

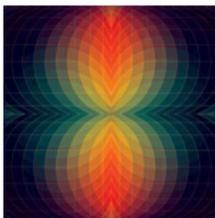
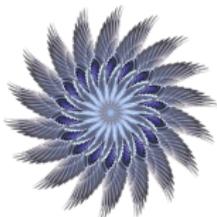
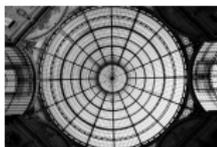
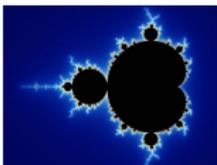
Part VIII

Rosettes

The goal for this part is to identify and classify rosette patterns.

Classify

For each picture, decide if it goes in the left pile or the right.



Rosettes

A *rosette pattern* is a pattern that has either of the following types of symmetry:

Cyclic Symmetry: rotation symmetry around a center point, but no mirror lines



Dihedral Symmetry: rotation symmetry around a center point with mirror lines through the center point.



What does the "n" mean in C_n and D_n ?

C_n means that the smallest angle of rotation that preserves the figure has _____ degrees. This rotation has order _____ .

Example:



When trying to figure out n , count the "number of petals".

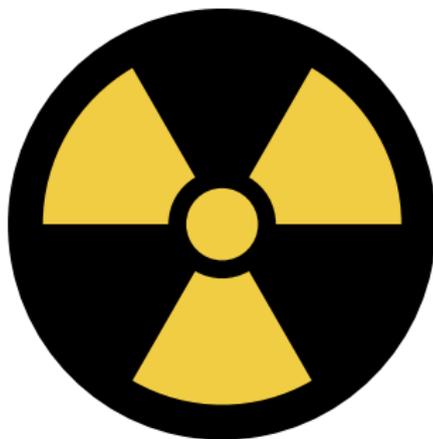
D_n means that there are _____ mirrors meeting at the center, and the (largest) order of rotation is _____ .

Example:



Orbifold notation for rosettes

In *The Symmetries of Things*, John Conway et al. use the notation $n\cdot$ for C_n and $*n\cdot$ for D_n .



How many isometries preserve the figure?



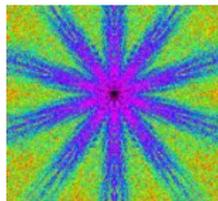
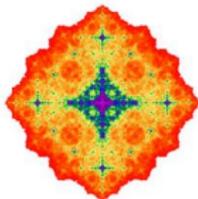
- ▶ For a figure with C_5 symmetry, how many distinct isometries preserve the figure? Include the "do nothing" isometry, also called the identity isometry.
- ▶ For a figure with D_3 symmetry,
 - ▶ How many distinct rotations preserve the figure? (Include do nothing as a 0° rotation.)
 - ▶ How many distinct reflections preserve the figure?
 - ▶ In total, how many distinct isometries preserve the figure?

How many isometries preserve the figure?



- ▶ In general, for a figure with C_n symmetry, how many distinct isometries preserve the figure? Include the "do nothing" isometry, also called the identity isometry.
- ▶ For a figure with D_n symmetry,
 - ▶ How many distinct rotations preserve the figure? (Include do nothing as a 0° rotation.)
 - ▶ How many distinct reflections preserve the figure?
 - ▶ In total, how many distinct isometries preserve the figure?

Practice classifying rosettes



Ambigrams

Each design on this page is really half of a word. Can you figure out what each design says? To read a design, take two copies of this page, place one copy on top of the other, and slide them around until the two copies of the design meet. Hold the papers up to a light so you can see through both sheets. You may have to rotate or flip over one of the pages. For instance, the second design makes the word "mirror". (Scott Kim, 2000)

1. TCEBON 2 a C 5.

2. mi ns 6.

