**Icosahedron**

From Wikipedia, the free encyclopedia

|  |  |
| --- | --- |
| **Regular Icosahedron** | |
| [Icosahedron](http://en.wikipedia.org/wiki/File:Icosahedron.svg) [(Click here for rotating model)](http://en.wikipedia.org/wiki/File:Icosahedron.gif) | |
| Type | [Platonic solid](http://en.wikipedia.org/wiki/Platonic_solid) |
| [Elements](http://en.wikipedia.org/wiki/Euler_characteristic) | *F* = 20, *E* = 30 *V* = 12 (χ = 2) |
| Faces by sides | 20{3} |
| [Schläfli symbols](http://en.wikipedia.org/wiki/Schl%C3%A4fli_symbol) | {3,5} |
| s{3,4}, sr{3,3} |
| [Wythoff symbol](http://en.wikipedia.org/wiki/Wythoff_symbol) | 5 | 2 3 |
| [Coxeter diagram](http://en.wikipedia.org/wiki/Coxeter%E2%80%93Dynkin_diagram) | CDel node.pngCDel 5.pngCDel node.pngCDel 3.pngCDel node 1.png |
| [Symmetry](http://en.wikipedia.org/wiki/List_of_spherical_symmetry_groups) | [Ih](http://en.wikipedia.org/wiki/Icosahedral_symmetry), H3, [5,3], (\*532) |
| [Rotation group](http://en.wikipedia.org/wiki/Point_groups_in_three_dimensions#Rotation_groups) | [I](http://en.wikipedia.org/wiki/Icosahedral_symmetry), [5,3]+, (532) |
| [References](http://en.wikipedia.org/wiki/Uniform_polyhedron#Indexing) | [U](http://en.wikipedia.org/wiki/Uniform_polyhedron)22, [C](http://en.wikipedia.org/wiki/Harold_Scott_MacDonald_Coxeter)25, [W](http://en.wikipedia.org/wiki/List_of_Wenninger_polyhedron_models)4 |
| Properties | [Regular](http://en.wikipedia.org/wiki/Regular_polyhedron) [convex](http://en.wikipedia.org/wiki/Convex_polyhedron" \o "Convex polyhedron)[deltahedron](http://en.wikipedia.org/wiki/Deltahedron) |
| [Dihedral angle](http://en.wikipedia.org/wiki/Dihedral_angle) | 138.189685° = arccos(-√5/3) |
| [Icosahedron](http://en.wikipedia.org/wiki/File:Icosahedron_vertfig.svg) 3.3.3.3.3 ([Vertex figure](http://en.wikipedia.org/wiki/Vertex_figure)) | [Dodecahedron.png](http://en.wikipedia.org/wiki/File:Dodecahedron.png) [Dodecahedron](http://en.wikipedia.org/wiki/Dodecahedron) ([dual polyhedron](http://en.wikipedia.org/wiki/Dual_polyhedron)) |
| [Icosahedron](http://en.wikipedia.org/wiki/File:Icosahedron_flat.svg) [Net](http://en.wikipedia.org/wiki/Net_(polyhedron)) | |

In [geometry](http://en.wikipedia.org/wiki/Geometry), an **icosahedron** ([/](http://en.wikipedia.org/wiki/Help:IPA_for_English)[ˌaɪkɵsəˈhiːdrən](http://en.wikipedia.org/wiki/Help:IPA_for_English#Key)[/](http://en.wikipedia.org/wiki/Help:IPA_for_English) or [/](http://en.wikipedia.org/wiki/Help:IPA_for_English)[aɪˌkɒsəˈhiːdrən](http://en.wikipedia.org/wiki/Help:IPA_for_English#Key)[/](http://en.wikipedia.org/wiki/Help:IPA_for_English)) is a [polyhedron](http://en.wikipedia.org/wiki/Polyhedron) with 20 triangular faces, 30 edges and 12 vertices. A **regular icosahedron** with identical equilateral faces is often meant because of its geometrical significance as one of the five [Platonic solids](http://en.wikipedia.org/wiki/Platonic_solid).

It has five triangular faces meeting at each vertex. It can be represented by its [vertex figure](http://en.wikipedia.org/wiki/Vertex_figure) as 3.3.3.3.3 or 35, and also by [Schläfli symbol](http://en.wikipedia.org/wiki/Schl%C3%A4fli_symbol" \o "Schläfli symbol) {3,5}. It is the [dual](http://en.wikipedia.org/wiki/Dual_polyhedron) of the [dodecahedron](http://en.wikipedia.org/wiki/Dodecahedron), which is represented by {5,3}, having three pentagonal faces around each vertex.

A regular icosahedron is a [gyroelongated](http://en.wikipedia.org/wiki/Johnson_solid" \l "Names" \o "Johnson solid) [pentagonal bipyramid](http://en.wikipedia.org/wiki/Pentagonal_bipyramid) and a biaugmented [pentagonal antiprism](http://en.wikipedia.org/wiki/Pentagonal_antiprism) in any of six orientations.

Icosahedrite is a mineral (found in remote parts of Russia) that has the crystal shape of an icosahedron.

The name comes from [Greek](http://en.wikipedia.org/wiki/Greek_language) είκοσι *(eíkosi)*, meaning "twenty", and εδρα *(hédra)*, meaning "seat". The plural can be either "icosahedrons" or "icosahedra" (-[/](http://en.wikipedia.org/wiki/Help:IPA_for_English)[drə](http://en.wikipedia.org/wiki/Help:IPA_for_English#Key)[/](http://en.wikipedia.org/wiki/Help:IPA_for_English)).

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* [2 Area and volume](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes#Area_and_volume)
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**Dimensions**

If the edge length of a regular icosahedron is *a*, the [radius](http://en.wikipedia.org/wiki/Radius) of a circumscribed [sphere](http://en.wikipedia.org/wiki/Sphere) (one that touches the icosahedron at all vertices) is

r_u = \frac{a}{2} \sqrt{\varphi \sqrt{5}} = \frac{a}{4} \sqrt{10 +2\sqrt{5}} = a\sin\frac{2\pi}{5} \approx 0.9510565163 \cdot a [OEIS](http://en.wikipedia.org/wiki/On-Line_Encyclopedia_of_Integer_Sequences) [A019881](http://oeis.org/A019881)

and the radius of an inscribed sphere ([tangent](http://en.wikipedia.org/wiki/Tangent) to each of the icosahedron's faces) is

r_i = \frac{\varphi^2 a}{2 \sqrt{3}} = \frac{\sqrt{3}}{12} \left(3+ \sqrt{5} \right) a \approx 0.7557613141\cdot a [OEIS](http://en.wikipedia.org/wiki/On-Line_Encyclopedia_of_Integer_Sequences) [A179294](http://oeis.org/A179294)

while the midradius, which touches the middle of each edge, is

r_m = \frac{a \varphi}{2} = \frac{1}{4} \left(1+\sqrt{5}\right) a = a\cos\frac{\pi}{5} \approx 0.80901699\cdot a [OEIS](http://en.wikipedia.org/wiki/On-Line_Encyclopedia_of_Integer_Sequences) [A019863](http://oeis.org/A019863)

where *φ* (also called *τ*) is the [golden ratio](http://en.wikipedia.org/wiki/Golden_ratio).

**Area and volume**

The surface area *A* and the [volume](http://en.wikipedia.org/wiki/Volume) *V* of a regular icosahedron of edge length *a* are:

A = 5\sqrt{3}a^2 \approx 8.66025404a^2, [OEIS](http://en.wikipedia.org/wiki/On-Line_Encyclopedia_of_Integer_Sequences) [A010527](http://oeis.org/A010527)

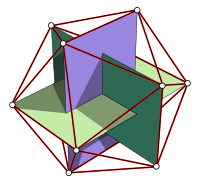
V = \frac{5}{12} (3+\sqrt5)a^3 \approx 2.18169499a^3. [OEIS](http://en.wikipedia.org/wiki/On-Line_Encyclopedia_of_Integer_Sequences) [A102208](http://oeis.org/A102208)

The latter is F=20 times the volume of a general [tetrahedron](http://en.wikipedia.org/wiki/Tetrahedron) with apex at the center of the inscribed sphere, where the volume of the tetrahedron is one third times the base area √3a2/4 times its height ri.

The volume filling factor of the circumscribed sphere is

f=V/(4 \pi r_u^3/3) = \frac{20(3+\surd 5)}{(2\surd 5+10)^{3/2}\pi}\approx 0.6054613829.

**Cartesian coordinates**

[](http://en.wikipedia.org/wiki/File:Icosahedron-golden-rectangles.svg)

Icosahedron vertices form three orthogonal golden rectangles

The following [Cartesian coordinates](http://en.wikipedia.org/wiki/Cartesian_coordinates) define the vertices of an icosahedron with edge-length 2, centered at the origin:[[1]](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes" \l "cite_note-1)

(0, ±1, ±*φ*)

(±1, ±*φ*, 0)

(±*φ*, 0, ±1)

where *φ*=\tfrac{1+\sqrt{5}}{2} is the [golden ratio](http://en.wikipedia.org/wiki/Golden_ratio) (also written *τ*). Note that these vertices form five sets of three concentric, mutually [orthogonal](http://en.wikipedia.org/wiki/Orthogonal) [golden rectangles](http://en.wikipedia.org/wiki/Golden_rectangle), whose edges form [Borromean rings](http://en.wikipedia.org/wiki/Borromean_rings" \o "Borromean rings).

If the original icosahedron has edge length 1, its dual [dodecahedron](http://en.wikipedia.org/wiki/Dodecahedron) has edge length \tfrac{\sqrt{5}-1}{2}, one divided by the [golden ratio](http://en.wikipedia.org/wiki/Golden_ratio).

