NATIONAL MUSEUM
OF THE UNITED STATES AIR FORCE™

Math and Science with a Fighter Kite

Using the traditional art of kite making and flying, students will explore a number of different STEM opportunities.

LESSON PLAN

Learning Objectives:

The students will:

- Build and fly an Indian Fighter Kite – also known as a Patang
- Use the kite to perform any or all of the following lessons:
  - Calculate surface area of simple geometric shapes
  - Calculate the altitude of the kite using simplified trigonometric functions
  - Calculate the altitude based on vector quantities
  - Calculate the length of arched dowel rod
  - Investigate the Bernoulli principle
  - Investigate Newton's laws of motion
  - Experiment with three axes of movement (pitch, yaw, & roll)
  - Utilize lift to drag ratio
  - Record information using scientific method
  - Use a CAD system to design a kite
  - Calculate cost of materials to build their kite

Purpose:

This class is designed to give students practice with various science and math concepts through the building and flying of a fighter kite.

Introduction:

The fighter kite was invented in India, where they are flown daily from rooftops and during the kite season at large festivals. It is exceptionally maneuverable and capable of flying at amazing speeds with a considerable amount of directional control. It is sometimes equipped with cutting devices such as ground glass or porcelain glued to the line below the bridle by means of egg white, rice or other natural adhesives. The U.S. does not use such cutting devices for competitions, and according to the American Kitefliers Association's Fighter Committee, the combat rules for the fighter kites include line touching games, or interacting with objects. Other countries like Japan, Afghanistan, Pakistan, China, and Korea also have a rich background in making and flying the traditional fighter kite with some variations in structure and design.

Grade Level: 8 – 12

Ohio Learning Standards/Science (2018)

8.PS.1: Force due to an external field
8.PS.2: Forces can change the motion of objects
PS.FM.1: Motion
PS.FM.2: Forces
PS.FM.3: Dynamics
P.F.1: Application of Newton's Laws
P.F.2: Gravitational force and fields
P.F.5: Air resistance and drag

Ohio Learning Standards/Mathematics (2017)

N.VM.1: Recognize vector quantities
G.SRT.6: Trigonometric ratios
G.SRT.7: Use relationship between sine and cosine
G.SRT.8: Solve problems involving right triangles

Materials Required:
[The following are based on choosing the kite design at the end of the lesson]

- 1 large sheet of tissue paper, 20"x 20", for the sail
- 1 small piece of tissue paper, 4"x 4", for kite fin
- 2 hardwood dowel rods, 1/8" in diameter
- Flying line
- Transparent adhesive tape
- Glue
- Scissors
- Ruler, meter or yard stick
- Decorating supplies - markers, water paints, poster paints, crayons, colored pencils, etc.
- Calculator
- Pencil

Related activities to choose from:

1. Discuss the methods for finding the surface area of geometric objects and find the area of the kite.

2. While flying the kite, have the students use vector quantities to determine its altitude. Students will need to use a predetermined length of string (the vector magnitude) and a protractor device (see resources) to measure the angle between the kite flier's hand and the location of the kite. Students should draw a diagram and calculate the altitude (which will be the side of the "triangle" opposite the angle).

3. While flying the kite, have the students use the tangent function to determine its altitude. Students will need to use a protractor device (see resources) to measure the angle between the kite flier's hand and the location of the kite and a measuring wheel to determine the distance between the kite flier and the ground directly beneath the kite. Students should draw a diagram and calculate the altitude (which will be the side of the "triangle" opposite the angle).

4. Have each student determine, using the Pythagorean theorem, how long the vertical spar needs to be since it will need to fit the diagonal distance across the kite (i.e. a 20 inch square if using the included instructions).

5. Have each student determine how long the horizontal (curved) spar needs to be since it must be ¼ of the circumference of a circle with a radius the same distance as the side of the square used to make the kite.

6. Explore various graphing techniques and graph some data from the kite activity.

7. Demonstrate and discuss the Bernoulli Effect by blowing across the top of a sheet of paper to show the effect. Try the same effect with two hanging ping-pong balls about an inch apart. Blow between them using a straw. The balls should come together. Then show the effect using different styles of airfoils.

8. Talk about the four forces of flight - lift, weight, thrust and drag. Experiment with lift, drag, pitch, roll, and yaw, and compute the force of the kite using a spring balance. Discuss how they relate to the kite.

