Math308 Term Project

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Build Your Own Virus

There are links that connect the geometry and the nature.

Believe or not, you can "build" your own virus by using some basic geometry structures. But, the question is "How"?

Before we get into this topic, let’s make a quick recap:

Euclid’s Elements proves that there are exactly five regular solids:
Tetrahedron
Cube
Octahedron
Dodecahedron and Icosahedron

Euler proved that if F is the number of faces of a solid, V the number of vertices, and E the number of edges, then
F + V - E = 2

Icosahedron is the one will be used today to transform into some shapes samiliar with natural virus.

To construct our virus, you must know what is the "magic number".

Let F = 20T, E = 30T, V = 10T + 2, where T=a^2 + ab + b^2,

this gives an "almost regular" solid, the psedo-icosahedron of type(a,b)

The "magic" numbers 10(a^2+ab+b^2) + 2 play a special role in the structure of a virus. These are numbers of identical units (of protein molecules) that can be fitted together in an "almost regular" way to form a nearly spherical surface.

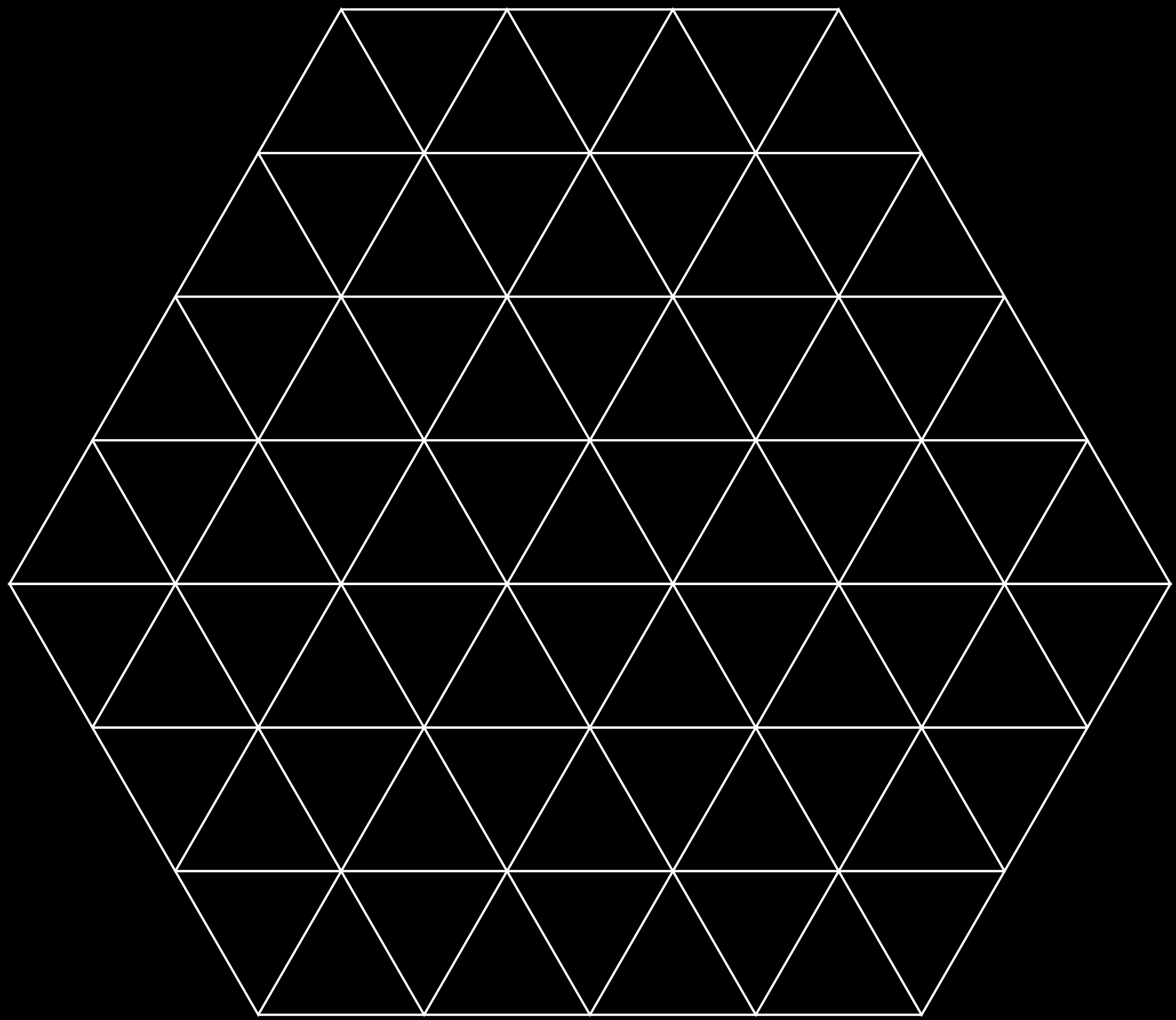
Following are some interesting faces:

a	b	10(a^2+ab+b^2)+2	virus
1	1	32	turn yellow mosaic
2	0	42	bacteriophage
2	1	72	rabbit papilloma
2	2	122	
3	0	92	REO
4	0	162	Herpes, chickenpos
5	0	252	Adenvorius type 12

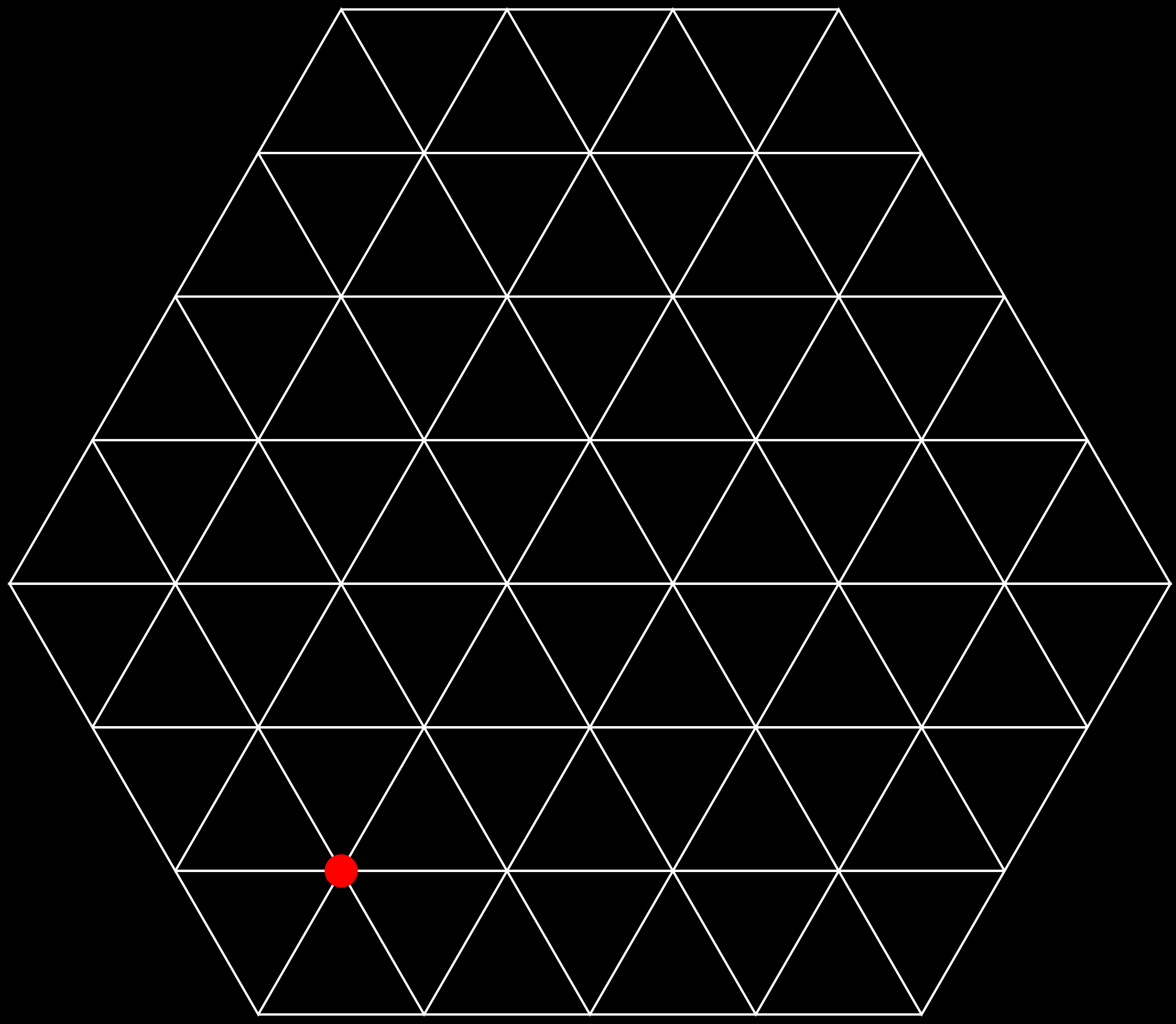
so, what is "a" and "b" ? how to apply these numbers ?

Goldberg-Caspar-Klugpseudo-icosahedron

Start with a tiling of the plane by equilateral triangles.



Find some vertex



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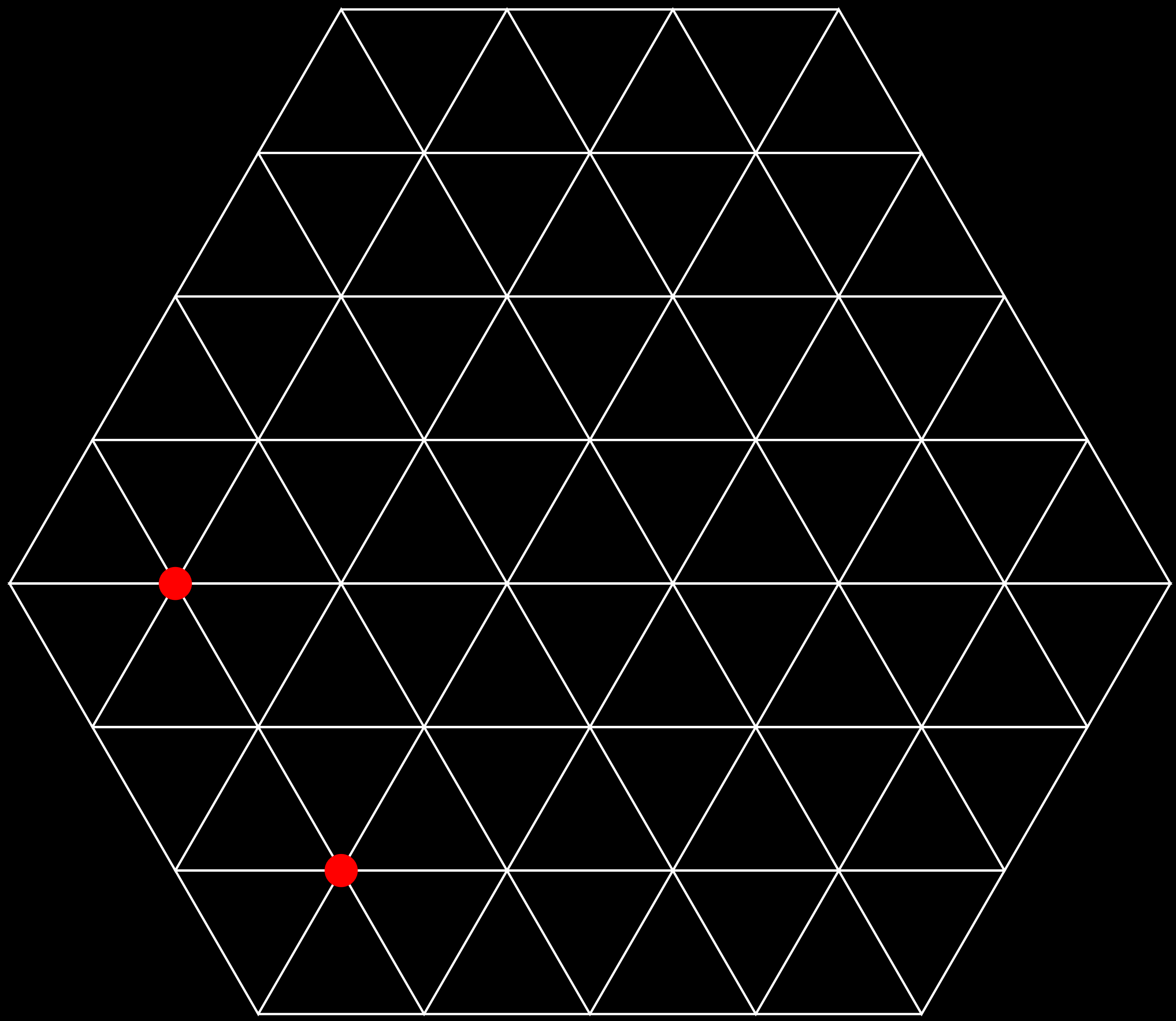

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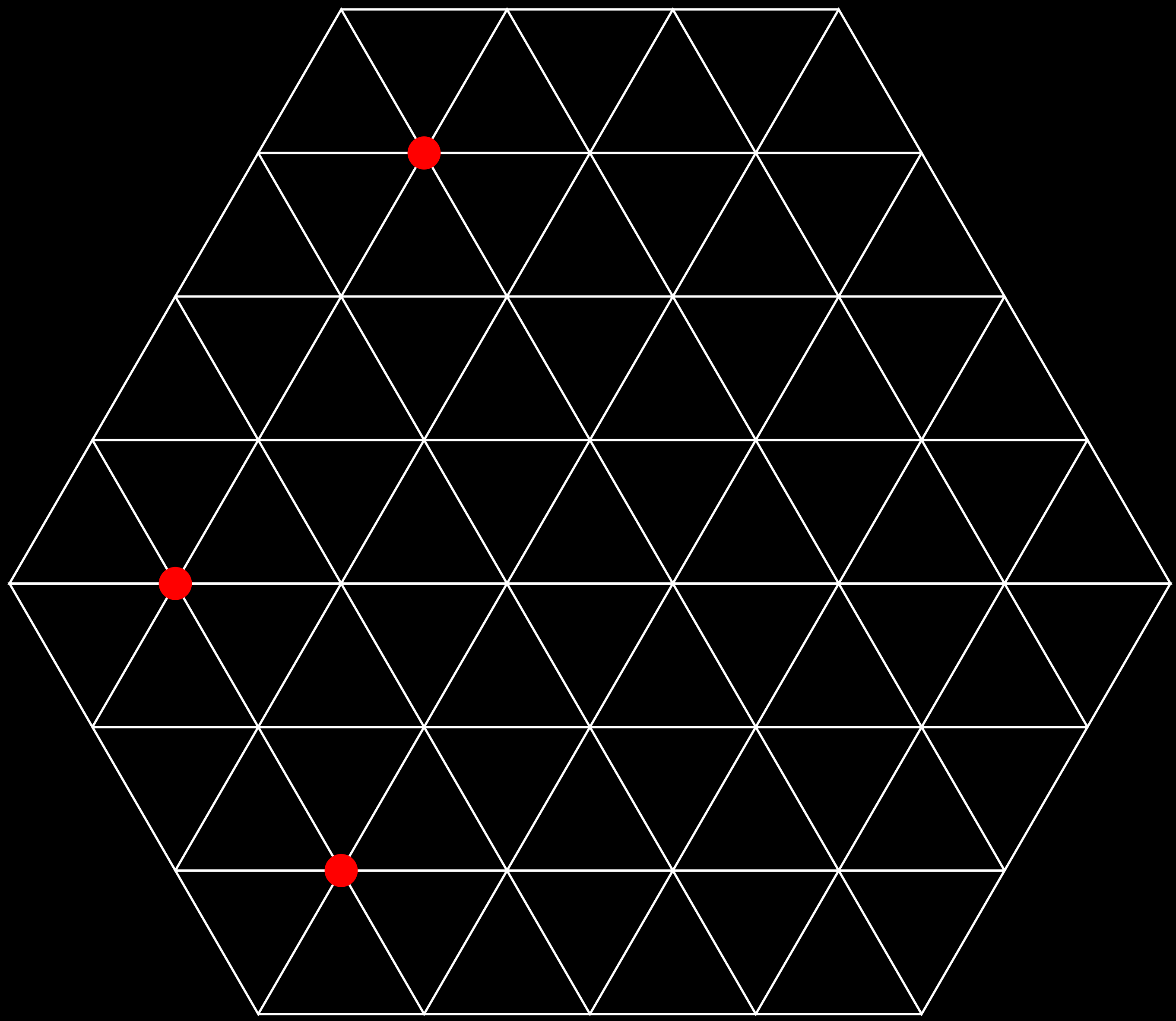

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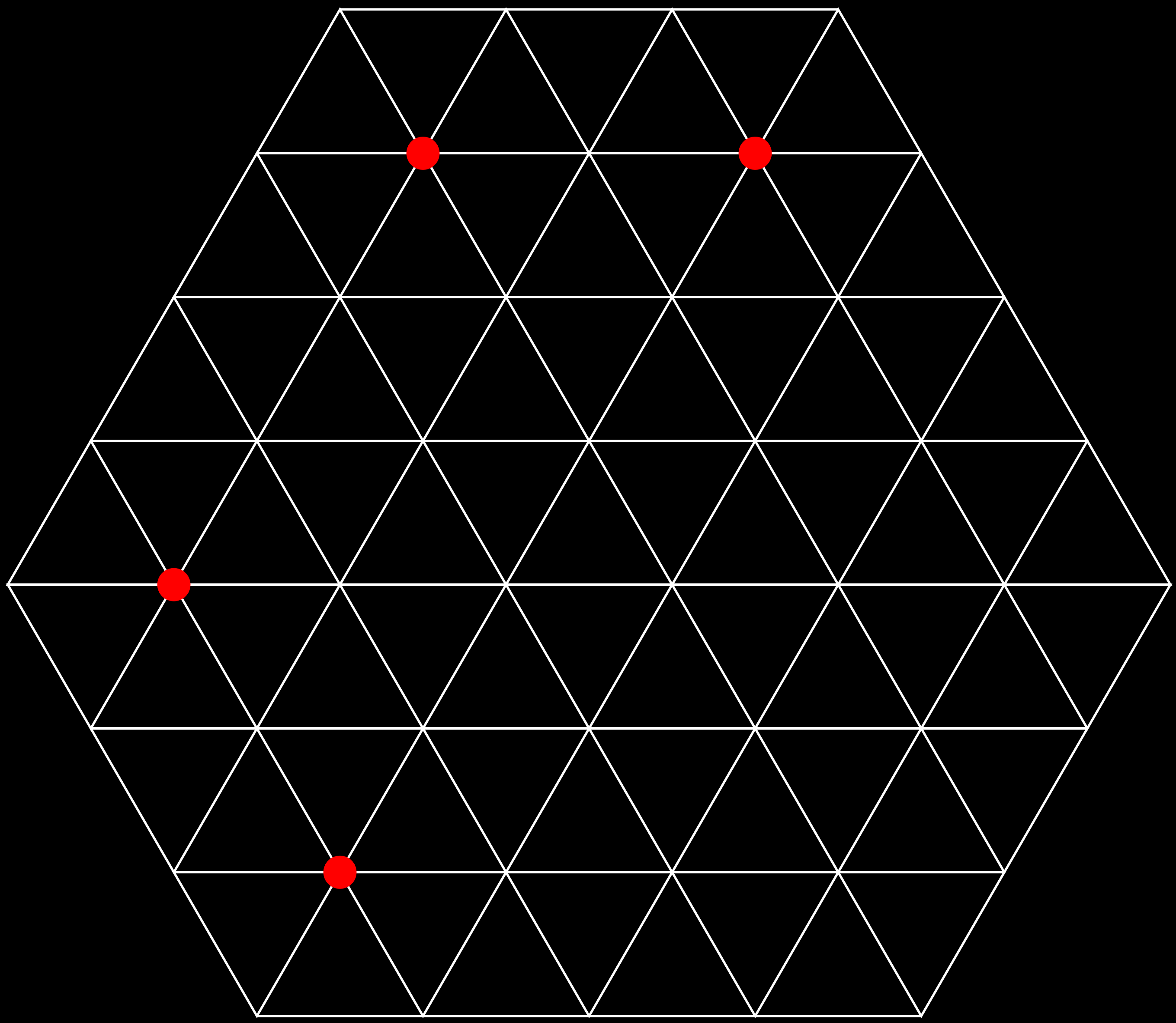

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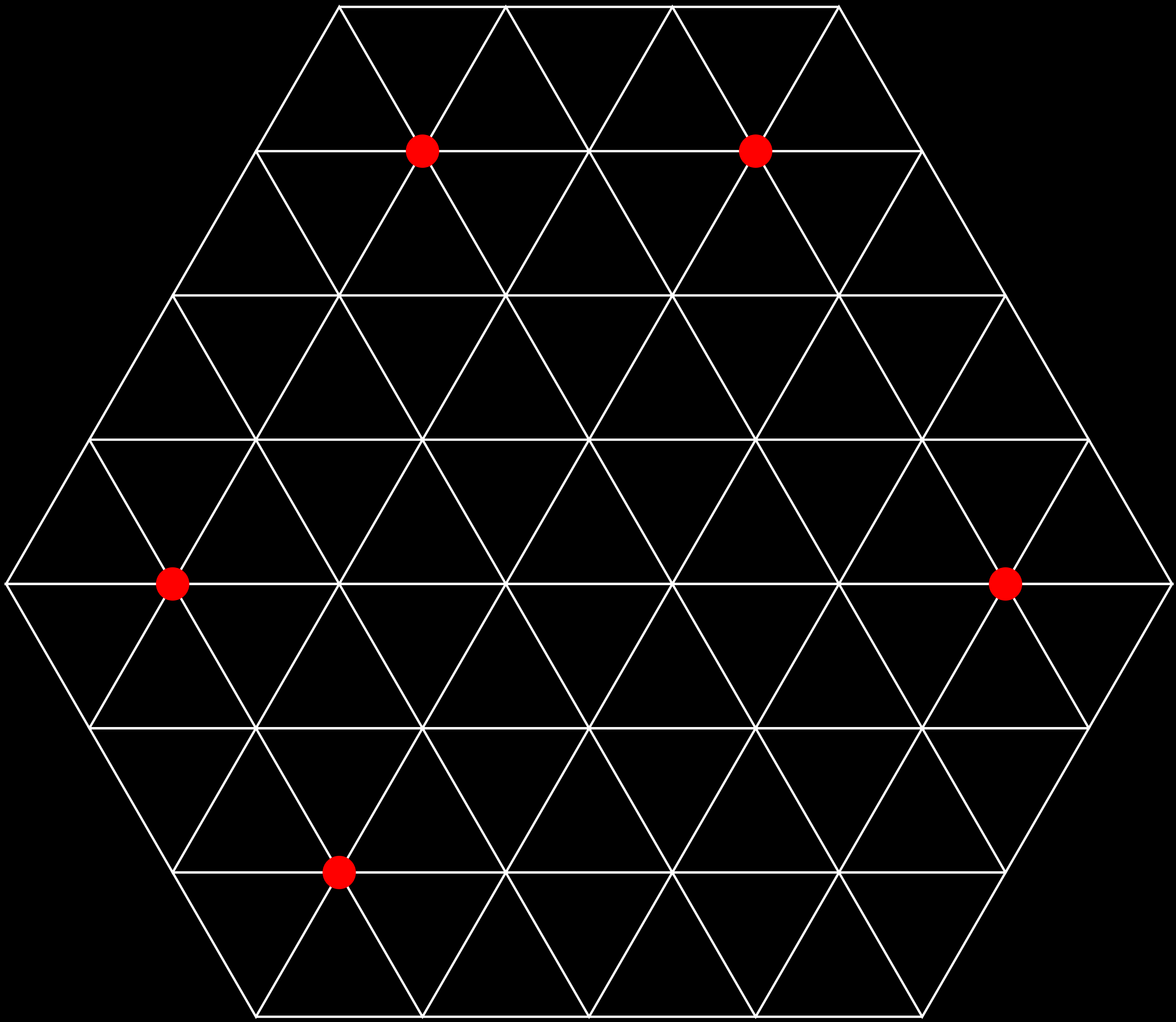

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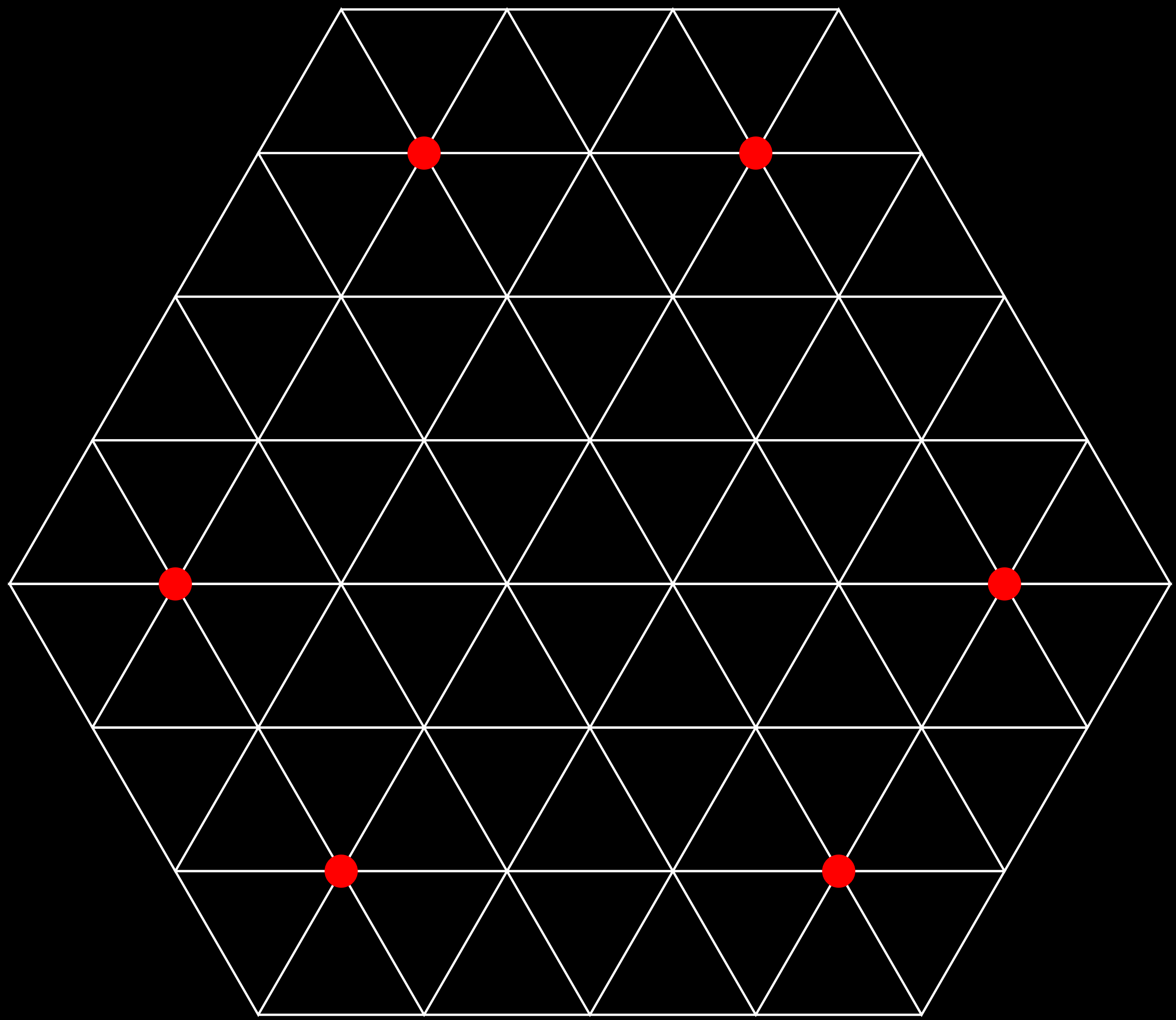
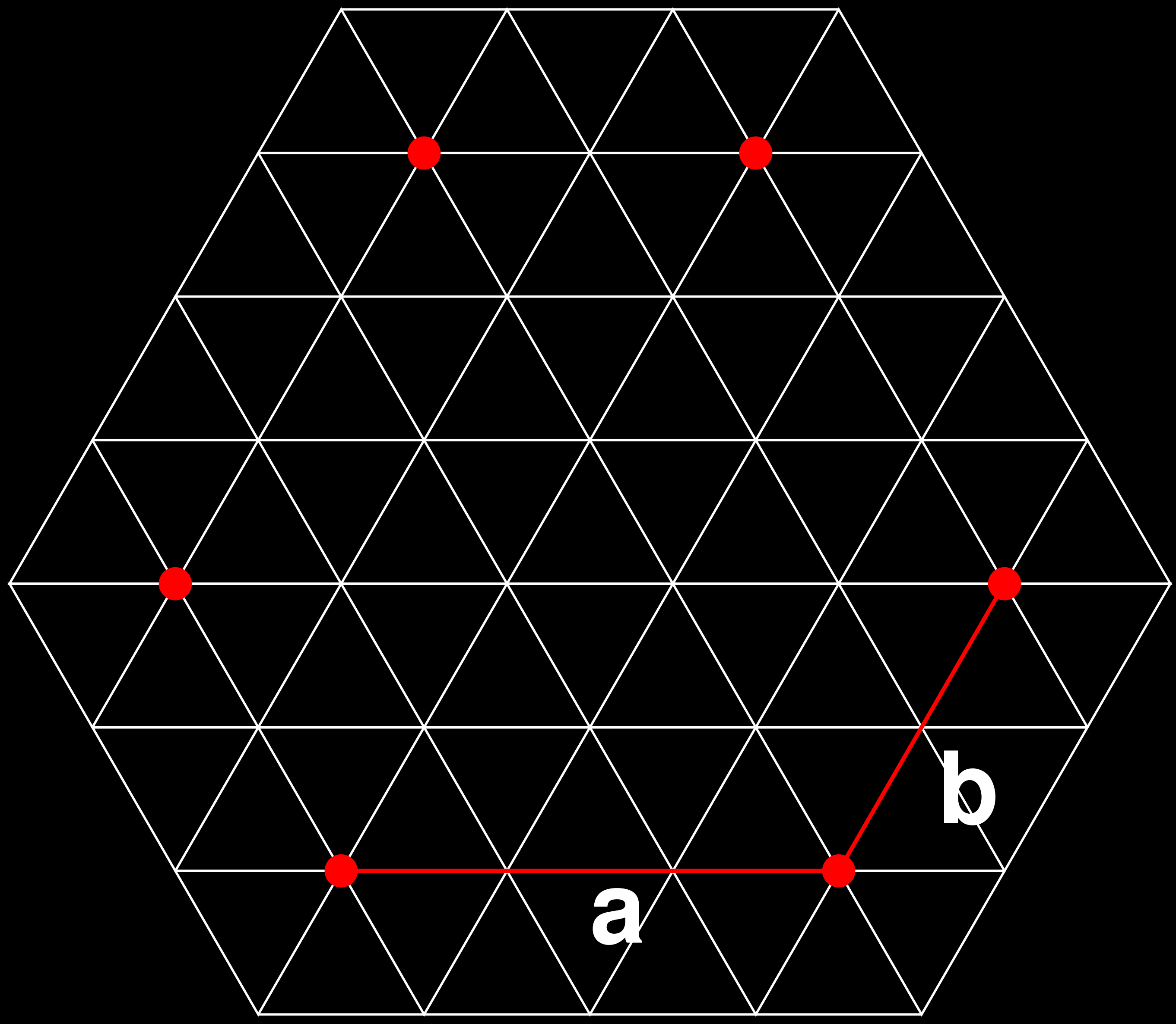


