From Kites to Space

Kite Honor Material

A Brief History of Man's Journey From Kite Flying to Space Travel

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Introduction

The kite part of this unit is designed to be part of a study on **The History of Space Flight**. Kites were a very important part of the Wright brothers' studies on flight. This ultimately led to today's shuttles that take us to space. The kite instruction can be done independently of the space unit.

The unit also fits into math studies, art, or Pathfinders. If the kites are made from cloth instead of paper, it can even be used in a sewing class. If completed, the student will earn the Kites Honor. It has been tested on grades 1-8.

There are many available kite designs on the internet. Very simple ones have been chosen for this unit, with an eye to ease of construction and inexpensive available materials.

A LIST of MATERIALS to assemble

- Single hole punch
- Kite string
- Spar material (bamboo skewers work great)
- Small paper bags
- Tail material (strips of plastic, streamers, or surveyor's ribbon)
- Cardboard (cereal boxes work fine)
- Copier paper (colored is nice, but white works fine)
- Rolls of freezer paper
- Markers or paints
- Rulers
- Scissors
- Garbage bags
- Masking tape or duct tape

Pathfinder Kites Honor Requirements

1. When were kites first made and flown? Name at least three ways kites have helped in scientific research and tell how each has affected the world we live in. Tell the story of Benjamin Franklin and his kite.

2. Name some of the ways that kites might be used today.

3. Explain briefly how kites fly.

4. Define the following terms:

- **a.** Spine
- **b.** Spar
- **c.** Vent
- **d.** Bowstring
- **e.** Cover
- **f.** Frame
- **g.** Tail
- **h.** Keel
- **i.** Flying line
- **j.** Bridle
- **k.** Reel

5. What is a common cause of kite failure?

6. What should be done when a kite loops during flight?

7. Why is a tail needed on a kite?

8. Know at least three safety rules for kite flying.

9. Do the following:

- **a.** Correctly wind line on a stick.
- **b.** Tie broken ends with the fisherman's knot.

10. Make and successfully fly two of the following kites:

- **a.** Sled kite
- **b.** Flat kite
- **c.** Two-stick diamond kite
- **d.** Delta wing kite
- **e.** Eddy or Malay kite
- **f.** Box kite
- **g.** Tetrahedral kite

Skill Level 1

Original Honor 1986 Recreation General Conference 2001 Edition

Man and Space . . . and GOD

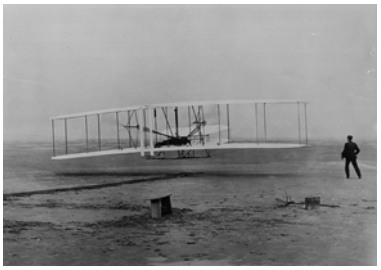
"And God said, 'Let there be lights in the expanse of the sky to separate the day from the night, and let them serve as signs to mark seasons and days and years, and let them be lights in the expanse of the sky to give light on the earth.' " Genesis 1:14, 15

Adam's first day on Earth was jam-packed with new and exciting experiences. But as the sun set, there were more adventures in store. Above him twinkled a moon and millions of stars. Did Adam see patterns that first night in the stars? Did God stand beside him and show him how the stars could be used for navigation on the Earth? Did He name some of the constellations, and tie those names to the great themes of the Universe?

I suppose that there was plenty to do and see on the Earth itself for many years. Who was the first person to look into the night sky and wonder if it was possible to go there? Who was the first to wish that he could fly like the aerial wildlife? We don't know the answers to these questions, but we do know that ancient records show that man's interest in the stars happened very early in time. The constellations of what we now know as the Zodiac were named many centuries ago. Eventually we developed telescopes that allow us to see into space, leading to the Hubble Telescope, which is a large one in space.

Man's love affair with kites goes back thousands of years before Jesus' birth. Eventually, the Wrights would use kites to discover aerodynamic principles that led to a successful plane flight. From that first short airplane flight at Kitty Hawk to man's first step on the moon would be less than 70 years.

The prophet Daniel wrote: *"But you, Daniel, close up and seal the words of the scroll until the time of the end. Many will go here and there to increase knowledge." Daniel 12:4*
Man's rapid movement into space in the past century surely seems to fulfill this prophecy.



The HISTORY of Kites

No one knows when or where the first kite was flown, but we do know that they were flown in China and the Malay Archipelago at least two thousand, five hundred years ago! Kites were being flown at least five hundred years before Jesus was born.

Several hundred years ago, sailors told of seeing the Micronesians in the Pacific Islands using leaf kites to catch fish.

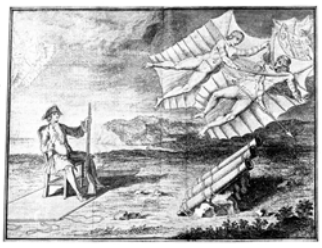
The Polynesians also have a long kite history. One of their myths tells of two brother gods named Tan and Rango. Tan and Rango were having a kite duel above the earth. Tan's kite got tangled in a tree, but Rango's flew high and free. The humans watching learned about kites. Today in Polynesia the person whose kite flies the highest is honored by having his kite dedicated to Rango.

Polynesia also made bird-form kites. A chief flew a kite when wanting to communicate with heaven. One story tells of a mother of two murdered boys who asked a chief for help. The chief dedicated a kite to each dead boy and had them flown high in the sky. After a short while the kites hovered over the hut of the boys' killer.

The earliest written account of a kite flying, around 169 BC, was during the Han Dynasty in China. A Chinese general, named Han Hsin, had his soldiers fly a kite over a city he was trying to conquer. From the height in the sky he was able to determine how far he needed to tunnel in under the city walls. (He did win the battle!) Another time this general had his troops fly giant kites that had noise makers attached. The enemy thought the sounds were a heavenly omen of impending doom, and fled in terror.

The popularity of kite flying spread from China along trade routes to Korea, India, and Japan. They arrived in Korea sometime in the five centuries after Christ was born. During the Silla dynasty (595-673 AD) a General Gim Yu-Sin was ordered to subdue a revolt. But his troops would not fight because they saw a large shooting star fall from the sky. They thought that this was too bad an omen. Cleverly, the general had a kite carry a fireball back up into the sky where it disintegrated. His troops believed that the star had gone back up in the sky, and so agreed to fight again. They rallied and defeated the rebels.

Korean General Gim Yu-Sin sent a kite with an attached "fireball" into the sky to drift off away from an upcoming battle site near the city of Kyongju. The drifting fireball was an omen to his troops that there would be no bloodshed on the battlefield where they were camped. (Recorded in "The Three Kingdoms", written in A.D. 1145.)