[](http://en.wikipedia.org/wiki/File:Icosahedron_model.JPG)

Model of an icosahedron made with metallic spheres and magnetic connectors

The 12 edges of a regular [octahedron](http://en.wikipedia.org/wiki/Octahedron) can be subdivided in the golden ratio so that the resulting vertices define a regular icosahedron. This is done by first placing vectors along the octahedron's edges such that each face is bounded by a cycle, then similarly subdividing each edge into the golden mean along the direction of its vector. The [five octahedra](http://en.wikipedia.org/wiki/Compound_of_five_octahedra) defining any given icosahedron form a regular [polyhedral compound](http://en.wikipedia.org/wiki/Polyhedral_compound), while the [two icosahedra](http://en.wikipedia.org/wiki/Compound_of_two_icosahedra) that can be defined in this way from any given octahedron form a [uniform polyhedron compound](http://en.wikipedia.org/wiki/Uniform_polyhedron_compound).

**Spherical coordinates**

The locations of the vertices of a regular icosahedron can be described using [spherical coordinates](http://en.wikipedia.org/wiki/Spherical_coordinates), for instance as [latitude and longitude](http://en.wikipedia.org/wiki/Latitude_and_longitude). If two vertices are taken to be at the north and south poles (latitude ±90°), then the other ten vertices are at latitude ±[arctan](http://en.wikipedia.org/wiki/Arctan" \o "Arctan)(1/2) ≈ ±26.57°. These ten vertices are at evenly spaced longitudes (36° apart), alternating between north and south latitudes.

This scheme takes advantage of the fact that the regular icosahedron is a pentagonal [gyroelongated bipyramid](http://en.wikipedia.org/wiki/Gyroelongated_bipyramid" \o "Gyroelongated bipyramid), with D5d [dihedral symmetry](http://en.wikipedia.org/wiki/Dihedral_symmetry_in_three_dimensions)—that is, it is formed of two congruent pentagonal pyramids joined by a pentagonal [antiprism](http://en.wikipedia.org/wiki/Antiprism" \o "Antiprism).

**Orthogonal projections**

The *icosahedron* has three special [orthogonal projections](http://en.wikipedia.org/wiki/Orthogonal_projection), centered on a face, an edge and a vertex:

|  |  |  |  |
| --- | --- | --- | --- |
| **Orthogonal projections** | | | |
| **Centered by** | **Face** | **Edge** | **Vertex** |
| [**Coxeter plane**](http://en.wikipedia.org/wiki/Coxeter_plane) | **A2** | **A3** | **H3** |
| **Graph** | [Icosahedron t0 A2.png](http://en.wikipedia.org/wiki/File:Icosahedron_t0_A2.png) | [Icosahedron graph A3 1.png](http://en.wikipedia.org/wiki/File:Icosahedron_graph_A3_1.png) | [Icosahedron t0 H3.png](http://en.wikipedia.org/wiki/File:Icosahedron_t0_H3.png) |
| **Projective symmetry** | [6] | [2] | [10] |
| **Graph** | [Icosahedron fnormal.png](http://en.wikipedia.org/wiki/File:Icosahedron_fnormal.png) Face normal | [Icosahedron graph A3 2.png](http://en.wikipedia.org/wiki/File:Icosahedron_graph_A3_2.png) Edge normal | [Icosahedron vnormal.png](http://en.wikipedia.org/wiki/File:Icosahedron_vnormal.png) Vertex normal |

**Other facts**

* An icosahedron has 43,380 distinct [nets](http://en.wikipedia.org/wiki/Net_(polyhedron)).[[2]](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes#cite_note-2)
* To color the icosahedron, such that no two adjacent faces have the same color, requires at least 3 colors.[[3]](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes#cite_note-3)
* A problem dating back to the ancient Greeks is to determine which of two shapes has larger volume, an icosahedron inscribed in a sphere, or a dodecahedron inscribed in the same sphere. The problem was solved by [Hero](http://en.wikipedia.org/wiki/Hero_of_Alexandria), [Pappus](http://en.wikipedia.org/wiki/Pappus_of_Alexandria" \o "Pappus of Alexandria), and [Fibonacci](http://en.wikipedia.org/wiki/Fibonacci), among others.[[4]](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes#cite_note-4) [Apollonius of Perga](http://en.wikipedia.org/wiki/Apollonius_of_Perga) discovered the curious result that the ratio of volumes of these two shapes is the same as the ratio of their surface areas.[[5]](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes#cite_note-5) Both volumes have formulas involving the [golden ratio](http://en.wikipedia.org/wiki/Golden_ratio), but taken to different powers.[[6]](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes#cite_note-6) As it turns out, the icosahedron occupies less of the sphere's volume (60.54%) than the dodecahedron (66.49%).[[7]](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes#cite_note-7)

**Construction by a system of equiangular lines**

|  |  |
| --- | --- |
| [Icosahedron t0 H3.png](http://en.wikipedia.org/wiki/File:Icosahedron_t0_H3.png) Icosahedron H3 Coxeter plane | [6-cube t5 B5.svg](http://en.wikipedia.org/wiki/File:6-cube_t5_B5.svg) [6-orthoplex](http://en.wikipedia.org/wiki/6-orthoplex) D6 Coxeter plane |
| This construction can be geometrically seen as the 12 vertices of the [6-orthoplex](http://en.wikipedia.org/wiki/6-orthoplex) projected to 3 dimensions. This represents a [geometric folding](http://en.wikipedia.org/wiki/Coxeter%E2%80%93Dynkin_diagram#Geometric_folding)of the D6 to H3 [Coxeter groups](http://en.wikipedia.org/wiki/Coxeter_group" \o "Coxeter group): [Geometric folding Coxeter graph D6 H3.png](http://en.wikipedia.org/wiki/File:Geometric_folding_Coxeter_graph_D6_H3.png)  Seen by these 2D [Coxeter plane](http://en.wikipedia.org/wiki/Coxeter_plane" \o "Coxeter plane) orthogonal projections, the two overlapping central vertices define the third axis in this mapping. | |

The following construction of the icosahedron avoids tedious computations in the [number field](http://en.wikipedia.org/wiki/Algebraic_number_field) \mathbb{Q}[\sqrt{5}] necessary in more elementary approaches.

The existence of the icosahedron amounts to the existence of six [equiangular lines](http://en.wikipedia.org/wiki/Equiangular_lines) in \mathbb R^3. Indeed, intersecting such a system of equiangular lines with a Euclidean sphere centered at their common intersection yields the twelve vertices of a regular icosahedron as can easily be checked. Conversely, supposing the existence of a regular icosahedron, lines defined by its six pairs of opposite vertices form an equiangular system.

In order to construct such an equiangular system, we start with this 6×6 square [matrix](http://en.wikipedia.org/wiki/Matrix_(mathematics)):

A=\left(\begin{array}{crrrrr}
0&1&1&1&1&1\\
1&0&1&-1&-1&1\\
1&1&0&1&-1&-1\\
1&-1&1&0&1&-1\\
1&-1&-1&1&0&1\\
1&1&-1&-1&1&0\end{array}\right).

A straightforward computation yields *A*2 = 5*I* (where *I* is the 6×6 identity matrix). This implies that *A* has [eigenvalues](http://en.wikipedia.org/wiki/Eigenvalue,_eigenvector_and_eigenspace) \scriptstyle -\sqrt{5}and \scriptstyle \sqrt{5}, both with multiplicity 3 since *A* is [symmetric](http://en.wikipedia.org/wiki/Symmetric_matrix) and of [trace](http://en.wikipedia.org/wiki/Trace_(linear_algebra)) zero.

The matrix \scriptstyle A+\sqrt{5}I induces thus a [Euclidean structure](http://en.wikipedia.org/wiki/Euclidean_space) on the [quotient space](http://en.wikipedia.org/wiki/Quotient_space_(linear_algebra)) \mathbb R^6/\ker(A+\sqrt{5}I) which is [isomorphic](http://en.wikipedia.org/wiki/Isomorphism) to \mathbb R^3 since the [kernel](http://en.wikipedia.org/wiki/Kernel_(linear_operator)) \ker(A+\sqrt{5}I) of \scriptstyle {A+\sqrt{5}I} has [dimension](http://en.wikipedia.org/wiki/Dimension) 3. The image under the [projection](http://en.wikipedia.org/wiki/Projection_(linear_algebra)) \pi:\mathbb R^6 \longrightarrow \mathbb R^6/\ker(A+\sqrt{5}I) of the six coordinate axes \mathbb R v_1,\dots,\mathbb R v_6 in \mathbb R^6 forms thus a system of six equiangular lines in \mathbb R^3 intersecting pairwise at a common acute angle of \scriptstyle{\arccos}\tfrac{1}{\sqrt{5}}. Orthogonal projection of ±*v*1, ..., ±*v*6 onto the [[\scriptstyle \sqrt{5}](http://en.wikipedia.org/wiki/Eigenvalue,_eigenvector_and_eigenspace)-eigenspace](http://en.wikipedia.org/wiki/Eigenvalue,_eigenvector_and_eigenspace) of *A* yields thus the twelve vertices of the icosahedron.

A second straightforward construction of the icosahedron uses [representation theory](http://en.wikipedia.org/wiki/Group_representation) of the [alternating group](http://en.wikipedia.org/wiki/Alternating_group) *A*5 acting by direct [isometries](http://en.wikipedia.org/wiki/Isometry" \o "Isometry) on the icosahedron.

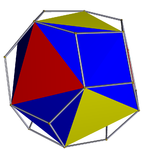
**Symmetry**

The rotational [symmetry group](http://en.wikipedia.org/wiki/Symmetry_group) of the regular icosahedron is [isomorphic](http://en.wikipedia.org/wiki/Isomorphic) to the [alternating group](http://en.wikipedia.org/wiki/Alternating_group) on five letters. This non-[abelian](http://en.wikipedia.org/wiki/Abelian_group) [simple group](http://en.wikipedia.org/wiki/Simple_group) is the only non-trivial [normal subgroup](http://en.wikipedia.org/wiki/Normal_subgroup) of the [symmetric group](http://en.wikipedia.org/wiki/Symmetric_group) on five letters. Since the [Galois group](http://en.wikipedia.org/wiki/Galois_group) of the general [quintic equation](http://en.wikipedia.org/wiki/Quintic_equation" \o "Quintic equation) is isomorphic to the symmetric group on five letters, and this normal subgroup is simple and non-abelian, the general quintic equation does not have a solution in radicals. The proof of the [Abel–Ruffini theorem](http://en.wikipedia.org/wiki/Abel%E2%80%93Ruffini_theorem) uses this simple fact, and [Felix Klein](http://en.wikipedia.org/wiki/Felix_Klein) wrote a book that made use of the theory of icosahedral symmetries to derive an analytical solution to the general quintic equation, ([Klein 1888](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes#CITEREFKlein1888)). See [icosahedral symmetry: related geometries](http://en.wikipedia.org/wiki/Icosahedral_symmetry#Related_geometries) for further history, and related symmetries on seven and eleven letters.

