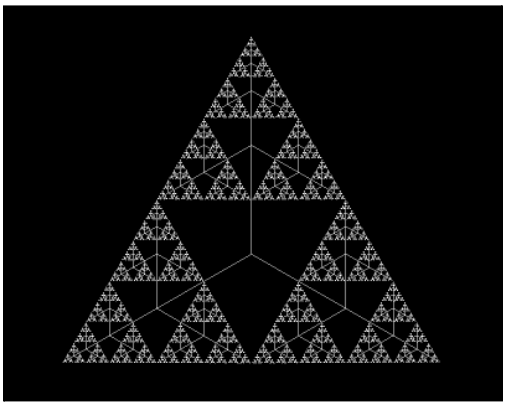
Additional Project Resources:

- Preliminary Desmos Activity
- Drafting Resource

Fractals Project



For this project, you will design your own fractal tree. We've seen many examples of fractals in class, including fractal trees made out of one-dimensional shapes. The fractal tree that you create will have a pattern that is similar to the trees we've seen, except that its branches will be made out of a **two-dimensional shape**.

Here's an example of fractal tree made out of two-dimensional shape: LINK

Here are some **resources** that you've developed that will help you come up with ideas for your own custom fractal tree:

Key Resources:

- Fractals: Lesson 3 (Trees) on student.desmos.com
- Fractals: Lesson 6 (Intro to Project) on student.desmos.com
- Fractals: Check-in #2 on paper

* * *

SECTION 0: FRACTAL TREE MADE WITH LINES

To prepare for this project, complete this "Fractals: Project Desmos". These slides provide a basic example of a fractal tree made out of one-dimension shapes (lines).

* * *

SECTION 1: YOUR FRACTAL TREE

For this option, you will make a fractal tree out of one of the two dimensional **base-shapes given below.** Here are the different options and levels of challenge:

- Rectangle (but not a square) — (Basic: ***Yellow Belt***)
- Equilateral triangle (tutorial) — (Intermediate: ***Green Belt***)
- Rhombus or Hexagon (tutorial) — (Intermediate to Advanced: ***Brown Belt***)
- Regular Pentagon or polygon with more than 6 equal sides — (Advanced: ***Black Belt Fractal Master!!***)

Note: You can design a base-shape that is not given on the list above — but let's have a discussion about it before you build your fractal.

STEP 1: Drafting Your Fractal

You'll begin by sketching your idea on paper. Here are the **basic requirements**:

- ❏ Build the branches up to at least **Stage 3**.
    - ❏ You'll construct the **branches** off the base-shape using the "Transform" tools in the final draft.
- ❏ Design your fractal tree so that it is **symmetric**. Remember that there are different types of symmetry: rotational, reflective, dilational, etc.
- ❏ The fractal tree must be **self-similar** and you must be able to explain why.

Now get the "**Fractals: Project Draft**" handout. As you're drafting your fractal, think carefully about how to make your fractal original and interesting. Consider:

- use an unusual **scale factor** (not 1/2)
- have an interesting **pattern of growth** (not simply doubling at each stage)
- **rotate** the shapes from stage to stage (this could help make space for more shapes)

STEP 2: Final Draft on Desmos

After you've drafted and received feedback on your fractal idea, construct your base-shape on Slide 8 of the "Fractals: Project Desmos".

- Make sure you build your base-shape with the **Polygon** tool.
- Next build branches off of your base-shape using the **Transform** tools.

Remember that your fractal tree should look artistic. Add colors, labels, etc. Review the **Key Resources** listed at the top of this document for ideas.

When you've finished constructing your fractal tree in Desmos, take a screenshot of it and paste the image below. Then continue onto Section 2 below.

Screenshot of fractal:

* * *

SECTION 2: ANALYSIS OF FRACTAL TREE

Complete this table of information for your fractal tree below.

	Total Number of Shapes Added at Each Stage	**Side-Length of Shape**	**Perimeter of a Shape**	**Area of a Shape**
STAGE 0				
STAGE 1				

STAGE 2				
STAGE 3				
Describe how to calculate for any **STAGE "N"**				
Write an equation for calculating any **STAGE "N"**				

Now show how to calculate the **area** of your base-shape. Show all work.

Response:

* * *

SECTION 3: REFLECTION

1) Write a paragraph describing **the patterns of growth** from stage to stage in your fractal, including:

- scale-factor
- side-length
- number of shapes
- area of shapes

Your response:

2) a. Define **self-similarity** in your own words.

Your response:

b. Describe how your fractal tree involves **self-similarity**. Be specific as possible in your response.

Your response:

c. Draw a red box around a part of your fractal that is *self-similar to the entire design*. Take a screenshot of your fractal with the red box and paste the image below.

Screenshot:

3) a. What is happening to the **side-lengths** on the individual shapes as the stages increase? Explain why.

Your response:

b. Use your equation and a calculator to find a side-length at Stage 100.
- Resource: Desmos Calculator

Your response:

c. What happens to the side-lengths as the stage number becomes **extremely large**? Will the side-length ever become equal to **zero**? Explain your thinking.

Your response:

Bonus: The smallest measurable length in the universe is called a **Planck length**. How does a side-length of a shape at Stage 100 on your fractal compare to a Planck length?

Your response:

4) Describe the different types of **symmetry** in your design. Consider if your fractal involves:
- reflective symmetry (describe location of line(s) of reflection)
- rotational symmetry (describe degrees and center of rotation)
- dilational symmetry (describe scale factor and point(s) of dilation)

Your response:

 5) In "Fractals: Lesson 3 (Trees)" we investigated "spirals" in fractals trees. What would a spiral in your fractal tree look like?

a. Find the *area* of a spiral up to Stage 3. Then find the area of a *complete spiral*.
   - Hint: Research *sum of infinite geometric series*.

Your response:

b. Bonus: Can you explain why the formula for the "sum of infinite geometric series" calculates the area of a complete spiral? Why does it work? Research this.

Your response: