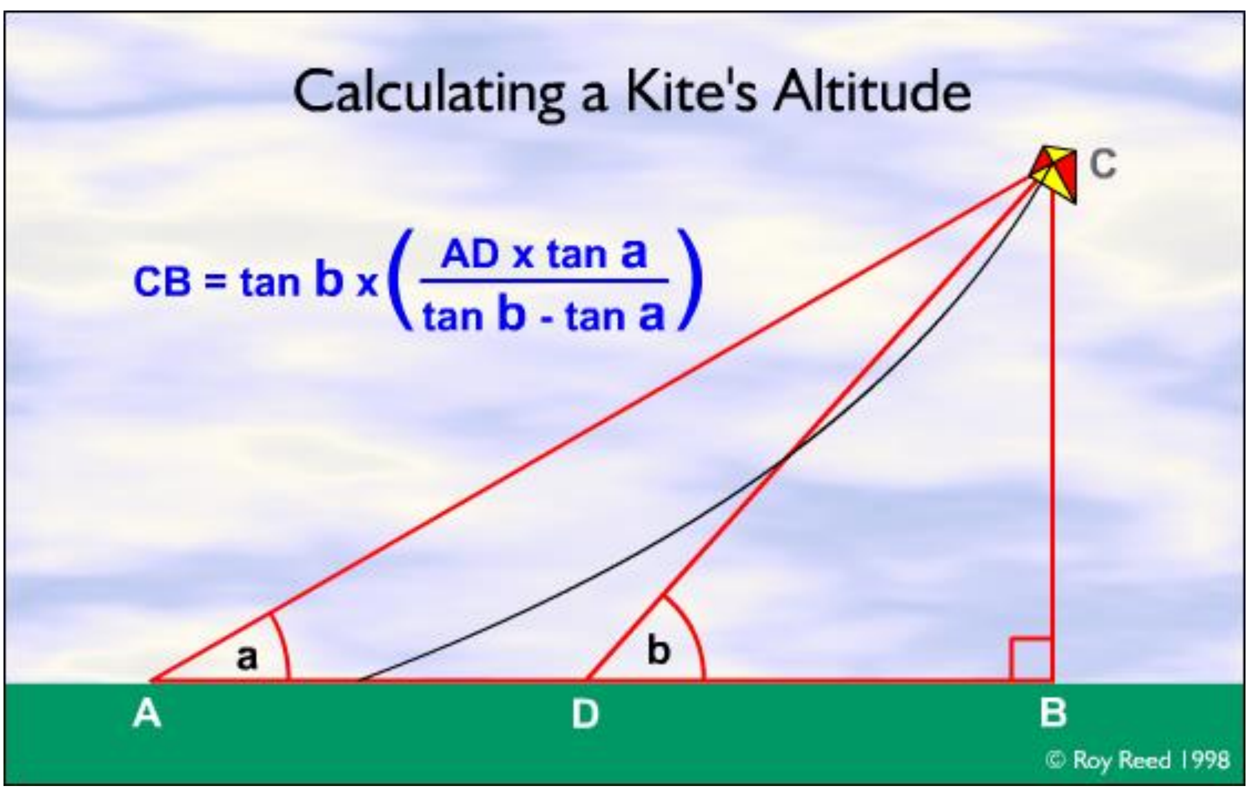
reference line – length = L


Calculating a Kite's Altitude
CB = tan b x (AD x tan a / (tan b - tan a))
C
a
b
A
D
B
© Roy Reed 1998

20 Minute Kite

This stunningly simple kite design comes from Jonathan Socher of Molokai, Hawaii, who regularly builds these diminutive flyers with local school groups.

Materials

- 1 sheet of 8 1/2-by-11-inch brightly colored paper
- Ruler
- Pencil
- 3/4-inch masking or clear tape
- Wire snips
- Thin bamboo skewer (such as used for kebabs) [for a variation, use straws or stiff floral wire]
- Plastic surveyor's tape in a bright color (available at hardware stores) [for a variation, use plastic grocery bags cut into strips]
- Hole reinforcing stickers: optional, or reinforce area with tape
- Hole punch
- 10 feet of string (or more, if flying clear of hazards)
- Small piece of cardboard, pencil, or other material for handle, ex. a popsicle/craft stick.

Instructions

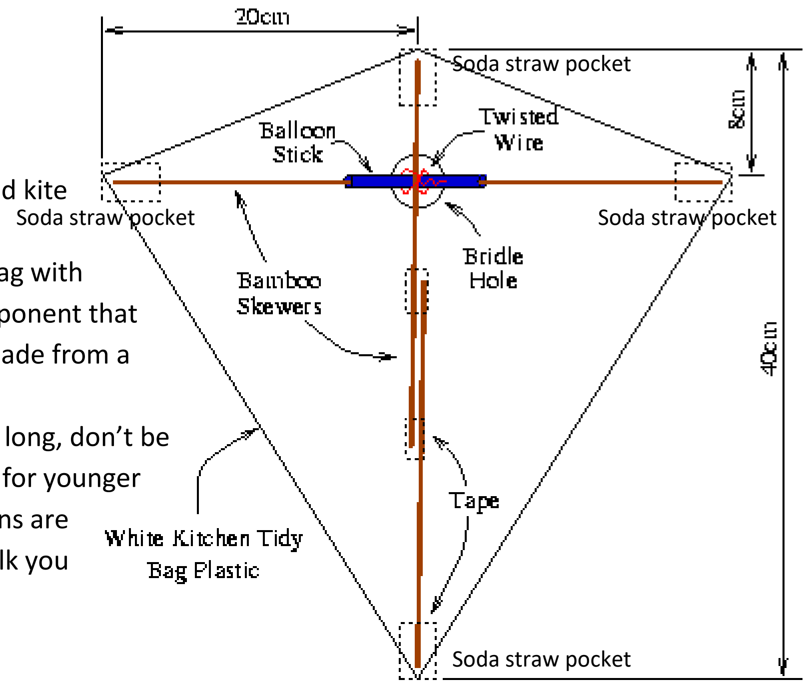
1. 

