Fascinating geometry I—Fractals

(Junior Cycle OL)

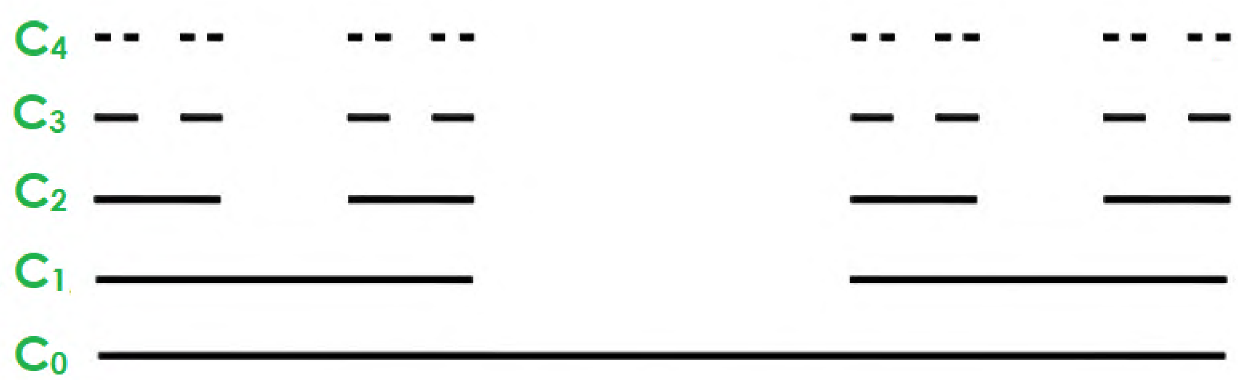
The term fractal, derived from the Latin word fractus ("fragmented," or "broken"), was coined by the Polish-born mathematician Benoit B. Mandelbrot. A fractal is a never-ending pattern. Fractals are infinitely complex patterns that are self-similar across different scales. They are created by repeating a simple process over and over in an ongoing feedback loop. If you divide a fractal pattern into parts you get a nearly identical reduced-size copy of the whole. Natural fractals include branching patterns like trees, river networks, lightening bolts, blood vessels etc. Fractals are geometric figures, just like rectangles, circles and squares, but fractals have special properties that those figures do not have.

Resources: Ruler, pencil, straightedge, 60/30 degrees set square, rubber, two A4 sheet of paper per student, activity sheet (see below), Power Point presentation

Strands: Geometry, patterns, mathematical notation

Time: 80 minutes

Activity I: Students, on A4 sheets, at the bottom, draw a line segment 27 cm long. Then, at a distance of 3 cm, they draw another line segment parallel to the one previously drawn. Repeat this step three more times. Mark the lines C_0 , C_1, C_2, C_3, C_4 respectively. Ask the students to divide C_1 segment into three equal parts Rub out the middle of C_1. Repeat this on the C_2 ,and remaining two sections divide into three parts, rub out the middle again. Apply these steps to the remaining lines (showed below)



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Questions: Is this construction infinite?

Can we find the length of C_1, C_2, C_3, C_4 ?

Can we find the length of the erased sectors?

Inform the students, that the reason, we named line segments C's , is because of German mathematician, who first introduced that mathematical concept, Georg Cantor in 1883.

Activity II: On the next sheet, students will create (advanced ones can construct) a figure created by another famous mathematician- Helge von Koch called "the Koch curve".

The pupils, at the bottom of the page, draw a line segment 15 cm long. At a distance of 6 cm they draw another one, parallel to the previous one. They draw five lines in total, that they name accordingly: K_0, K_1, K_2, K_3, K_4 ('K' stands for Koch). Line segment—K_1 divide into 3 equal sections. Rub out the middle section. This part will be used for the construction of an equilateral triangle, without the base- let's use 60/30 degree set square. Repeat the procedure on the line K_2. Next, divide every straight line (including the arms of the triangle) into three equal parts, rub out the middle, and construct on the rubbed out part an equilateral triangle (4 triangles in total) Repeat these steps up to K_4. The smallest triangles in the last step, can be drawn without any tools as they are tiny. (See page 3)

Questions: Is this construction infinite?

What does this shape remind you off? (snowflake)

Can we fond the length of each curve?

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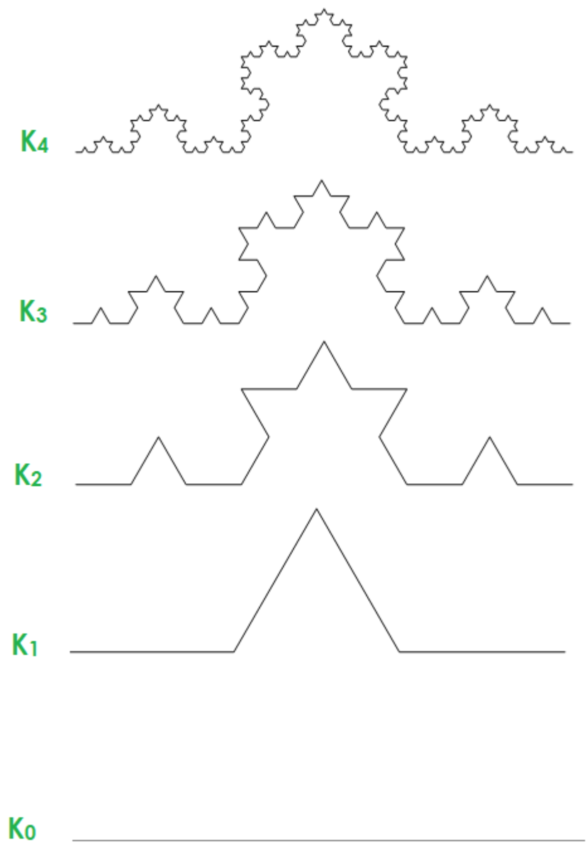

Activity III: Divide students into groups of two or three. Hand out the two worksheets (page 4 and 5). Allow them to analyse the shapes given on the worksheet. Ask them to do the work on their own, but consult within the group if needed.

