Ho'olele lupe

1 Introduction

The Hawaiian demigod *Maui* is given credit for the *ho'olele lupe* (Hawaiian kite) invention. Oral traditions as well as the creation chants of *Kaelikuahulu* suggest that *ho'olele lupe* were an important part of Hawaiian society. They not only were flown for recreational purposes by young and old but were used for maritime propulsion, fishing, and fighting.(*Ho'olele lupe*) were made of *hau* covered with *kapa* or pandanus leaf. *Ho'olele lupe* might also have held much religious significance as evidenced by the effort of missionaries to suppress its use. (Ho'olele Lupe-An Analysis of the Ancient Practice of Hawaiian Kite-flying, Damion Sailors)

2 Grade Levels and Topics

- **Algebra:**
  - **Equation of a Circle:**

$$(x-h)^2 + (y-k)^2 = r^2$$

$$y = \pm\sqrt{r^2 - (x-h)^2} + k$$

    Where r is the radius and the point (h, k) is the center of the circle.

- **Geometry:**
  - **Circle:** πr^2
  - **Triangle:** $\frac{1}{2}bh$
  - **Trapazoid:** $\frac{h(b_1 + b_2)}{2}$

3 Discussion/Solutions for specific sections:

3.1 Composing Kites

- Have the students break up the shapes into "simple" shapes (i.e. squares, quadrilaterals, triangles, or shapes they know area formulas to) and have each person/group share how they broke up each kite.
- Discuss with the students that each shape can be broken up differently and depending on the information that you know (measurements), one way of breaking up the shape may be more usefull than another.
- Also discuss with the students that every polygon can be broken up into triangles and have them retry number 3 by breaking it up into all triangles.
- Finally you can discuss with the students which solution they find the "best" in terms of easiest to compute with least measuring, least number of different shapes, creativity, etc.

3.2 Geometry Problems

- Problem 1-a and 1-b, discuss how these two problems relate to the previous section. For 1-a you may want to discuss how it is easier to compute the area by breaking it up into two triangles and for problem 1-b you may want to discuss if there is a benefit to breaking it up into two trapazoids rather than six triangles.
- Problem 2-a uses the idea of similar triangles. Have the students share their solutions and how they came to those answers before going into the solution involving similar triangles. The bigger triangle on the left half and the smaller triangle on the right half have the same angles and all of the sides are different by a factor of 2.
- Problem 1-c can be thought of as cutting out a circle with radius 13cm out of a circle with radius 17cm.

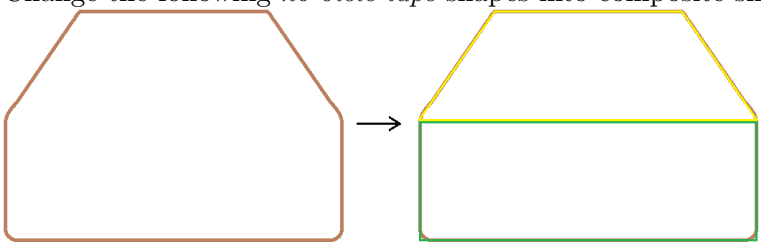
3.3 Modeling with fuctions

- The goal of this portion of the worksheet is to have the students understand how to use equations, in this case of an ellipse/cirlce, in order to maximize the area of a kite design. A way to approach this problem is to compute the area formula for the shape of kite that will be cut out of the *kapa*. So, for this problem we want the area formula for a kite which is $A = LH$ where A is the area, L is the horizontal length of the kite and H is half of the vertical height of the kite. So if the students have an equation for the area of their kite, then the next goal is to turn that formula into a function based of of where they will cut the kite out. One thing to note is that L is a constant as it will always be 54. Looking at the problem, H is $f(x)$ and $f(x)$ is the equation of a circle centerd at the origin with radius 27. So, in conclusion, the students should obtain a formula $A(x) = 54f(x)$ and this formula will give us the area of a kite cut out of a circular piece of paper with radius 27. To optimize this, the students can either graph it or solve it numerically.