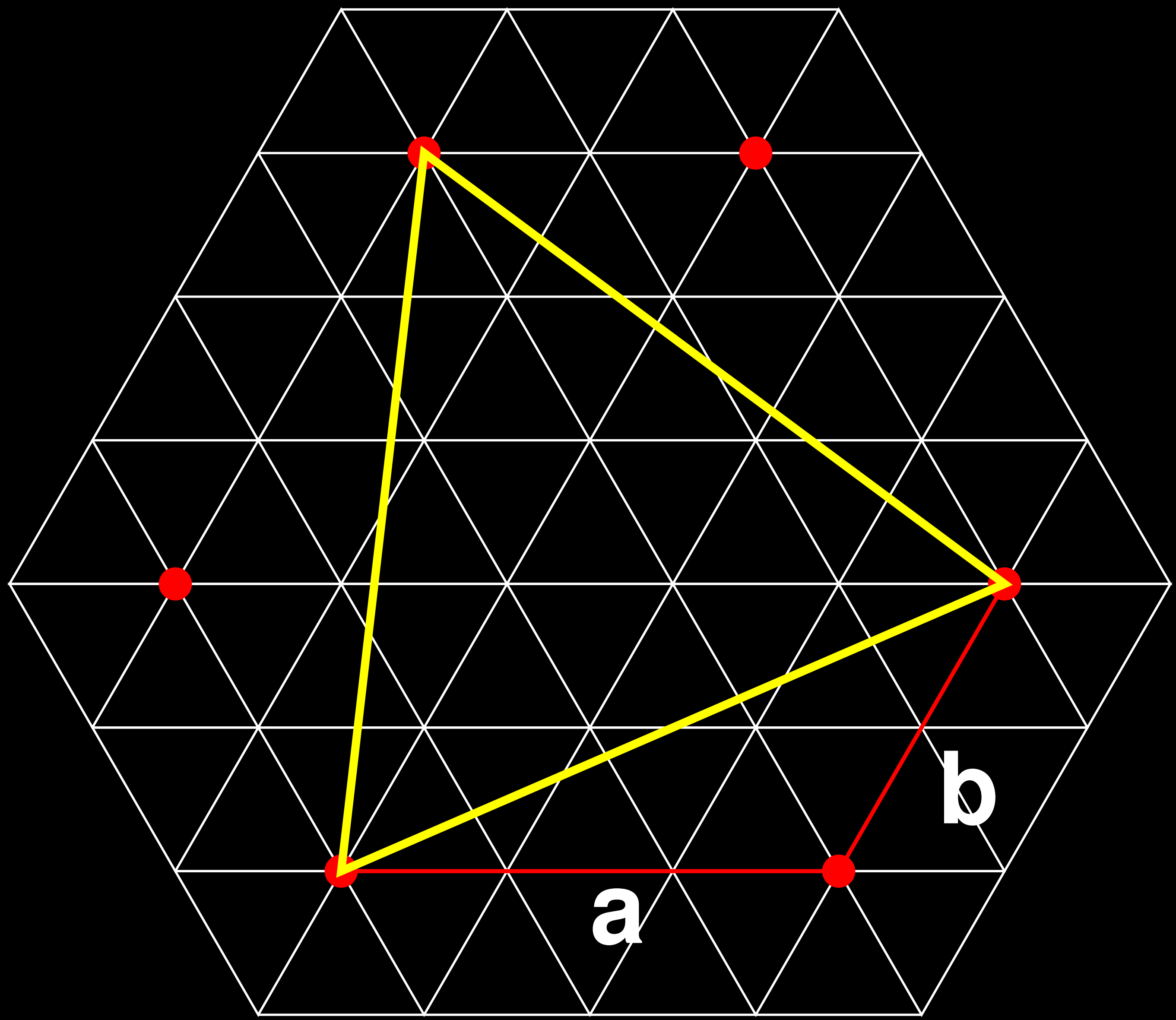
Pick two numbers 'a' and 'b'.

Starting at some vertex, move a units right

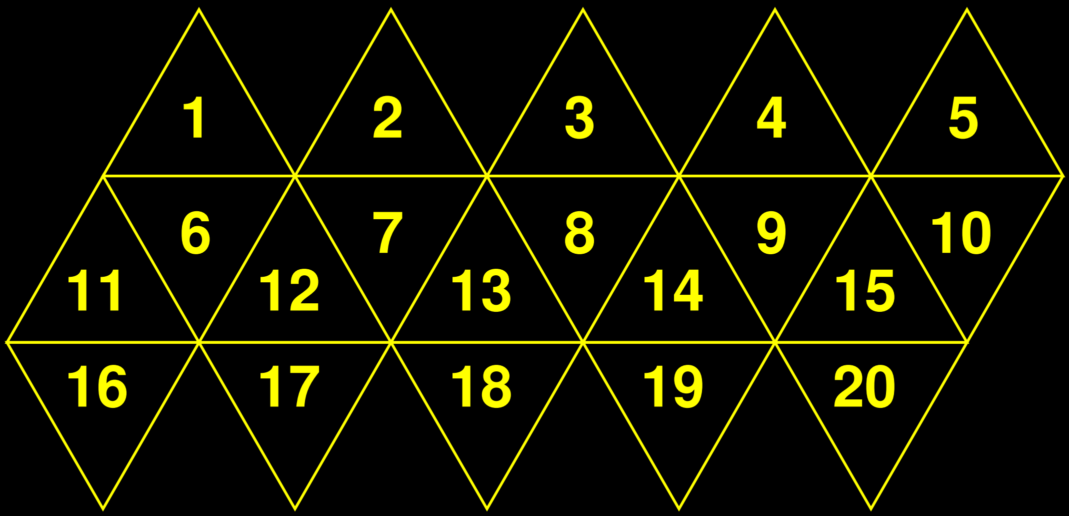
and b units up to form a second vertex

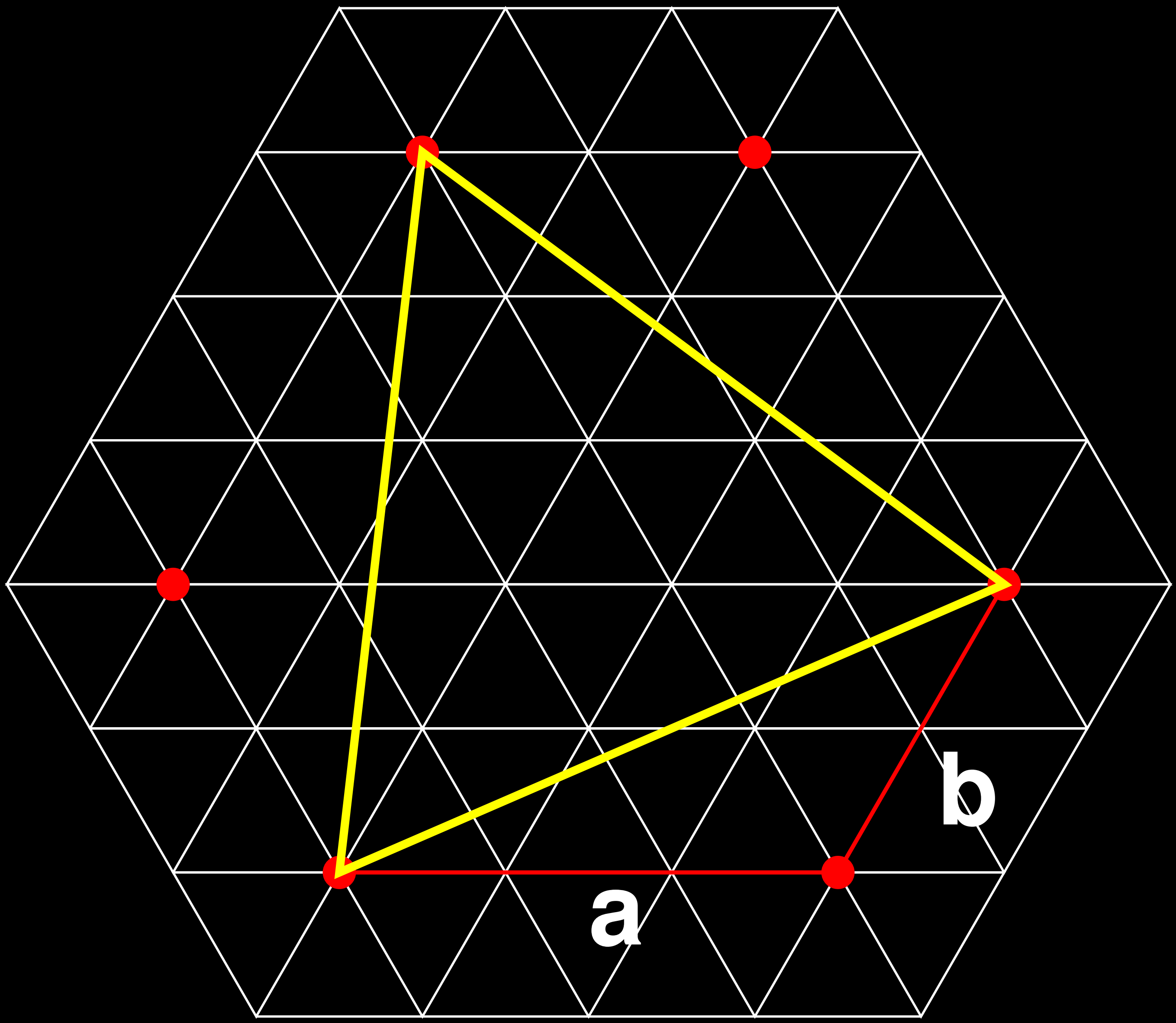


Repeat to create a large triangle



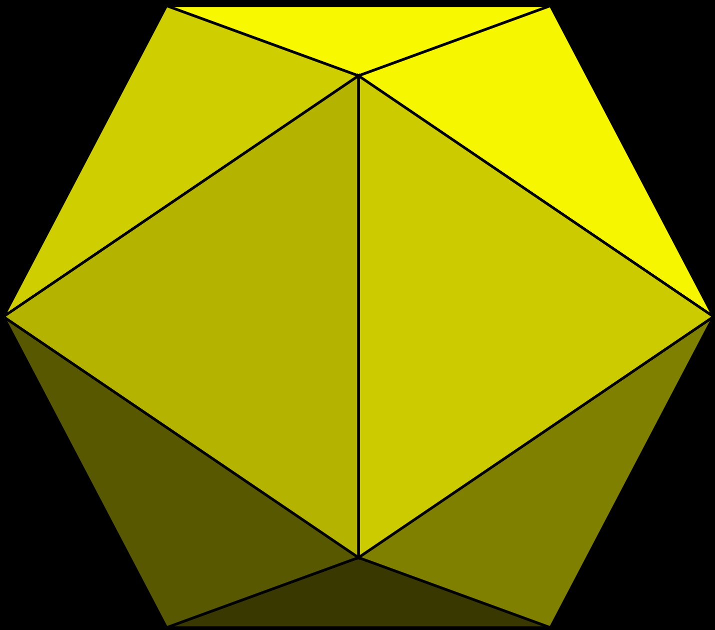
Fit together 20 of these large triangles to form an icosahedron

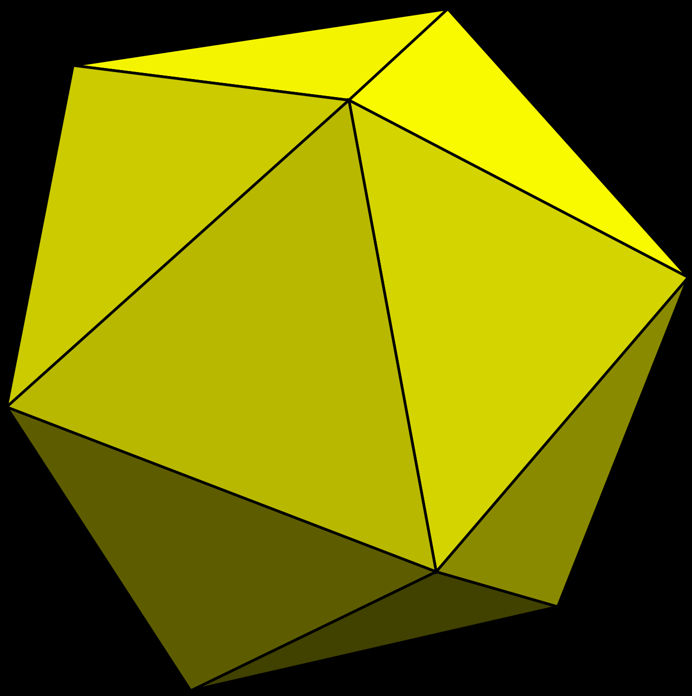


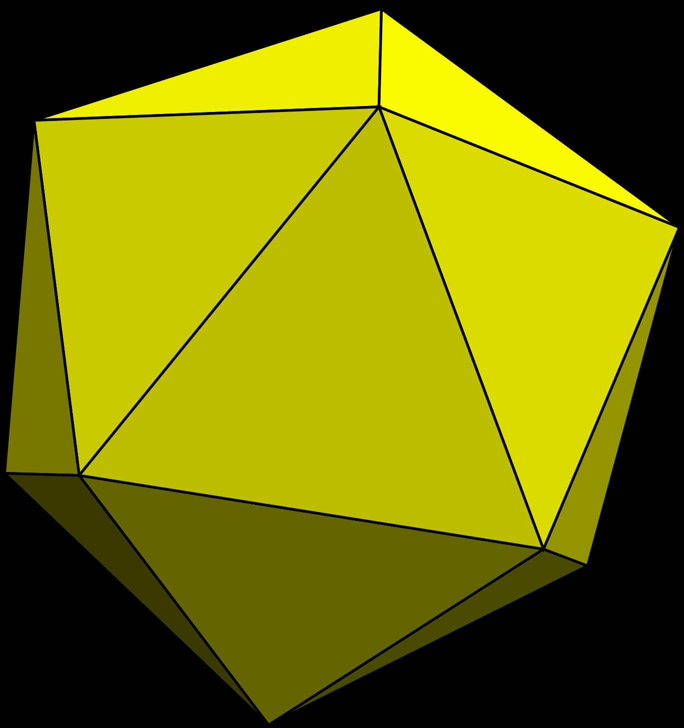


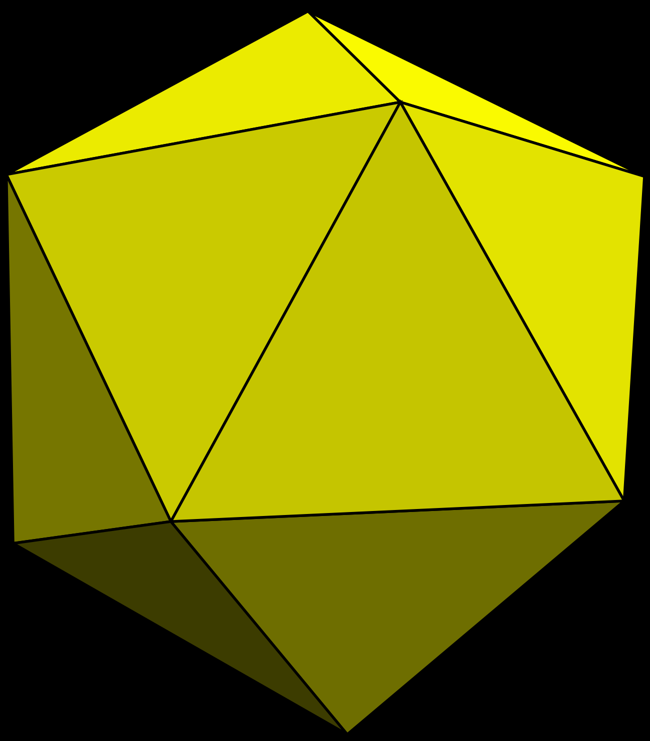
Assembling twenty basic units

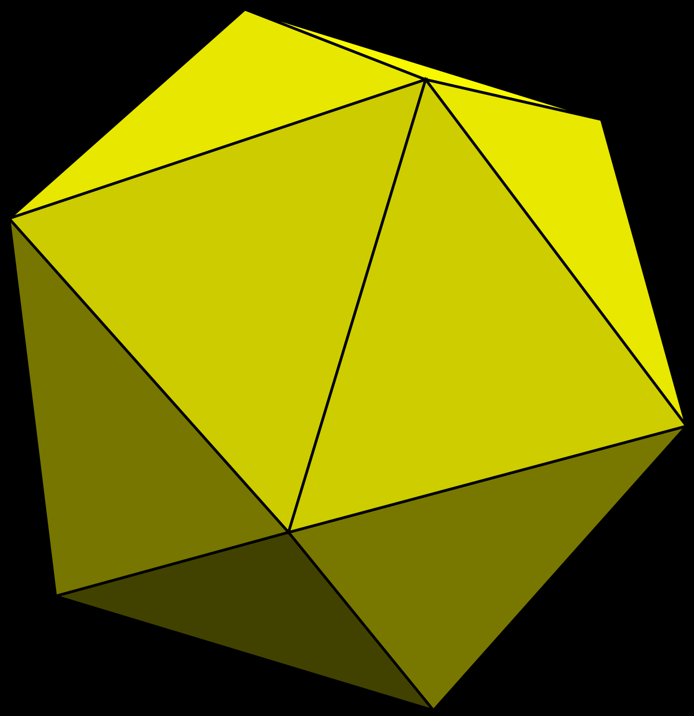
we could make a regular icosahedron....

