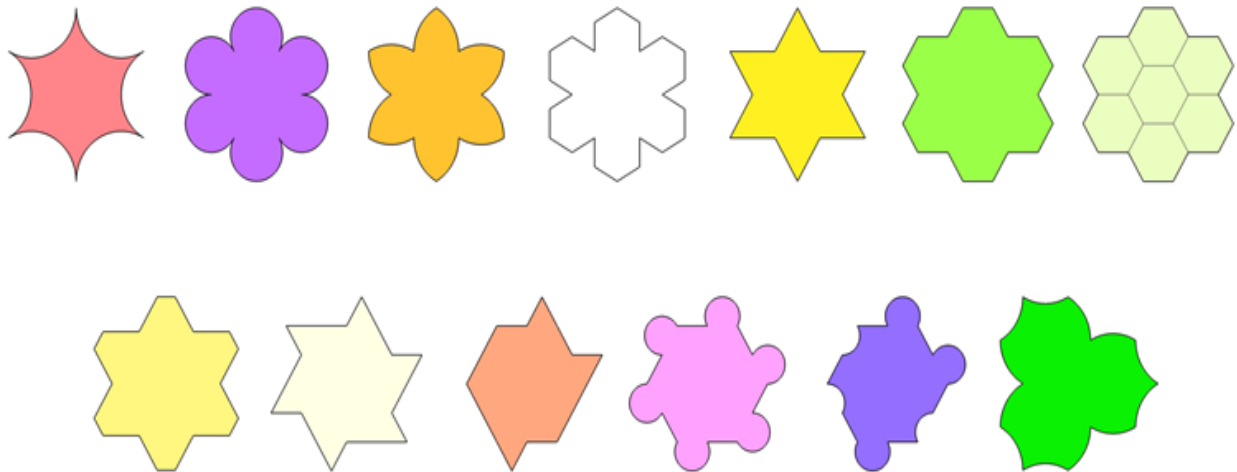


LUCKY 13

A baker's dozen of combinatorial puzzles
by Michael Dowle



presented by Kate Jones
to the 13th Gathering for Gardner
April 11-15, 2018
Atlanta, Georgia

Combinatorial Puzzle Designs

by Michael D. Dowle

(2017)

Preface/Background

The vintage (late 1960s/early 1970s) “Beat the Computer” Pla-Puzzle No. 0 was the only puzzle published by Tenyo, Japan, with rounded puzzle pieces. This puzzle triggered my interest and an idea for a new puzzle design, and subsequently groups of puzzles. I purchased the Pla-Puzzle No. 0 in the early 1970s. I was, however, disappointed and frustrated by the puzzle design, since two of the thirteen pieces were identical. Each puzzle piece was a circle with up to six protuberances around the circumference, but there was no circular piece without any protuberances. Instead there were two circular pieces with one protuberance.

Replacing one of the duplicate pieces with a circle created a complete geometric set comprising thirteen different puzzle pieces. This set satisfyingly filled a template with three-fold circular symmetry.

Combinatorial Puzzle Designs

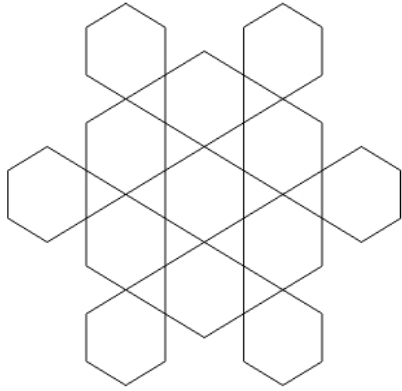
The Combinatorial Puzzles presented here require a set of 13 puzzle pieces to be fitted inside a template. The objective is to find 13 solutions. Each solution must have a different puzzle piece covering the center of the template (except for Puzzle 8). There may be alternate solutions for each puzzle piece.

The pieces for each puzzle are generated using the same principle and constitute a geometric set. A set of puzzle pieces is produced by arranging up to six shapes in every possible configuration around a differently shaped central piece that exhibits six-fold rotational symmetry (except for Puzzle 5). The templates possess three-fold rotational symmetry. These properties can be seen in the following illustrations.

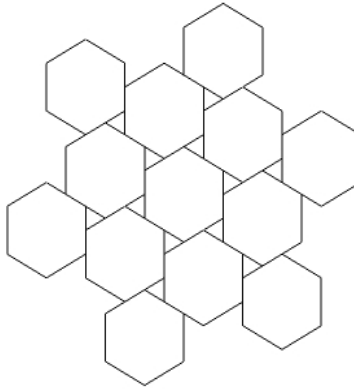
Three groups of Combinatorial Puzzles are described – each group has its own design characteristics, but all groups share the same common objective.

Each Combinatorial Puzzle is presented on a page in a common format, *viz.* puzzle pieces (on left); design grid structure and puzzle template (on right); puzzle solutions (bottom).

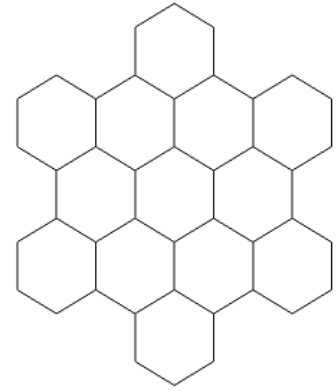
The designs of the puzzle pieces and corresponding templates are different for the three groups presented. For the first group (Puzzles 1 through 8), 12 of the 13 pieces have mirror symmetry (five of which also have rotational symmetry) while the 13th piece is chiral. The templates possess both three-fold rotational symmetry and mirror symmetry. The chiral piece may be used with either face upward. The pieces are vertex-connected.



Group 1 – vertex-connected



Group 2 – vertex to edge



Group 3 – edge-connected

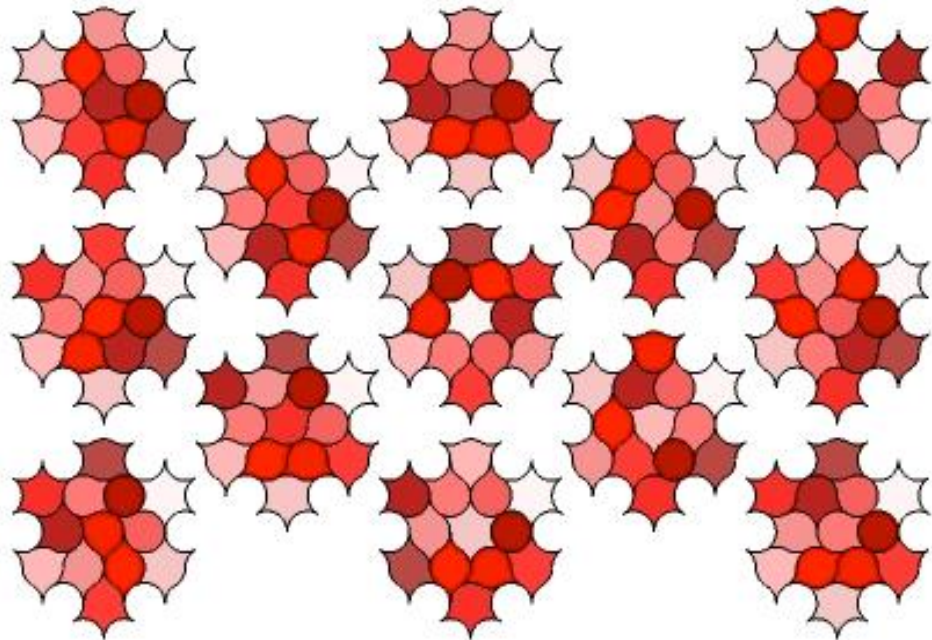
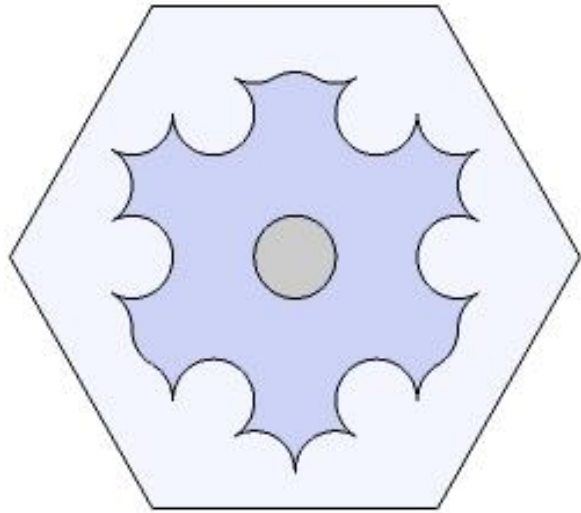
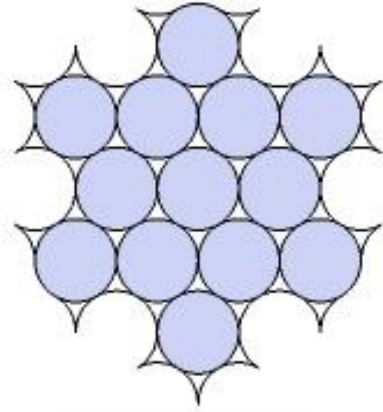
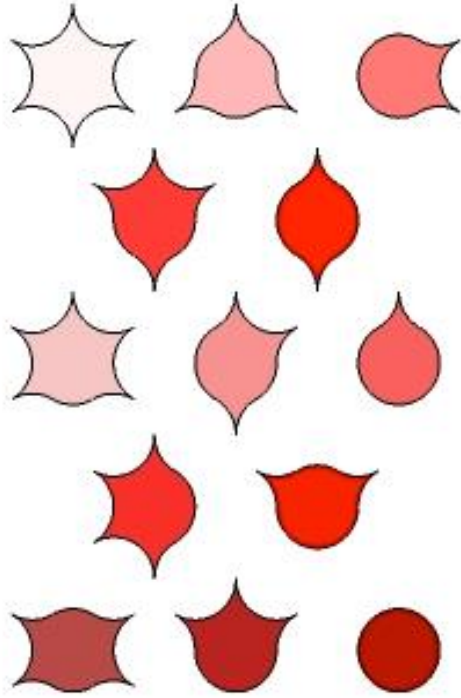
For the second group (Puzzles 9 through 12), 12 of the 13 pieces are chiral (4 of which have rotational symmetry) while the 13th piece has both rotational and mirror symmetry. The templates are chiral with three-fold rotational symmetry. The chiral pieces may be used with only one face upward, the face consistent with the chirality of the template. The chiral pieces can have two different shapes. The pieces are connected vertex-to-edge.