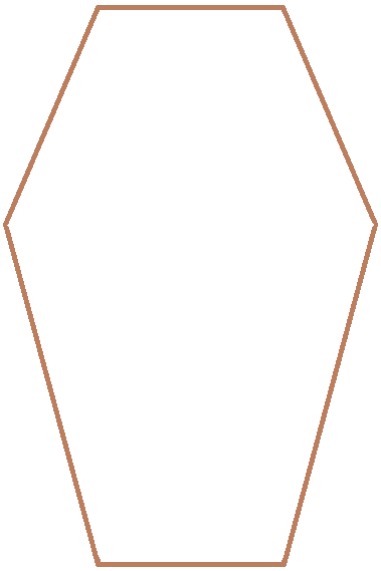
4 Composing Kites

4.1 Questions

Change the following *ho'olele lupe* shapes into composite shapes. Example:



1.



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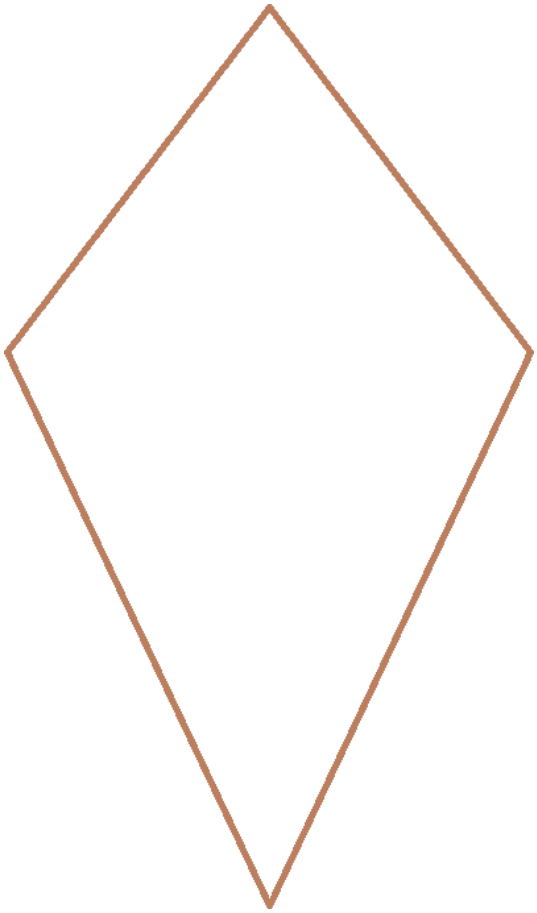

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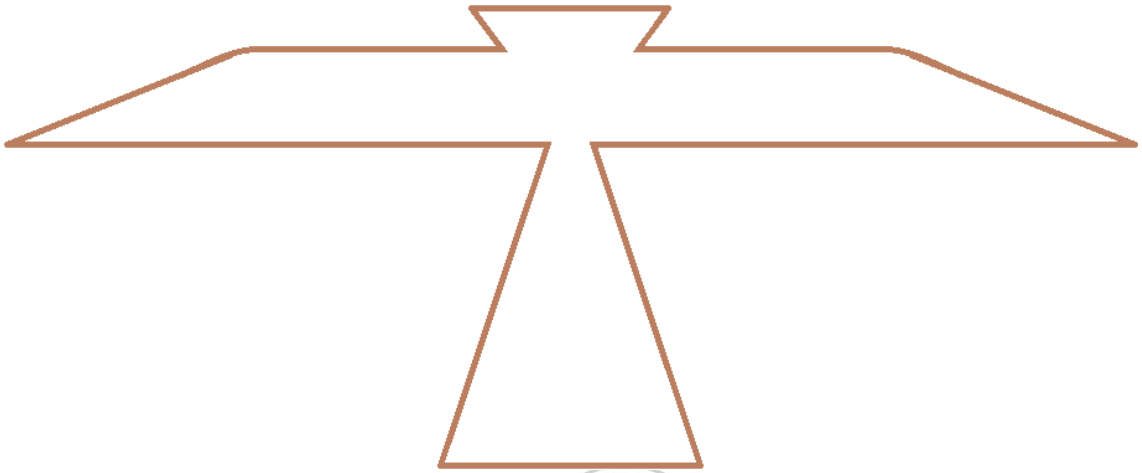