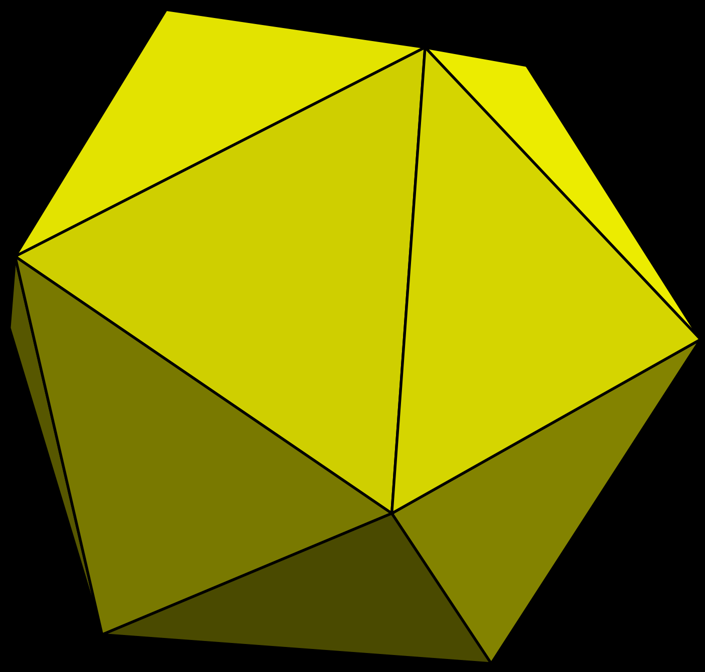


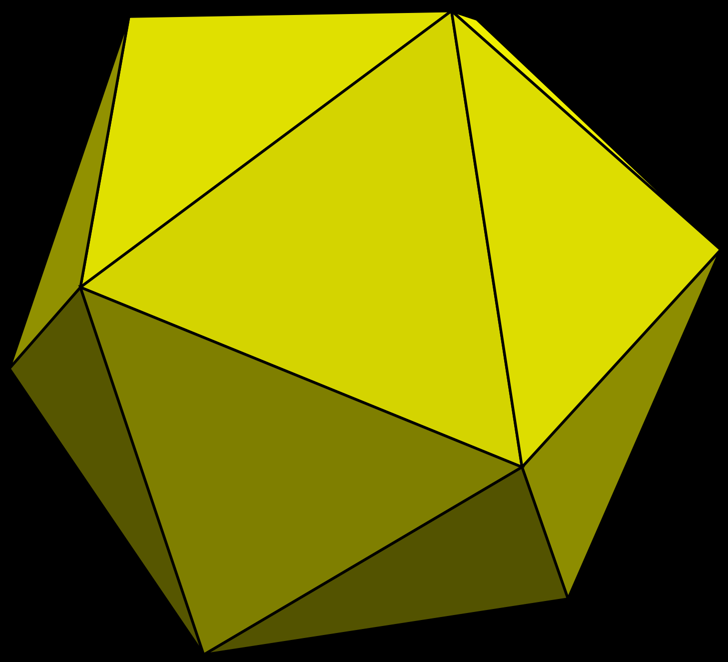


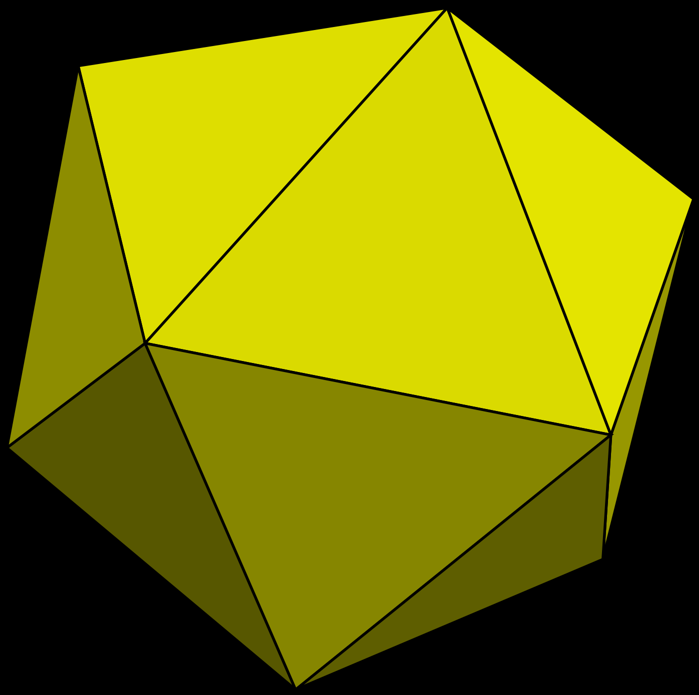


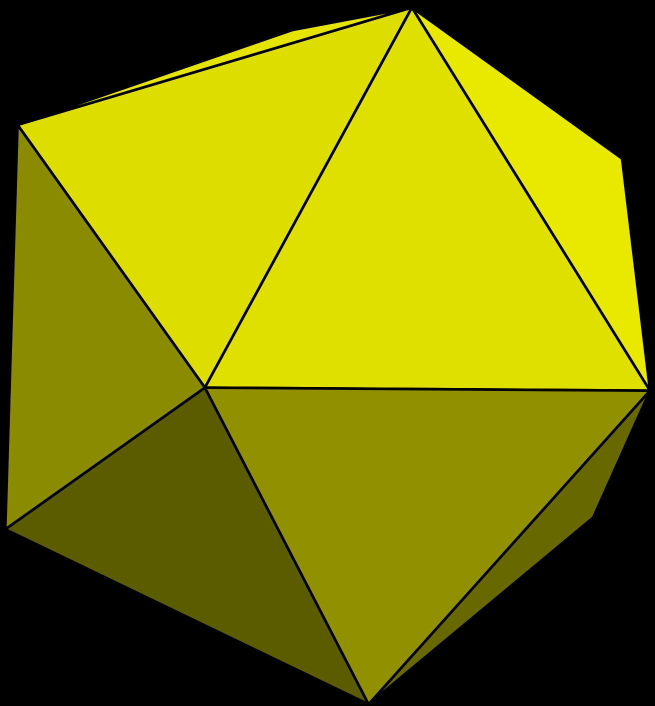


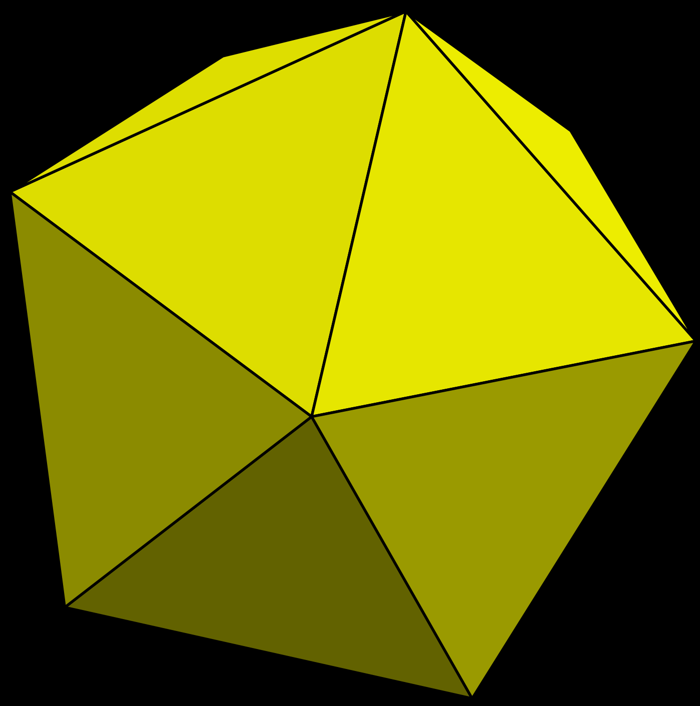


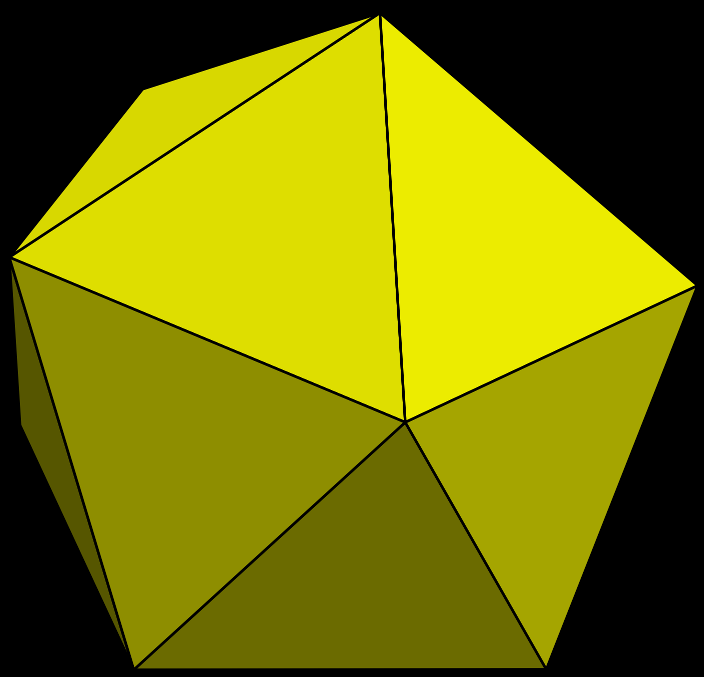


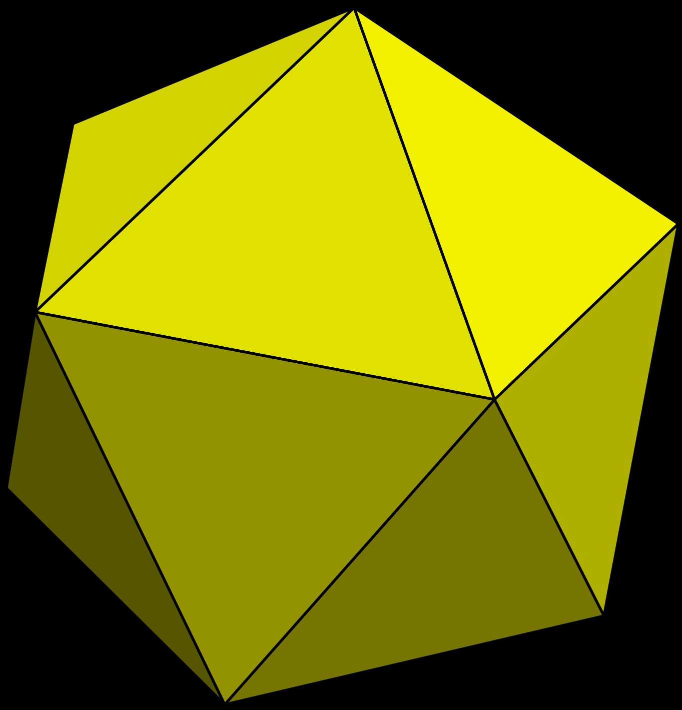


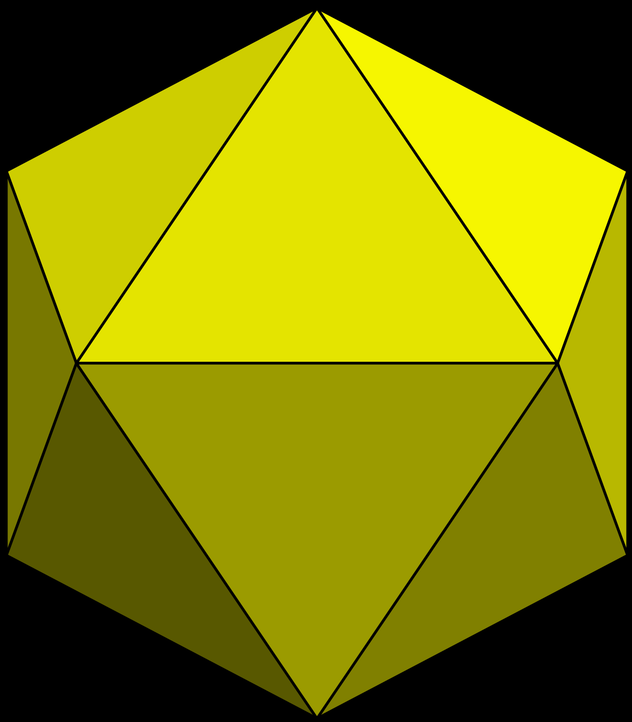


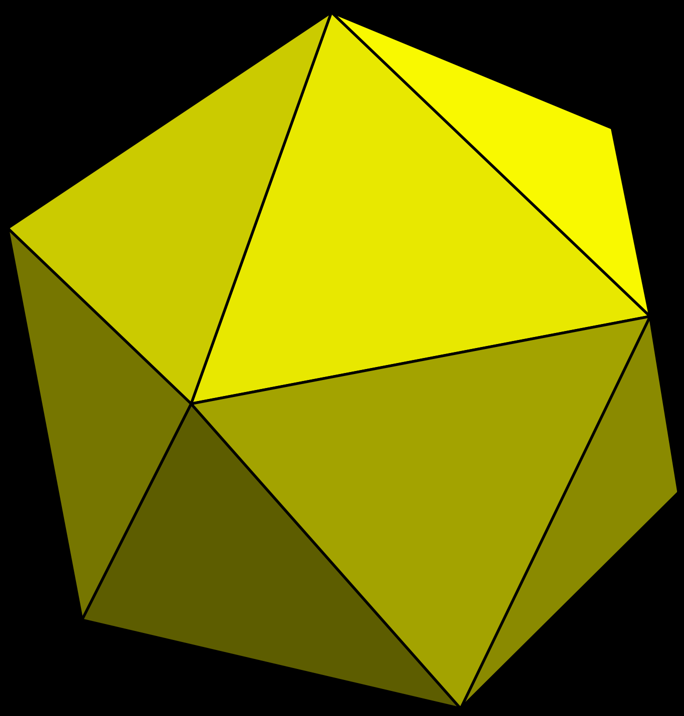


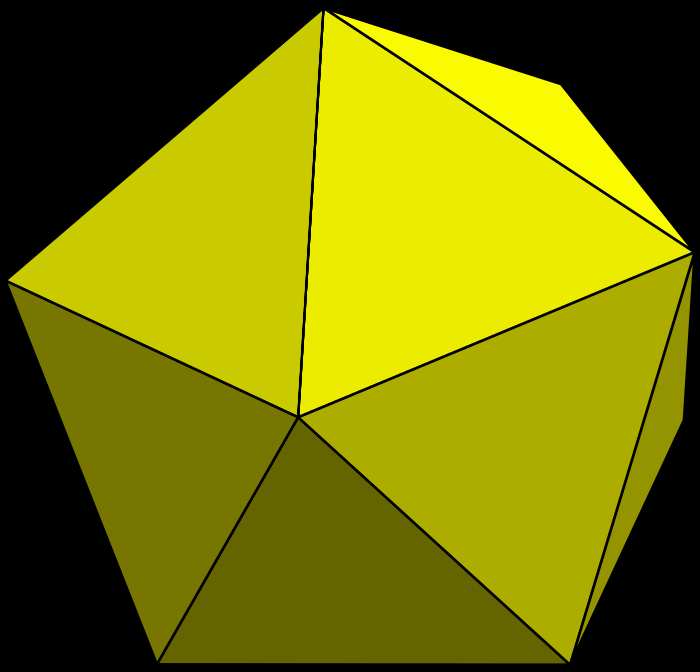












Now, we want to show the transformation from icosahedron to truncated icosahedron,which has much the same structure with Poliovirus, C60 (carbon atoms) and ....

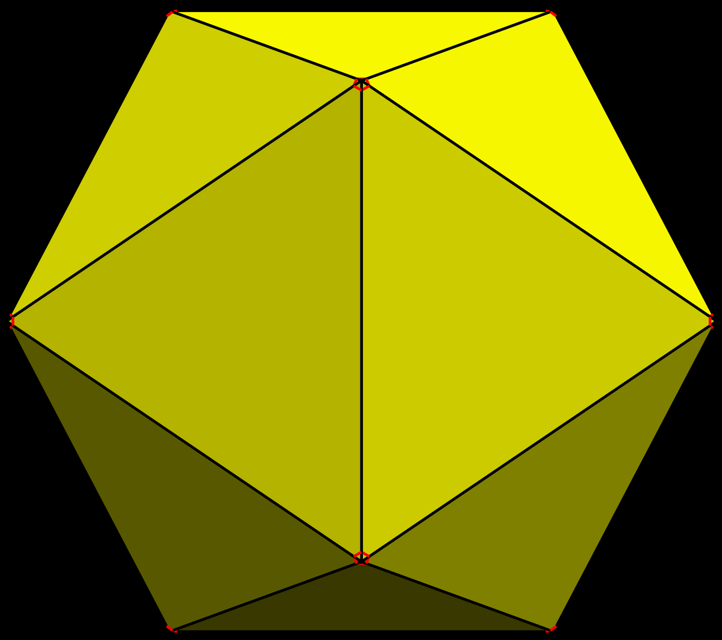
S..O...C...C...E...R.........b...A....L....l

To do this, we need to cut every triangle into

pentagon or hexagons.

The truncated icosahedron will have 60 vertex.

First, we draw the area which we will cut.



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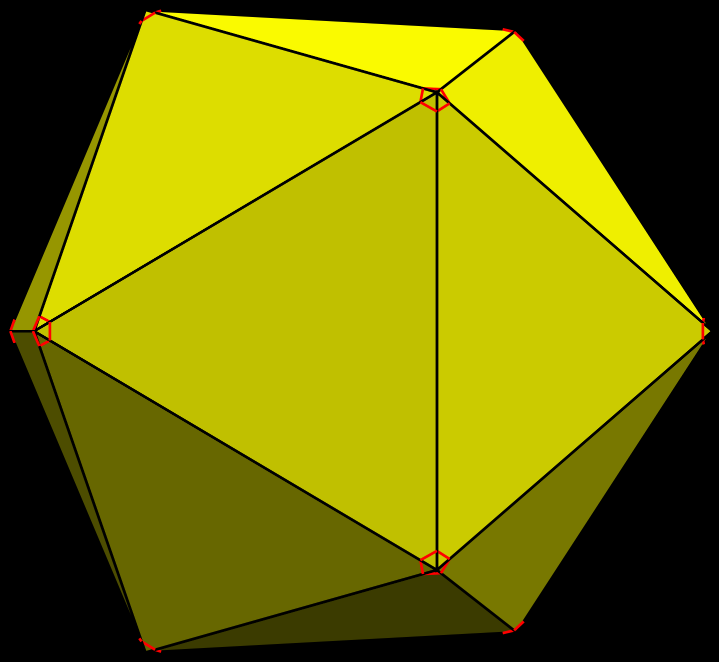

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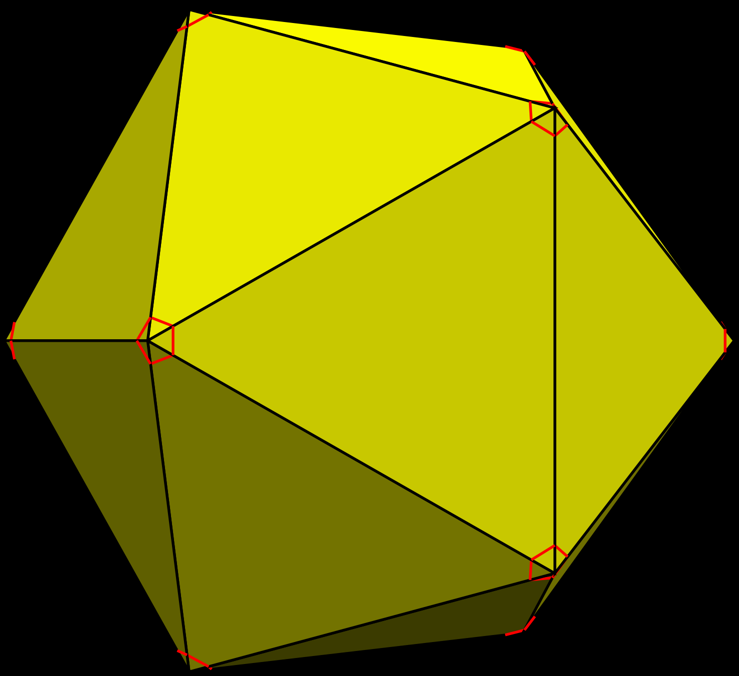

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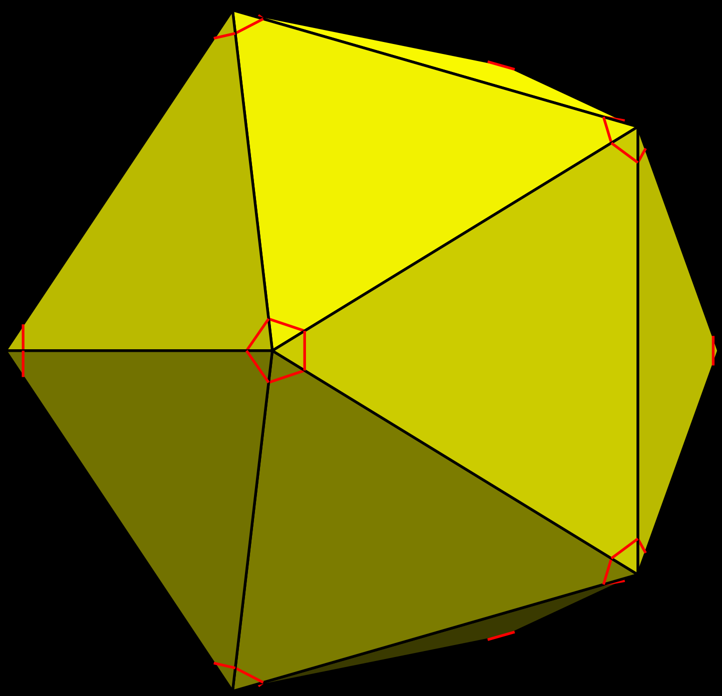

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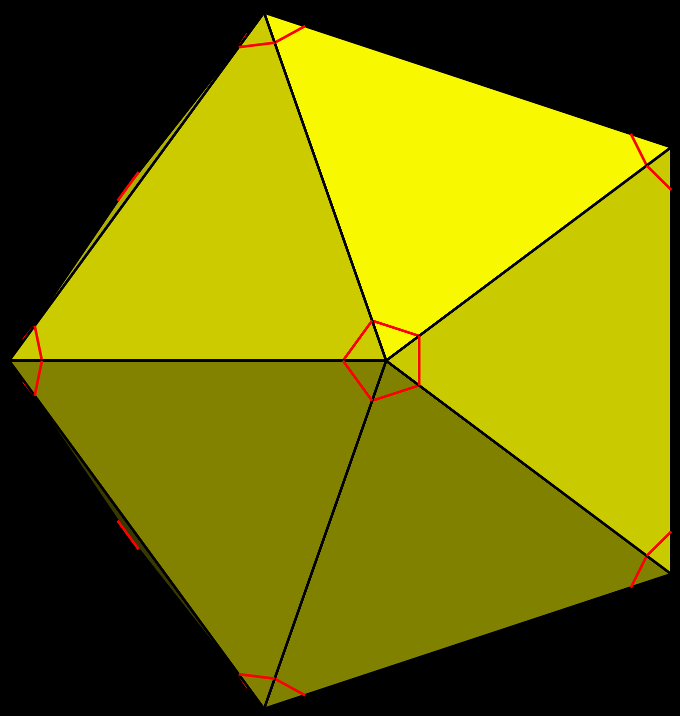

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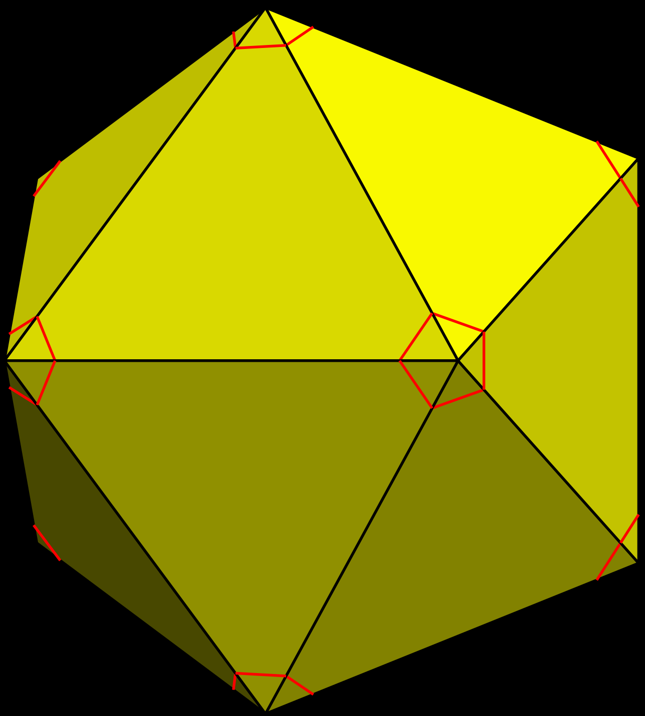

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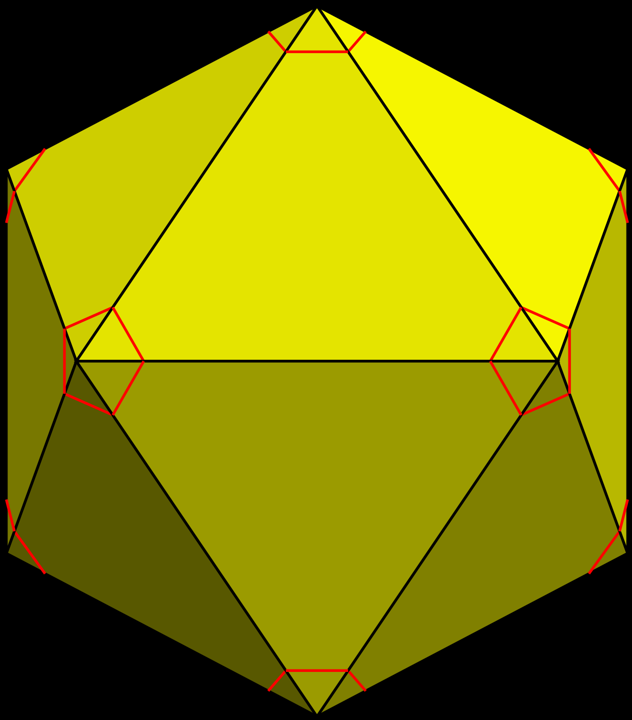

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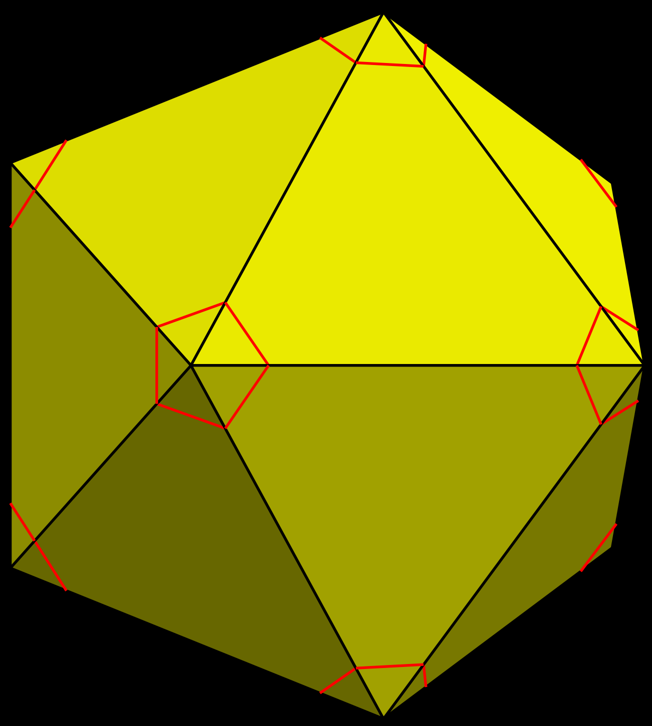

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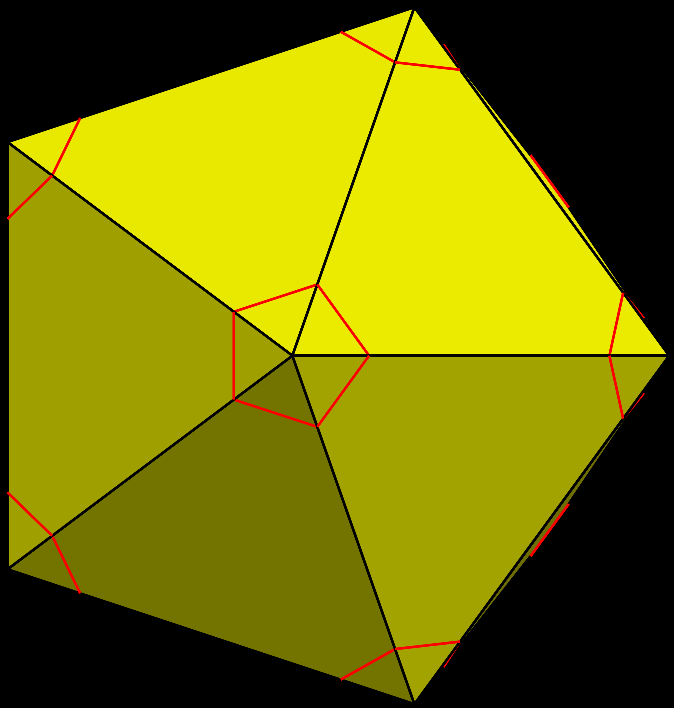

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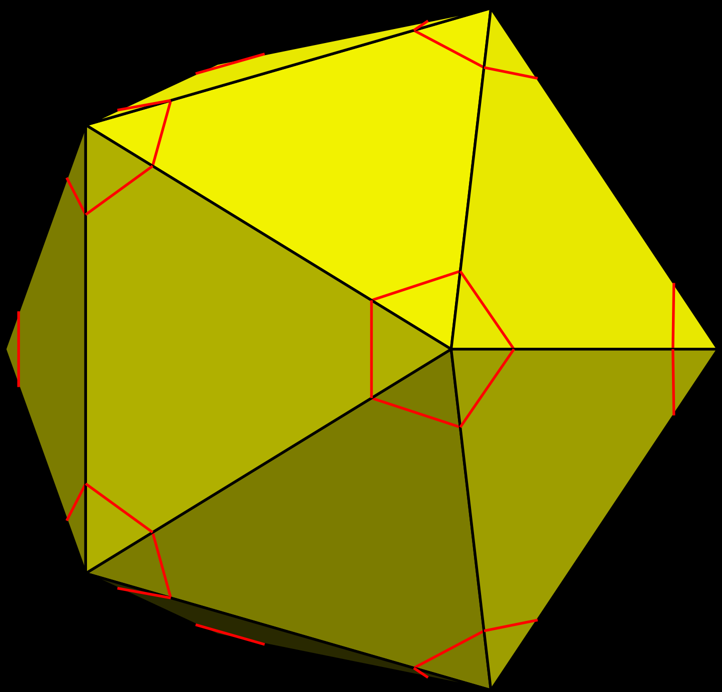

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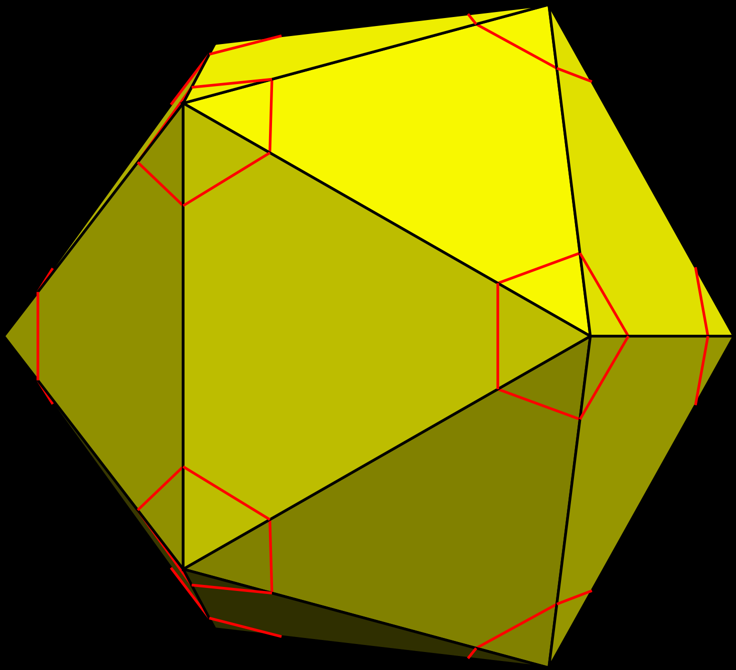

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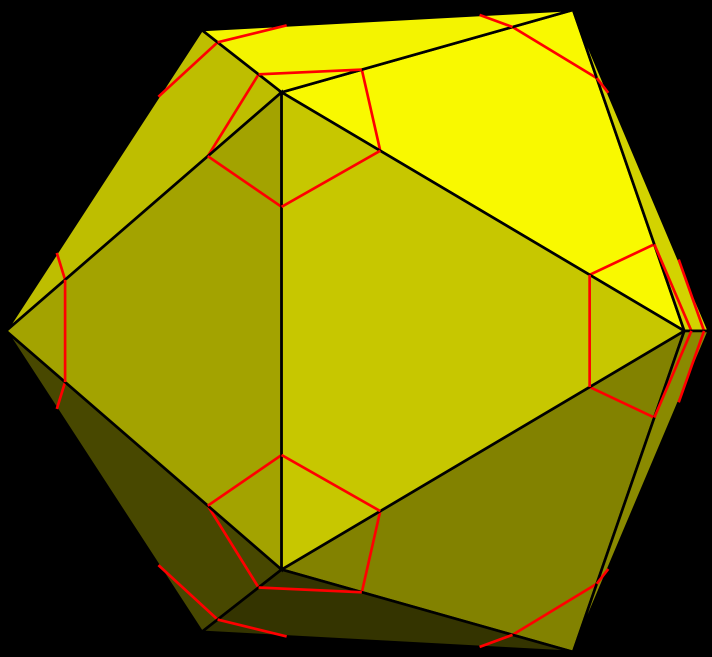

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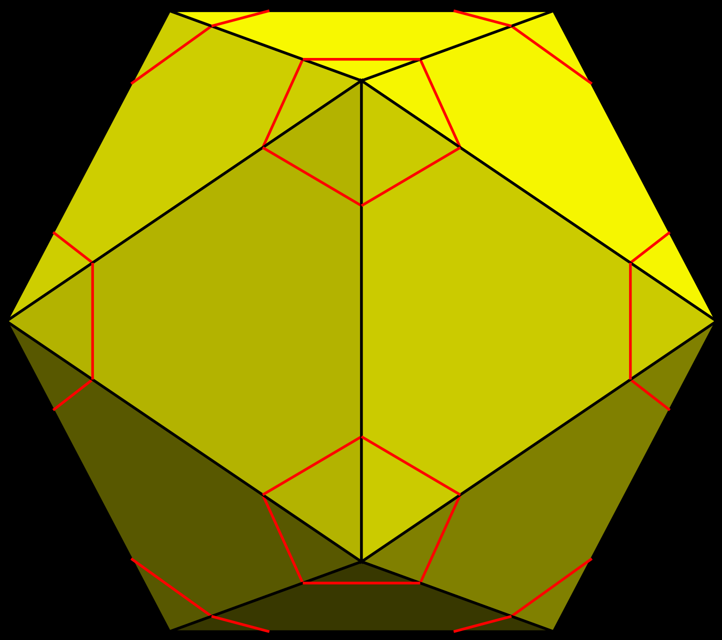

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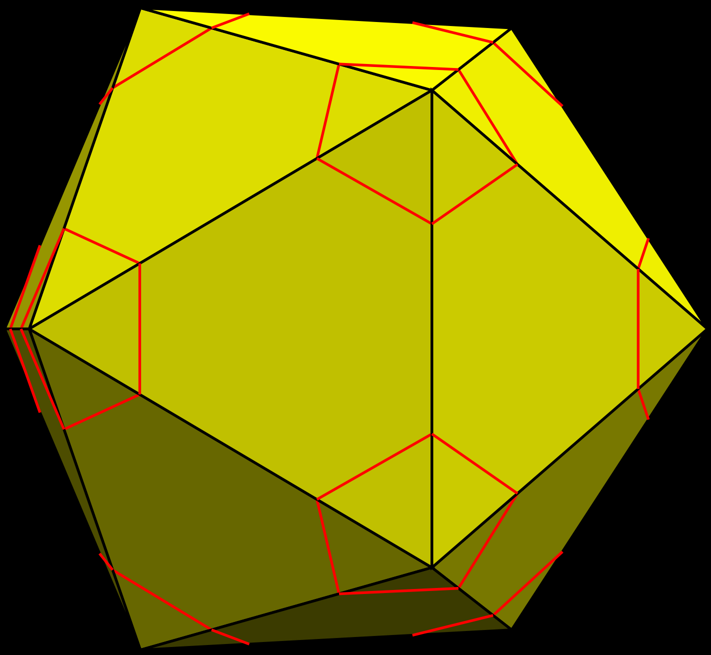

