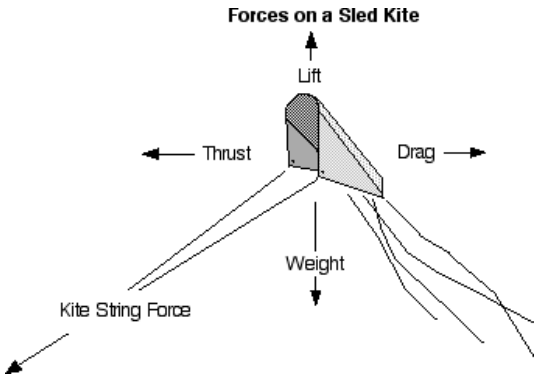
Name _____ Class Period _____

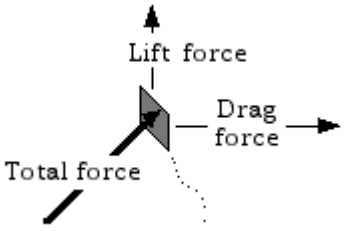
Background Information about Lift and Newton's Third Law: Wind striking a kite surface will create a force that causes the kite to fly. This force can be felt as wind pushes on the kite and as the kite tugs on its string. An understanding of Newton's Third Law explains this force.

Newton's Third Law, often stated as, "for every action (or force) there is always an equal and opposite reaction (or force)," is one of the basic principles on which flight is based. 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.

At any time there are four forces acting on a flying kite: lift, weight, thrust, and drag. The force that lifts, or pushes, or pulls the kite vertically upward is called "lift". Gravity pulls the kite toward the earth. The downward force of gravity acting on the mass of the kite is called "weight." As you pull on a kite string you are providing "thrust." The resistance of the kite to the horizontal thrust is called "drag." When a kite flies at a constant velocity all forces are equal. Lift opposes and equals weight while thrust opposes and equals drag.



You can feel the force of a kite tugging on its string. The total force on the kite is a combination of its lifting force and its drag force.



Directions: In this activity, you will work with a simple but powerful kite to discover the relationship between surface area and lifting capacity.

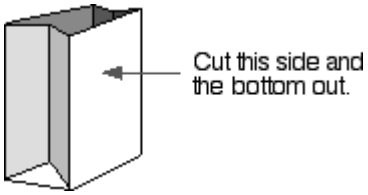
AEROLAB

KITES, SURFACE AREA & NEWTON'S 3rd LAW

How to Build a Sled Kite: A recent kite design, the sled, is simple to build and a powerful lifting machine in light-to-moderate breezes. A 43-cm x 64-cm model is illustrated, but one can vary these dimensions and determine the lifting capacity of other models with different surface areas. A simple scaling activity using graph paper can precede kite building to illustrate changes in size while retaining proportional dimension.

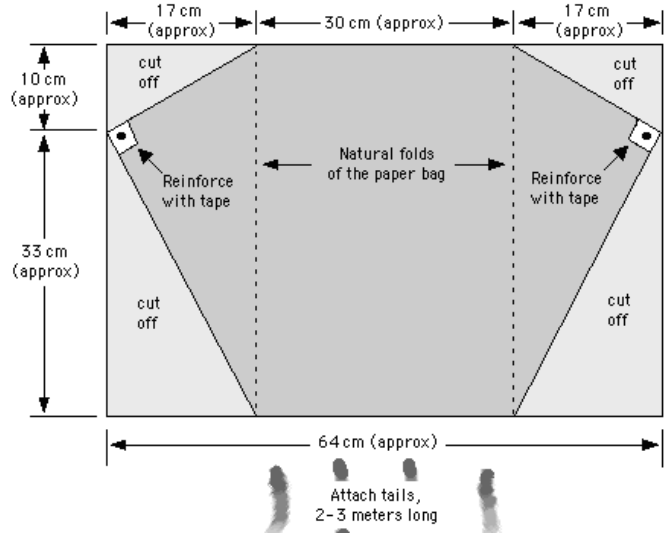
Materials:	**Tools:**
Standard-size brown paper grocery bags	Pencils
Masking tape	Meter sticks or rulers
Kite string	Scissors
2 Force meters per kite	Colored markers

