

[Index](#)

GIANT

3D MODELS

**18 fascinating geometric constructions
without glue, tape or photocopying!**

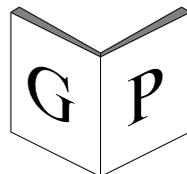
Geoff Phillips

[Index](#)

GIANT

3D MODELS

© Geoff Phillips 1996, 2010





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[Index](#)

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First Published 1996

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Printed in Australia by Croydon Printers

ISBN 0 646 28352 9

By the same author:
GeoMat Investigations

INTRODUCTION

[Index](#)

Problems with conventional methods of 3D model construction.

I have always been fascinated by the patterns and symmetry of three dimensional geometric models, or 'polyhedra'. The conventional method of constructing such models is to begin with a plan, or 'net' showing the required shapes joined as far as a flat plan permits. One would mark out or photocopy a net onto card, cut it out and glue or tape adjacent edges together. Even today I find it difficult to achieve a neat finished model using this method for the following reasons:

- It is not always easy to accurately mark a net onto card.
- Glue tends to smudge ink lines marking the edges.
- It is virtually impossible to glue or tape the last edges together without crumpling the model.
- The use of sticky tape detracts from the smooth finish of the model.
- Models must be painted to achieve decorative results - this is very fiddly.
- Models are generally small, since complete nets are usually required to fit onto a single A4 page.

Advantages of the 'no fuss' method for making Giant 3D Models.

Most of the problems associated with conventional methods relate to joining the faces. The method described in this book involves curved tabs which are cleanly and cheaply joined using a single staple on the outside of the model. The effect, perhaps surprisingly, is to enhance the beauty of the completed model by adding circular symmetry to the polygon patterns already present.

It is possible to purchase staplers that take standard 26/6 staples (the recommended size for model construction) for around \$2.00. Many come with 100's of staples, though separate packets containing 5000 staples are quite cheap.

Templates for single, large faces are included in this book. They may be cut out and used to trace as many faces as required of each shape onto any type of card - e.g. cereal packet cardboard, old calendars, coloured card etc. There is no need to photocopy nets onto card.

Instructions are based on simple combinations of only a few shapes, so it's not necessary to look at nets to construct models. Being large, the faces are easier to handle, and since curved tabs are folded along straight scored edges, inaccuracy in cutting out is largely hidden. Another advantage is that edges that are not joined satisfactorily may be taken apart by removing a single staple and re-joined more accurately.

Different colours for different faces of the model? No problem! Just use different colour card (e.g. A4 cover paper) as required. No painting is necessary! You'll find Giant 3D Models make a great display too.

Details on how to construct Giant 3D Models begin on page 6.

Good luck - I hope you have as much fun making the models in this book as I did.

Geoff Phillips

INDEX

[Introduction and instructions](#)

The Models

- [1.](#) Tetrahedron
- [2.](#) Cube
- [3.](#) Octahedron
- [4.](#) Truncated tetrahedron
- [5.](#) Cuboctahedron
- [6.](#) Dodecahedron
- [7.](#) Icosahedron
- [8.](#) Truncated octahedron
- [9.](#) Truncated cube
- [10.](#) Small rhombicuboctahedron
- [11.](#) Icosidodecahedron
- [12.](#) Snub cube
- [13.](#) Great rhombicuboctahedron
- [14.](#) Truncated dodecahedron
- [15.](#) Truncated icosahedron
- [16.](#) Small rhombicosidodecahedron
- [17.](#) Snub dodecahedron
- [18.](#) Great rhombicosidodecahedron

[Displaying Models](#)

[Models Summary](#)

[Triangle templates](#)

[Square templates](#)

[Pentagon templates](#)

[Hexagon templates](#)

[Octagon template](#)

[Half decagon template](#)

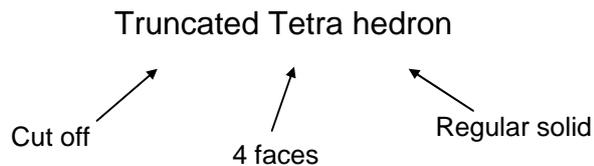
GEOMETRICAL TERMS

[Index](#)

The following terms form parts of the names of the 3D models (polyhedra) in this book. They are, in many cases, derived from Latin words.

