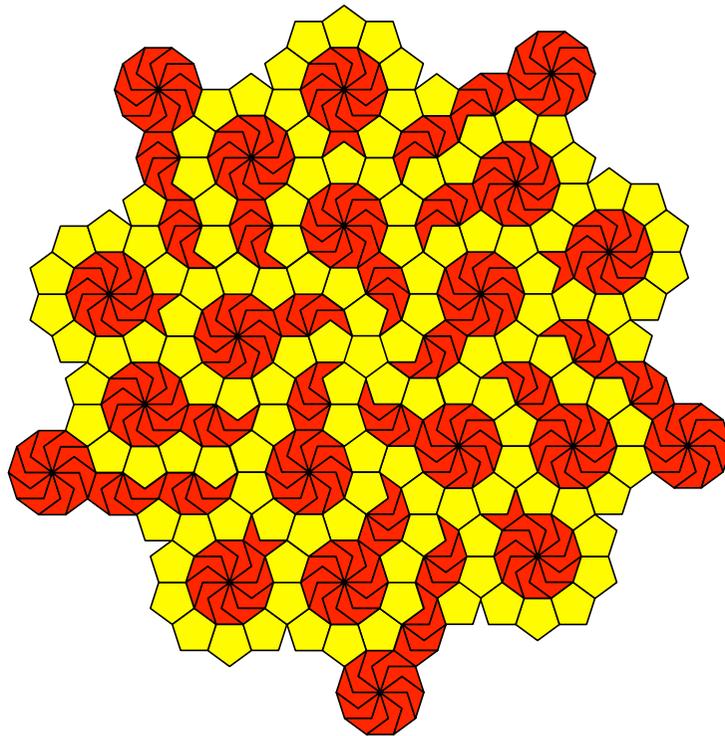
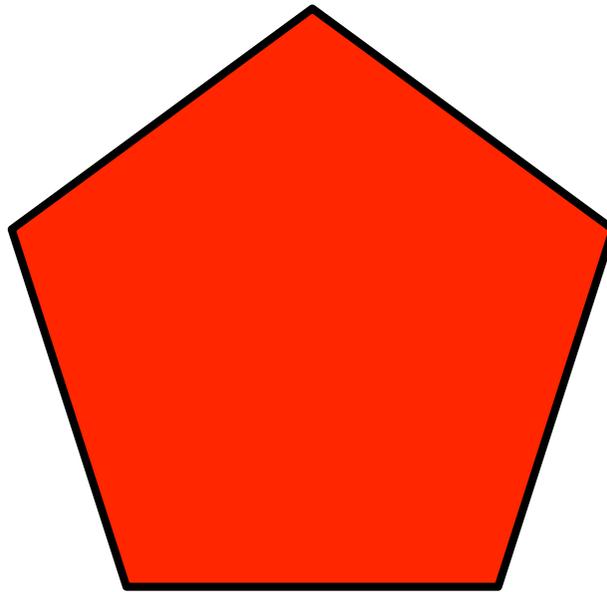


Semi-Regular Figures Between Beauty and Regularity

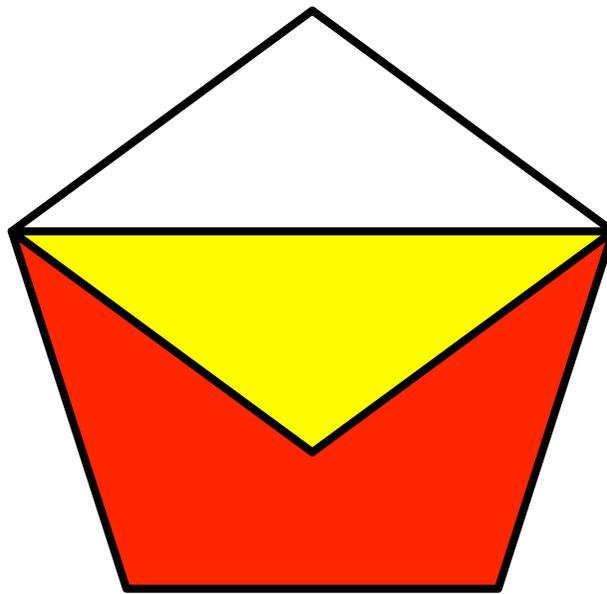


Hans Walser
www.walser-h-m.ch/hans/

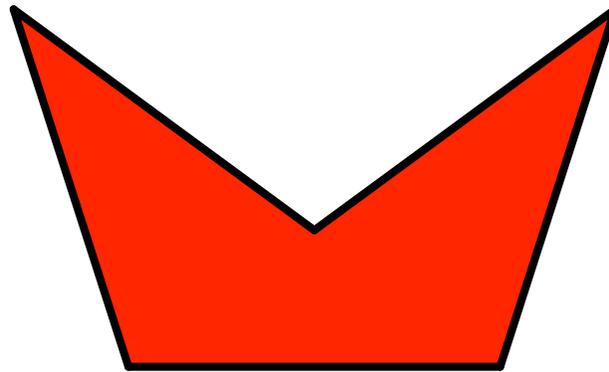
Regular Pentagon



Regular Pentagon



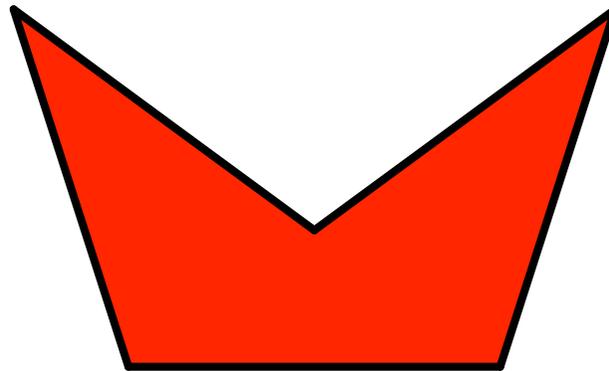
Our semi-regular tile



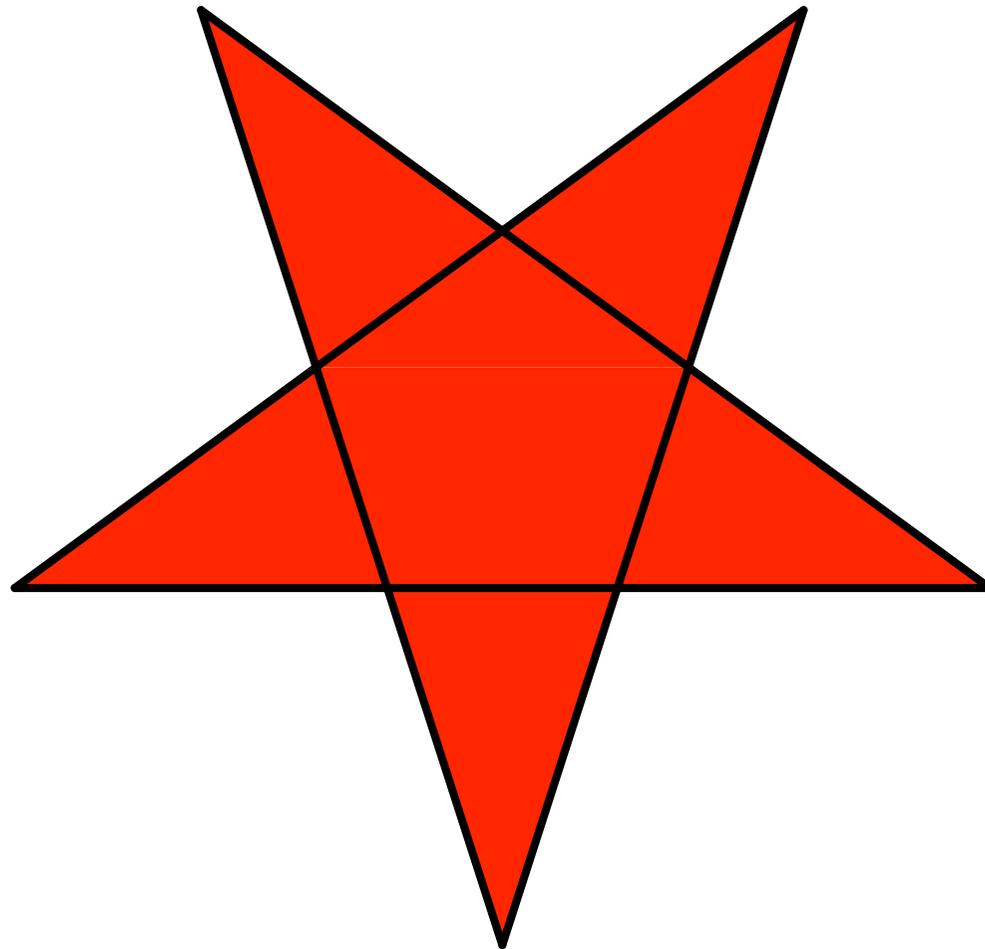
Our semi-regular tile

Equal sides

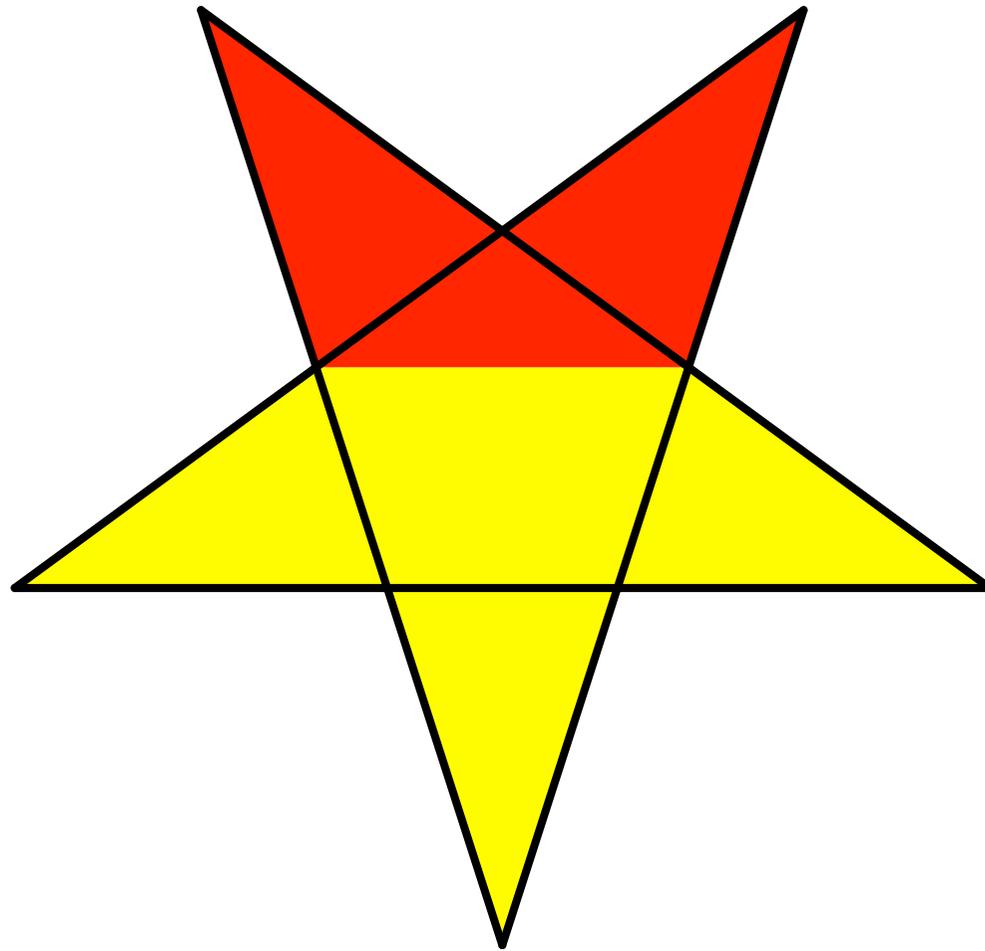
Different angles (108° , 36° , 252° , 36° , 108°)



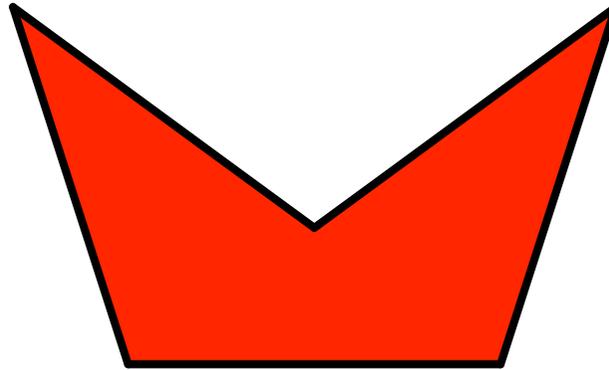
Pentagram



Pentagram

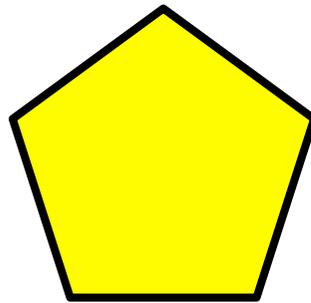


Our semi-regular tile

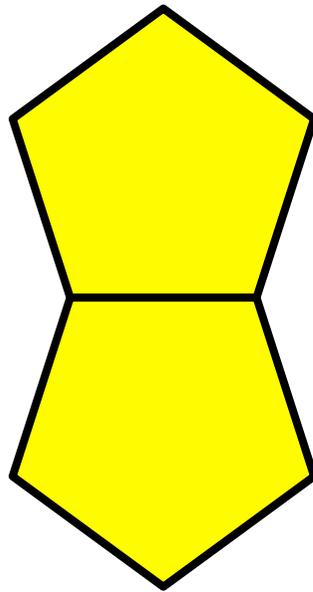


Tiling

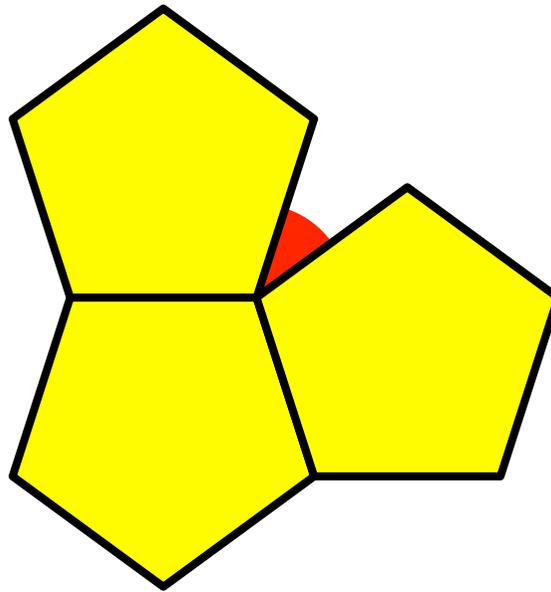
Tiling with regular pentagons only?



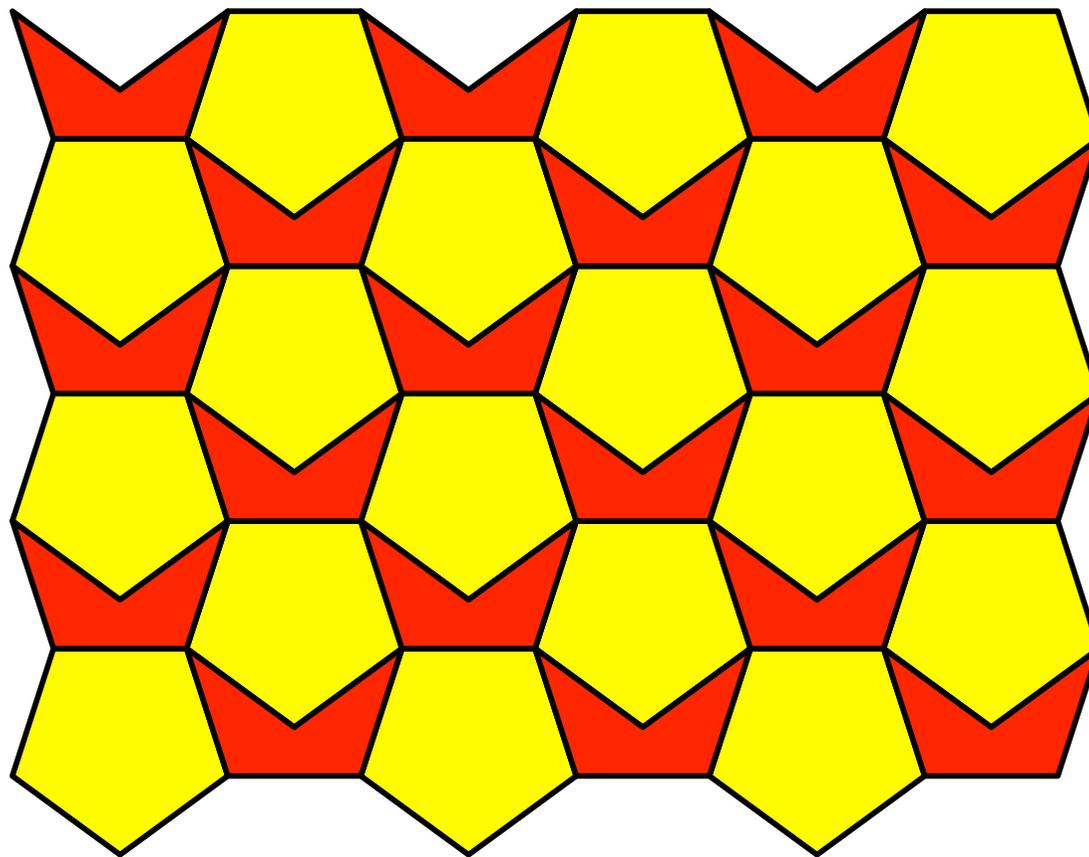
Tiling with regular pentagons only?



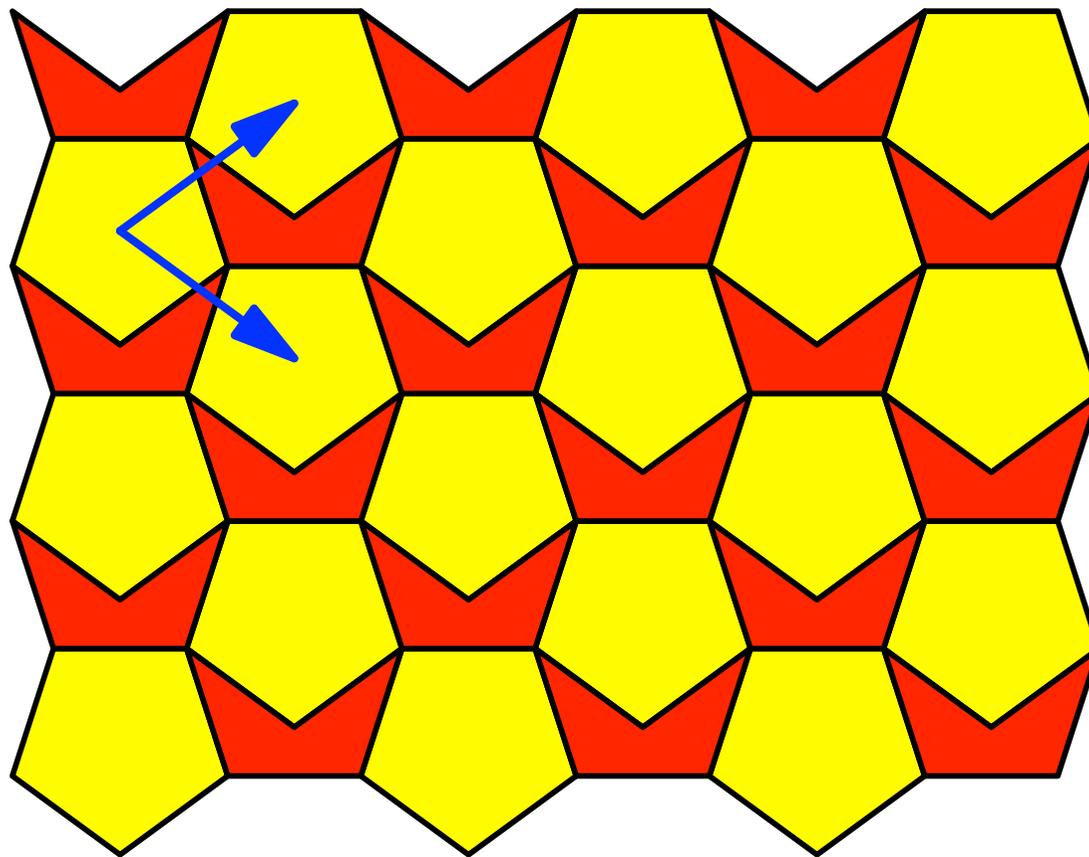
Tiling with regular pentagons only **impossible**



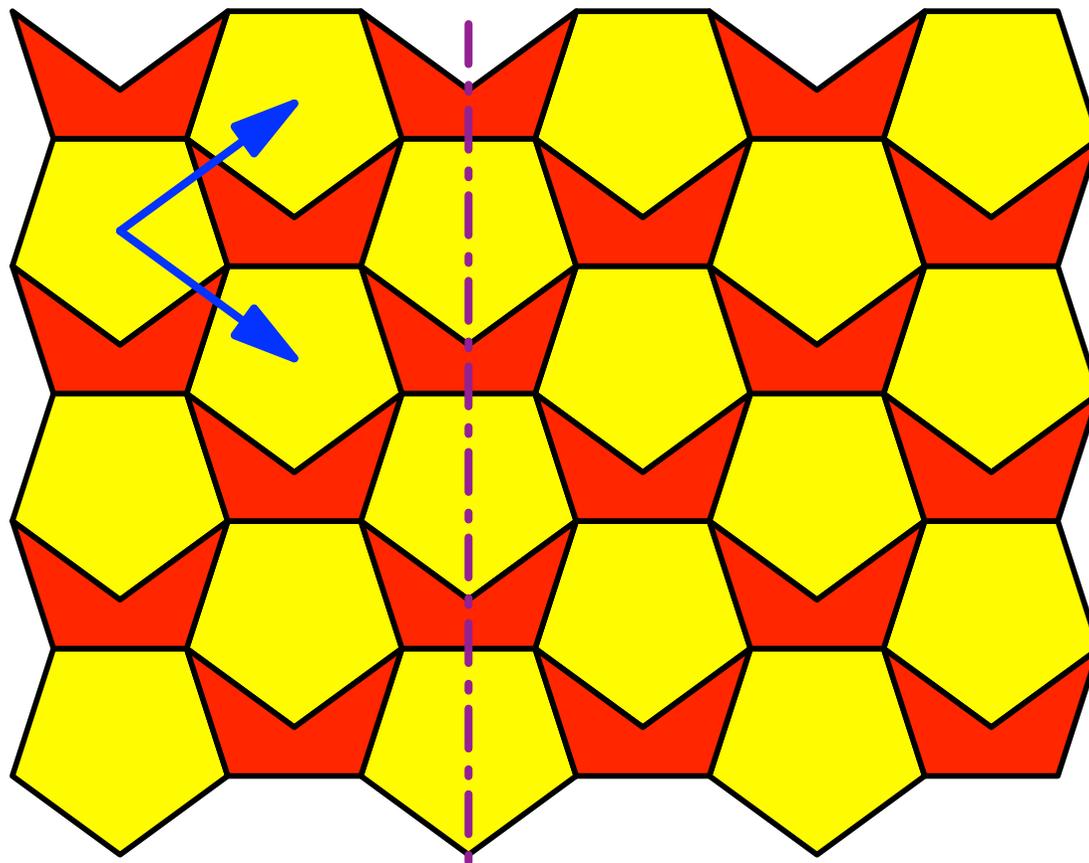
Regular and semi-regular pentagons



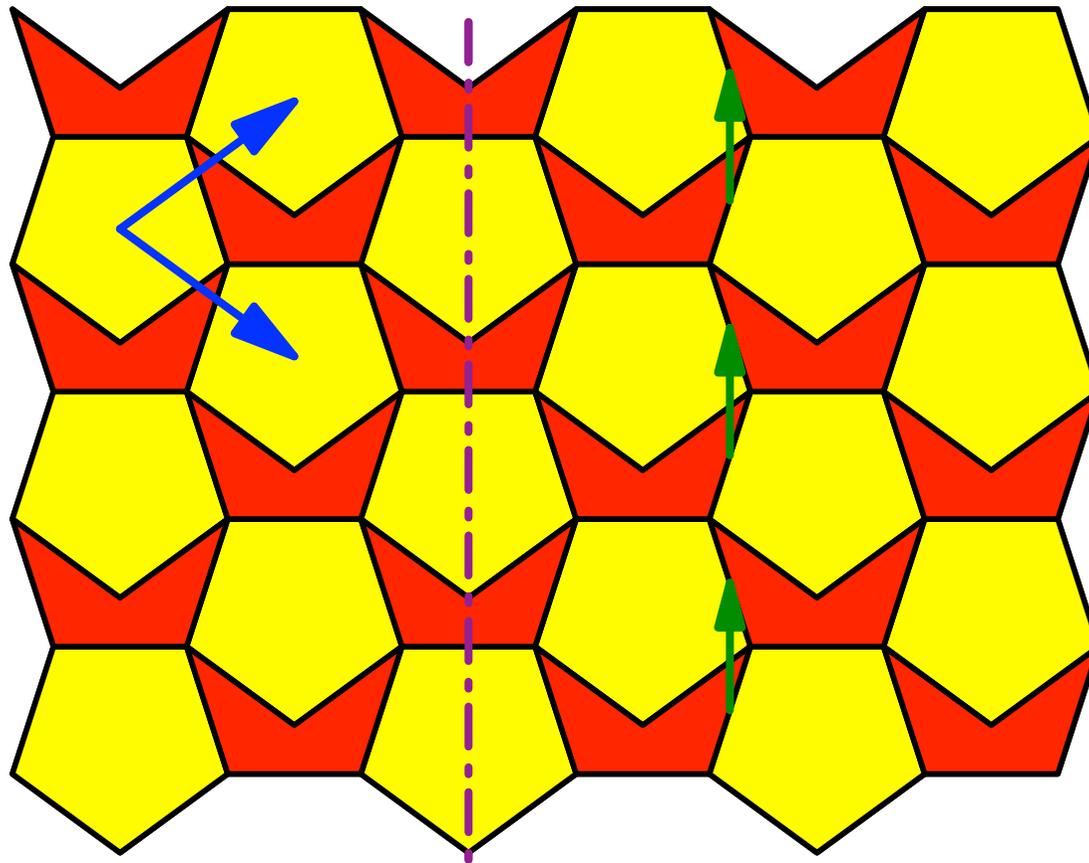
Translations

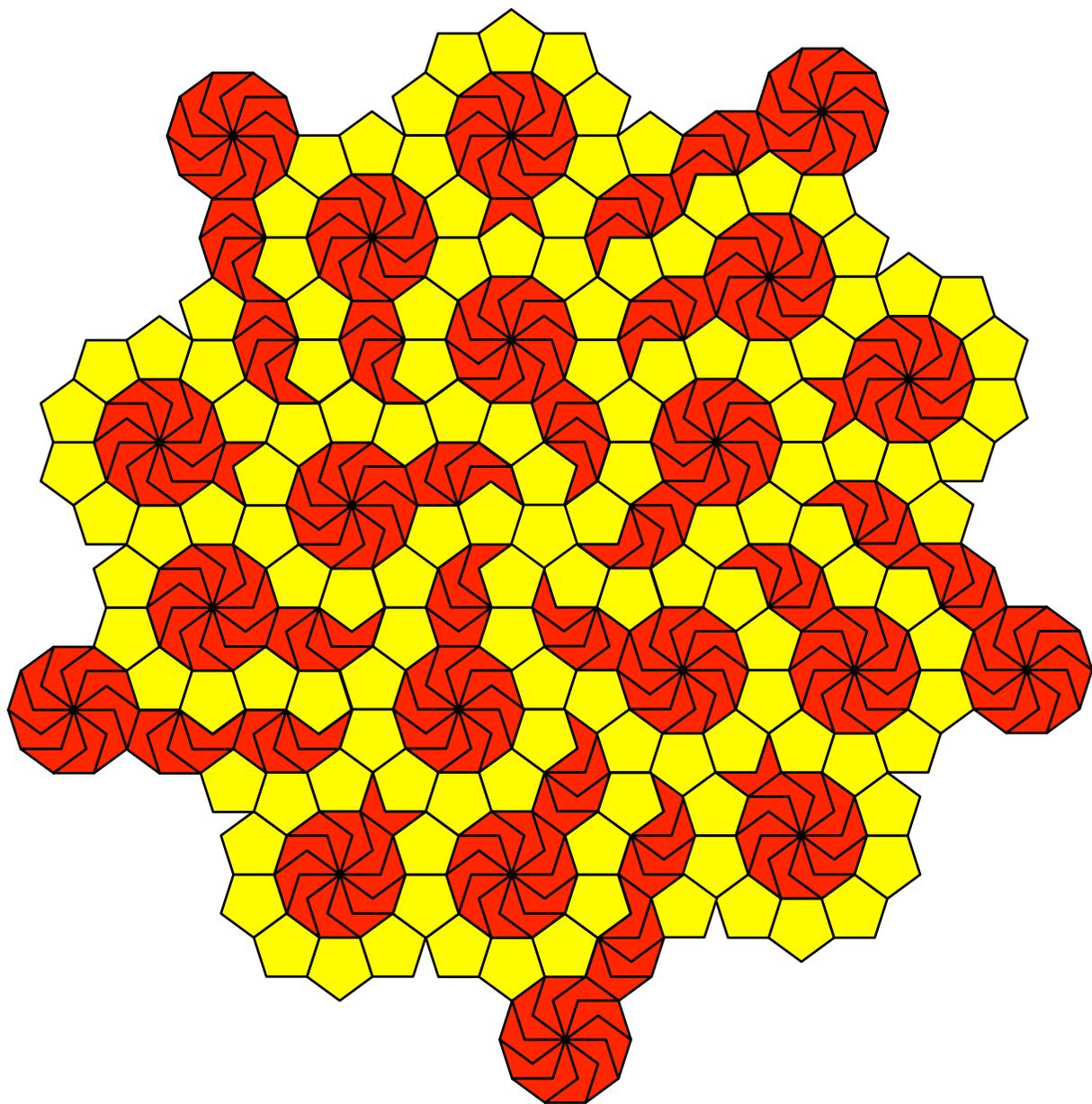


Translations – Reflections

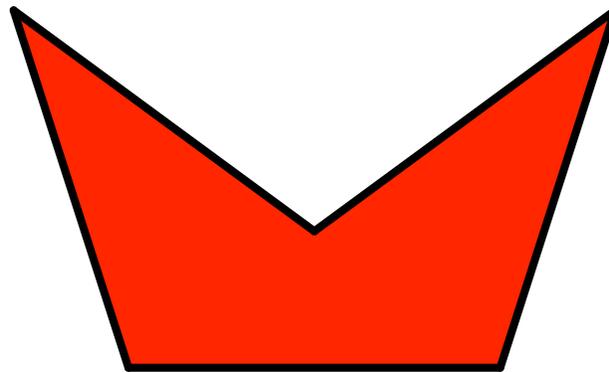


Translations – Reflections – Glide reflections (cm)