Fold the sheet of paper in half widthwise. Use a ruler and pencil to measure and draw a diagonal line, as indicated.
2. Place the ruler against the line and crease the paper along it.
3. 
Fold back the top layer of paper and tape along the fold line. Trim any excess tape.

4. Using wire snips, trim the bamboo skewer to 8 inches in length. Position the skewer as a brace across the top back of the kite and firmly tape it down.
5. Cut a 6-foot kite tail from the surveyor's tape. Tape it to the rear edge of the kite. Next, flip the kite over and fold the flap (to which you'll tie the string) back and forth until it stands straight up. [Fold the keel so the wings of the kite are even and balanced.]
6. 

Fold a small piece of tape over the edge of the flap about 3 inches from the top. Punch a hole through the tape 1/4 inch in from the folded edge. Tie one end of the string through the hole. [Always reinforce the string hole with a piece of tape or hole reinforcers.]
7. To make a string winder, tie the other end of the string around the middle of the cardboard, securing it with a strip of tape. Wind on the rest of the string, and you're ready to fly!

Small Eddy Kite



Diamond Kite

Firstly, what exactly is an Eddy kite?
The *original* design was a large diamond-shaped kite from the 1800s which flew without a tail. This diamond kite is basically a white kitchen tidy bag with bamboo BBQ skewers. However the main component that makes this kite work is a dihedral angle joint made from a short bit of ''Balloon Stick''.
While the following directions may look a little long, don't be put off. This is a very simple kite to build, even for younger students if they get a bit of help, the instructions are very detailed and tips are provided so as to walk you through the steps as easily as possible.

Materials:

- Plastic bag
  Small kitchen trash bags come on rolls of 25 to 60 bags, in white plastic. You may want to look for the cleanest looking you can find with the smallest amount of advertising on them. You could also use the shopping bags you end up with every time you shop at the supermarket, though they get very wrinkled in the process.
- Soda Straws: Cut into small pieces, 5cm or smaller, and form a pocket with tape
- 25cm Bamboo BBQ Skewers (4 per kite)
  Make sure that are at least 25cm long, usually sold in packets of 100 for under a dollar, again at the supermarket.
- 5cm of Balloon Stick (plastic tube)
  Only about 5cm is needed for each kite so even bent and broken balloon sticks can still provide enough for 5 or so diamond kites. Balloon Sticks are the cheap plastic tubes, to which balloons are tied to a plastic balloon holder on one end, at fetes and other public events. If you go to such an event you will find handfuls of these sticks thrown away after the balloon has burst. One such event will yield you enough balloon sticks for hundreds of diamond kites, now and in the future. If you must buy them you can find a source at basically any party shop in packets of 100 to 1000 or more!
  You can build this kite without balloon sticks but the kite flies better with them.
- 3 meters of Plastic steamer for tail
  Tip: Plastic Surveyors Pegging Tape sold in fluorescent colors from the local hardware, in 50 or 100 meter rolls works well, though other alternatives work well.
- Twisted Nylon 'Netting repair' line.
  In large fishing and marine shops you can find 500 meter rolls of thin twisted nylon line which is sold for repairing fish netting. One roll for about 5 dollars is enough for about 150 kites, with 30

meter kite lines. But you can also use some other light 'not fuzzy' string, or thicker sewing thread.

- Wire Twist
  A bit of wire to tie the balloon stick to the longeron. The twist ties with the thick plastic coating removed should also work fine too. NOTE: the wire should be easy to twist, IE no too thick. Hot glue had also been found to be an alternative.
- Scotch or Masking Tape
  Tip: avoid the really cheap scotch tape as it seems to go yellow and flake away from the plastic after a month or two. Scotch (magic) tape seems to keep on working unless you drag it though the sand on a beach. Try and get the tape of extra wide rolls (2cm wide) if you can, as it makes taping the spars so much easier. Masking tape is also good and much stronger, but can look ugly, on the finished kite when flying in the sky
- Material for Handle: Cardboard tubes or large craft sticks work well for this.

Instructions:

1. Cut one half the dowel/skewer to fit vertically. This is the Spine. Cut the remaining half in two pieces and trim as necessary for the two cross spars.
2. Sail can be made of any lightweight material: Mylar giftwrap, plastic bag, etc.
3. If using plastic shopping bags or kitchen garbage bags. Make a cardboard/paper/plastic template of the above diamond, 40cm x 40cm with cross spar 1/5th (8cm) from the top. If you also make a small hole at the spar cross point, you can also mark that position when you mark out the patterns onto the plastic. Cut off the bottom of a kitchen tidy bag, (or shopping bag) and down one side of the bag to give you a large sheet of plastic. Tape this flat to your workbench. Layer more plastic sheets, over the first, if you are making lots of kites.
4. Using the template, and a fine tip permanent pen, have students mark the four corners and the spar cross point onto the plastic sheet. Repeat as many times as they can, preferably without any of the advertising that the manufacturers seem to like printing on the bags.
5. Cut out the sails, using a sharp craft knife. Fold the sail twice into rough quarters at the spar cross point (which you marked using the template) and cut off the folded corner in a arc to make a small hole (1-2cm diameter) for the bridle. Option: This step could be skipped, and you can punch the bridle line though the sail later, but if you make the hole anyway it stops the bridle line from distorting the sail.
6. You should now have a stack of 6-8 sails. Cut more, if you want, while you are at it.

Decorate the Sail

Have students decorate the sail with permanent felt tip marker pens . It is easier if you lightly tape the 'skin' to your workbench before you let them at it. Also if decorating large areas ensure it dries well as some of these pens remain sticky for quite some time and marker spreads.

Option: Students can come up with their own designs or younger students can use clean looking pictures, clip-art, sketches, icons, etc., and enlarge them to just fill a letter page, put that page underneath the plastic kite sail, follow the image with a black permanent pen, and then use other permanent pens to color it in. Quick, simple and lots of ideas and designs around.