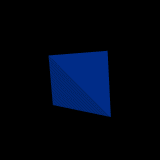
The full symmetry group of the icosahedron (including reflections) is known as the [full icosahedral group](http://en.wikipedia.org/wiki/Full_icosahedral_group), and is isomorphic to the product of the rotational symmetry group and the group *C*2 of size two, which is generated by the reflection through the center of the icosahedron.

**Pseudoicosahedron**

|  |  |
| --- | --- |
| **Pseudoicosahedron** | |
| [Pseudoicosahedron-2.png](http://en.wikipedia.org/wiki/File:Pseudoicosahedron-2.png)[Pseudoicosahedron-1.png](http://en.wikipedia.org/wiki/File:Pseudoicosahedron-1.png) [Pseudoicosahedron-4.png](http://en.wikipedia.org/wiki/File:Pseudoicosahedron-4.png)[Pseudoicosahedron-3.png](http://en.wikipedia.org/wiki/File:Pseudoicosahedron-3.png) Four views of the pseudoicosahedron, with eight equilateral triangles (red and yellow), and 12 blue isosceles triangles. | |
| [Coxeter diagrams](http://en.wikipedia.org/wiki/Coxeter_diagram) | CDel node.pngCDel 4.pngCDel node h.pngCDel 3.pngCDel node h.png (pyritohedral) [Uniform polyhedron-43-h01.svg](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-43-h01.svg) CDel node h.pngCDel 3.pngCDel node h.pngCDel 3.pngCDel node h.png (tetrahedral) [Uniform polyhedron-33-s012.svg](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-s012.svg) |
| [Faces](http://en.wikipedia.org/wiki/Face_(geometry)) | 20 triangles: 8 equilateral 12 isosceles |
| [Edges](http://en.wikipedia.org/wiki/Edge_(geometry)) | 30 (6 short + 24 long) |
| [Vertices](http://en.wikipedia.org/wiki/Vertex_(geometry)) | 12 |
| [Symmetry group](http://en.wikipedia.org/wiki/List_of_spherical_symmetry_groups#Polyhedral_symmetry) | [Th](http://en.wikipedia.org/wiki/Pyritohedral_symmetry), [4,3+], (3\*2), order 24 |
| [Rotation group](http://en.wikipedia.org/wiki/Point_groups_in_three_dimensions#Rotation_groups) | [Td](http://en.wikipedia.org/wiki/Tetrahedral_symmetry), [3,3]+, (332), order 12 |
| [Dual polyhedron](http://en.wikipedia.org/wiki/Dual_polyhedron) | [Pyritohedron](http://en.wikipedia.org/wiki/Pyritohedron) |
| Properties | [convex](http://en.wikipedia.org/wiki/Convex_set) |
| **[Pseudoicosahedron flat.png](http://en.wikipedia.org/wiki/File:Pseudoicosahedron_flat.png)** [**Net**](http://en.wikipedia.org/wiki/Net_(polyhedron)) | |

[](http://en.wikipedia.org/wiki/File:Snub-polyhedron-icosahedron.png)

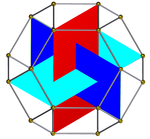
The pseudoicosahedron as an [alternated](http://en.wikipedia.org/wiki/Alternation_(geometry)) [truncated octahedron](http://en.wikipedia.org/wiki/Truncated_octahedron).

[](http://en.wikipedia.org/wiki/File:P1-P5.gif)

The icosahedron can be constructed from the[tetrahedron](http://en.wikipedia.org/wiki/Tetrahedron) by a rotation of the triangular faces, inserting pairs of new triangles in place of the original 6 edges.

A **pseudoicosahedron** is an icosahedron with [pyritohedral symmetry](http://en.wikipedia.org/wiki/Pyritohedral_symmetry" \o "Pyritohedral symmetry). The 20 triangular faces are divided into two groups of 8 [equilateral triangles](http://en.wikipedia.org/wiki/Equilateral_triangle) and 12 [isosceles triangles](http://en.wikipedia.org/wiki/Isosceles_triangle). If all the triangles are[equilateral triangles](http://en.wikipedia.org/wiki/Equilateral_triangle), the symmetry can also be distinguished by coloring the 8 and 12 triangle sets differently. The pseudoicosahedron is an [alternated](http://en.wikipedia.org/wiki/Alternation_(geometry)) [truncated octahedron](http://en.wikipedia.org/wiki/Truncated_octahedron).

**Pyritohedral symmetry**

[](http://en.wikipedia.org/wiki/File:Truncated_octahedron_internal_rectangles.png)

The 3 rectangles with 12 vertices of the 24 vertex[truncated octahedron](http://en.wikipedia.org/wiki/Truncated_octahedron), corresponding to the vertices of the pseudoicosahedron. The rectangle edge length ratios of 2:1.

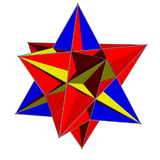
If the 8 equilateral triangles are geometrically identical, the pseudoicosahedron has [pyritohedral symmetry](http://en.wikipedia.org/wiki/Pyritohedral_symmetry" \o "Pyritohedral symmetry) (3\*2), [4,3+], with order 24. A lower [tetrahedral symmetry](http://en.wikipedia.org/wiki/Tetrahedral_symmetry) (332), [3,3]+, exists as well, seen as the 8 triangles marked (colored) in alternating pairs of four, with order 12. These symmetries offer [Coxeter-Dynkin diagrams](http://en.wikipedia.org/wiki/Coxeter-Dynkin_diagram" \o "Coxeter-Dynkin diagram): CDel node.pngCDel 4.pngCDel node h.pngCDel 3.pngCDel node h.png and CDel node h.pngCDel 3.pngCDel node h.pngCDel 3.pngCDel node h.png respectfully, each representing the lower symmetry to the regular icosahedron CDel node 1.pngCDel 3.pngCDel node.pngCDel 5.pngCDel node.png, (\*532), [5,3] [icosahedral symmetry](http://en.wikipedia.org/wiki/Icosahedral_symmetry) of order 120.

**Cartesian coordinates**

The coordinates of the 12 vertices can be defined by the vectors defined by all the possible cyclic permutations and sign-flips of coordinates of the form (2, 1, 0). These coordinates represent the [truncated octahedron](http://en.wikipedia.org/wiki/Truncated_octahedron) with [alternated](http://en.wikipedia.org/wiki/Alternation_(geometry)) vertices deleted.

This construction is called a *snub tetrahedron* in its regular icosahedron form, generated by the same operations carried out starting with the vector (φ, 1, 0), where φ is the [golden ratio](http://en.wikipedia.org/wiki/Golden_ratio).[[8]](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes#cite_note-8)

The regular [star polyhedron](http://en.wikipedia.org/wiki/Star_polyhedron), [great icosahedron](http://en.wikipedia.org/wiki/Great_icosahedron), CDel node h.pngCDel 3x.pngCDel rat.pngCDel d2.pngCDel node h.pngCDel 3x.pngCDel rat.pngCDel d2.pngCDel node h.png, CDel node h.pngCDel 3x.pngCDel rat.pngCDel d2.pngCDel node h.pngCDel 4.pngCDel node.png or CDel node h.pngCDel 3x.pngCDel node h.pngCDel 4.pngCDel rat.pngCDel 3x.pngCDel node.png can be considered a special case of parametric *pseudoicosahedron* with a [vertex figure](http://en.wikipedia.org/wiki/Vertex_figure) that overlaps into a regular[pentagram](http://en.wikipedia.org/wiki/Pentagram). The [tetrahedral symmetry](http://en.wikipedia.org/wiki/Tetrahedral_symmetry) of this form is called a [retrosnub tetrahedron](http://en.wikipedia.org/wiki/Retrosnub_tetrahedron" \o "Retrosnub tetrahedron):

[](http://en.wikipedia.org/wiki/File:Retrosnub_tetrahedron.png)

**Crystal pyrite**

[Iron pyrites](http://en.wikipedia.org/wiki/Iron_pyrites) have been observed to have formed crystals in the form of pseudoicosahedra.[[9]](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes#cite_note-9)

**Stellations**

According to specific rules defined in the book [*The Fifty-Nine Icosahedra*](http://en.wikipedia.org/wiki/The_Fifty-Nine_Icosahedra), 59 [stellations](http://en.wikipedia.org/wiki/Stellation" \o "Stellation) were identified for the regular icosahedron. The first form is the icosahedron itself. One is a regular[Kepler–Poinsot polyhedron](http://en.wikipedia.org/wiki/Kepler%E2%80%93Poinsot_polyhedron). Three are [regular compound polyhedra](http://en.wikipedia.org/wiki/Polyhedral_compound#Regular_compounds).[[10]](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes#cite_note-10)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **21 of 59 stellations** | | | | | | | | |
| [Zeroth stellation of icosahedron facets.png](http://en.wikipedia.org/wiki/File:Zeroth_stellation_of_icosahedron_facets.png) The faces of the icosahedron extended outwards as planes intersect, defining regions in space as shown by this[stellation diagram](http://en.wikipedia.org/wiki/Stellation_diagram) of the intersections in a single plane. | [Zeroth stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Zeroth_stellation_of_icosahedron.png) | [First stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:First_stellation_of_icosahedron.png) | [Second stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Second_stellation_of_icosahedron.png) | [Third stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Third_stellation_of_icosahedron.png) | [Fourth stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Fourth_stellation_of_icosahedron.png) | [Fifth stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Fifth_stellation_of_icosahedron.png) | [Sixth stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Sixth_stellation_of_icosahedron.png) | [Seventh stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Seventh_stellation_of_icosahedron.png) |
| [Eighth stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Eighth_stellation_of_icosahedron.png) | [Ninth stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Ninth_stellation_of_icosahedron.png) | [Tenth stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Tenth_stellation_of_icosahedron.png) | [Eleventh stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Eleventh_stellation_of_icosahedron.png) | [Twelfth stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Twelfth_stellation_of_icosahedron.png) | [Thirteenth stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Thirteenth_stellation_of_icosahedron.png) | [Fourteenth stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Fourteenth_stellation_of_icosahedron.png) | [Fifteenth stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Fifteenth_stellation_of_icosahedron.png) |
| [Sixteenth stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Sixteenth_stellation_of_icosahedron.png) | [Seventeenth stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Seventeenth_stellation_of_icosahedron.png) | [First compound stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:First_compound_stellation_of_icosahedron.png) | [Second compound stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Second_compound_stellation_of_icosahedron.png) | [Third compound stellation of icosahedron.png](http://en.wikipedia.org/wiki/File:Third_compound_stellation_of_icosahedron.png) |  |  |  |