During Marco Polo's China travels of 1282, he reported seeing manned kites. Chinese shipping merchants would tie someone (usually a drunkard) to a huge frame (kite) held by eight strings. Then, having launched the kite with the man in the wind, they would determine whether the voyage would be a prosperous voyage or not. He also explained how the men would pull on the rope attached to the eight strings to lift the kite higher. If the manned kiteflew straight up, it was a good omen for the voyage; if it failed to rise, no merchant would load his wares onto that ship.

Another general who found his way blocked by cliffs covered with enemy troops built large kites and dropped fire from them.

In one ancient ceremony, a kite would be flown for the eldest son's seventh birthday. It would be cut loose so that it could take away all the boy's bad luck.

In India young lovers would drop message-bearing kites onto roof tops in order to communicate with each other.

In 1712 a thief named Kakinoki Kinsuke used a large kite to carry himself to the top of Nagoya Castle. There under the cover of darkness he stole scales from a pair of golden dolphins. Even though he was successful, he unfortunately could not keep from boasting to his friends about his deed. He was captured and boiled in oil.

Giant kites were used by a Japanese architect to lift workmen to the roof a temple he was constructing.

In the 1700's Benjamin Franklin flew a kite in a storm to prove that lightning and electricity are the same things.

In the early 1800s an English schoolteacher named George Pocock invented a horseless, energy-saver carriage. He lashed two giant kites (that were 15 and 12 feet along the spine) to a lightweight carriage. This would draw the carriage along at up to 20 miles per hour—very fast for those days!

Men were never successful in building "flapping wings" kites. But before building the first successful airplanes, the Wright brothers experimented with various designs by using kites. By making many different kite models of their airplanes, they eventually came up with a design that worked, and the rest is history.

Any way you look at it, whether you are designing or building a kite, kites can enhance the learning process. Alexander Wilson used a train of kites in 1749 to learn about the atmosphere. In 1943, Dr. Paul Garber designed a kite for target practice so sailors could learn to be better shots with their big guns. In April 2002, *National Geographic Magazine* reported that scientists from Mexico and the US used kites to monitor atmospheric pollutants at 4000 feet. They have been used to raise meteorological instruments

Did you know that one of the most famous kite flyers of all time was a 10-year-old boy? His name was Homan Walsh, and without him the Niagara Falls Suspension Bridge would not have been built in 1847. Before building of the bridge could begin, someone needed to get a line from one side of the gorge to the other. Homan successfully flew a kite from one side of the gorge to the other, and his kite line was the first to span the gorge. After securing Homan's initial kite string, workmen fed heavier and heavier line across until a steel cable could be connected across the gorge so that bridge construction could begin. Homan Walsh was rewarded with a ten-dollar cash prize, which was a lot of money in 1847!

In both the World Wars airmen used kites to send distress calls, as targets for gunnery practice, and to tow behind airplanes to fool the enemy.

There has been a renewed interest in kiting. A type of kite led to the modern hang-glider and parasailing. Peter Powell invented a dual line stunt kite in 1972 that led to a whole new sport called stunt flying. Today Stunt competitions are held around the world.

Maui's Kite: A Legend

Long ago in Hawaii people told stories to explain the wonders of nature. This story is about Maui, who wanted to tame the winds.

The weather had been first warm and then cool that month. There was a feeling of uncertainty, of change, of excitement in the air that inspired Maui, and he decided to build a kite.

And what a kite it was! For a sail, his mother gave him her largest, strongest piece of barkcloth. For cross-pieces he used great lengths of bamboo carefully cut and notched. And from the olona shrub he cut long lengths of branch, twisting them together to make a strong rope. With great care he constructed his kite.

Maui's kite was a work of art. His friends excitedly gathered around to help him carry it to Keeper-of-the-Winds. Maui and the others paraded though the village, and all the people left their work and came to watch.

To the Cave-of-the-Winds they marched. As they approached the cave they could see Keeper-of-the-Winds sitting by the entrance.

"O Keeper-of-the-Winds," cried Maui, "come, bring Ipu Iki, the small gourd that holds the gentle breezes, and let us fly our kite!"

Keeper-of-the-Winds was a wise old woman, and knew that the gentle winds of Ipu Iki would play kindly with the boy. She went into her cave and returned, carrying a small calabash, or hollowed-out gourd.

"The name of this calabash is Ipu Iki," she said, "and it holds the gentle winds; the soft, the misty, and the dusty." And she sang her song,

O Wind, Soft Wind of Hilo,
Wind from the calabash of everlasting winds,
come from Ipu Iki.
O Wind, Soft wind of Hilo,
Come gently, come with mildness.

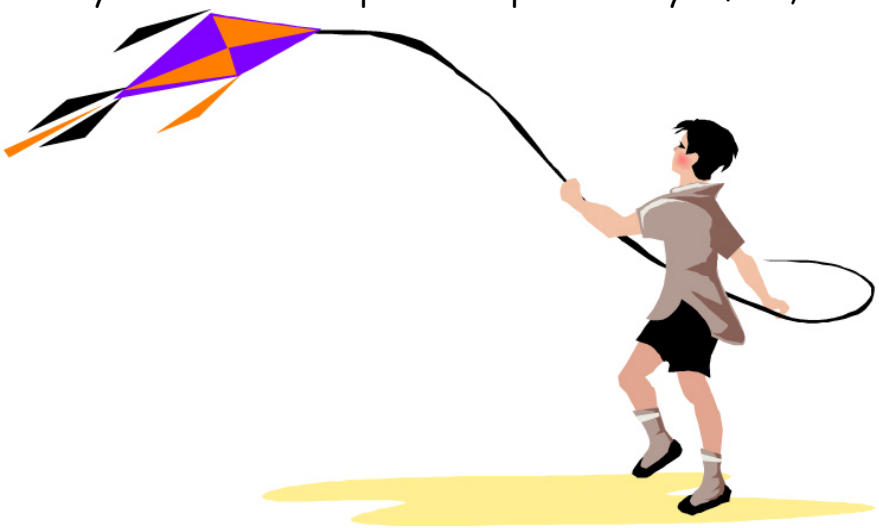
The lid of the calabash began to stir, and Keeper-of-the-Winds carefully lifted its edge. Slowly Soft Wind of Hilo drifted out and tugged at the kite. Maui let out some cord and his friends held up the great sail, but the wind could do no more than rustle the cloth. Again Keeper-of-the-Winds sang her song.

O Wind, Soft Wind of Waimea,
Wind from the calabash of everlasting winds,
come from Ipu Iki.

O Wind, Soft wind of Waimea,
hasten to me, come to me with strength.

Again the lid of the calabash stirred, and Keeper-of-the-Winds raised it slightly. Misty Wind of Waimea flew out, sweeping the kite from the hands of Maui's friends, sending it soaring over the trees.