Making the Dihedral

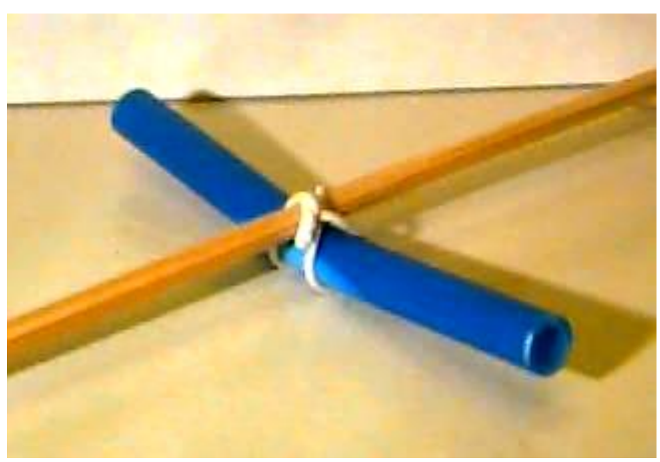
From a balloon stick score and snap off a 5cm length. Hold both ends of the 5cm plastic tube of the balloon stick and while pulling on both ends, put your thumb into the center of the stick to bend it slowing. **Do NOT use your thumb nail!** Alternatively, you can use two bamboo skewers which have been marked 2.5cm from the ends. Insert the skewers into both ends of the tube so the two meet in the middle (use the marks to gage this). You can then use the skewers to slowly bend the balloon stick. Do not do this too fast or you will snap the tube, particularly in cold weather, slow and easy is the trick. The trick here is to stretch the underside of the stick but without puckering or indenting the top (inside of bend) of the stick. This is very important if you want your kite to withstand a higher wind, or sudden really big gust without folding up double. The puckering weakens the bend considerably. Tips: Warm it up using a blow dryer set on HOT, and bend to make a 15-degree angle.

Option: In one variation you do away with the dihedral all together. Just use a straight cross spar. This can be just tied, (or wired) to the longeron (spine), and/or to stop it slipping up the longeron, glued applied to the joint. A longer tail is recommended and this kite will not fly quite as well.

Fixing the Corners

Tape the soda straw pockets to each corner of the sail. As an alternative, use straws that are about the same internal diameter as the skewers. Cut short 1cm lengths of this tubing, and poke a hole into one side at the center of the short tubing. You can use a sharp blade to make this hole an 'X' to enlarge. Push the end of the skews into this hole, so the tube is perpendicular (right angles) to the skewer. Later the sail will be taped over this smooth rounded tubing, rather than the sharp end of the skewer, allowing a longer life span of the kite.

Forming the Backbone



Take two of the bamboo skewers and with the points toward the center measure them to form one long spar 39.5 cm long (5mm shorter than the kite sails height). This will form the diamond kites longeron, also called the kite's spine, or backbone. Using scotch (magic) tape or masking tape, tape the two skewers together around the pointy ends so that it is tightly held and can't stick into anything it shouldn't. See the plan diagram above. Wire the plastic dihedral you made from bending a balloon stick, to middle of one of the skewers (IE: toward one end of the final spar, not where the two skewers overlap. using telephone wire or twist tie.) The dihedral should angle up away from the spar, like the wings of a glider. Upwards, not down. Option: Hot glue also works very well. You will however have to correctly position the dihedral as you are gluing, as you cannot slide it to the right point afterward.

No Dihedral Option: If you are making this kite without the balloon stick tube dihedral, just tape the second two pairs of skewers together in the same way you did for the longeron, tape them to the sail, then wire that pair to each other in the same way as the dihedral is wired above. The kite will fly fine, though a longer tail is recommended.

Taping Spars to the Sail

Tape the longeron (spine) to the decorated kite sail starting at the top of the kite. The dihedral wired to the longeron should be at the same end. Attach a 5-7cm length of tape (the wider variety if possible) to the front of the kite and with the spar in place fold the tape over the corner of the sail, and the end of the spar on the back. Press the tape to the kite sail really well on both sides of the skewer. The harder the better. Then do the same with the other end of the longeron.

When doing this try and tighten the sail, but not so much that it stretches, just taunt.

If the scotch or masking tape you are using is not wide enough, tape another piece of tape across the spar at the back to hold the first piece of tape in place.

If you wired the dihedral to the longeron, slide it so it lines up with the hole in the kite sail. If you hot glued it to the spar, it should already be in the right position.

Then with the other two bamboo skewers cut off the pointy end to form the cross spars about 19.5 cm long (5mm too short). Insert the ends of each of the two shorter spars into the side pockets. Turn the ends of the two shorter spars downward a bit, and insert the ends into the spar connector/dihedral. Tape them down, in the same way as the longeron. Repeat with the other side, pulling the kite sail taunt.

NOTE: The spars are intentionally a few millimeters too short so that the corner plastic can also cover the rounded end of the skewer. This also helps prevent the skewer punching though the scotch tape.

Bridling the Kite

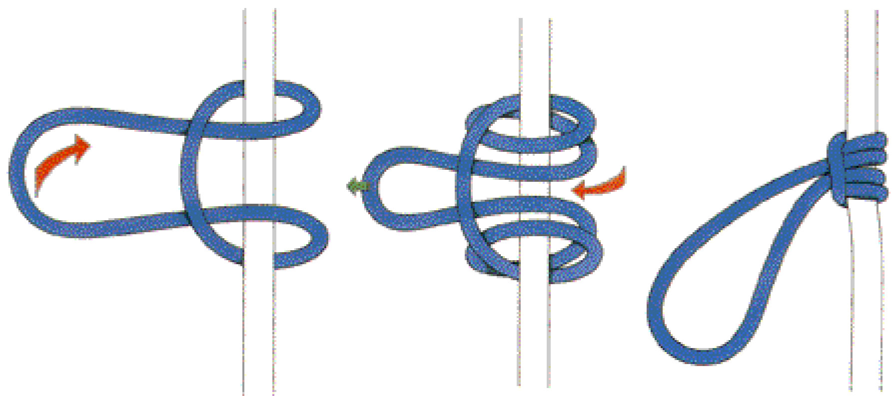
Note: For diagrams of the kinds of knots used, a good reference source is the Kite Flier's knot gallery at http://gamma.nic.fi/~sos/knots.htm. These four knots are all a kite flier needs. By clicking the thumbnail image you'll get a better JPEG-image. TIP: You may want to show a demonstration of the various knots (using a good length of rope) to the students before you begin.