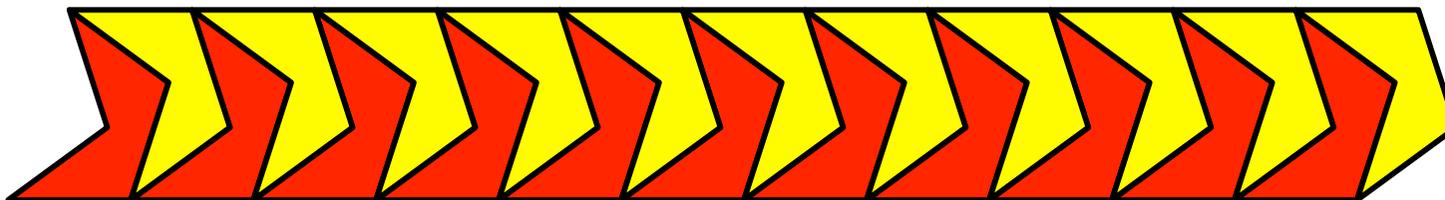


Using semi-regular tiles only



Frieze patterns

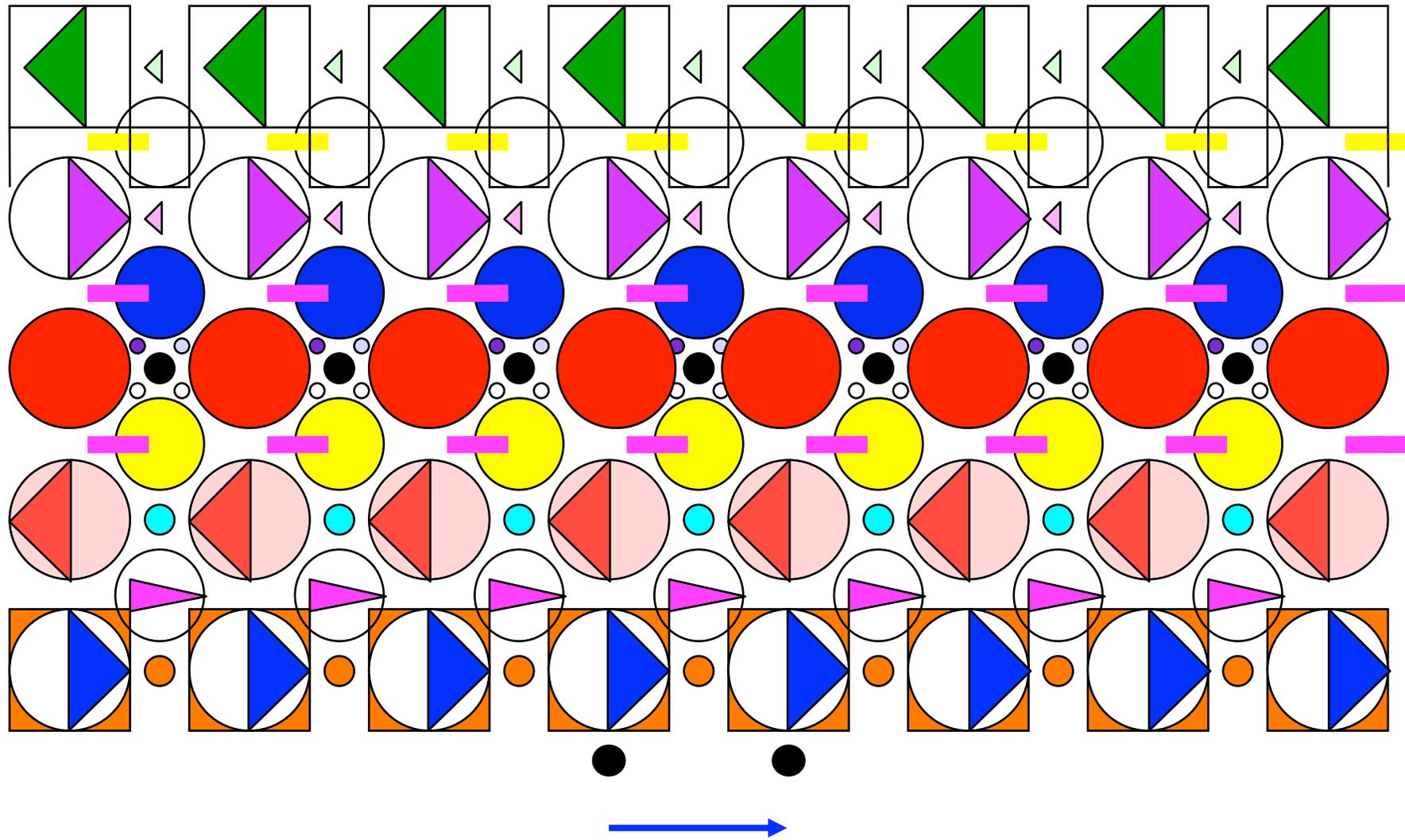
Translation only (p1)



Frieze patterns

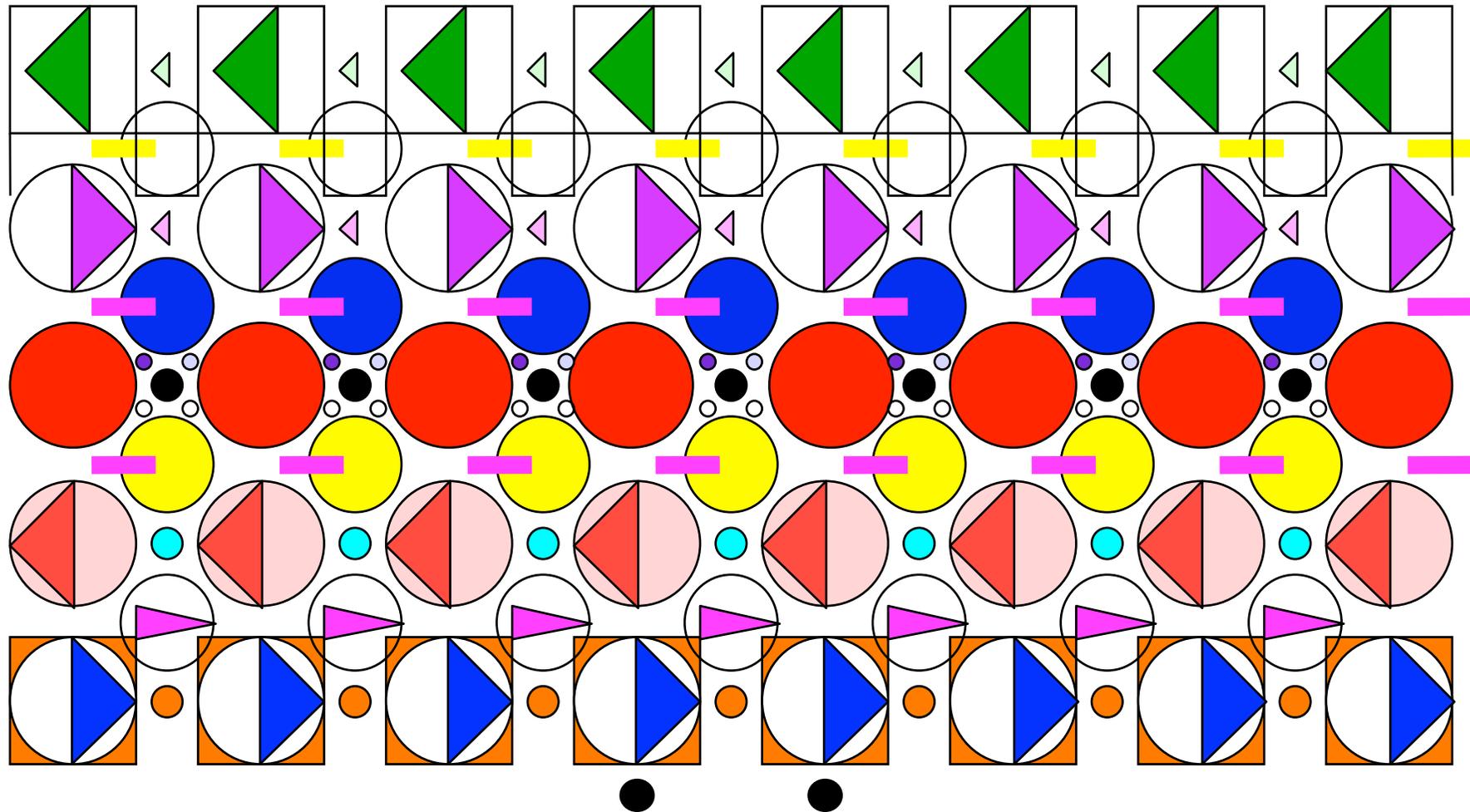
Translation only (p1)

Frieze patterns. Translation only (p1)



Autostereogram

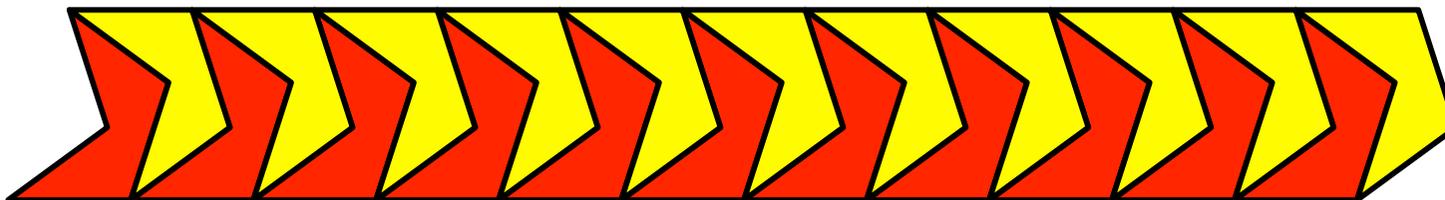
Frieze patterns. Translation only (p1)



Autostereogram

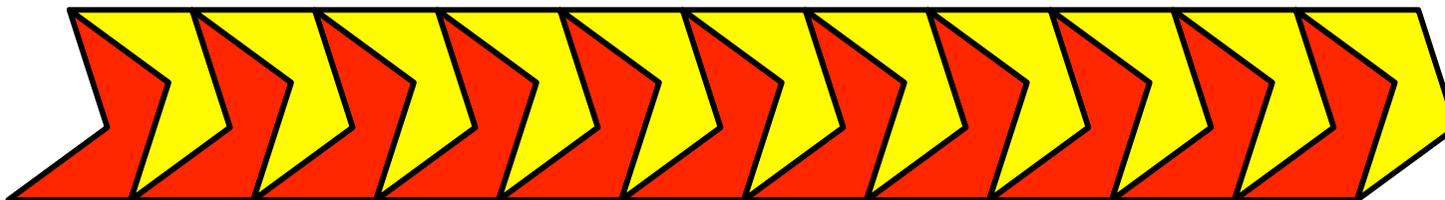
Frieze patterns

Translation only (p1)

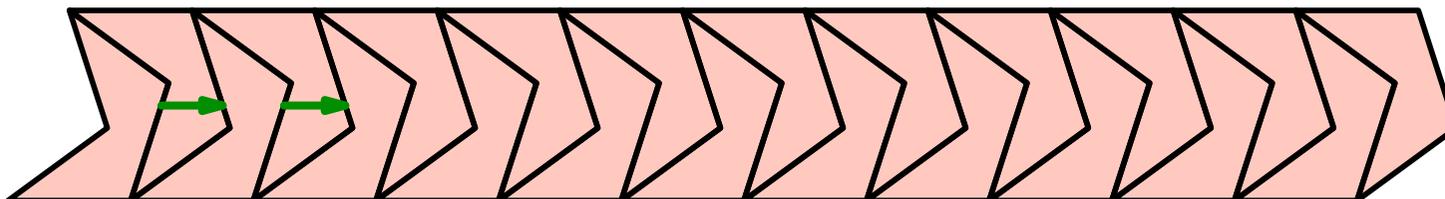


Frieze patterns

Translation only (p1)



Translation and glide reflection (p11g)



Frieze patterns

Translation and glide reflection



In which direction did the tractor drive?

Frieze patterns
Translation and glide reflection



In which direction was the car driving?

Frieze patterns
Translation and glide reflection



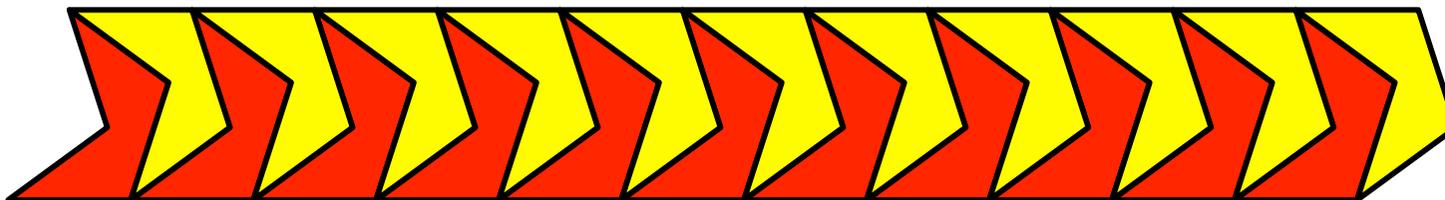
Car tire



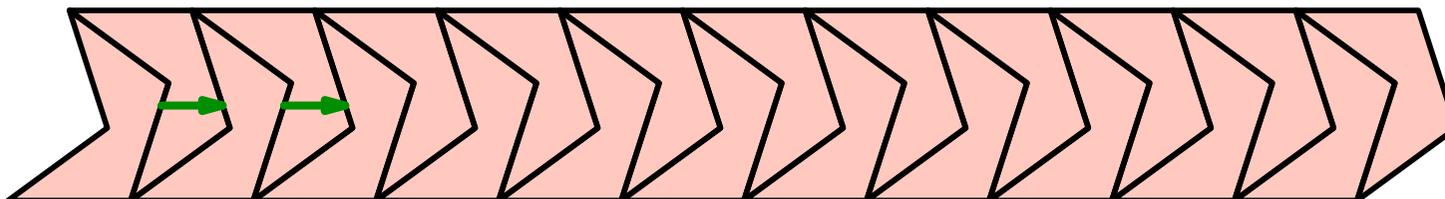


Frieze patterns

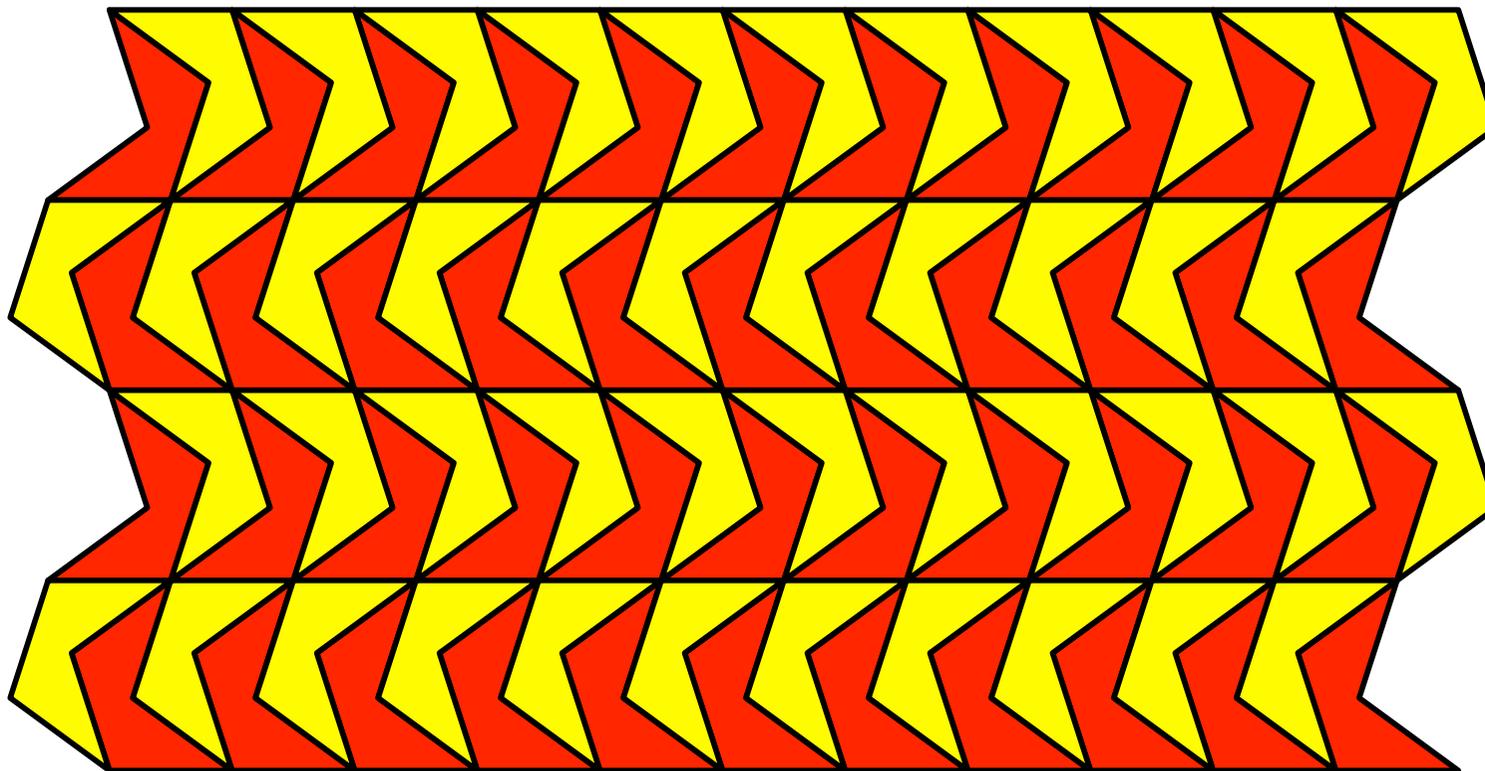
Translation only (p1)



Translation and glide reflection (p11g)

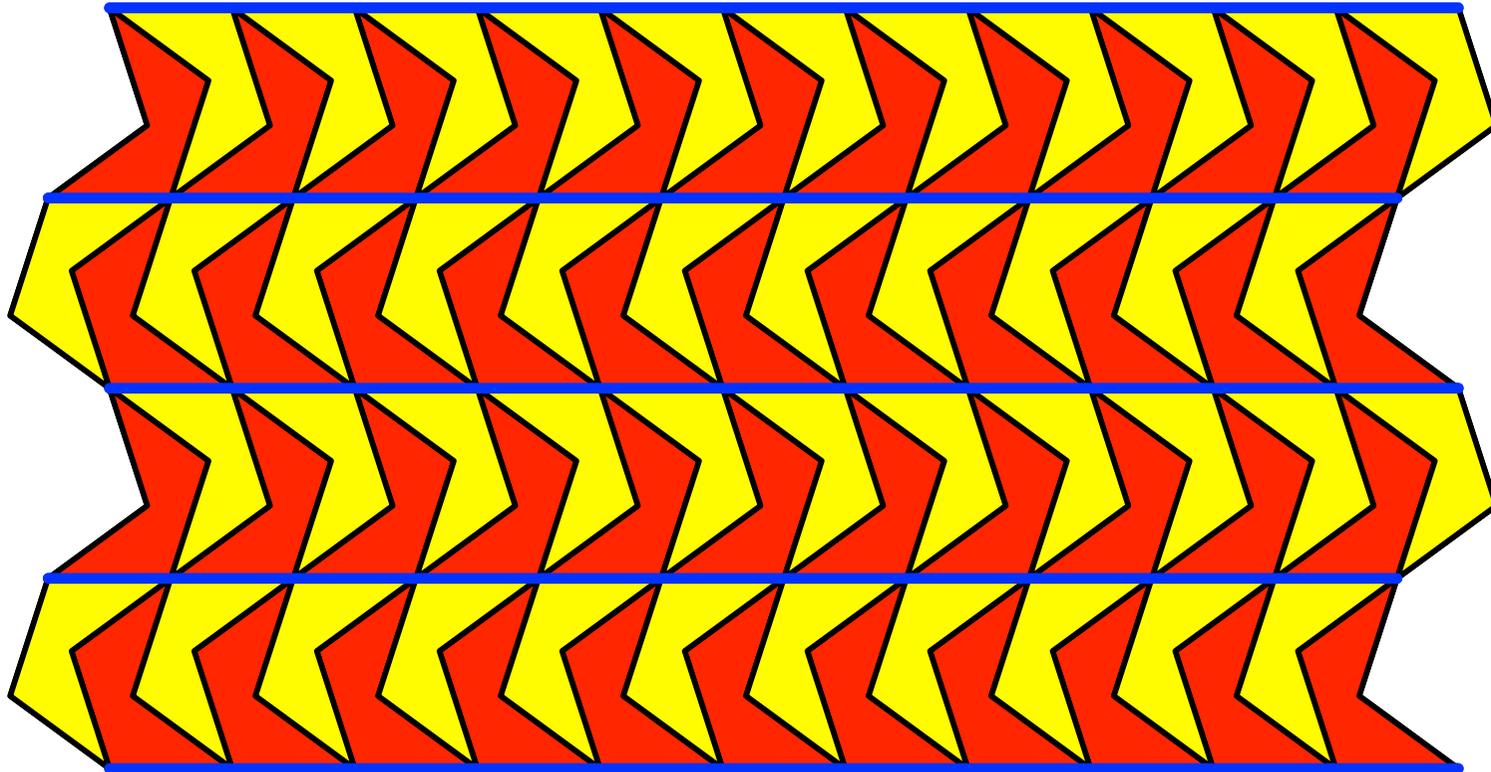


Plane symmetry group pattern



Wallpaper patterns. Plane crystallographic groups

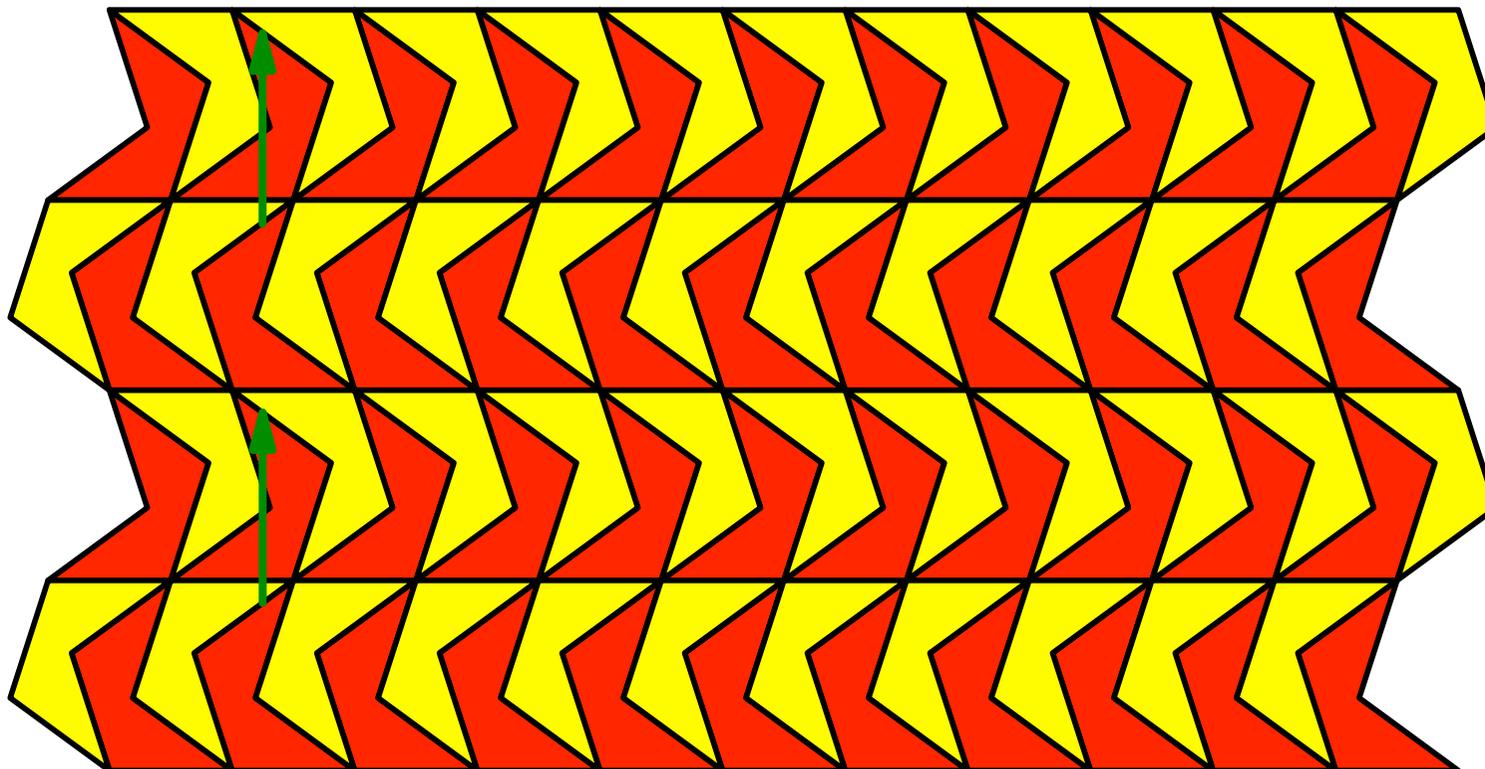
Blue lines parallel?