Maui's friends cheered as he let out the cord, and even Keeper-of-the-Winds became excited. She called Dusty Wind and Smoky Wind. The kite soared like a great bird out over the sea. Maui leaned back and laughed in happiness as Keeper-of-the-Winds stood silently and looked with pleasure upon the boy's face, and then at the kite.



"That's enough for today," said Keeper-of-the-Winds. "One must respect the winds; they should not be taken for granted. They will respect you if you respect them."

After a few moments of silence, Maui slowly nodded his head. "Yes, O Keeper-of-the-Winds," he said a little reluctantly. "Call your winds back to you."

Keeper-of-the-Winds removed the lid from Ipu Iki and called back her winds. Slowly the kite dropped, and as Maui reeled in the line, his friends caught the kite. Keeper-of-the-Winds put the lid back on the calabash, and everyone went home.

But Maui was not content. He had seen how high his kite had gone, but wondered just how much higher it could fly. He remembered the words of Keeper-of-the-Winds, and knew that he must respect the winds, but still he wondered.

The next day Maui and his friends took the great kite and went back to Cave-of-the-Winds. They found Keeper-of-the-Winds sitting out front.

"O Keeper-of-the-Winds, bring out Ipu Nui, calabash of the Four Great Winds!" cried out Maui.

"The winds of Ipu Iki were enough, Maui," said the old woman. "Do you not remember what I said to you? You must respect the winds, especially the Four Great Winds."

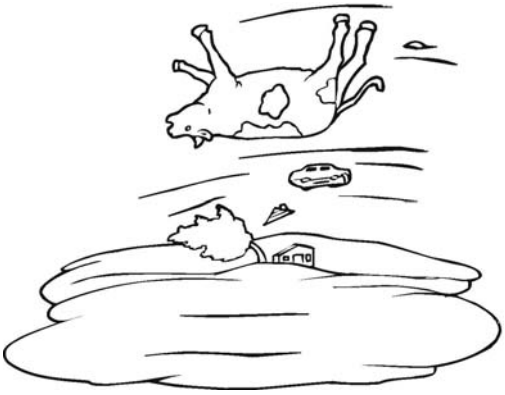
"But I am strong, as strong as the Four Great Winds," said Maui, only half believing his own words, and he began to chant,

O Winds, mighty as the gods,
Wind from the calabash of everlasting winds,
come from Ipu Nui.
Strong Wind of the East,
Churning Wind of the North,
hasten and come to me.

From inside the cave came a mighty roar. Keeper-of-the-Winds started and ran towards the entrance, but she was greeted by North Wind and East Wind, who bowled her over and snatched the kite from the hands of Maui's friends. Maui leaned back as far as he could as the kite was swept far out over the sea. He laughed with delight when he saw how far his kite had gone, and at Keeper-of-the-Winds who was struggling vainly to put the lid back on Ipu Nui. But with a great screaming and howling, West Wind and South Wind roared out of the calabash, knocking it from the woman's hands and sending it rolling away.

The kite went as high as the cord was long, and still it tugged violently. The cord began to hum in the wind, and as the sky grew dark, the kite disappeared into the clouds.

Thinking himself to be in control, Maui called out, "O Winds, mighty as the gods, return to Ipu Nui."

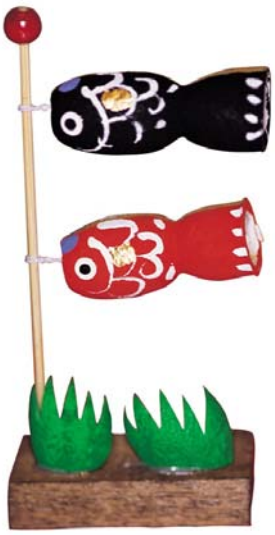


But of course the winds were beyond his control. The sky darkened. The four howling winds raged stronger and stronger until the cord attached to the kite snapped with a mighty crack, sending Maui reeling backwards. The kite sailed away over the mountain, never to be seen again.

Yet the winds continued to rage. The palms that grew around Cave-of-the-Winds bent down their heads in the face of the onslaught, until they too broke. Over the entire island the winds screamed and howled. The sheets of barkcloth set out to dry were blown away and a heavy rain began, flooding the fields, sending the men scurrying in all directions. The winds had proven who was the stronger.

In desperation Keeper-of-the-Winds pounced on Ipu Nui and took it back to the cave and worked the night, gently coaxing the winds back into the calabash. Finally the storm ended.

Maui was in disgrace, and people started to call him He-Who-Brought-the-Great-Storm. The people would have nothing to do with him. His friends left him and Keeper-of-the-Winds looked the other way when Maui came to visit.



Finding himself alone with nothing to do, Maui built another kite, small than the first, and flew it near his home when there was no one else about. He would tie the kite to a rock and study its movements in the sky, and soon he could tell when the weather would be fine, or stormy. One day he noticed some men going off to the fields.

"It will rain today," said Maui to the men, "Tomorrow will be a better day to work the fields."

But the men just scowled at him. Soon it did begin to rain, and the men came running back to the village, looking in amazement at Maui as they ran by.

Another day Maui warned a group of women that their barkcloth could be blown from its drying place, because his kite told him that there would be a storm that day. The women paid him no attention. Soon, however, they were out of their yards, chasing the cloth which was blowing about in the storm.

In time, the village people began to rely on Maui and his kite. He taught them how to predict for themselves from the dancing movements of the kite which days would be good for planting, or fishing, or drying barkcloth. People stopped calling Maui He-Who-Brought-the-Great-Storm and started calling him Teacher-and-Foreteller-of-the-Weather. Keeper-of-the-Winds became friendly towards him again, but Maui had learned his lesson. Never again did he call for the winds of Ipu Iki or Ipu Nui.

Benjamin Franklin: An Account of the Kite Experiment

From Carl Van Doren's "Benjamin Franklin," ©1938 by Carl Van Doren

Before that he [Benjamin Franklin] had thought of another way of proving his theory, and with the help of his electrical kite had drawn lightning from a cloud. The episode of the kite, so firm and fixed in legend, turns out to be dim and mystifying in fact. Franklin himself never wrote the story of the most dramatic of his experiments. All that is known about what he did on that famous day, of no known date, comes from Joseph Priestley's account, published fifteen years afterwards but read in manuscript by Franklin, who must have given Priestley the precise, familiar details.

"As every circumstance relating to so capital a discovery (the greatest, perhaps, since the time of Sir Isaac Newton) cannot but give pleasure to all my readers, I shall endeavour to gratify them with the communication of a few particulars which I have from the best authority.

