The FUTURES Channel®

MOVIE GUIDE

MOVIE NUMBER 1011

Windsails

The Movie:

Windsail designer Trevor Baylis develops the shape of a sail on his computer, builds it in his shop and tests it out on the waves. Featured: Trevor Baylis, Waddell Sails. *(Movie length: 1:42)*

Background:

If you could take the wing off an airplane and hold it over your head in a strong wind, you would find that the wing has quite a bit of lifting ability.

But what if, instead of holding it over your head, you put the base of the wing down on the ground with the end sticking up in the air? With wind blowing across the wing, it would be pulled sideways in exactly the same way it was pulled upwards when positioned horizontally. That's probably not a very practical way of traveling across the ground, but what would happen if you made that wing quite a bit smaller and a great deal lighter, and attached it to a surfboard? You would have just invented the sport of windsurfing. And you would be an aeronautical engineer named Jim Drake, in the year 1967.

Since then, windsurfing has grown into not only an international sport, but also an international industry, and a great deal of research has been done to find out what characteristics of mast, sail and board give the best performance in which conditions. The result is a sport which is an elegant and thrilling combination of physical coordination and strength, materials science, physics and mathematics.

Curriculum Connections:

Ratios

1

The mast used in a wind sail must have certain characteristics to work well: a specific shape, great strength, as little weight as possible, and the ability to hold its shape in spite of powerful forces (referred to as "stiffness").

Generally, the more carbon that is used to make a mast, the better the mast, and also the more expensive.

Since carbon is lighter than other materials used in a mast, masts that have more carbon weigh less per centimeter of length. Use this fact to put the following four masts in order of least to most percentage of carbon:

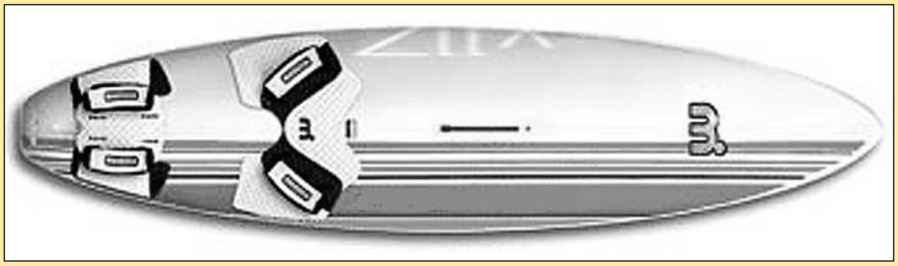
Mast	Length (cm)	Weight (kg)
a	370	2.1
b	460	1.7
c	490	2.3
d	400	2

Geometry (volume)

2

Windsurfing boards can be made with a foam core, which might have a density anywhere from .04 grams to 0.2 grams per cubic centimeter. Estimate the volume of this board using rectangles, trapezoids and triangles. (Hint: Volume = area x thickness of the board.) What would the weight of its core be with the lightest density of foam core? The heaviest?

62 cm



Thickness = approx. 5.5 cm

267 cm

Algebra (coordinate systems)

3

a) These numbers represent the shape of a wind sail mast. Plot the points and sketch the shape of the masts.

x	0	20	40	60	80	100	120	140	160	180	200
y	0	1	1.5	2	2.5	3	4	5	6	7	8

x	220	240	260	280	300	320	340	360	380	400
y	9	9.5	10	9.5	8.5	7.5	6	4	2	0

b) The mast you just sketched has its highest curvature about two-thirds of the way toward the top. Create a set of numbers for a mast that has its highest curvature even closer to the top of the mast. Keep the curve as smooth as you can.

x	0	20	40	60	80	100	120	140	160	180	200
y											

x	220	240	260	280	300	320	340	360	380	400
y										

c) Create a set of numbers for a mast that has its highest curvature right in the middle of the mast. Remember to keep the curve smooth.

x	0	20	40	60	80	100	120	140	160	180	200
y											

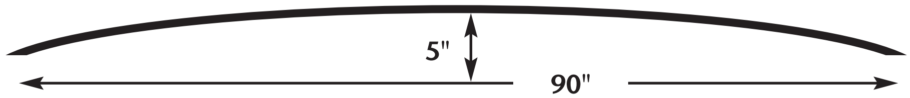
x	220	240	260	280	300	320	340	360	380	400
y										