The third type (Puzzle 13), created by Jacques Griffioen and developed by Kate Jones, has 12 of the 13 pieces with mirror symmetry (5 of them also have rotational symmetry). The 13th piece is chiral and may be used with either face upward. The template has three-fold rotational symmetry and is chiral. The pieces are edge-connected.

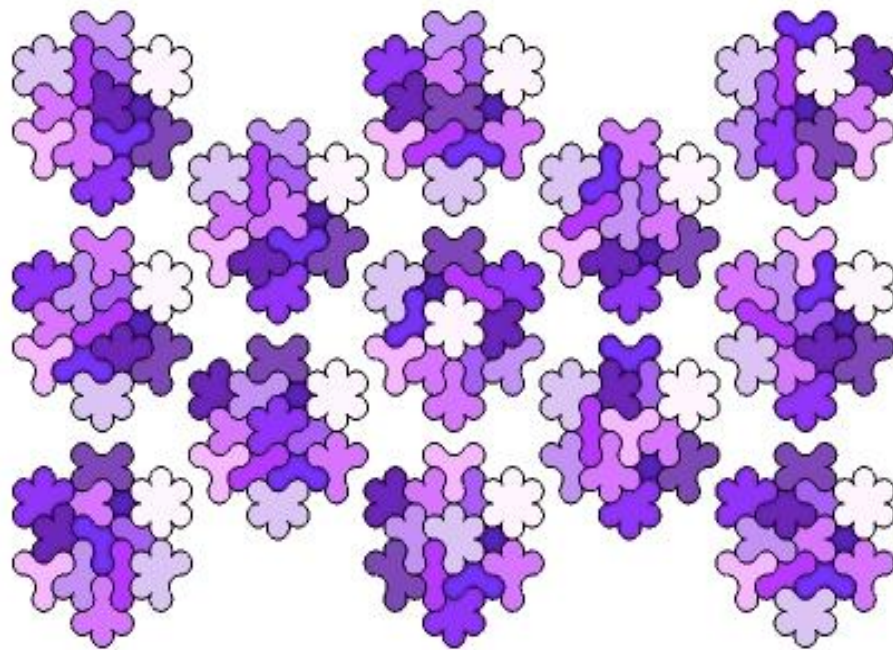
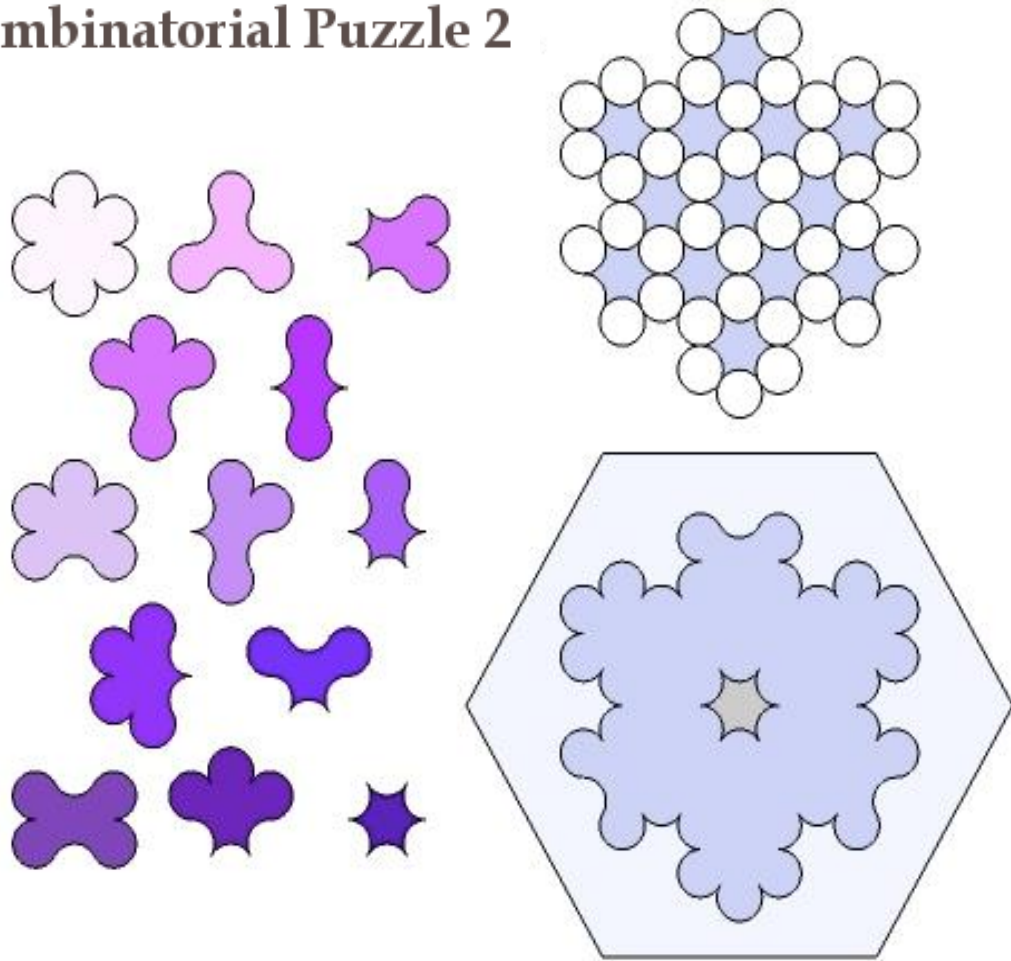
NOTES

- *Combinatorial Puzzle 1* – Twelve of its thirteen puzzle pieces appeared in the “Beat the Computer” Pia-Puzzle No. 0 published by Tenyo, Japan, in the 1960s-1970s. The “Beat the Computer” puzzle used a different template design and duplicated one of the puzzle pieces to obtain a thirteenth puzzle piece.
- *Combinatorial Puzzle 5* – Some of its complete geometric set of pieces are used in the STAR HEX™ puzzle published by Kadon Enterprises, Inc. The STAR HEX™ puzzle uses more pieces than Combinatorial Puzzle 5 and has different objectives.
- *Combinatorial Puzzle 7* – Some of this complete geometric set of pieces are used in the HEXNUT™ puzzles published by Kadon Enterprises, Inc. The HEXNUT™ puzzles use more pieces than Combinatorial Puzzle 7 and have different objectives.