Cut a length of about 60cm of nylon twisted fish netting line for the kites bridle. If you use this kind of line, you will need to use a cigarette lighter to cut the line so as to prevent the line untwisting.

With a large needle (or a broken bamboo skewer) thread one end through the sail (and scotch tape) 2cm from the bottom of the kite, and tie it around the longeron (spine), pulling tight. Tie the other end around the dihedral and longeron though the hole in the sail. The bridle line is of course as with most kites on the front of the kite with the spars at the back.

Cut (burn) off a 10 cm length of nylon fish netting line, and make a loop using a large figure-8 knot. This knot will be a stopper knot which you can larks head the bridle line to.

Prusik Knot the loop onto the bridle line and then adjust its position as shown in the diagram below.



Tying loop to bridle with Prusik Knot

If you cut the bridle line about 60cm long before tying it to the kite, the bridle point should be almost directly above the dihedral of the kite. The kite is very forgiving of this point and will fly well on a badly positioned bridle (important with kids).

Later the kite line can be attach with a "larks head" onto the loops 'stopper knot'

Note: To make the instructions simpler for a younger class situation you can also do away with the complexity of the bridle. Just have the students tie the flying line directly to the cross spar, THROUGH the hole in the kites sail. Note: you will find even with that instruction a number of kids will tie the line from the back of the kite, which will NOT work. So keep an eye out and make sure they do it right. A longer tail is also recommended.

Attach a Tail

Use fluorescent surveyors tape and cut off a 3 meter length of plastic streamer and thread it behind the longeron spar of the diamond, twice, at roughly the center of the streamer. You do not need to tie a knot in the steamer, just loop it around the spar will hold it in place.

Tie your flying line around the spar connector and spine. (Insert the line from the front of the kite through the hole, wrap the line around both the connector and the spine, and go back out through the front. Tie a good knot in the front.)

Flying your New Kite

Tie a generous loop into the end of about 15 meters of that fish netting nylon line (add a small pull handle to tip of the loop), and larks head this to the stopper knot (see the Knots section above for more details).
Have students tie the other end to a bit of cardboard tube or other handle material, such as a large craft stick, to give the students a good handle to hang on to. Option: Also cut some slots into one end to hold the end of the line when you wind it up and detach the kite.

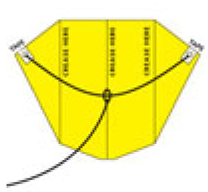
Hint: After tying a generous loop in the end of their flying line have students tie a very very small knot in the very tip of the large loop. This small knot creates a small 'handle' which you can grab to very quickly untie the larks head. This saves you the frustration of try to use your fingernails on such small and difficult nylon line when untying it at the end of the day.
The only adjustment that may be necessary is to slide the prusik knotted bridle loop in the bridle line 5mm at a time, downward, if the kite does large loops, or upward if the kite refuses to rise or wobbles side to side. To adjust the bridle, ''unlock'' the prusik knot by pulling the bridal line straight and sliding the knot. When positioned, pull on the bridle loop while folding the bridle line in half at the knot, to ''lock'' the prusik knot.
If the knot is positioned just above where the spars cross, or maybe a little further up from that point (See bridling) the kite should fly perfectly. The kite is very forgiving with a large range of acceptable bridle points, so a roughly positioned bridle should work fine.

The Easiest Kite Ever. Really!

Materials

- Kite template printed on an 8 1/2- by 11-inch sheet of office paper
- Scissors
- Clear tape
- Single-hole punch
- Embroidery thread or kite cord
- Stapler
- 5-foot-long ribbons, made from surveyor's tape