Kite construction: Complete the following construction steps:

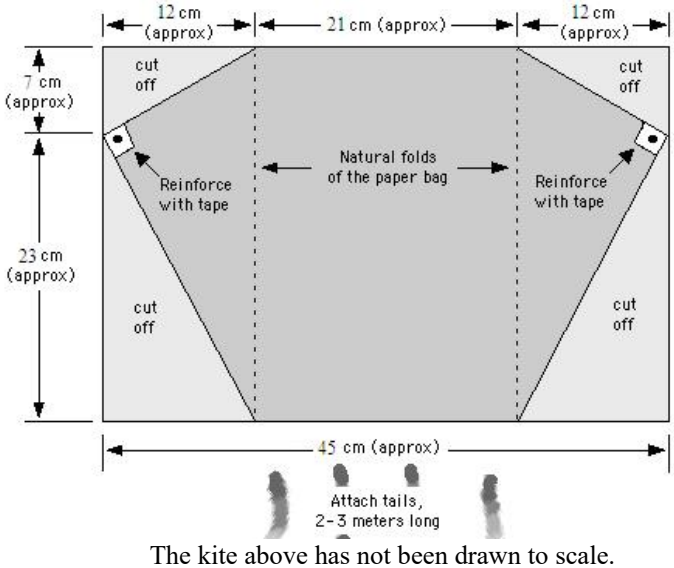


1. Cut out the side and bottom of a standard-sized brown paper grocery bag.
2. Unfold the bag and mark out the dimensions given in the illustration.
3. Reinforce the bridle-attachment points with tape and attach bridle string (approximately 2 meters in length, depending on the kite). Tie a simple loop knot, at the midpoint of the bridle.
4. Decorate as desired using colored markers.
5. Use the dimensions below to create kites with different surface areas.

Full-Scale Kite: Surface Area = 2021 cm^2



Half-Scale Kite: Surface Area = 1010.5 cm^2



The kite above has not been drawn to scale.

Kite Testing Procedure:

1. Prior to flying your kites, attach two force meters to one another and pull gently apart. What do you notice when you read each meter?

2. Finish this hypothesis: If surface area of a kite increases, then…

3. Fly a large and small kite while standing side by side in a line that runs perpendicular to the wind. Both kites should also be flying at the same altitude.

4. While flying your 2 kites, create a small loop on each string and attach a force meter.

5. Measure the force pulling on each kite at the same instant so that the wind speed will be the same for each kite. The teacher will tell you when to read the forces for each trial.

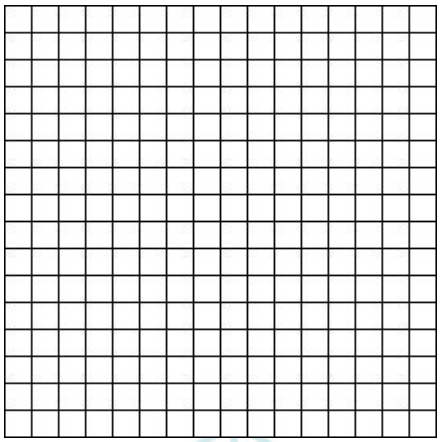
6. Write your data below and continue for 4 more trials.

Surface Area of Kite	**Force (Newtons) Exerted**					**Average Force (N)**
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	
1010.5 cm^2						
2021 cm^2						

7. After flying, share your Average Force data with the class.
8. Create a scatter-plot graph of the class data to show how surface area of the kite is related to force.

How Surface Area (cm^2) of the Kite Affects Force (Newtons)

Force (Newtons)



Surface Area of Kite (cm^2)

9. What is the relationship between surface area and force? Analyze the graph and explain.

10. Which pulled harder? The kite or your hand?