KITES

Lesson Plan: Sled Kites and Trigonometry

Grade Level: 9-12

Subject Area: Geometry & Algebra II

Time Required: ***Preparation:*** 2 weeks
Activity: 1-2 hours

National Standard Correlation:

Math (grades 9-12)

- Algebra Standard: Represent and analyze mathematical situations and structures using algebraic symbols. Use mathematical models to represent and understand quantitative relationships.
- Problem Solving Standard: Apply and adopt a variety of appropriate strategies to solve problems (i.e. – make a graph).
- Geometry Standard: Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.
- Measurement Standard: Apply appropriate techniques, tools, and formulas to determine measurements.
- Data Analysis and Probability Standard: Formulate questions that can be addressed with data, and collect, organize, and display relevant data, to answer them.
- Data Analysis and Probability Standard: Develop and evaluate inferences and predictions that are based on data.

Summary: Students will work in teams of three to construct sled kites that fly successfully. Prior to flying kites all students will be instructed in the following: history of kites, fundamental properties of kite flying, and safety procedures for flying kites in a crowded area. Students will use a protractor to estimate the angle the flying line (hypotenuse) makes with the ground, measure the distance from the Pilot to a point directly under the kite (adjacent side), and apply the formulas for sine and cosine to calculate the height of the kite (opposite side). They will convert these calculations to vectors and draw a vector diagram of the kite flying experience.

Objectives: Students will:

- Build and fly kites
- Apply vectors
- Apply trigonometric functions
- Measure angles and distances
- Graph the results of each group

Background: The sled kite is a standard workshop kite that can be made in a variety of sizes and with a variety of materials. The kite is simple to make, and is an excellent flyer. There are three main forces that affect the flight of a kite. They are: lift, gravity, and drag. Lift causes the kite to rise. Gravity causes the kite to fall. Drag is the pull on the kite by the passing air. When all three of these forces are balanced, the kite will fly. A kite has many parts that help keep lift, gravity, and drag balanced. The flying line holds the kite so that it will not fly away in the wind. The bridle is

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connected to the kite at two points, and the flying line is connected to the bridle at its tow point. If the bridle is not set at the correct angle, the kite will not fly properly. If the kite does not rise, there may not be enough wind, or the bridle may be too short. If the kite starts to fly and then crashes, you may need to make the bridle longer. If the kite tends to spin or wobble, you may need to check the midpoint of the bridle. As the kite is flying, the flying line forms an angle with the ground. If we drop an imaginary line perpendicular to the ground from any point along the flying line it will form a right triangle with the Pilot as one vertex and the flying line as the hypotenuse.

Materials:

Students will need:

- 1/8” diameter dowel rods (24” long)
- Plastic garbage bags (tall kitchen size)
- String
- Scissors
- Reinforced packing tape
- Hole punch
- Measuring tape
- Protractor
- Permanent marker
- Flying line
- Calculators

Safety Instructions:

Students should not place garbage bags near their faces.

Procedure:

A. Warm-up

1. Make sure all concepts are taught prior to doing the activity.
2. Review terminology.
3. Instruct students to work in teams of three.
4. Have a sample sled kite available for comparison.

B. Activity I

1. Use the permanent marker to mark off the flying line in increments of 10’.
2. Students will copy the pattern from the dimensions listed on the overhead. All sled kites follow the same proportions.
3. Lay the plastic garbage bag flat. To tape the dowels in place, use about 1.5” – 2” of strapping tape. It is very helpful to pre-cut the tape into 1.5” – 2” pieces. Each student will need ten pieces. Place the dowels parallel to one another. Place tape on the back of the kite skin (about half the length of a piece of tape), and fold it toward the front of the kite to secure the dowel. Press down firmly around the dowel, and repeat at the other end. Once both dowels are taped in place, put one piece of tape (lengthwise) in the center of the dowel to hold the middle. By wrapping the tape from the back to front, the ends of the dowels are more secure.
4. At the outside corners, place tape on the backside (about half the length of a piece of tape), and fold toward the front of the kite. Use another piece of tape and repeat the procedure, but tape in the opposite direction to reinforce the corner.

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5. Fold the kite in half. Match the reinforced corners and punch holes through the reinforced corners.

6. To make the bridle, cut a piece of string that is five times the length of the dowel (about 10 feet). This proportion works for all sled kites. If this string is cut too short, the kite will not open wide enough to catch the wind. Tie one end of the string through each hole. Square knots work the best. Match the holes and find the exact midpoint of the string.

7. **THIS IS A CRITICAL STEP!** If the loop is not at the midpoint, the kite will dive to one side. Now tie a knot, leaving a small loop. Tie your flying line to the loop and you are ready to fly.

C. Wrap-up for Activity I

Prior to flying kite, obtain the windspeed and direction from the National Weather Service, The Weather Channel, or your local weather forecaster. Students will need it to draw their vector representations.

D. Activity II

1. Students will work in teams of three to fly the kites. Remind the Pilot to stand still in order to increase accuracy.

2. The Measurer will use the protractor to estimate the angle that the string makes with the ground, and the Recorder will record the estimate in the Flight Log.

3. The Measurer will measure the distance from a point directly under the kite to the Pilot. This distance is one leg of the right triangle. Record the data.