**Geometric relations**

There are distortions of the icosahedron that, while no longer regular, are nevertheless [vertex-uniform](http://en.wikipedia.org/wiki/Vertex-uniform). These are [invariant](http://en.wikipedia.org/wiki/Invariant_(mathematics)) under the same [rotations](http://en.wikipedia.org/wiki/Rotation) as the tetrahedron, and are somewhat analogous to the [snub cube](http://en.wikipedia.org/wiki/Snub_cube) and [snub dodecahedron](http://en.wikipedia.org/wiki/Snub_dodecahedron), including some forms which are [chiral](http://en.wikipedia.org/wiki/Chirality_(mathematics)) and some with Th-symmetry, i.e. have different planes of symmetry from the tetrahedron. The icosahedron has a large number of stellations, including one of the [Kepler–Poinsot polyhedra](http://en.wikipedia.org/wiki/Kepler%E2%80%93Poinsot_polyhedra" \o "Kepler–Poinsot polyhedra) and some of the regular compounds, which could be discussed here.

The icosahedron is unique among the [Platonic solids](http://en.wikipedia.org/wiki/Platonic_solids) in possessing a [dihedral angle](http://en.wikipedia.org/wiki/Dihedral_angle) not less than 120°. Its dihedral angle is approximately 138.19°. Thus, just as hexagons have angles not less than 120° and cannot be used as the faces of a convex regular polyhedron because such a construction would not meet the requirement that at least three faces meet at a vertex and leave a positive [defect](http://en.wikipedia.org/wiki/Defect_(geometry)) for folding in three dimensions, icosahedra cannot be used as the [cells](http://en.wikipedia.org/wiki/Cell_(geometry)) of a convex regular [polychoron](http://en.wikipedia.org/wiki/Polychoron" \o "Polychoron) because, similarly, at least three cells must meet at an edge and leave a positive defect for folding in four dimensions (in general for a convex [polytope](http://en.wikipedia.org/wiki/Polytope) in *n* dimensions, at least three [facets](http://en.wikipedia.org/wiki/Facet_(mathematics)) must meet at a[peak](http://en.wikipedia.org/wiki/Peak_(geometry)) and leave a positive defect for folding in *n*-space). However, when combined with suitable cells having smaller dihedral angles, icosahedra can be used as cells in semi-regular polychora (for example the [snub 24-cell](http://en.wikipedia.org/wiki/Snub_24-cell)), just as hexagons can be used as faces in semi-regular polyhedra (for example the [truncated icosahedron](http://en.wikipedia.org/wiki/Truncated_icosahedron)). Finally, non-convex polytopes do not carry the same strict requirements as convex polytopes, and icosahedra are indeed the cells of the [icosahedral 120-cell](http://en.wikipedia.org/wiki/Icosahedral_120-cell), one of the ten [non-convex regular polychora](http://en.wikipedia.org/wiki/Schl%C3%A4fli%E2%80%93Hess_polychoron).

An icosahedron can also be called a [gyroelongated pentagonal bipyramid](http://en.wikipedia.org/wiki/Gyroelongated_dipyramid" \o "Gyroelongated dipyramid). It can be decomposed into a [gyroelongated pentagonal pyramid](http://en.wikipedia.org/wiki/Gyroelongated_pentagonal_pyramid" \o "Gyroelongated pentagonal pyramid) and a [pentagonal pyramid](http://en.wikipedia.org/wiki/Pentagonal_pyramid) or into a[pentagonal antiprism](http://en.wikipedia.org/wiki/Pentagonal_antiprism) and two equal pentagonal pyramids.

**Uniform colorings and subsymmetries**

There are 3 [uniform colorings](http://en.wikipedia.org/wiki/Uniform_coloring) of the icosahedron. These colorings can be represented as 11213, 11212, 11111, naming the 5 triangular faces around each vertex by their color.

The icosahedron can be considered a snub tetrahedron, as [snubification](http://en.wikipedia.org/wiki/Snub_(geometry)" \o "Snub (geometry)) of a regular tetrahedron gives a regular icosahedron having chiral [tetrahedral symmetry](http://en.wikipedia.org/wiki/Tetrahedral_symmetry). It can also be constructed as an alternated truncated octahedron, having [pyritohedral symmetry](http://en.wikipedia.org/wiki/Pyritohedral_symmetry" \o "Pyritohedral symmetry). The pyritohedral symmetry version is sometimes called a [pseudoicosahedron](http://en.wikipedia.org/wiki/Pseudoicosahedron" \o "Pseudoicosahedron), and is dual to the [pyritohedron](http://en.wikipedia.org/wiki/Pyritohedron" \o "Pyritohedron).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | Regular icosahedron | [snub octahedron](http://en.wikipedia.org/wiki/Snub_octahedron) | [Snub tetratetrahedron](http://en.wikipedia.org/wiki/Snub_tetratetrahedron) | Pentagonal [gyroelongated bipyramid](http://en.wikipedia.org/wiki/Gyroelongated_bipyramid) |
| [**Coxeter-Dynkin**](http://en.wikipedia.org/wiki/Coxeter-Dynkin_diagram) | CDel node.pngCDel 5.pngCDel node.pngCDel 3.pngCDel node 1.png | CDel node.pngCDel 4.pngCDel node h.pngCDel 3.pngCDel node h.png | CDel node h.pngCDel 3.pngCDel node h.pngCDel 3.pngCDel node h.png |  |
| [**Schläfli symbol**](http://en.wikipedia.org/wiki/Schl%C3%A4fli_symbol) | {3,5} | s{3,4} | sr{3,3} |  |
| [**Wythoff symbol**](http://en.wikipedia.org/wiki/Wythoff_symbol) | 5 | 3 2 |  | | 3 3 2 |  |
| [**Symmetry**](http://en.wikipedia.org/wiki/List_of_spherical_symmetry_groups) | Ih [5,3] (\*532) | Th [3+,4] (3\*2) | T [3,3]+ (332) | D5d [2+,10] (2\*5) |
| **Symmetry order** | 60 | 24 | 12 | 10 |
| [**Uniform coloring**](http://en.wikipedia.org/wiki/Uniform_coloring) | [Uniform polyhedron-53-t2.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-53-t2.png) (11111) | [Uniform polyhedron-43-h01.svg](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-43-h01.svg) (11212) | [Uniform polyhedron-33-s012.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-s012.png) (11213) | [Pentagonal gyroelongated bipyramid.png](http://en.wikipedia.org/wiki/File:Pentagonal_gyroelongated_bipyramid.png) (11122)&(22222) |

