NATIONAL MUSEUM
OF THE UNITED STATES AIR FORCE™

Double-Pocket Sled Kite

Students will build a double-pocket sled kite using an integrated math/science approach. They will utilize skills associated with blueprint construction, pattern creation, and kite building, while following a given set of directions.

LESSON PLAN

Learning Objectives:

The students will:

- Construct a blueprint of a given kite
- Use proportions to create an appropriate pattern for a kite
- Build a kite according to certain specifications
- Fly the kite, using correct safety instructions and flying methods
- Evaluate the kite according to the four forces of flight

Purpose:

This class is designed to introduce blueprints, proportions, building, and flying a Double-Pocket Sled Kite. Students will also evaluate the kite's effectiveness based on the four forces of flight.

Introduction:

There are four forces that act on an object in flight: lift, weight, thrust, and drag. Lift causes an object to rise, weight causes an object to fall, thrust causes an object to move in a given direction, and drag causes resistance to the object's motion. When designing a kite, these four forces will need to work together to ensure flight. Careful attention will need to be paid to the design of a proper bridle string and tow point – two important details that establish a proper angle of attack. Students will have to incorporate mathematical and scientific skills in cooperative groups to accomplish this task. This is an excellent way to integrate learning in two disciplines.

Grade Levels: 7 – 8

Ohio Learning Standards/Science (2018)

Physical Science
8.PS.1: Objects experience force due to external field
8.PS.2: Forces can act to change the motion of objects

Ohio Learning Standards/Mathematics (2017)

Geometry
7.G.1.a: Compute actual lengths and areas from a scale drawing and reproduce a scale drawing at a different scale.
7.G.1.b. Represent proportional relationships within and between similar figures
8.G.2: Two-dimensional congruency
8.G.4: Two-dimensional similarity

Materials Required:

- 1 large garbage bag, 30 - gallon size per team
- 3 dowel rods (each 3/16" x 26") per team
- Strapping tape (for taping dowels to trash bag)
- Masking tape (for securing pattern to trash bag)
- Graph paper
- Pencil
- Hole puncher
- Ruler or meter stick
- Protractor
- Scissors
- Erasable markers
- Flying line (medium weight)

Procedure:

1. Safety Guidelines from the American Kitefliers Association

    a. Gloves should be worn to protect your hands from cuts and burns by the kite line, especially when flying a hard-pulling kite.

    b. Never fly a kite in wet or stormy weather; keep your line dry.

    c. Never fly kites around power lines, transmission towers or antennas. Should a kite get tangled with power lines, do NOT attempt to free it – contact the local power company to report the situation.

    d. Do not use wire or metal in kite construction or line.

    e. Do not fly from, or over, public streets and highways.

    f. Do not fly near airports and air traffic patterns.

    g. Do not fly maneuverable kites close to bystanders; this applies to the flying line as well as the kite.

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

    i. Do not fly near trees; if your kite should get caught in a tree, don't pull the kite or climb the tree. Let the wind dislodge the kite.

    j. Use caution when launching, flying and landing very large kites.

    k. Do not fasten kite lines to yourself unless you have a quick release system.

2. Weather conditions that are best to fly a kite

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

Material	***Wind (mph)***	***General Range***
Light paper	4-12	Light to Gentle
Light plastic	8-24	Gentle to Fresh
Light cloth	8-31	Gentle to Strong
Heavy plastic	13-31	Moderate to Strong
Heavy cloth	13-31	Moderate to Strong

Kite Type	*Wind (mph)*	*General Range*
Fighter	4-12	Light to Gentle
Sled	6-18	Light to Moderate
Diamond	6-18	Light to Moderate
Delta	6-18	Light to Moderate
Box	13-31	Moderate to Strong

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

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

3. Build a Kite

a. Review measurements and proportions. Review principles of flight (lift, weight, thrust, drag). Use a visual that illustrates these principles of flight. Review and demonstrate kite terminology (keel, bridle, tow, flying line). Use a previously constructed kite for this.

b. Have a sample available of a previously made sled kite as well as all the materials needed for the kites.

c. Give each group of students a scaled drawing of a double-pocket sled kite (see figure A).

d. Instruct each group to create one blueprint (to scale) of the kite, using graph paper, ruler and a pencil. Students can determine their own scale, as long as it is accurately drawn. Right angles should be checked, with a protractor, to ensure accuracy.

e. Once the blueprint has been checked by the teacher, create a pattern (actual measurements) for the kite. Use sheets of newspaper or roll paper for the pattern. Carefully measure angles and draw lines using ruler or meter stick.

f. When the pattern has been traced and checked by the teacher, have students cut out the pattern and throw remaining scraps away.

g. Attach the pattern (using very small bits of masking tape) to the fold of a trash bag. Carefully trace around the pattern using a light-colored, erasable marker. This will show up on a black trash bag under room lights.

h. Remove the pattern and cut out the kite, making sure to ALSO cut along the fold. Two pieces of the pattern, separate from one another, should remain. Gliding scissors along the trash bag, rather than cutting, produces smoother edges. If marker lines still show, they can be wiped off.