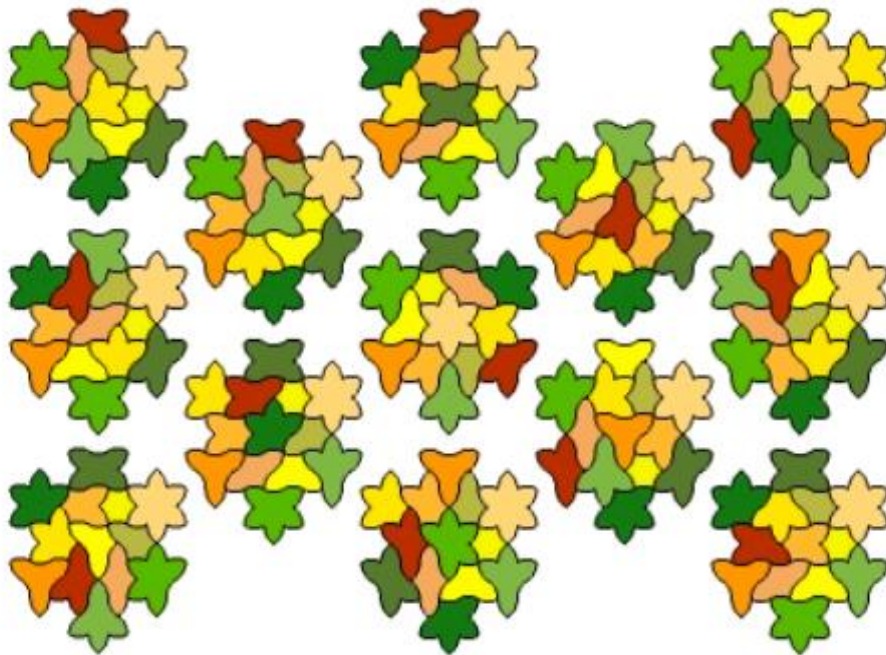
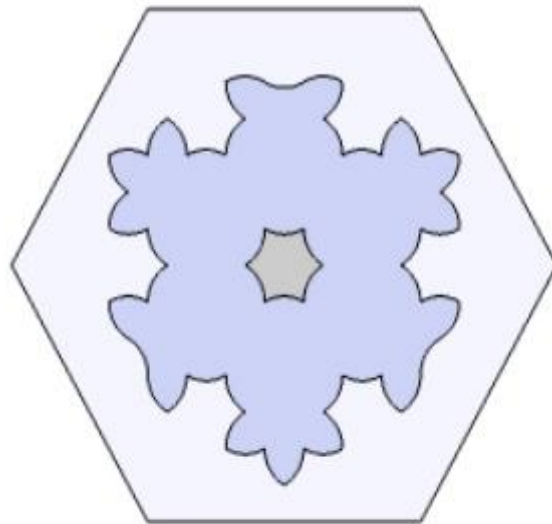
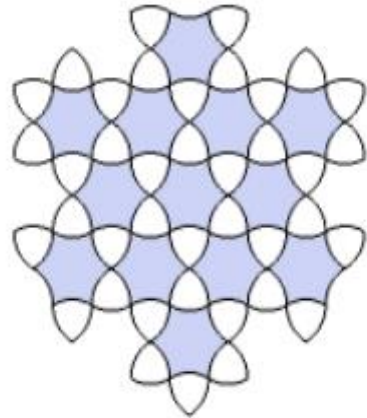
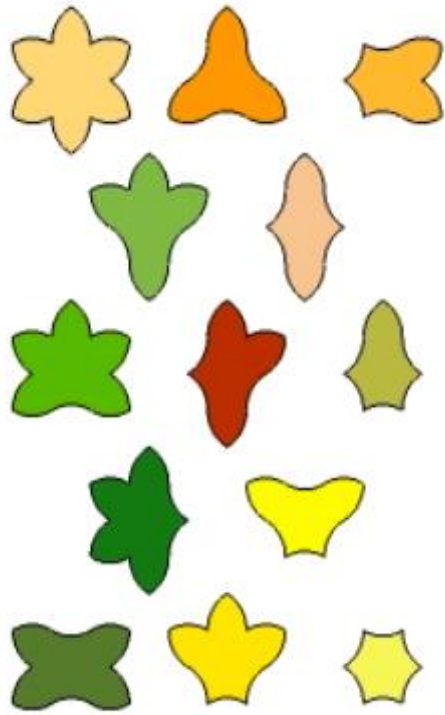
Combinatorial Puzzle 1



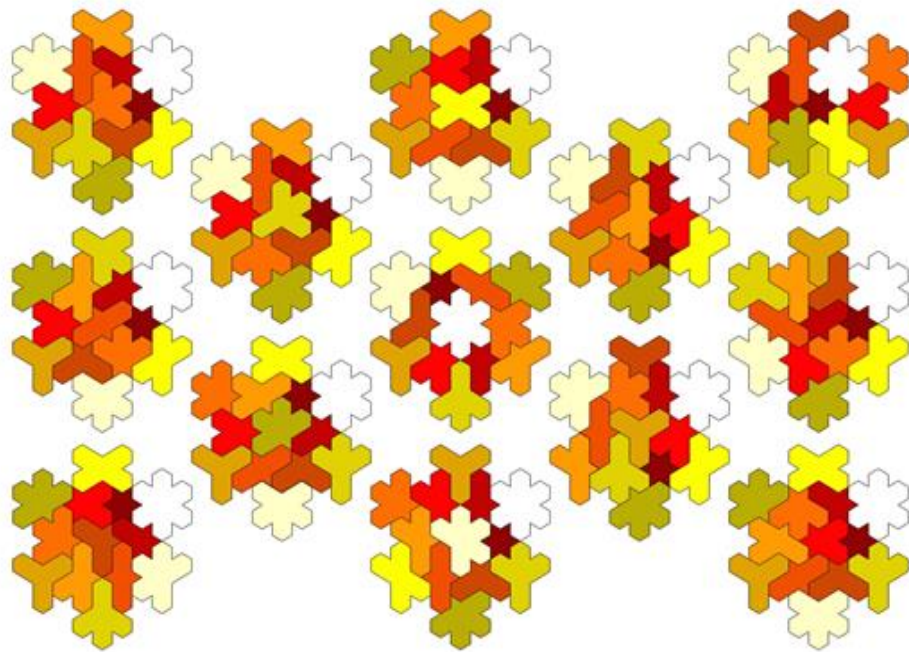
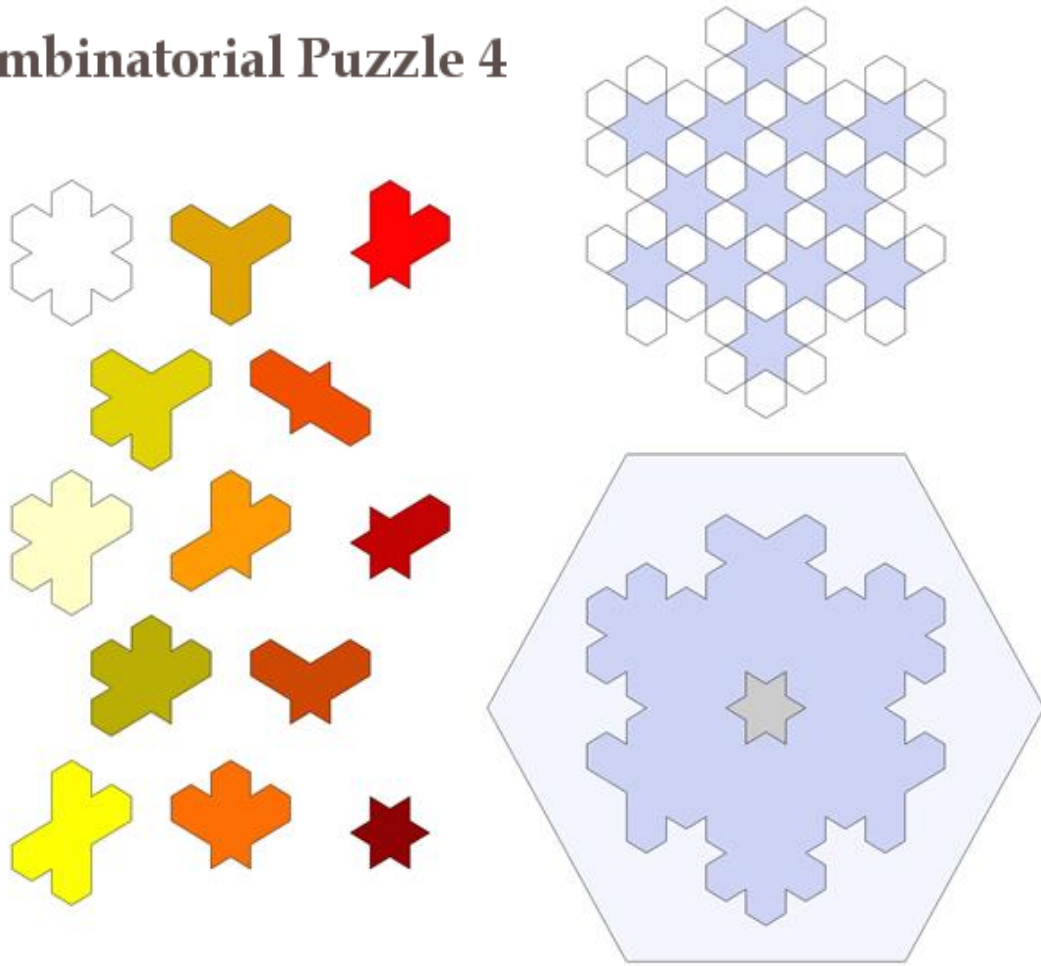
Combinatorial Puzzle 2