"The Doctor, having published his method of verifying his hypothesis concerning the sameness of electricity with the matter of lightning, was waiting for the erection of a spire [on Christ Church] in Philadelphia to carry his views into execution; not imagining that a pointed rod of a moderate height could answer the purpose; when it occurred to him that by means of a common kite he could have better access to the regions of thunder than by any spire whatever. Preparing, therefore, a large silk handkerchief and two cross-sticks of a proper length on which to extend it, he took the opportunity of the first approaching thunderstorm to take a walk in the fields, in which there was a shed convenient for his purpose. But, dreading the ridicule which too commonly attends unsuccessful attempts in science, he communicated his intended experiment to nobody but his son" — then twenty-one, not a child as in the traditional illustrations of the scene — "who assisted him in raising the kite.

"The kite being raised, a considerable time elapsed before there was any appearance of its being electrified. One very promising cloud had passed over it without any effect; when, at length, just as he was beginning to despair of his contrivance, he observed some loose threads of the hempen string to stand erect, and to avoid one another, just as if they had been suspended on a common conductor. Struck with this promising appearance, he immediately presented his knuckle to the key, and (let the reader judge of the exquisite pleasure he must have felt at that moment) the discovery was complete. He perceived a very evident electric spark. Others succeeded, even before the string was wet, so as to put the matter past all dispute, and when the rain had wet the string he collected electric fire very copiously. This happened in June 1752, a month after the electricians in France had verified the same theory, but before he heard of anything they had done."

From: http://www.ushistory.org/franklin/info/kite.htm

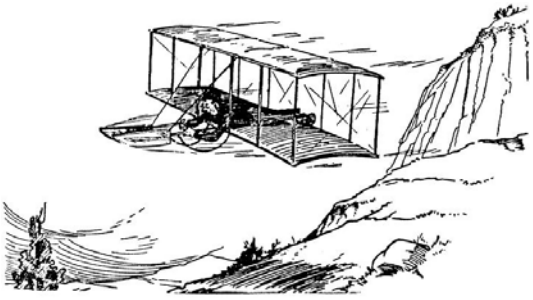
Today if you ask someone what they do, they will tell you about their jobs. A person might be a janitor, a teacher, an electrician, or doctor.

Benjamin Franklin, though, was many things: inventor, printer, philosopher, scientist, diplomat, writer, politician. His life story is very interesting. Among other things, he invented the Franklin stove, a much better way of heating a house. He was involved in forming the new country the United States, and spent time as a diplomat in France. He remained an influential force in the world until his death.

AERODYNAMICS

An excellent way to gain a feel for aerodynamic forces is to fly a kite. Kites have been around for thousands of years, and they are a part of many different cultures around the world.

From an aerodynamics point of view, two of the most important users of kites were the Wright brothers. In 1899, as they were developing their theories for the control of an aircraft by using wing warping, they built a small maneuverable kite to verify their ideas. Between 1900 and 1903 they would often fly their gliders as unmanned kites at Kitty Hawk, North Carolina. These experiments led directly to their successful 1903 aircraft.



Each style of kite looks different, but the forces acting on all kites are exactly the same. With the exception of thrust, 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. Gas balloons and bubbles are **lighter than air** and rely on *buoyancy forces* to fly. Like an aircraft, kites have a solid frame normally made of wood or plastic, and this frame is covered by a paper, plastic, or cloth "skin" to generate the lift necessary to overcome the kite's weight.

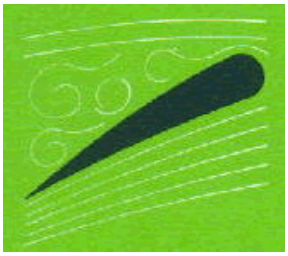
A kite must be made as light as possible for good performance, yet be strong enough to withstand high winds. Determining the forces on a kite can be difficult. NASA has prepared a kite simulator KiteModeler (www.grc.nasa.gov/WWW/K-12/airplane/kiteprog.html) to design your own kites and study these forces. You can then build a kite based on your design and compare the results with the computer program.

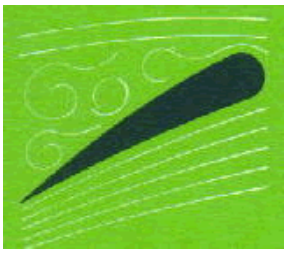
LIFT, DRAG, AND GRAVITY

Thanks to National Kite Month http://www.nationalkitemonth.org/kids/whykitesfly.shtml

A kite and airplanes are heavier-than-air object that are flown by the lift created by air in motion over their wings. An airplane relies on thrust from its engines. A kite is tethered in place and needs moving air (wind) to fly.

There are many possible kite shapes. Each of these shapes, and how the kite uses its aerodynamic features (either built in or added on) will determine if or how it flies.





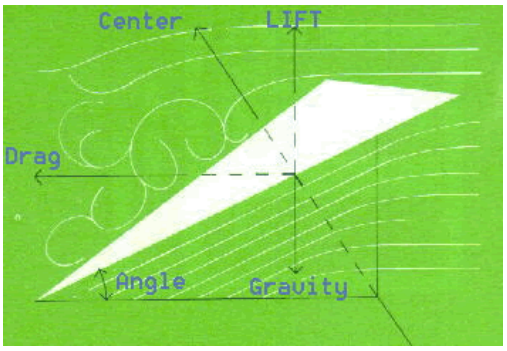
Wind moving across the sail of a kite creates pressure. **Lift** results from this wind pressure being deflected along the face of the kite. In other words, the wind pushes up on the kite. Think of wind pressure as a hand, pushing the kite up into the sky and holding it there. If the hand is removed, the kite will fall.

At the same time, wind passing over the top of the kite creates an area of low pressure, like a vacuum, along the back of the kite. This creates a pull from behind.

A kite is affected by thrust, drag and by gravity.

Drag is created by wind resistance on the kite's surface (and tail). Drag can also result from turbulence behind the kite. **Gravity** is the downward force created by the weight of the kite. **Thrust** is the power of the wind which creates lift.

To fly, a kite needs to have enough lift to overcome gravity and drag.



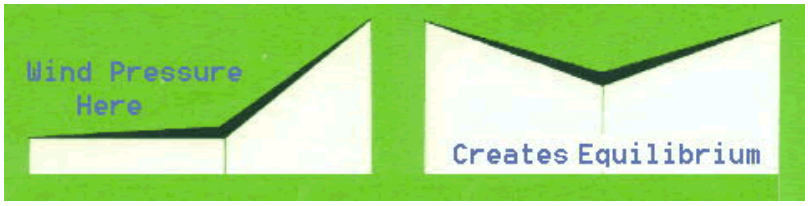
All of these forces -- *lift, drag, gravity, and the thrust of the wind* -- come together in the kite at a place called the **center of pressure** . And not surprisingly, that's where you tie your kite string. We call this special place the **tow point** .

By moving the place your string is attached to the kite on the bridle line, you can change the amount of lift that is created. You do this by changing what we call the **angle of attack** . This is the angle at which the kite leans into the wind.