9. Conduct experiments to discover Newton's three laws of motion and how the kite may be affected by them.

10. Introduce CAD (Computer Aided Drawing) to students. Have them make a two dimensional drawing of a simple object. Have students sketch the kite design based on the information received from their math and science investigations. Then have the student draw this design using the CAD system.

11. Have the student prepare a materials list and cost analysis for his/her design.

12. Have students build and decorate the kite they designed using the materials provided.

13. Discuss proper safety habits for flying kites. Have the students test fly their kites making changes necessary to improve their kite.

14. Kite craft is at least two thousand years old. Cover the history of kite flying, the people involved, and the achievements advanced through kite flying.

15. Have students research the etymology of various words related to kite flying. Have them write poems in different styles about making and flying kites. This is also a good activity to have them write research reports about the history of kite flying.

16. Kite flying is a major activity in India and Japan. Learning about these cultures and language using kites would be an exciting opportunity.

17. Students can create new designs, alter existing designs, or even repair old kites as an extension activity.

Resources:

https://kite.org/education/

https://kite.org/education/styles/single-line/fighter-kites/

http://www.csun.edu/~ghsiung/fighters2.html

http://fighterkitecentral.com/pdfs/FusionFighterManualV02a.pdf

http://www.windpowersports.com/guides/fighter-kite.php

https://www.kiteplans.org/cat_1/sub_16/

https://www.kiteplans.org/planos/indian/indian_2.html

https://kitelife.com/2004/10/01/issue-38-tangler-fighter-kite-plans/

http://www.nafka.org/plans/

https://www.my-best-kite.com/fighter-kites.html

http://www.fighterkitecentral.com/ (see links on the left for detailed instructions for building)

https://www.oneworldkites.com/KitesInformationPage.html

Instructions for building a Patang Indian Fighter Kite

a. Go through checklist of kite parts. Each student should have a square of tissue paper 20" x 20" for the body of the kite, two dowel rods (one the same length as the diagonal of the square and the other one-fourth the circumference of a circle of radius 20"), and a 4"x 4" square of tissue paper for the tail fin.

b. Have students pre-measure and cut out even strips of adhesive tape and keep them ready on the side of the table for easy access.

c. Apply a line of glue along the diagonal of the square and attach the dowel rod of the same length. Reinforce this bond with adhesive tape.

d. Measure out two pieces of adhesive tape, about 4" in length in readiness for the next step. These will be used to create the wingtip pockets for fitting the other dowel rod.

e. Take one 4" length of tape and attach it to the underside of one of the wingtips with half the width free for step 6. Do the same with the other wingtip.

f. Apply a little glue to the exposed side of the wingtip. Place one end of the second dowel rod along the edge of the glue at the wingtip. Fold the wingtip over the rod and press tightly down on the adhesive tape to seal the dowel rod into the wingtip pocket. Reinforce with more adhesive tape if necessary.

g. Bow the rod across the other dowel rod and fix the other end similarly in the other wingtip pocket, by repeating steps 5 and 6.A special type of kite that requires no rigid frame is the flex foil, which was invented by Domina Jalbert. This kite resembles an airplane's wing and is made up of a number of cells that are inflated to create an airfoil shape with the pressure of the wind.

h. Now take the 4" x 4" piece of tissue paper and cut it along the diagonal so that it forms two triangles. Glue one triangle to the underside of the kite for the tail fin. Turn the kite back over and position the two 3" cut dowel rods on the tail fin as shown in the figure. Glue them down. Place the remaining triangle over the other triangle with the dowel rods sandwiched in the middle and glue it firmly down. Reinforce along the edges with adhesive tape. The tail fin is complete.

i. Reinforce all the edges of the kite with adhesive tape. (This step is optional although it is highly recommended).

Bridling the Fighter for Action – see drawing on next page

a. The strips represent the adhesive tape.

b. The little circles represent the positions where holes are to be made to insert the flying line to bridle the kite.

c. The dot in the center represents the midpoint of the diagonal. Each dot on the diagonal is equidistant from the midpoint.

d. The dashed line represents the bridle.

e. It is important to remember that the three dots form an equilateral triangle. They also represent the positions where the flying line is to be tied in double knots.