i. Using strapping tape, fold each piece of the kite along $\overline{CD}$ and tape the two kite pieces together along this line (see figure B).

j. Now bring edges $\overline{AB}$ across to $\overline{EF}$ (on each piece) and tape them in place, creating a tube on each side (see figure B).

k. On the reverse side of the kite (opposite pockets), tape dowel rods along both sets of $\overline{AB}$ and the adjoined $\overline{CD}$ (3 dowels total, each 26" in length).

l. Reinforce each dowel with one 26" strip of tape that runs from the top of the kite to the bottom. This ensures that air will not pass between the dowel and the kite, causing it to rip.

m. Reinforce wing tips with one to two pieces of strapping tape and punch a hole in tips for the bridle string.

n. Construct bridle string using flying line. Measure a piece of string five times the length of the dowel rods.

o. Using a square knot, attach each end of the bridle string to the wing tips (see figure C).

p. Once the bridle string is attached to the wing tips, bring the wing tips together and find the center and tie a loop.

q. Attached the rest of the string to the loop, and you are ready to fly.

***Summary**:*

Today we created a blueprint, created a pattern, built a kite according to specifications, flew our kites, and evaluated their performance.

Assessment/Evaluation:

Students should be evaluated on their ability to follow directions, work cooperatively in groups, and produce quality work. They should also be required to explain in writing how and why a kite flies using the four forces of flight. As a math extension, students can be required to find the surface area of the kite. Their blueprint, pattern, and kite should be evaluated as well.

***Activity**:* Let's Go Fly A Kite! (time and weather permitting)

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

b. Special Instructions: Here are some trouble shooting hints for successful kite-flying.

1) If the kite does not rise, there may not be enough wind or the bridle may be too short.

2) If the kite flies and then crashes, you may need to lengthen the bridle.

3) If the kite tends to spin or wobble, you may need to check the midpoint of the bridle.

Resources:

