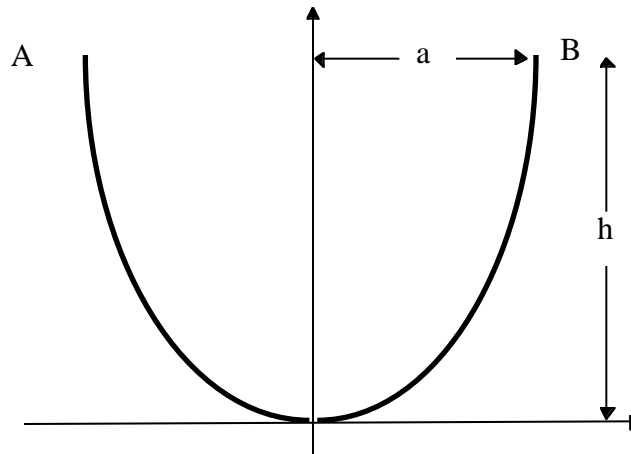


Project 3.

Catenary

To work this project you should have worked through project 2.

We assume here that we have a cable hanging from two points A and B, at the same height as shown in the sketch. The span of the catenary is $2a$ and the sag is h , while the total length is $2l$.



Two interesting problems arise with reference to the catenary,

- (i) Given the length of the cable and the sag, find the span.
- (ii) Given the span and the length of the cable, find the tension.

Let's look at a simple situation where these problems occur.

Two surveyors are measuring a lot with a 100 foot tape. Let's suppose that the tape weighs one ounce per foot.

- (a) Use Maple V to derive an expression which will give the actual distance (that is to say the span) being measured in terms of the sag. Give a plot of this for sag values from 0 to 3 feet.
- (b) Find a Taylor polynomial of degree 6 for the span as a function of the sag.
- (c) Find the maximum tension in the tape (this occurs at A and B) and plot this for sag values from 1 to 3. What is the maximum tension when the sag is 1 foot?
- (d) If the maximum tension the surveyors can exert on the tape is 100 pounds what will be the sag? What will be the actual distance they are measuring.
- (e) If the tape will break when the tension is in excess of 150 pounds, what is the minimum sag that can be achieved with this tape? What will be minimum error that can be achieved by this tape when measuring 100 feet?