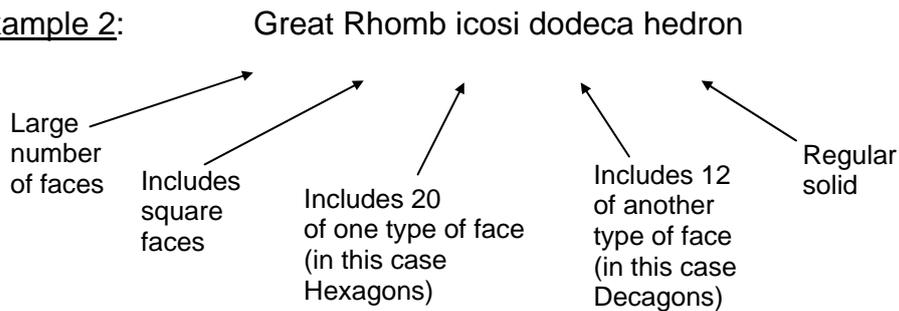
<u>Term</u>	<u>Meaning</u>
Regular	- having the same side (edge) length
Poly	- many
Gon	- angles
Tri	- 3
Tetra	- 4
Pent	- 5
Hex	- 6
Oct	- 8
Deca	- 10
Dodeca	- 12
Icosa/Icosi	- 20
Hedron	- solid with regular faces
Truncated	- cut off
Cub(e)	- includes squares
Rhomb(i)	- includes squares
Great	- has a large number of faces

Example 1:



A Truncated Tetrahedron is a polyhedron that is a 4 faced regular solid with some corners cut off.

Example 2:

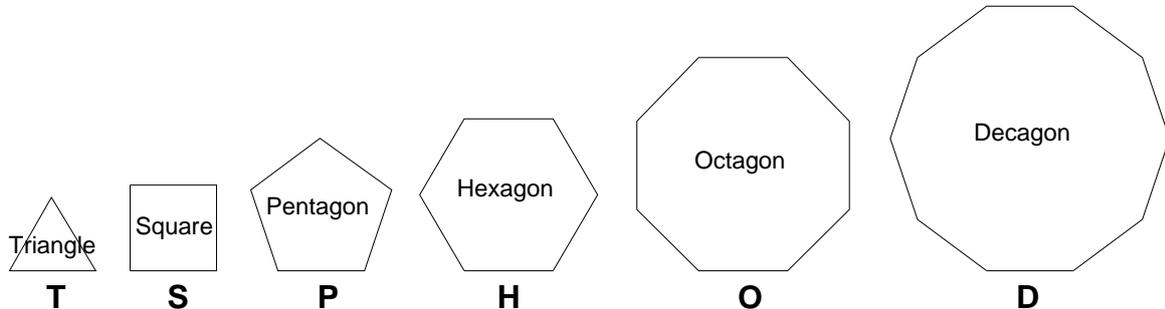


A Great Rhombicosidodecahedron is a regular solid that has a large number of faces including square ones. It has 20 of one type of face and 12 of another.

POLYGONS AND POLYHEDRA

[Index](#)

Each page in the models section of this book describes how to construct a different giant 3D model (polyhedron). The models are made up of panels or 'faces' which are all regular polygons. A regular polygon is a shape with equal angles and straight sides all the same length.



The regular polygons used in this book and their symbols.

Polyhedra made up of only one type of regular polygon are called 'Platonic' polyhedra.

Polyhedra made up of different regular polygons are called 'Archimedean' polyhedra. There are 5 different Platonic polyhedra and 13 different Archimedean polyhedra, all of which are included in this book.