DIHEDRAL:

The one other thing that is important in understanding flight is something called **dihedral.** This is a special word from geometry that describes the angle formed when two wings come together.

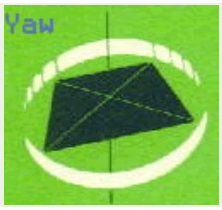
The **dihedral angle** of a kite's wings helps the kite fly smoothly. If the wings lean back at the same angle, then the wind pushes equally on both wings. If one side of the kite begins to turn further into the wind, then the wind will push harder on that side until the kite becomes stable again. So with a proper dihedral angle built into the kite's design, it will fly properly balanced in the sky. We call that **equilibrium** .



FLIGHT STABILITY:

Properly balancing the dihedral of the kite, the tow point of the bridle, and even a varying amount of tail will affect the stability of your kite along the vertical (**yaw**), lateral (**pitch**) and longitudinal (**roll**) axes.

Yaw is the rotating action about a kite's vertical axis. This is the imaginary line that goes from the ground up through the kite into the sky. The kite turns to the right or left, just like an airplane turns from the right or the left as you watch it from the ground.



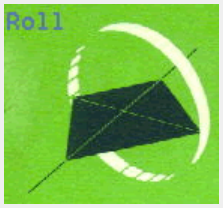
If the tow point is too far forward, or if the kite is not properly balanced, it may start sliding or rotating. To correct the problem:

- Try moving the tow point back
- Check the kite for balance
- Try adding tail (drag at the bottom of the kite)

Pitch is the rotating action about a kite's lateral axis. This is another imaginary line. On an airplane, you can think of the wings as the lateral axis. If a kite has a poor bridle, or inadequate sticks, the wind can distort its shape and create a flapping or pitching motion.

To correct the problem:

- Add more bridle lines to balance the wind pressure around the kite
- Use stronger sticks



Roll is the rotating action about a kite's longitudinal axis. On an airplane, this would be the imaginary line through the body or fuselage. When an airplane, or kite, rolls, one wing lifts higher and the other is lowered.

A flat kite will be unstable and will tend to dip to one side or the other to reduce pressure on the sails. To correct the problem:

- Move the tow point forward
- Add more tail to the kite
- Bow the kite to create a dihedral

For more absolutely great material, check out:

National Kite Month:

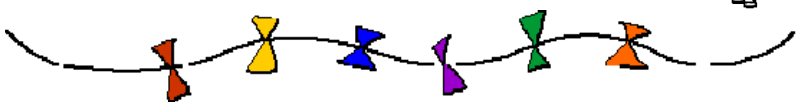
http://www.nationalkitemonth.org/kids/whykitesfly.shtml

NASA web sites:

You can read about the aerodynamics of kite flying:
Benson, T., 2006. "Kites," Glenn Research Center: National Aeronautics and Space Administration (NASA). http://www.grc.nasa.gov/WWW/K-12/airplane/kite1.html

http://www.grc.nasa.gov/WWW/K-12/airplane/shortk.html

KITE TERMS



FACE is the kite's front surface—the part you see in the sky, facing you. The rear surface is the **BACK**.

The top is called the **NOSE** and the bottom is called (surprise!) the **BOTTOM**.

The **LEADING EDGE** is the top edge and the **TRAILING EDGE** is the bottom edge of the kite sail.

The **FLYING LINE, STRING** or **TETHER** holds the kite captive to the wind.

The **BRIDLE** connects the flying line to the kite at the **TOW POINT**, and sets the angle of the kite to the wind, which is called the **ANGLE OF ATTACK**. The bridle attaches to the kite at the **BRIDLE POINT**.

STRUTS are the side and cross sticks, also known as the **SPAR** or **SPREADER**, that kept the kite open. The center strut or backbone of a kite is called the **SPINE**.

The spine and struts together make up the **FRAME** or **BONES** of the kite. Not all kites have frames.

The kite covering is known as the **SKIN** or **SAIL** or **COVER**.

A **VENT** is an opening for the passage of wind. A **CELL** is an enclosed area that captures air as on a box kite.

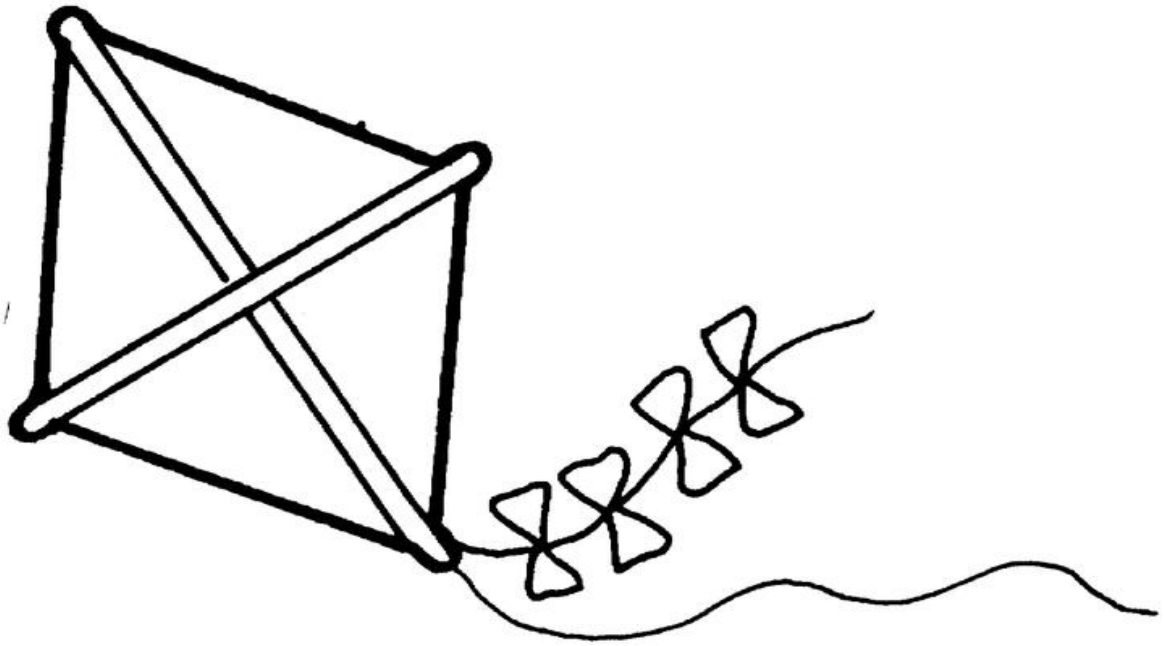
Some kites have **WINGS** that provide more lift.

The **TAIL** is attached to the bottom of the kite. It adds stability, and is frequently longer than the kite. A **DROGUE** (or **WINDCUP**) or **WIND SOCK** may be added for extra drag.