Questions:

1. Can you point at self- similarities?
2. What type of triangles are there?
3. What is the scale factor? (compare the largest triangle to the smallest one etc.)
4. Where can you find fractals in nature? (Power Point Presentation)

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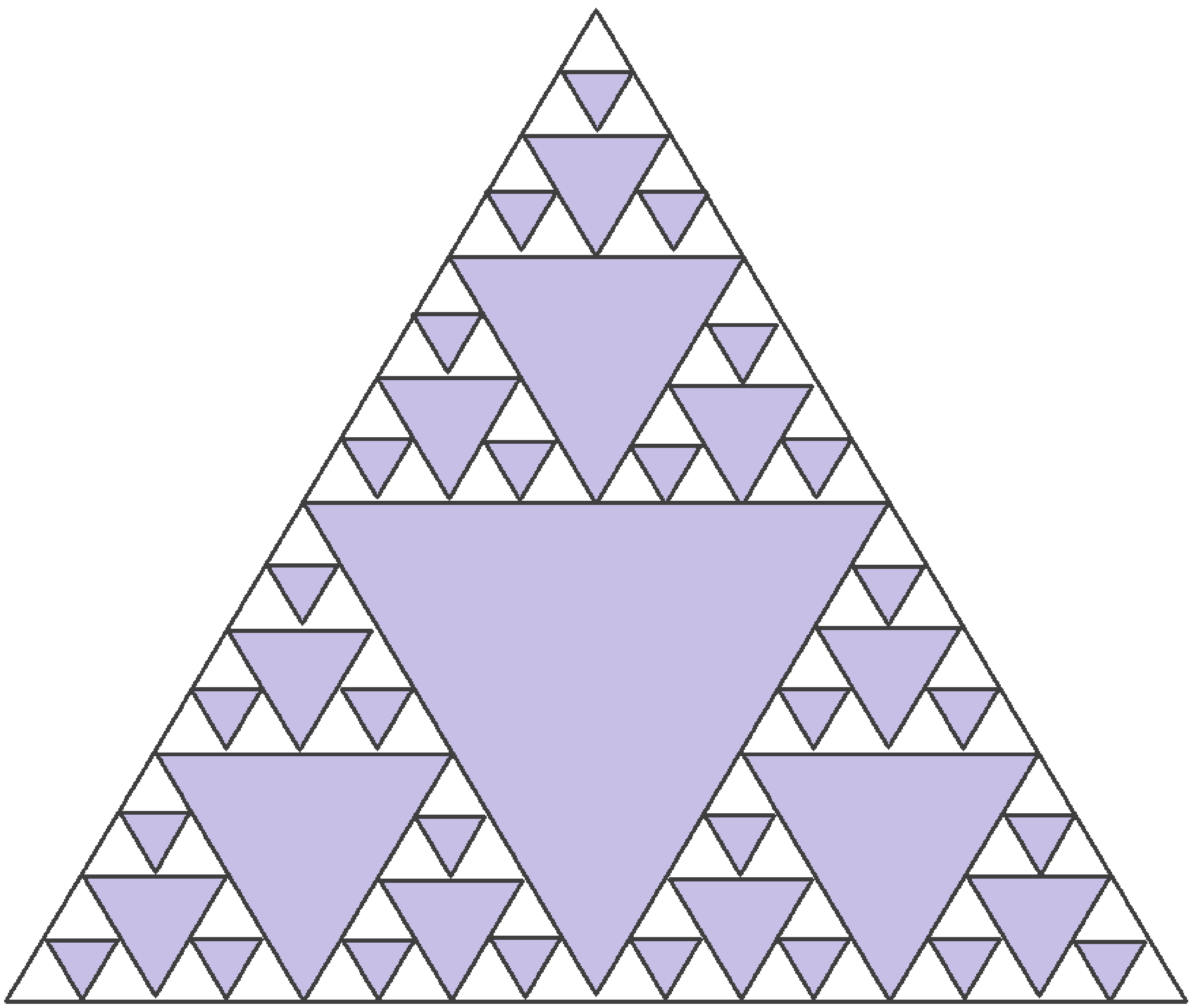
(Junior Cycle OL) **Worksheet 1**

<u>The Sierpinski triangle</u> is a fractal described in 1915 by Polish mathematician, Waclaw Sierpinski . It is a self similar structure that occurs at different levels of iterations, or magnifications.

1. Can you point at self- similarities?
2. Can you, using 60-30 degree set square, ruler and pencil, recreate the shape below?



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(Junior Cycle OL) **Worksheet 2**

Can you perform the next step to the shape below?