Each model is described by a 'formula' which gives the number of each type of polygon face required to make it.

e.g. $P_{12}H_{20}$ is the formula for a model containing 12 Pentagons and 20 Hexagons.

The letters used in each formula are the first letters of the polygon names above, i.e. T, S, P, H, O and D.

TEMPLATES

To join the polygon faces of the various models, curved tabs are added to each side. A template for each type of face is included with this book.

The first step in making a giant 3D model is to cut out the templates printed on card at the centre of this book. Do this very carefully, as they will be used to trace the faces for the models.

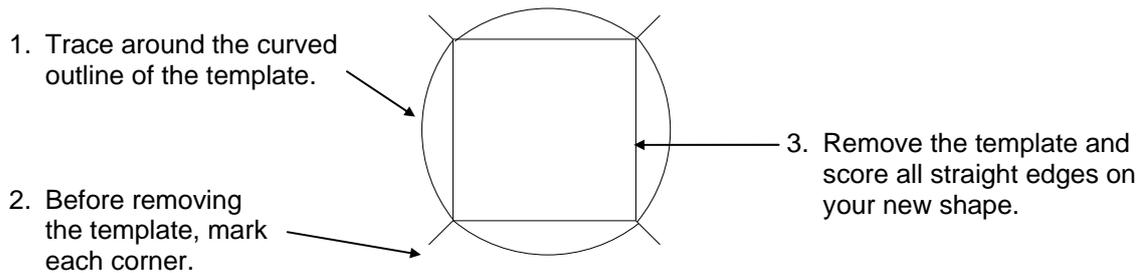
If you need to make new templates later, you may follow the instructions on pages 9 and 10.

CONSTRUCTING FACES

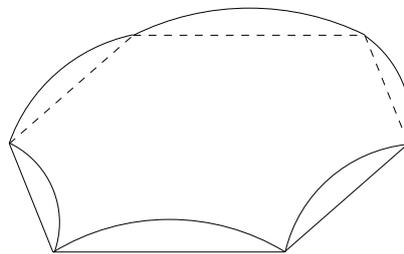
[Index](#)

To construct faces for your model, obtain a suitable piece of card (e.g. cereal packet cardboard or A4 cover paper) and follow the steps below.

1. Place the required book template on top of your card and trace its outline.
2. Mark each corner of the polygon with a small line segment as shown.
3. Remove the template and use a pen to score straight edges of the polygon between the marks to make folding the curved tabs easier.



4. Carefully cut around the curved outline of your new shape.
5. With the marked side facing downwards, fold each tab upwards so that the marked edges will be on the inside of the model.



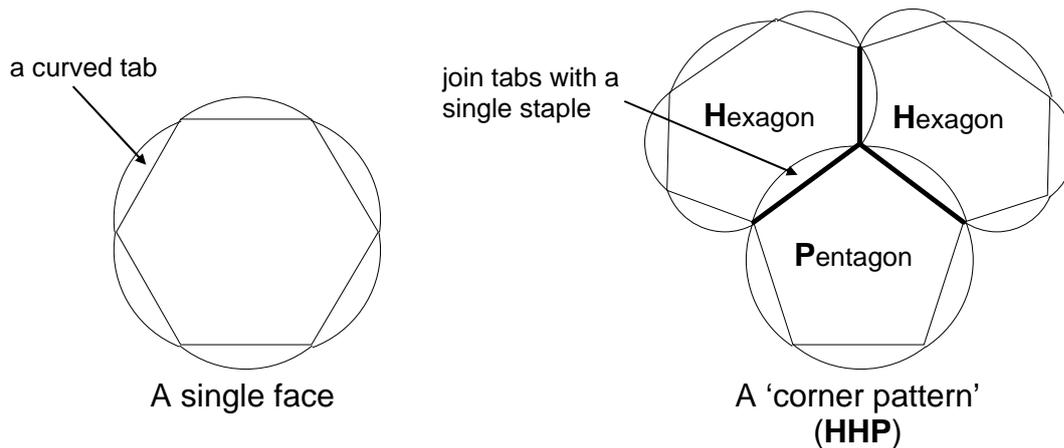
The instructions for each model tell you how many of each face you will need.