Blue lines parallel? – yes

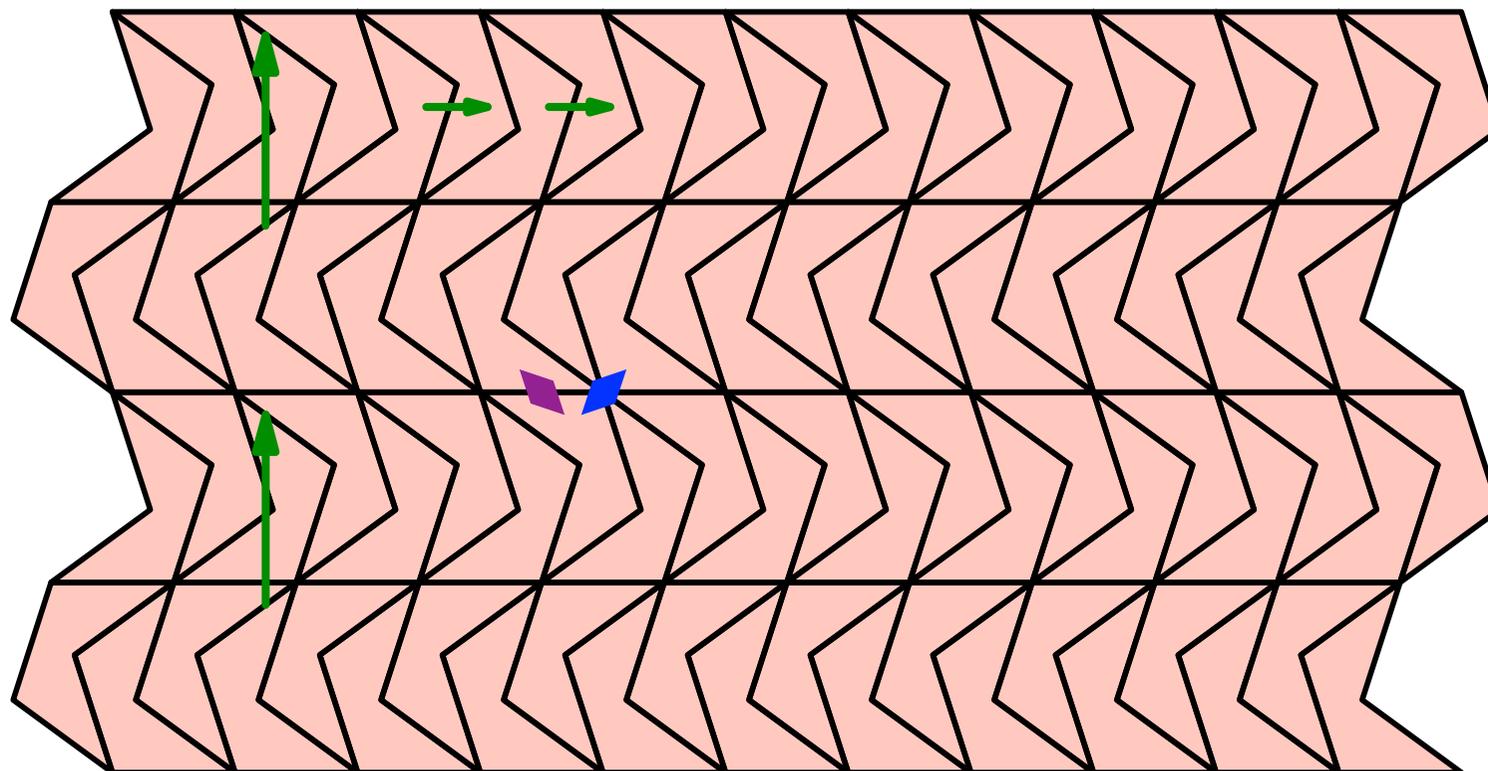


Plane symmetry group pattern



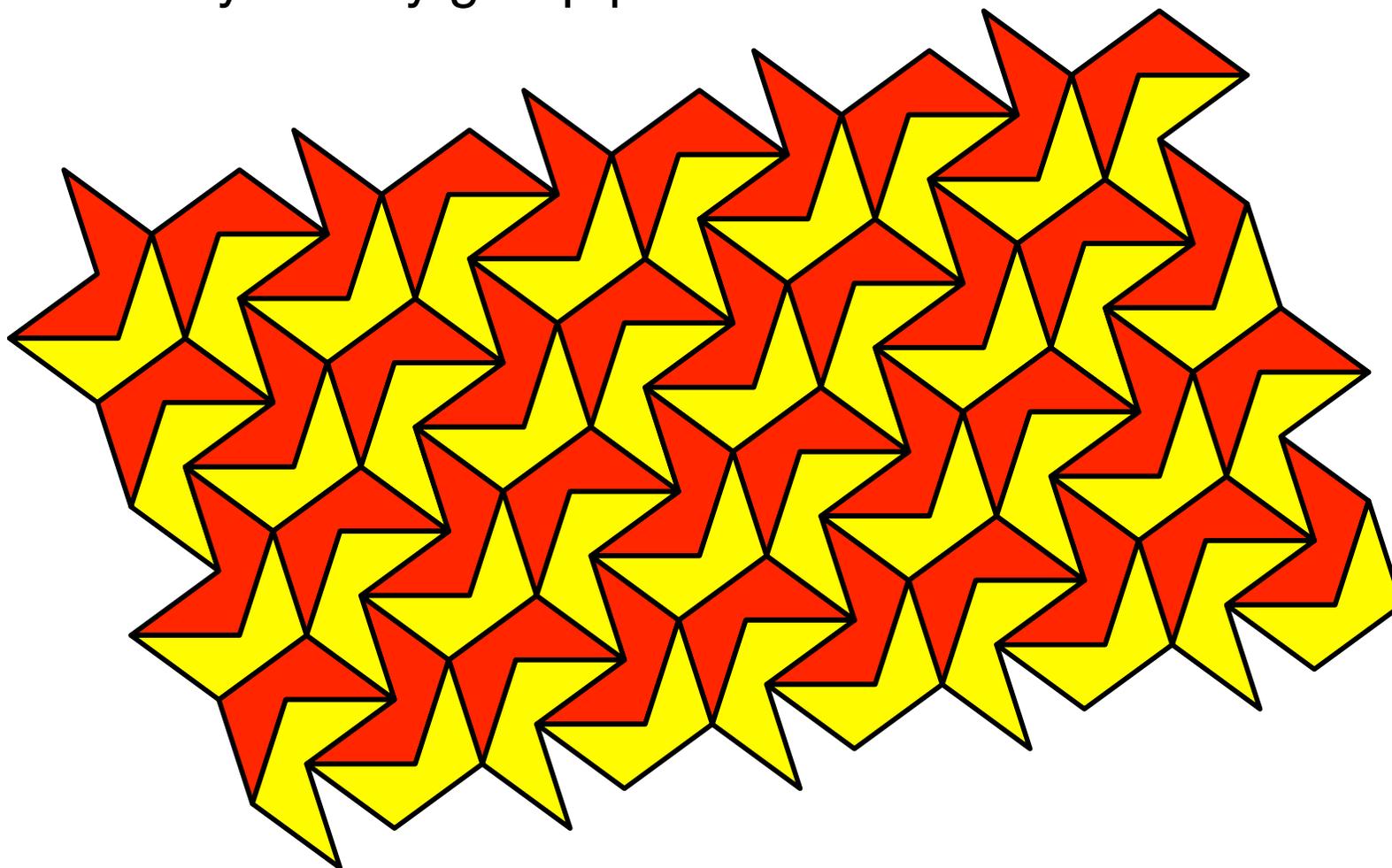
Translations and glide reflections (p4)

Plane symmetry group pattern



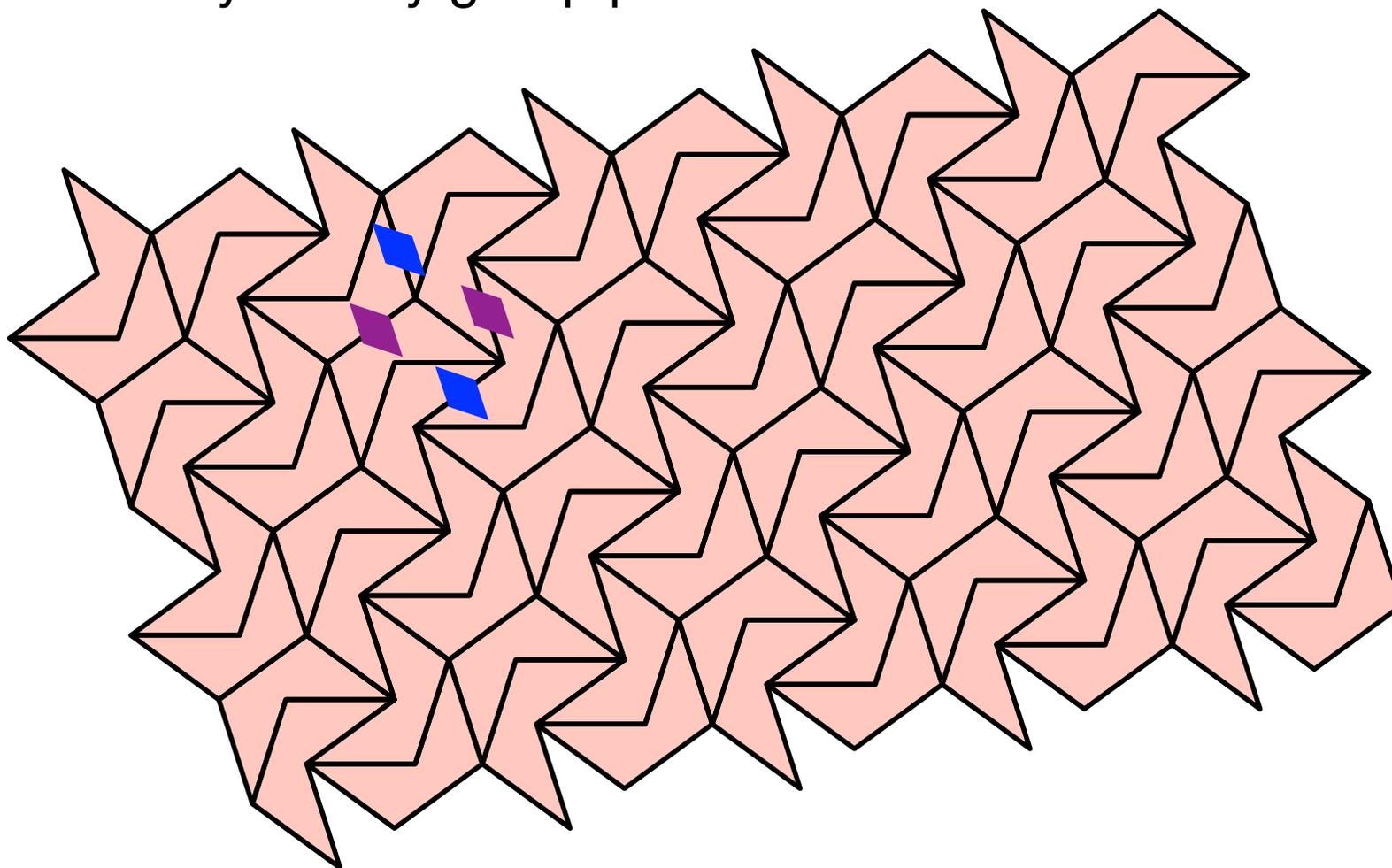
Translations and glide reflections, more glide reflections and two-fold rotational symmetry (pgg)

Plane symmetry group pattern



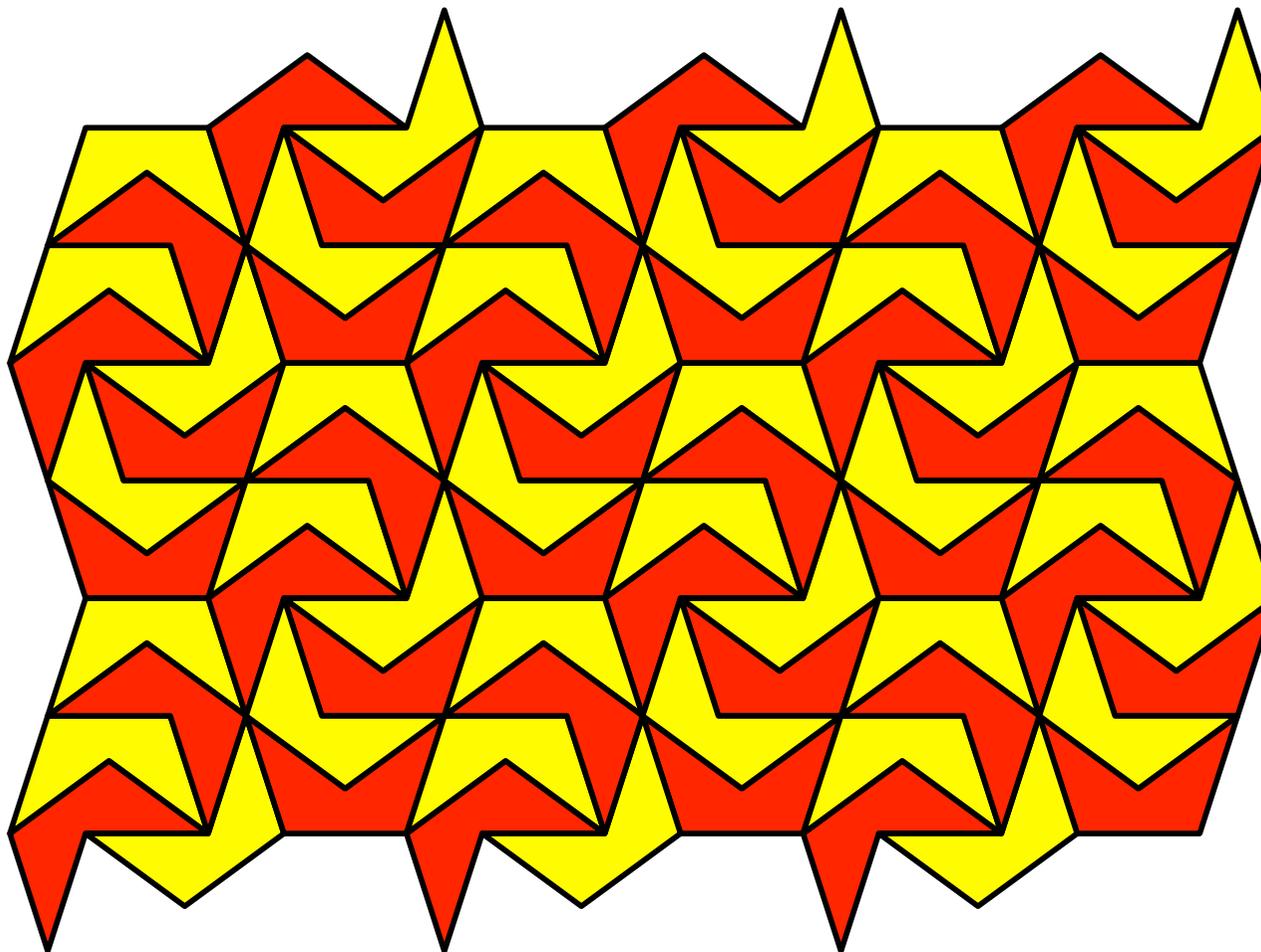
Translations only (p1)

Plane symmetry group pattern



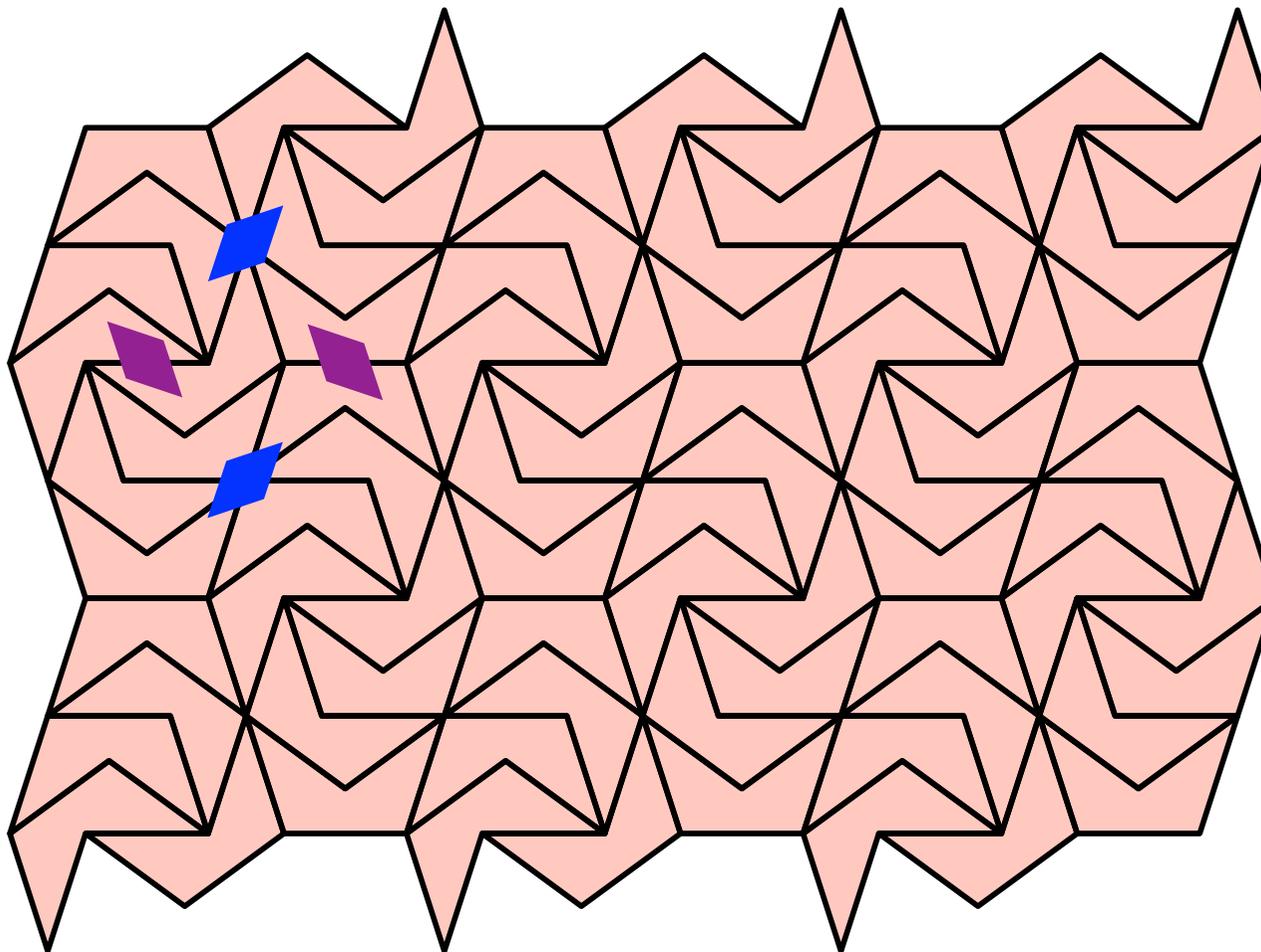
Translations and **twofold rotational symmetry** (p2)

Plane symmetry group pattern



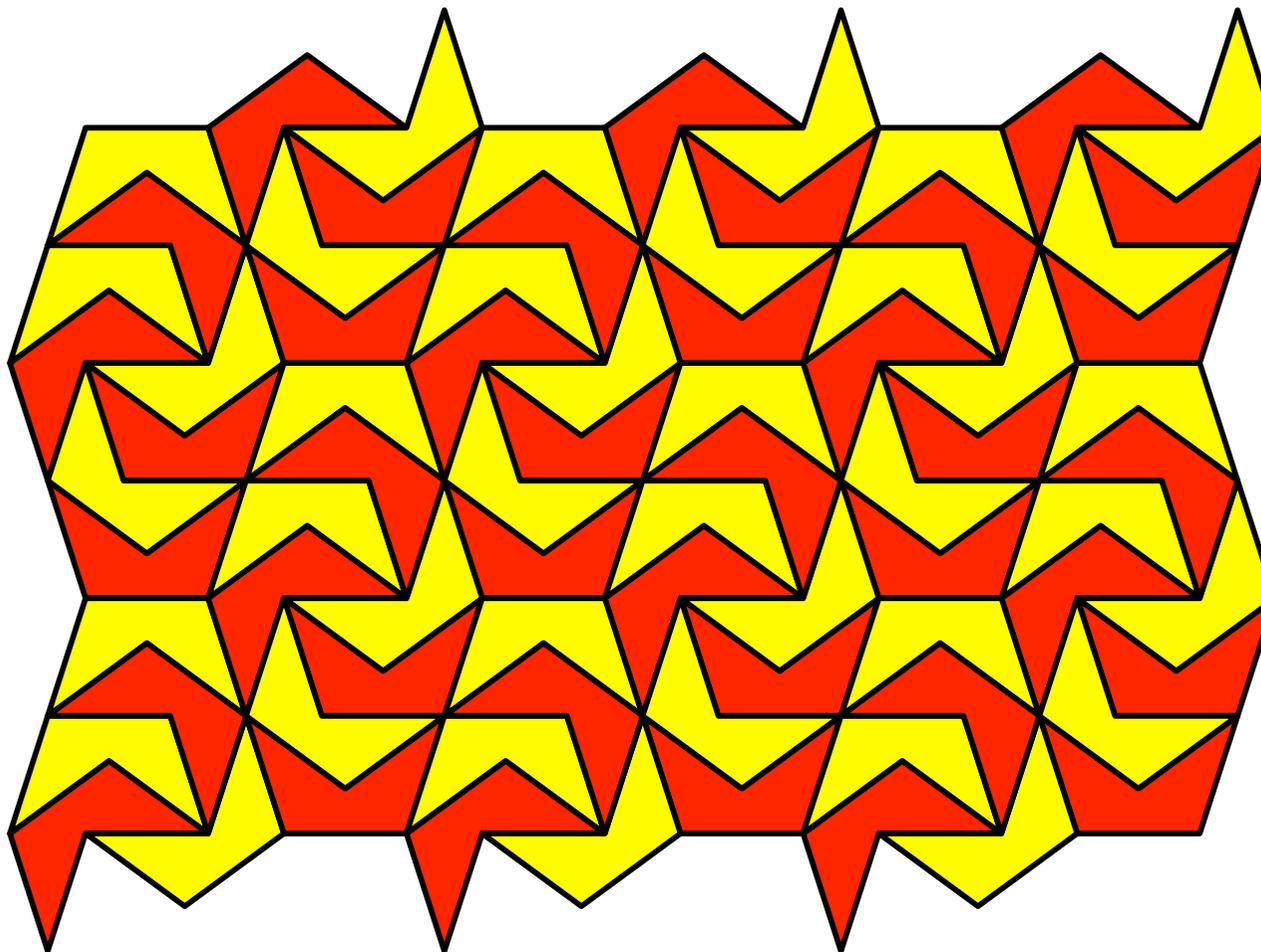
Translations only (p1)

Plane symmetry group pattern



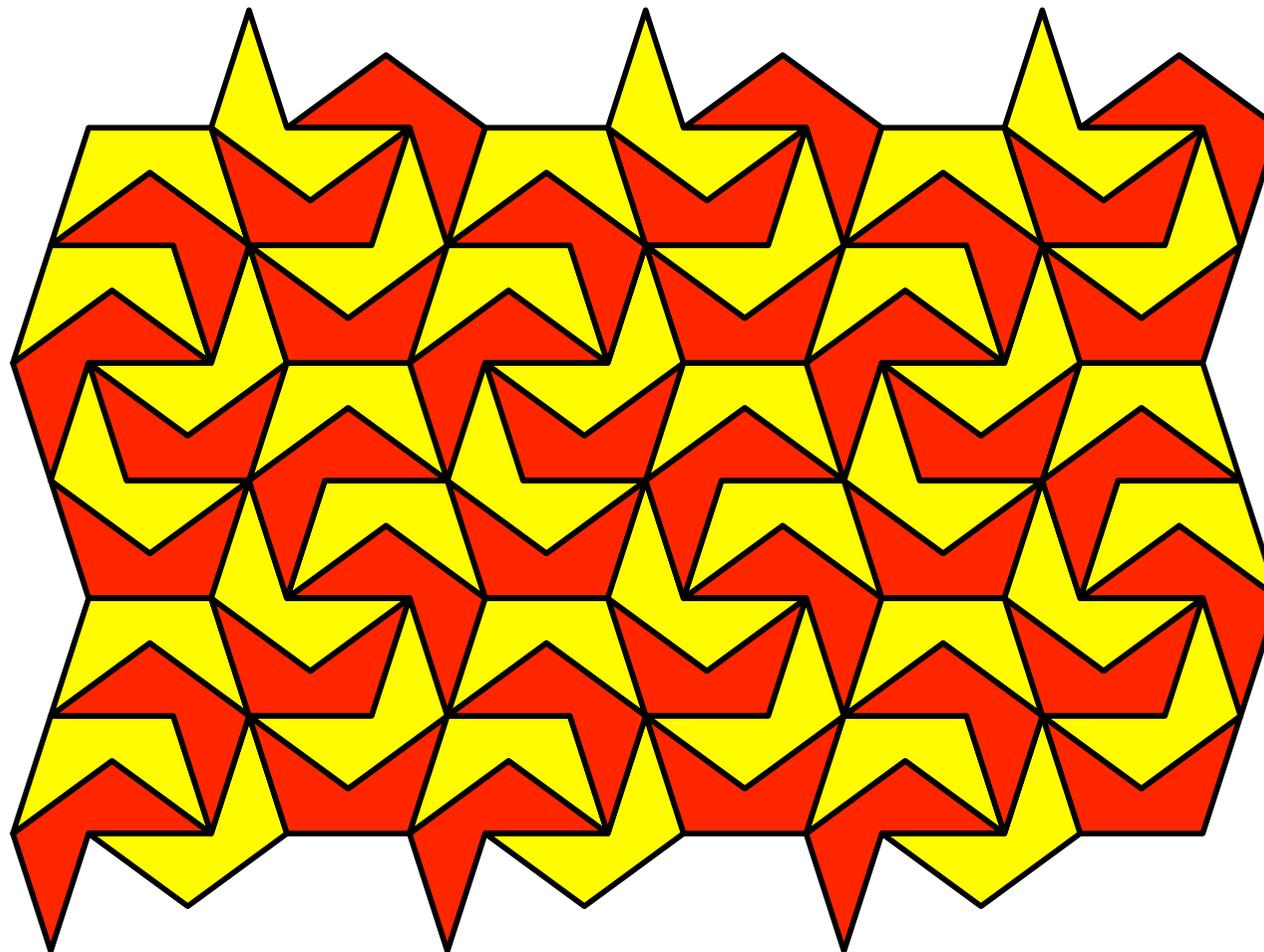
Translations and **twofold rotational symmetry** (p2)

Plane symmetry group pattern

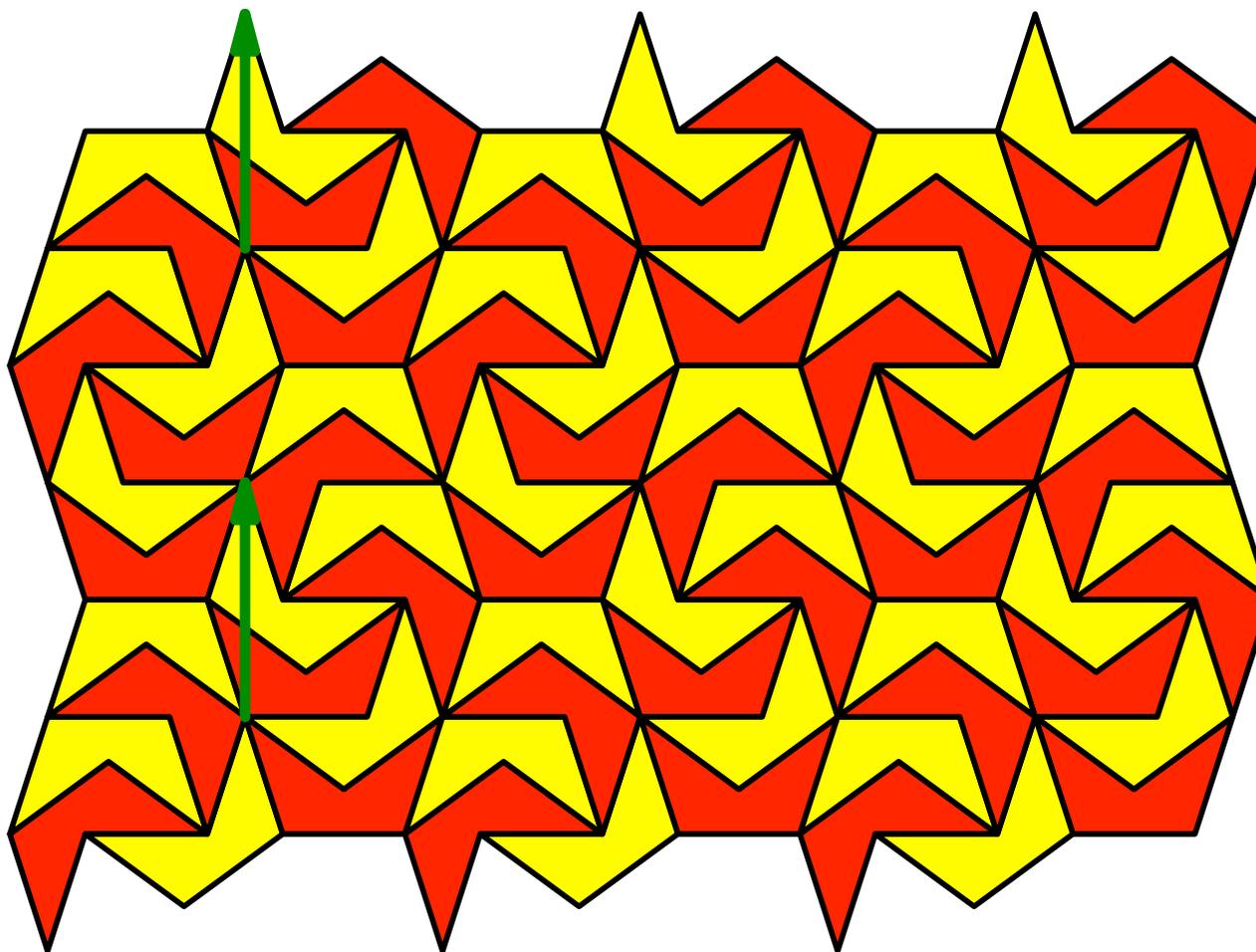


Translations only (p1)