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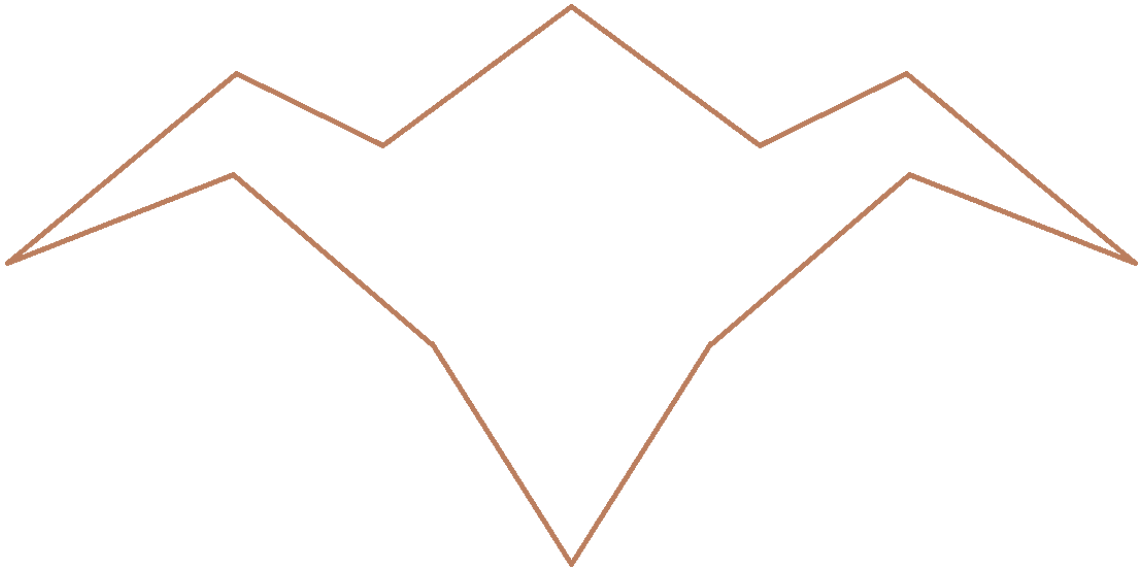
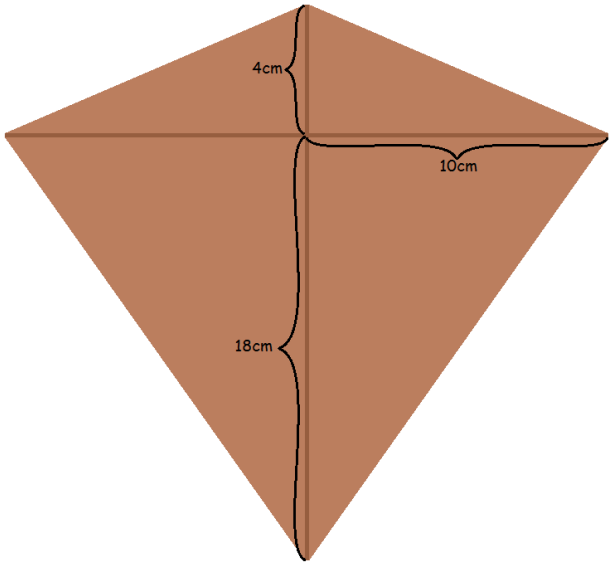


5 Geometry Problems

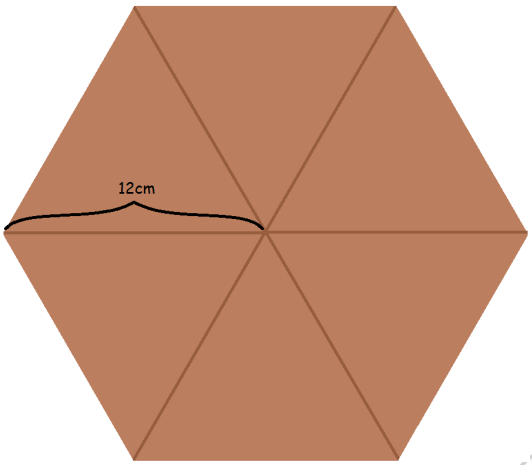
5.1 Questions

1) Determine the area of the following *ho'olele lupe*.