JOINING FACES

[Index](#)

Faces are best joined using a single standard staple (size 26/6) to connect curved tabs, although glue may also be used. Be careful to align the curved tabs on both sides.

Join faces so that the same combination of shapes meet at every corner in the same order. This 'corner pattern' is highlighted by bold lines on each instruction page, and is labelled with the first letter of each of the shapes involved (e.g. **HHP** for Hexagon-Hexagon-Pentagon).



Repeating the corner pattern **HHP** all over the model produces a complete polyhedron - in this case a 'Truncated Icosahedron'.

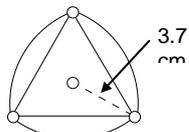


A completed Truncated Icosahedron.

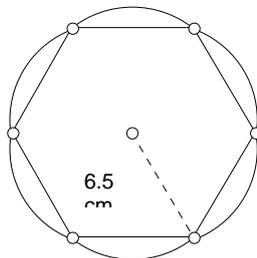
TEMPLATE SPECIFICATIONS

[Index](#)

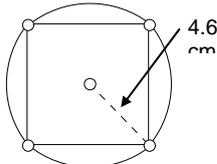
Each shape used in this book has a side length of 6.5 cm. The distance from the centre to a corner (shown as dotted lines below) varies depending on the shape. e.g. For a triangle, the centre to corner distance is 3.7 cm.



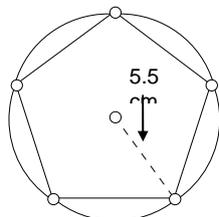
Triangle



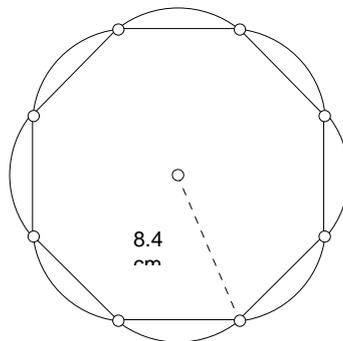
Hexagon



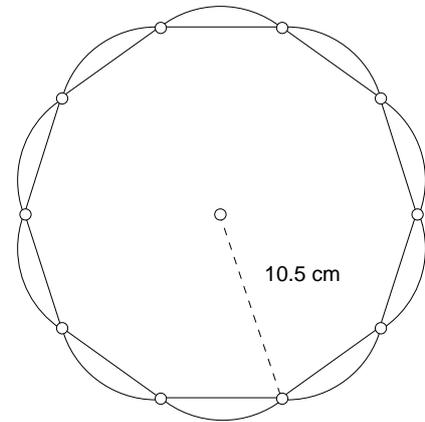
Square



Pentagon



Octagon



Decagon

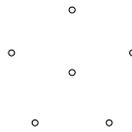
The curved sections around each shape match those around the outside of the protractor on the Geo-Pro and Maths-Pro Maths templates (available from Geoff Phillips Publications).

MAKING TEMPLATES USING GEO-PRO OR MATHS-PRO

[Index](#)

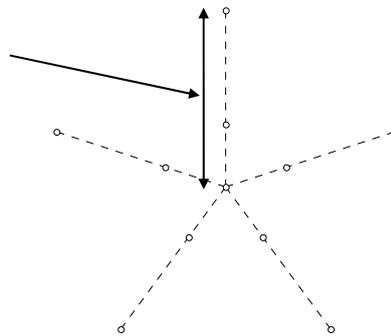
Templates may be constructed using a Geo-Pro or Maths-Pro template as shown below.