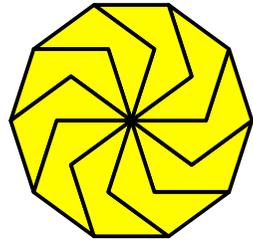
Plane symmetry group pattern

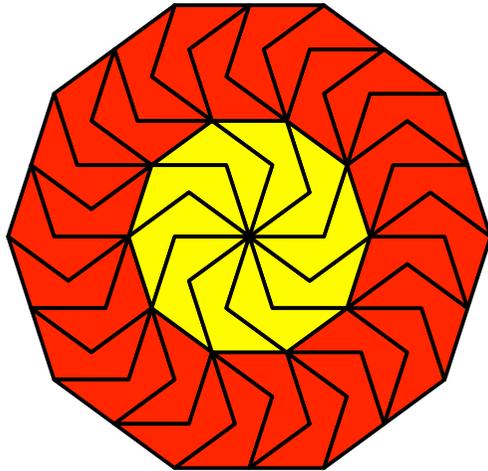


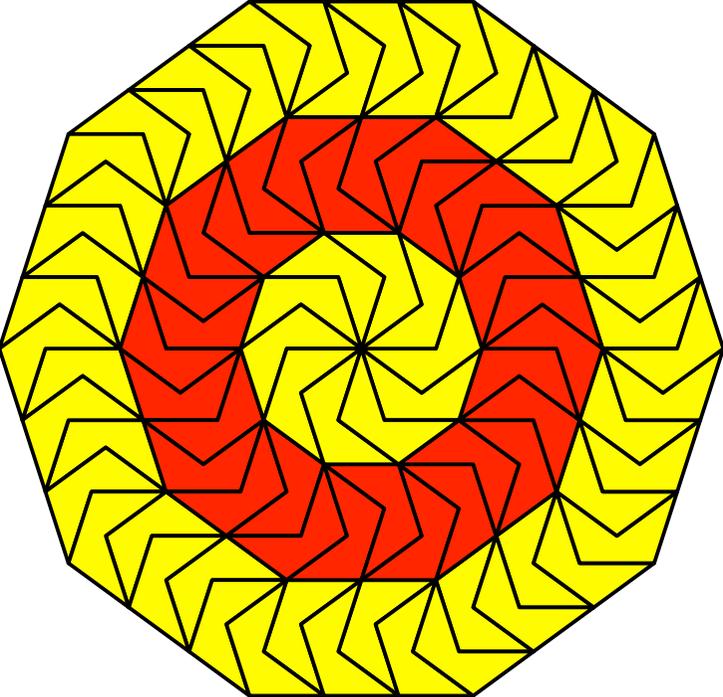
Plane symmetry group pattern



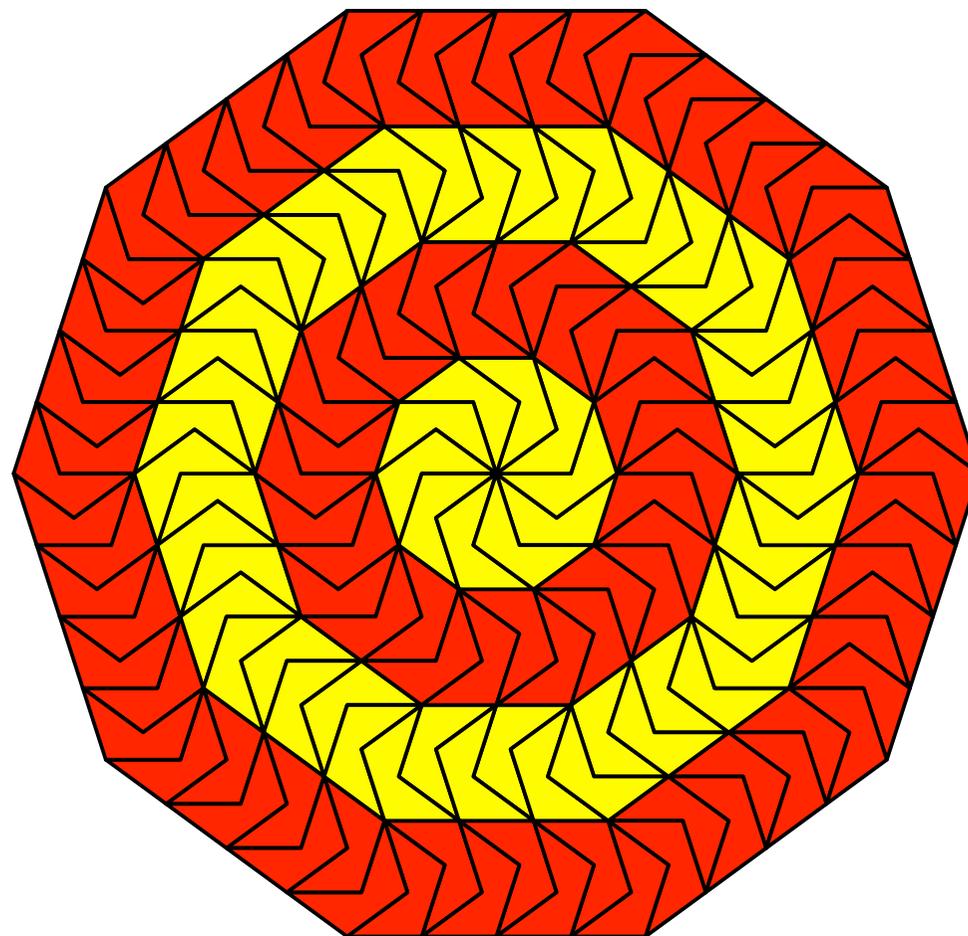
Translations and glide reflections





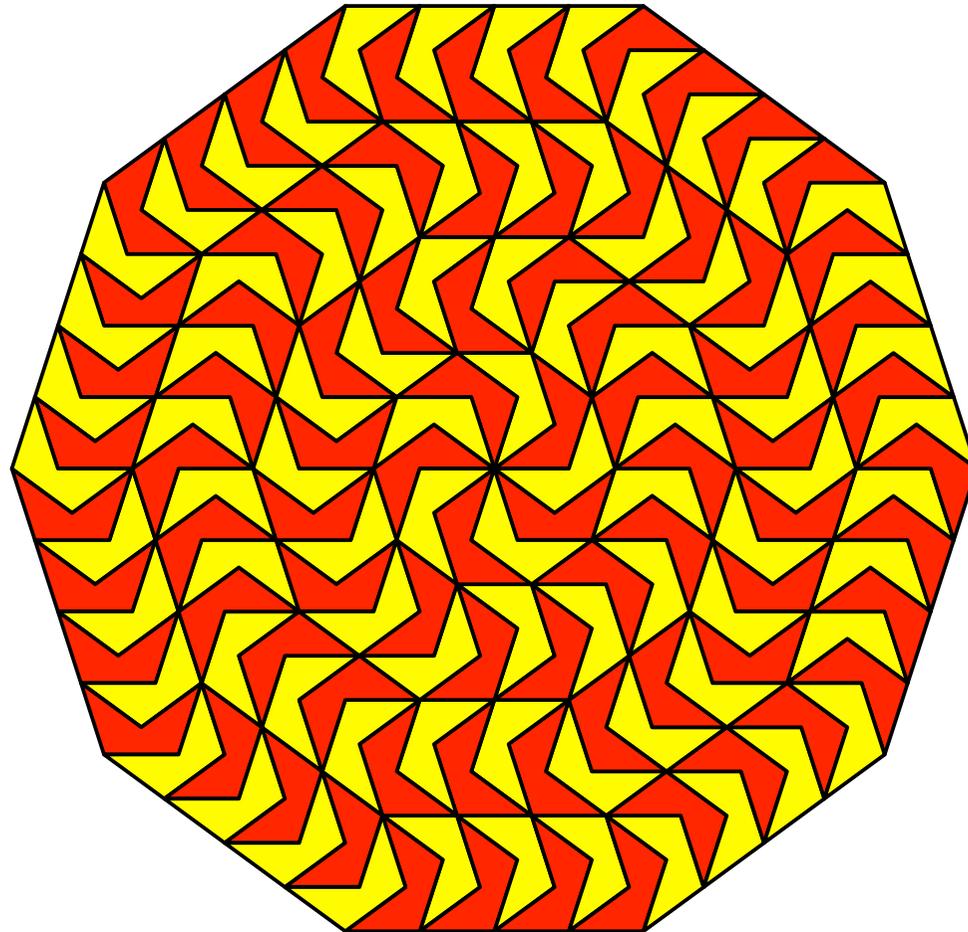


No plane symmetry group pattern



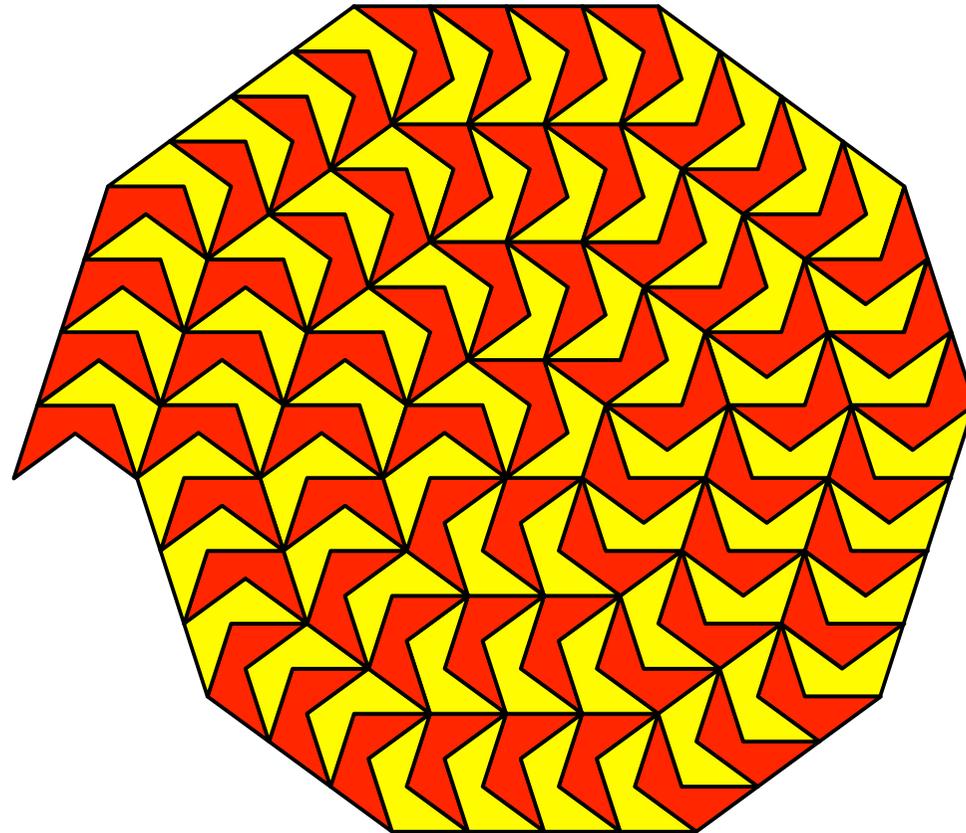
No Translations. But tenfold rotational symmetry

No plane symmetry group pattern

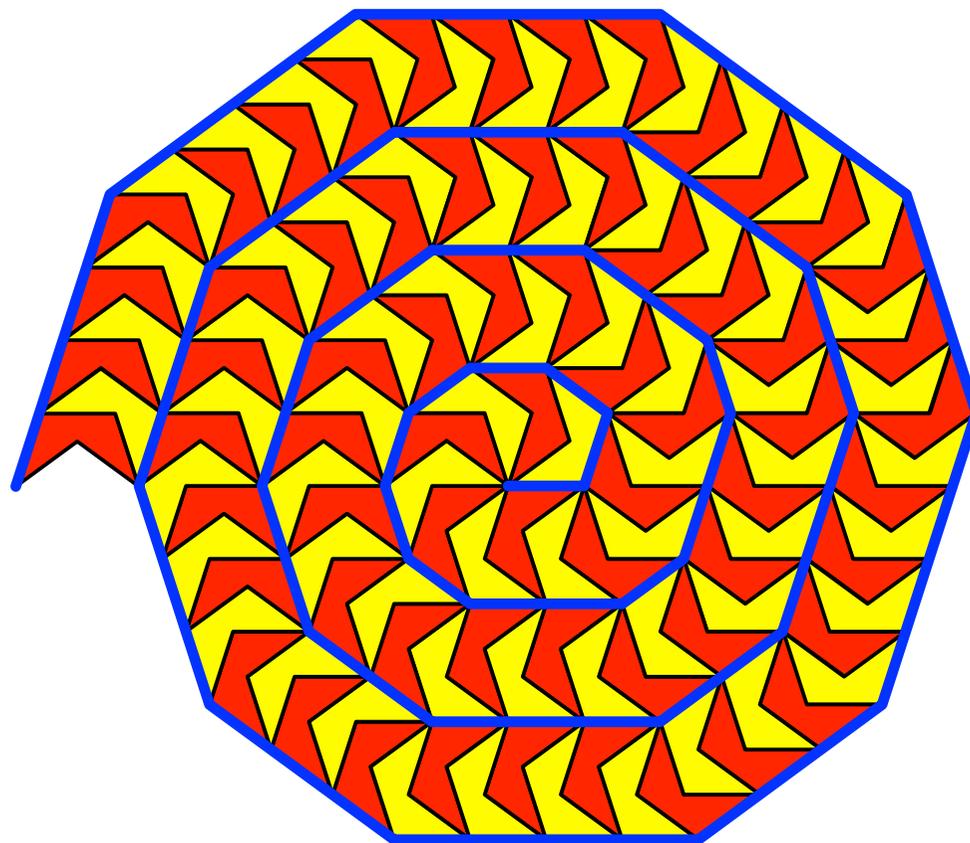


Fivefold rotational symmetry

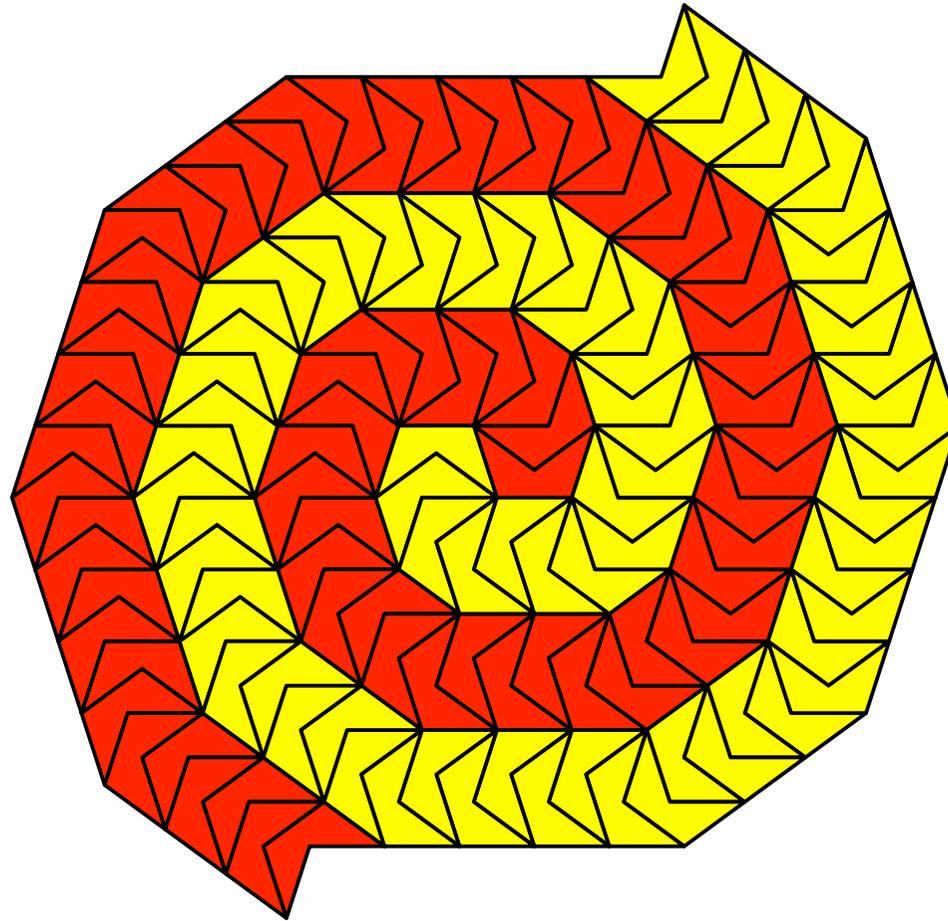
Pattern?



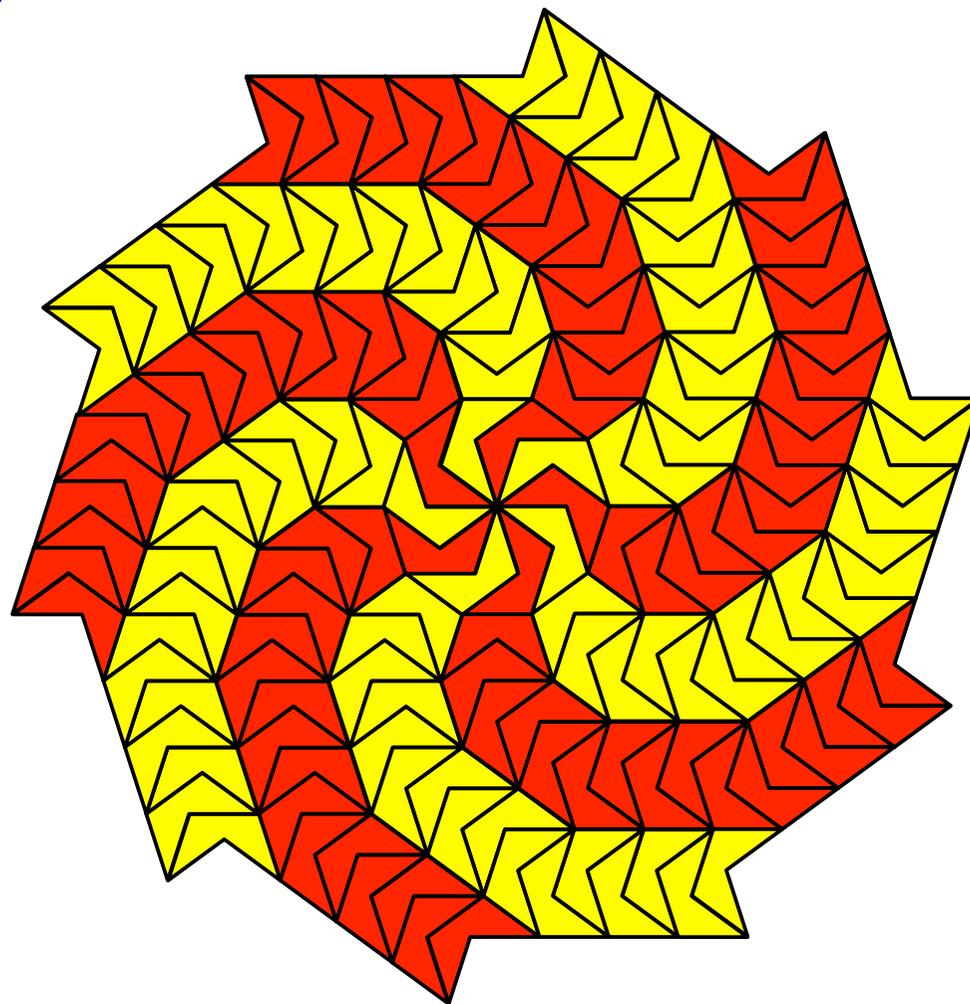
Archimedean spiral



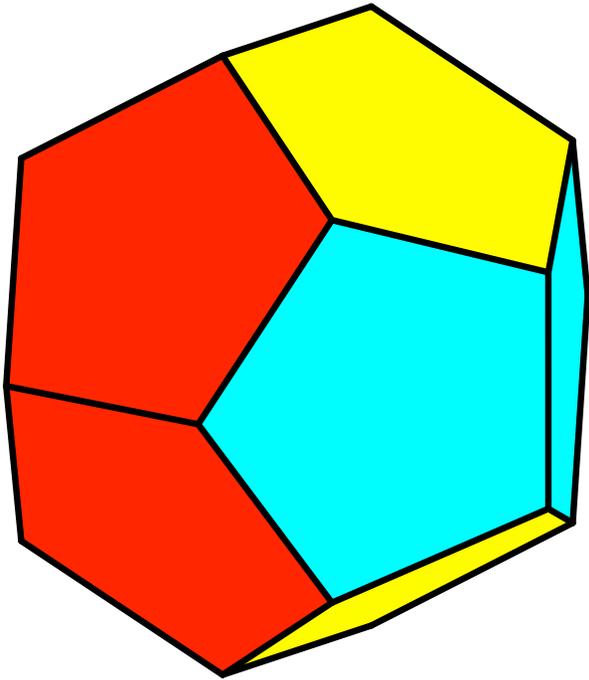
Double spiral



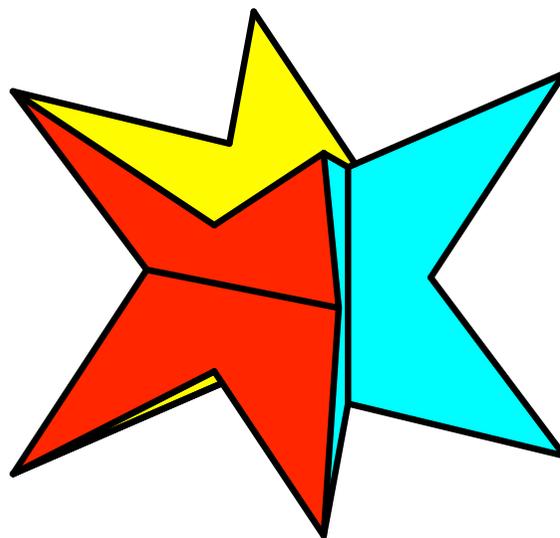
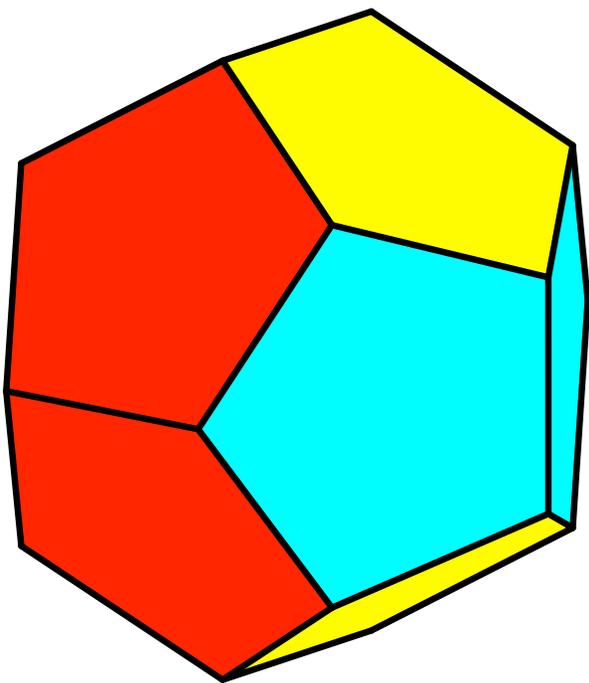
10 spirals



Dodecahedron

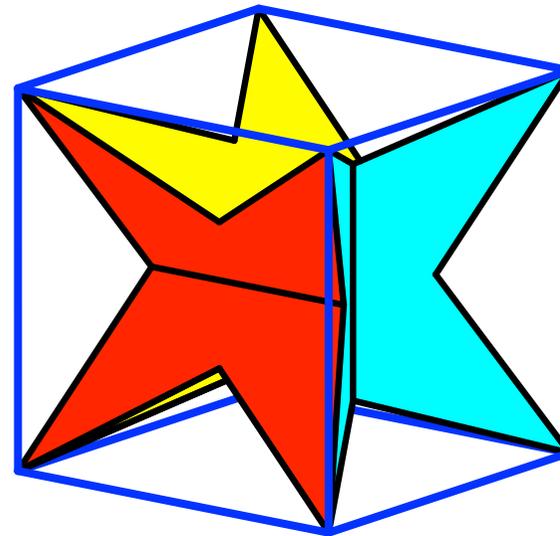
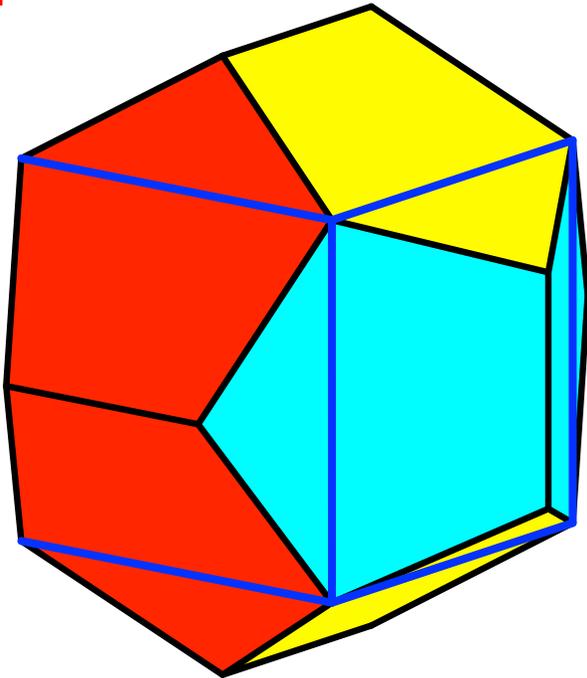