The **WINDER** or **REEL** holds the flying line.

Name: _____ Date: _____

Label the parts of the Kite



Label the:

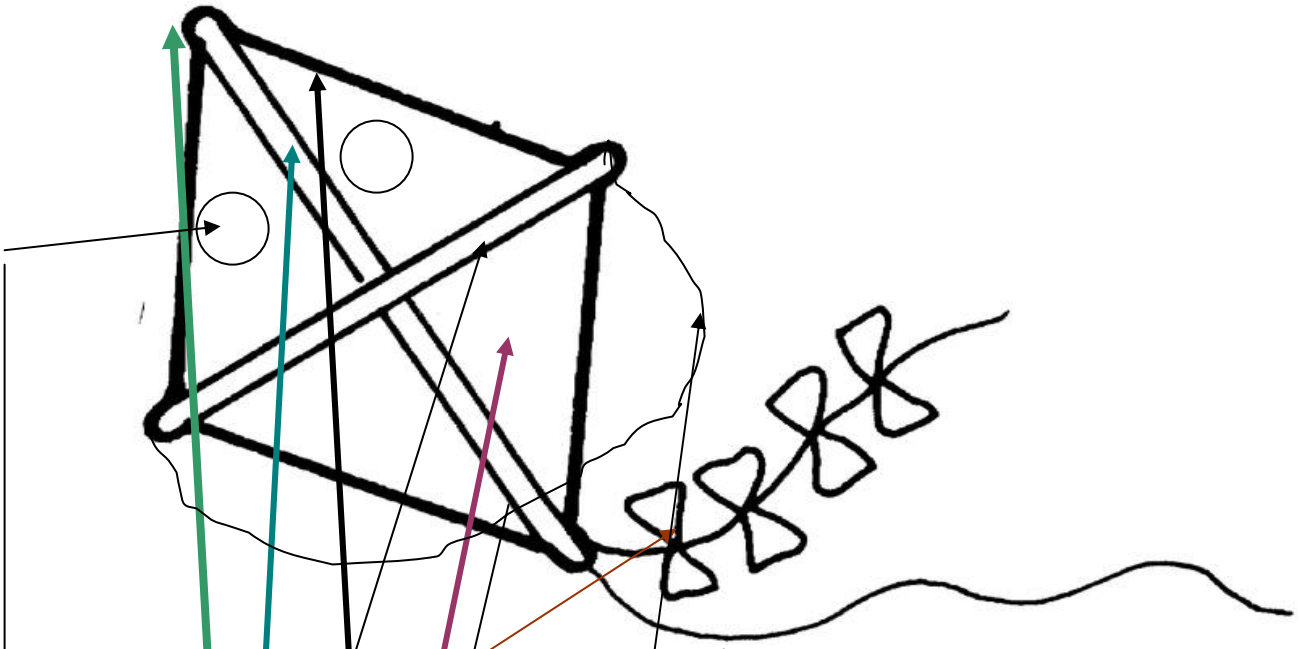
- Tail
- Nose
- Leading edge
- Spar
- String
- Spine
- Skin or sail

Add and label the:

- Tow point
- Bridle
- Vent

KEY Name: _____ Date: _____

Label the parts of the Kite



Label the:

- Tail
- Nose
- Leading edge
- String
- Spine
- Spar
- Skin or sail

Add and label the:

- Tow point
- Bridle
- Vent

Kite Terminology Advanced

(thanks to: American Kite Association http://www.aka.kite.org/)

Angle of Attack

The angle the kite flies in relation to the wind. This angle of attack can be adjusted from the bridle.

Aspect Ratio

This is a term referring to the height compared to the width of a kite. As the kite's sail becomes more elongated and less square in shape the kite may be referred to as having a high aspect ratio sail.

Ballet

Flying a sport kite to music.

Batten

Piece of fiberglass used to stiffen a kite sail. These are often used in wing tips.

Beaufort Scale

A scale of wind ranges. 0 = under 1 mph, 1 = 1-3 mph, 2 = 4-7 mph, 3= 8-12 mph, 4 = 13-18 mph, 5 = 19-24 mph.

Birdsnest

Lines that are tangled so badly that they may as well be thrown away.

Brake lines

Usually the lower lines on a four-line foil kite.

Bridle

Lines leading from the kite to the flying line.

Center T

Fitting where the lower spars of a kite attach.

Control Bar

Another way to control a two-line kite. A length of (usually metal) bar to which kite lines are attached.

Dacron Line

Kite line used for single-line kites. It has some stretch so it is not the best for use with sport kites. Spectra or Dyneema line is preferred for dual or quad-line kites.

Delta

Refers to a triangular shaped kite.

Drogue

Usually a cone-shaped chute acting like a kite tail which increases drag.

Dual Line

A kite that is controlled with two flying lines. This term implies that the kite is a controllable sport kite.

End Cap

Plastic or vinyl cap that fits over the end of a fiberglass or carbon rod or tube.

Ferrule

A tube usually made of aluminum used to join together two spars.

Foil

A stick-less kite containing cells that fill with air to form a wing.

Kevlar

A fiber used for kite bridles and flying lines. Because ultraviolet light causes breakdown and because of the abrasiveness, spectra line now is usually preferred.

Larks Head Knot

A knot used widely to attach flying line to a kite and to kite straps and handles. Also this knot is frequently used to attach the kite bridle to the kite spars.

Leading Edge

The side of a kite that runs from the nose of the kite to the tip of the wing.

Lift

The upward force that wind creates on a kite.

Line Set

A set (two or four) lines on a winder, and frequently including straps or handles.

Nock

A plastic cap with a notch.

Precision

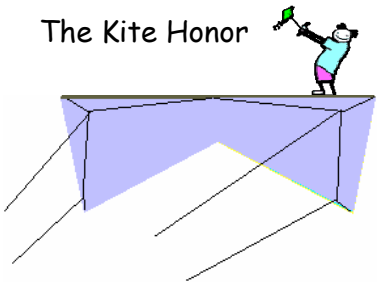
Flying a predetermined pattern in the air. A category in competition.

Pull Turn

Refers to two-line flying. A pull turn creates a rounded turn while a push turn will create a sharper square turn.

Push Turn

Refers to two-line flying. A push turn creates a sharp, square turn vs. a rounded turn from a pull turn.



Quad Line

A kite flown on four lines. Most quad line kites can be flown forward and backwards.

Ripstop

A type of cloth used for kite making. The cloth has squares of reinforcing that resists tearing.

Sail

The cloth part of a kite less the spars.

Single Line Kite

A kite flown on a single kite line.

Sleeve

A short line that the actual flying line passes through. The sleeve provides reinforcement to flying line where it attaches to the kite and to the handles or straps.