https://kite.org/education/

https://www.britannica.com/topic/kite-aeronautics

https://www.grc.nasa.gov/www/k-12/airplane/kite1.html

https://www.grc.nasa.gov/www/k-12/airplane/kitefor.html

https://www.grc.nasa.gov/www/Wright/airplane/kite00.html

https://www.sciencefriday.com/educational-resources/kite-engineering/

https://www.grc.nasa.gov/WWW/K-12/airplane/forces.html

https://www.hq.nasa.gov/office/aero/pdf/four_forces_5_8.pdf

https://howthingsfly.si.edu/forces-flight/four-forces

Figure A

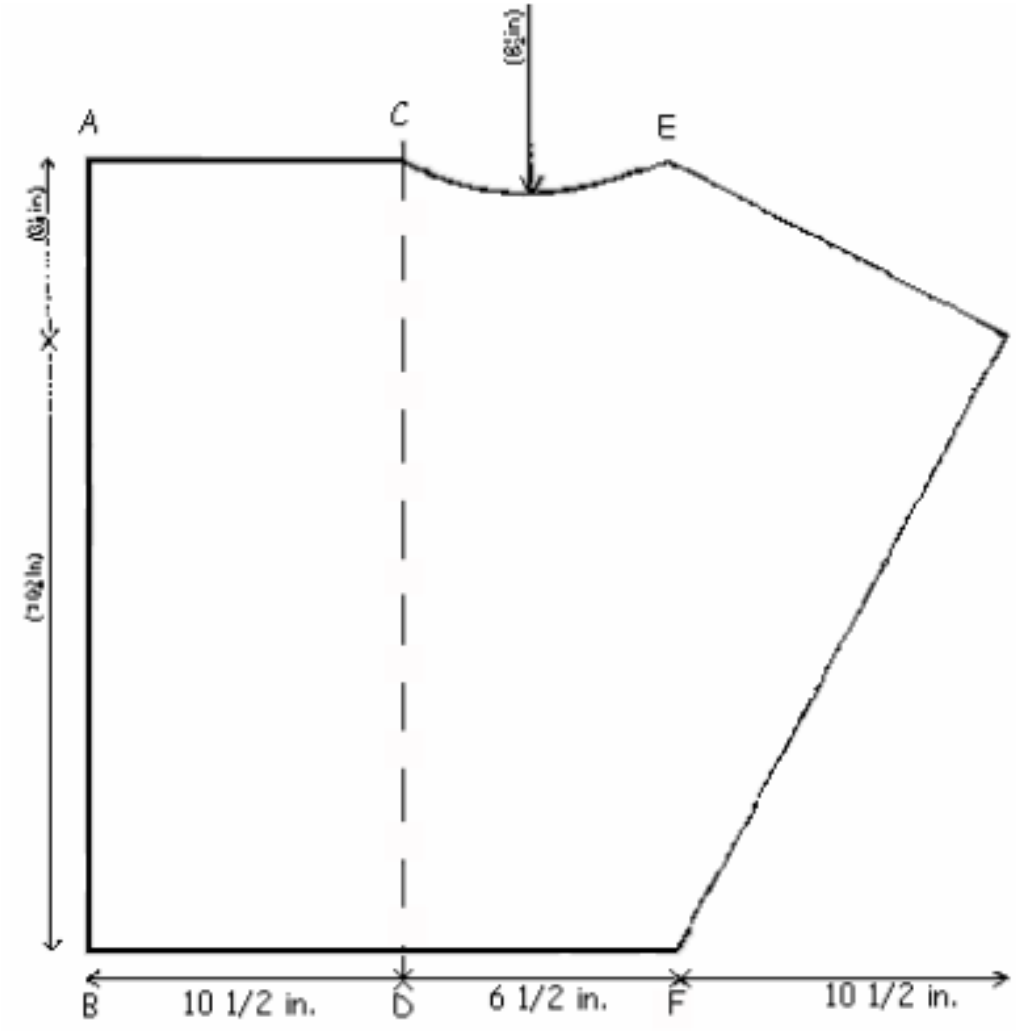

Figure B

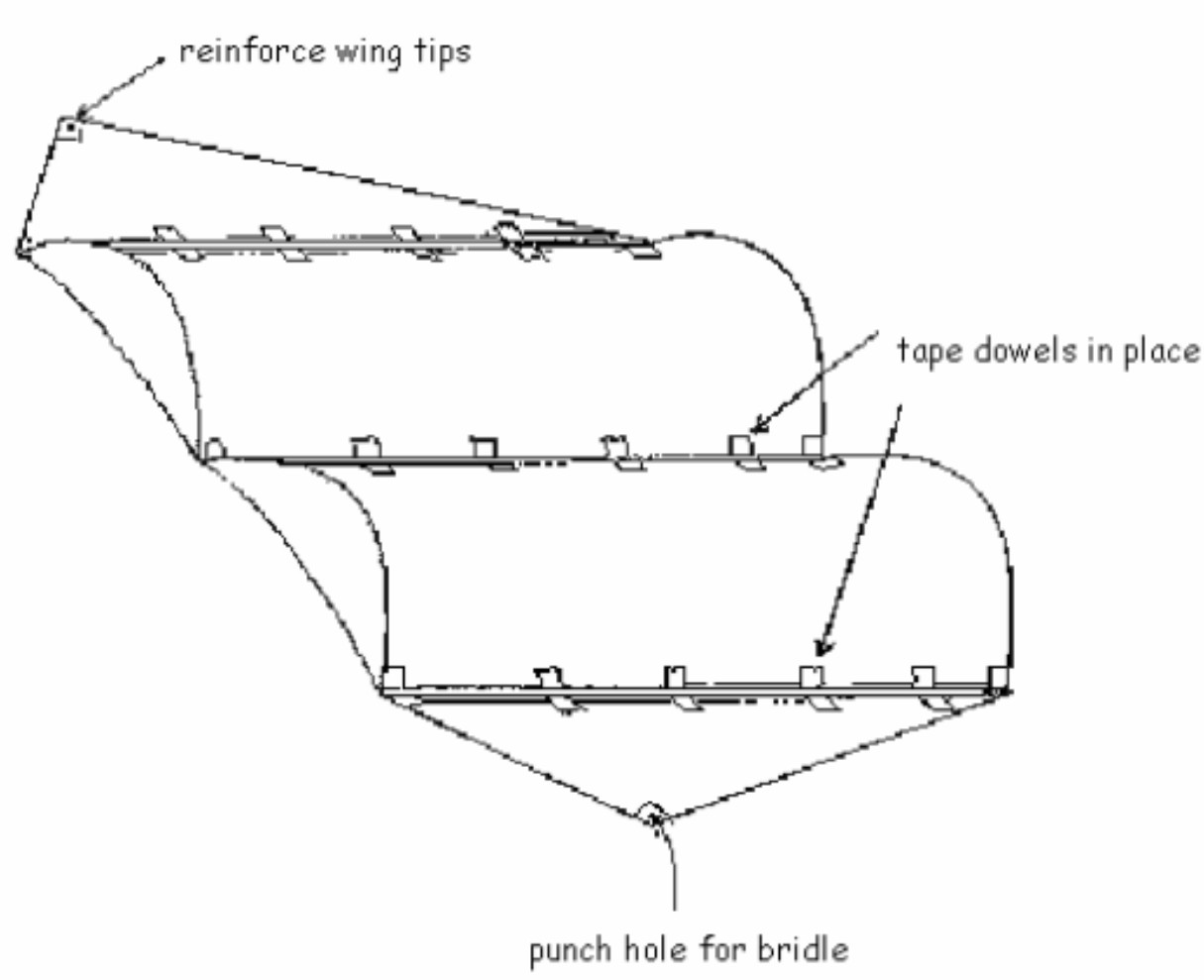
reinforce wing tips
tape dowels in place
punch hole for bridle

Figure C