Dodecahedron and semi-regular dodecahedron



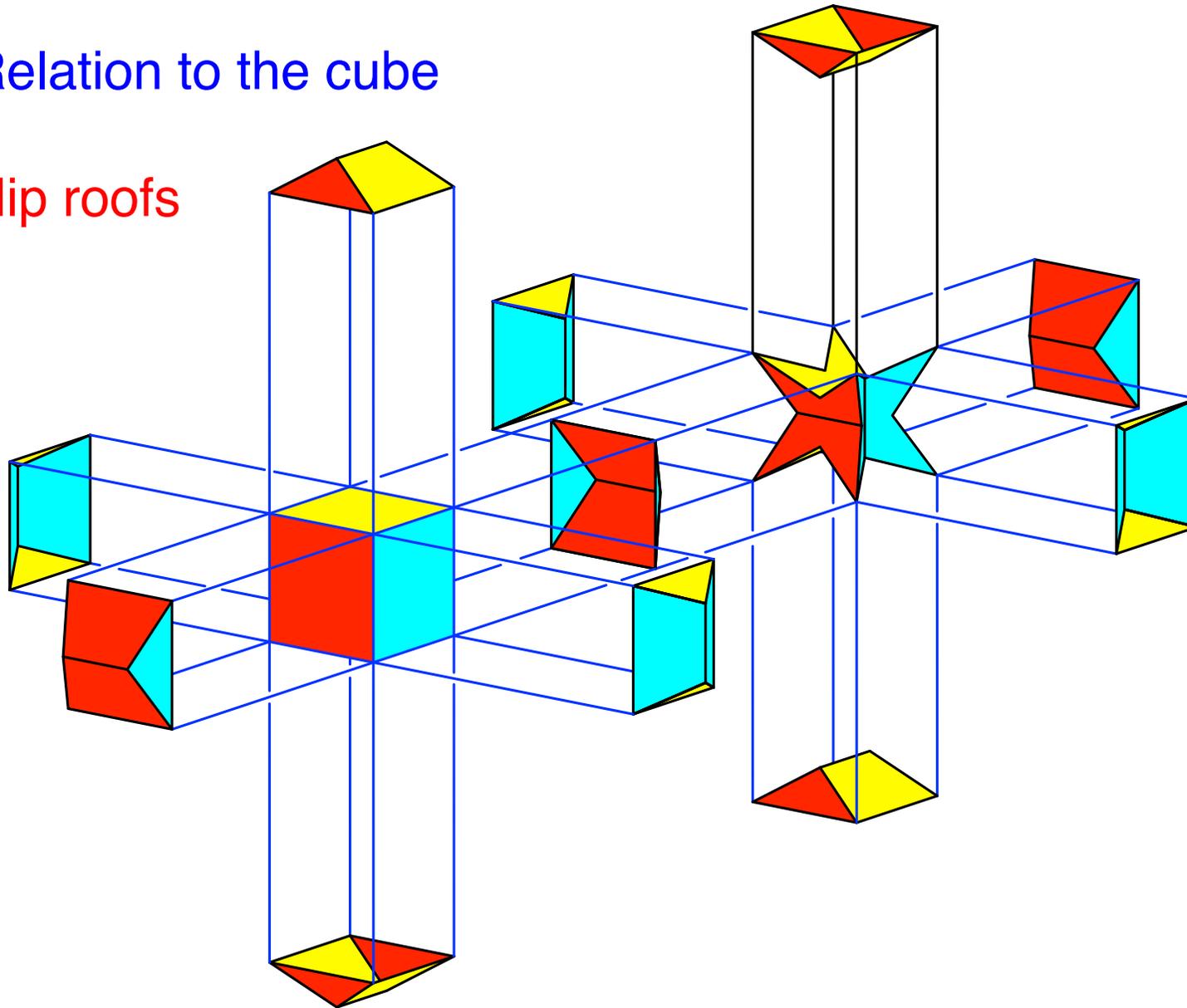
Relation to the cube

Hip roofs



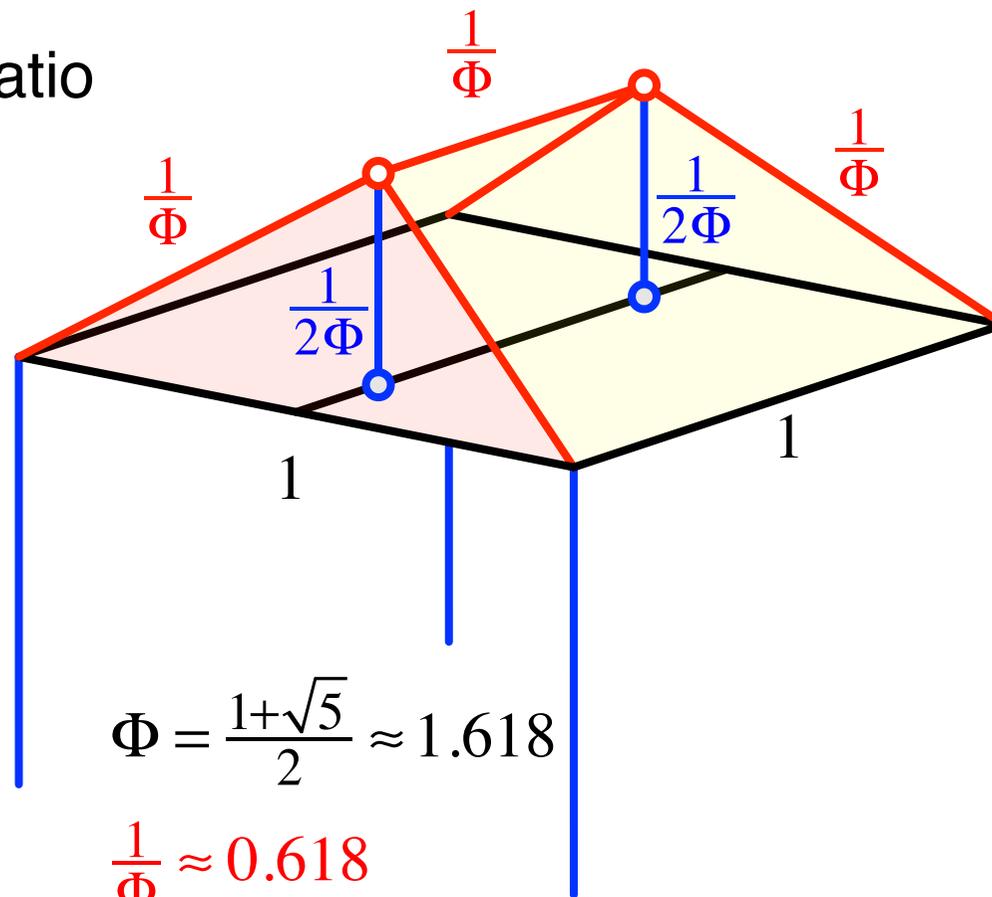
Relation to the cube

Hip roofs



Geometry of the hip roof

Golden ratio



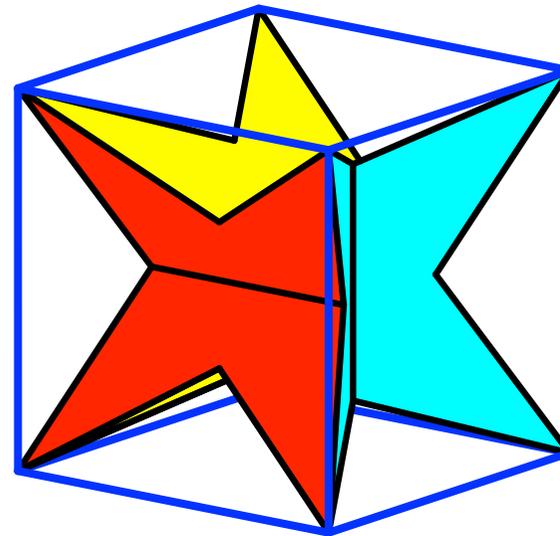
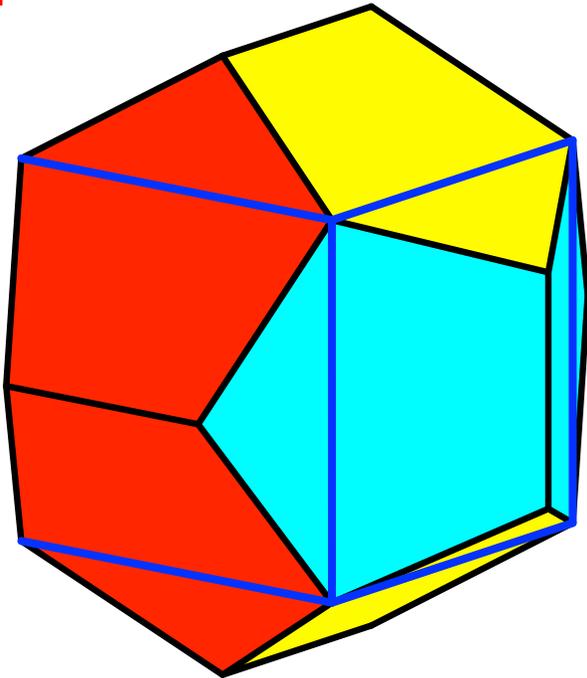
$$\Phi = \frac{1+\sqrt{5}}{2} \approx 1.618$$

$$\frac{1}{\Phi} \approx 0.618$$

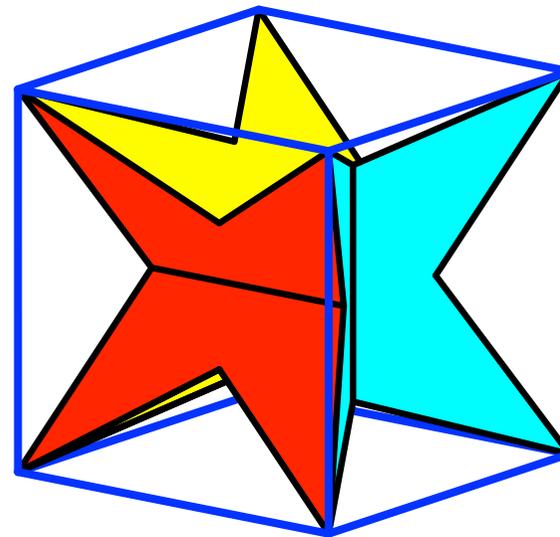
$$\frac{1}{2\Phi} \approx 0.309$$

Relation to the cube

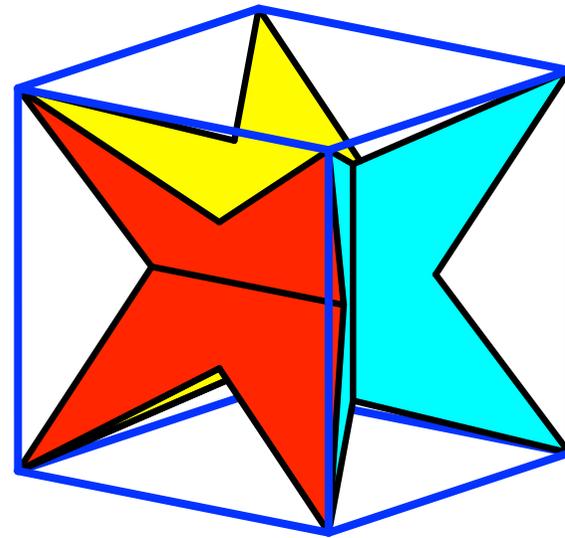
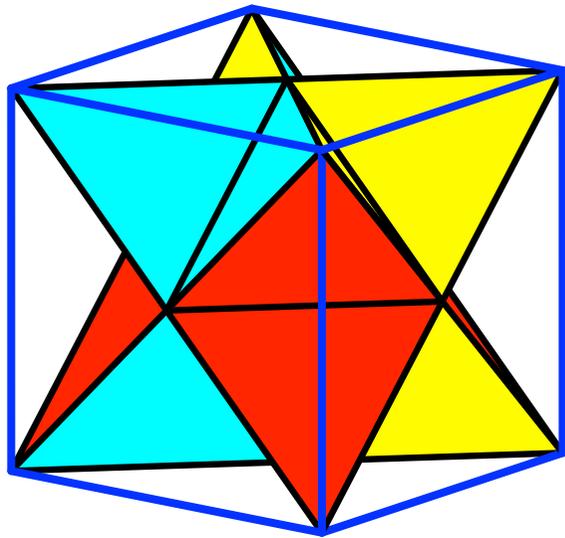
Hip roofs



Relation to the cube

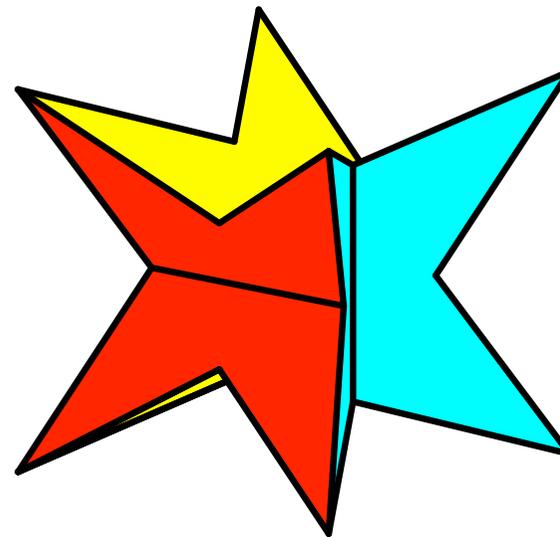
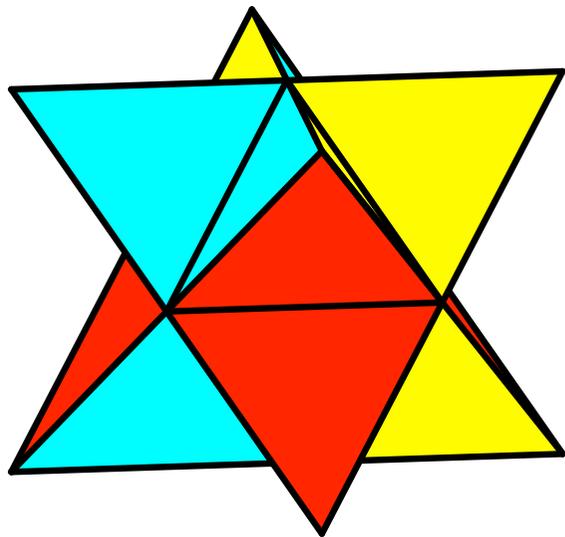


Stella octangula and semi-regular dodecahedron



Johannes Kepler (1571-1630)

Stella octangula and semi-regular dodecahedron



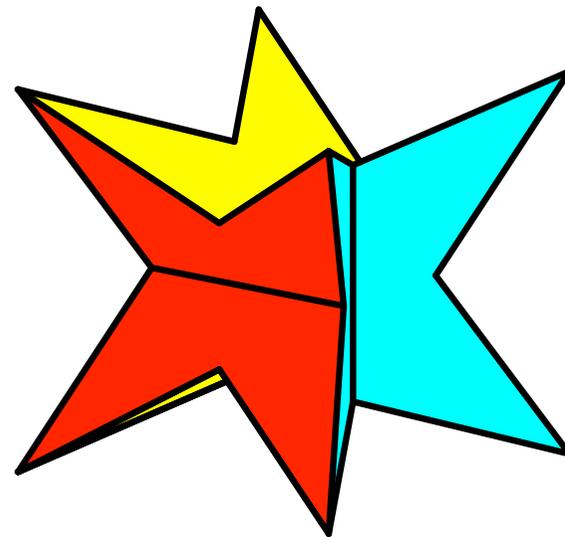
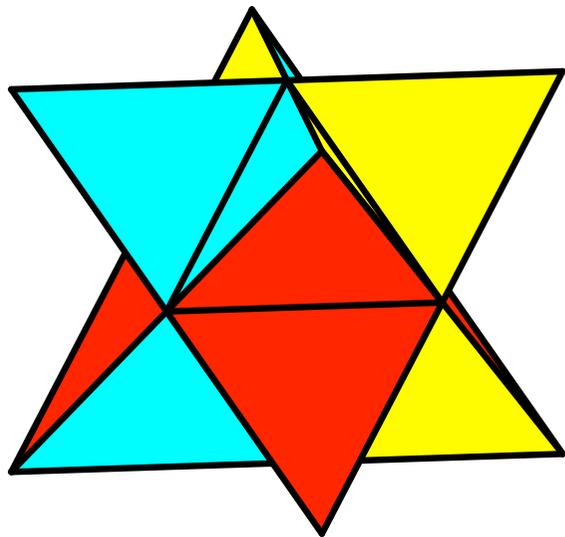
Johannes Kepler (1571-1630)

Stella octangula



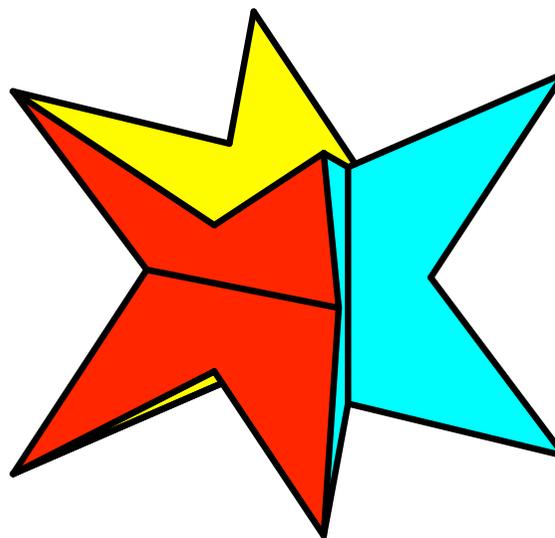
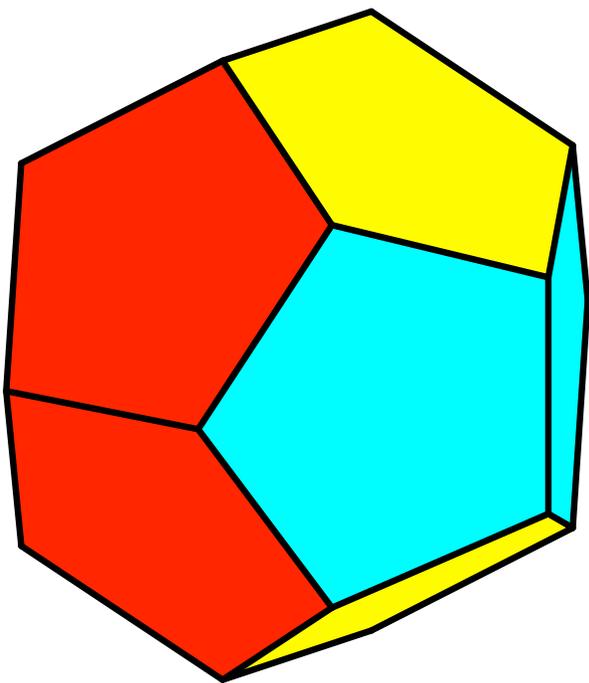
Johannes Kepler (1571-1630)

Stella octangula and semi-regular dodecahedron

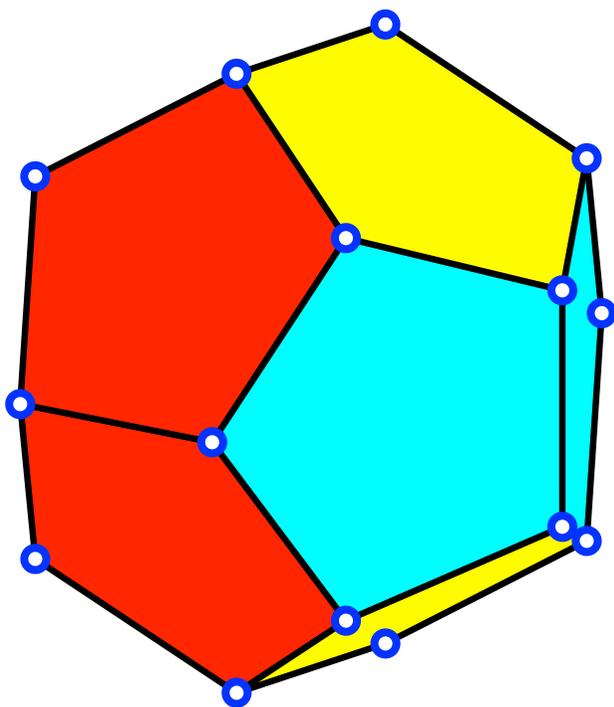


Johannes Kepler (1571-1630)

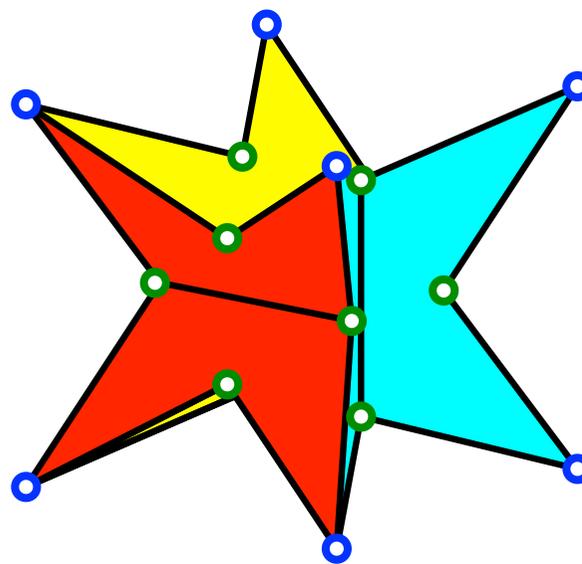
Dodecahedron and semi-regular dodecahedron



Dodecahedron and semi-regular dodecahedron



20 vertices

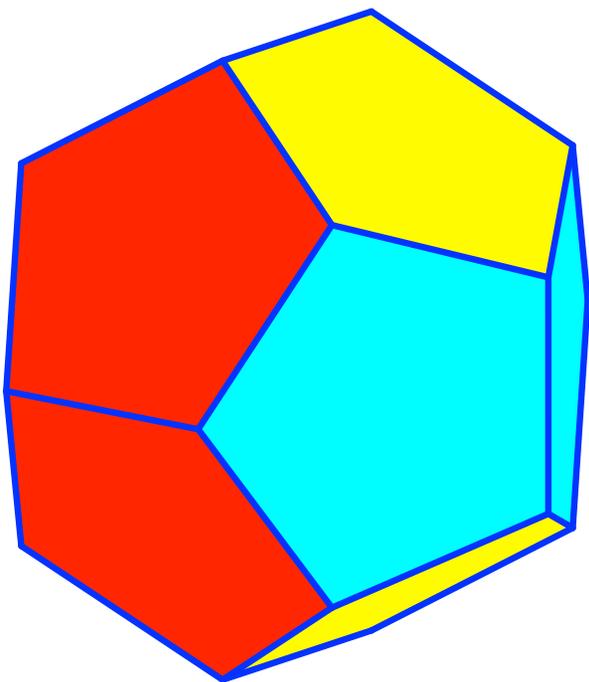


8 + 12 = 20 vertices

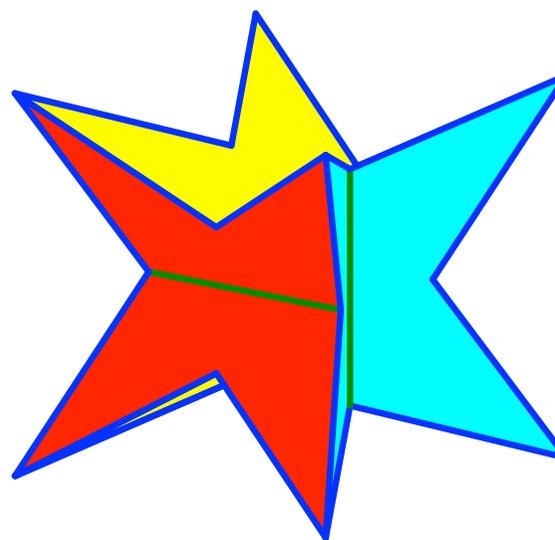
convex

hyperbolic

Dodecahedron and semi-regular dodecahedron



20 vertices
30 edges

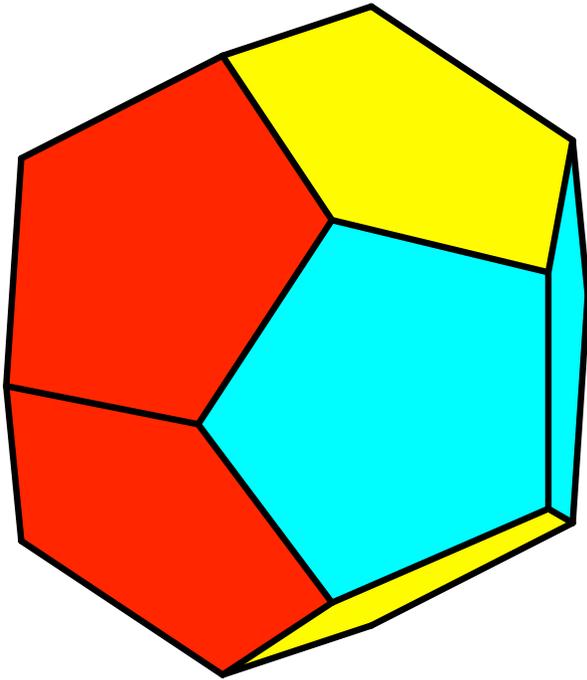


$8 + 12 = 20$ vertices
 $24 + 6 = 30$ edges

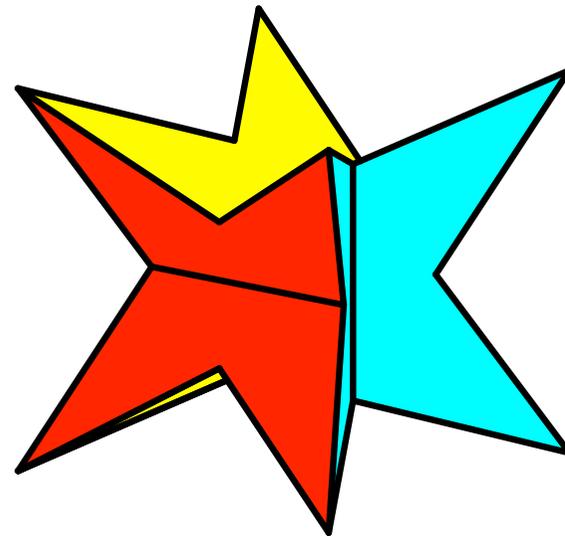
convex

valleys

Dodecahedron and semi-regular dodecahedron



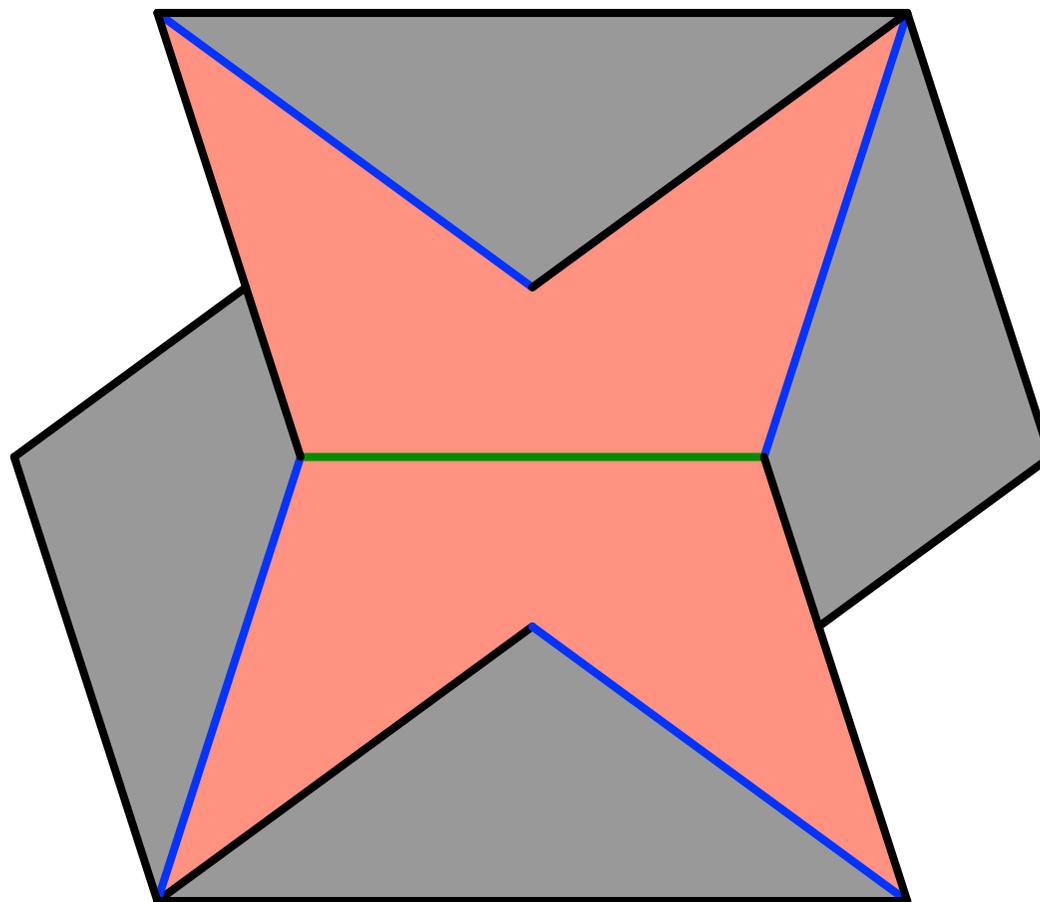
20 vertices
30 edges
12 faces (regular pentagons)



$8 + 12 = 20$ vertices
 $24 + 6 = 30$ edges
12 faces (semiregular)



Pattern for double face



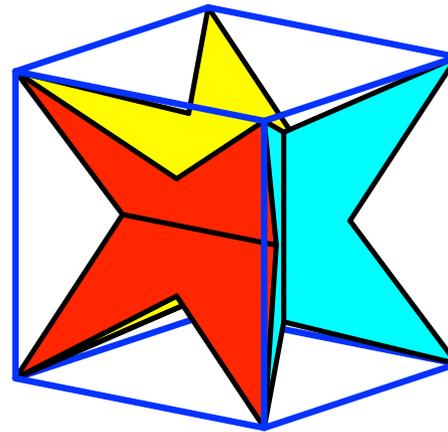
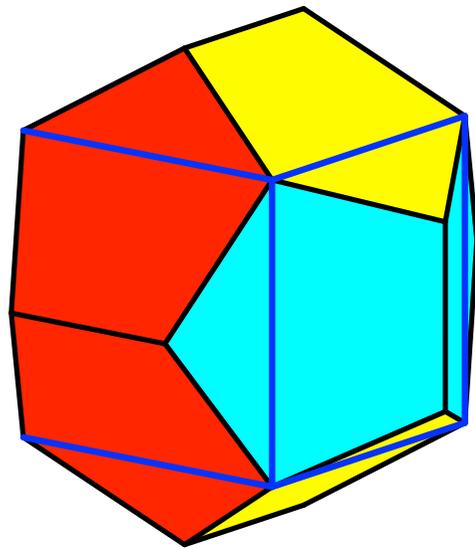
Black: cut

Gray: Lashes to tuck in

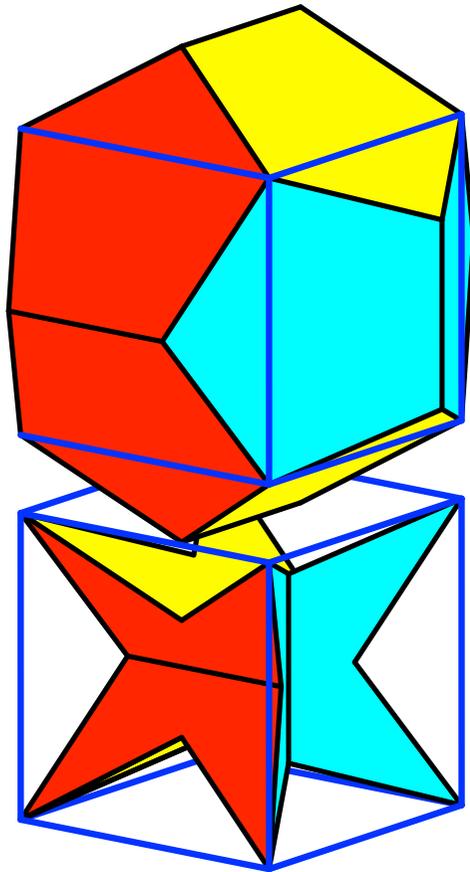
Blue: Mountain fold

Green: Valley fold

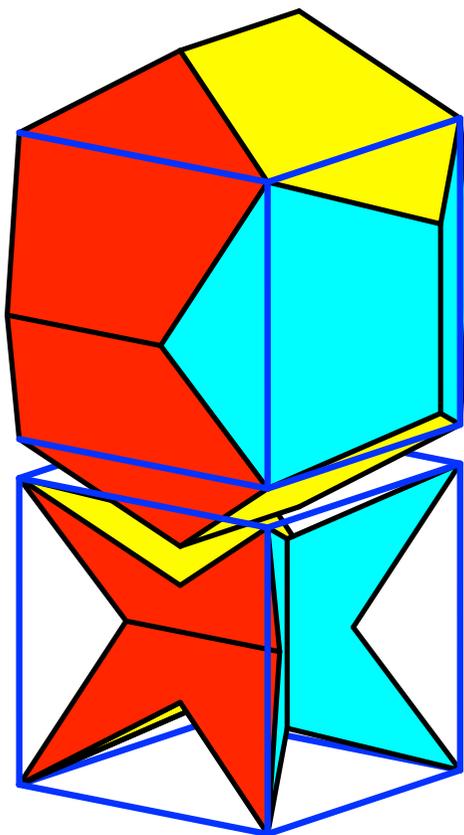
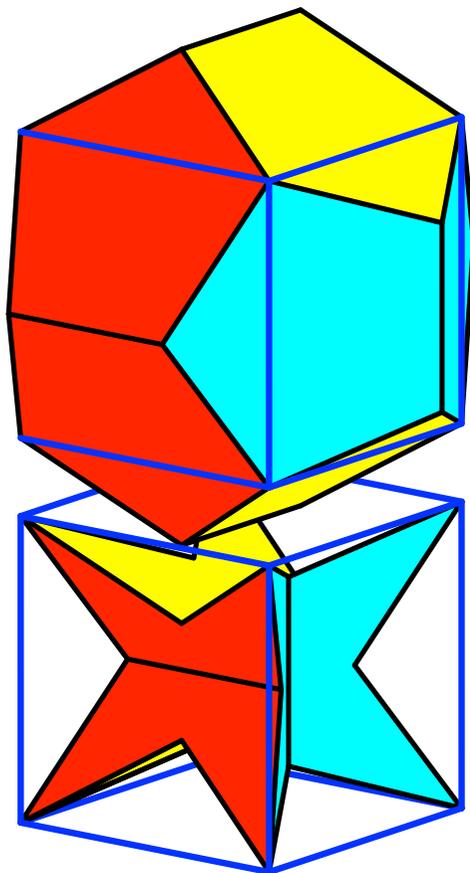
Relation to the cube