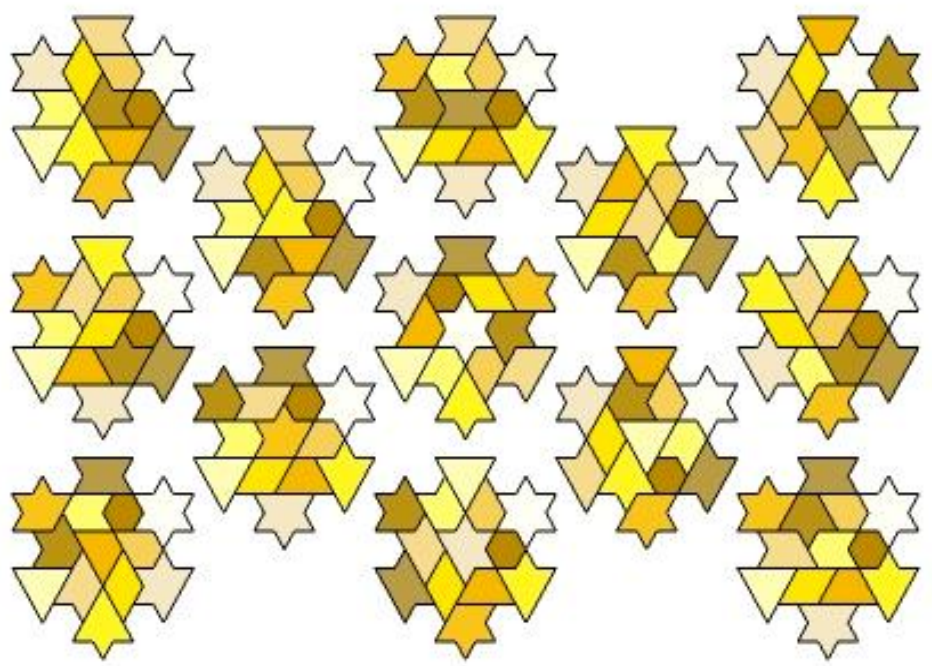
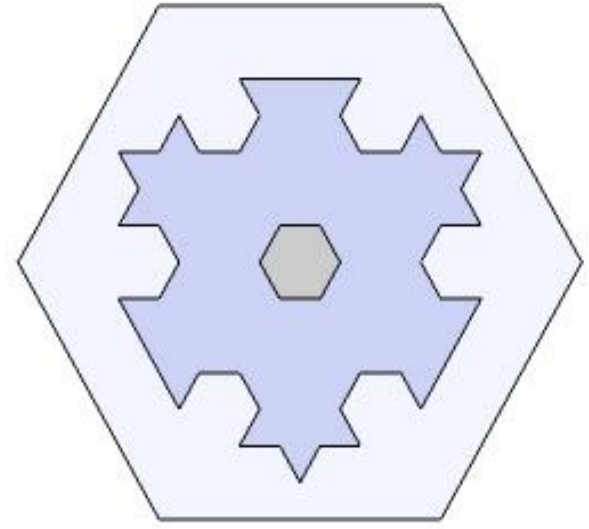
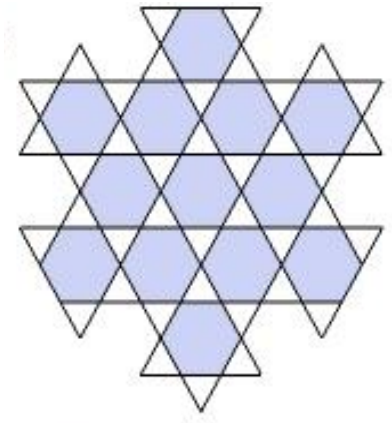
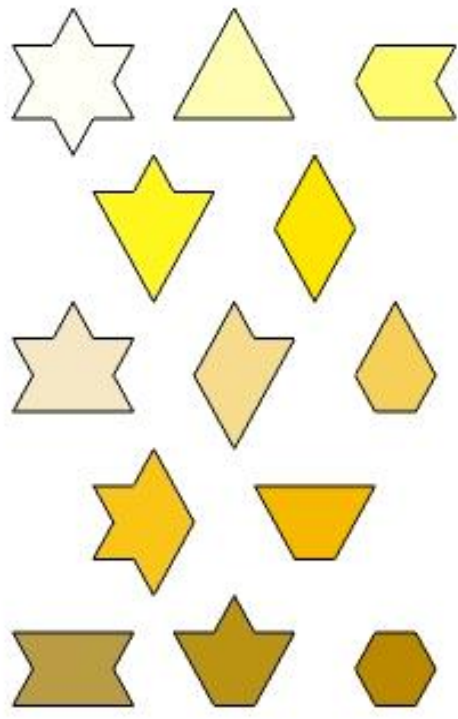
Combinatorial Puzzle 3



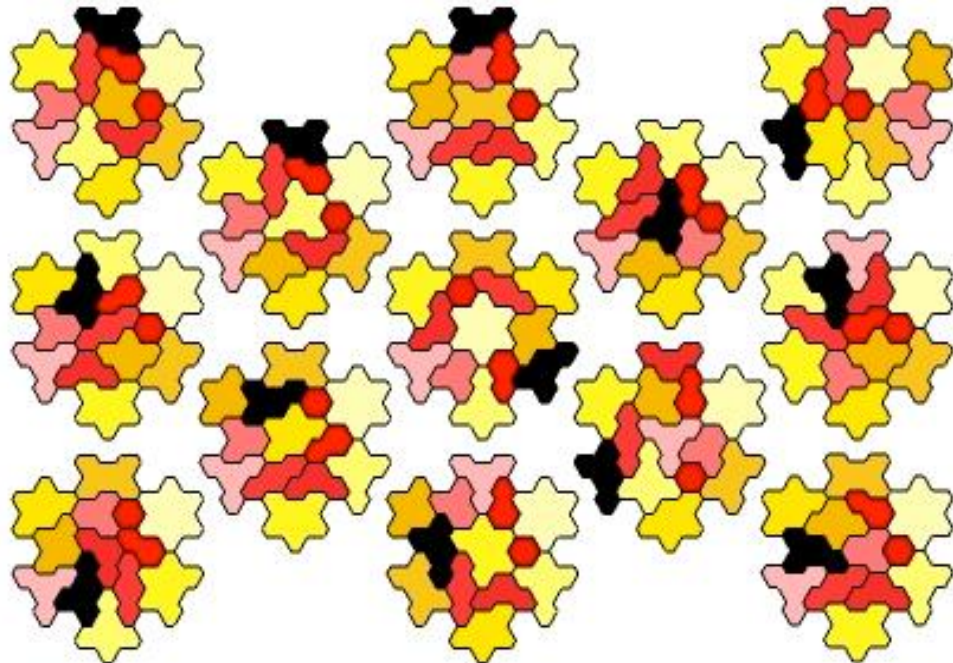
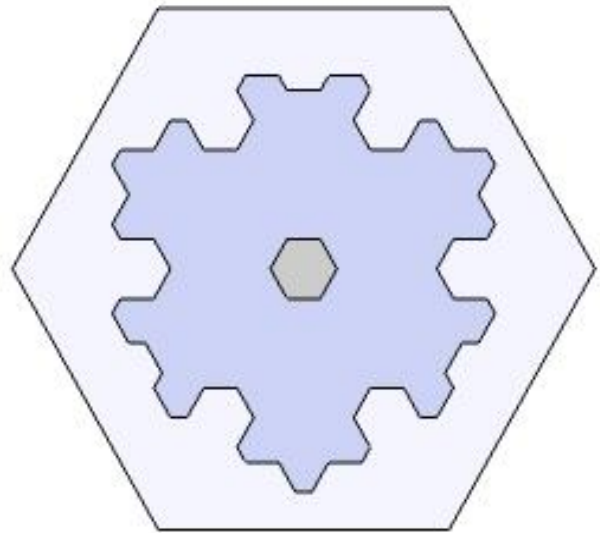
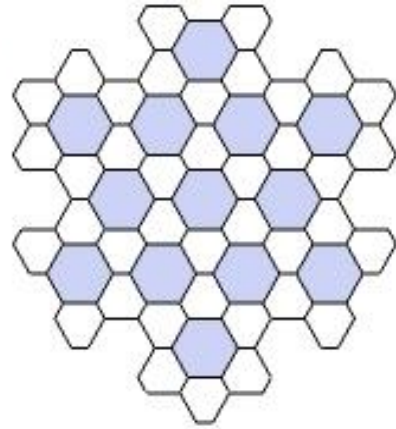
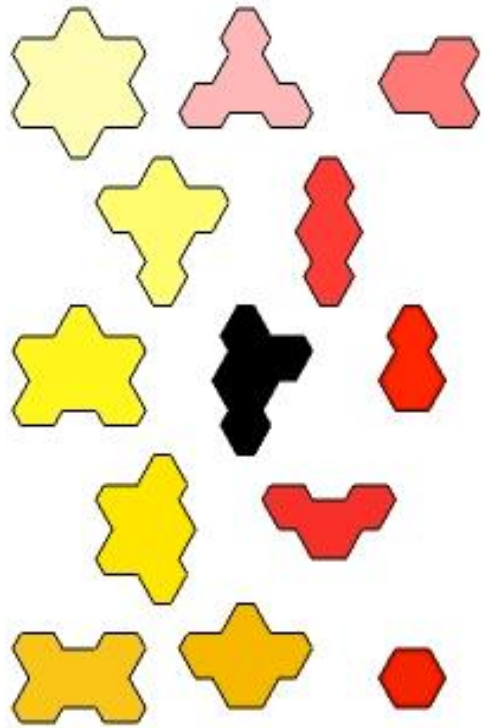
Combinatorial Puzzle 4