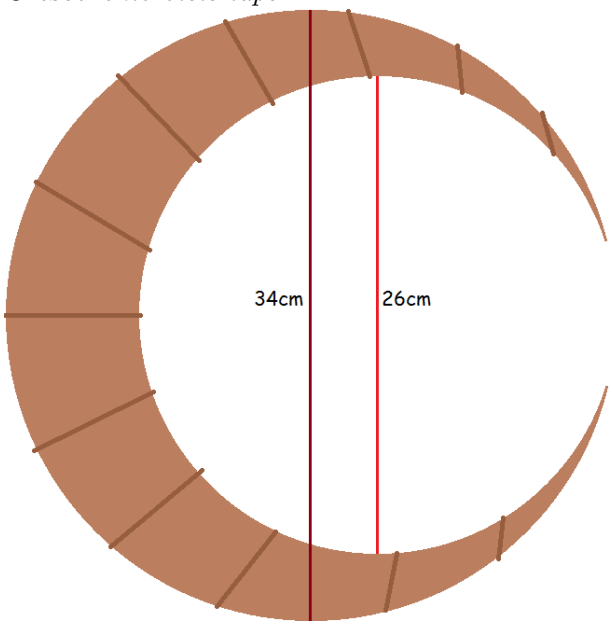
(a) Kite shaped *ho'olele lupe*:



(b) Hexagonal *ho'olele lupe*:



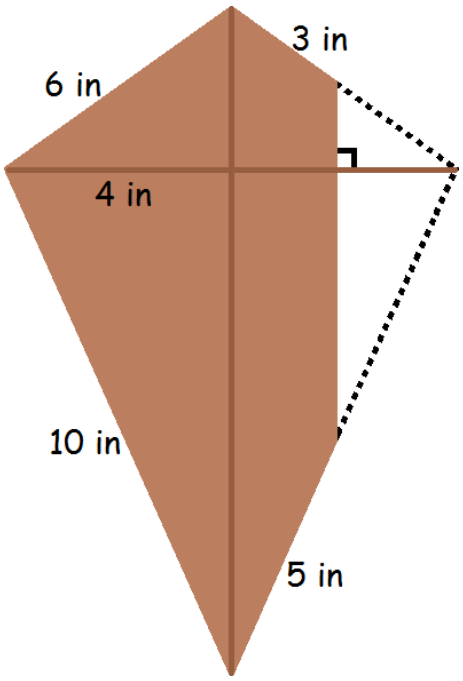
(c) Crescent *ho'olele lupe*:



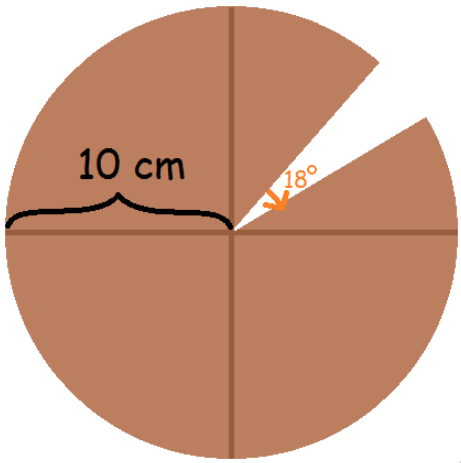
2) For each broken *ho'olele lupe*, determine the amount of *kapa* required to repair the missing piece.