1. Mark the corners and centre of the desired shape.
Here, a pentagon is used as an example.

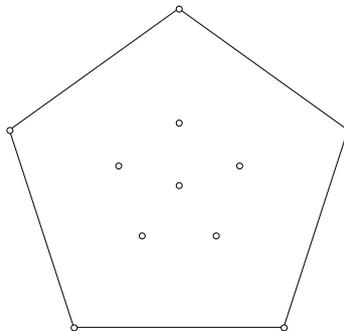


2. Measure out from the centre through each corner the required distance to mark new corners for a larger shape (see dotted line distances on the next page - e.g. for a pentagon, this is 5.5 cm).

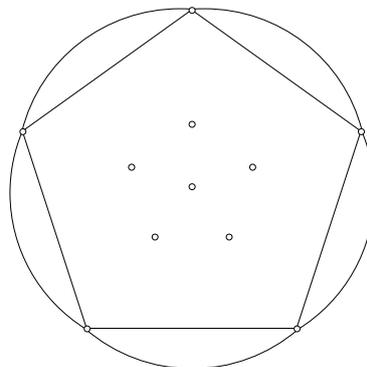
5.5 cm for a pentagon.
See page 10 for
distances for other
shapes.



3. Join corners with straight lines.



4. Add curved tabs using one of the arcs around the protractor.



[Index](#)

THE MODELS

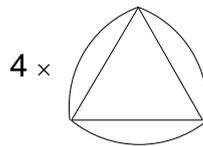
1. TETRAHEDRON

[Index](#)

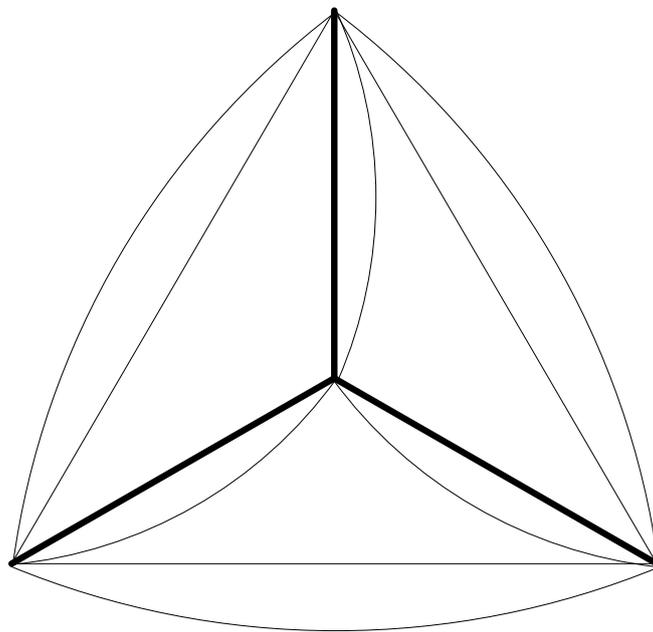
T_4

You will need:

4 Triangles.



Corner pattern:



TTT

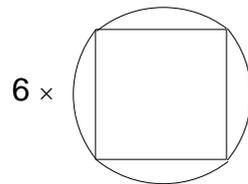
2. CUBE

[Index](#)

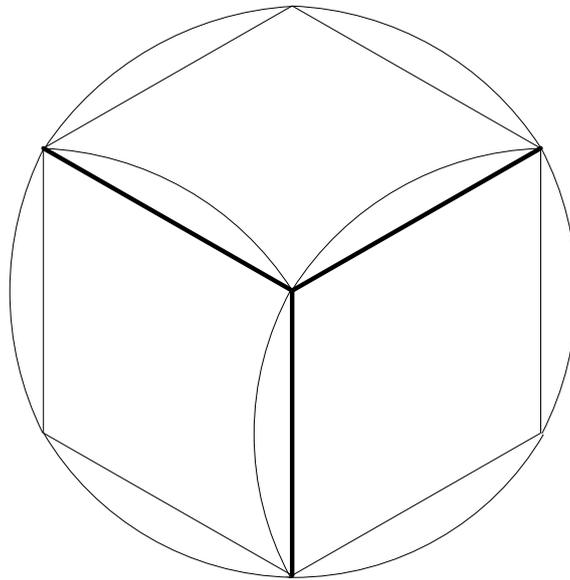
S_6

You will need:

6 Squares.



Corner pattern:



SSS

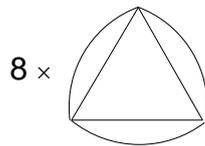
3. OCTAHEDRON

[Index](#)

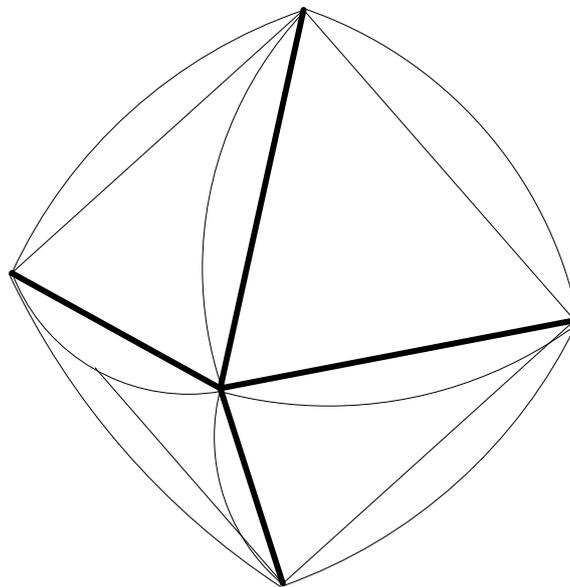
T_8

You will need:

8 Triangles.



Corner pattern:



TTTT

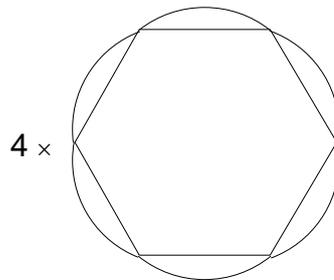
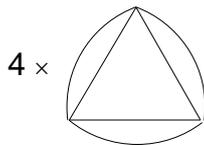
4. TRUNCATED TETRAHEDRON

[Index](#)

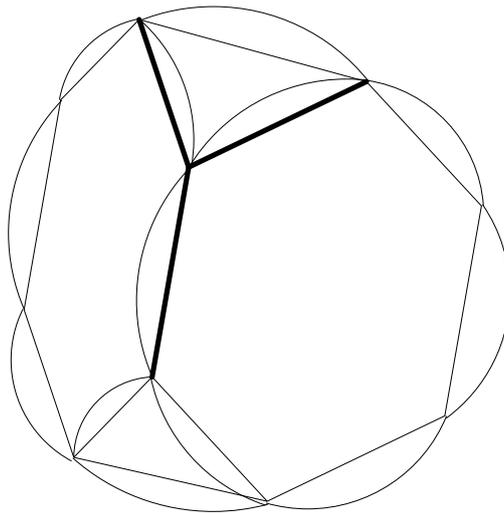
T_4H_4

You will need:

4 Triangles and 4 Hexagons.



Corner pattern:



THH

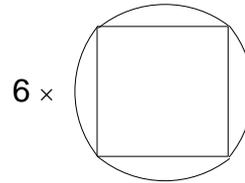
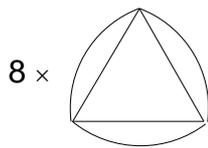
5. CUBOCTAHEDRON

[Index](#)