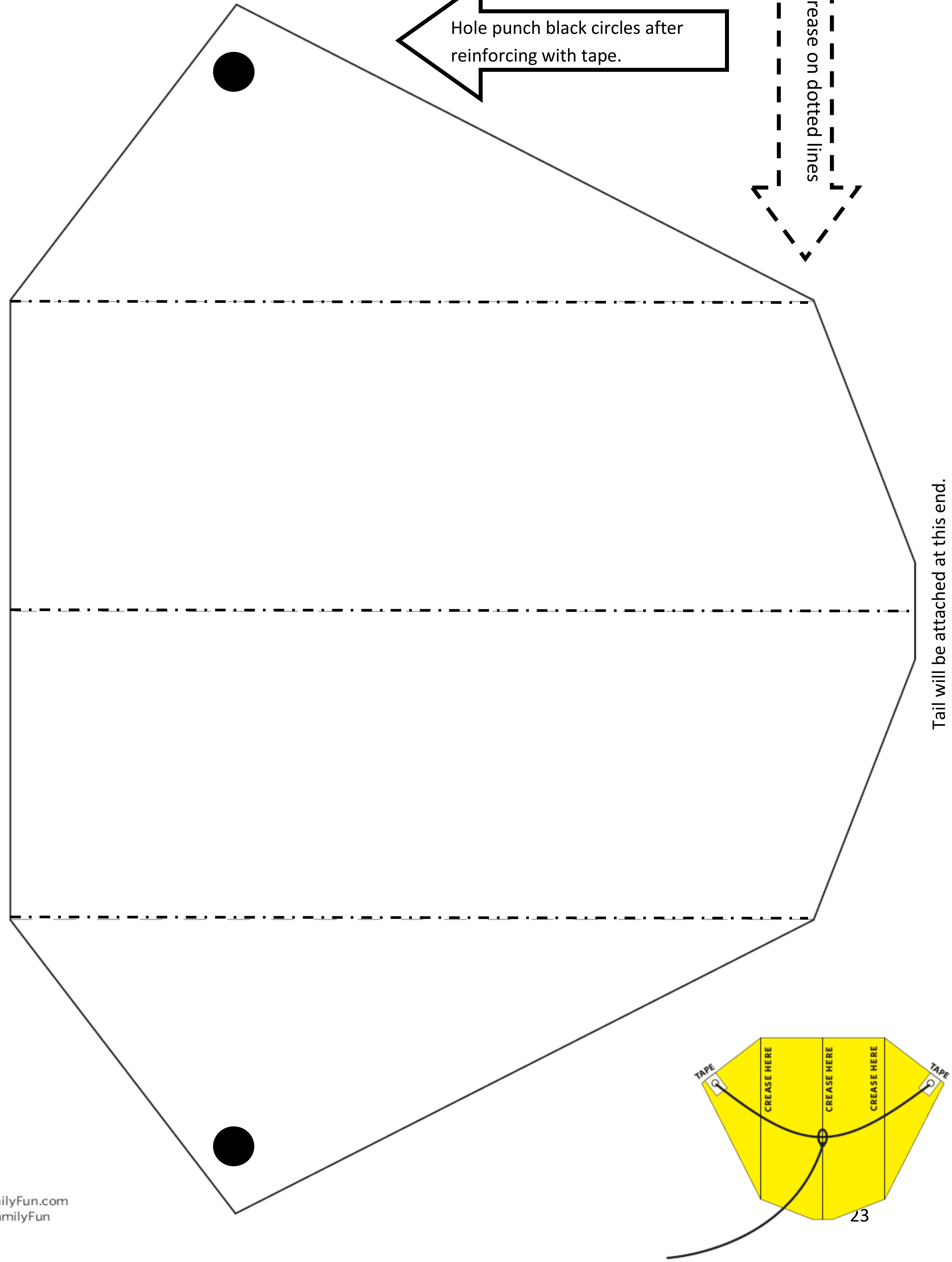
Instructions

1.  Print out enough copies for students.

2. Have students cut them out, following the black line around the edge, then make creases as shown on the dotted lines. Reinforce the side points with tape as shown, then punch a hole in each point.
3. To make the kite harness, tie the ends of a 2-foot length of embroidery thread or kite cord to the holes.
4. For the kite string, tie one end of a length of thread or cord to the harness. Make the loop loose so that the string slides easily along the harness.
5. Staple the ribbon to the bottom of the kite for a tail.

Hole punch black circles after reinforcing with tape.

Crease on dotted lines



Tail will be attached at this end.

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Test predictions by flying kites.

Have kids experiment with how fast they need to move to keep their kites flying. What forces affect them, etc.

The original designs are very light weight, and strong winds tend to make the kite loop and dive, thus is very difficult to get it to fly well in such winds. Here is a problem chart, to try and help solve such flying problems.

Problem: Kite does not rise (does not loop just wobbles side to side)
Reason: Bridle point is too low
Solution: Move bridle loop up 5mm at a time until it rises.

Problem: Tail is too long and heavy
Solution: Try shortening it, or removing one half of the double tail.

Problem: Wind is too light for the kite (rarely with either plan above)
Solution: Let the kids run with it, or try another day.

Problem: Kite zooms upward then loops and dives, repeatedly
Reason: Bridle point too high
Solution: Move it down little by little

Problem: Wind is too strong
Solution: Add longer and heaver tail, or try another day.

Re-design

Challenge them to change one thing about their kites to make them fly better, test them, and then discuss what happened.
Examples:

- They can add some bows to the tail to give it weight. Remember the tail has the important job of pointing the kite toward the wind.
- Decide on a new shape or form. Kites come in various shapes and forms. The variations are endless but the basic forms are: flat or bowed, box or cellular and semirigid or nonrigid.
- Design the sticks and frames for the kite. Remind them to make sure it will be a strong frame but also be light weight.
- Choose a cover material. Remember, strong but light!
- Remind them to choose and think about how they will stabilize their kite. Will their kite have a tail? Will they use a drogue or wind cup which catches the air and acts as an anchor, which stabilizes the kite.

- Will they bow their kite? Bowing can be one of several things. It can be a smooth curve or an angle at the center of the kite. It can also be angles somewhere else on the kite. The bowing can be subtle or exaggerated. The bowing tends to stabilize the kite.
- Will they vent their kite? Venting is deliberate openings in the covering material of the kite. Venting allows some air to go through the kite and can add stability to some kites.

Bring the group back together and discuss:

• When air pushes on the bottom of the kite, how does the kite move? (Upwards)
• How did you get air to push on the bottom of your kite? (By pulling it through the air)
• What are some ways to improve how a kite flies? (You can increase the amount of air pushing on the kite by increasing the sail size or adjusting the flight angle. You can also minimize the effect of gravity by reducing weight.)

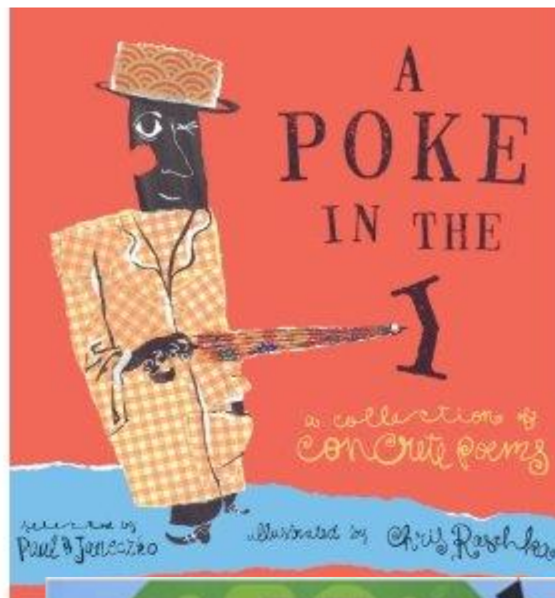
Review the activity's key ideas by asking everyone the following questions.

Option: Each question is worth 50 points. Whenever you hear an acceptable answer, award 50 points to the entire group.
• Do something that demonstrates gravity.
(Kids can drop a pencil or jump up and down.)
• Name two things that depend on moving air to stay airborne. (Birds, airplanes, kites, paper airplanes, hang gliders, etc.)
• When you skip or walk faster, why does your kite go higher? (It goes higher because there is more air pushing on the kite.)
• What's a possible advantage and a possible disadvantage if you tripled the size of your kite? (The larger size would catch more air, which could be an advantage. It would also weigh more, which might be a disadvantage.)
• Doing science and engineering involves making predictions, testing them (which includes doing something, making observations, and drawing conclusions), and sharing your results. Give an example of how we did these steps today. (Answers will vary.)