**Related polyhedra and polytopes**

The icosahedron can be transformed by a [truncation](http://en.wikipedia.org/wiki/Truncation_(geometry)) sequence into its [dual](http://en.wikipedia.org/wiki/Dual_polyhedron), the dodecahedron:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Family of uniform icosahedral polyhedra** | | | | | | | |
| [**Symmetry**](http://en.wikipedia.org/wiki/List_of_spherical_symmetry_groups)**:**[**[5,3]**](http://en.wikipedia.org/wiki/Icosahedral_symmetry)**, (\*532)** | | | | | | | **[5,3]+, (532)** |
| **CDel node 1.pngCDel 5.pngCDel node.pngCDel 3.pngCDel node.png** | **CDel node 1.pngCDel 5.pngCDel node 1.pngCDel 3.pngCDel node.png** | **CDel node.pngCDel 5.pngCDel node 1.pngCDel 3.pngCDel node.png** | **CDel node.pngCDel 5.pngCDel node 1.pngCDel 3.pngCDel node 1.png** | **CDel node.pngCDel 5.pngCDel node.pngCDel 3.pngCDel node 1.png** | **CDel node 1.pngCDel 5.pngCDel node.pngCDel 3.pngCDel node 1.png** | **CDel node 1.pngCDel 5.pngCDel node 1.pngCDel 3.pngCDel node 1.png** | **CDel node h.pngCDel 5.pngCDel node h.pngCDel 3.pngCDel node h.png** |
| [Uniform polyhedron-53-t0.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-53-t0.png) | [Uniform polyhedron-53-t01.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-53-t01.png) | [Uniform polyhedron-53-t1.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-53-t1.png) | [Uniform polyhedron-53-t12.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-53-t12.png) | [Uniform polyhedron-53-t2.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-53-t2.png) | [Uniform polyhedron-53-t02.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-53-t02.png) | [Uniform polyhedron-53-t012.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-53-t012.png) | [Uniform polyhedron-53-s012.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-53-s012.png) |
| [{5,3}](http://en.wikipedia.org/wiki/Dodecahedron) | [t{5,3}](http://en.wikipedia.org/wiki/Truncated_dodecahedron) | [r{5,3}](http://en.wikipedia.org/wiki/Icosidodecahedron) | [2t{5,3}=t{3,5}](http://en.wikipedia.org/wiki/Truncated_icosahedron) | **2r{5,3}={3,5}** | [rr{5,3}](http://en.wikipedia.org/wiki/Rhombicosidodecahedron) | [tr{5,3}](http://en.wikipedia.org/wiki/Truncated_icosidodecahedron) | [sr{5,3}](http://en.wikipedia.org/wiki/Snub_dodecahedron) |
| **Duals to uniform polyhedra** | | | | | | | |
| **CDel node f1.pngCDel 5.pngCDel node.pngCDel 3.pngCDel node.png** | **CDel node f1.pngCDel 5.pngCDel node f1.pngCDel 3.pngCDel node.png** | **CDel node.pngCDel 5.pngCDel node f1.pngCDel 3.pngCDel node.png** | **CDel node.pngCDel 5.pngCDel node f1.pngCDel 3.pngCDel node f1.png** | **CDel node.pngCDel 5.pngCDel node.pngCDel 3.pngCDel node f1.png** | **CDel node f1.pngCDel 5.pngCDel node.pngCDel 3.pngCDel node f1.png** | **CDel node f1.pngCDel 5.pngCDel node f1.pngCDel 3.pngCDel node f1.png** | **CDel node fh.pngCDel 5.pngCDel node fh.pngCDel 3.pngCDel node fh.png** |
| [Icosahedron.svg](http://en.wikipedia.org/wiki/File:Icosahedron.svg) | [Triakisicosahedron.jpg](http://en.wikipedia.org/wiki/File:Triakisicosahedron.jpg) | [Rhombictriacontahedron.svg](http://en.wikipedia.org/wiki/File:Rhombictriacontahedron.svg) | [Pentakisdodecahedron.jpg](http://en.wikipedia.org/wiki/File:Pentakisdodecahedron.jpg) | [POV-Ray-Dodecahedron.svg](http://en.wikipedia.org/wiki/File:POV-Ray-Dodecahedron.svg) | [Deltoidalhexecontahedron.jpg](http://en.wikipedia.org/wiki/File:Deltoidalhexecontahedron.jpg) | [Disdyakistriacontahedron.jpg](http://en.wikipedia.org/wiki/File:Disdyakistriacontahedron.jpg) | [Pentagonalhexecontahedronccw.jpg](http://en.wikipedia.org/wiki/File:Pentagonalhexecontahedronccw.jpg) |
| **V5.5.5** | [V3.10.10](http://en.wikipedia.org/wiki/Triakis_icosahedron) | [V3.5.3.5](http://en.wikipedia.org/wiki/Rhombic_triacontahedron) | [V5.6.6](http://en.wikipedia.org/wiki/Pentakis_dodecahedron) | [V3.3.3.3.3](http://en.wikipedia.org/wiki/Dodecahedron) | [V3.4.5.4](http://en.wikipedia.org/wiki/Deltoidal_hexecontahedron) | [V4.6.10](http://en.wikipedia.org/wiki/Disdyakis_triacontahedron) | [V3.3.3.3.5](http://en.wikipedia.org/wiki/Pentagonal_hexecontahedron) |

As a snub tetrahedron, and alternation of a truncated octahedron it also exists in the tetrahedral and octahedral symmetry families:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| [**Family of uniform tetrahedral polyhedra**](http://en.wikipedia.org/wiki/Uniform_polyhedron#.283_3_2.29_Td_Tetrahedral_symmetry) | | | | | | | |
| [**Symmetry**](http://en.wikipedia.org/wiki/List_of_spherical_symmetry_groups)**:**[**[3,3]**](http://en.wikipedia.org/wiki/Tetrahedral_symmetry)**, (\*332)** | | | | | | | **[3,3]+, (332)** |
| **CDel node 1.pngCDel 3.pngCDel node.pngCDel 3.pngCDel node.png** | **CDel node 1.pngCDel 3.pngCDel node 1.pngCDel 3.pngCDel node.png** | **CDel node.pngCDel 3.pngCDel node 1.pngCDel 3.pngCDel node.png** | **CDel node.pngCDel 3.pngCDel node 1.pngCDel 3.pngCDel node 1.png** | **CDel node.pngCDel 3.pngCDel node.pngCDel 3.pngCDel node 1.png** | **CDel node 1.pngCDel 3.pngCDel node.pngCDel 3.pngCDel node 1.png** | **CDel node 1.pngCDel 3.pngCDel node 1.pngCDel 3.pngCDel node 1.png** | **CDel node h.pngCDel 3.pngCDel node h.pngCDel 3.pngCDel node h.png** |
| [Uniform polyhedron-33-t0.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-t0.png) | [Uniform polyhedron-33-t01.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-t01.png) | [Uniform polyhedron-33-t1.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-t1.png) | [Uniform polyhedron-33-t12.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-t12.png) | [Uniform polyhedron-33-t2.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-t2.png) | [Uniform polyhedron-33-t02.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-t02.png) | [Uniform polyhedron-33-t012.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-t012.png) | [Uniform polyhedron-33-s012.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-s012.png) |
| [{3,3}](http://en.wikipedia.org/wiki/Tetrahedron) | [t{3,3}](http://en.wikipedia.org/wiki/Truncated_tetrahedron) | [r{3,3}](http://en.wikipedia.org/wiki/Octahedron) | [t{3,3}](http://en.wikipedia.org/wiki/Truncated_tetrahedron) | [{3,3}](http://en.wikipedia.org/wiki/Tetrahedron) | [rr{3,3}](http://en.wikipedia.org/wiki/Cuboctahedron) | [tr{3,3}](http://en.wikipedia.org/wiki/Truncated_octahedron) | [sr{3,3}](http://en.wikipedia.org/wiki/Pseudoicosahedron) |
| **Duals to uniform polyhedra** | | | | | | | |
| **CDel node f1.pngCDel 3.pngCDel node.pngCDel 3.pngCDel node.png** | **CDel node f1.pngCDel 3.pngCDel node f1.pngCDel 3.pngCDel node.png** | **CDel node.pngCDel 3.pngCDel node f1.pngCDel 3.pngCDel node.png** | **CDel node.pngCDel 3.pngCDel node f1.pngCDel 3.pngCDel node f1.png** | **CDel node.pngCDel 3.pngCDel node.pngCDel 3.pngCDel node f1.png** | **CDel node f1.pngCDel 3.pngCDel node.pngCDel 3.pngCDel node f1.png** | **CDel node f1.pngCDel 3.pngCDel node f1.pngCDel 3.pngCDel node f1.png** | **CDel node fh.pngCDel 3.pngCDel node fh.pngCDel 3.pngCDel node fh.png** |
| [Tetrahedron.svg](http://en.wikipedia.org/wiki/File:Tetrahedron.svg) | [Triakistetrahedron.jpg](http://en.wikipedia.org/wiki/File:Triakistetrahedron.jpg) | [Hexahedron.svg](http://en.wikipedia.org/wiki/File:Hexahedron.svg) | [Triakistetrahedron.jpg](http://en.wikipedia.org/wiki/File:Triakistetrahedron.jpg) | [Tetrahedron.svg](http://en.wikipedia.org/wiki/File:Tetrahedron.svg) | [Rhombicdodecahedron.jpg](http://en.wikipedia.org/wiki/File:Rhombicdodecahedron.jpg) | [Tetrakishexahedron.jpg](http://en.wikipedia.org/wiki/File:Tetrakishexahedron.jpg) | [POV-Ray-Dodecahedron.svg](http://en.wikipedia.org/wiki/File:POV-Ray-Dodecahedron.svg) |
| [V3.3.3](http://en.wikipedia.org/wiki/Tetrahedron) | [V3.6.6](http://en.wikipedia.org/wiki/Triakis_tetrahedron) | [V3.3.3.3](http://en.wikipedia.org/wiki/Cube) | [V3.6.6](http://en.wikipedia.org/wiki/Triakis_tetrahedron) | [V3.3.3](http://en.wikipedia.org/wiki/Tetrahedron) | [V3.4.3.4](http://en.wikipedia.org/wiki/Rhombic_dodecahedron) | [V4.6.6](http://en.wikipedia.org/wiki/Tetrakis_hexahedron) | [V3.3.3.3.3](http://en.wikipedia.org/wiki/Pyritohedron) |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [**Uniform octahedral polyhedra**](http://en.wikipedia.org/wiki/Uniform_polyhedron#.284_3_2.29_Oh_Octahedral_symmetry) | | | | | | | | | | |
| [**Symmetry**](http://en.wikipedia.org/wiki/List_of_spherical_symmetry_groups)**:**[**[4,3]**](http://en.wikipedia.org/wiki/Octahedral_symmetry)**, (\*432)** | | | | | | | **[4,3]+ (432)** | **[1+,4,3] = [3,3] (\*332)** | | **[3+,4] (3\*2)** |
| [{4,3}](http://en.wikipedia.org/wiki/Cube) | [t{4,3}](http://en.wikipedia.org/wiki/Truncated_cube) | [r{4,3}](http://en.wikipedia.org/wiki/Cuboctahedron) r{31,1} | [t{3,4}](http://en.wikipedia.org/wiki/Truncated_octahedron) t{31,1} | [{3,4}](http://en.wikipedia.org/wiki/Octahedron) {31,1} | [rr{4,3}](http://en.wikipedia.org/wiki/Rhombicuboctahedron) s2{3,4} | [tr{4,3}](http://en.wikipedia.org/wiki/Truncated_cuboctahedron) | [sr{4,3}](http://en.wikipedia.org/wiki/Snub_cube) | [h{4,3}](http://en.wikipedia.org/wiki/Tetrahedron) {3,3} | [h2{4,3}](http://en.wikipedia.org/wiki/Truncated_tetrahedron) t{3,3} | [s{4,3}](http://en.wikipedia.org/wiki/Pseudoicosahedron) s{31,1} |
| CDel node 1.pngCDel 4.pngCDel node.pngCDel 3.pngCDel node.png | CDel node 1.pngCDel 4.pngCDel node 1.pngCDel 3.pngCDel node.png | CDel node.pngCDel 4.pngCDel node 1.pngCDel 3.pngCDel node.png | CDel node.pngCDel 4.pngCDel node 1.pngCDel 3.pngCDel node 1.png | CDel node.pngCDel 4.pngCDel node.pngCDel 3.pngCDel node 1.png | CDel node 1.pngCDel 4.pngCDel node.pngCDel 3.pngCDel node 1.png | CDel node 1.pngCDel 4.pngCDel node 1.pngCDel 3.pngCDel node 1.png | CDel node h.pngCDel 4.pngCDel node h.pngCDel 3.pngCDel node h.png |  |  | CDel node h.pngCDel 3.pngCDel node h.pngCDel 4.pngCDel node.png |
|  |  | CDel node h0.pngCDel 4.pngCDel node 1.pngCDel 3.pngCDel node.png = CDel nodes 11.pngCDel split2.pngCDel node.png | CDel node h0.pngCDel 4.pngCDel node 1.pngCDel 3.pngCDel node 1.png = CDel nodes 11.pngCDel split2.pngCDel node 1.png | CDel node h0.pngCDel 4.pngCDel node.pngCDel 3.pngCDel node 1.png = CDel nodes.pngCDel split2.pngCDel node 1.png | CDel node 1.pngCDel 4.pngCDel node h.pngCDel 3.pngCDel node h.png |  |  | CDel node h1.pngCDel 4.pngCDel node.pngCDel 3.pngCDel node.png = CDel nodes 10ru.pngCDel split2.pngCDel node.png or CDel nodes 01rd.pngCDel split2.pngCDel node.png | CDel node h1.pngCDel 4.pngCDel node.pngCDel 3.pngCDel node 1.png = CDel nodes 10ru.pngCDel split2.pngCDel node 1.png or CDel nodes 01rd.pngCDel split2.pngCDel node 1.png | CDel node h.pngCDel 3.pngCDel node h.pngCDel 4.pngCDel node h0.png = CDel node h.pngCDel split1.pngCDel nodes hh.png |
| [Uniform polyhedron-43-t0.svg](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-43-t0.svg) | [Uniform polyhedron-43-t01.svg](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-43-t01.svg) | [Uniform polyhedron-43-t1.svg](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-43-t1.svg) [Uniform polyhedron-33-t02.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-t02.png) | [Uniform polyhedron-43-t12.svg](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-43-t12.svg) [Uniform polyhedron-33-t012.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-t012.png) | [Uniform polyhedron-43-t2.svg](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-43-t2.svg) [Uniform polyhedron-33-t1.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-t1.png) | [Uniform polyhedron-43-t02.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-43-t02.png) [Rhombicuboctahedron uniform edge coloring.png](http://en.wikipedia.org/wiki/File:Rhombicuboctahedron_uniform_edge_coloring.png) | [Uniform polyhedron-43-t012.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-43-t012.png) | [Uniform polyhedron-43-s012.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-43-s012.png) | [Uniform polyhedron-33-t0.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-t0.png)[Uniform polyhedron-33-t2.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-t2.png) | [Uniform polyhedron-33-t01.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-t01.png)[Uniform polyhedron-33-t12.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-t12.png) | [Uniform polyhedron-43-h01.svg](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-43-h01.svg) [Uniform polyhedron-33-s012.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-s012.png) |
| **Duals to uniform polyhedra** | | | | | | | | | | |
| [V43](http://en.wikipedia.org/wiki/Octahedron) | [V3.82](http://en.wikipedia.org/wiki/Triakis_octahedron) | [V(3.4)2](http://en.wikipedia.org/wiki/Rhombic_dodecahedron) | [V4.62](http://en.wikipedia.org/wiki/Tetrakis_hexahedron) | [V34](http://en.wikipedia.org/wiki/Cube) | [V3.43](http://en.wikipedia.org/wiki/Deltoidal_icositetrahedron) | [V4.6.8](http://en.wikipedia.org/wiki/Disdyakis_dodecahedron) | [V34.4](http://en.wikipedia.org/wiki/Pentagonal_icositetrahedron) | [V33](http://en.wikipedia.org/wiki/Tetrahedron) | [V3.62](http://en.wikipedia.org/wiki/Triakis_tetrahedron) | [V35](http://en.wikipedia.org/wiki/Pyritohedron) |
| CDel node f1.pngCDel 4.pngCDel node.pngCDel 3.pngCDel node.png | CDel node f1.pngCDel 4.pngCDel node f1.pngCDel 3.pngCDel node.png | CDel node.pngCDel 4.pngCDel node f1.pngCDel 3.pngCDel node.png | CDel node.pngCDel 4.pngCDel node f1.pngCDel 3.pngCDel node f1.png | CDel node.pngCDel 4.pngCDel node.pngCDel 3.pngCDel node f1.png | CDel node f1.pngCDel 4.pngCDel node.pngCDel 3.pngCDel node f1.png | CDel node f1.pngCDel 4.pngCDel node f1.pngCDel 3.pngCDel node f1.png | CDel node fh.pngCDel 4.pngCDel node fh.pngCDel 3.pngCDel node fh.png | CDel node fh.pngCDel 4.pngCDel node.pngCDel 3.pngCDel node.png | CDel node fh.pngCDel 4.pngCDel node.pngCDel 3.pngCDel node f1.png | CDel node fh.pngCDel 3.pngCDel node fh.pngCDel 4.pngCDel node.png |
|  |  | CDel node f1.pngCDel 3.pngCDel node.pngCDel 3.pngCDel node f1.png | CDel node f1.pngCDel 3.pngCDel node f1.pngCDel 3.pngCDel node f1.png | CDel node.pngCDel 3.pngCDel node f1.pngCDel 3.pngCDel node.png | CDel node f1.pngCDel 4.pngCDel node fh.pngCDel 3.pngCDel node fh.png |  |  | CDel node f1.pngCDel 3.pngCDel node.pngCDel 3.pngCDel node.png | CDel node.pngCDel 3.pngCDel node f1.pngCDel 3.pngCDel node f1.png | CDel node fh.pngCDel 3.pngCDel node fh.pngCDel 3.pngCDel node fh.png |
| [Octahedron.svg](http://en.wikipedia.org/wiki/File:Octahedron.svg) | [Triakisoctahedron.jpg](http://en.wikipedia.org/wiki/File:Triakisoctahedron.jpg) | [Rhombicdodecahedron.jpg](http://en.wikipedia.org/wiki/File:Rhombicdodecahedron.jpg) | [Tetrakishexahedron.jpg](http://en.wikipedia.org/wiki/File:Tetrakishexahedron.jpg) | [Hexahedron.svg](http://en.wikipedia.org/wiki/File:Hexahedron.svg) | [Deltoidalicositetrahedron.jpg](http://en.wikipedia.org/wiki/File:Deltoidalicositetrahedron.jpg) | [Disdyakisdodecahedron.jpg](http://en.wikipedia.org/wiki/File:Disdyakisdodecahedron.jpg) | [Pentagonalicositetrahedronccw.jpg](http://en.wikipedia.org/wiki/File:Pentagonalicositetrahedronccw.jpg) | [Tetrahedron.svg](http://en.wikipedia.org/wiki/File:Tetrahedron.svg) | [Triakistetrahedron.jpg](http://en.wikipedia.org/wiki/File:Triakistetrahedron.jpg) | [POV-Ray-Dodecahedron.svg](http://en.wikipedia.org/wiki/File:POV-Ray-Dodecahedron.svg) |