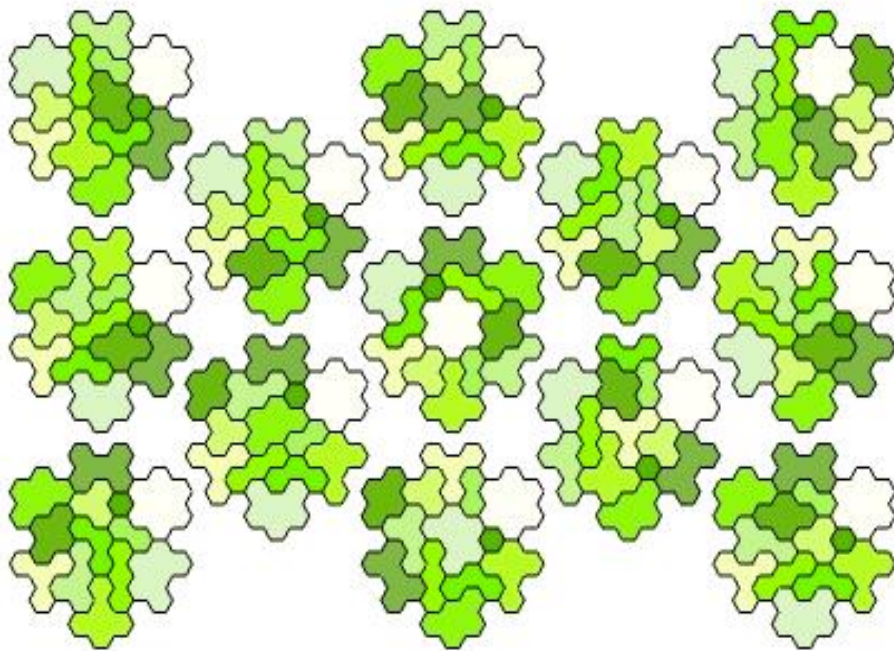
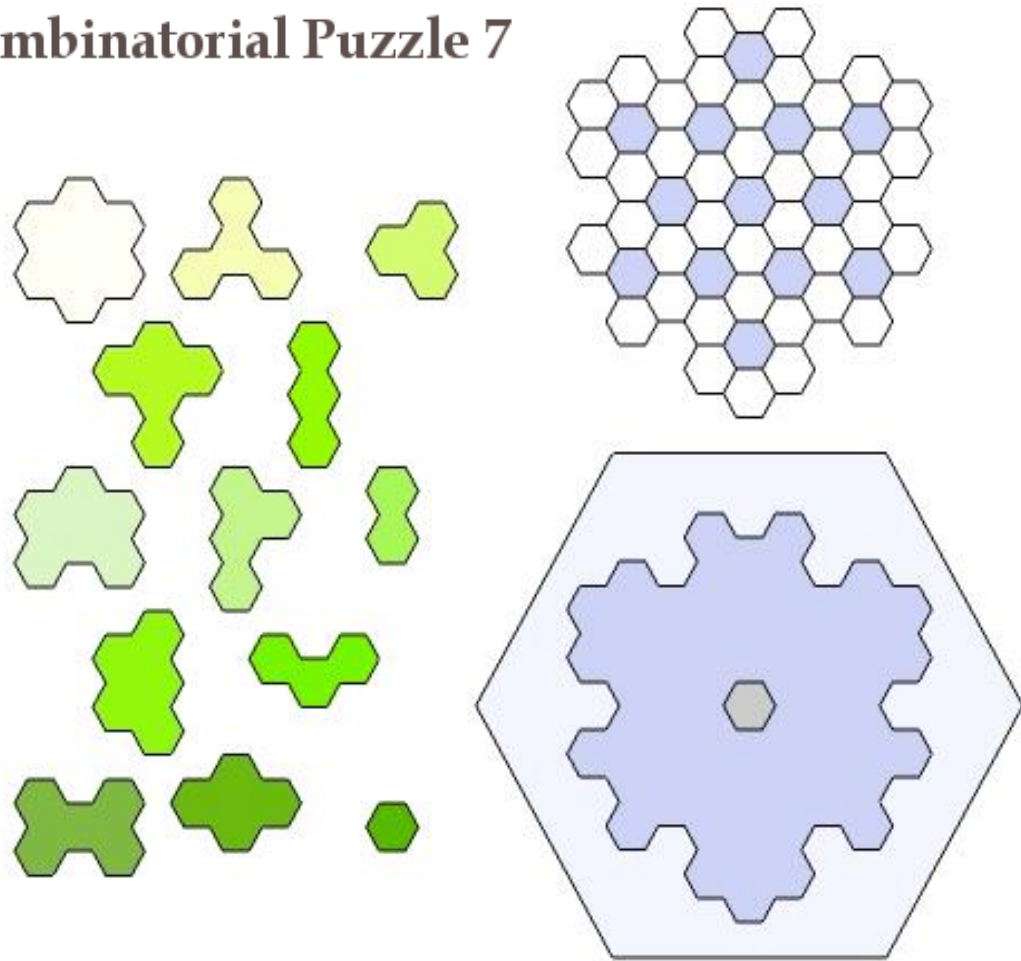
Combinatorial Puzzle 5



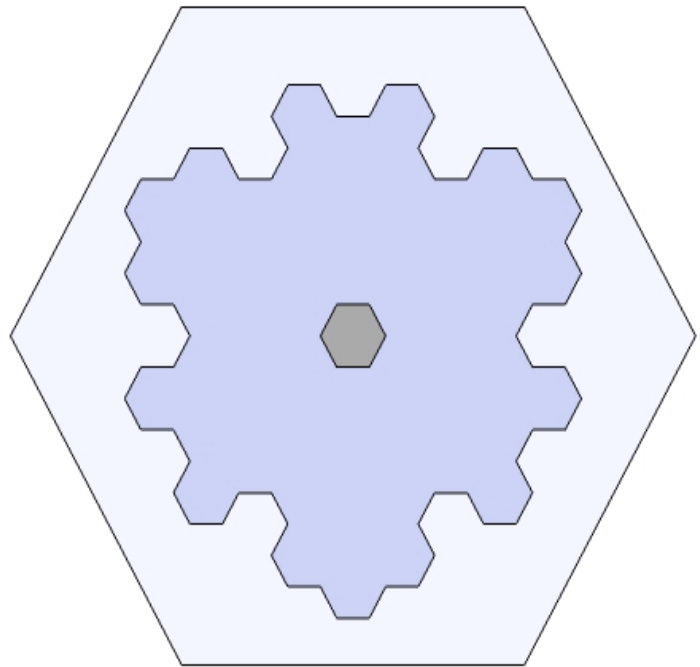
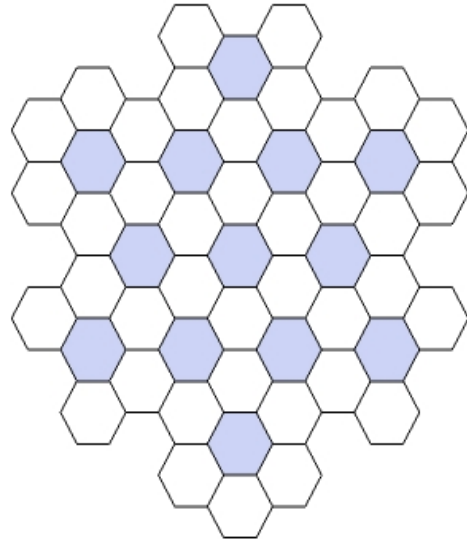
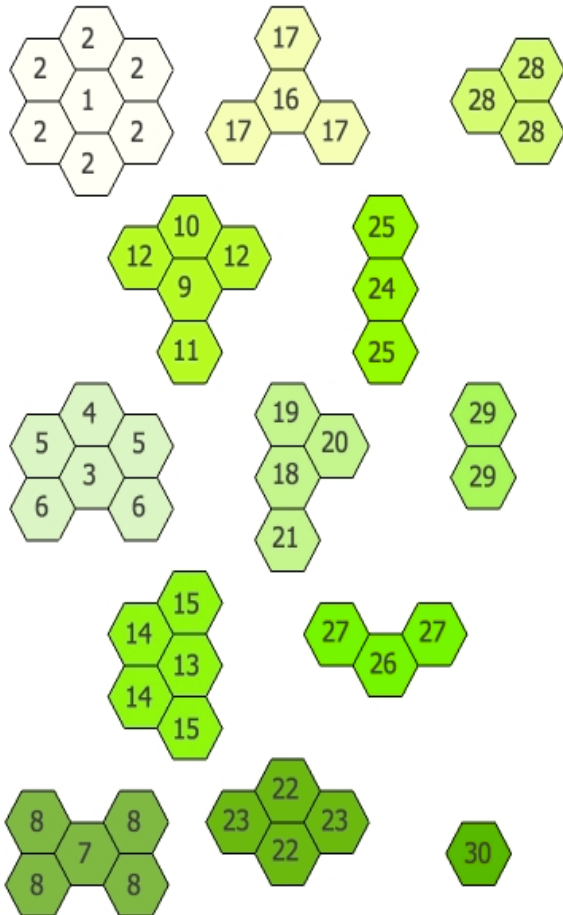
Combinatorial Puzzle 6