Tips:
Running with a kite really is not a good way to launch it. Instead, one should opt for a high start launch, in which one flyer stands about 100 feet (30 meters) downwind, with the kite facing bridle-side to the other flyer, who holds the end of the kite's line. With a steady breeze behind, a small amount of

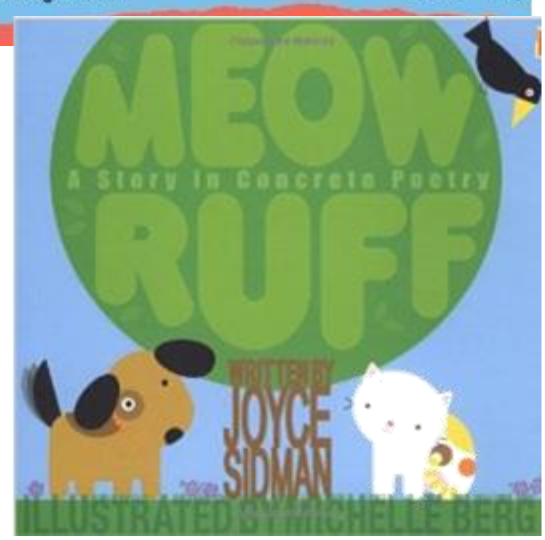
tension placed on the line allows the kite to rise effortlessly upward. A kite may also be self-launched by letting the kite fly from the flyer's hand as it takes out line.

- Stand with your back to the wind. Hold your kite up by the bridle point and let the line out. If there is sufficient wind, your kite will go right up. Let the kite fly away from you a little, then pull in on the line as the kite points up so it will climb. Repeat this until your kite gains the altitude necessary to find a good steady wind.
- Light Wind? Have a helper take the kite downwind and hold it up. On command, the helper releases the kite and the flier pulls the line hand-over-hand while the kite gains altitude. Practice this high-launch technique.
- No Helper? Prop the kite up against a bush, post, or wall. Reel out enough line for altitude and simply pull the kite aloft.
- If the kite sinks tail first, there might not be enough wind. If it comes down head first or spins, there might be too much wind. Different kites fly in different winds.
- Bridles: If your kite has an adjustable bridle, move it higher (nearer the top) in higher winds, and lower (towards the tail) in lower winds. (Adjust no more than 1/2" at a time.)
- Tails: Adding tails to your kite helps it remain stable in stronger winds. Use light-weight materials so you can use lots! Looks great!



Taking Shape

Many excellent resources are available to introduce students to shape/concrete poetry, for example, *Meow Ruff: A Story in Concrete Poetry* by Joyce Sidman and the amazing *A Poke in the I: A Collection of Concrete Poems* by Paul B. Janeczko [Here in a single extraordinary volume are thirty poems from some of the world's finest visual poets, including John Hollander, Emmett Williams, Maureen W. Armour, and Douglas Florian—a spirited "poke in the I" brought to you by the very talented Paul B. Janeczko and Chris Raschka.]



What on earth is a concrete or shape poem? Shape Poems are an unusual form of poetry, in that the arrangement of the poem's words on the page (or screen) forms an actual recognizable shape or picture. And well, for one thing, it's a lot more playful than a regular poem. It is a form that is both challenging and fun—rather like creating and solving a puzzle. The arrangement of letters or words, or the way the type--and even blank space--is placed on the page, or the typefaces chosen...all of these things can contribute to the creation of a shape poem.

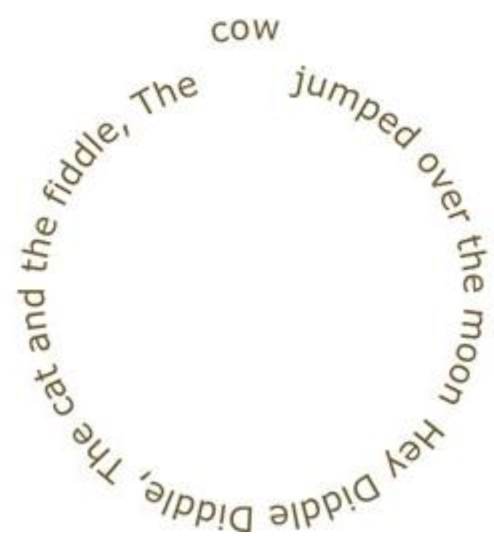
Shape poetry is poetry in which the visual arrangement of the words that make up the poem is just as important in conveying the intended effect as the conventional elements of the poem, such as meaning of words, rhythm, rhyme and so on. Shape poetry is also sometimes referred to as visual poetry, poetry in which the visual elements are as important as the text.

Shape poems startle and delight the eye and mind. The size and arrangement of words and letters can add or alter meaning — forming a poem that takes the shape of crows that fly off the page or becoming a balloon filled with rhyme, drifting away from outstretched hands. It is common for the poem's shape to show, or take the form of the poem's theme or subject, but it is not a requirement. Some funny shape poems deliberately challenge this convention for humorous effect. The term shape poem neatly ties the poem's form to its description, poems shaped by their subjects that wind, bump, and wiggle across the page, so we'll stick to calling them shape poems, rather than the other most often used term, concrete poem. That just makes it sound heavy.

So far, so simple, right? It's never that simple, is it?

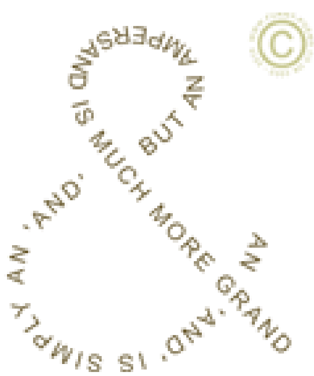
Getting twisted

There are two really quite distinct types of shape poetry, twisted shape poetry and true shape poetry. Twisted shape poems are sometimes easier to write for beginning poets, which makes them ideal for students. In the case of twisted shape poems, the words of the poem are written and then simply contorted or twisted to form the desired shape. The following is the opening of the traditional nursery rhyme, *Hey Diddle Diddle*, turned into a shape poem by Patrick Winstanley, you can see how the twisting of the words works:



But, there's a nice trick to twisted shape poems, if you're unhappy with how the poem turns out first time, you can easily untwist the words and twist them into different shapes until you find one that fits, see Patrick Winstanley's samples below. For this reason, some writers think that twisted shape poems are a cheat, because the same words can be twisted into almost any shape, but even if they're a cheat, they're still a lot of fun and can be full of meaning and humor.