This polyhedron is topologically related as a part of sequence of regular polyhedra with [Schläfli symbols](http://en.wikipedia.org/wiki/Schl%C3%A4fli_symbol" \o "Schläfli symbol) {3,*n*}, continuing into the [hyperbolic plane](http://en.wikipedia.org/wiki/Hyperbolic_space).

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Finite** | | | | **Euclidean** | **Compact hyperbolic** | | | | **Paracompact** |
| [Trigonal dihedron.png](http://en.wikipedia.org/wiki/File:Trigonal_dihedron.png) [{3,2}](http://en.wikipedia.org/wiki/Dihedron) | [Uniform polyhedron-33-t2.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-33-t2.png) [{3,3}](http://en.wikipedia.org/wiki/Tetrahedron) | [Uniform polyhedron-43-t2.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-43-t2.png) [{3,4}](http://en.wikipedia.org/wiki/Octahedron) | [Uniform polyhedron-53-t2.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-53-t2.png) **{3,5}** | [Uniform polyhedron-63-t2.png](http://en.wikipedia.org/wiki/File:Uniform_polyhedron-63-t2.png) [{3,6}](http://en.wikipedia.org/wiki/Triangular_tiling) | [Uniform tiling 73-t2.png](http://en.wikipedia.org/wiki/File:Uniform_tiling_73-t2.png) [{3,7}](http://en.wikipedia.org/wiki/Order-7_triangular_tiling) | [Uniform tiling 83-t2.png](http://en.wikipedia.org/wiki/File:Uniform_tiling_83-t2.png) [{3,8}](http://en.wikipedia.org/wiki/Order-8_triangular_tiling) | [Uniform tiling 39-t0.png](http://en.wikipedia.org/wiki/File:Uniform_tiling_39-t0.png) [{3,9}](http://en.wikipedia.org/w/index.php?title=Order-9_triangular_tiling&action=edit&redlink=1) | ... | [H2 tiling 23i-4.png](http://en.wikipedia.org/wiki/File:H2_tiling_23i-4.png) [(3,∞}](http://en.wikipedia.org/wiki/Infinite-order_triangular_tiling) |

The regular icosahedron, seen as a *snub tetrahedron*, is a member of a sequence of [snubbed](http://en.wikipedia.org/wiki/Snub_(geometry)) polyhedra and tilings with vertex figure (3.3.3.3.*n*) and [Coxeter–Dynkin diagram](http://en.wikipedia.org/wiki/Coxeter%E2%80%93Dynkin_diagram" \o "Coxeter–Dynkin diagram) CDel node h.pngCDel n.pngCDel node h.pngCDel 3.pngCDel node h.png. These figures and their duals have (n32) rotational [symmetry](http://en.wikipedia.org/wiki/Orbifold_notation), being in the Euclidean plane for n=6, and hyperbolic plane for any higher n. The series can be considered to begin with n=2, with one set of faces degenerated into [digons](http://en.wikipedia.org/wiki/Digon" \o "Digon).