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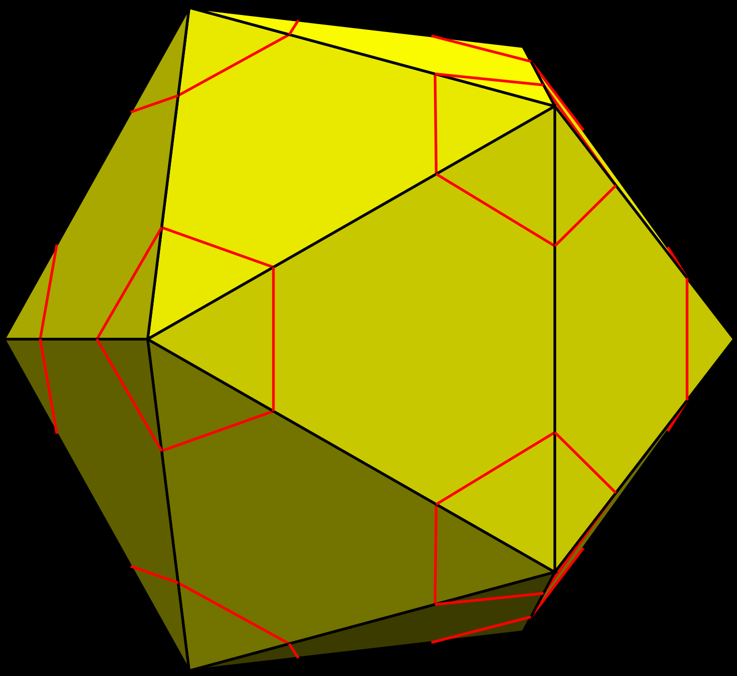

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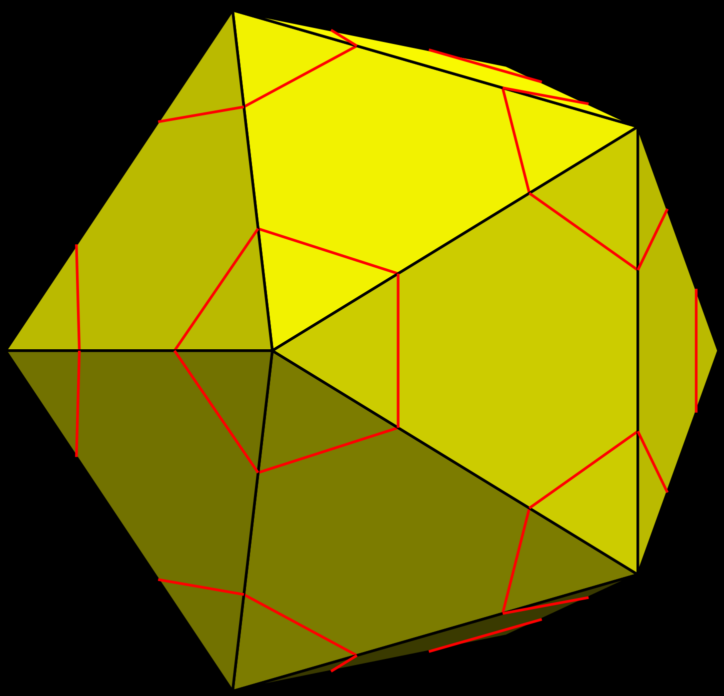

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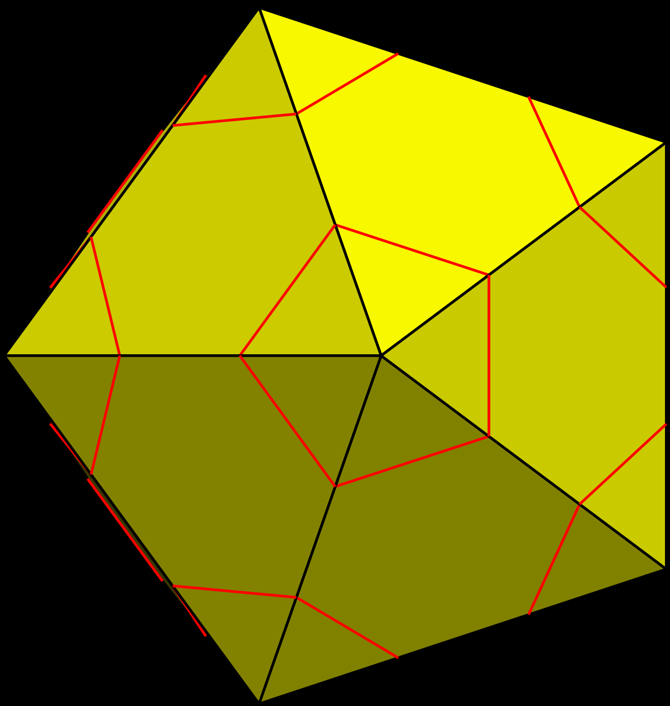

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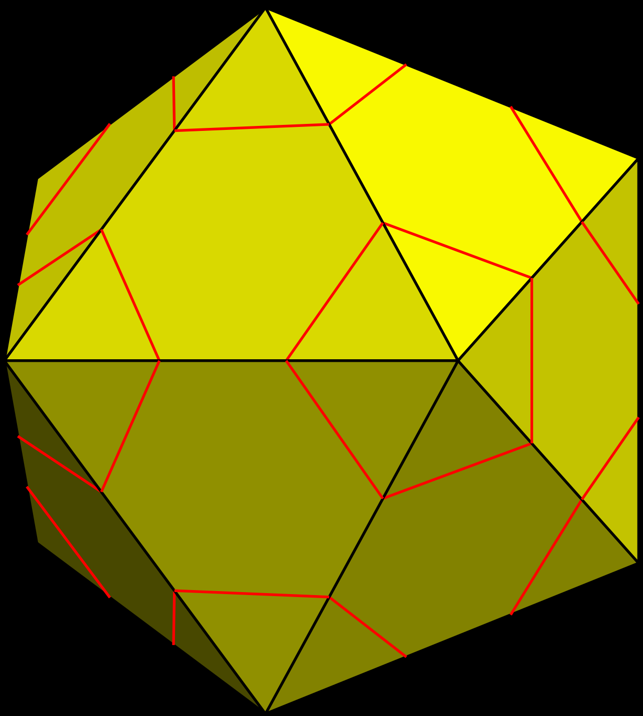
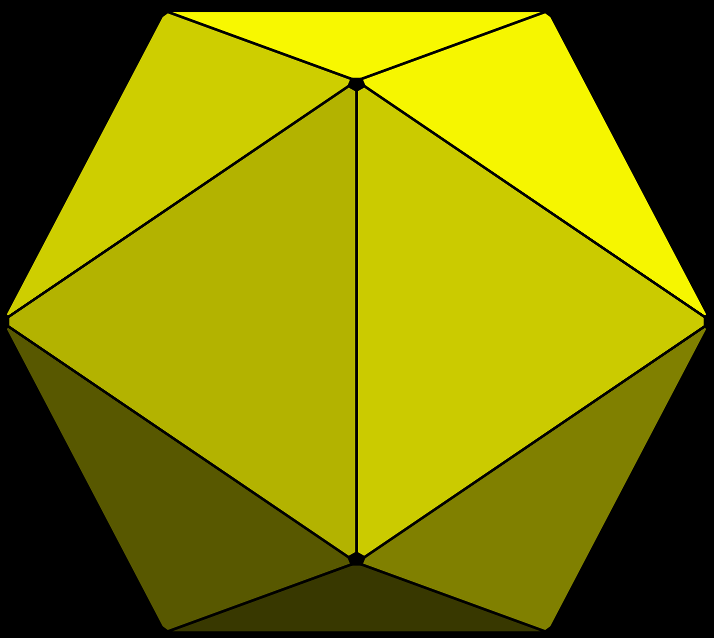


Now we cut it step by step



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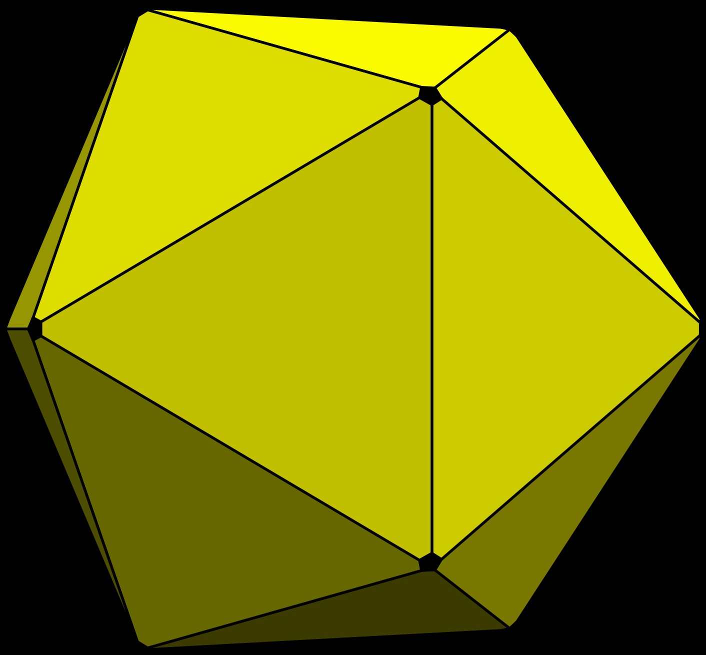

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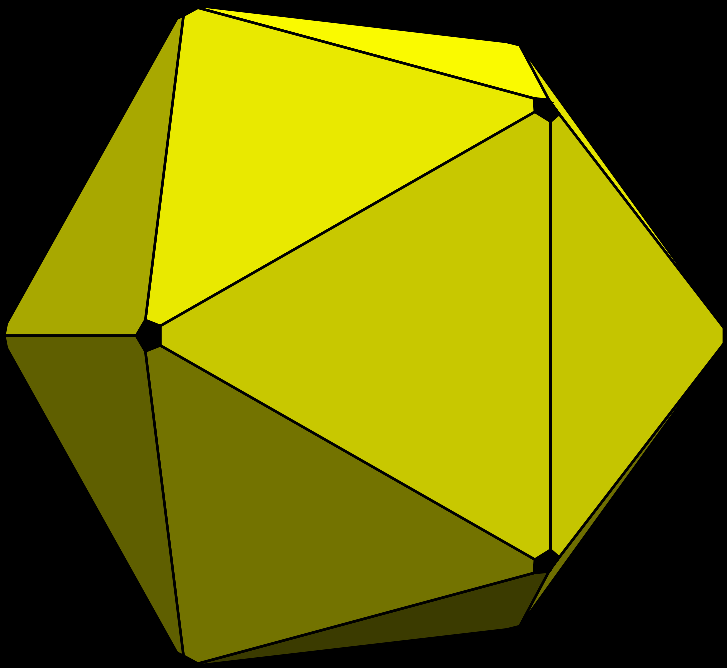

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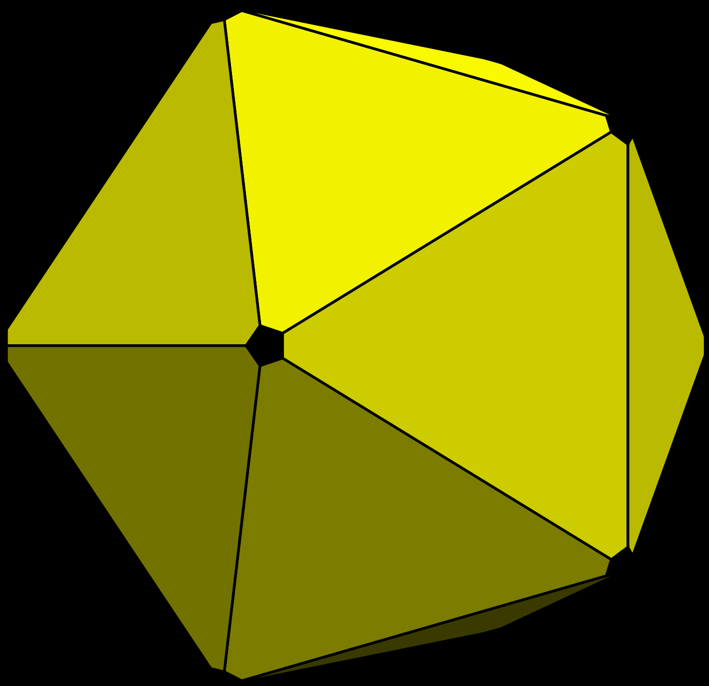

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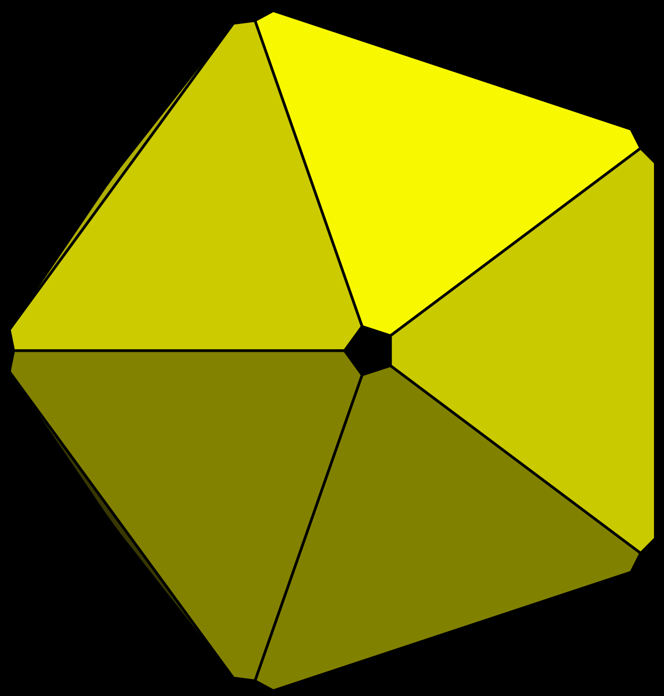

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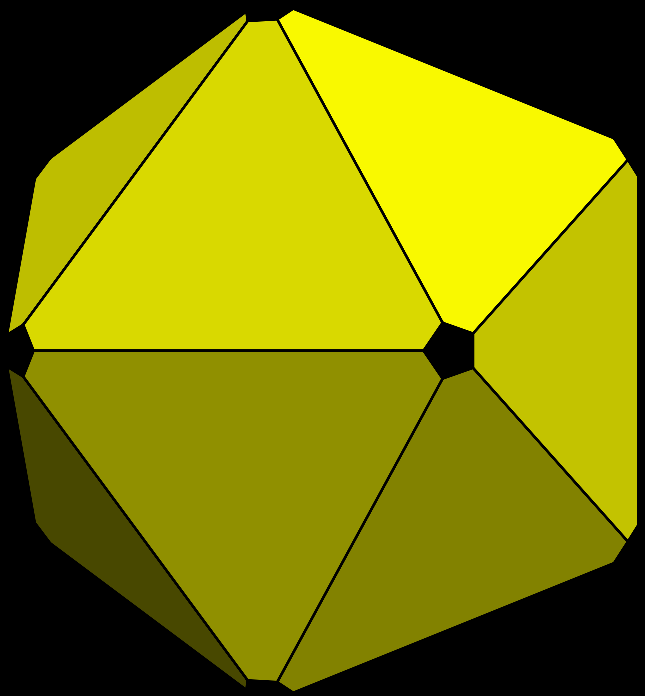

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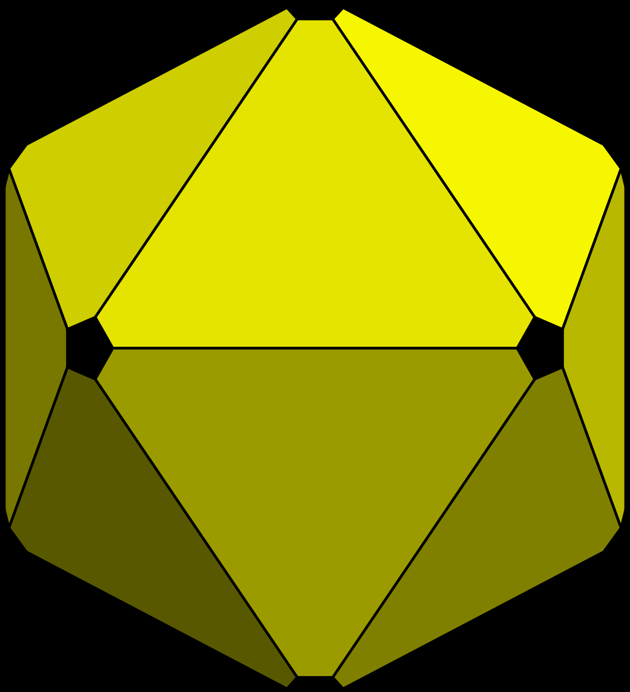

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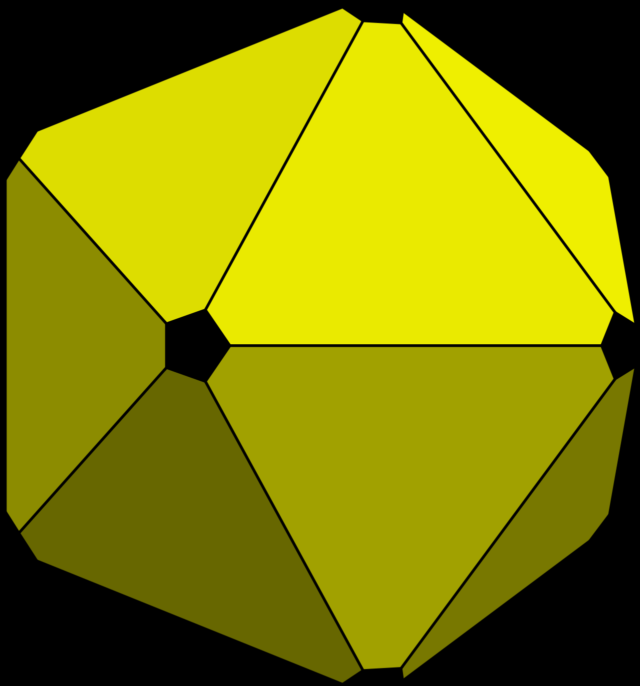

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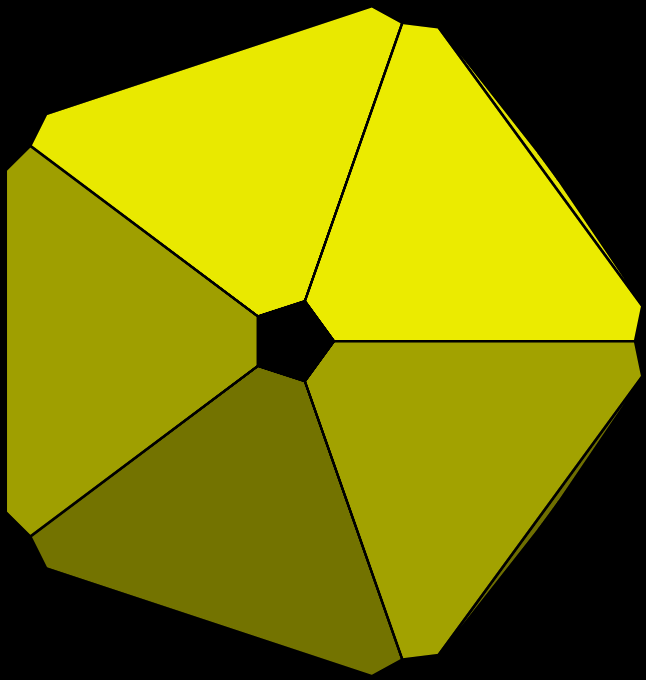

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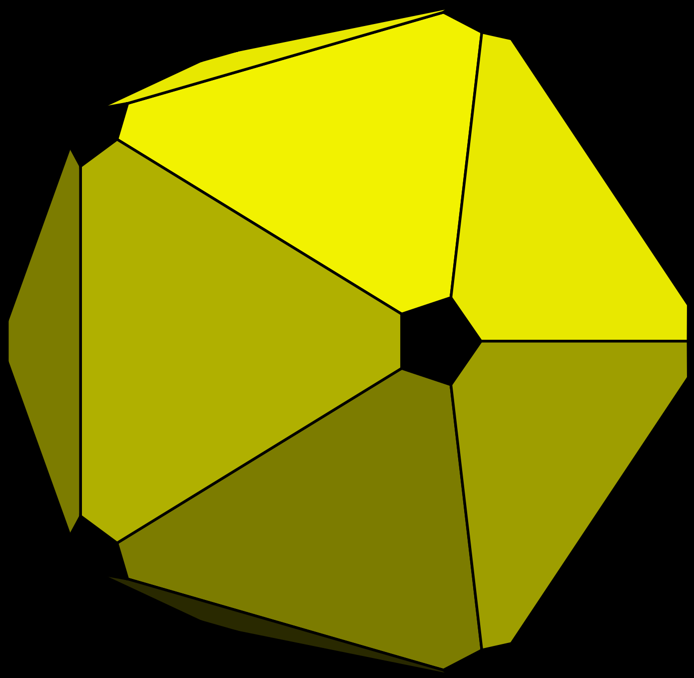

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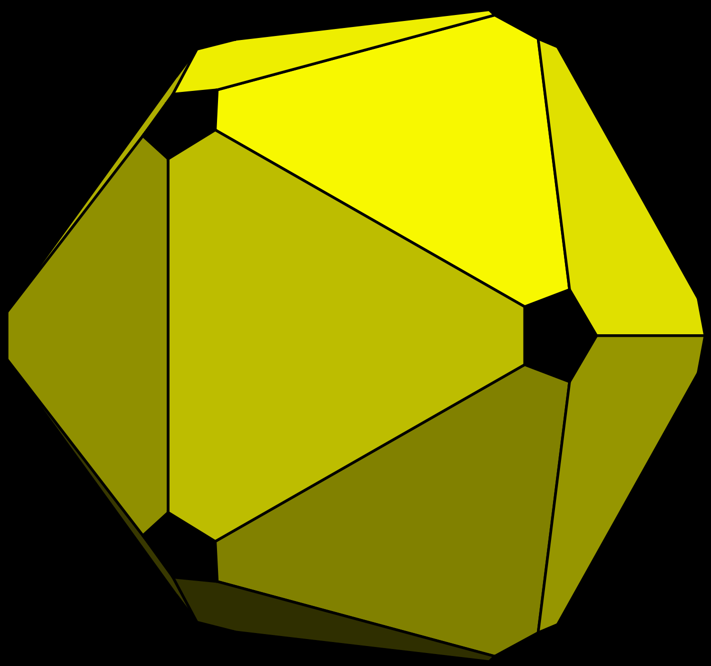

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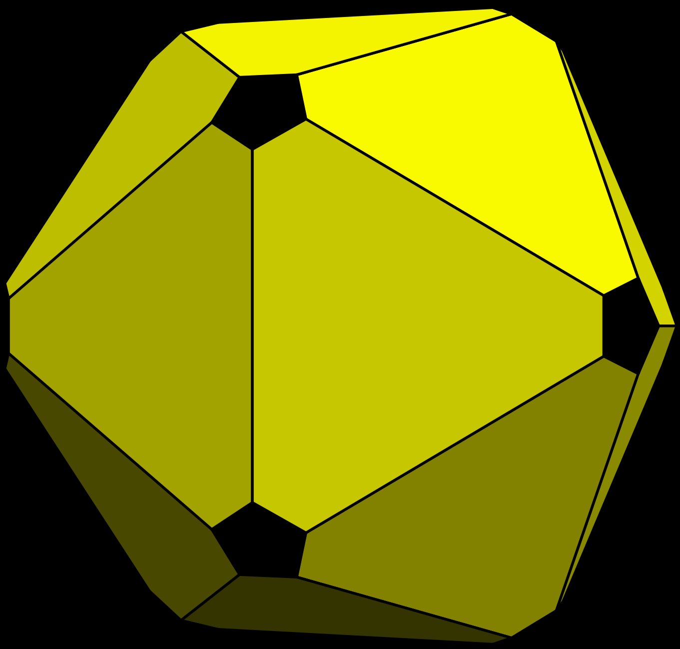

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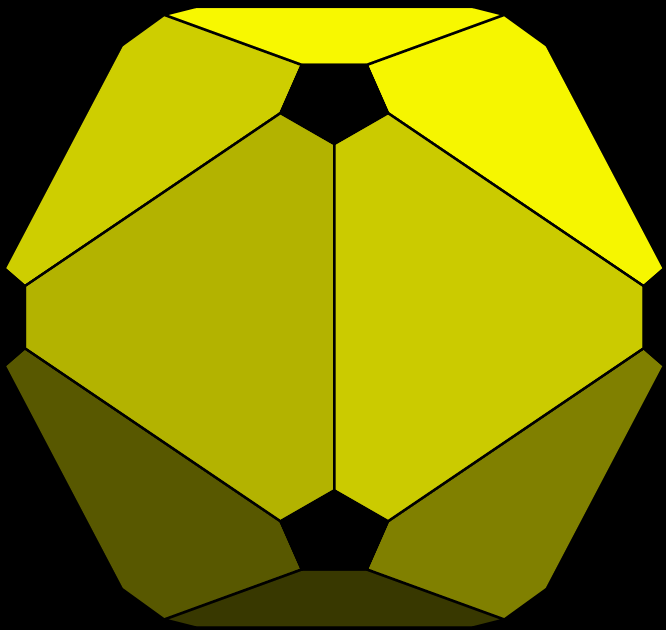

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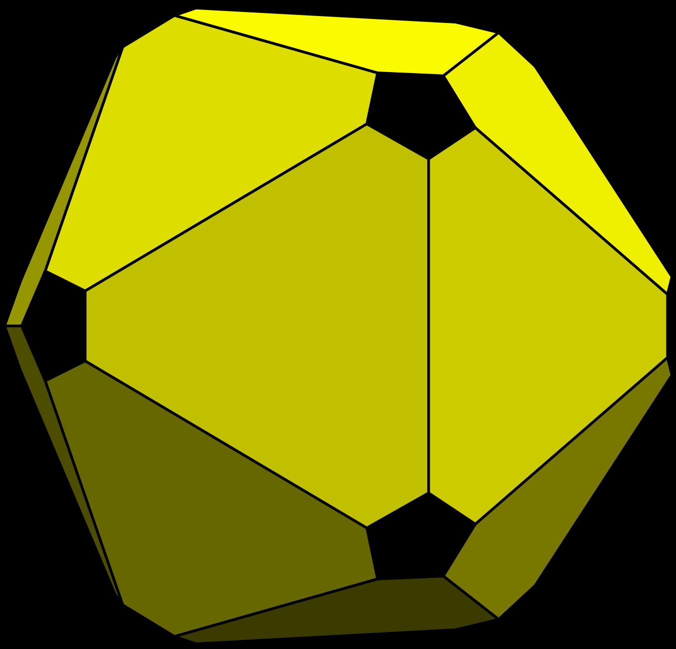

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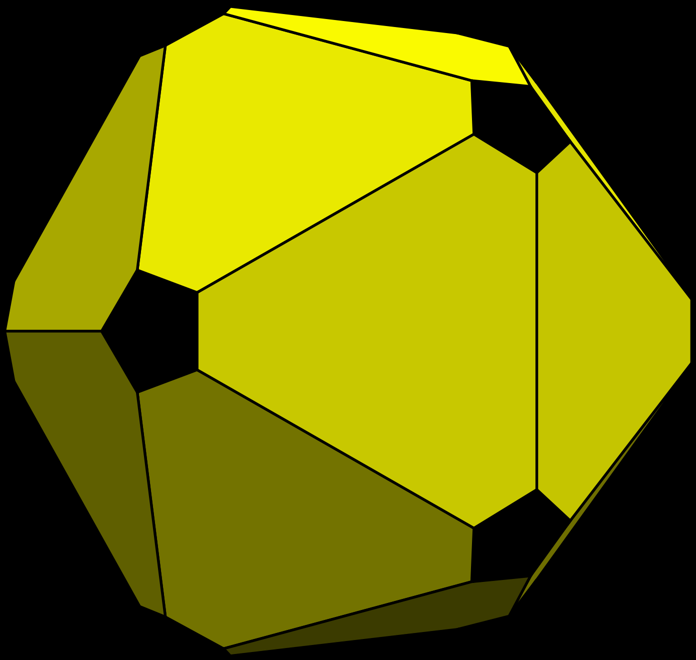

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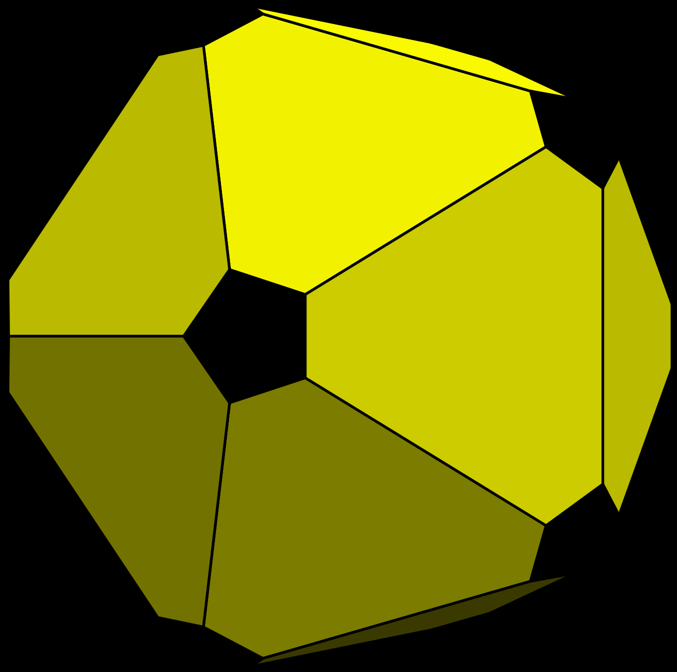