(a) Circular *ho'olele lupe*:

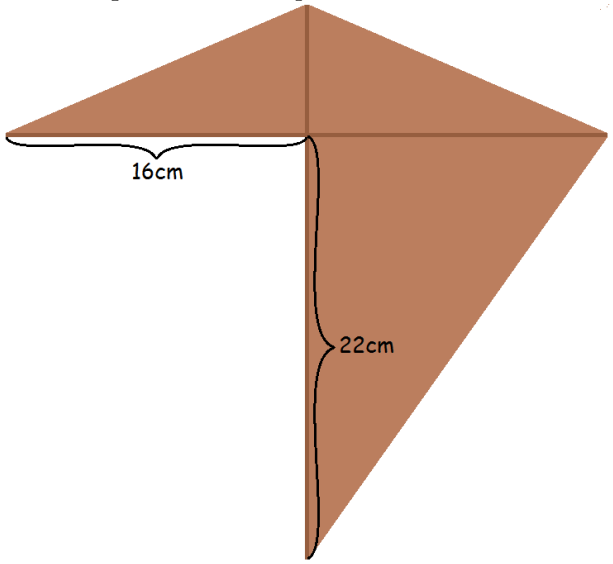
i.



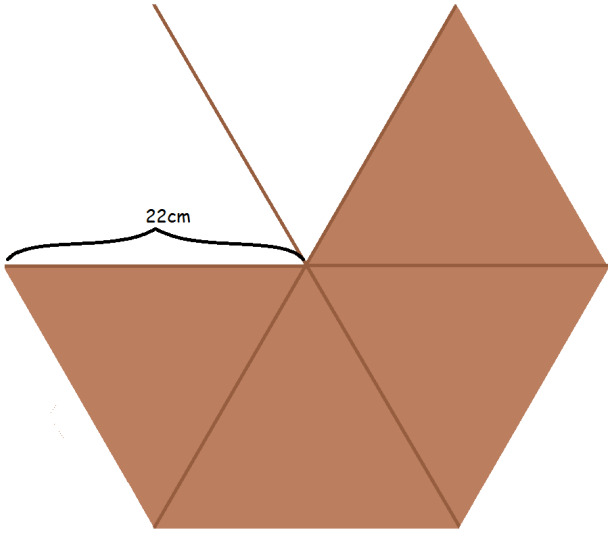
ii.



(b) Kite shaped *ho'olele lupe*:



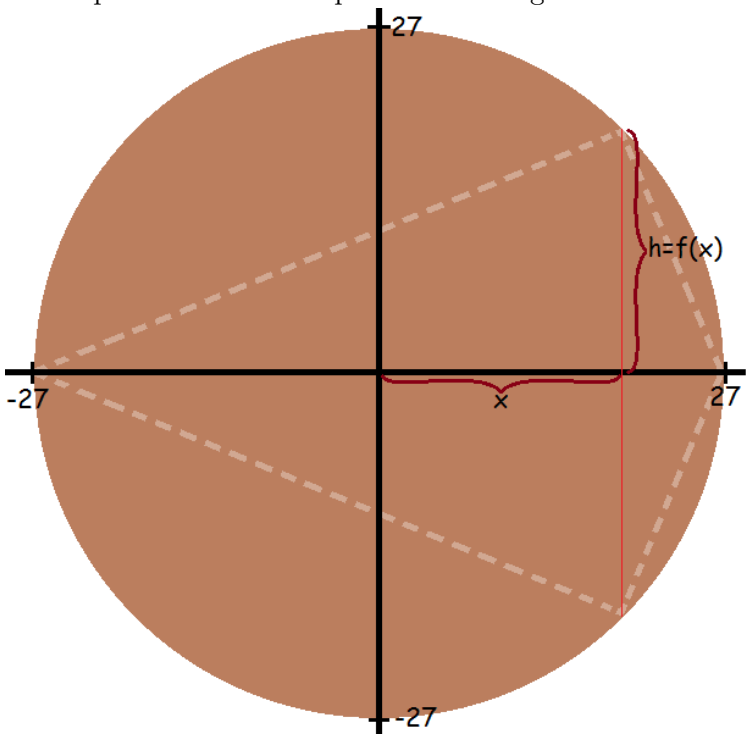
(c) hexagonal *ho'olele lupe*:



6 Modeling with Functions

6.1 Questions

1) The kapa is a circular shape. Use the diagram to:



(a) Create a function $A(x)$ that gives you the area of the kite shapped *ho'olele lupe* cut from the circular *kapa* with respect to x as defined in the picture.

(b) State the domain of $A(x)$.

(c) Graph $A(x)$.

(d) Use the graph to determine what the maximum area of our kite can be with respect to x.