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Dimensional family of snub polyhedra and tilings: *3.3.3.3.n*** | | | | | | | | |
| **Symmetry n32 [n,3]+** | [**Spherical**](http://en.wikipedia.org/wiki/List_of_spherical_symmetry_groups) | | | | [**Euclidean**](http://en.wikipedia.org/wiki/List_of_planar_symmetry_groups) | **Compact hyperbolic** | | **Paracompact** |
| **232 [2,3]+ D3** | **332 [3,3]+ T** | **432 [4,3]+ O** | **532 [5,3]+ I** | **632 [6,3]+ P6** | **732 [7,3]+** | **832 [8,3]+...** | **∞32 [∞,3]+** |
| **Snub figure** | [Spherical trigonal antiprism.png](http://en.wikipedia.org/wiki/File:Spherical_trigonal_antiprism.png) [3.3.3.3.2](http://en.wikipedia.org/wiki/Octahedron) | [Spherical snub tetrahedron.png](http://en.wikipedia.org/wiki/File:Spherical_snub_tetrahedron.png) **3.3.3.3.3** | [Spherical snub cube.png](http://en.wikipedia.org/wiki/File:Spherical_snub_cube.png) [3.3.3.3.4](http://en.wikipedia.org/wiki/Snub_cube) | [Spherical snub dodecahedron.png](http://en.wikipedia.org/wiki/File:Spherical_snub_dodecahedron.png) [3.3.3.3.5](http://en.wikipedia.org/wiki/Snub_dodecahedron) | [Uniform tiling 63-snub.png](http://en.wikipedia.org/wiki/File:Uniform_tiling_63-snub.png) [3.3.3.3.6](http://en.wikipedia.org/wiki/Snub_trihexagonal_tiling) | [Uniform tiling 73-snub.png](http://en.wikipedia.org/wiki/File:Uniform_tiling_73-snub.png) [3.3.3.3.7](http://en.wikipedia.org/wiki/Snub_triheptagonal_tiling) | [Uniform tiling 83-snub.png](http://en.wikipedia.org/wiki/File:Uniform_tiling_83-snub.png) [3.3.3.3.8](http://en.wikipedia.org/wiki/Snub_trioctagonal_tiling) | [Uniform tiling i32-snub.png](http://en.wikipedia.org/wiki/File:Uniform_tiling_i32-snub.png) [3.3.3.3.∞](http://en.wikipedia.org/wiki/Snub_triapeirogonal_tiling) |
| [**Coxeter**](http://en.wikipedia.org/wiki/Coxeter-Dynkin_diagram)[**Schläfli**](http://en.wikipedia.org/wiki/Schl%C3%A4fli_symbol) | **CDel node h.pngCDel 2x.pngCDel node h.pngCDel 3.pngCDel node h.png sr{2,3}** | **CDel node h.pngCDel 3.pngCDel node h.pngCDel 3.pngCDel node h.png sr{3,3}** | **CDel node h.pngCDel 4.pngCDel node h.pngCDel 3.pngCDel node h.png sr{4,3}** | **CDel node h.pngCDel 5.pngCDel node h.pngCDel 3.pngCDel node h.png sr{5,3}** | **CDel node h.pngCDel 6.pngCDel node h.pngCDel 3.pngCDel node h.png sr{6,3}** | **CDel node h.pngCDel 7.pngCDel node h.pngCDel 3.pngCDel node h.png sr{7,3}** | **CDel node h.pngCDel 8.pngCDel node h.pngCDel 3.pngCDel node h.png sr{8,3}** | **CDel node h.pngCDel infin.pngCDel node h.pngCDel 3.pngCDel node h.png sr{∞,3}** |
| **Snub dual figure** | [Hexahedron.svg](http://en.wikipedia.org/wiki/File:Hexahedron.svg) [V3.3.3.3.2](http://en.wikipedia.org/wiki/Cube) | [POV-Ray-Dodecahedron.svg](http://en.wikipedia.org/wiki/File:POV-Ray-Dodecahedron.svg) [V3.3.3.3.3](http://en.wikipedia.org/wiki/Dodecahedron) | [Pentagonalicositetrahedroncw.jpg](http://en.wikipedia.org/wiki/File:Pentagonalicositetrahedroncw.jpg) [V3.3.3.3.4](http://en.wikipedia.org/wiki/Pentagonal_icositetrahedron) | [Pentagonalhexecontahedroncw.jpg](http://en.wikipedia.org/wiki/File:Pentagonalhexecontahedroncw.jpg) [V3.3.3.3.5](http://en.wikipedia.org/wiki/Pentagonal_hexecontahedron) | [Tiling Dual Semiregular V3-3-3-3-6 Floret Pentagonal.svg](http://en.wikipedia.org/wiki/File:Tiling_Dual_Semiregular_V3-3-3-3-6_Floret_Pentagonal.svg) [V3.3.3.3.6](http://en.wikipedia.org/wiki/Floret_pentagonal_tiling) | [Ord7 3 floret penta til.png](http://en.wikipedia.org/wiki/File:Ord7_3_floret_penta_til.png) V3.3.3.3.7 | V3.3.3.3.8 | V3.3.3.3.∞ |
| [**Coxeter**](http://en.wikipedia.org/wiki/Coxeter-Dynkin_diagram) | **CDel node fh.pngCDel 2x.pngCDel node fh.pngCDel 3.pngCDel node fh.png** | **CDel node fh.pngCDel 3.pngCDel node fh.pngCDel 3.pngCDel node fh.png** | **CDel node fh.pngCDel 4.pngCDel node fh.pngCDel 3.pngCDel node fh.png** | **CDel node fh.pngCDel 5.pngCDel node fh.pngCDel 3.pngCDel node fh.png** | **CDel node fh.pngCDel 6.pngCDel node fh.pngCDel 3.pngCDel node fh.png** | **CDel node fh.pngCDel 7.pngCDel node fh.pngCDel 3.pngCDel node fh.png** | **CDel node fh.pngCDel 8.pngCDel node fh.pngCDel 3.pngCDel node fh.png** | **CDel node fh.pngCDel infin.pngCDel node fh.pngCDel 3.pngCDel node fh.png** |

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| **Spherical** | | **Hyperbolic tilings** | | | | | | |
| [Spherical pentagonal hosohedron.png](http://en.wikipedia.org/wiki/File:Spherical_pentagonal_hosohedron.png) [{2,5}](http://en.wikipedia.org/wiki/Hosohedron) CDel node 1.pngCDel 2.pngCDel node.pngCDel 5.pngCDel node.png | [Uniform tiling 532-t2.png](http://en.wikipedia.org/wiki/File:Uniform_tiling_532-t2.png) **{3,5}** CDel node 1.pngCDel 3.pngCDel node.pngCDel 5.pngCDel node.png | [H2 tiling 245-1.png](http://en.wikipedia.org/wiki/File:H2_tiling_245-1.png) [{4,5}](http://en.wikipedia.org/wiki/Order-5_square_tiling) CDel node 1.pngCDel 4.pngCDel node.pngCDel 5.pngCDel node.png | [H2 tiling 255-1.png](http://en.wikipedia.org/wiki/File:H2_tiling_255-1.png) [{5,5}](http://en.wikipedia.org/wiki/Order-5_pentagonal_tiling) CDel node 1.pngCDel 5.pngCDel node.pngCDel 5.pngCDel node.png | [H2 tiling 256-1.png](http://en.wikipedia.org/wiki/File:H2_tiling_256-1.png) [{6,5}](http://en.wikipedia.org/wiki/Order-5_hexagonal_tiling) CDel node 1.pngCDel 6.pngCDel node.pngCDel 5.pngCDel node.png | [H2 tiling 257-1.png](http://en.wikipedia.org/wiki/File:H2_tiling_257-1.png) [{7,5}](http://en.wikipedia.org/w/index.php?title=Order-5_heptagonal_tiling&action=edit&redlink=1) CDel node 1.pngCDel 7.pngCDel node.pngCDel 5.pngCDel node.png | [H2 tiling 258-1.png](http://en.wikipedia.org/wiki/File:H2_tiling_258-1.png) [{8,5}](http://en.wikipedia.org/w/index.php?title=Order-5_octagonal_tiling&action=edit&redlink=1) CDel node 1.pngCDel 8.pngCDel node.pngCDel 5.pngCDel node.png | ... | [H2 tiling 25i-1.png](http://en.wikipedia.org/wiki/File:H2_tiling_25i-1.png) [{∞,5}](http://en.wikipedia.org/wiki/Order-5_apeirogonal_tiling) CDel node 1.pngCDel infin.pngCDel node.pngCDel 5.pngCDel node.png |

The icosahedron shares its [vertex arrangement](http://en.wikipedia.org/wiki/Vertex_arrangement) with three [Kepler–Poinsot solids](http://en.wikipedia.org/wiki/Kepler%E2%80%93Poinsot_solid" \o "Kepler–Poinsot solid). The [great dodecahedron](http://en.wikipedia.org/wiki/Great_dodecahedron) also has the same [edge arrangement](http://en.wikipedia.org/wiki/Edge_arrangement).