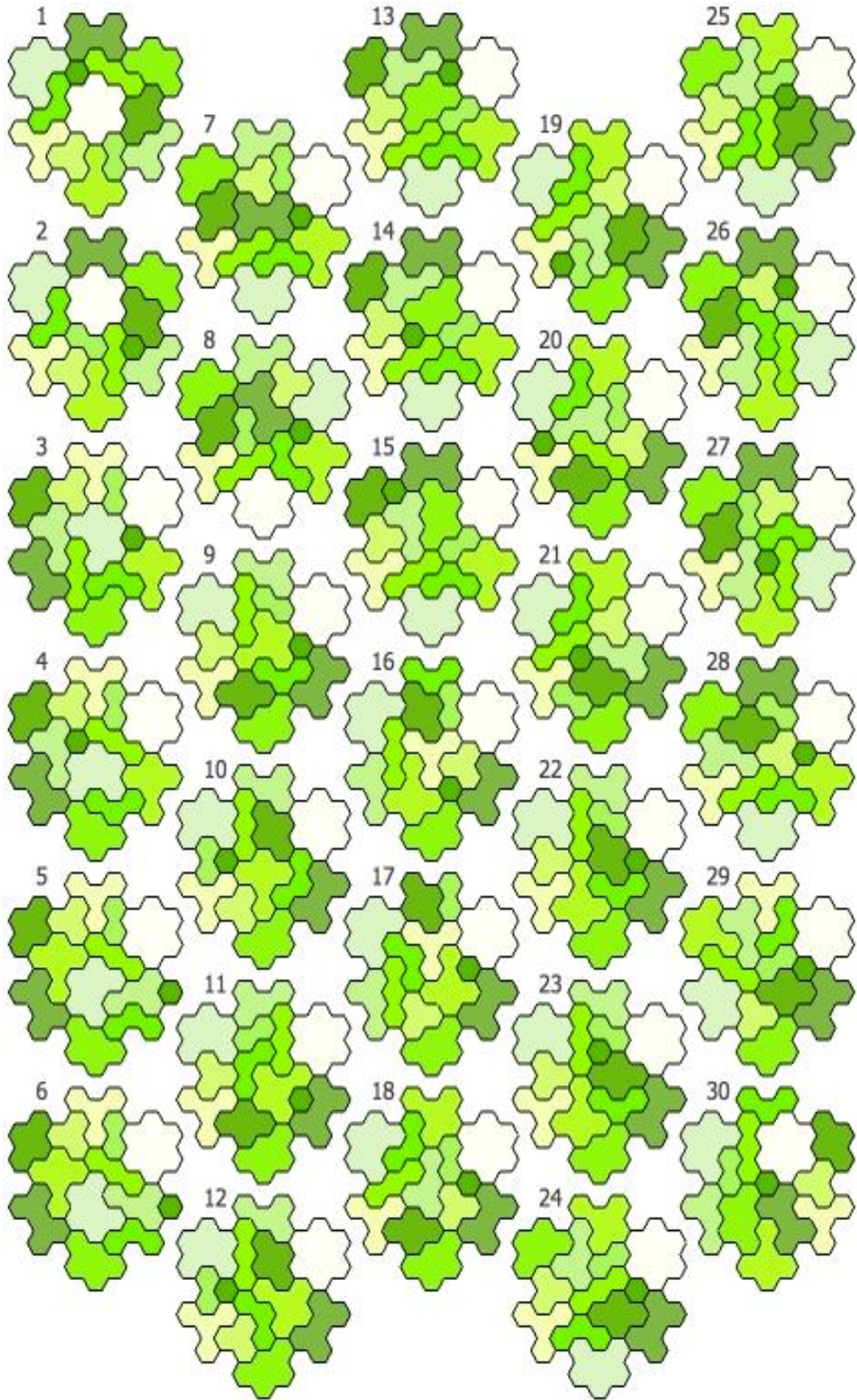
Combinatorial Puzzle 7



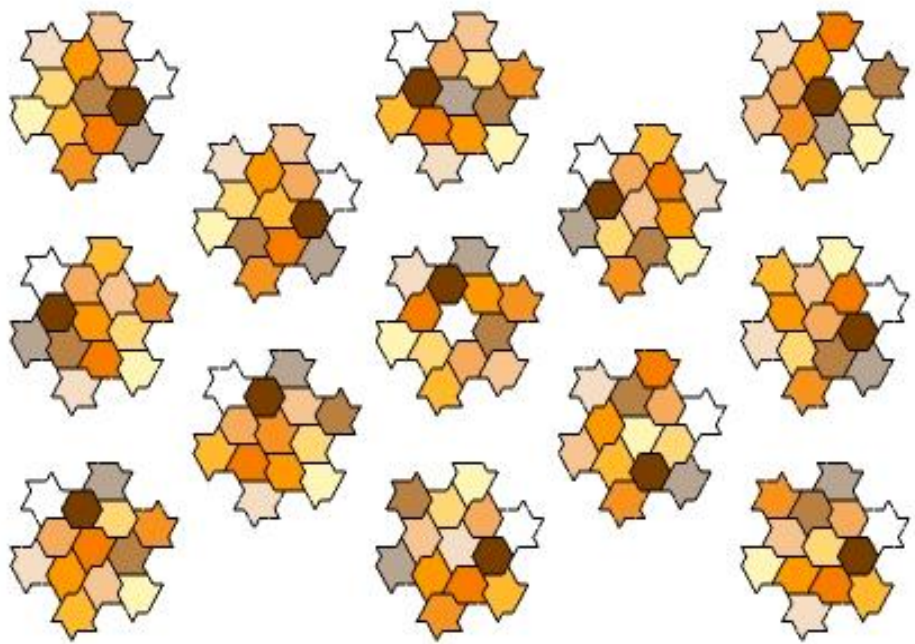
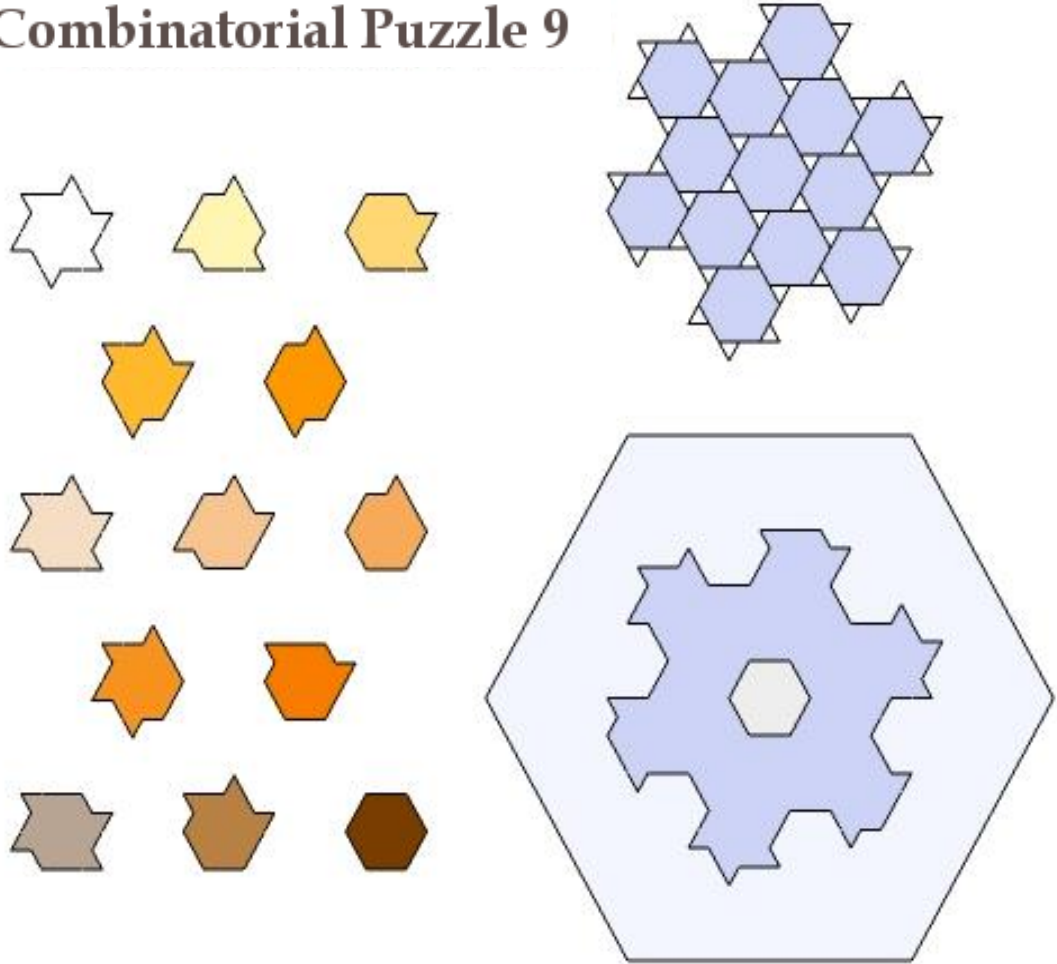
Combinatorial Puzzle 8