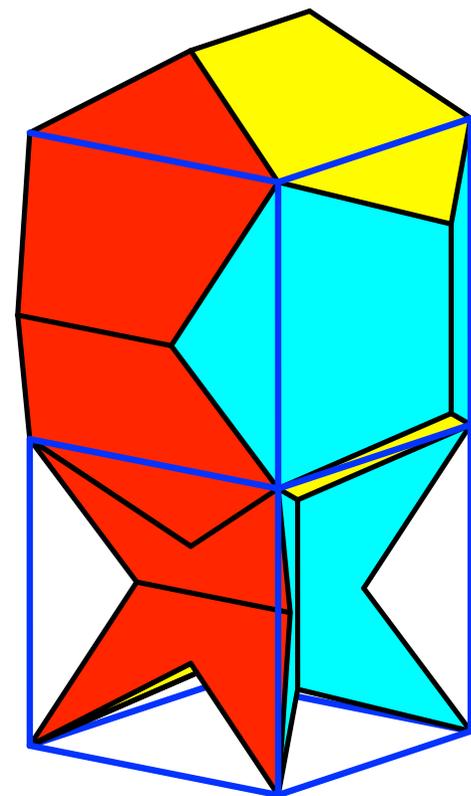
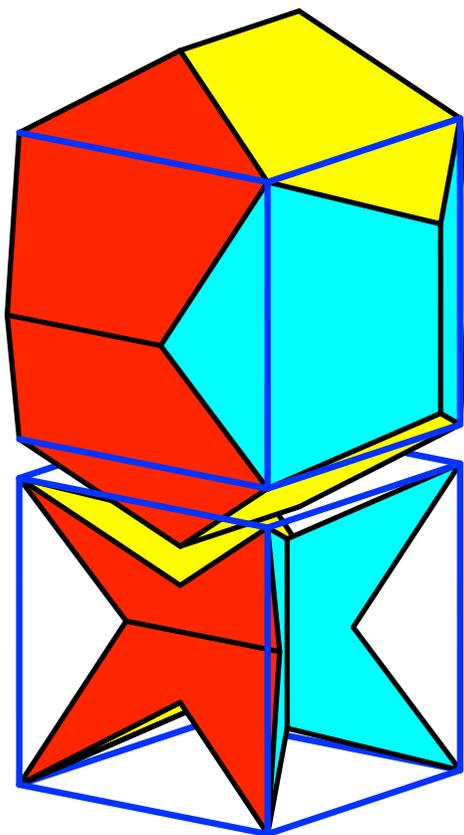
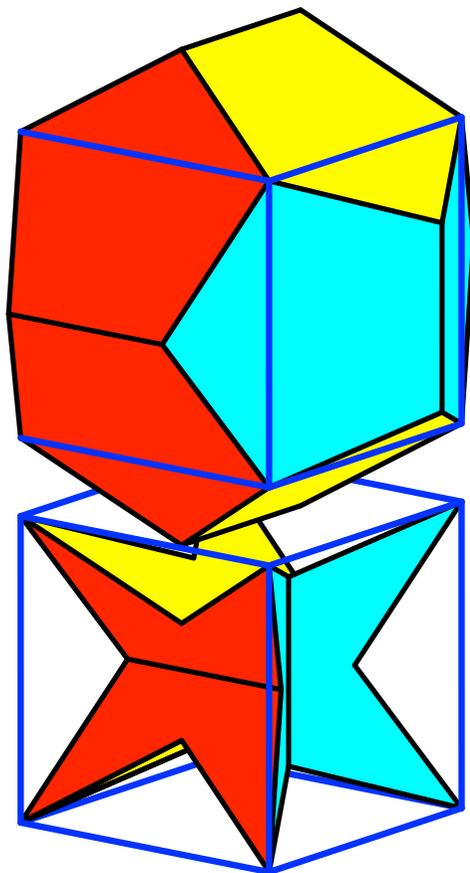
Relation to the cube



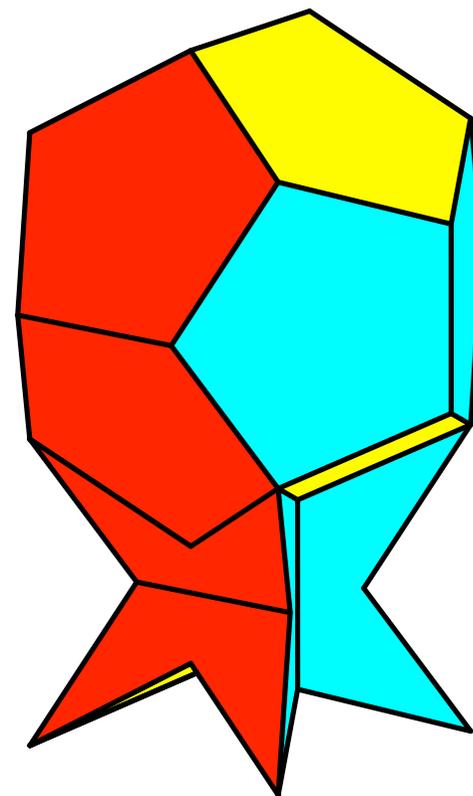
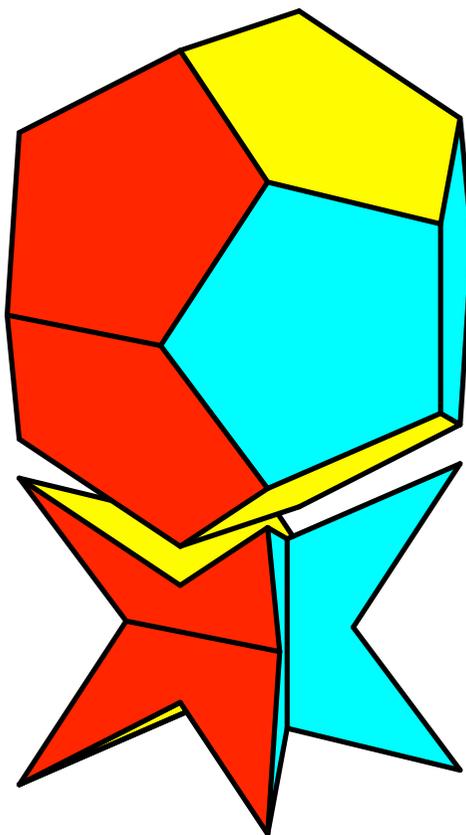
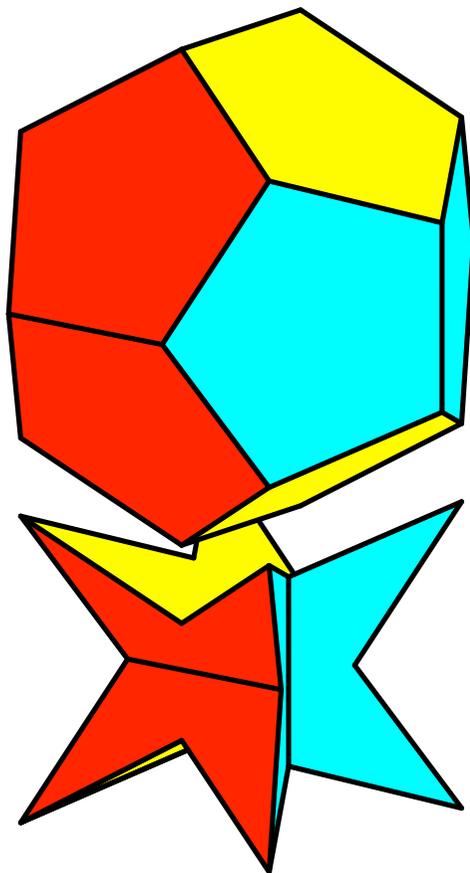
Relation to the cube



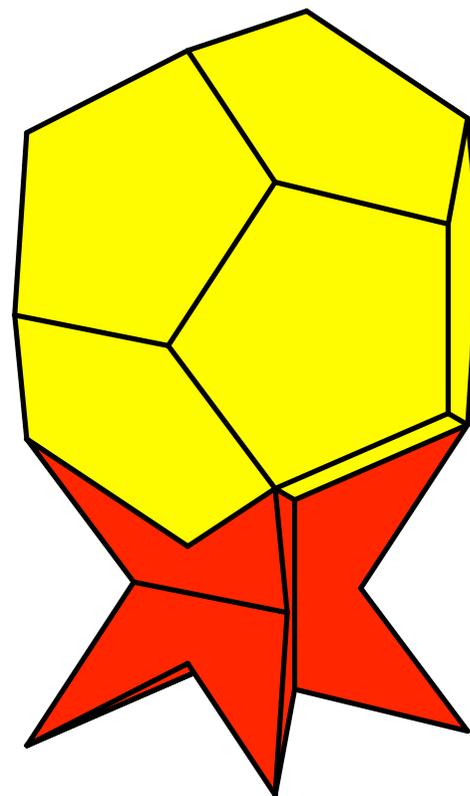
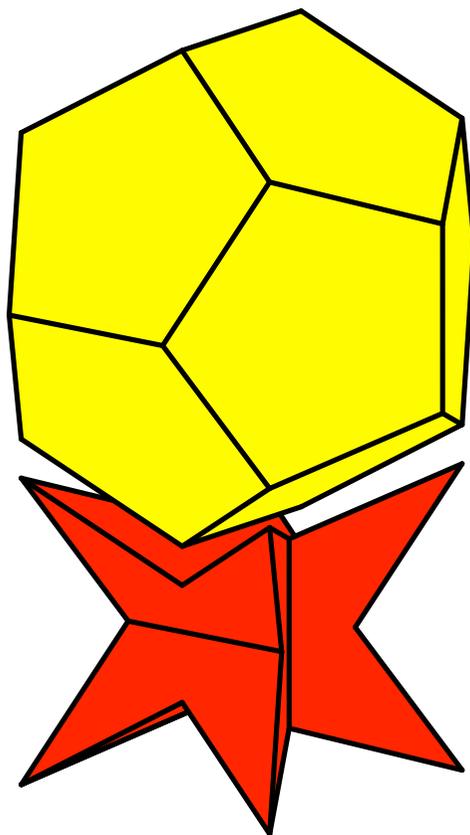
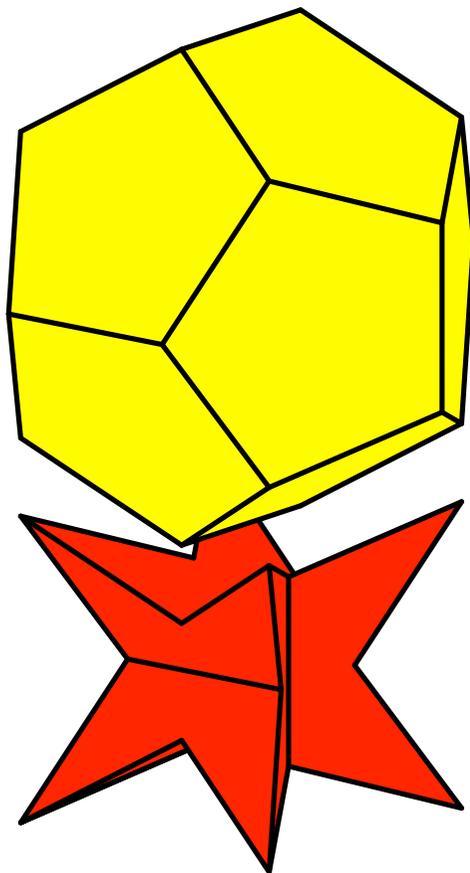
Relation to the cube