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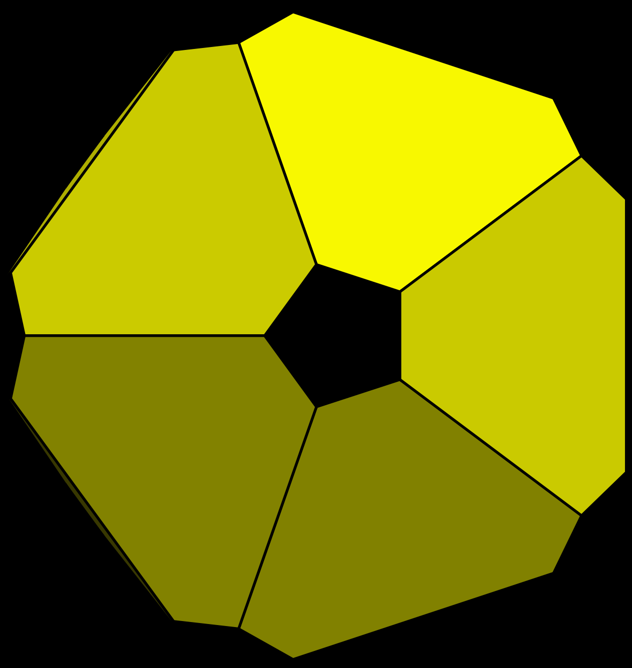

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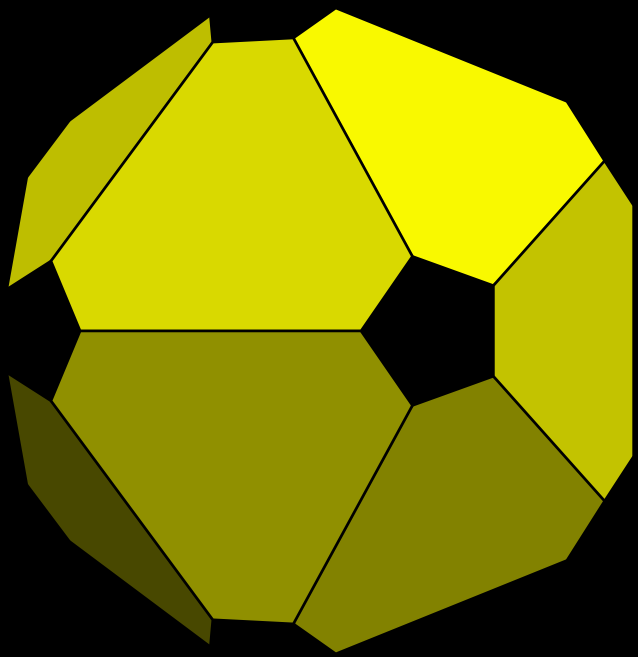

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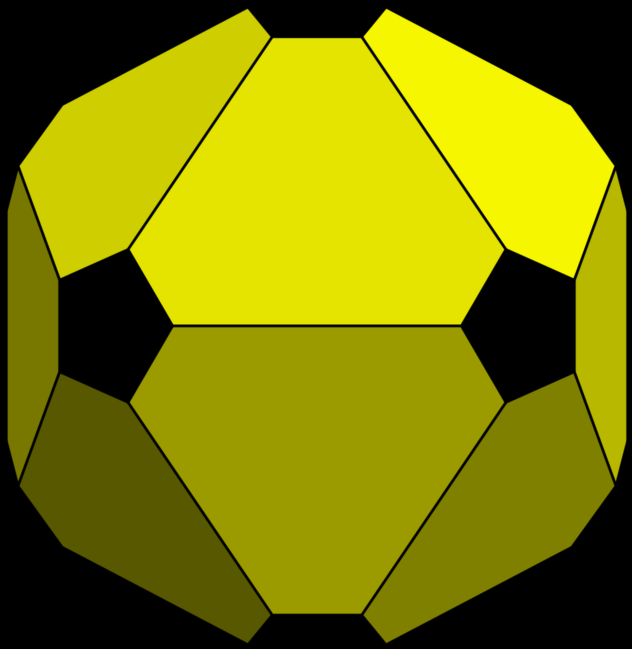

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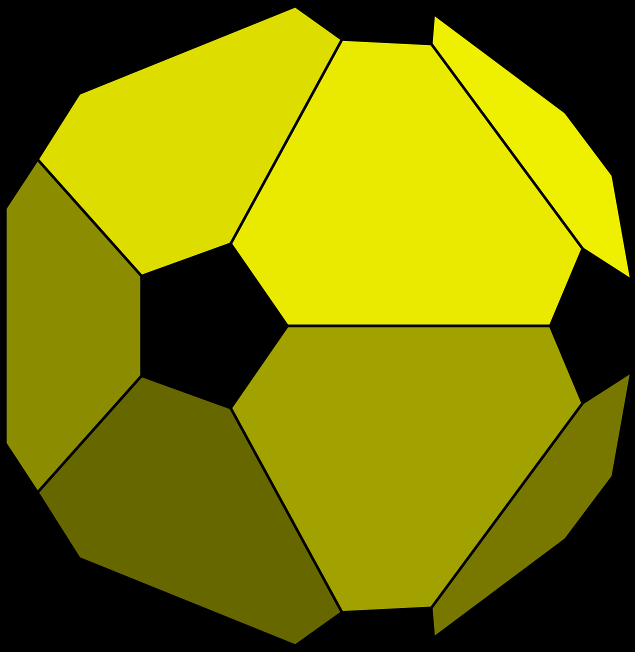

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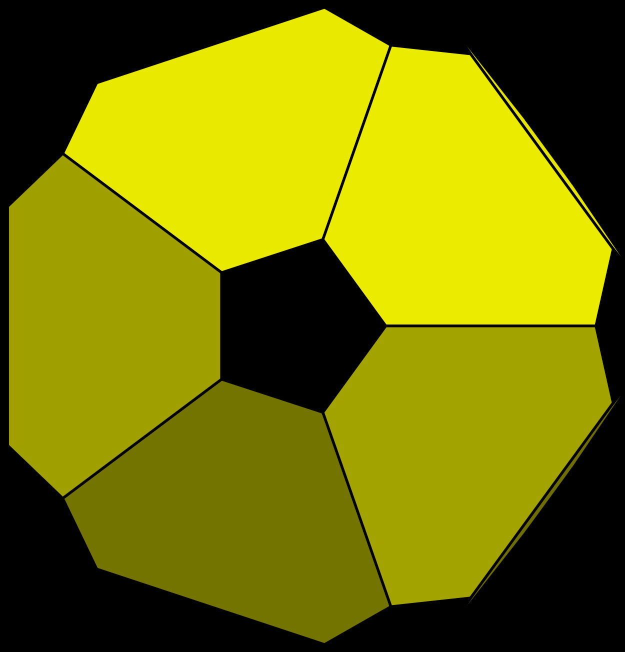

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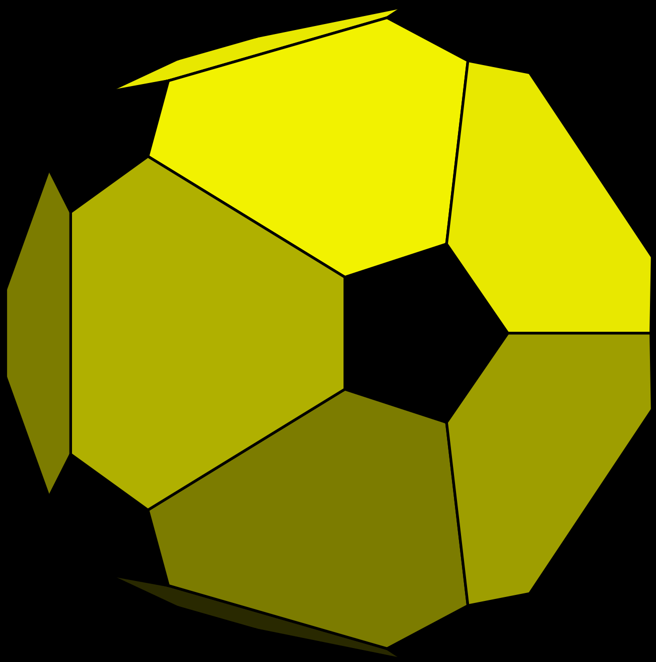

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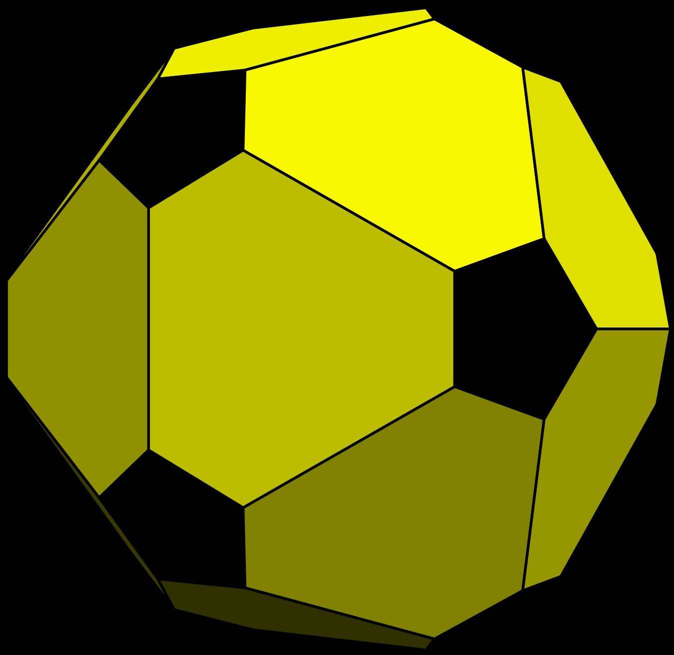

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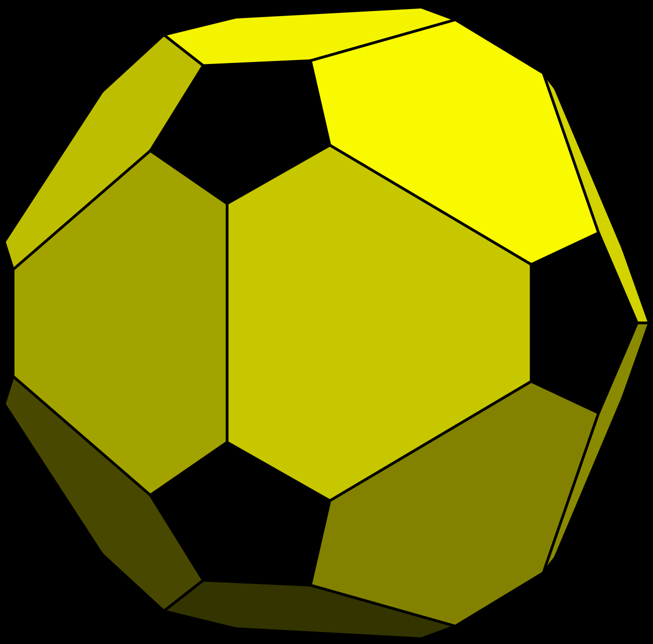

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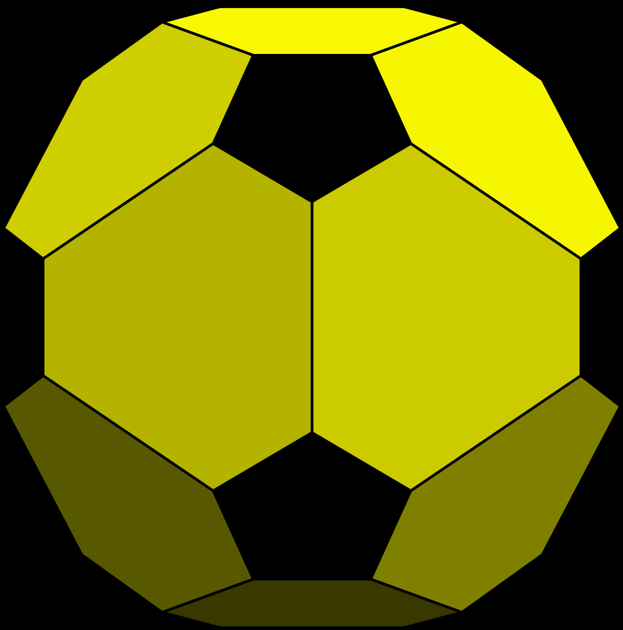

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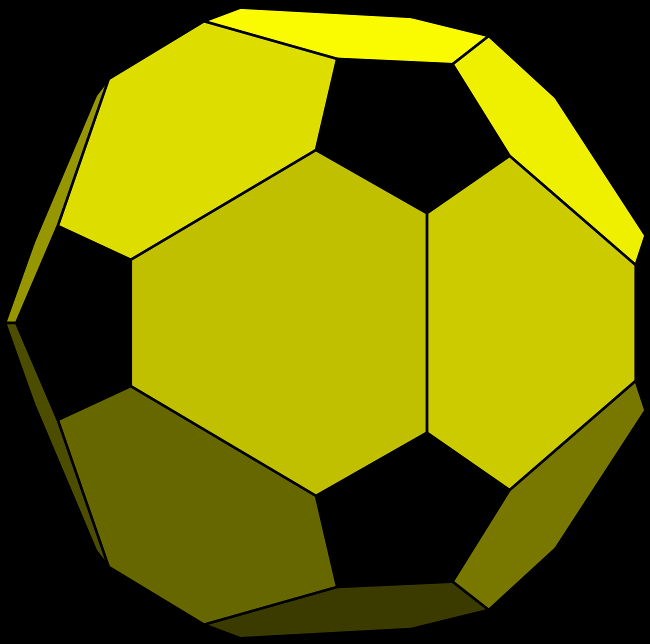

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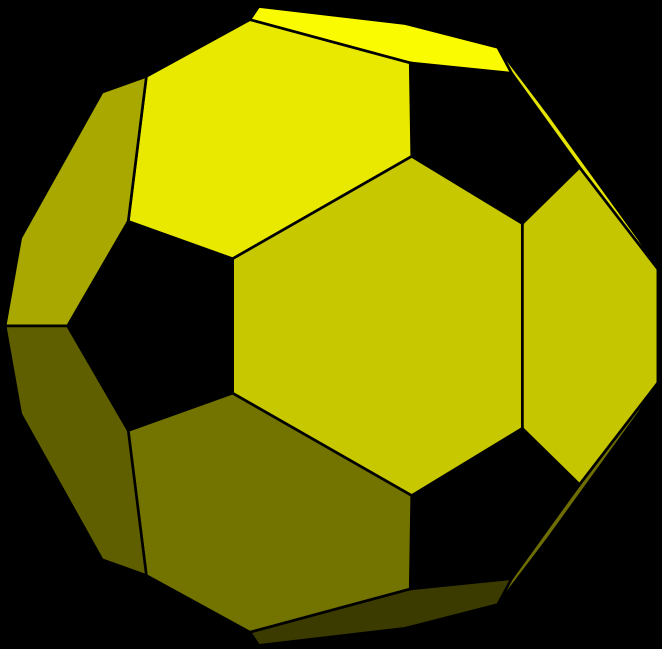

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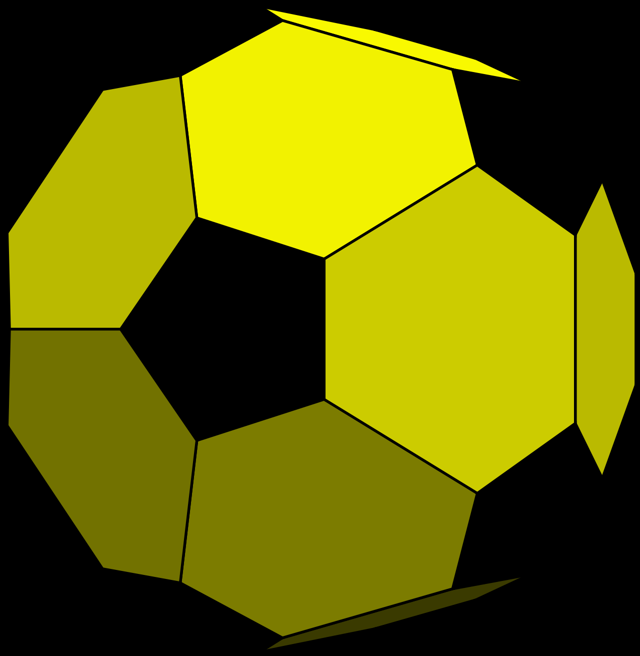

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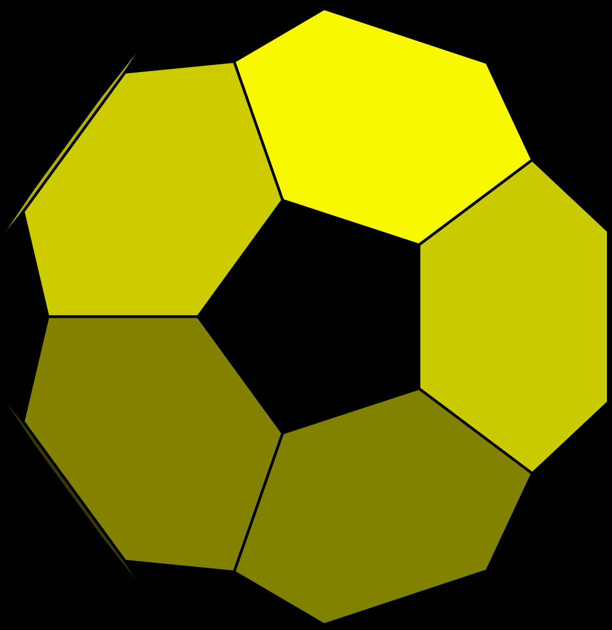

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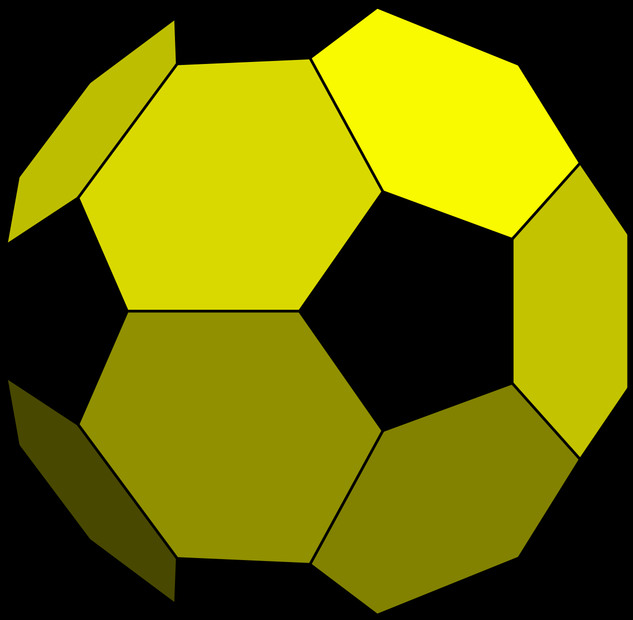

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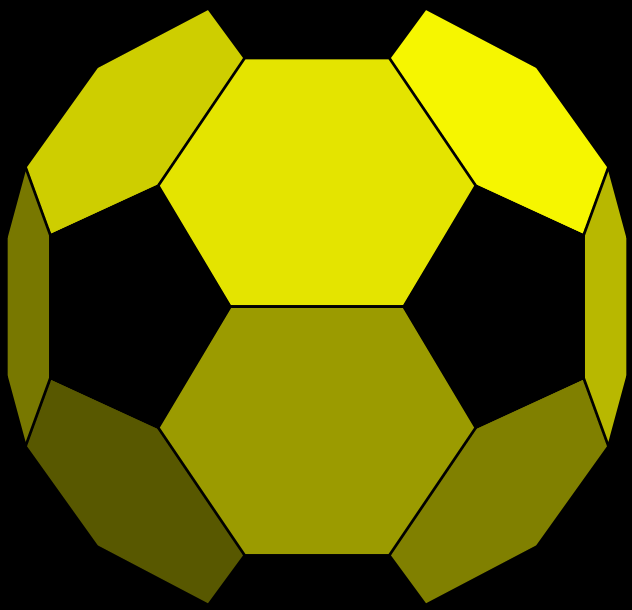

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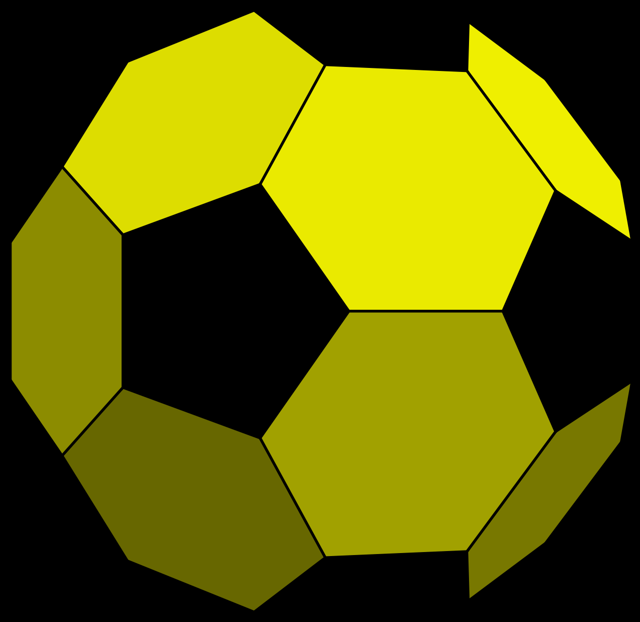

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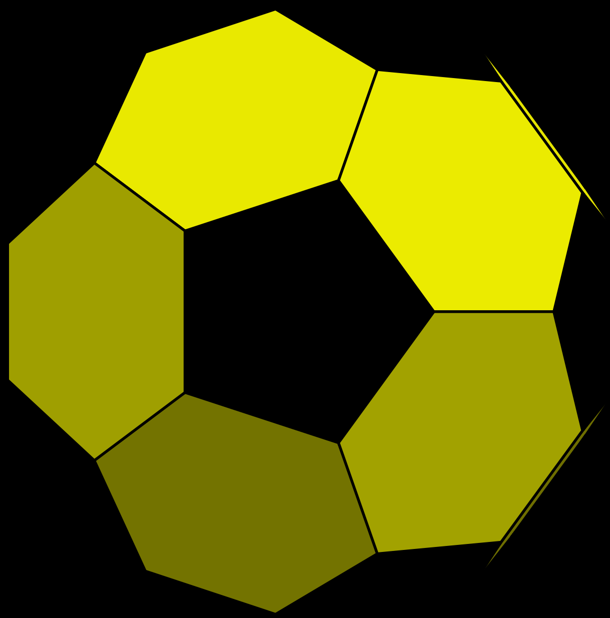

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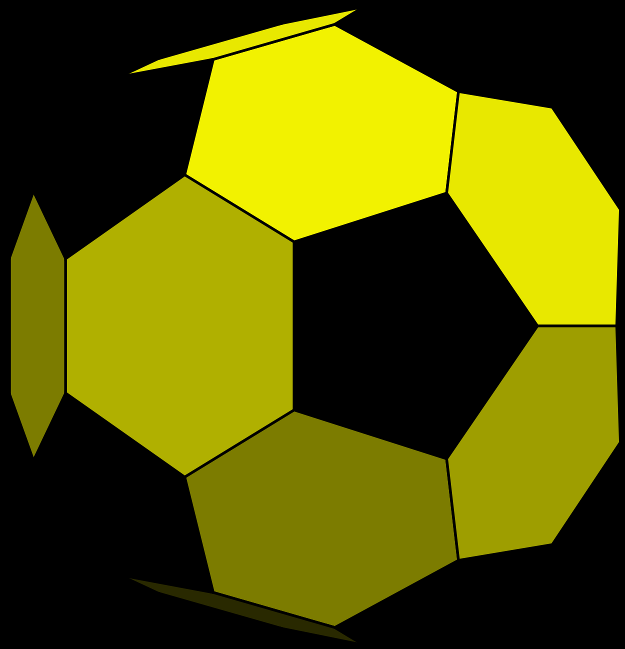

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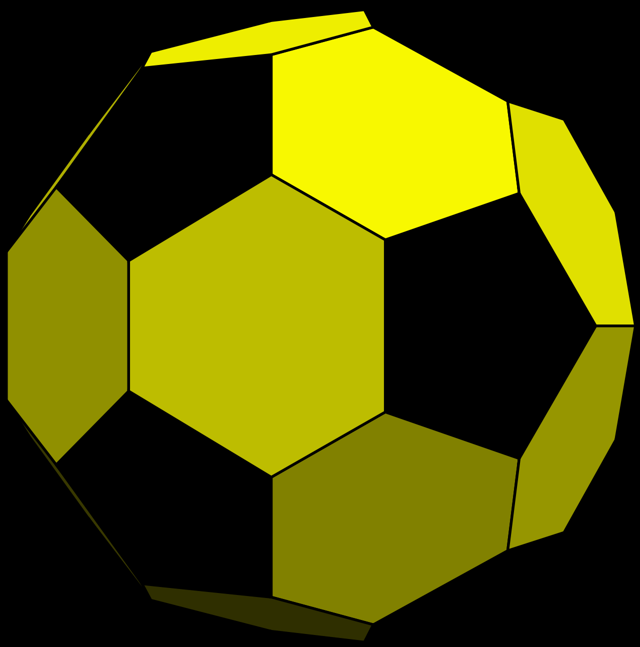
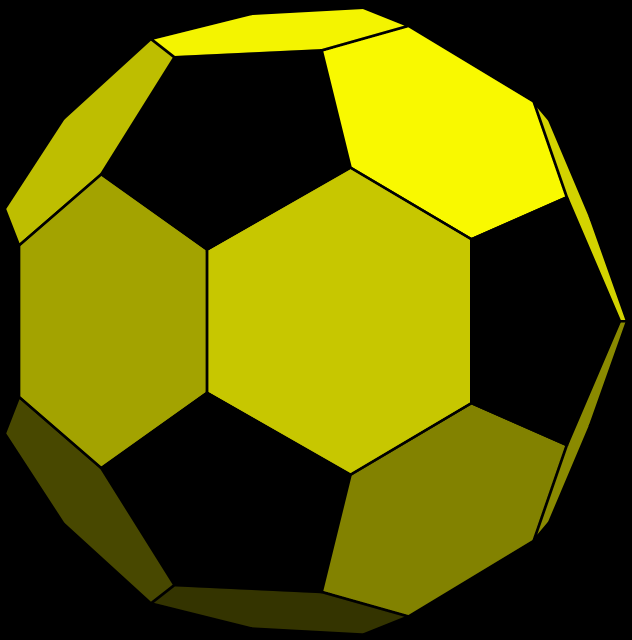


Here, we have a truncated icosahedron



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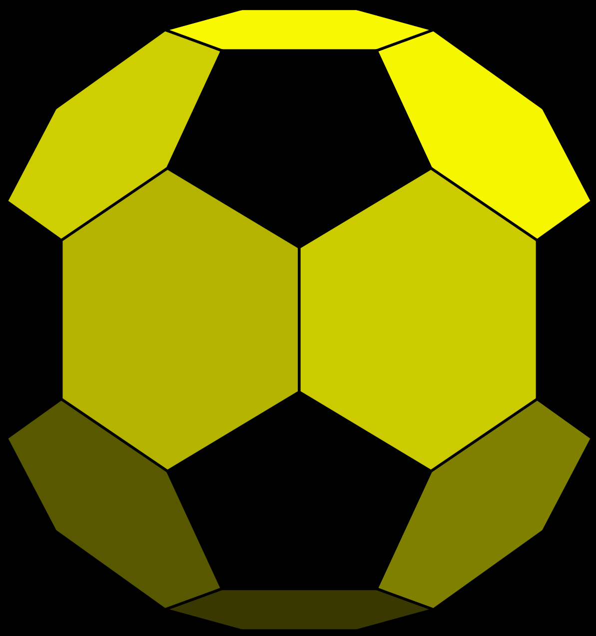

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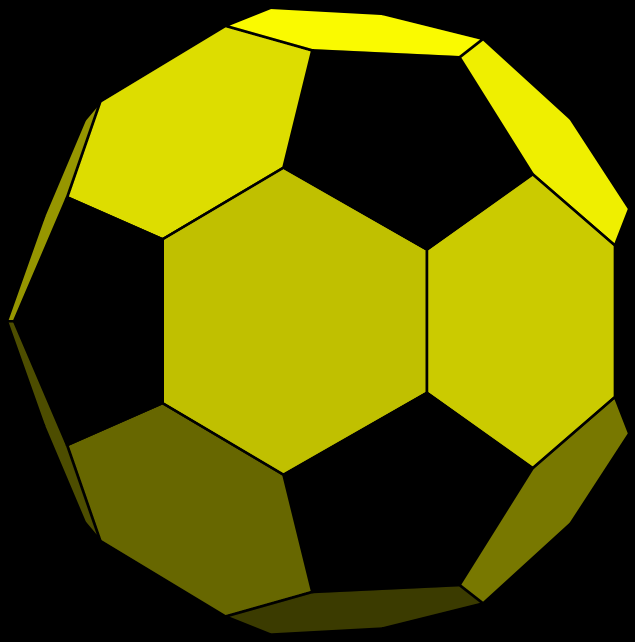

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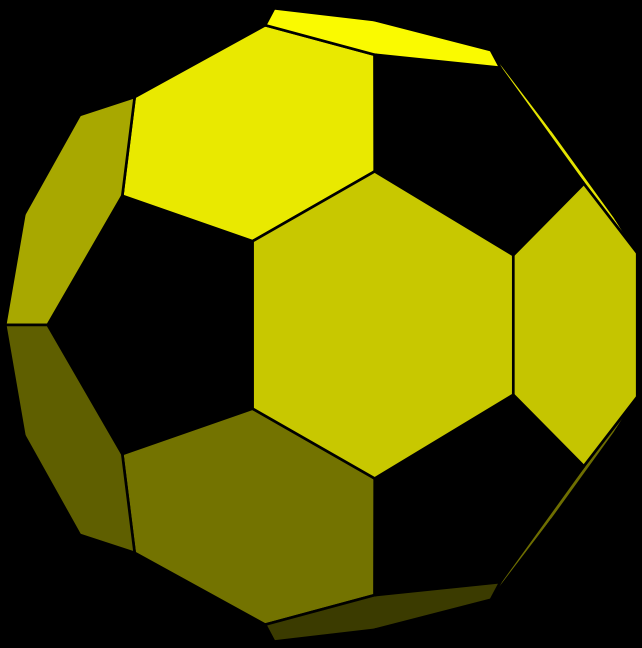
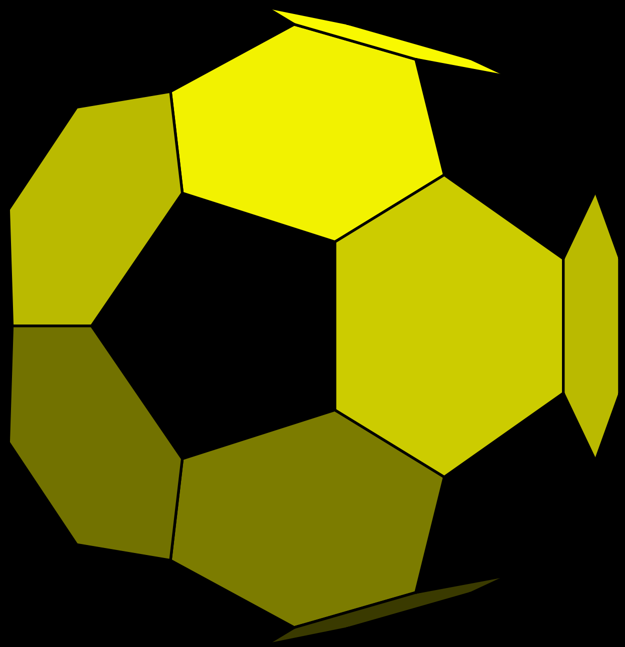


c60 and Poliovirus has much the same structure.