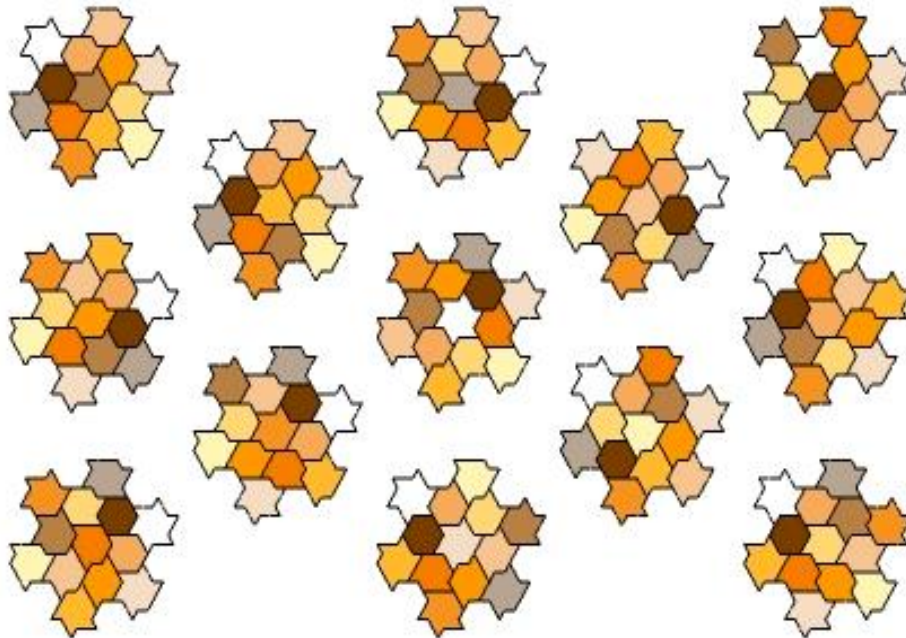
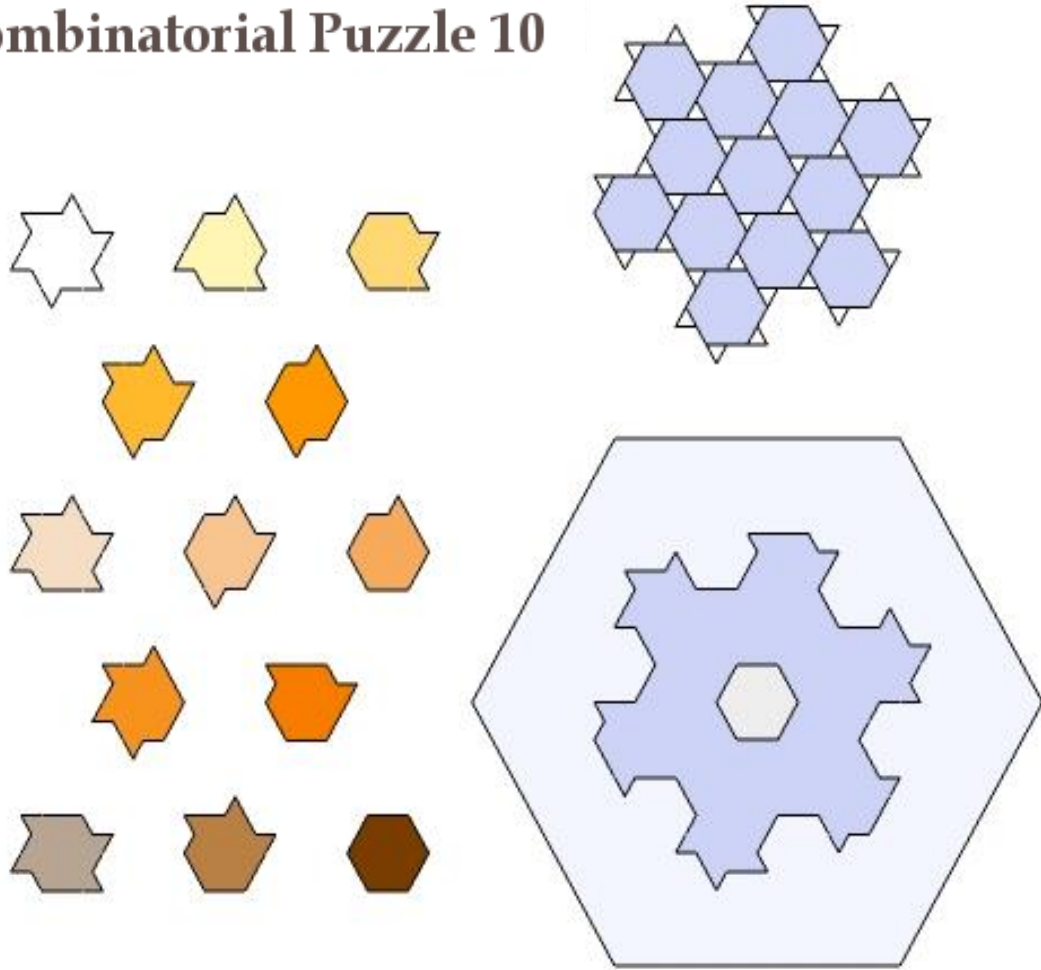
This puzzle differs from the previous versions inasmuch as the central shape and the surrounding shapes are congruent hexagons. An alternate objective for this puzzle is to find 30 solutions where every solution has a different hexagon at the center. See illustration below showing equivalent hexagons in the pieces.



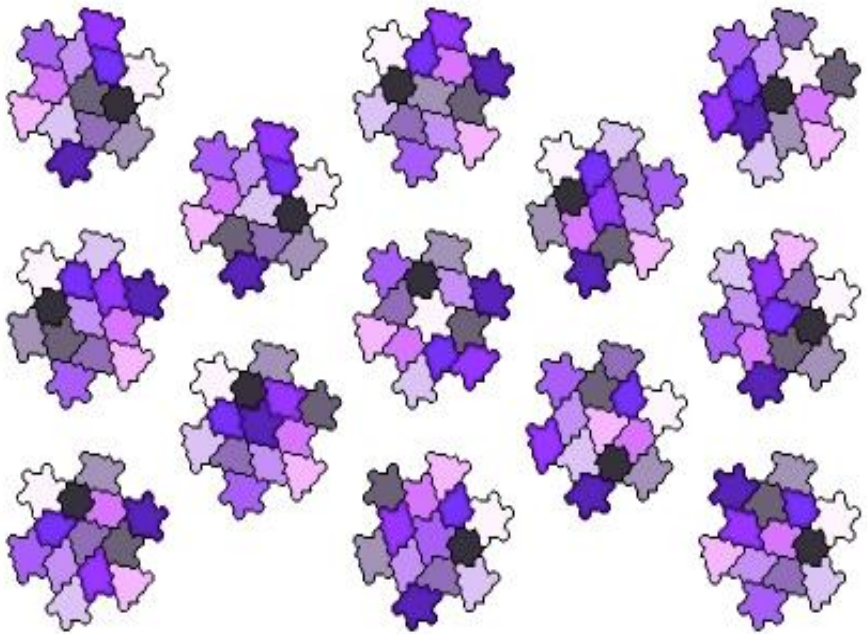
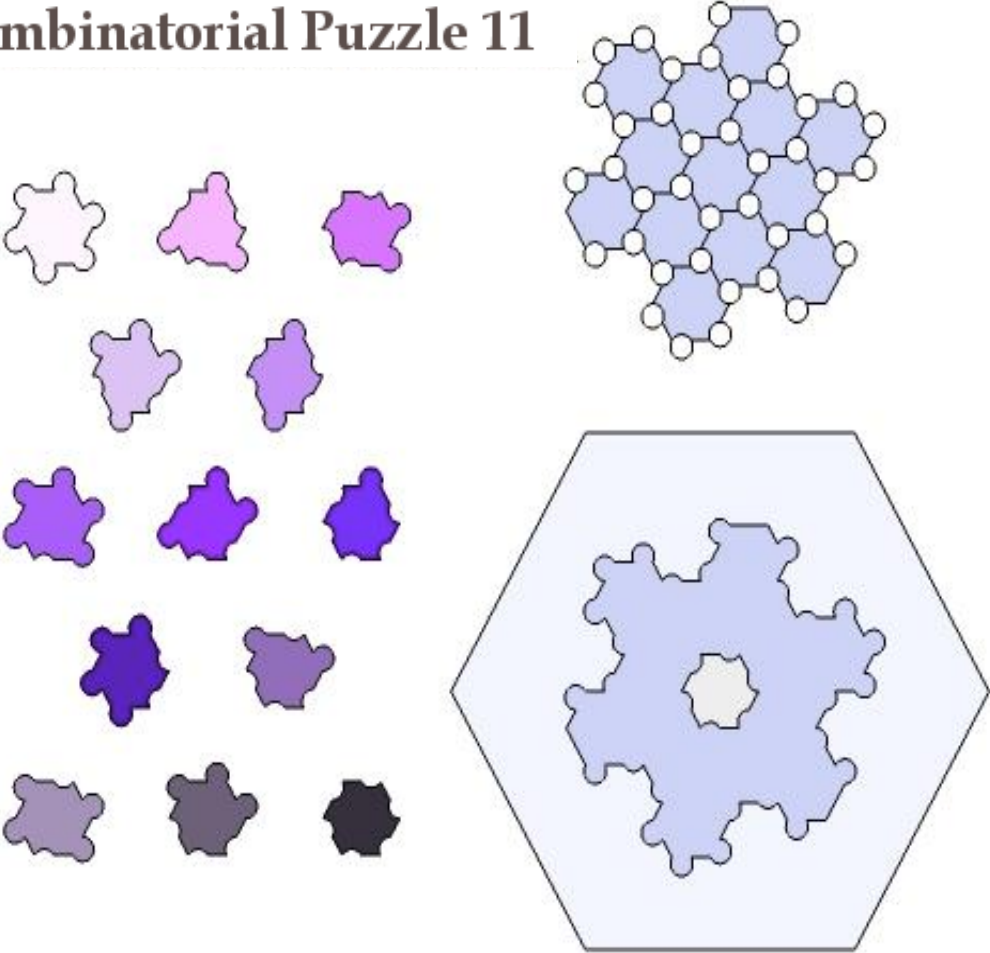
Combinatorial Puzzle 9