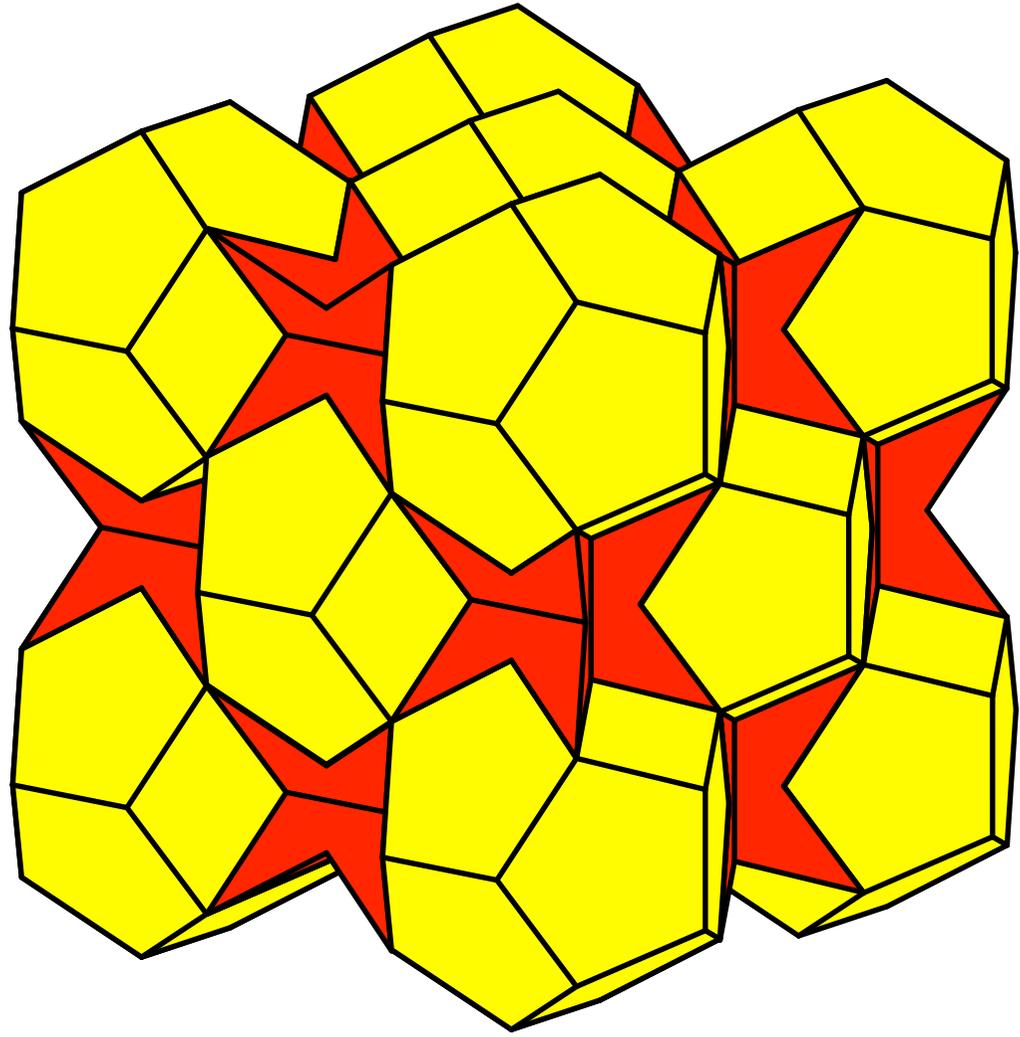


Relation to the cube

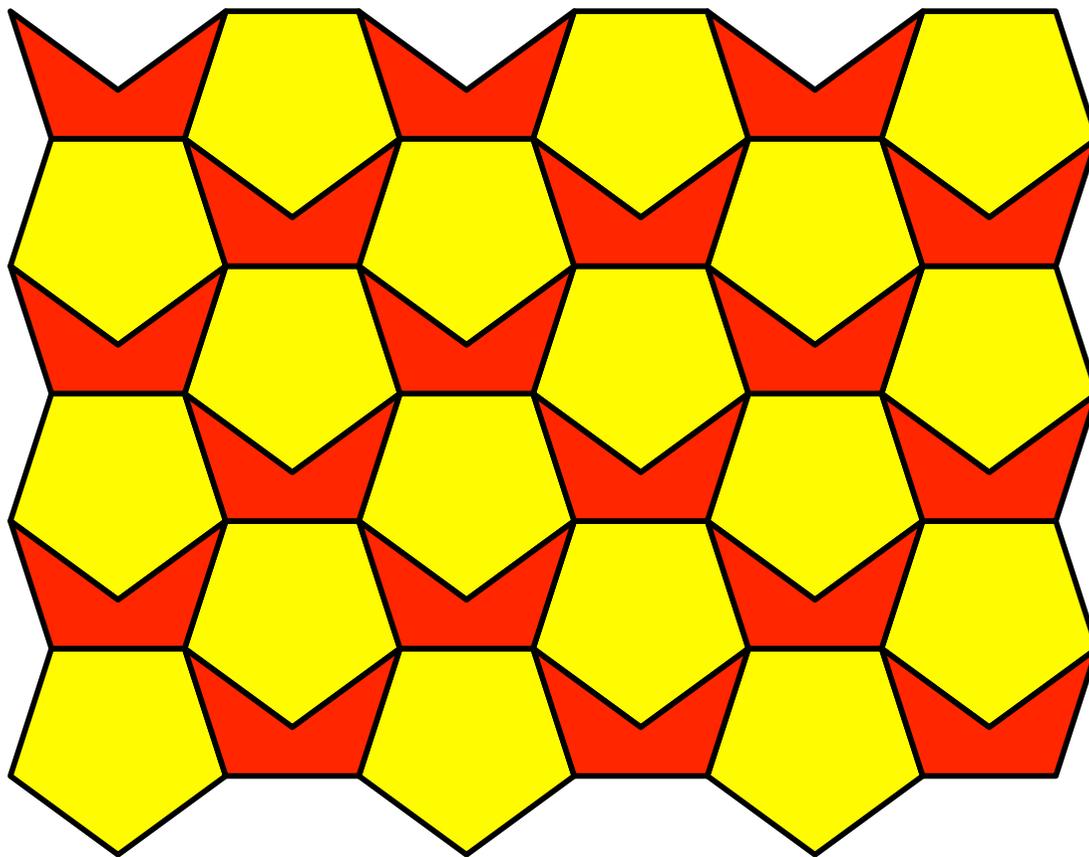


Egg cup

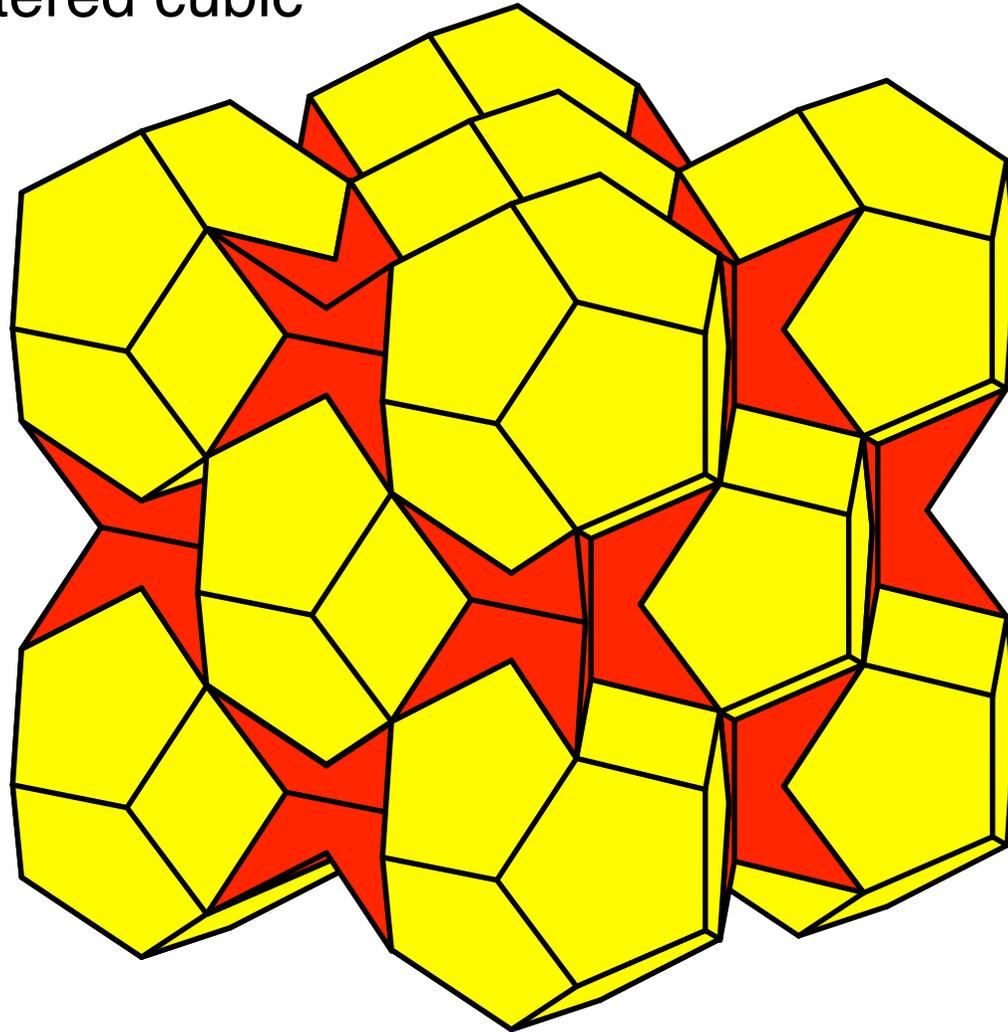




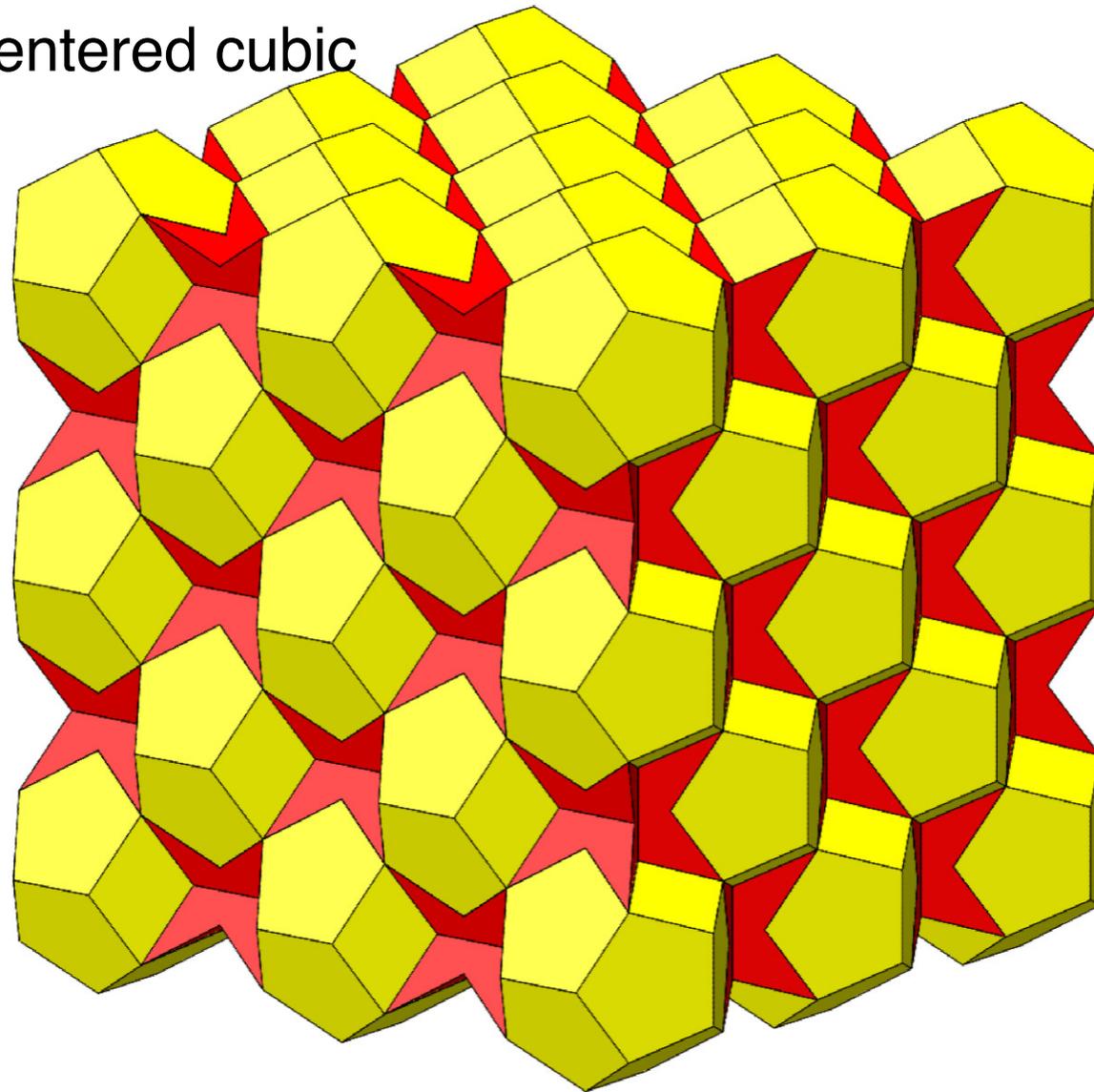
Regular and semi-regular pentagons

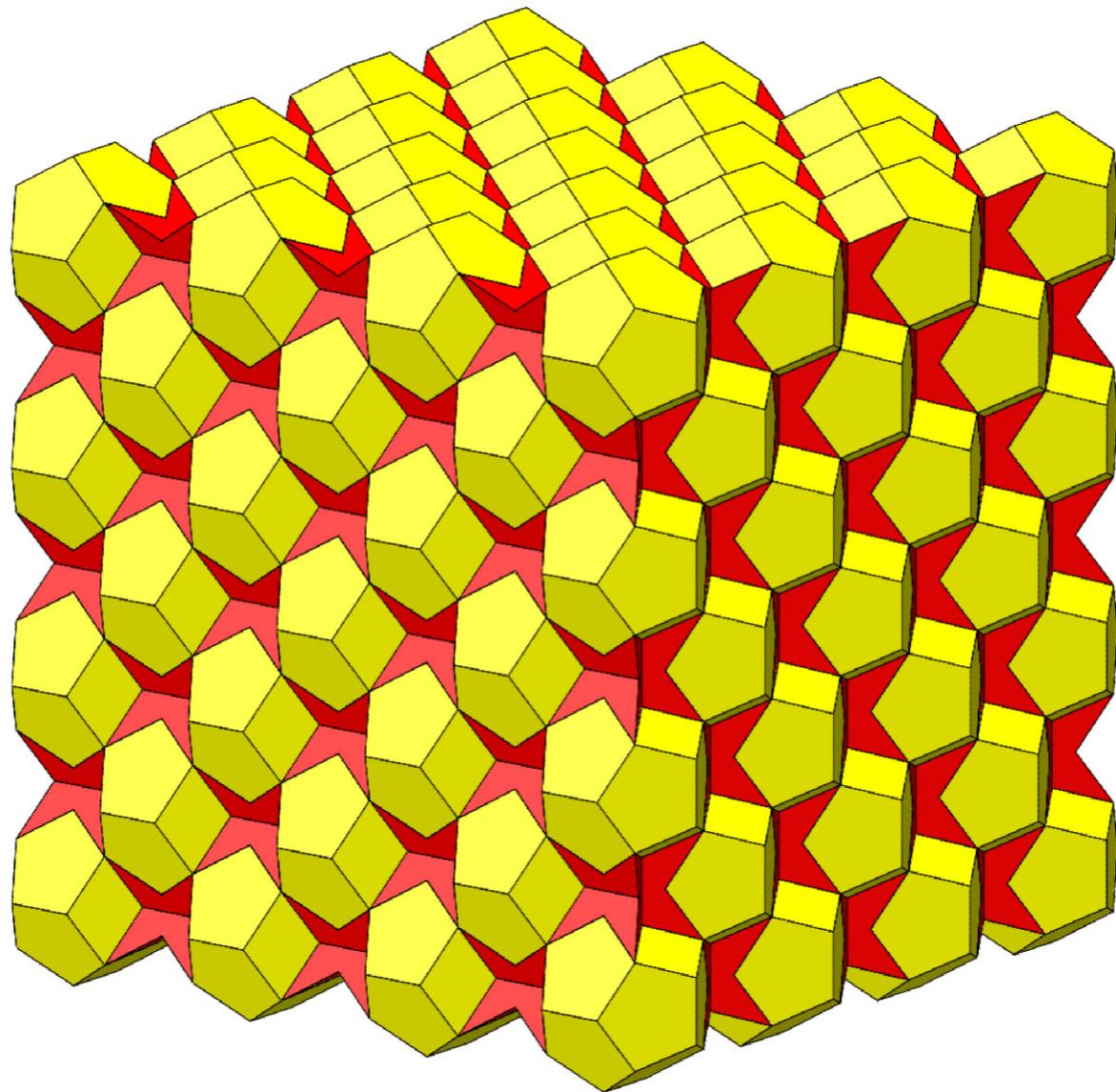


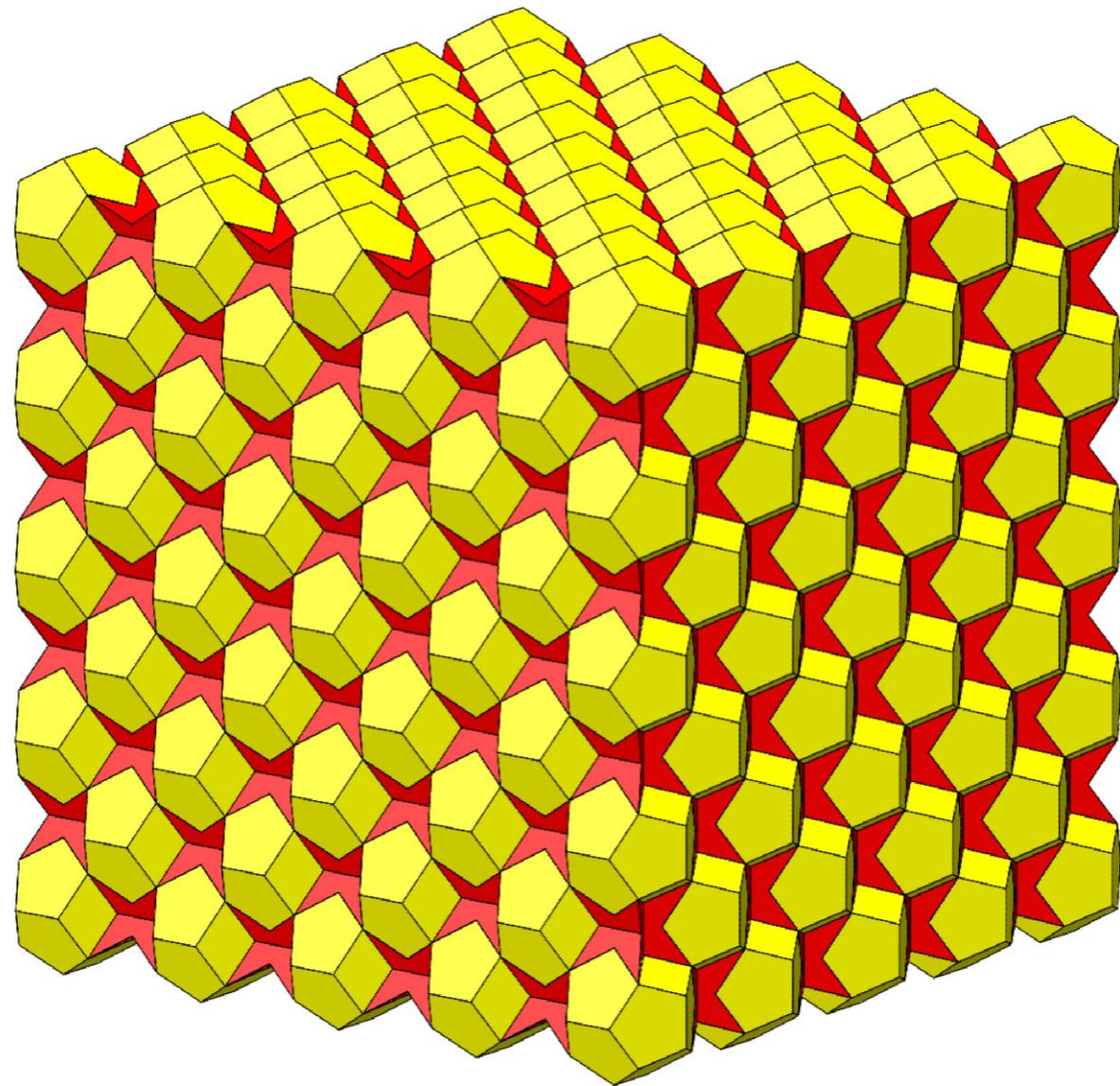
face centered cubic



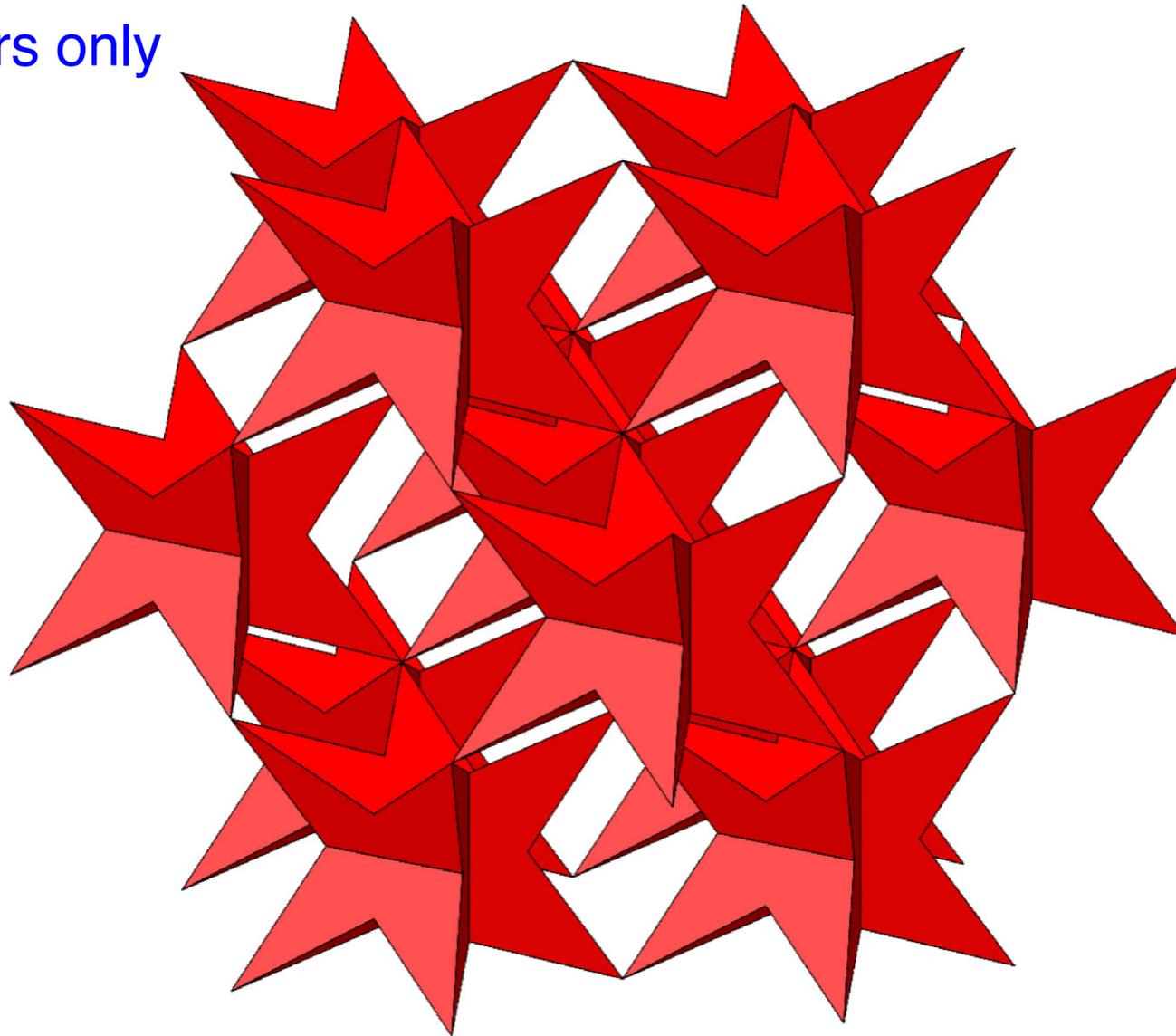
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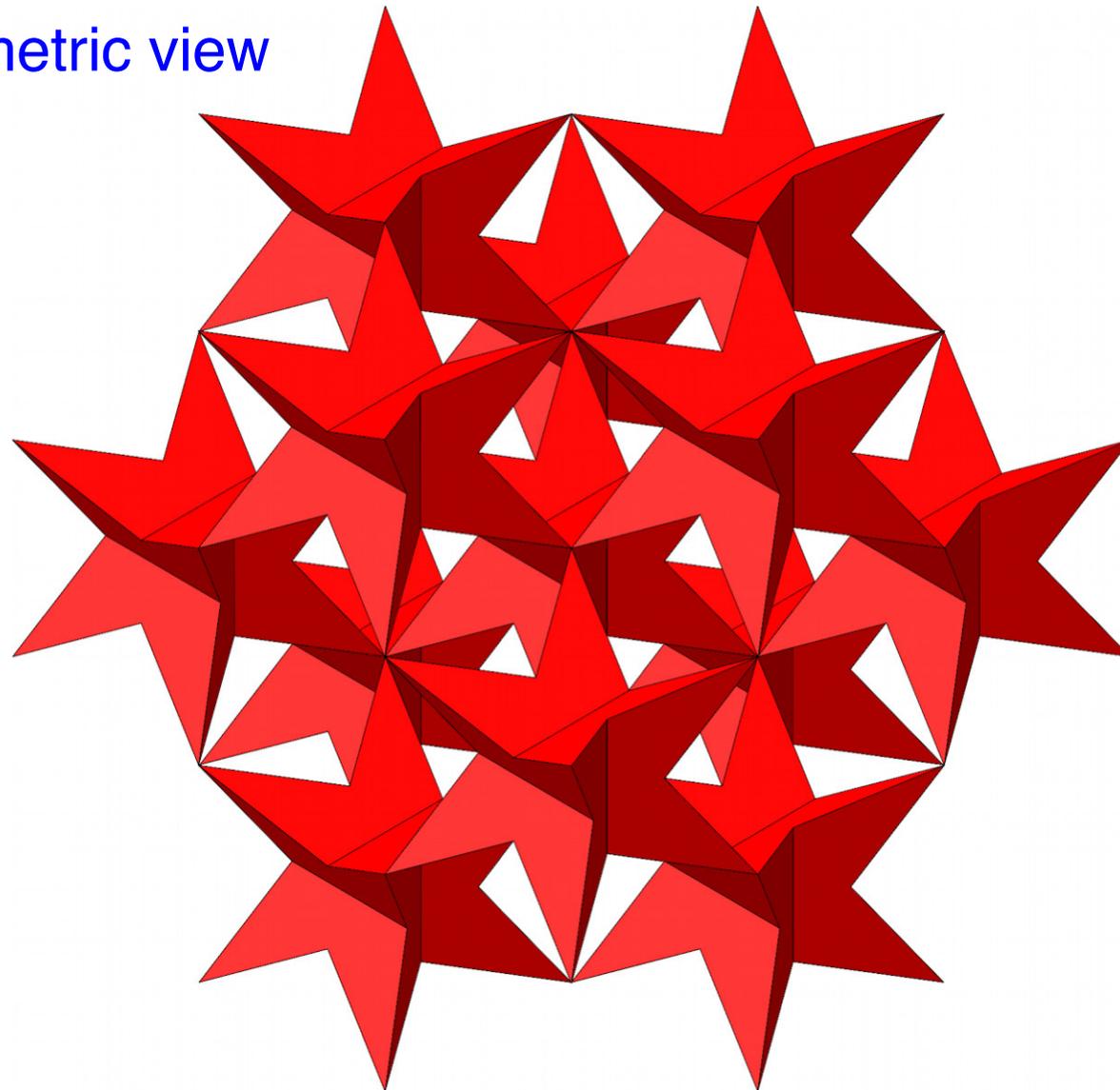