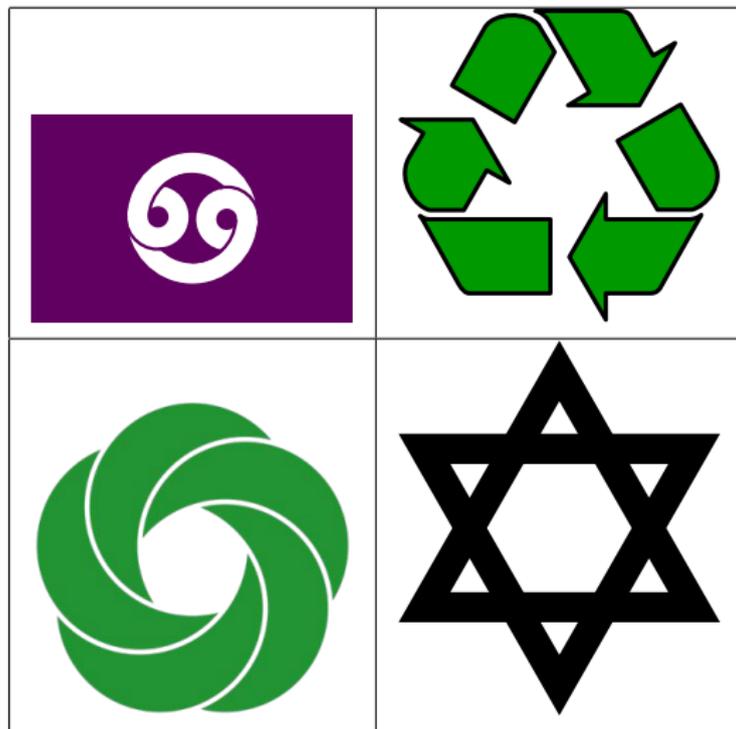
3. T-7-7 7.

4. Symu a ja z 8.

Fundamental domains

A *fundamental domain* for a symmetry pattern is a piece (of the smallest possible area) that can be repeated by isometries to generate the entire pattern.

Find a fundamental domain for each of the patterns below.



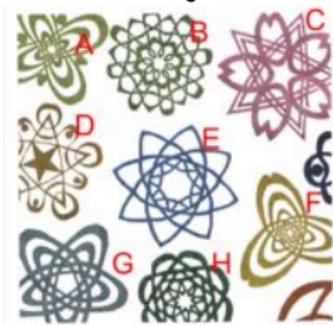
Paper cut-outs

- ▶ As a child, you may have made snowflake patterns by folding a piece of paper and cutting along the edges. Make snowflakes representing as many of these symmetry groups as you can: D_2 , D_3 , D_4 , D_5 , D_6 , and D_8 .
- ▶ Devise a way to make a snowflake with C_n symmetry for any values of n that you choose. Hint: you will need to make an extra cut.



Homework

1. Read Chapter 1 of The Symmetries of Things. (pages 7 - 12)
 - 1.1 Identify the signatures AND the number of mirror lines for the snowflakes picture on page 8. Don't worry about small partial snowflakes, just do the ones you can see, here labelled A - H.



- 1.2 Identify the signatures for the hubcaps picture on page 9. Don't worry about small partial hubcaps, just do the ones labelled A - E.



More Homework

- 3 Group the letters of the alphabet according to their symmetry types using C_n , D_n notation:
ABCDEFGHIJKLMNOPQRSTUVWXYZ
- 4 Take photos of hubcaps with different symmetry types. Try to get part of your hand or foot in the photo to prove that you were there. This assignment is worth 10 points, and you'll get 2 points per photo with distinct symmetry types. Yes, you can get extra credit this way if you find more than 5, but no more than 10 points extra credit.
- 5 Create an ambigram of your name. You can use your first, last, middle or some combination of your names, and you can draw it on paper or use Geometer's Sketchpad. Although there are ambigram-drawing websites out there, please don't submit anything created by one of these websites.

And more homework

1.

- 6 Make paper snowflakes with at least 4 of the following symmetry types: D_2 , D_3 , D_4 , D_5 , D_6 , C_2 , C_3 , C_4 . Hint: to cut a snowflake with type C_n symmetry, you will first have to make an additional cut, that you can tape back together at the end. Note: the idea is to fold or wrap so cleverly, that you can just cut out the motif once, and the folds and wraps will cause it to repeat forming D_n and C_n symmetry on its own.