SurfSail Designs

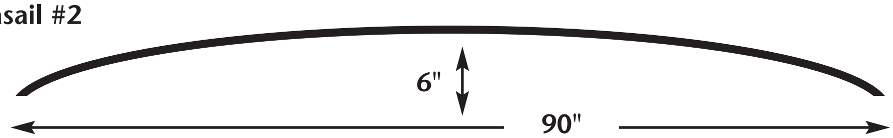
From: Design Chief

For our new “Quadrasail” design, we want to test several possible parabolic mast shapes:

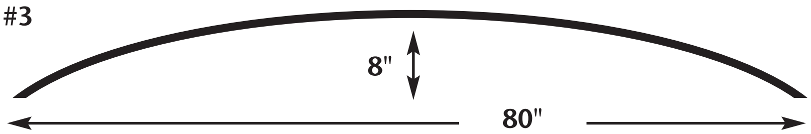
Quadrasail #1



Quadrasail #2



Quadrasail #3



Task #1: Please determine the equation of each of the above curves, so that we can get these potential designs into the computer.

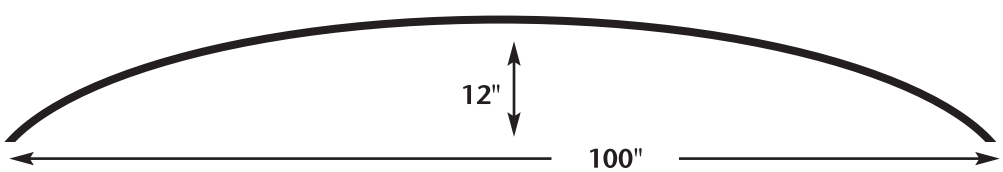
Task #2: The boss says we could produce a whole family of possible parabolic mast shapes, using this formula:

$$y = ax(x - h) \qquad h = \textit{height of mast.}$$

Let’s see if that’s right. Try these values for ***a*** for a mast which is 90" high, and show me what the resulting curves look like:

$$a = -4/(45*45) \qquad a = -8/(45*45) \qquad a = -6/(45*45)$$

Task #3: If we use the boss’s equation, what values of ***a*** and ***h*** should give the parabolic shape below?



The boss is out testing sails today, so I’d like you to get this finished before the end of the day and on her desk.

Teaching Guidelines: Surfsails Design
Math Topic: Quadratic Functions

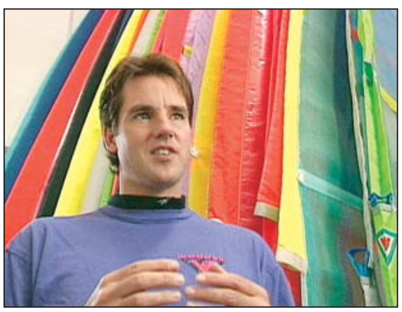
Procedure: This activity is best done with students working individually or in teams of two.

Distribute the handout and ensure that students understand the task.

Answers:

1. ***1:*** $y = -x^2/405 + 2x/9$
   2. $y = -2x^2/675 + 4x/15$
   3. $y = -x^2/200 + 2x/5$ (all assuming that the left end of the mast is placed at the origin)
2. $a = -12/10000$, $h = 100$



If you enjoyed this Futures Channel Movie, you will probably also like these:

The Pterodactyl Flies Again, #1002	A young aeronautical designer creates a flying replica of a prehistoric dinosaur.
Maglev Trains, #1004	Gliding on a wave of electromagnetic force, a maglev (magnetic levitation) train could travel at 300 miles per hour or faster. Designer-engineers Gordon Danby and James Powell describe the mechanics and future benefits of such superconductor trains.
Tornado Chase, #3002	Tornado-chasing meteorologists do research in the path of the storm's edge as they strive to understand tornadoes better for more accurate, faster forecasting.

THE FUTURES CHANNEL • 148 S. Victory Blvd., Burbank, CA 91502 • 877-937-7515 • www.thefutureschannel.com