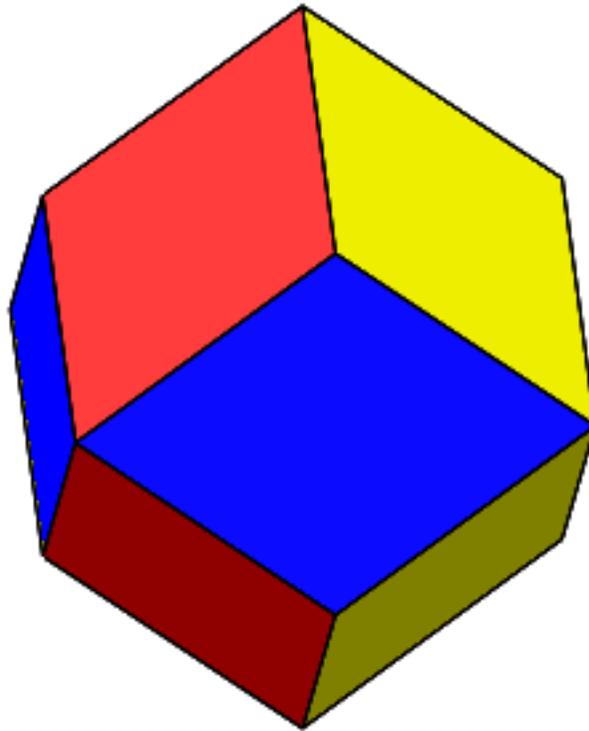
Stars only



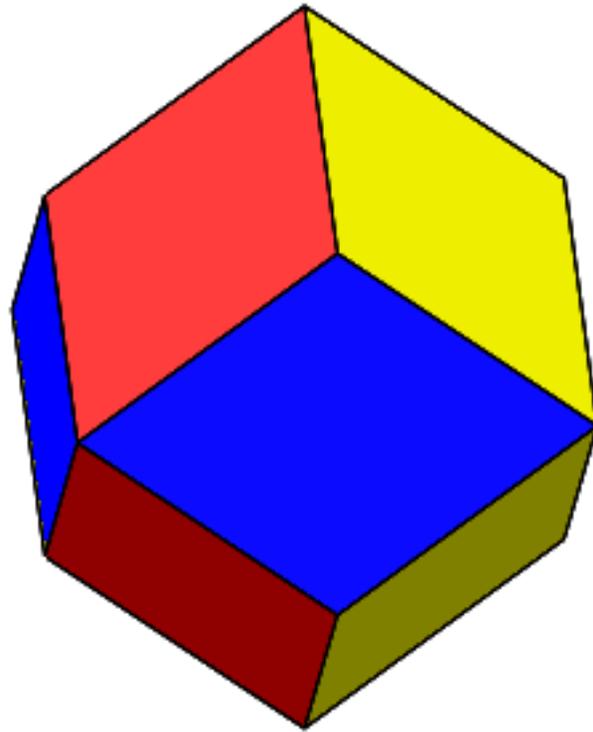
Symmetric view



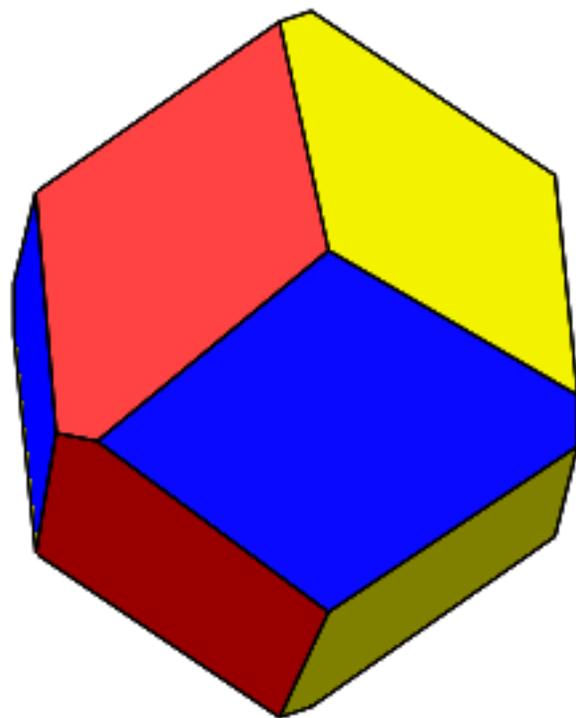
Transformations

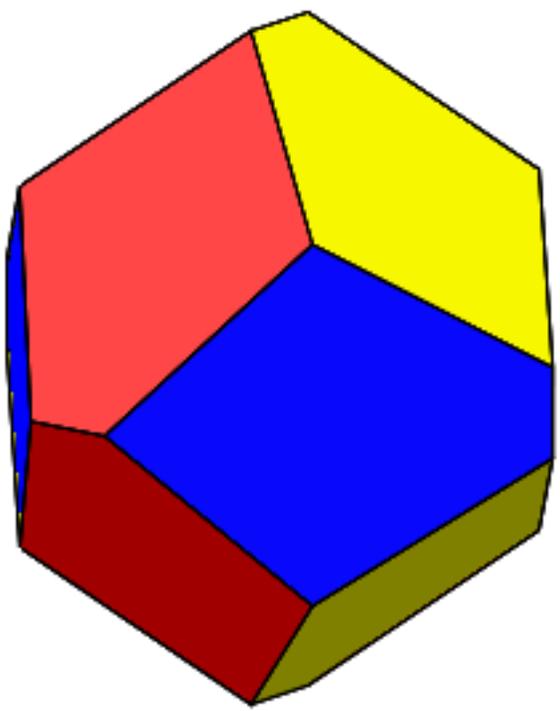


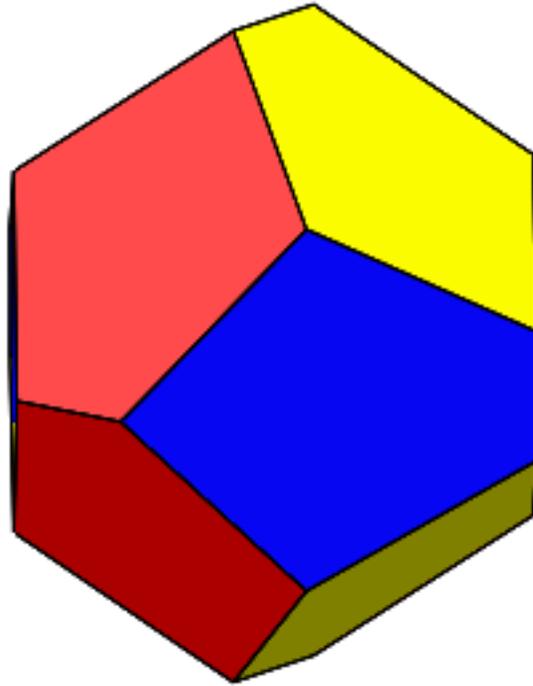
Rhombic dodecahedron

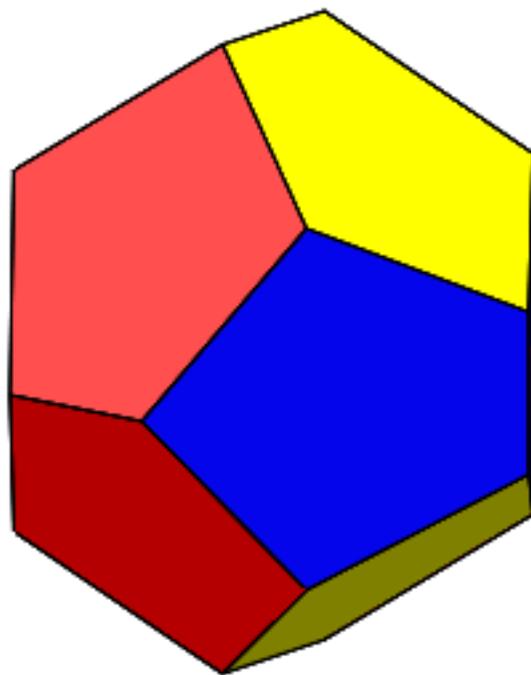


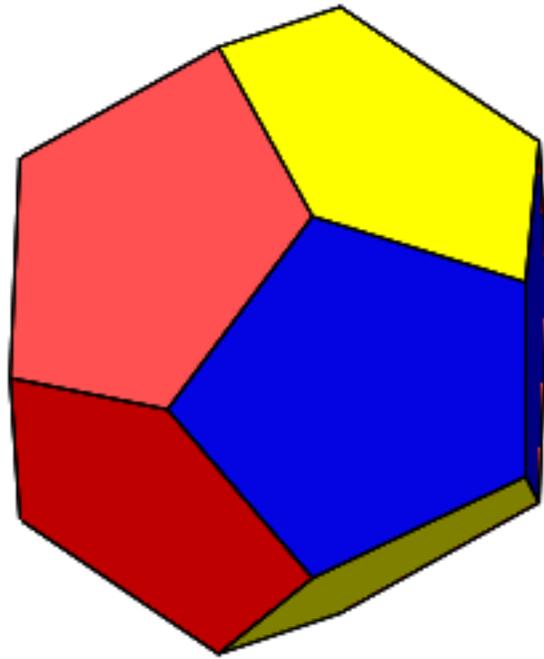
Rhombic dodecahedron

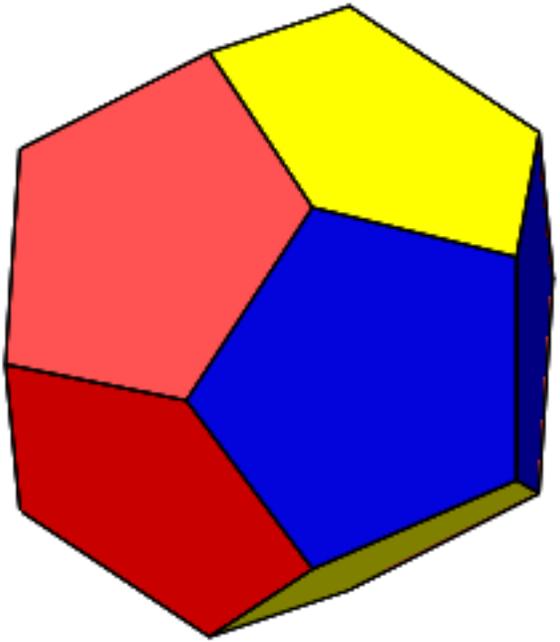




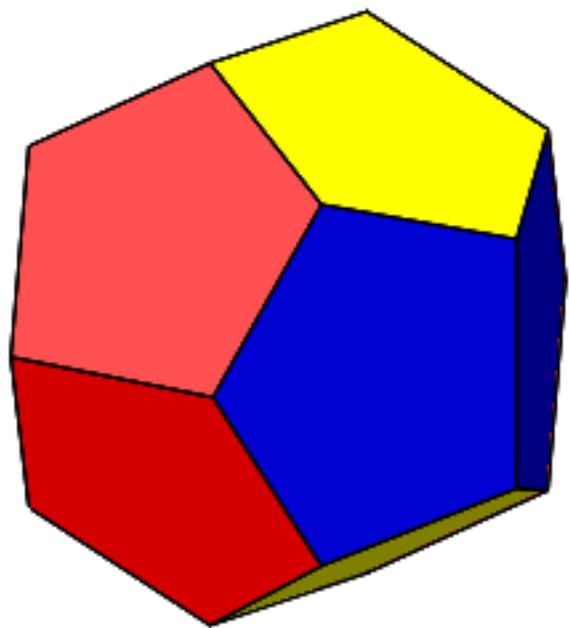


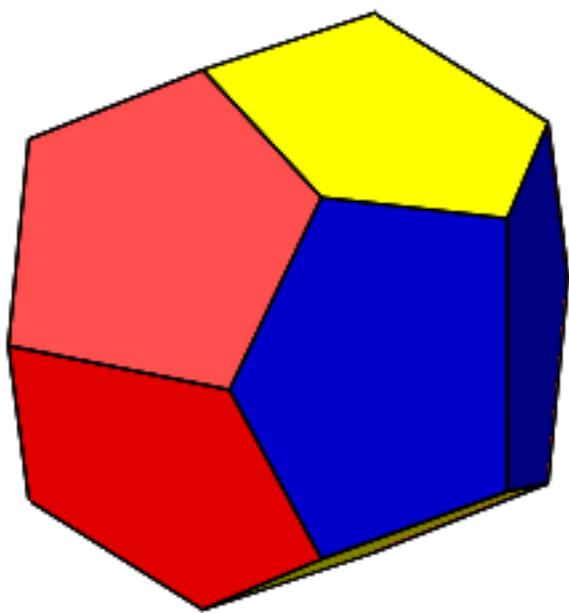


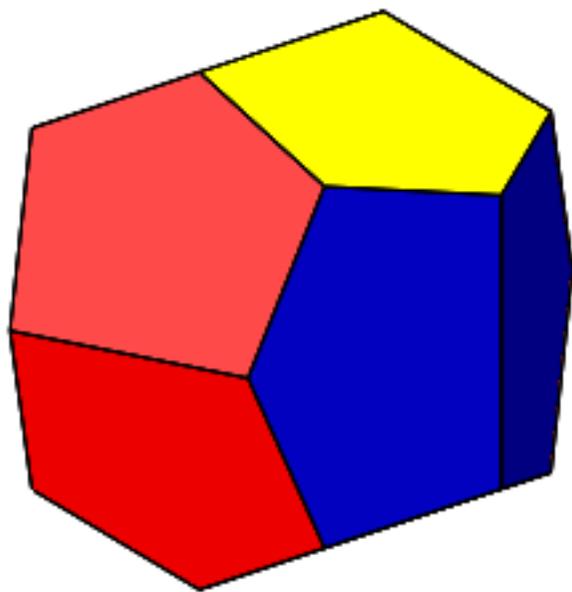


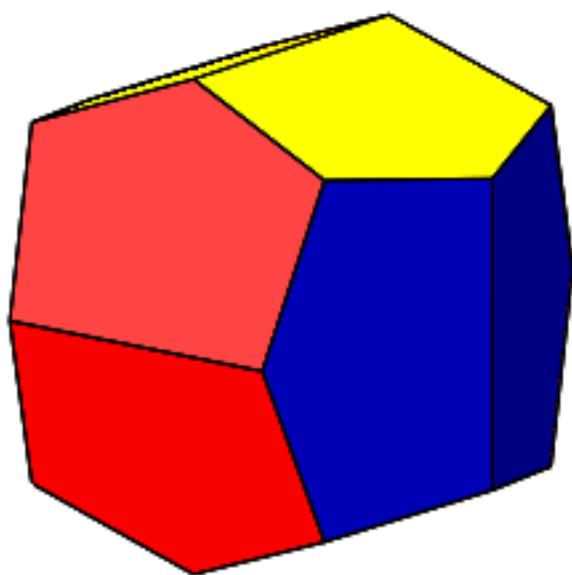


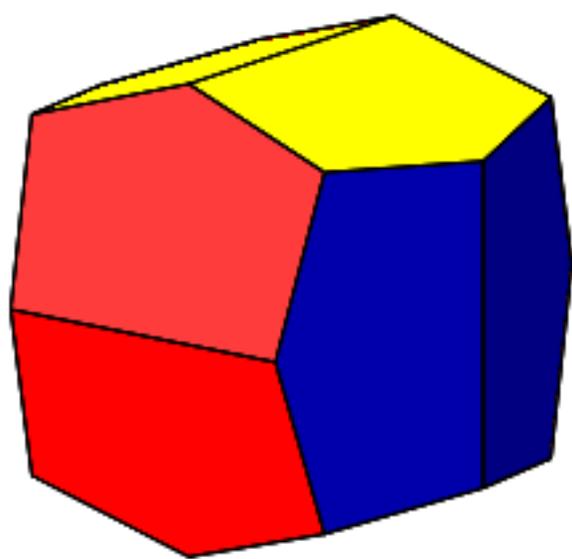
Regular dodecahedron

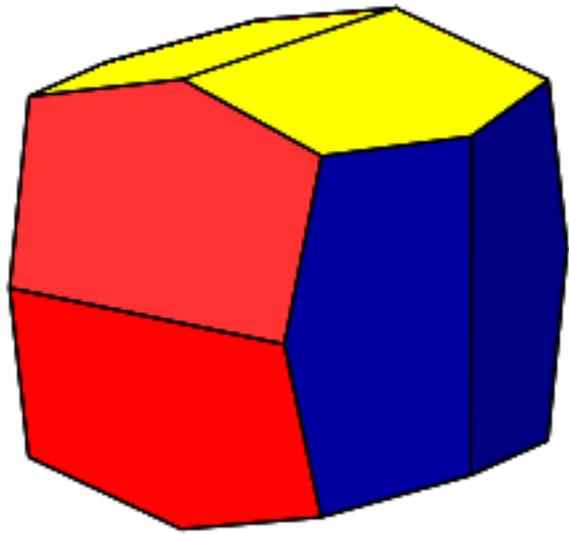


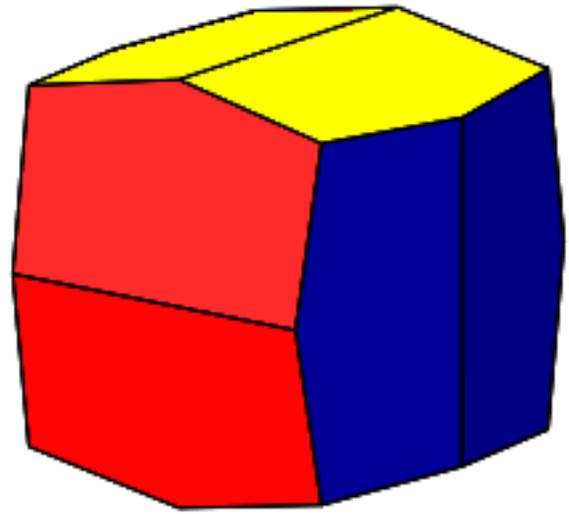


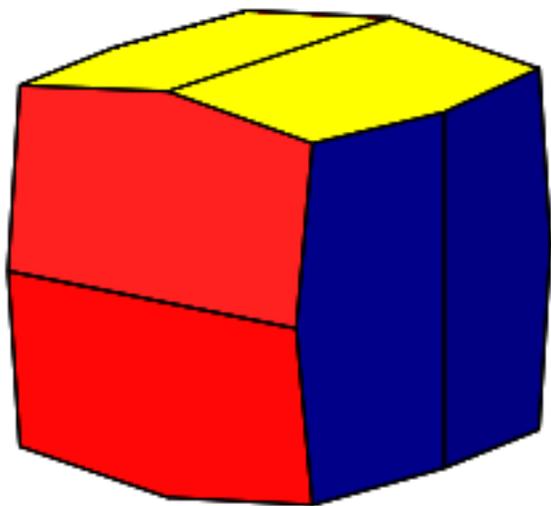


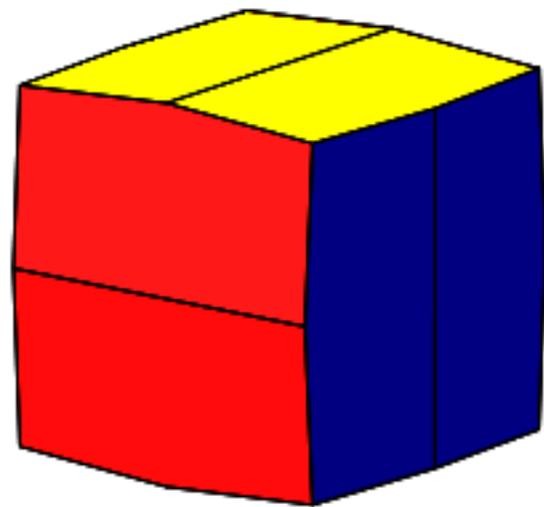


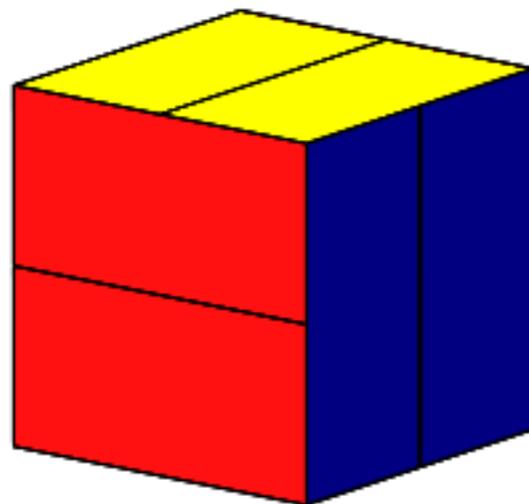




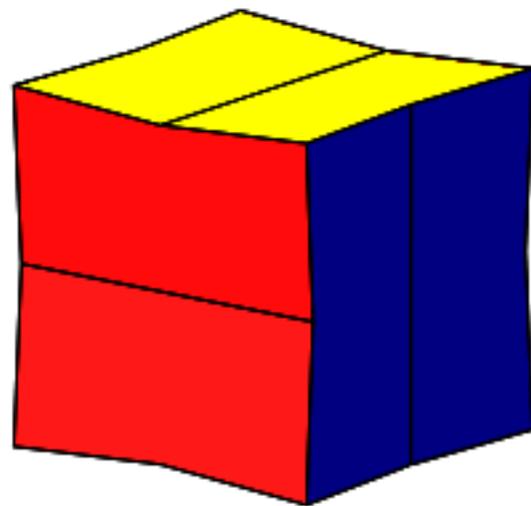


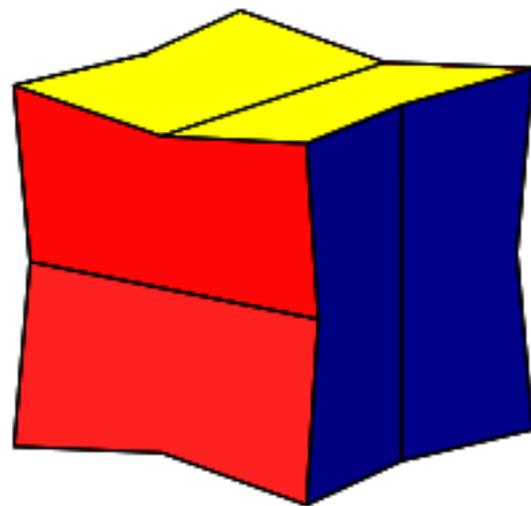


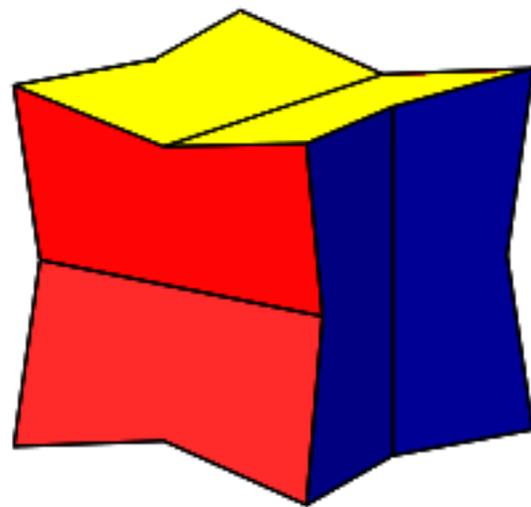


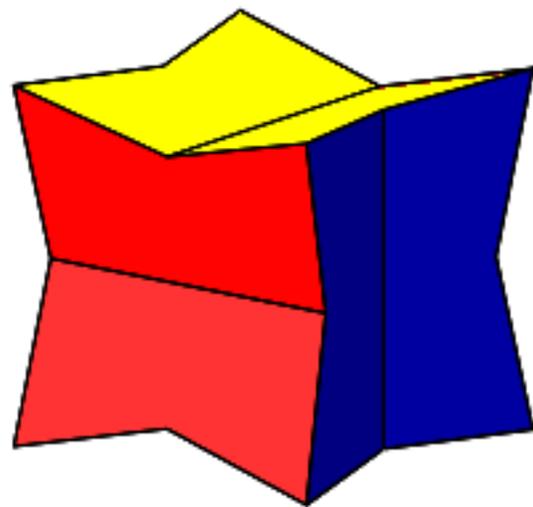


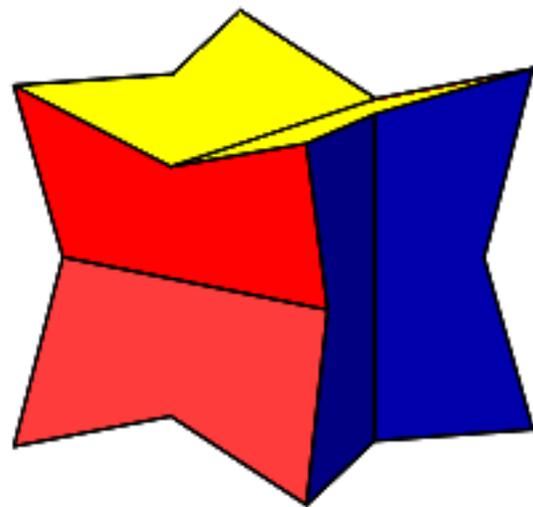
Cube

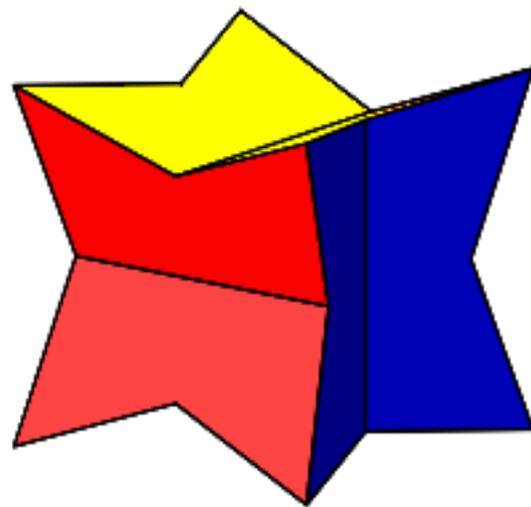


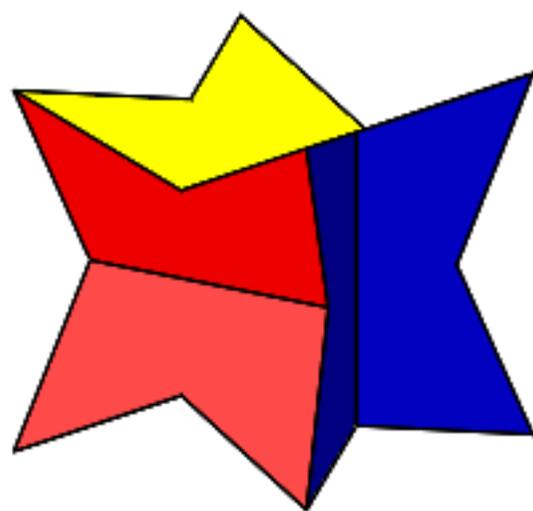


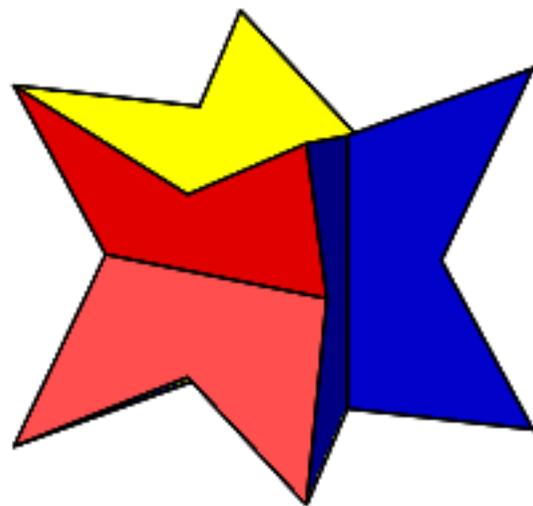


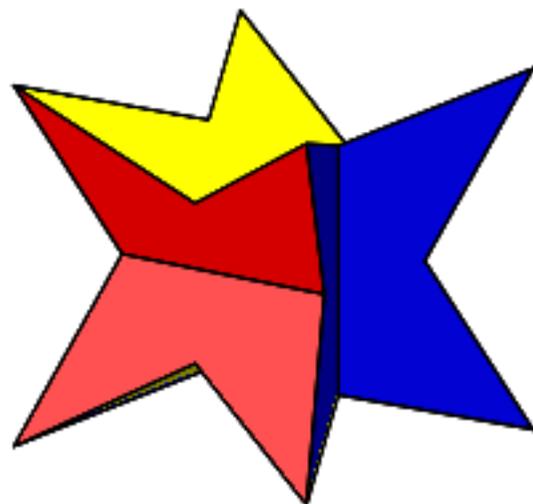


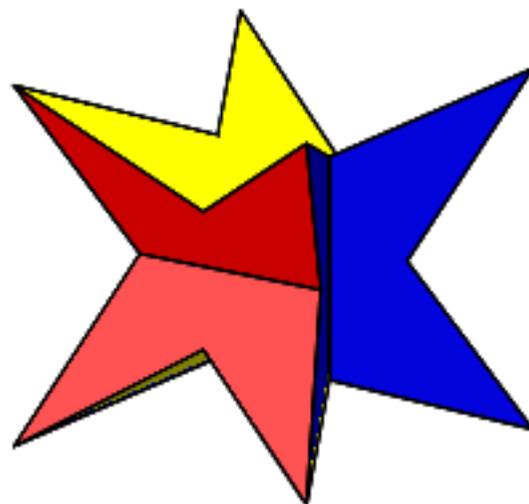




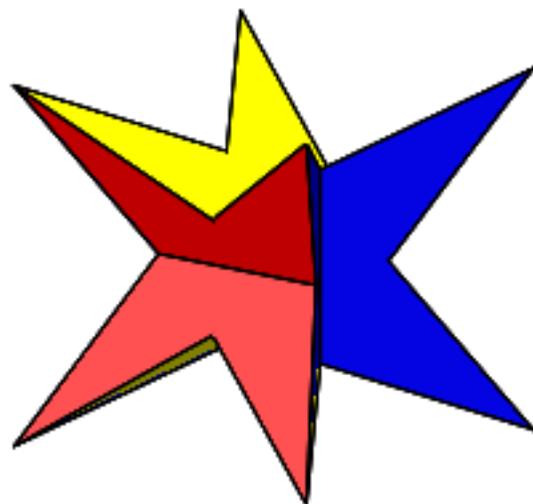


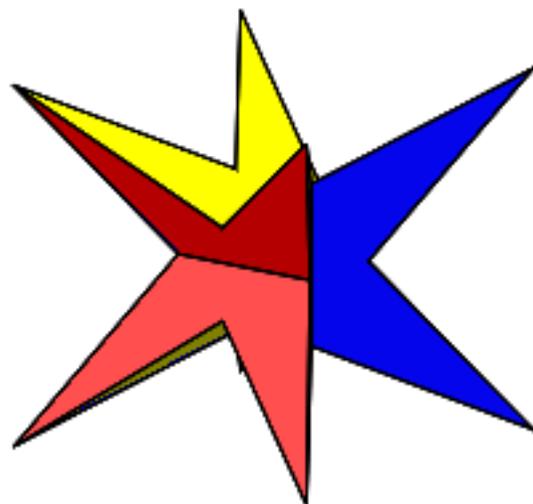


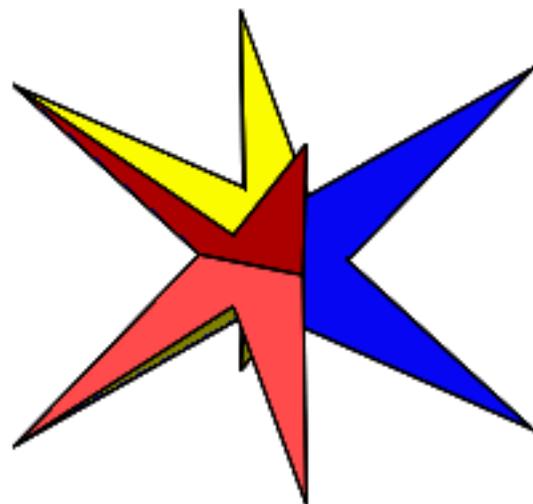


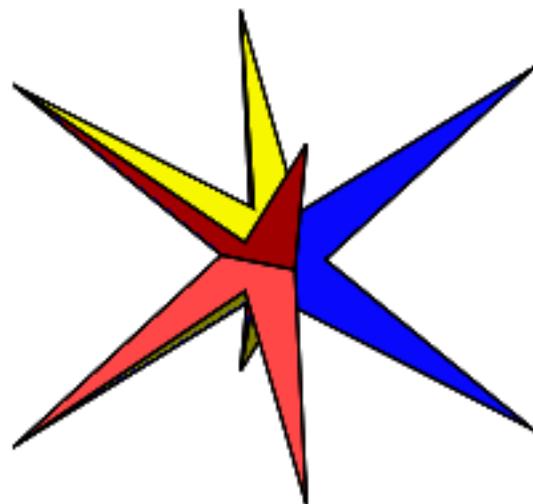


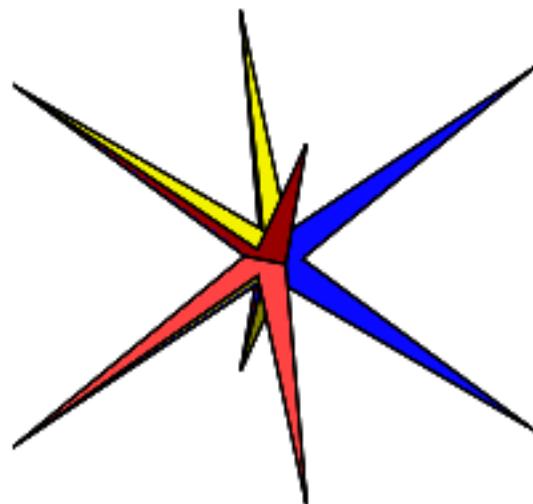
Semi-regular dodecahedron

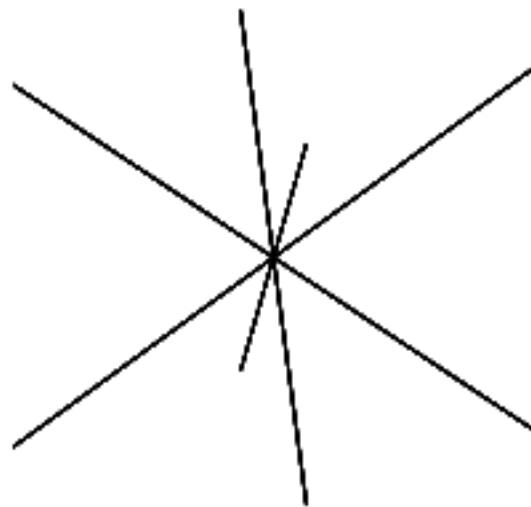




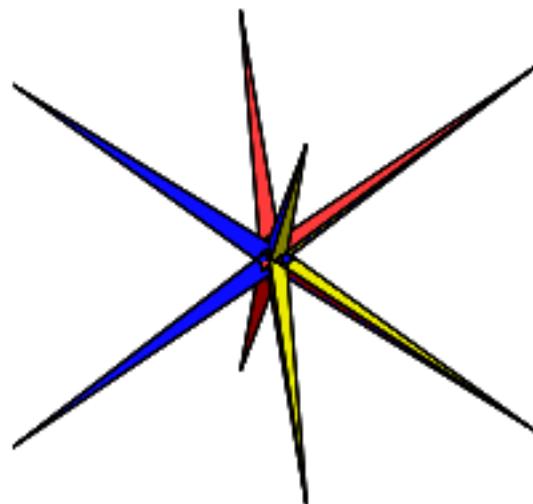


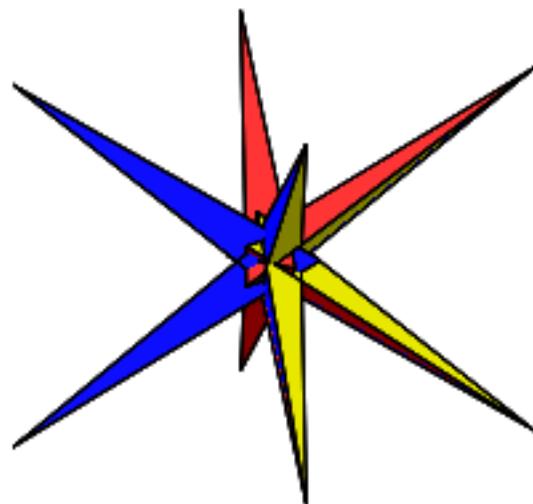


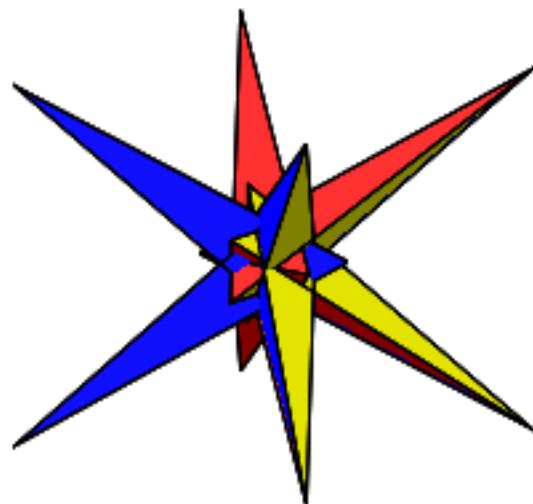


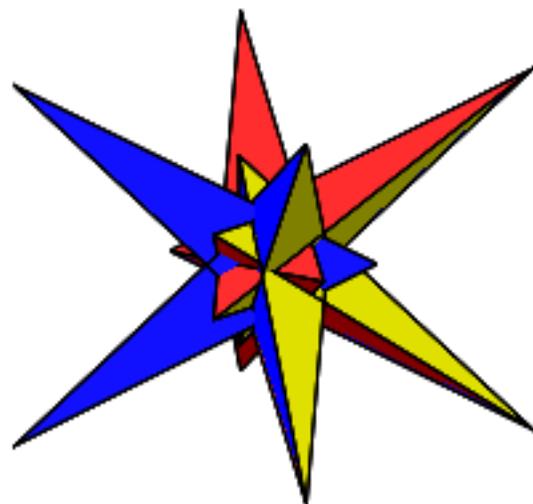


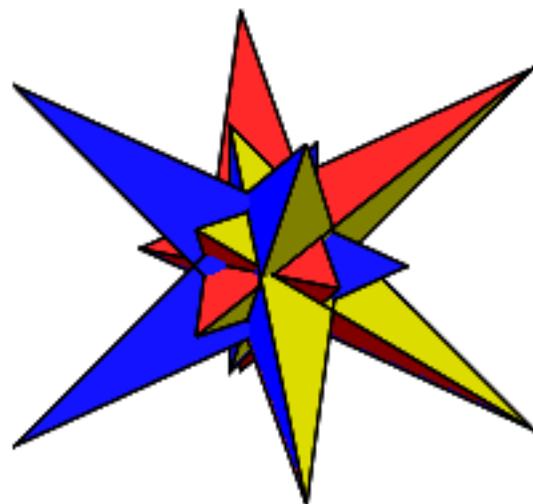
Diagonals of the cube

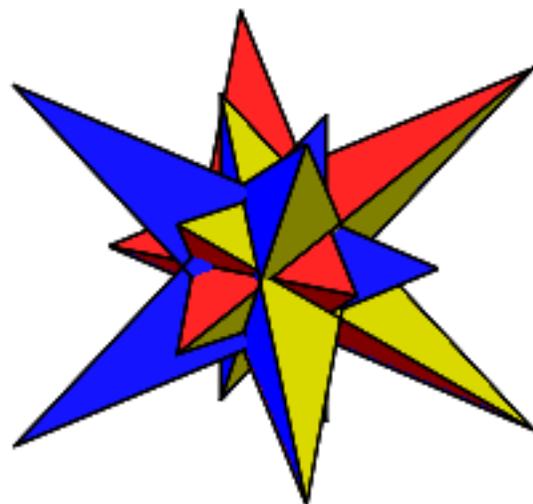


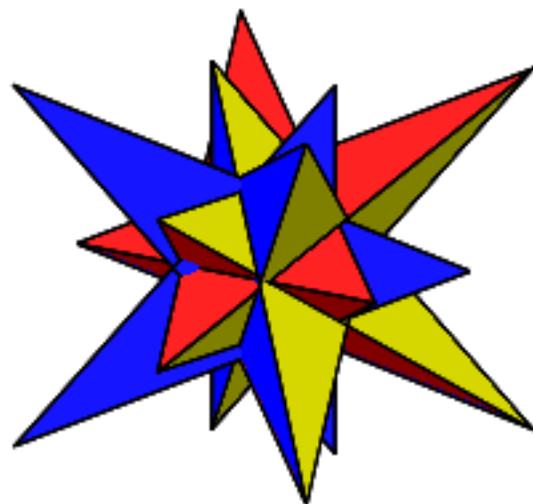


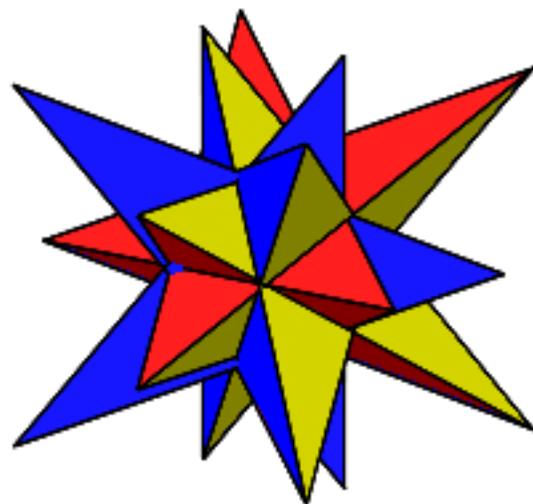


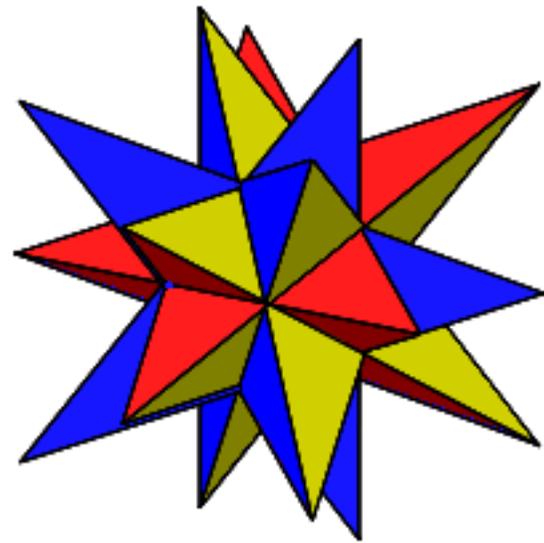


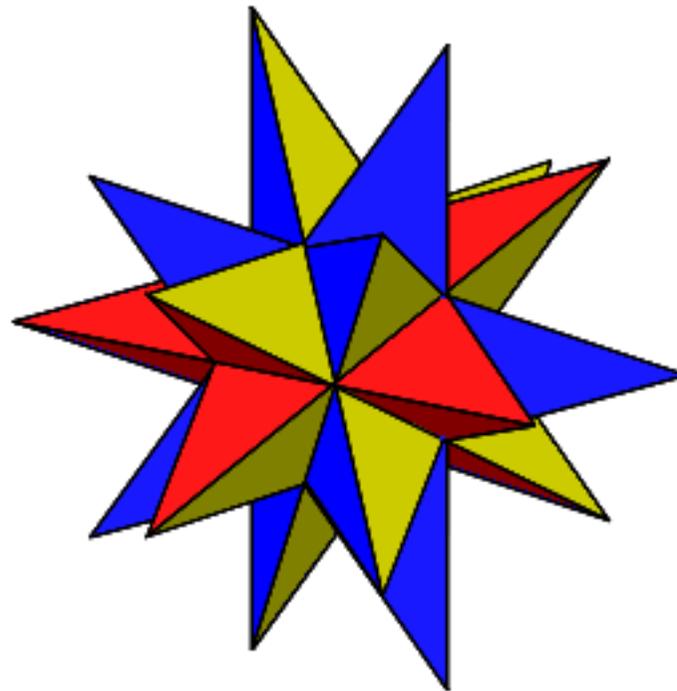




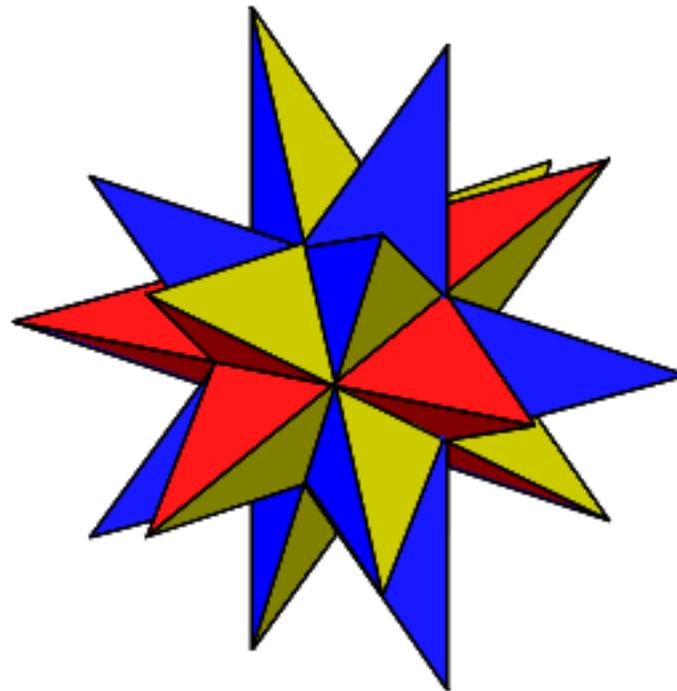








Stellated icosahedron



Thank you