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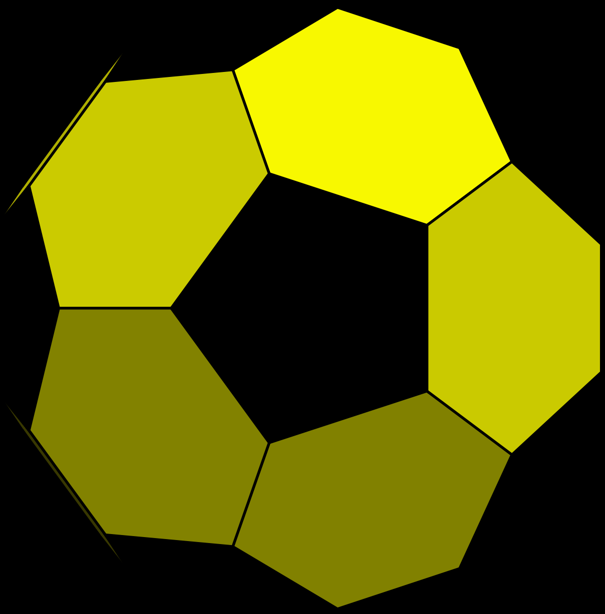

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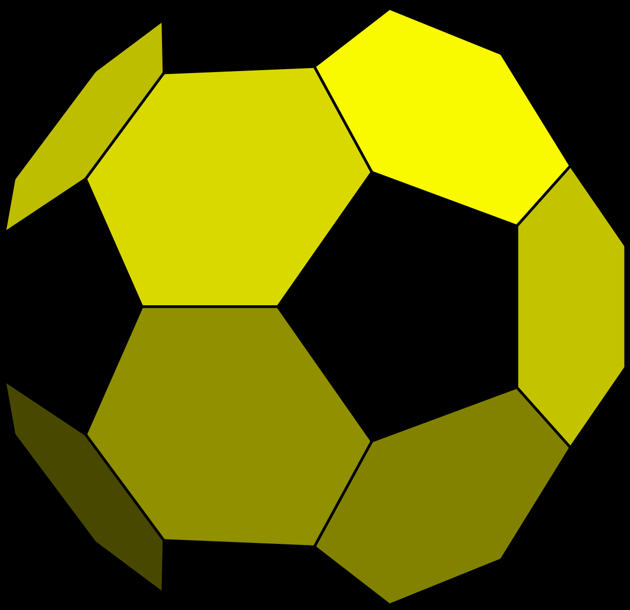

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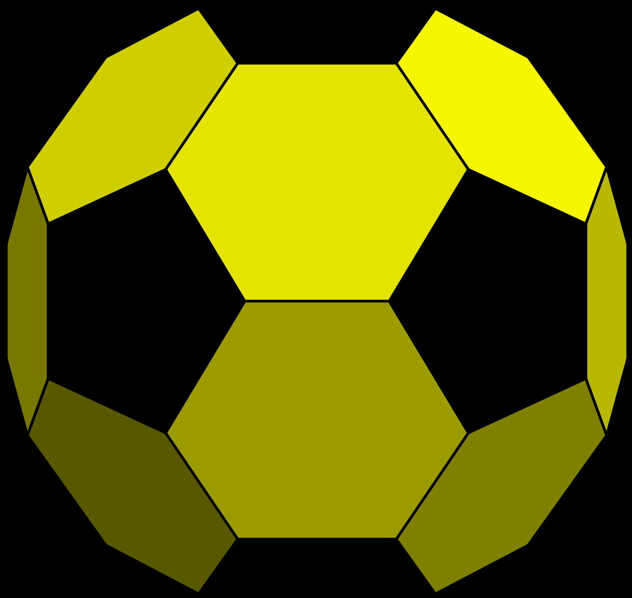

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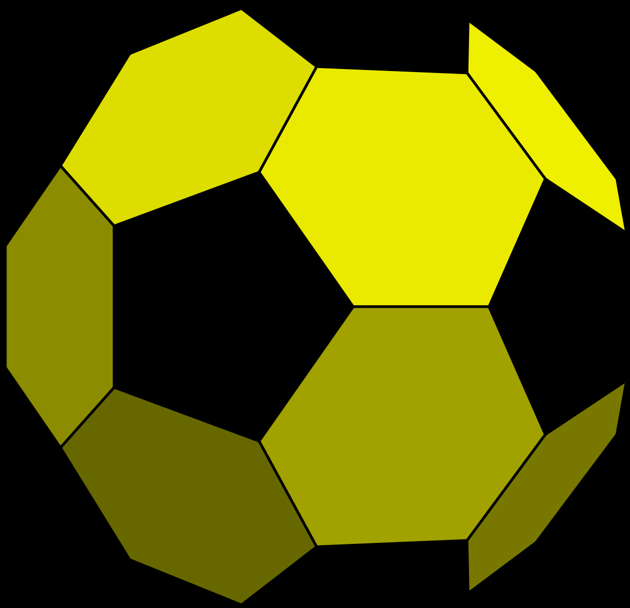

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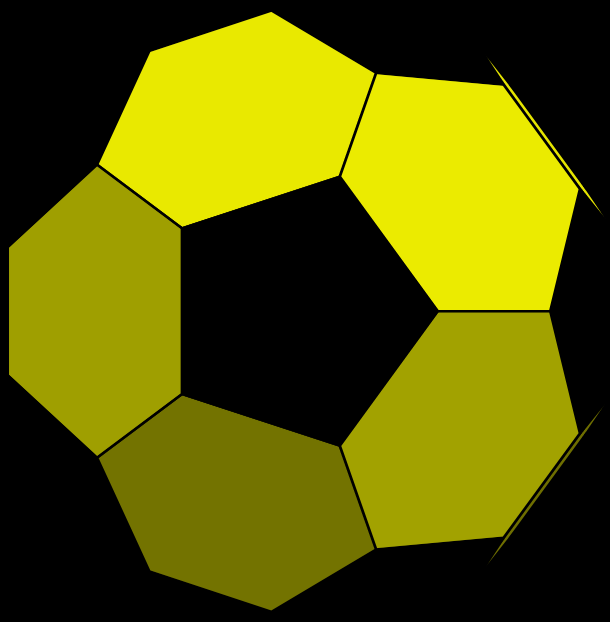

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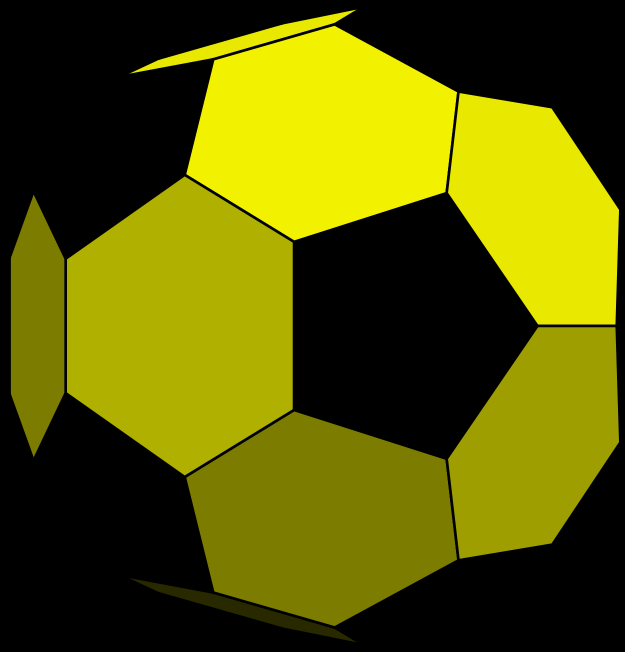

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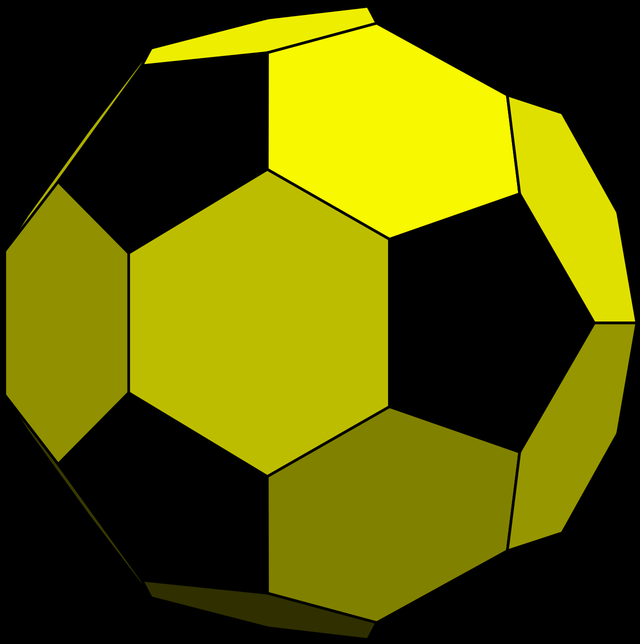

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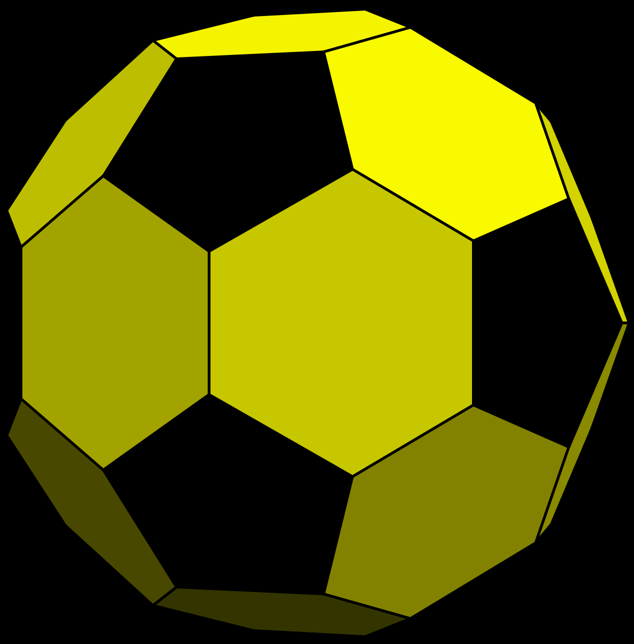
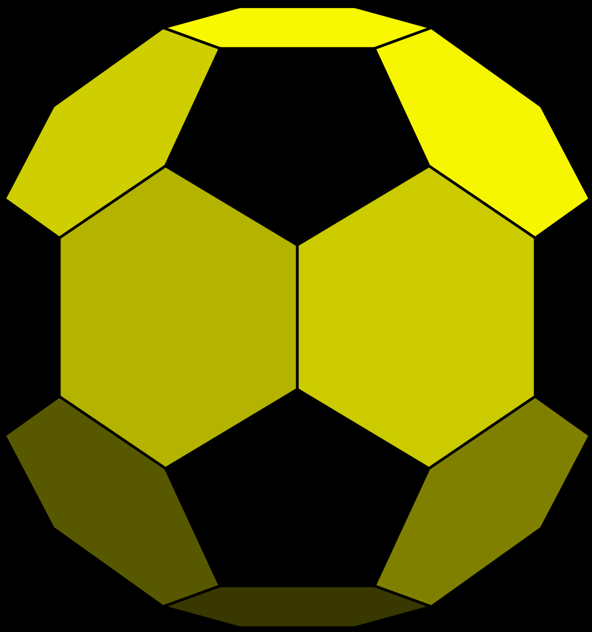


Now, we transform it into a soccer ball



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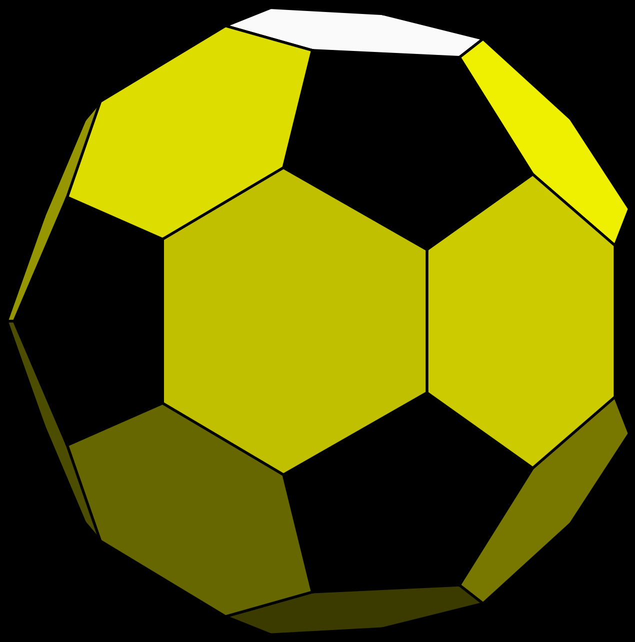

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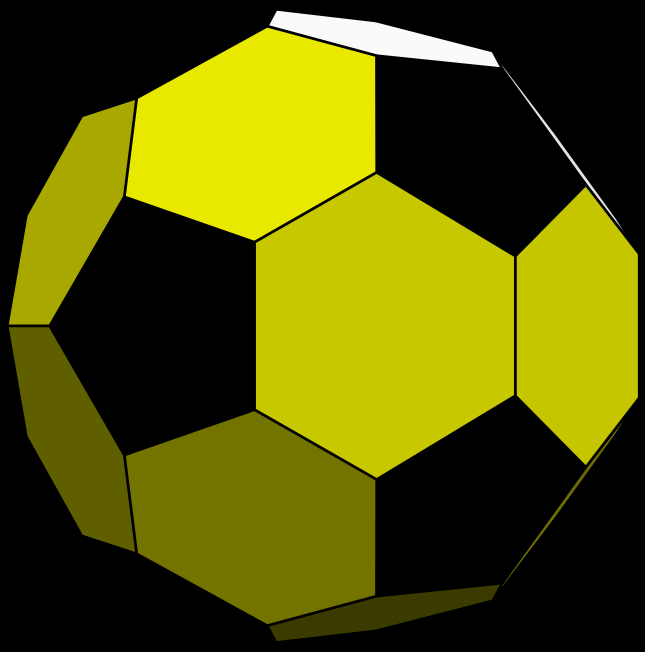

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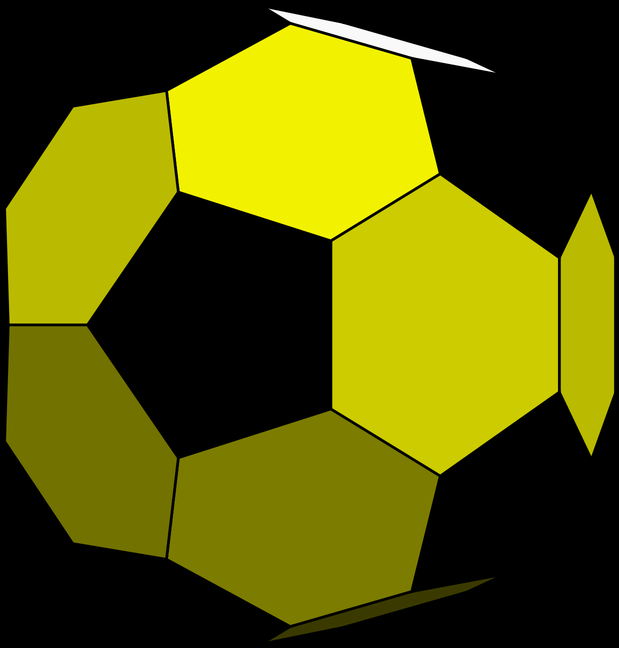

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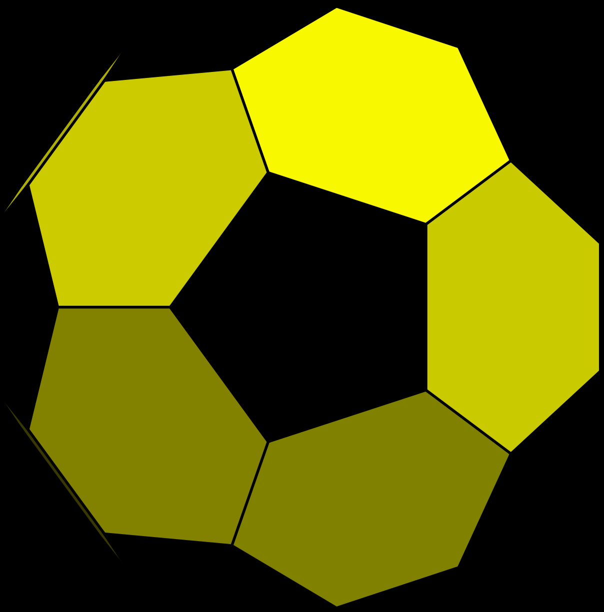

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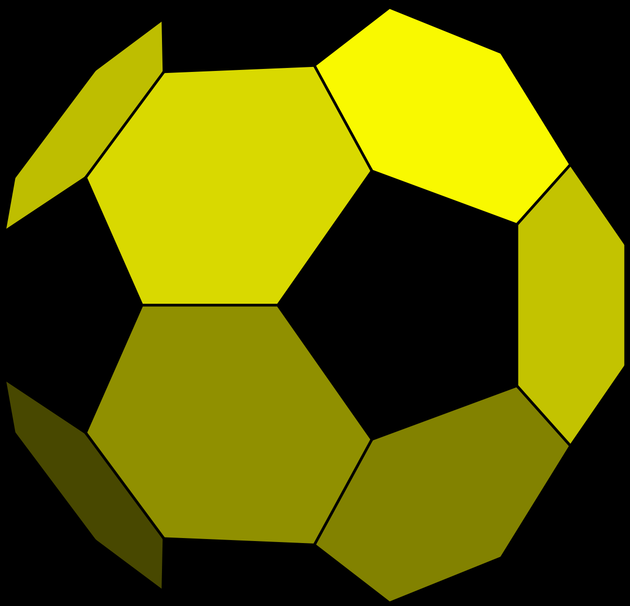

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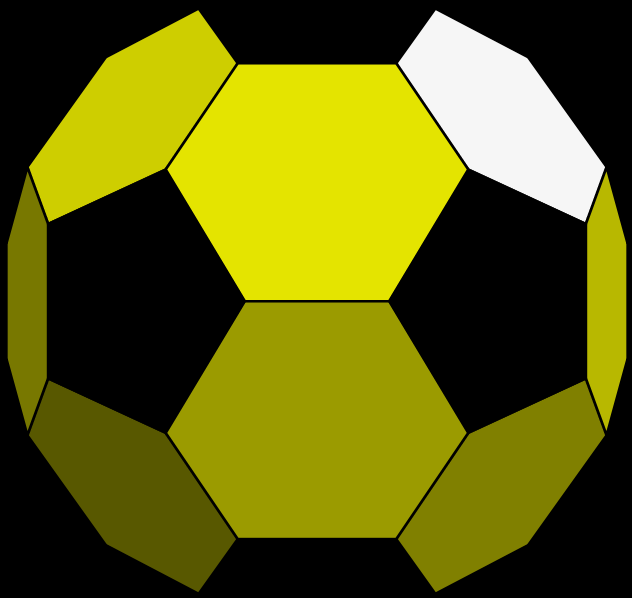

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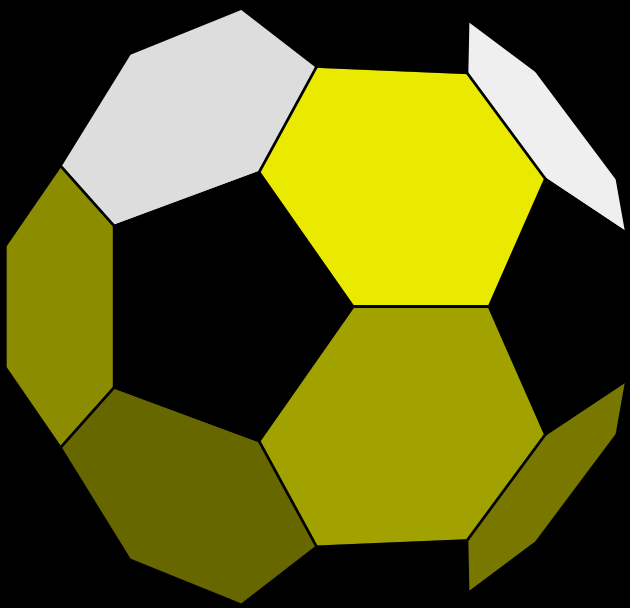

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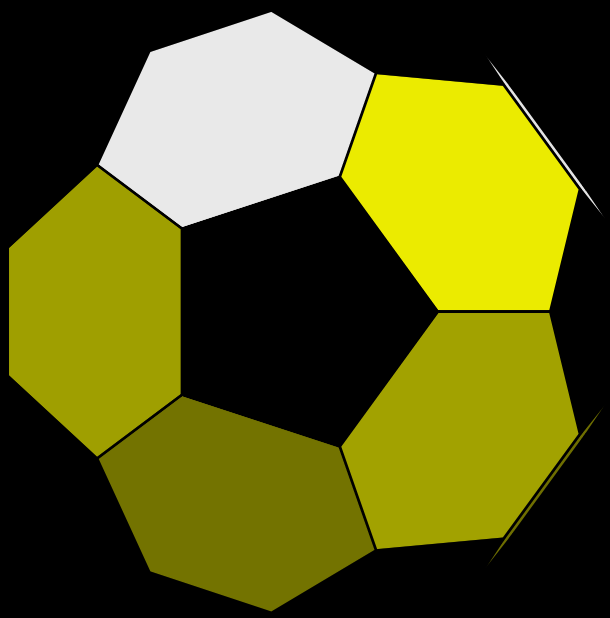

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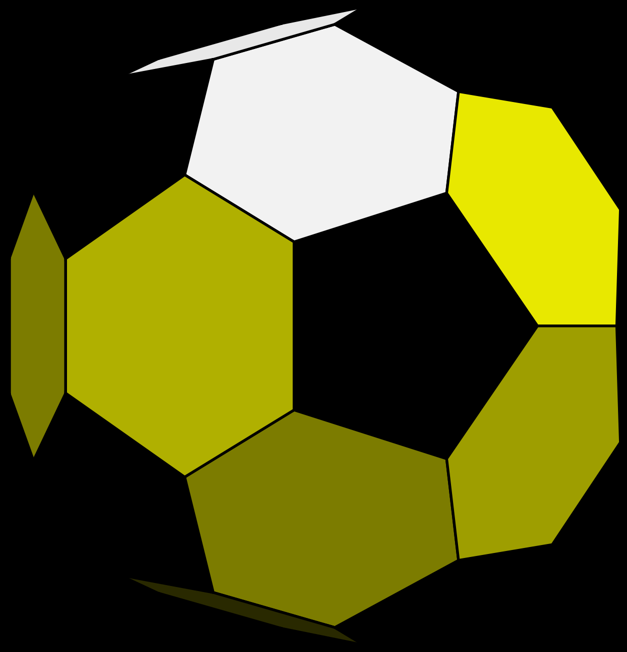

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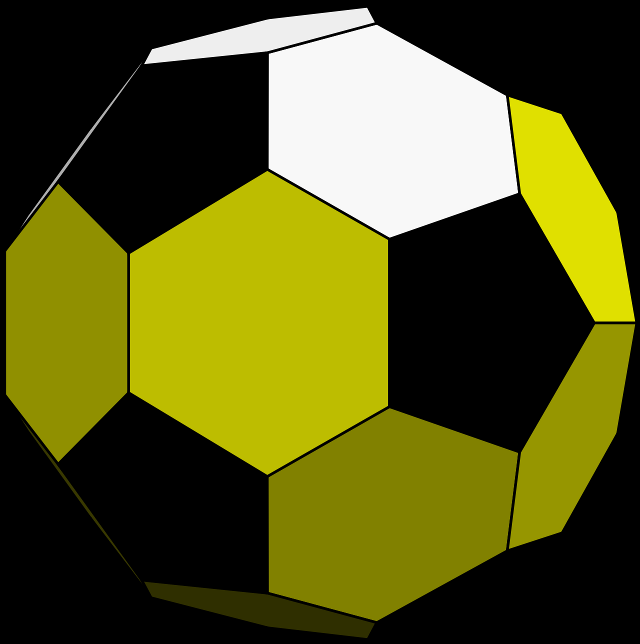

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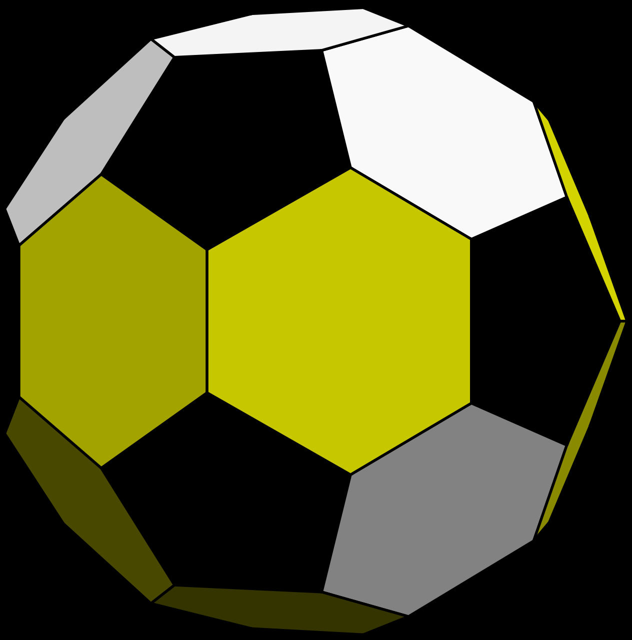

