

## Origami Bonsai® Instant Flowers Math Lesson Plan for Grades 9 through 12

Time: 20 to 60 minutes

Goal: Introduce students to real-world applications of Trigonometry. Students should discover that formulas introduced in your math class can be applied to construction, aerospace, automotive and other industries. Change the way students think about structures, and about how geometric shapes interact.

Materials: One Origami Bonsai® Instant Flower per student/group, and one print out of the Origami Bonsai® Instant Flower folding diagram per student/group. One unfolded Origami Bonsai® Instant Flower.

Description:

Pass out the Origami Bonsai® Instant Flower folding diagrams. Ask students to fold the paper in half width-wise. Direct students to stand the sheet of paper on their desks. Do the folded sheets support their own weight? If so, how much pressure can students apply?

Pass out the Origami Bonsai® Instant Flowers. Open them in the “Instant Flower” pattern. Ask students to place the flower on their desk, with the petals facing down and the bud facing up. Tell students that they’re not interested in destroying the flower, just to see when it begins to flex. Direct students to put their hand on top of the tip of the bud and apply pressure towards the desk. How much pressure can they apply?

How is it possible that one piece of paper can support a lot of weight, and another supports so little? The answer is triangles. The Origami Bonsai® Instant Flower is made up of many triangles. These triangles work together to support the weight of their hand. The instant flower can support thousands of times its own weight.

Ask them to open the Origami Bonsai® Instant Flower folding diagram. Hand out the unfolded Origami Bonsai® Instant Flower and ask students to compare it to the folding diagram and then pass it to the next student/group. The diagram corresponds to one petal of the flower. They should see the relationship, if not, point it out to them.

Direct students to identify all the triangles. Ask them to define them.

Challenge 1

If they’re given the dimension of one side of the diagram, for example let  $E=2$  inches, can they calculate all of the lengths of the sides of the other triangles?

## Challenge 2

Are there triangles that have sides that are NOT defined when E=2 inches? What does this imply?

## Challenge 3

Ask students if they can come up with applications for the folding pattern. What if the flower were made from folded steel? What if two petals were really long, and two short?

If there is extra time, direct them to find, and define all the triangles on the Origami Bonsai® Instant Flower folding diagram. Students should count and compare their results, and justify their answers.

If there is more extra time, and there's a computer in your classroom, students can go to [www.YouTube.com/InstaFlor](http://www.YouTube.com/InstaFlor) and fold other flowers.

Answers:

Challenge 1: Yes, they can define all the triangles. Here are the formulas for the sides of all the triangles:

The values can be calculated for any given E (height), G (desired appendage length), and  $\theta$  (calculated based on the number of petals desired), as follows:

We can make a shape with any number of equally distributed appendages (P) as expressed by:

$$\theta = \frac{360^\circ}{P}$$

It then follows that:

$$F = E \cdot \sin(2 \cdot \theta)$$

$$C = D = \frac{\frac{1}{2}E}{\cos\theta}$$

$$A = C \cdot \cos\theta$$

$$X = C \cdot \sin\theta$$

$$B = \sqrt{2 \cdot X^2}$$

$$H = \sqrt{F^2 + G^2}$$

### Challenge 2:

G and H are not defined. H is dependent upon the length of G, and G can be any value from zero to infinity. This means that a paper flower could have an infinitely long petal! Also, the angle between F and H is undefined as it is dependent upon the length of G.

### Challenge 3

There is probably no wrong answer, as long as you understand what the student's idea is. If made from steel, with two long petals, the flower design might be used as a bumper for a car. Again, if made from steel, the flower could be placed atop a lolly column and used to support floor joists. Many applications involving weight distribution are possible.

# Origami Bonsai® Instant Flower Folding Diagram

Patent Pending – Benjamin John Coleman

[www.OrigamiBonsai.org](http://www.OrigamiBonsai.org)

## One Petal of a Four Petal Flower