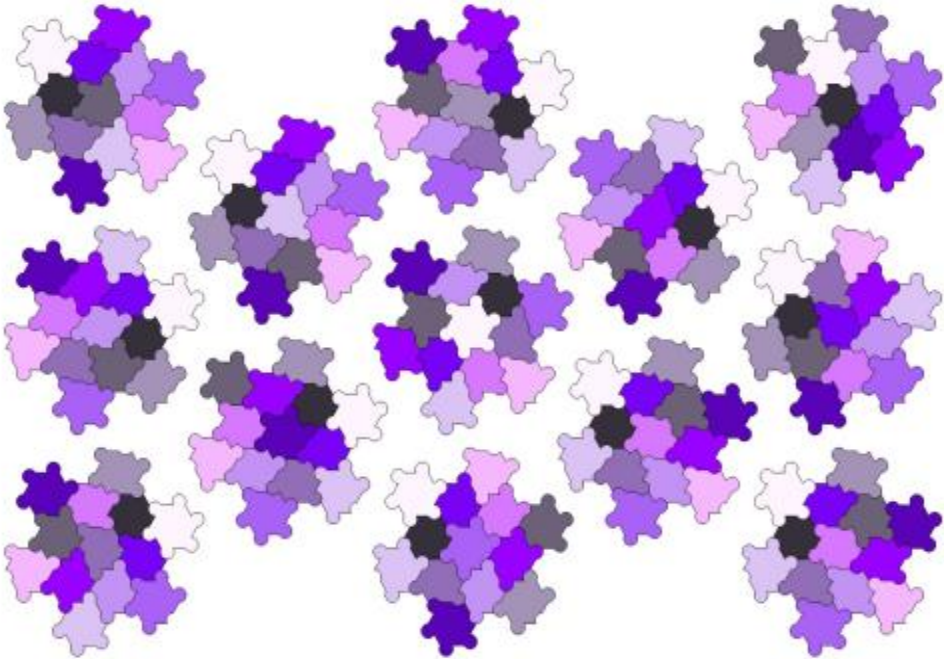
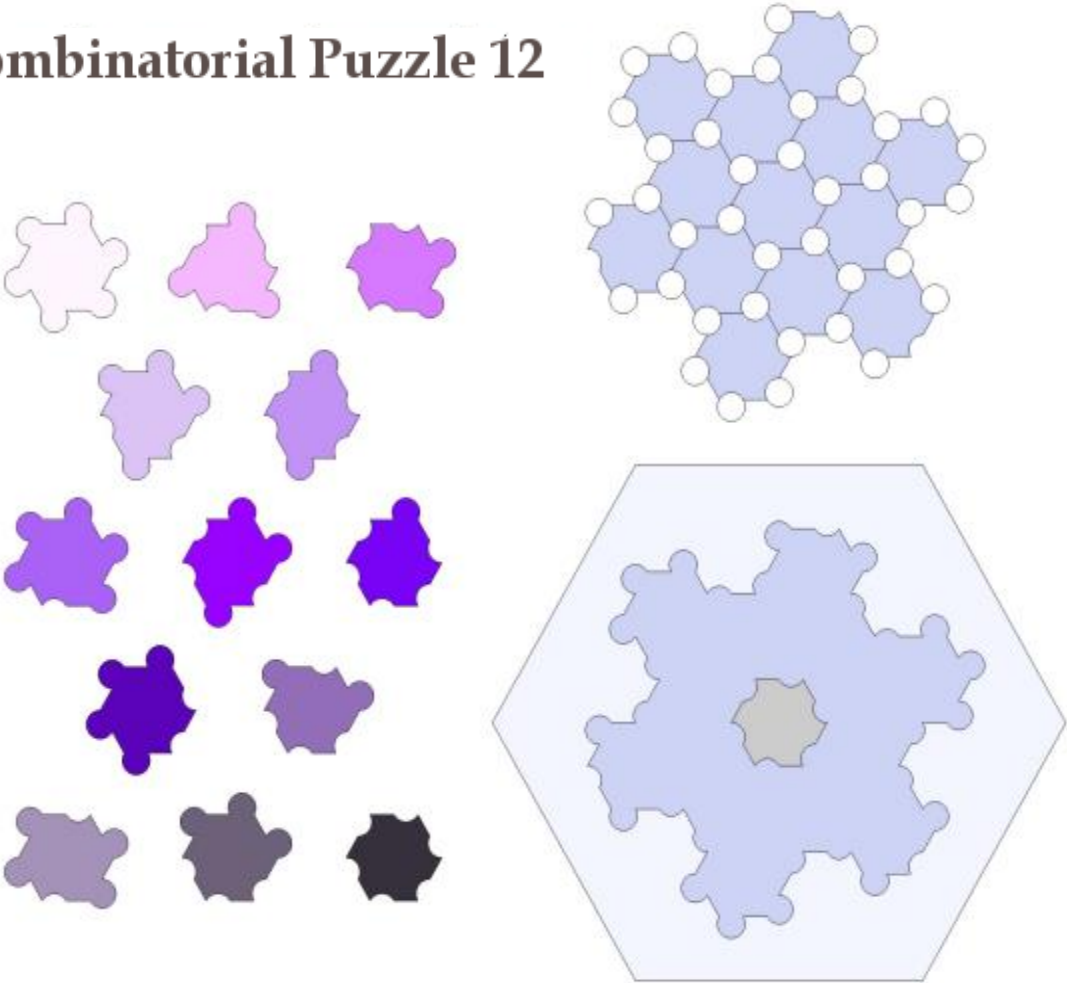
Combinatorial Puzzle 10



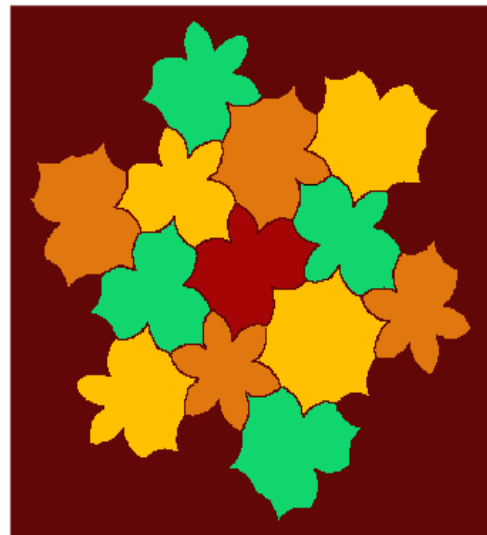
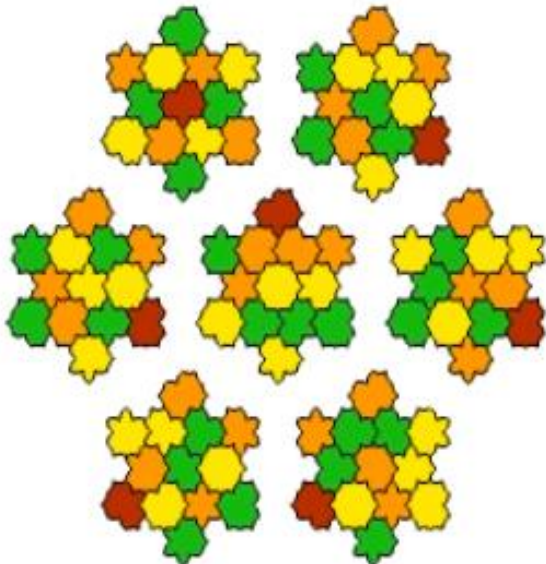
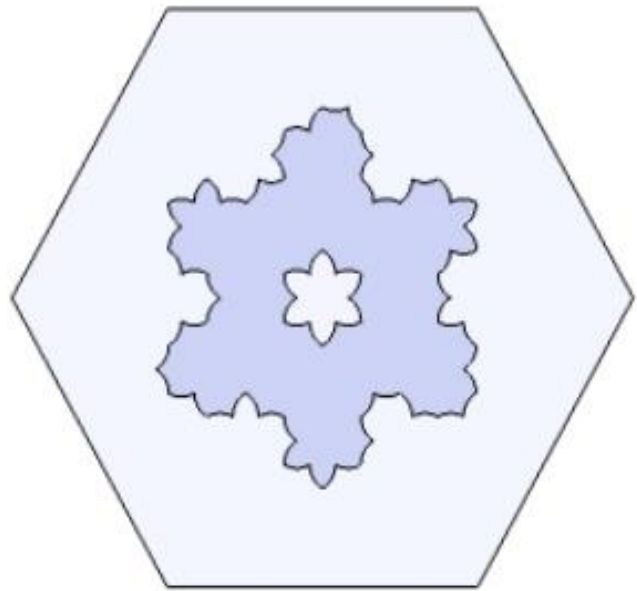
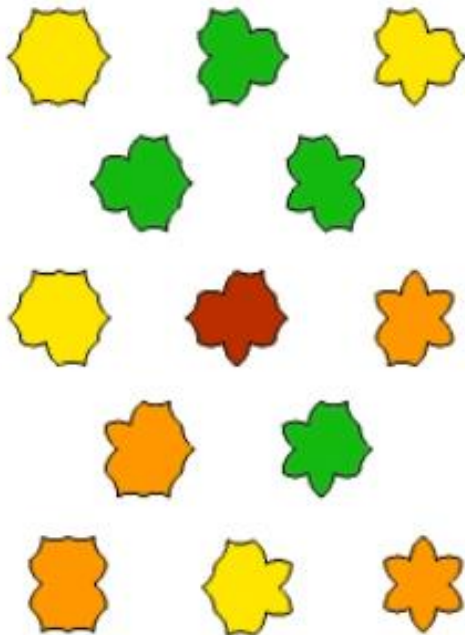
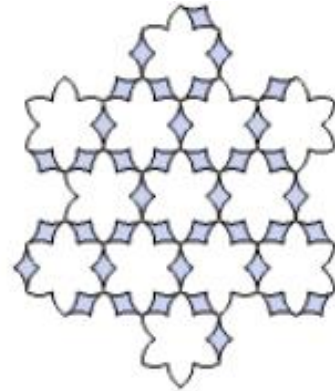
Combinatorial Puzzle 11



Combinatorial Puzzle 12



Combinatorial Puzzle 13 (Kadon's LEAVES Puzzle)



“LEAVES” is a trademark of Kadon Enterprises, Inc.

There are many alternate possibilities for the design of the LEAVES pieces and templates. Some samples of design grids by Michael Dowle are illustrated below.