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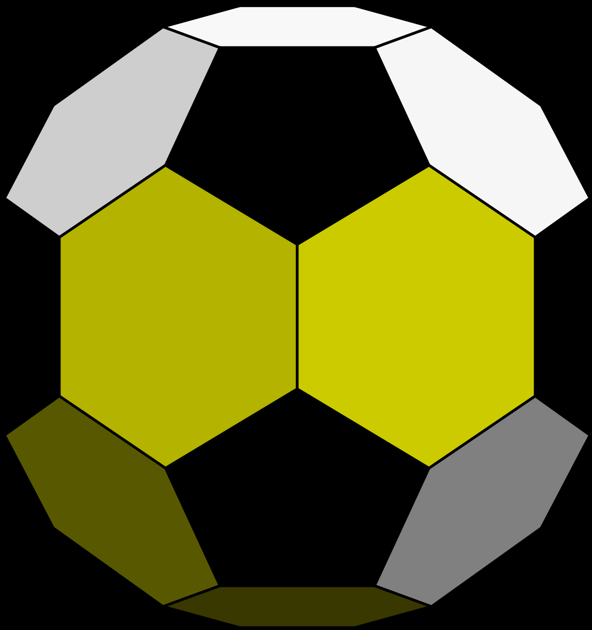

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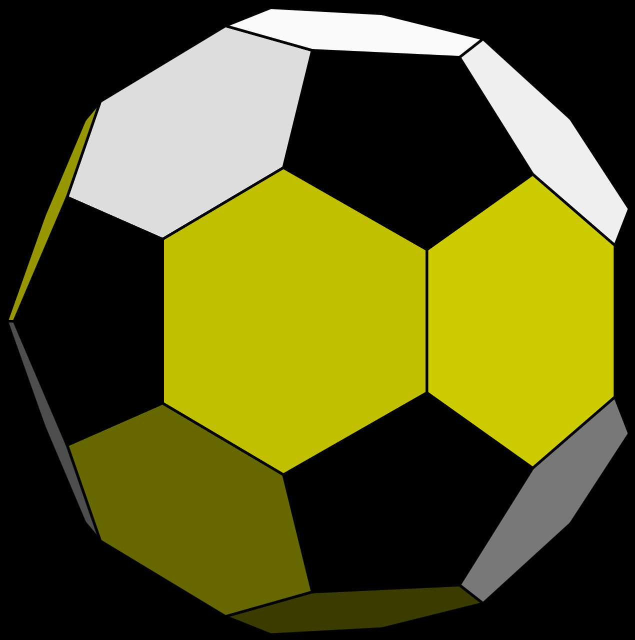

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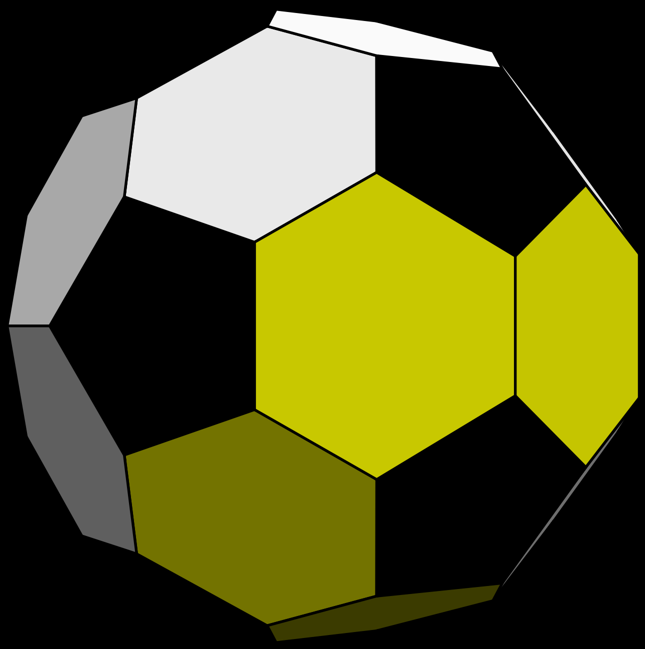

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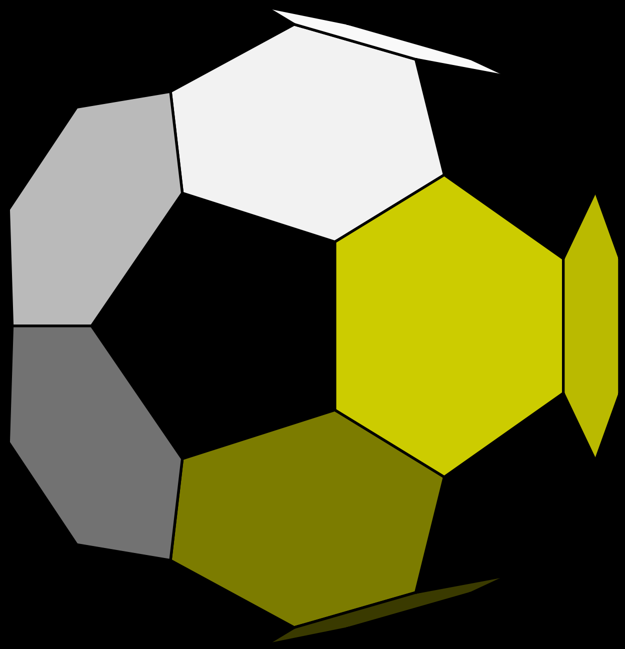

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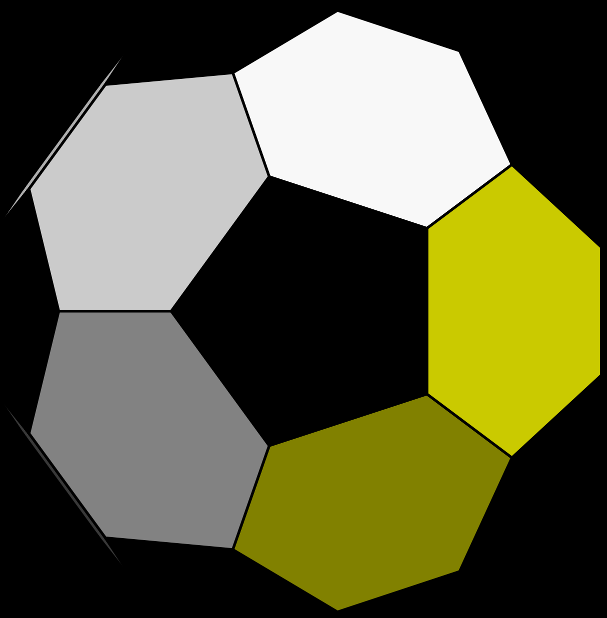

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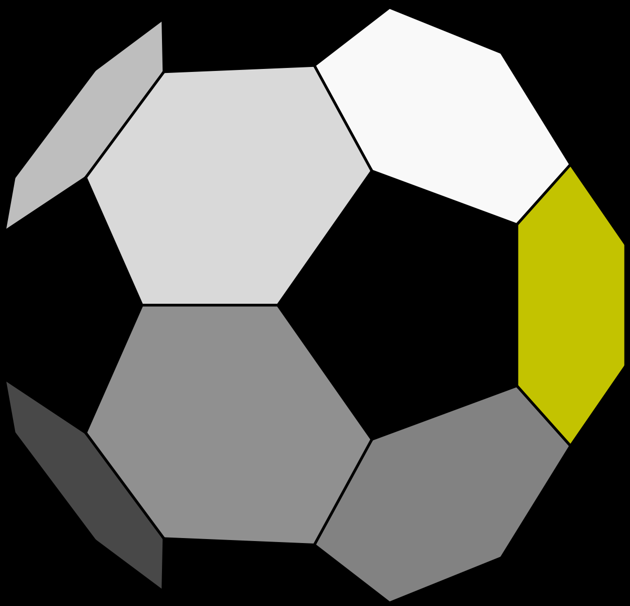

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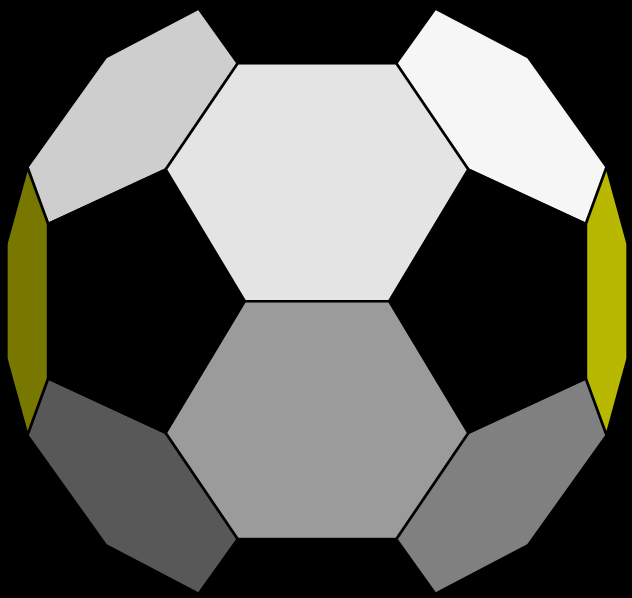

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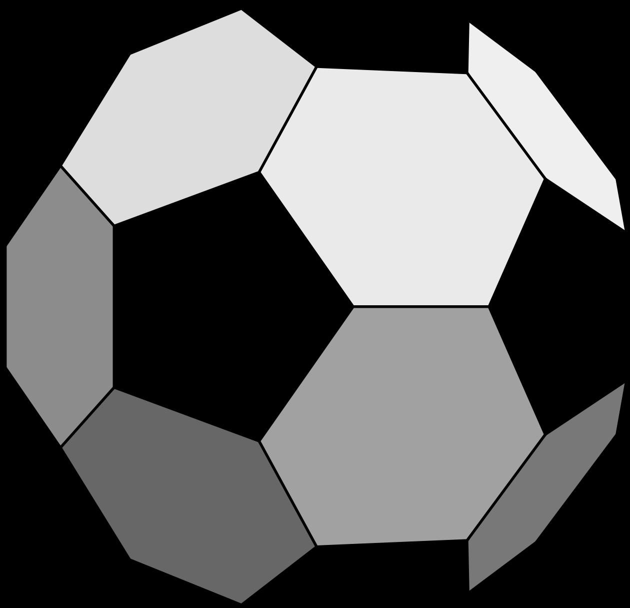

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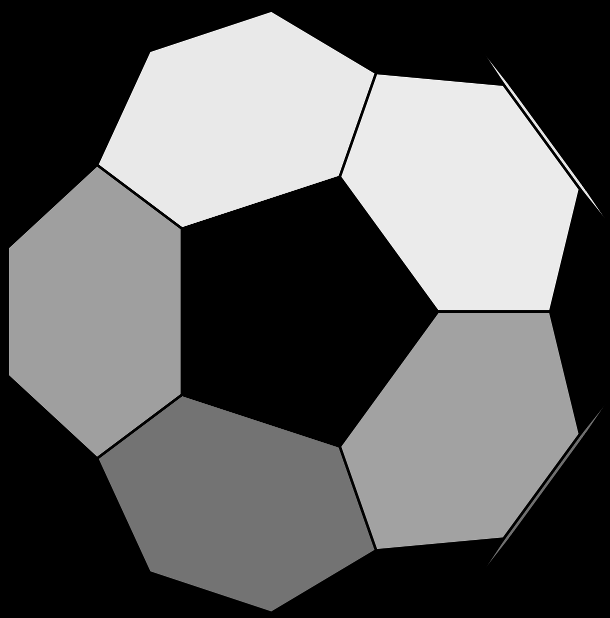

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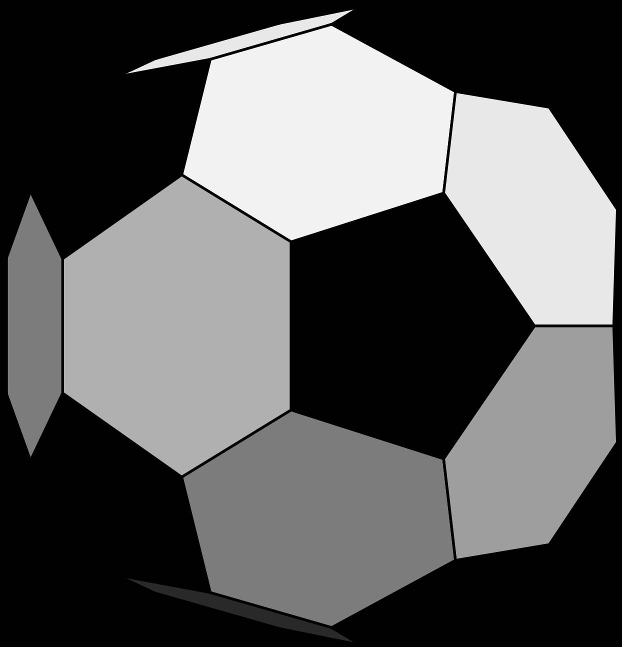

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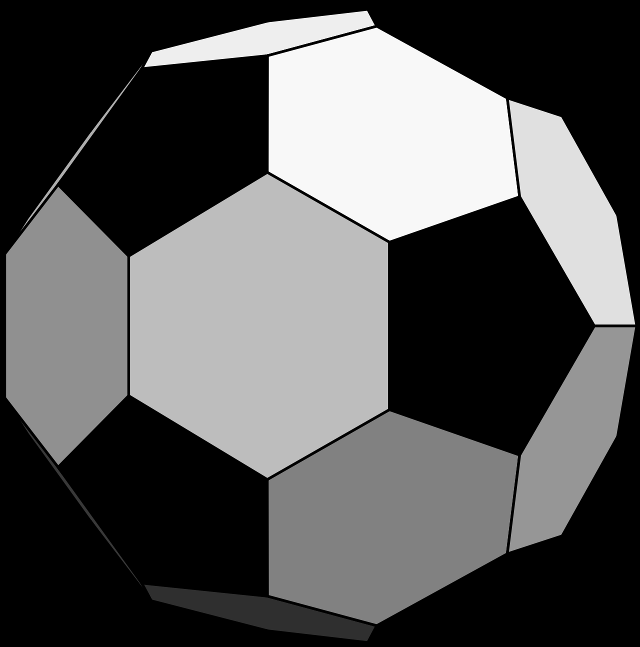

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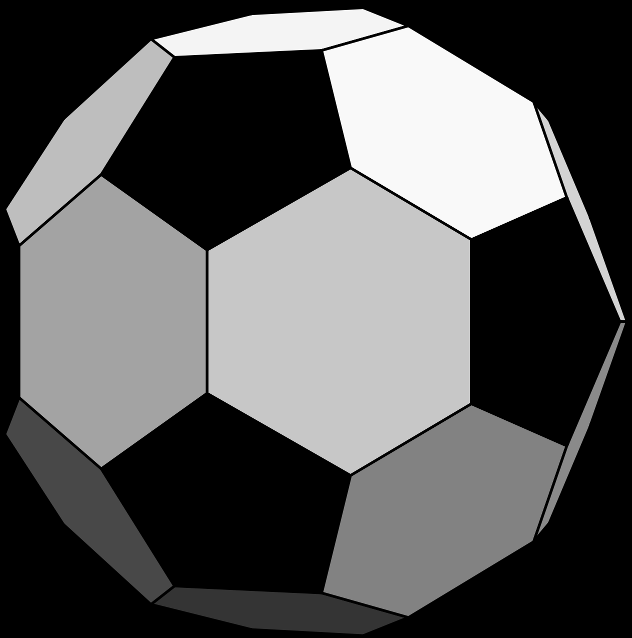

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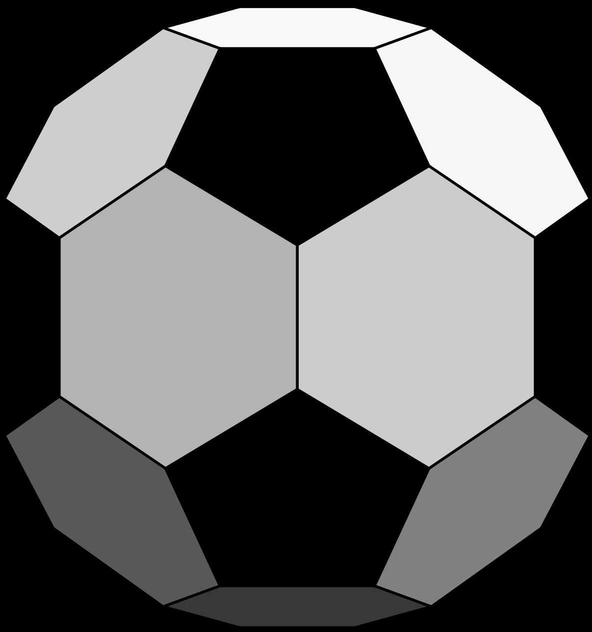

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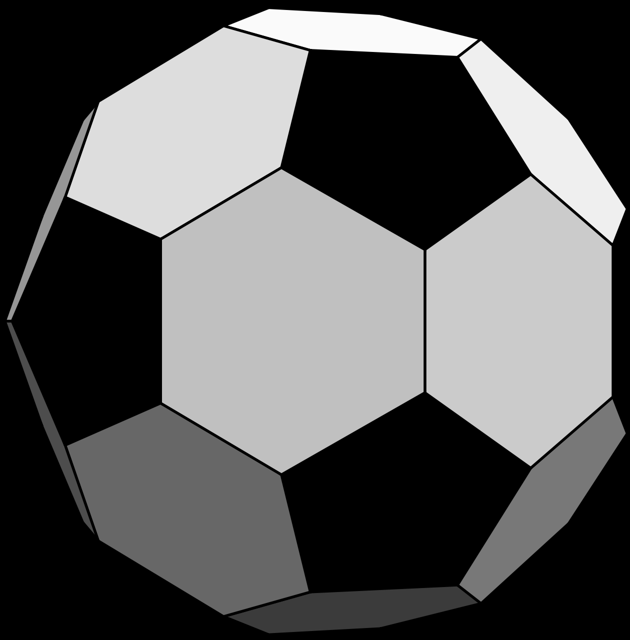

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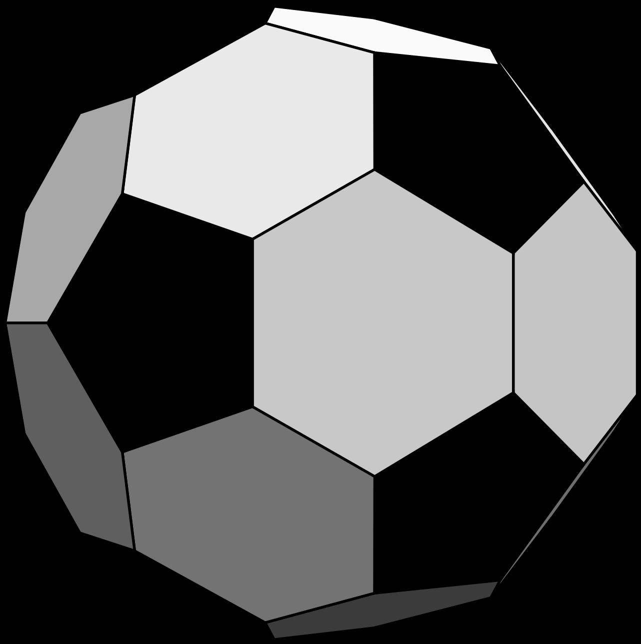
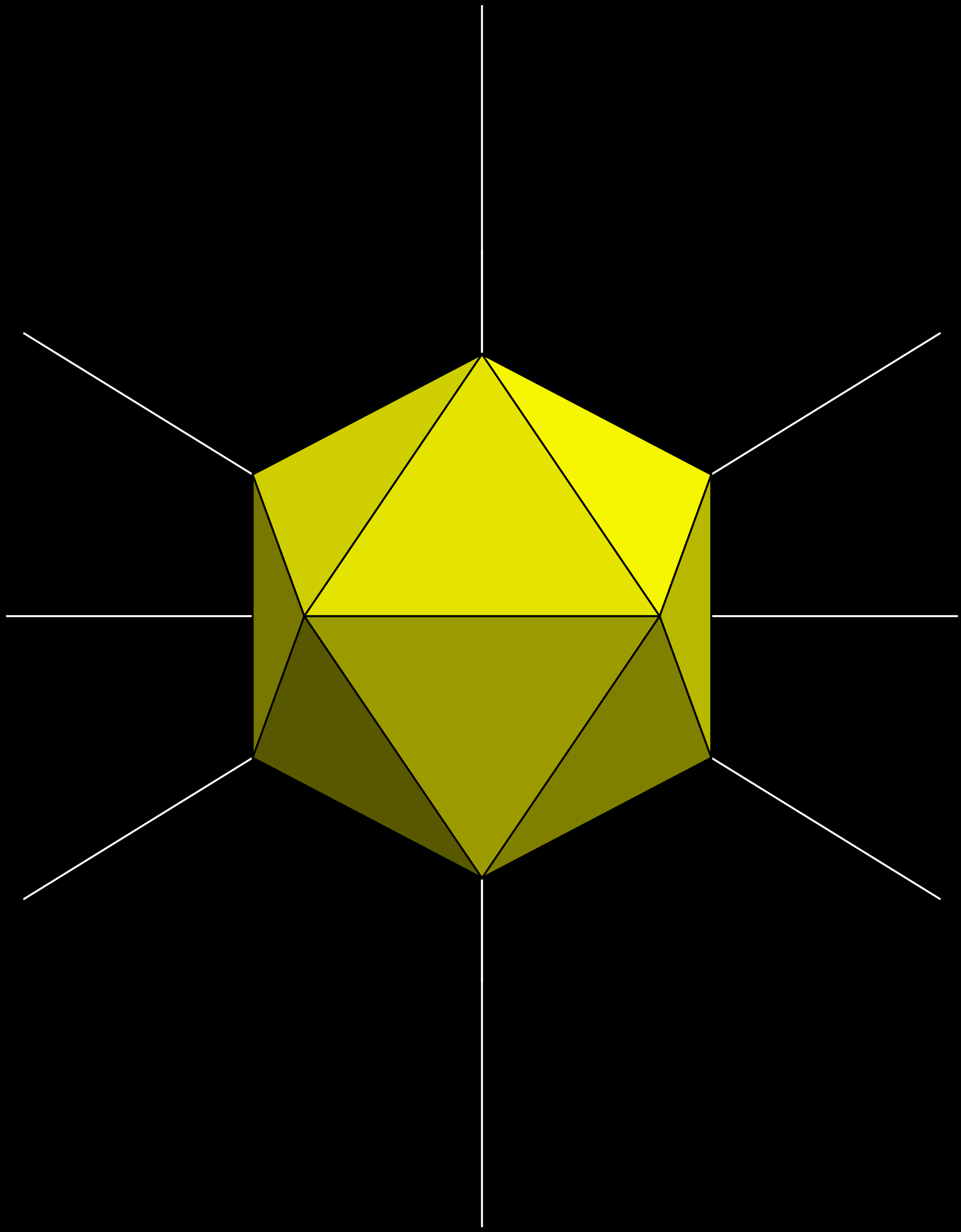
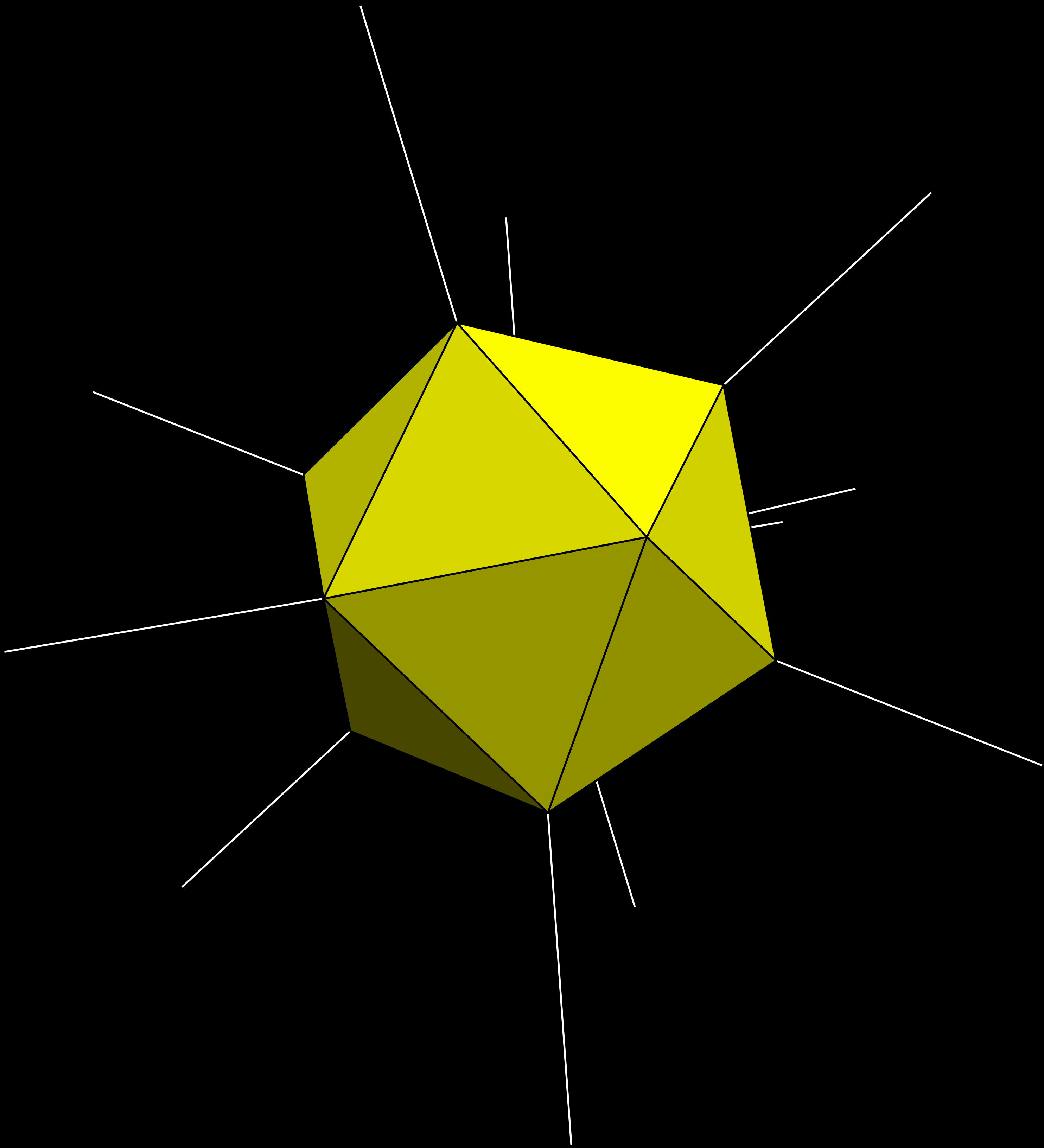
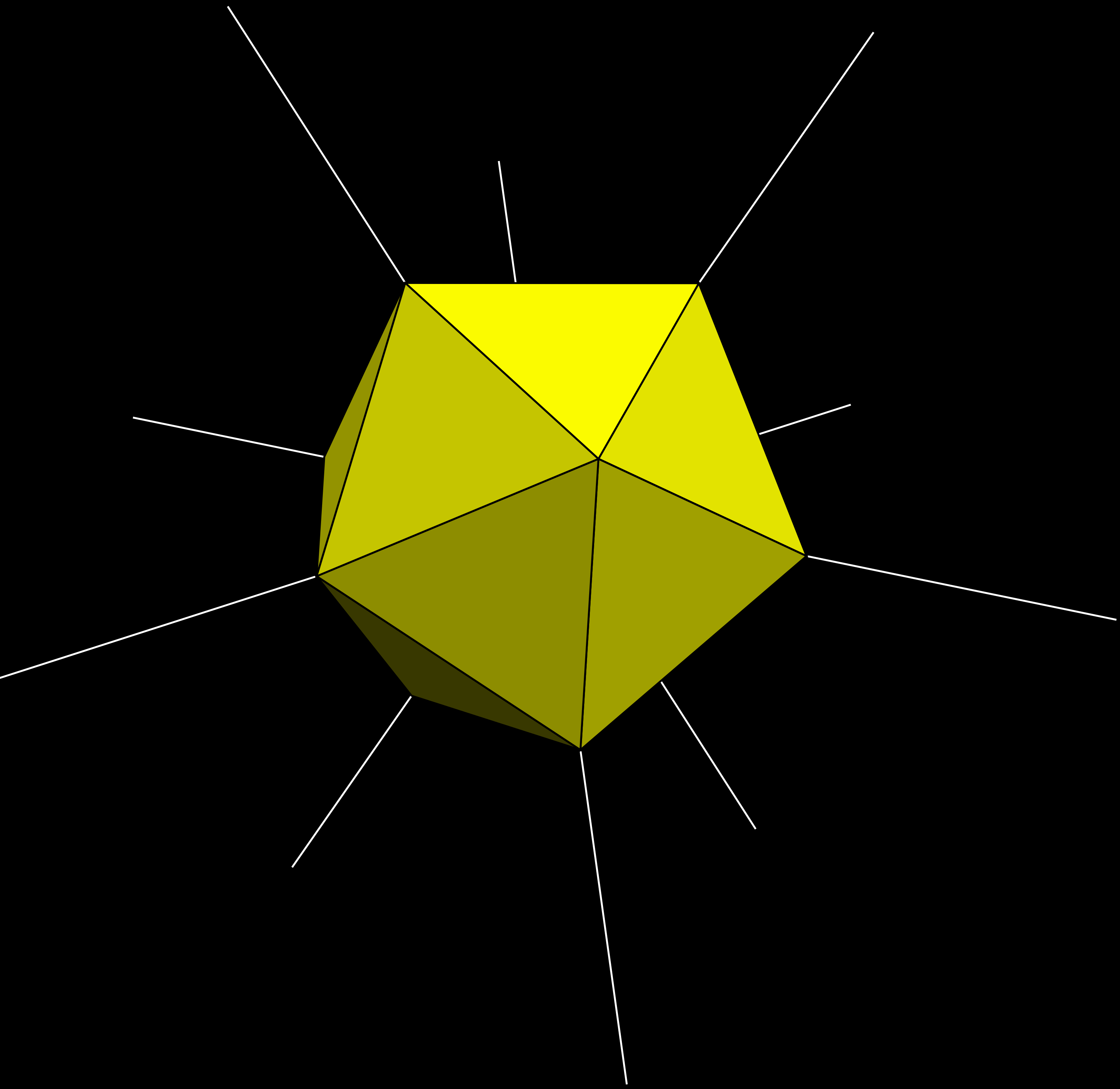
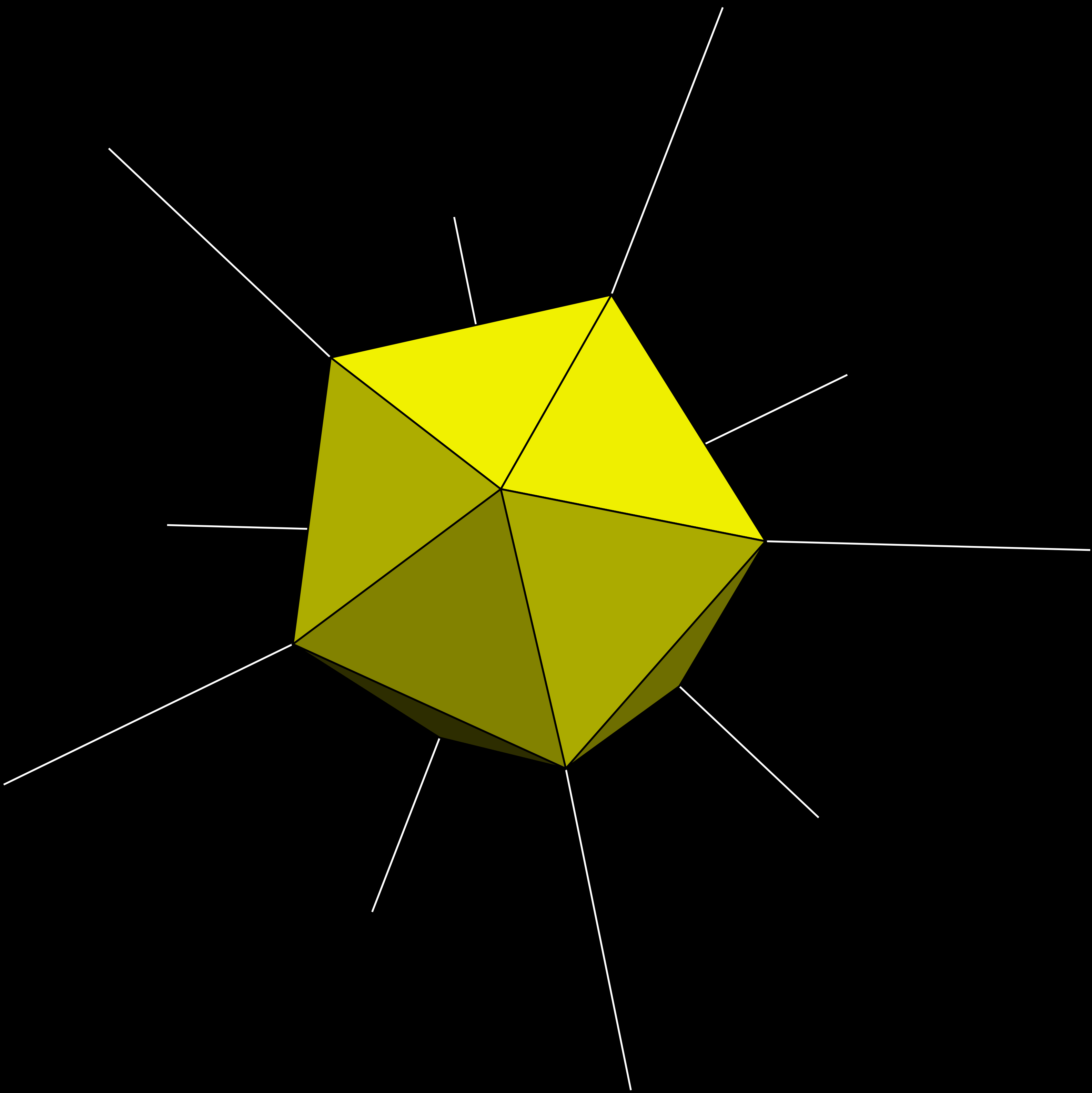