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| --- | --- | --- | --- |
| **Picture** | [Great dodecahedron.png](http://en.wikipedia.org/wiki/File:Great_dodecahedron.png) [Great dodecahedron](http://en.wikipedia.org/wiki/Great_dodecahedron) | [Small stellated dodecahedron.png](http://en.wikipedia.org/wiki/File:Small_stellated_dodecahedron.png) [Small stellated dodecahedron](http://en.wikipedia.org/wiki/Small_stellated_dodecahedron) | [Great icosahedron.png](http://en.wikipedia.org/wiki/File:Great_icosahedron.png) [Great icosahedron](http://en.wikipedia.org/wiki/Great_icosahedron) |
| [**Coxeter-Dynkin**](http://en.wikipedia.org/wiki/Coxeter-Dynkin_diagram) | CDel node 1.pngCDel 5.pngCDel node.pngCDel 5.pngCDel rat.pngCDel d2.pngCDel node.png | CDel node.pngCDel 5.pngCDel node.pngCDel 5.pngCDel rat.pngCDel d2.pngCDel node 1.png | CDel node 1.pngCDel 3.pngCDel node.pngCDel 5.pngCDel rat.pngCDel d2.pngCDel node.png |

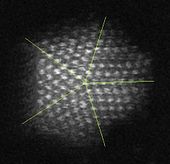
The icosahedron can tessellate hyperbolic space in the [order-3 icosahedral honeycomb](http://en.wikipedia.org/wiki/Order-3_icosahedral_honeycomb), with 3 icosahedra around each edge, 12 icosahedra around each vertex, with [Schläfli symbol](http://en.wikipedia.org/wiki/Schl%C3%A4fli_symbol" \o "Schläfli symbol) {3,5,3}. It is [one of four regular tessellations](http://en.wikipedia.org/wiki/List_of_regular_polytopes#Tessellations_of_hyperbolic_3-space) in the hyperbolic 3-space.

|  |
| --- |
| [Hyperb icosahedral hc.png](http://en.wikipedia.org/wiki/File:Hyperb_icosahedral_hc.png) It is shown here as an edge framework in a [Poincaré disk model](http://en.wikipedia.org/wiki/Poincar%C3%A9_disk_model" \o "Poincaré disk model), with one icosahedron visible in the center. |

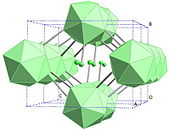
**Uses and natural forms**

[](http://en.wikipedia.org/wiki/File:20-sided_dice_250.jpg)

Twenty-sided [dice](http://en.wikipedia.org/wiki/Dice)

[](http://en.wikipedia.org/wiki/File:Twin2.jpg)

[Gold](http://en.wikipedia.org/wiki/Gold) nanoparticle viewed in electron microscope.

[](http://en.wikipedia.org/wiki/File:Gamma-bor.jpg)

Structure of γ-boron.

**Biology**

Many [viruses](http://en.wikipedia.org/wiki/Virus), e.g. [herpes](http://en.wikipedia.org/wiki/Herpes) virus, have icosahedral [shells](http://en.wikipedia.org/wiki/Capsid).[[11]](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes#cite_note-11) Viral structures are built of repeated identical [protein](http://en.wikipedia.org/wiki/Protein" \o "Protein)subunits known as [capsomeres](http://en.wikipedia.org/wiki/Capsomere" \o "Capsomere), and the icosahedron is the easiest shape to assemble using these subunits. A*regular* polyhedron is used because it can be built from a single basic unit protein used over and over again; this saves space in the viral [genome](http://en.wikipedia.org/wiki/Genome).

Various bacterial organelles with an icosahedral shape were also found.[[12]](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes#cite_note-Bobik2007-12) The icosahedral shell encapsulating enzymes and labile intermediates are built of different types of proteins with [BMC domains](http://en.wikipedia.org/wiki/BMC_domain).

In 1904, [Ernst Haeckel](http://en.wikipedia.org/wiki/Ernst_Haeckel) described a number of species of [Radiolaria](http://en.wikipedia.org/wiki/Radiolaria" \o "Radiolaria), including *Circogonia icosahedra*, whose skeleton is shaped like a regular icosahedron. A copy of Haeckel's illustration for this radiolarian appears in the article on [regular polyhedra](http://en.wikipedia.org/wiki/Regular_polyhedra).

**Chemistry**

The [closo](http://en.wikipedia.org/wiki/Closo_cluster" \o "Closo cluster)-[carboranes](http://en.wikipedia.org/wiki/Carboranes) are chemical compounds with shape very close to isosahedron. [Icosahedral](http://en.wikipedia.org/wiki/Icosahedral_twins) [twinning](http://en.wikipedia.org/wiki/Crystal_twinning) also occurs in crystals, especially[nanoparticles](http://en.wikipedia.org/wiki/Nanoparticle).

Many [borides](http://en.wikipedia.org/wiki/Crystal_structure_of_boron-rich_metal_borides) and [allotropes of boron](http://en.wikipedia.org/wiki/Allotropes_of_boron) contain boron B12 icosahedron as a basic structure unit. Also, icosahedrite (a mineral found in Russia) has a crystal shape of an icosahedron.

**Toys and games**

[](http://en.wikipedia.org/wiki/File:ScatDice.JPG)

[Scattergories](http://en.wikipedia.org/wiki/Scattergories) die

In several [roleplaying games](http://en.wikipedia.org/wiki/Roleplaying_game), such as [*Dungeons & Dragons*](http://en.wikipedia.org/wiki/Dungeons_%26_Dragons), the twenty-sided die ([d20](http://en.wikipedia.org/wiki/Dice#Non-cubical_dice) for short) is commonly used in determining success or failure of an action. This die is in the form of a regular icosahedron. It may be numbered from "0" to "9" twice (in which form it usually serves as a ten-sided die, or [d10](http://en.wikipedia.org/wiki/Dice#Non-cubical_dice)), but most modern versions are labeled from "1" to "20". See [d20 System](http://en.wikipedia.org/wiki/D20_System).

An icosahedron is the three-dimensional game board for Icosagame, formerly known as the Ico Crystal Game.

An icosahedron is used in the board game [Scattergories](http://en.wikipedia.org/wiki/Scattergories" \o "Scattergories) to choose a letter of the alphabet. Six letters are omitted (Q, U, V, X, Y, and Z).

Inside a [Magic 8-Ball](http://en.wikipedia.org/wiki/Magic_8-Ball), various answers to [yes-no questions](http://en.wikipedia.org/wiki/Yes-no_question) are inscribed on a regular icosahedron.

**Others**

[R. Buckminster Fuller](http://en.wikipedia.org/wiki/R._Buckminster_Fuller) and Japanese [cartographer](http://en.wikipedia.org/wiki/Cartographer) Shoji Sadao[[13]](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes" \l "cite_note-13) designed a world map in the form of an unfolded icosahedron, called the [Fuller projection](http://en.wikipedia.org/wiki/Fuller_projection), whose maximum [distortion](http://en.wikipedia.org/wiki/Distortion#Map_projections) is only 2%.

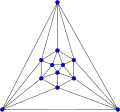
The "Sol de la Flor" light shade consists of twenty panels, which meet at the corners of an icosahedron in [rosettes](http://en.wikipedia.org/wiki/Rosette_(design)) resembling the overlapping petals of a [frangipani](http://en.wikipedia.org/wiki/Frangipani) flower.

If each edge of an icosahedron is replaced by a one [ohm](http://en.wikipedia.org/wiki/Ohm_(unit)) [resistor](http://en.wikipedia.org/wiki/Resistor), the resistance between opposite vertices is 0.5 ohms, and that between adjacent vertices 11/30 ohms.[[14]](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes#cite_note-14)

The company logo of the [TDK Corporation](http://en.wikipedia.org/wiki/TDK) contains a geometric figure which is based on the stellation diagram of the icosahedron.

A icosahedron was used for a logo for the Australian TV company; [Grundy Television](http://en.wikipedia.org/wiki/Grundy_Television).

**As a graph**

[](http://en.wikipedia.org/wiki/File:Icosahedron_graph.svg)

A planar representation of the icosahedral graph.

The skeleton of the icosahedron—the vertices and edges—form a [graph](http://en.wikipedia.org/wiki/Graph_(mathematics)). The high degree of symmetry of the polygon is replicated in the properties of this graph, which is [distance-transitive](http://en.wikipedia.org/wiki/Distance-transitive_graph), [distance-regular](http://en.wikipedia.org/wiki/Distance-regular_graph), and [symmetric](http://en.wikipedia.org/wiki/Symmetric_graph). The [automorphism group](http://en.wikipedia.org/wiki/Graph_automorphism" \o "Graph automorphism) has order 120. The vertices can be [colored](http://en.wikipedia.org/wiki/Graph_coloring) with 4 colors, the edges with 5 colors, and the [diameter](http://en.wikipedia.org/wiki/Graph_diameter) is 3.[[15]](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes#cite_note-15)

The icosahedral graph is [Hamiltonian](http://en.wikipedia.org/wiki/Hamiltonian_graph): there is a cycle containing all the vertices. It is also a [planar graph](http://en.wikipedia.org/wiki/Planar_graph).

**See also**

* [Geodesic grids](http://en.wikipedia.org/wiki/Geodesic_grid) use an iteratively bisected icosahedron to generate grids on a sphere
* [Icosahedral twins](http://en.wikipedia.org/wiki/Icosahedral_twins)
* [Infinite skew polyhedron](http://en.wikipedia.org/wiki/Infinite_skew_polyhedron)
* [Jessen's icosahedron](http://en.wikipedia.org/wiki/Jessen%27s_icosahedron)
* [Regular polyhedron](http://en.wikipedia.org/wiki/Regular_polyhedron)
* [Truncated icosahedron](http://en.wikipedia.org/wiki/Truncated_icosahedron)

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  3. [**Jump up^**](http://en.wikipedia.org/w/index.php?title=Icosahedron&printable=yes#cite_ref-3) This is true for all convex polyhedra with triangular faces except for the tetrahedron, by applying [Brooks' theorem](http://en.wikipedia.org/wiki/Brooks%27_theorem) to the [dual graph](http://en.wikipedia.org/wiki/Dual_graph) of the polyhedron.
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| **Notable [stellations of the icosahedron](http://en.wikipedia.org/wiki/The_fifty_nine_icosahedra" \o "The fifty nine icosahedra)** | | | | | | | | | |
| [Regular](http://en.wikipedia.org/wiki/Platonic_solid) | [Uniform duals](http://en.wikipedia.org/wiki/Uniform_polyhedron) | | | [Regular compounds](http://en.wikipedia.org/wiki/Compound_polyhedron) | | | [Regular star](http://en.wikipedia.org/wiki/Kepler-Poinsot_polyhedron) | Others | |
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| The stellation process on the icosahedron creates a number of related [polyhedra](http://en.wikipedia.org/wiki/Polyhedron" \o "Polyhedron) and [compounds](http://en.wikipedia.org/wiki/Compound_polyhedron) with [icosahedral symmetry](http://en.wikipedia.org/wiki/Icosahedral_symmetry). | | | | | | | | | |

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