Ampersand



A twisted shape poem which is in the shape of an ampersand, which is an abbreviated form of the word *and.*

True shape poems

True shape poems are a different kettle of fish entirely. In a true shape poem, the poet uses the poem's differing line lengths to create the desired shape.

Creating true shape poetry can be a tricky and frustrating business, but still a lot of fun. If you, as a poet, want to create a poem which rhymes and has a recognizable metre, you either need to select a fairly rectangular shape for your poem or to cheat like mad. When creating a true shape poem in a complex shape it's okay, as you're writing it, to let the start of new lines fall wherever they fall. It can also be helpful to highlight the initial letter of each line in bold or a contrasting color so that your audience know that it's reading a poem, rather than a very very short, strangely formatted novel.

Let's have a look at an example of a true shape poem and everything should fall into place. In this case Patrick Winstanley created a true shape poem in the shape of a man in a hat. He also included a riddle in the poem, just to take it a bit further, can you find it?

Have students use alpha-boxes to help them brainstorm a list of words or phrases that remind them of their topic word and list exciting verbs and descriptive adjectives related to kites and kite flying [ex. muddy, wind, high, fall, gravity, hot, sunshine, birds, flying, imagine] that will assist them with their writing. Their recent experiences with kites should help with the discussion and come into play, enabling them to think of words to describe what happened, what it was like, how they felt, etc.

Then, as a group develop a twisted shape or true shape poem for "kite" or another word such as *wind*, *breeze*, *March*, or *spring*, etc. To help inspire students you may want to read and create sample twisted and true shape poems and discuss and recognizing the pattern, flow of ideas, and word choice involved in the poems. Discuss with students what objects have very distinct shapes. As a group, make a list of 3 objects that have potential for concrete poetry. Now, choose the object that interests you most as a group, ex. kite. What special significance does your object have? As a group use the Alpha-boxes to list as many words as you can to describe your object, including words related to each of the senses [Smell Sight Touch Sound Taste] to create the sensory word bank.

On the included "Ordinary, No Extraordinary!" sheet, and/or as a group, have students write down a list in each column of nouns, adjectives, adverbs and verbs they might ordinarily put in a poem. Then, in the next other columns, have students look in a thesaurus for vivid synonyms to those words that could be used instead, to spice up their poetry. Students will use the word banks they create through this process to help write their poems.

Then on the board, begin crafting the words in your word bank and the special significance into a visual poem. Remind students to not get discouraged if it takes several drafts to get the words in the right position, [you may want to demonstrate this] that's the beauty of twisted shape poems, just keep twisting, and for true shape poems, just keep shaping those words. Most concrete poems take a bit of time to get just right! That's the fun of revising and editing. Remember to demonstrate creative phrasing, word choice and idea flow as you work with the students. Sample shape poem below:

Kids
fun through
fields, a wild game of
tug- o-war, trying
to touch the
clouds
every
time
they
pull
the
string.

Distribute rough draft paper and have children then begin following the process you practiced as a group. Listing objects [then they can choose their own words to describe and assign the teacher a word to twist and shape], creating a word bank, using words they put in their alpha-boxes to help, creating first drafts, shaping and twisting, all with the understanding that each poem needs to be concise, have brevity, clarity, accuracy and be vivid. Encourage them to use vivid verbs, nouns, and powerful adverbs and adjectives, from their lists and others, to fizz up the action, paint word-pictures within their word pictures, and evoke feelings in their readers and rivet readers' attention.

After they finish their first draft, have students do their revisions according to their grade level skills, those listed in the SPIs, looking up synonyms for words they used frequently, checking grammar and punctuation, editing for conciseness, etc.

Important Terms:

- Concise: being brief and to the point, using few words, not including extra or unnecessary information
- Brevity: the use of few words to say something, being short or brief
- Clarity: the quality of being clear, easily understood, and expressed, remembered, etc., in a very exact way.
- Accuracy: freedom from mistake or error
- Vivid: producing a strong or clear impression on the senses; specifically: producing distinct mental images.
- Relevant: important and relating to a subject in an appropriate way.

Alpha-Boxes: Collect favorite words [related to Sound, Sight, Touch, Taste, and Smell] in the boxes below to use in your writing later on. Topic(s):________________________________