Spar

The sticks in a kite. Spars can be made of wood, carbon, or fiberglass. Spars can be tube or solid rod.

Spectra

A low stretch, thin line most suitable for controllable kite flying. Spectra comes in several break strengths. Dyneema is a very similar product.

Spreader

Spars that run horizontally across the kite.

Stand-off

A short length of carbon or fiberglass rod that runs from the bottom of the kite sail to the lower spreaders. Typical sizes for spreaders are .080 in., .098 in, .110 in.

UL (Ultra Light)

Refers to a kite that is designed to fly in very light winds or even indoors. This term is used to describe a special carbon spar.

Winder

A storage device for kite line. Winders can be plastic, wood, or fiberglass. They may have handles or be shaped like a donut.

Wind Range

The minimum and maximum wind speed a particular kite should be flown in.

Wind Window

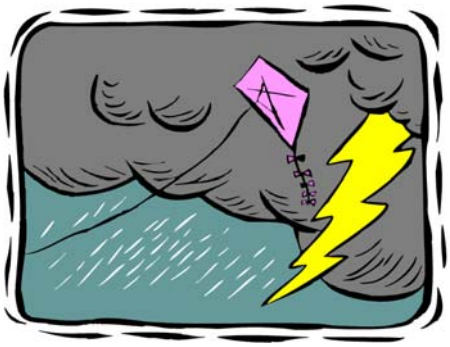
The area down wind of the flyer where the kite can fly.

Yo-Yo

Can refer to a type of line winder shaped like a wide ring or to a kite trick where the kite rolls up and down around its lines.

SAFETY CODE POSTER

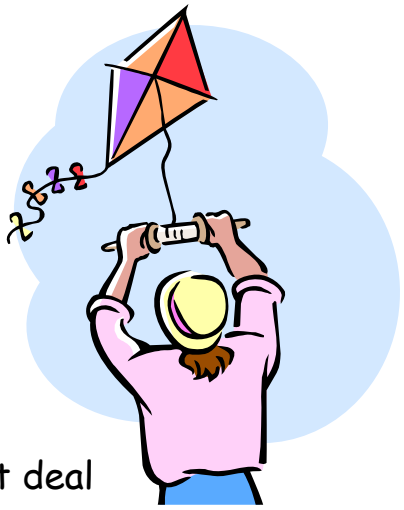
NEVER fly your kite near power lines. If a kite becomes tangled, leave it there, and call the utility company.



NEVER fly your kite during an approaching storm or in the rain. Ben Franklin was just lucky, folks!

DON'T FLY in air traffic patterns close to airports.

YOU CAN BURN OR CUT yourself on the string if you are not careful. Wear gloves if flying large kites.



EVERYONE has the right to the same sky. Try to keep a safe distance from other fliers.

WATCH OUT for cars!! And other people!

EVEN A SMALL kite can fall from the sky with a great deal of force. Do not let a kite come down on your head!

Mathematics Applications To Kite Making

Measuring:

- Measure the parts of a kite in both metric and English units.
- Figure the area of the sail of each of the kites you make.
- Measure the various angles of a kite.

Scaling:

- Many patterns for kites come in percentages. Find a pattern on line and figure out the measurements for various sizes of kites.
- Use an existing diamond kite and get ratios (width/height) to scale another one proportionately.

Symmetry:

- Most kites are symmetric across the spine of the kite. Discuss geometry and symmetry using kites.
- When using a pattern, note the symmetry involved.

Sail Loading:

The ratio of the weight of a kite to the size (area) of a kite is called ***sail loading***. This ratio tells us how well the kite will fly in light winds.

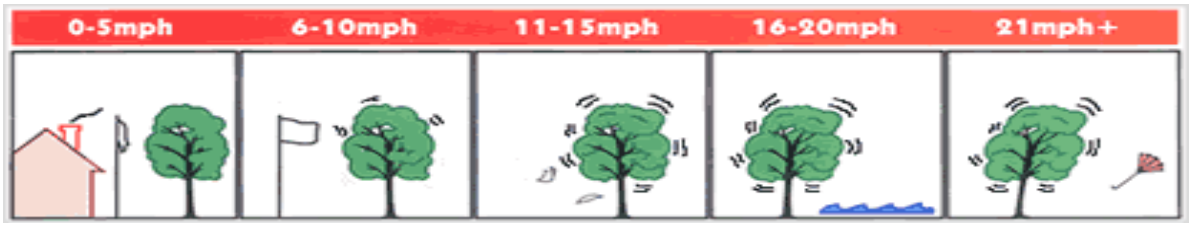
The formula: Sail load = weight/area

- Calculate the sail loading for the kites you constructed. You will need the weight of the whole kite (including the tail and bridle, but not the string) and the area of the sail.
- Add weight to the kite. This might be a little plastic figure that is taped on, or just the addition of heavy tape and ribbons. Now figure the sail load again.

Flying a Kite

Choose the best location:
Find an open place that has no trees, power lines, buildings, or other obstructions. If you are flying a huge, heavy kite, choose a place where there are few people. Buildings can not only block the wind, but they can cause turbulence. If there are buildings, you should move away at least seven times the height of the obstacle.

When to fly:
Observe the wind before trying to fly your kite. Every kite is rated for different wind speeds. A small lightweight kite only needs a breeze. Other, heavier kites may need quite a wind speed.



Do not fly in a storm or even if one is threatening.

Wind Direction:
Always fly with the wind at your back. By observing flags, grass, leaves, smoke, your breath in cold weather, and so on, you should be able to tell the direction of the wind.

Be prepared:
Get a small plastic pencil case or ziplock bag and make yourself a "flight kit." You should have some scissors, Scotch and duct tapes, extra string, extra spar material, bandaids, insect repellant, and sunblock.

Reels and Knots

REELS: Some sort of flying string or line is needed to fly a kite. Lightweight thread, string, or fishing line can all be used. Small kites only need a short line, which can be tied on a stick. But to fly a kite high in the sky, a long line is needed. And that means some way of controlling and organizing a string must be used.

The device used to control the string is called a reel. Just about anything that a string can be wrapped around can be a reel. The most important thing to remember when wrapping a string on a reel is to make sure that it is fastened tightly to the reel. Otherwise, when the kite has flown the length of the string, the string will come off and the kite will escape.

If you put a hook on the end of the string, the reel of string can be attached and reattached to several kites.

Some people fly their kites from fishing poles and reels.

The best reels allow the string to feed out without burning or cutting the fingers.

KNOTS: For the simple kites in this unit, no special knots are really needed. However, the larger and more expensive kites should be attached with special knots. Below are some places to find how to tie these knots. Particularly look for and study the knots for:

"Figure-8" to make a large "stopper knot" in a loop

"Larks Head" knot for attaching a loop at the end of the flying line over a stopper knot. This is sometimes called a "girth hitch".