4. From the markings on the flying line estimate the length of the line. This is the hypotenuse.

5. Use the sine and cosine ratios to calculate the height of the kite.

6. Use the angle of attack, length of hypotenuse, and length of the adjacent side to convert the vectors into their coordinate positions.

7. Draw a vector representation of the flight of your kite.

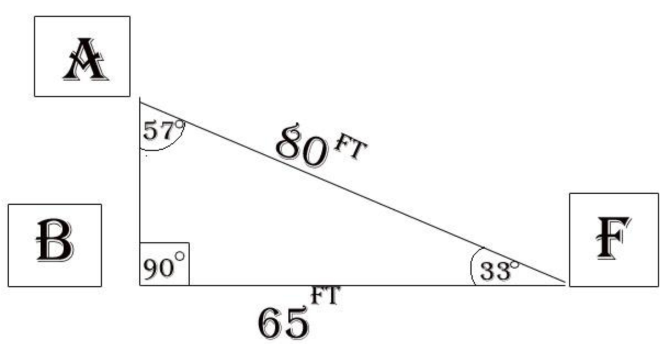
E. Wrap-up for Activity II

As a class, compare vector diagrams.

Example:

Wind speed: 10 mph from the northeast

- Point A is the kite
- Point B is the right angle
- Point F is the Pilot
- String (segment AF) is marked in feet. (We will use 80 feet)
- Measure of angle AFB = 33° (therefore the measure of angle FAB = 57°)
- Segment BF =65
- Height of kite flier's hand



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is 5 feet

Sin 33 = x/80	cos 57 = x/80
80(sin 33) = x	80(cos 57) = x
80(.5446) = x	80(.5446) = x
43.568 = x	43.568 = x
44 = x	44 = x

Round all answers to the nearest whole number. Do not forget to add the height of the arm holding the kite. Therefore, the kite is actually 44 + 5 =49 feet high. As demonstrated, either the sine or cosine measurement can be used.

Represent the direction and distance in vectors. (on hardcopy)
Put the vector on the coordinate plane
OB/OA = cos 33 and BA/OA = sin 57
OB = OA(cos 33) BA = OA(sin 57)
OB = 10(.8387) BA = 10(.5446)
OB = 8.387 BA = 5.446
A is at the coordinates: A = (10(cos33),10(sin57) or A = (8.387.5.446)

Graph the results.

TEAM WIND HYPOTENUSE ANGLE OF ATTACK BF AB TOTAL HEIGHT

A	10	80	33	65	44	49
B						
C						
D						
E						
F						

Assessment/ Evaluation:

Each student should be assessed on his/her ability to work the experiment correctly, and on the accuracy of the calculations. Differences in answers may be due to rounding differences.

Extensions:

Use the Pythagorean Theorem to check the answers.

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Table of Tangents

Angle	Tangent	Angle	Tangent	Angle	Tangent
1	0.017	31	0.601	61	1.80
2	0.035	32	0.625	62	1.88
3	0.052	33	0.649	63	1.96
4	0.070	34	0.674	64	2.05
5	0.087	35	0.700	65	2.14
6	0.105	36	0.727	66	2.25
7	0.123	37	0.754	67	2.36
8	0.141	38	0.781	68	2.48
9	0.158	39	0.810	69	2.61
10	0.176	40	0.839	70	2.75
11	0.194	41	0.869	71	2.91
12	0.213	42	0.900	72	3.08
13	0.231	43	0.933	73	3.27
14	0.249	44	0.966	74	3.49
15	0.268	45	1.00	75	3.73
16	0.287	46	1.04	76	4.01
17	0.306	47	1.07	77	4.33
18	0.325	48	1.11	78	4.70
19	0.344	49	1.15	79	5.14
20	0.364	50	1.19	80	5.67
21	0.384	51	1.23	81	6.31
22	0.404	52	1.28	82	7.12
23	0.424	53	1.33	83	8.14
24	0.445	54	1.38	84	9.51
25	0.466	55	1.43	85	11.4
26	0.488	56	1.48	86	14.3
27	0.510	57	1.54	87	19.1
28	0.532	58	1.60	88	28.6
29	0.554	59	1.66	89	57.3
30	0.577	60	1.73	90	---

Angle_____________________________ Tangent of angle ____________________

Distance from flier to kite ____________________

Height = Tangent of the angle x distance from flier to kite

Height of Kite = _____________________________

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Sled Kites and Trigonometry
Flight Log

Windspeed: ___________________

Wind Direction: ________________

Estimated Angle	Length of Adjacent Leg (m)	Length of Flying Line (Hypotenuse) (m)	Sine	Cosine	Height of Kite (m)

NOTE: The height of the arm holding the kite is important. It is approximately 5 feet!

sine =opposite/hypotenuse

cosine=adjacent/hypotenuse

Round all answers to the nearest whole number.

1. Draw a diagram of your kite flying experiment. Label the distance of each side and the estimated angle between the flying line and the ground.

2. Use the formula for the sine of an angle to determine the height of the kite.

3. Use the formula for the cosine of an angle to determine the height of the kite.

4. Represent the direction and distance in vectors.

5. Use graph paper to put the vectors on the coordinate plane.

6. Graph the results.

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