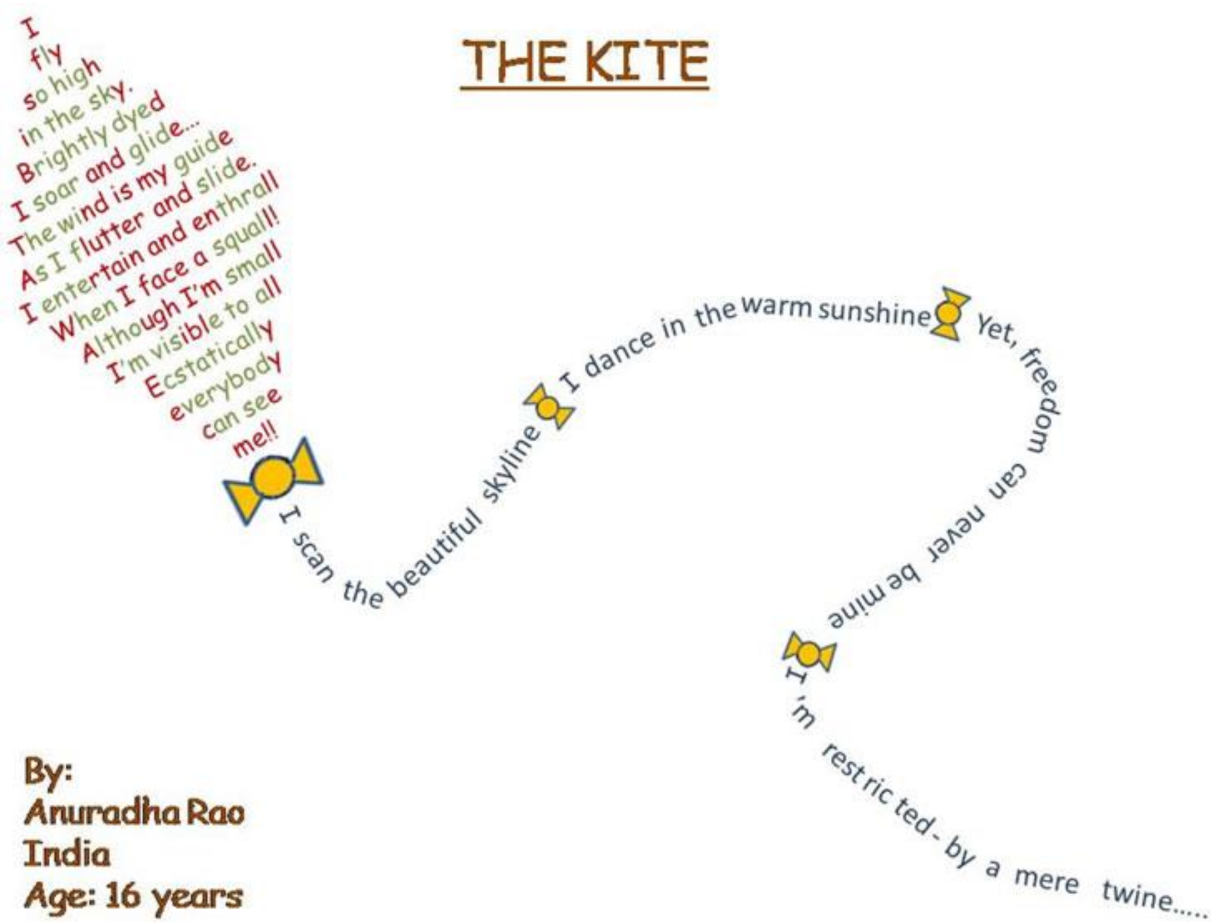
____

A	B	C	D
E	F	G	H
I	J	K	L
M	N	O	P
Q	R	S	T
U	V	W	XYZ

Ordinary? No, Extraordinary!

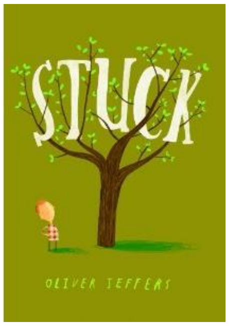
Noun	Vivid Synonym(s)	Verb	Vivid Synonym(s)	Adjective or adverb	Vivid Synonym(s)

Another Example of a True Shape Poem



Anuradha Rao, is sixteen years old and lives in Chennai, India. Copyright © Patrick Winstanley / [Funny Poems for Kids](#) 2002-12 All Rights Reserved

Fluttering Bits of Paper



You may want to introduce this project by reading a book related to the joys of kites and kite flying with the students such as the award-winning laugh-out-loud kite flying story *Stuck* by Oliver Jeffers.

Students will assemble colorful blocks of paper, like a puzzle, and attach them to the cardstock! Mosaics were traditionally made with bits of tile or glass, but a paper mosaic is a great project for students.

Materials:

- Construction paper, tissue paper, or other colored paper
- White cardstock
- Gray crayons/markers
- Scissors
- Glue or glue sticks

Start with a directed line drawing. It's important to note that even though you may use, "directed line drawing", it's rare that you want to give your students just one option, most of the time you'll end up with many drawings all across the white board. Look at pictures and picture books and brainstorm together what a flying kite can look like, or many kites all in a line, or crazy shaped kites, and create sketches up on the board. Give lots of examples! Draw a few different ones; some realistic, some silly, kites in groups, kites alone, kites flying over landscapes or cityscapes, keeping your then talk with students how you could change the shape, the background, making simple **large** shapes that will be filled in later, and making it interesting, not mundane. This technique works well, as you want the children to learn to draw but also want them to be as individual as possible.

In the process of drawing on the white board, always incorporate mistakes. **Always**. Laugh at your "mistakes", tell the kids to expect them and then show them how to turn mistakes into something else. It's critical that you show your artistic side, no matter what you privately think of it, and inspire your students.

Have students lightly draw a picture on a piece of white cardstock with a grey crayon, a marker, or a chalk, but they should not shade it or put a lot of details in it. The objective is simply to create an outline for the image they will be creating. Do NOT allow students to use pencils to draw. Pencils make most kids tight, draw small and rely on that eraser. Given the opportunity to work with pencils, the project will take A LONG TIME. For little ones, the pencil lead is just so tiny that tiny drawings are often the result, making it difficult to fit pieces of paper in those miniscule drawings. For older kids, they know they can erase pencil, so they do. Again and again and again. Encourage kids to draw big. If the kids make mistakes, *recovering* from the mistake is a huge part of art. Teach them, in art: it is not a mistake… it's an opportunity! Mistakes are either fixed or ignored. Mosaic paper hides most mistakes. If a line is drawn where it shouldn't be and paper won't cover it up, then encourage the kids to brainstorm on how that one wayward line can evolve into part of the artwork. It usually does. Option: When you begin a project have them draw on one side, then flip over and start again…then we decide which one we like the best and go forward with the project.

When their drawings are done, have students get some colored paper. For this project construction paper, tissue paper, colored cardstock or printer paper and be used, or look in the junk mail for glossy catalogs with brightly colored photos to add variety. Option: for some mosaics styles objects are included, ex. colored sand can be incorporated, rice and beans can add texture, etc.

Have students their pieces of paper over the sketch they just made. Students can leave a small gap between each piece for a tiled effect, or place them close together or overlapping for a different look.

Tip: Cheap tweezers can help students with placement and avoiding rubbing their hands in the glue.

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