"Prusik" knot is a special knot allowing a loop to be fixed in place but still, if it needs to be, unlocked to be adjusted.

- Kite Flyer's Knot Gallery -- Simo Salanne http://gamma.nic.fi/~sos/knots.htm
- Prusik Knot -- Dan Leigh www.deltas.freeserve.co.uk/knots.html#prusik
- KAP Knots and Hitches www.emporia.edu/kite/knots/knots.htm
- BRMRG Knot Review www.geospectra.net/kite/knots/knots.htm

TYPES OF KITES

Diamond or Eddy This is the shape that most people think of when they think of kites. It needs a higher wind.

Box A very old style of kite, this needs a very steady wind. However, a modified box style made from a paper bag will float on a nearly still air.

Delta This tends to be a stable flyer and does not need a lot of wind.

Parafoil In thousands of designs, these kites use different styles of pockets for lift.

Dragon Dragons have long tails and usually a flat nose. They come in all styles, not just dragons.

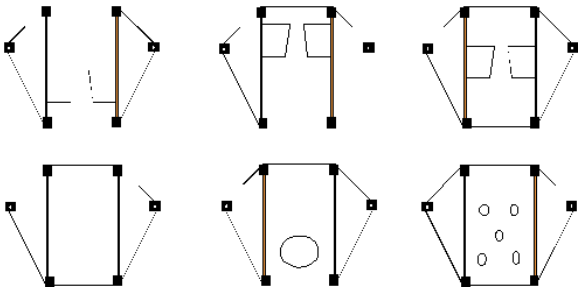
Sled Very easy to make from practically any material including plastic garbage bags, this kite will also fly in light or erratic winds.

Asian Kite Asia of course does not limit itself to one style of kite, but this style starts with a rectangle and usually has vents in the sail.

Fighting or Sport Kites These kites have more than one string for extreme maneuverability.

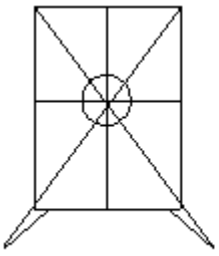
Suggestions for Further Investigations

After you have made and flown the sled shown in the plans, you might like to investigate the purpose of the vents on kites. What do the vents cut in the sail of the kites actually do? Do they have to be this size, and in this location? Try different sizes and shapes for the vents. Try cutting the vents in different locations. Fly these experimental versions while also flying the standard sled. Are there any differences in flight characteristics? Do they pull harder or lighter? Do they need more or less wind to fly? Write a report on your findings.

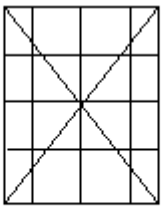


Sleds are very strong pulling kites. A large version will be able to pull you along on a skate board quite easily. As the size of the kite increases, it will be necessary to use stronger materials, but this will also increase the weight of the kite. Try building a kite three times the size of the one in the plans and using it to tow you across your school's playground. Can you work out how fast you are able to travel? What is the maximum speed you reach?

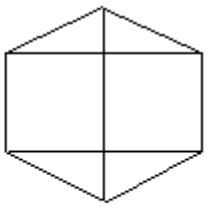
You might find that you will move faster if you don't point directly downwind. Why do you think this might be so? Try steering yourself at a variety of angles and record the speeds you reach. What is the best angle to travel downwind at the fastest speed? Can you work out a way of steering a sled in the sky? If the kite can be made to turn to one side or the other, it should be possible to make your kite and cart behave very much like a sailboat, and you should be able to steer yourself at right angles to the wind at least.



Korean Fighting Kite



Japanese "Edo"



Japanese "Rokkaku"

Additional Kite Resources

There are literally thousands of kite sites on the web. Here are just a few that are large and easy sites to navigate. Please see KITE MAKING PLANS for more sites.

American Kitefliers Association http://www.aka.kite.org/
This is the largest association of kiters in the world. Its purpose is to educate the public in the art, history, technology, and practice of building and flying kites and to advance the joys and values of kiting in all nations. They are men, women, adults and children from all walks of life. Their interests run from kite building to multi-line kite competition, from miniature kites, to aerial photography and more. The AKA is a nonprofit organization dedicated to educating the public in the art, history, technology, and practice of building and flying kites.

ON the site of American Kitefliers Association http://www.aka.kite.org/, choose the Table of Contents Tab at the top left of the page. Then choose "Publications" and then "Manuals". You will find wonderful pdf files that include instructions on kite flying, kite building, and safety. There is also a great one on Kites in the Classroom. Most notable are "How To Fly A Kite" by Glenn Davison and "Kites In The Classroom" by Glenn Davison.

The Virtual Kite Zoo http://www.blueskylark.org/zoo/
This has a lot of information, and also includes links to many other pages. Included are links to knot-tying instructions. There are simple kite plans included, as well as terminology.

How to Make and Fly Kites http://www.howtomakeandflykites.com/
This is a more advanced kite site. There are some very interesting kite plans here.

Canadian Science Projects http://www.hilaroad.com/camp/projects.html
Under "Engineering" you will find a kite project. But all the rest of the projects are great, too. There are videos included with these.

Dryden Flight Research Center at NASA
http://www.dfrc.nasa.gov/Education/OnlineEd/K4Guide/PDF/10sled.pdf

Kites, Kids and Education http://kckiteclub.org/DaveEllis/TOC.htm
Dave Ellis' site is chock full of goodies for kids and educators alike.

Meg's World: History of Kites http://fly.to/megsworld

Kites In The Classroom http://www.aka.org.au/kites_in_the_classroom/index.htm

How Does a Kite Fly? http://www.skratch-pad.com/kites/fly.html
A basic explanation of the physics behind kite-flying.

Kite Flight: Safety First!! http://windstarkites.com/KiteSafetyFieldCard.htm
Read this through thoroughly, and then keep these important rules with your kite gear to help avoid nasty accidents.

National Kite Month: Kite Plans http://www.nationalkitemonth.org/plans/
Plans for four kites, background on kites in other countries, kite games, and kite photos from around the world. Includes teaching links.

Professor Kite and the Secret of Kites http://www.GombergKites.com/howgen.html
Kite-flying savvy from Professor Kite: what are the best kite days, help to get your kite to fly, and which kinds of kites to fly in which winds.

The Virtual Kite Zoo http://www.kites.org/zoo/
Can't get enough of kites? Philip Le Riche's Virtual Kite Zoo has in-depth information on different kinds of kites. Advanced beginners will enjoy his list of kite terms, how-to knots page, and construction techniques.

National Geographic
http://magma.nationalgeographic.com/ngm/0312/feature1/index.html
A must-see site from National Geographic that deals with aerodynamics and flight.

Kids Point http://www.kidspoint.org