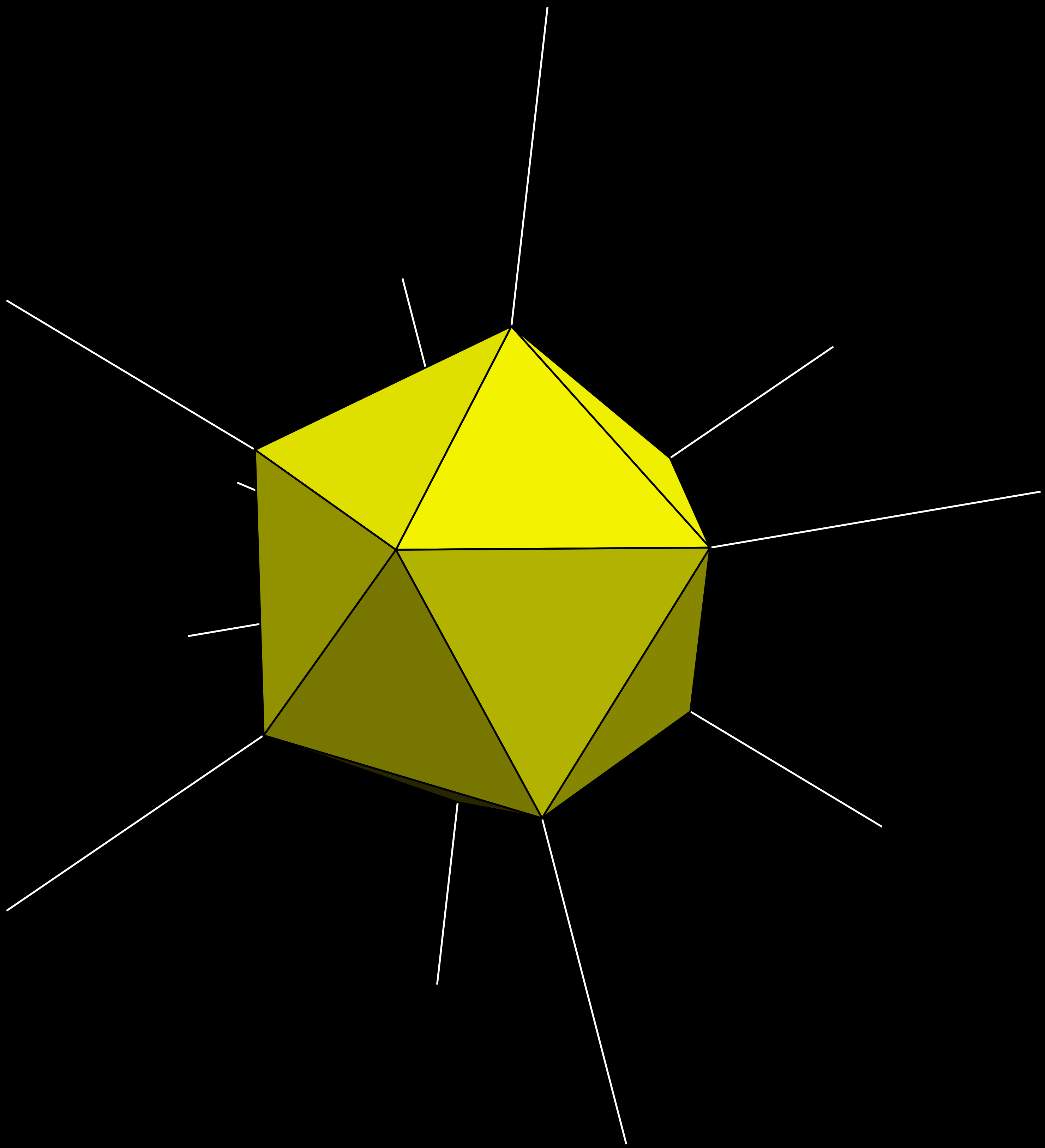
Another well-known virus, Adenovirus type 12, has a type{5,0} arrangment of spherical protein untis. Adenovirus has the basic shape of icosahedron PLUS a spike on each vertex.

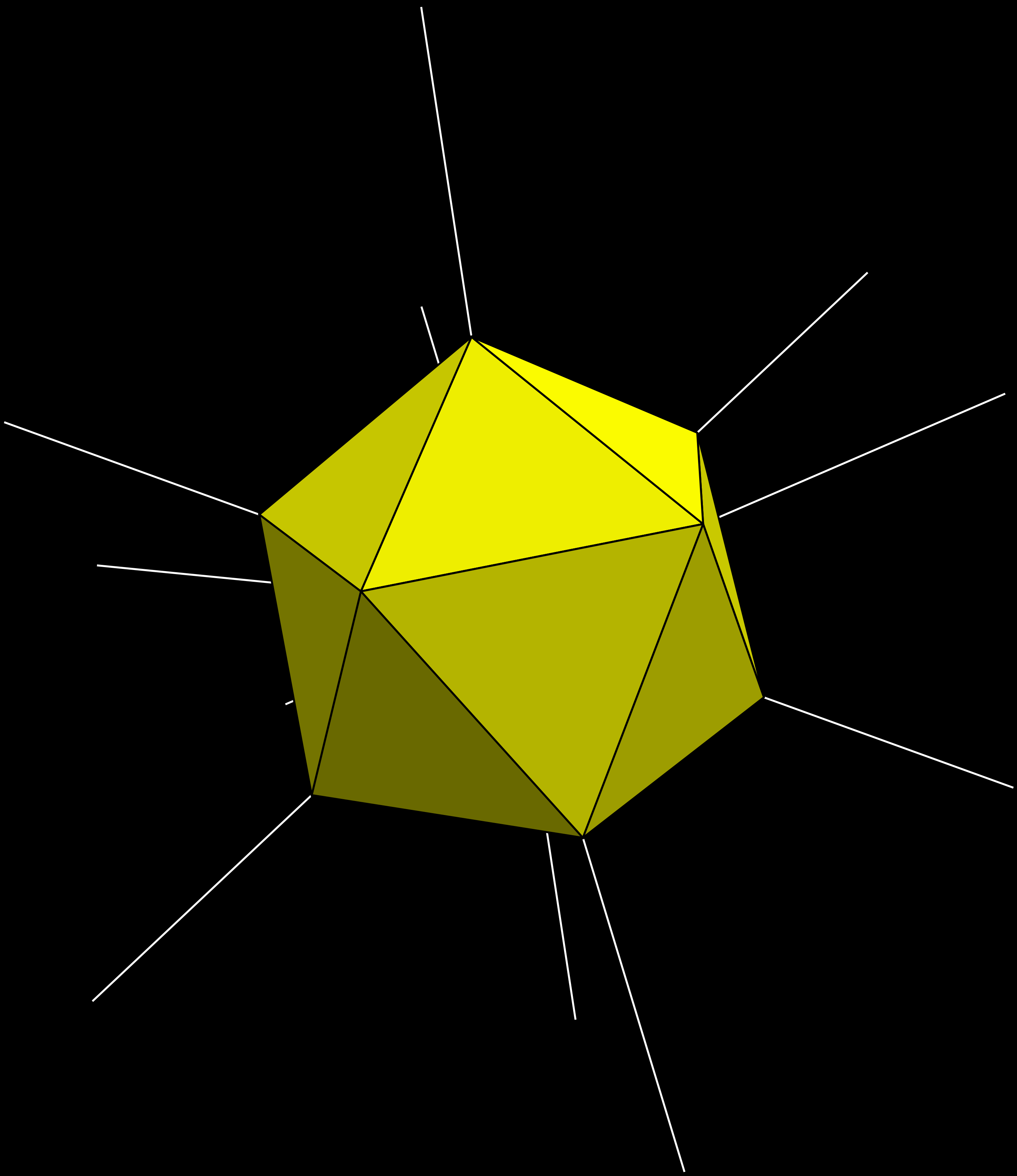


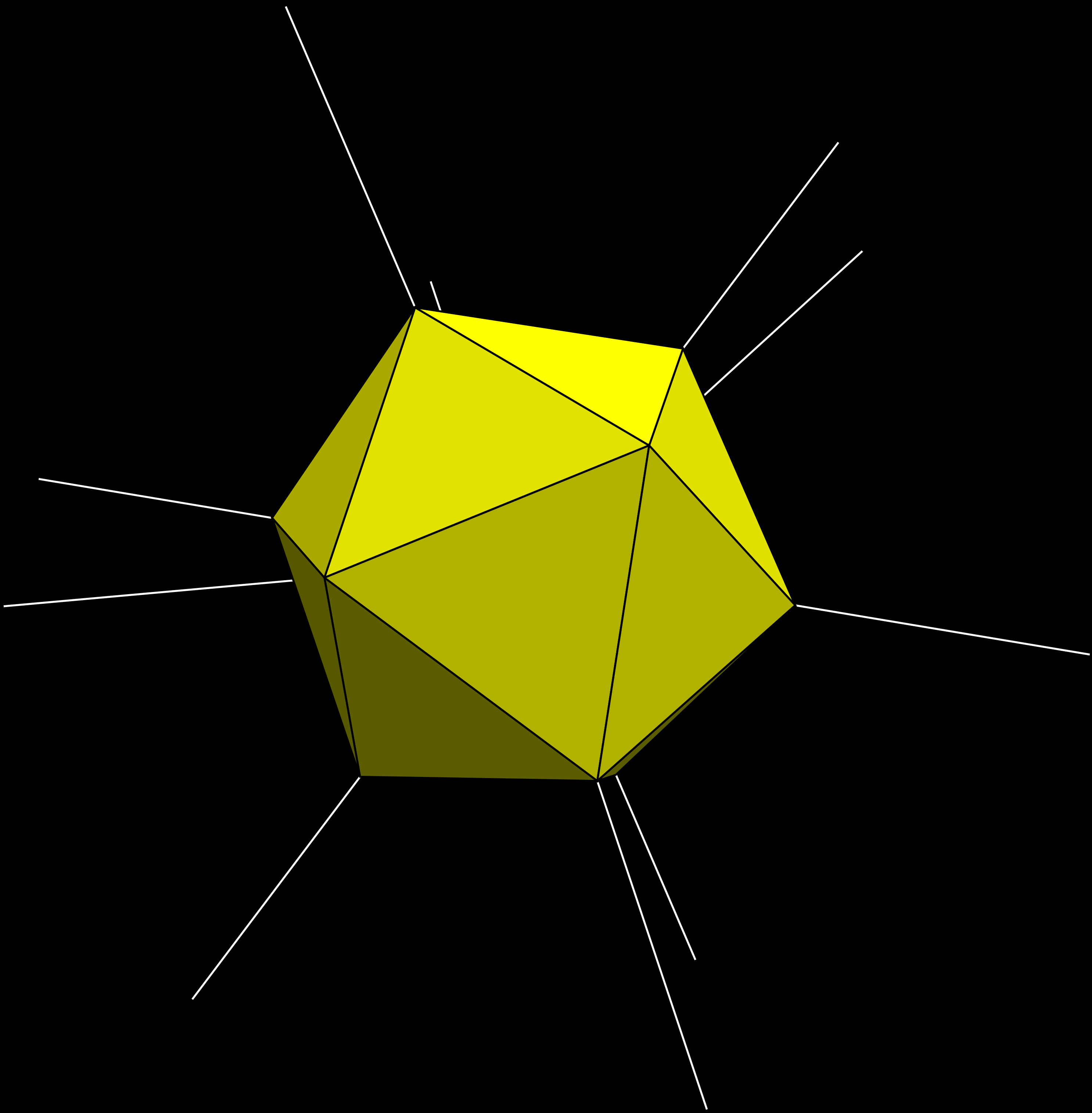


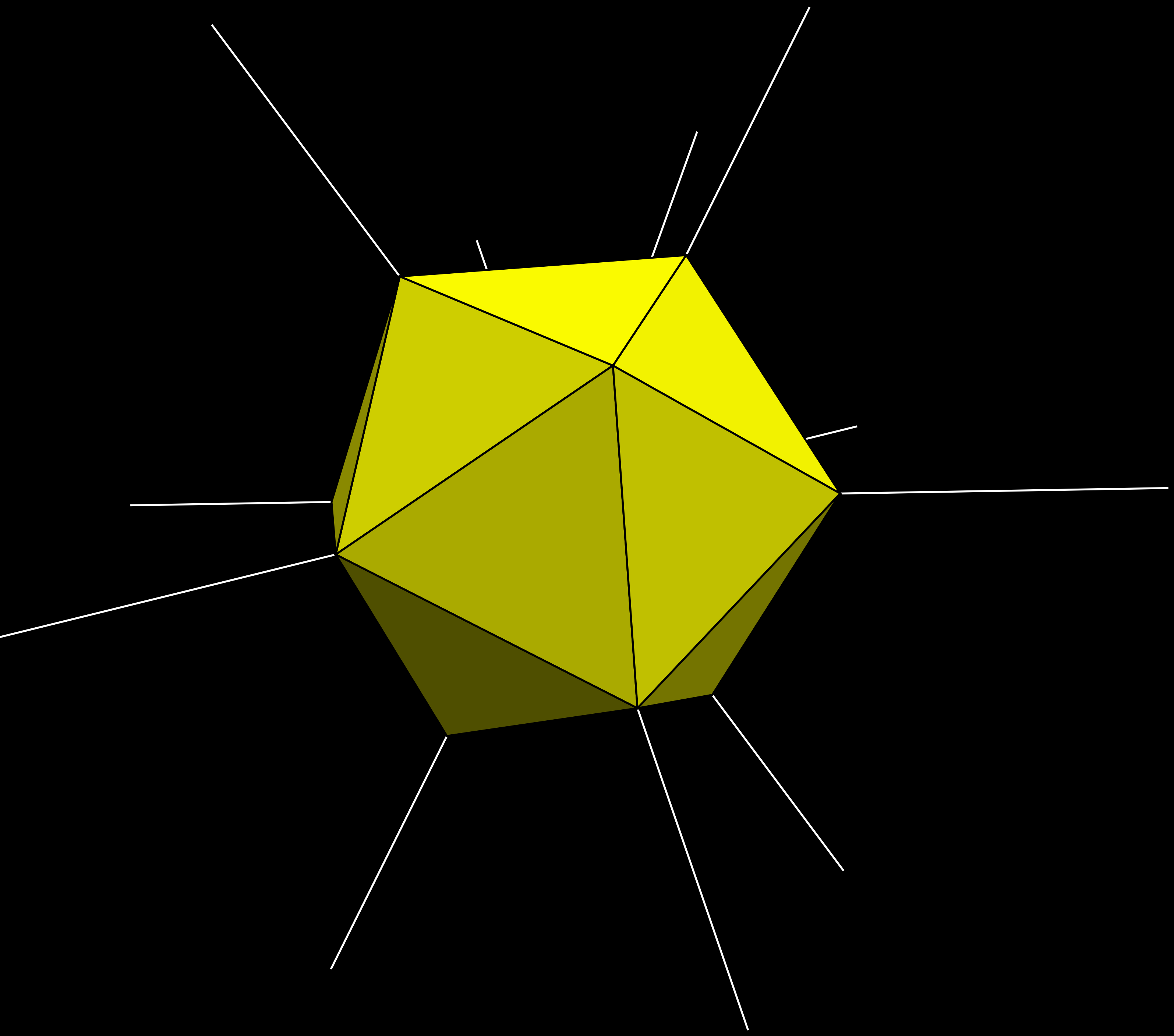


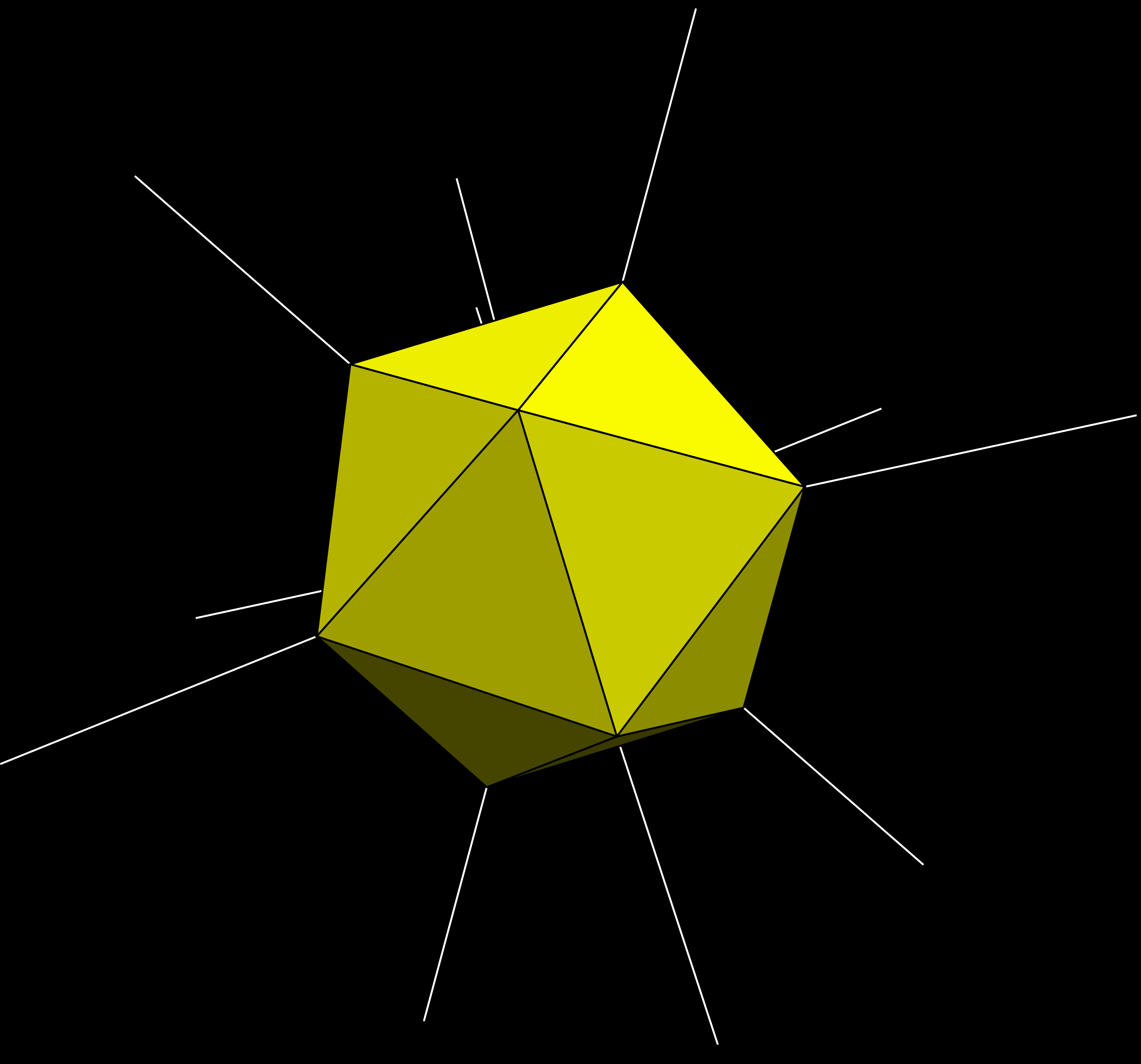


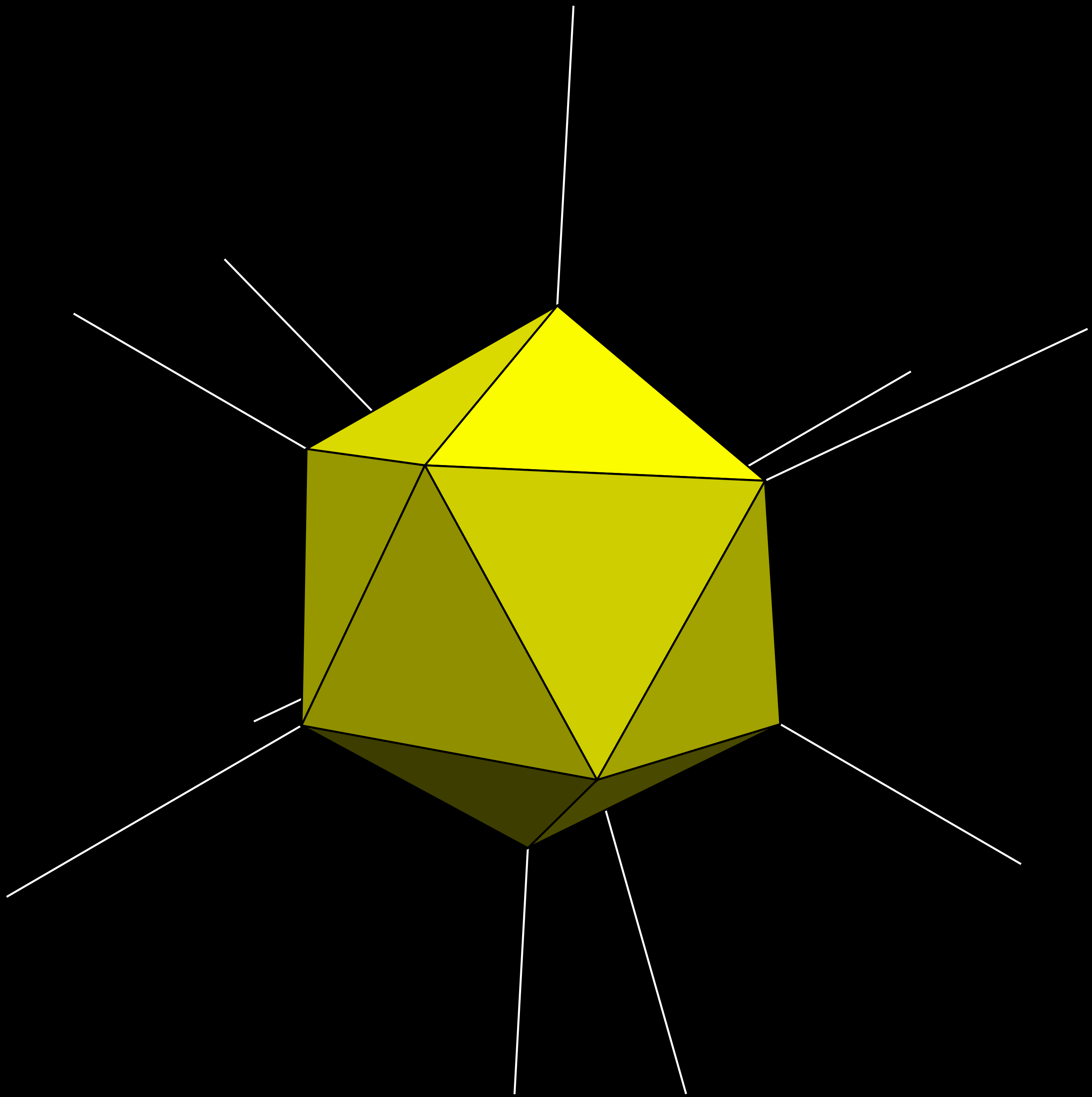












THE END

This project is completed by

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Thank You