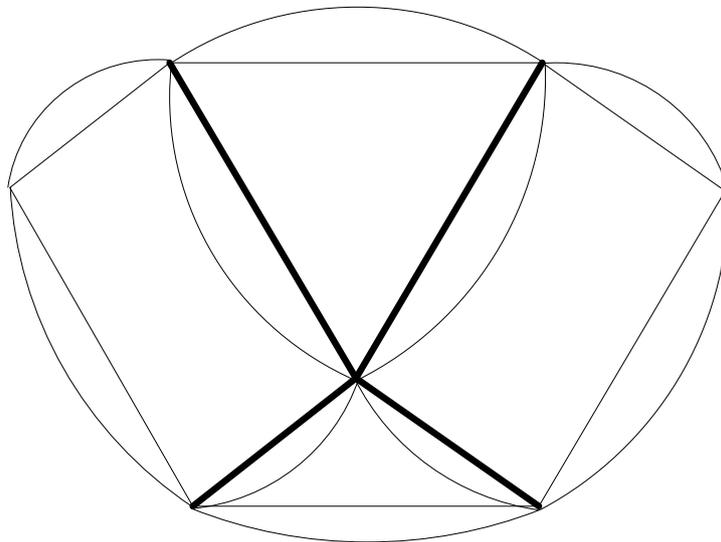
T₈S₆

You will need:

8 Triangles and 6 Squares.



Corner pattern:



TSTS

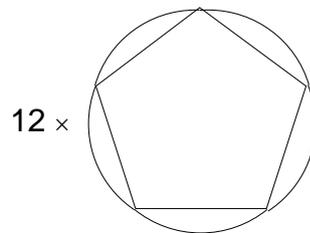
6. DODECAHEDRON

[Index](#)

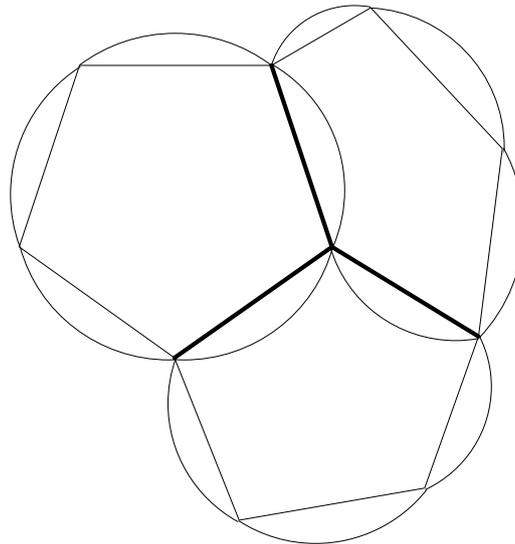
P_{12}

You will need:

12 Pentagons.



Corner pattern:



PPP

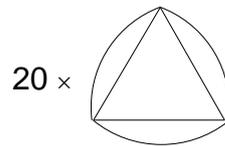
7. ICOSAHEDRON

[Index](#)

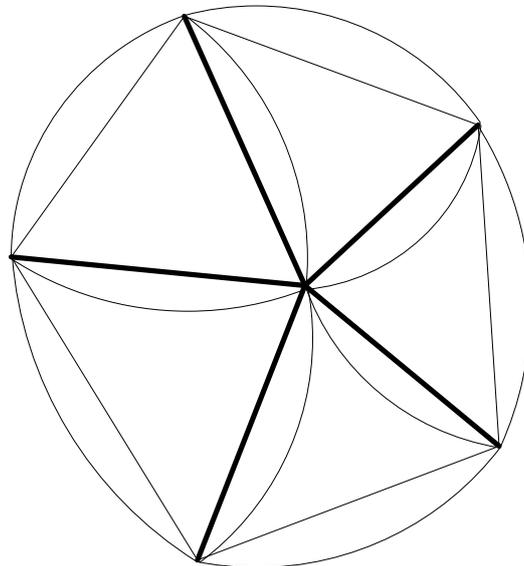
T_{20}

You will need:

20 Triangles.



Corner pattern:



TTTTT

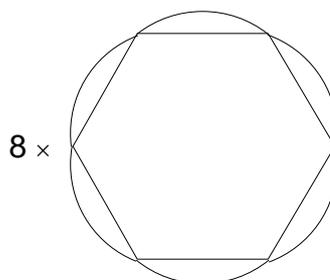
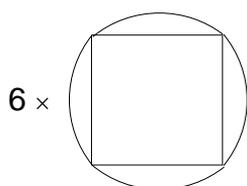
8. TRUNCATED OCTAHEDRON

[Index](#)

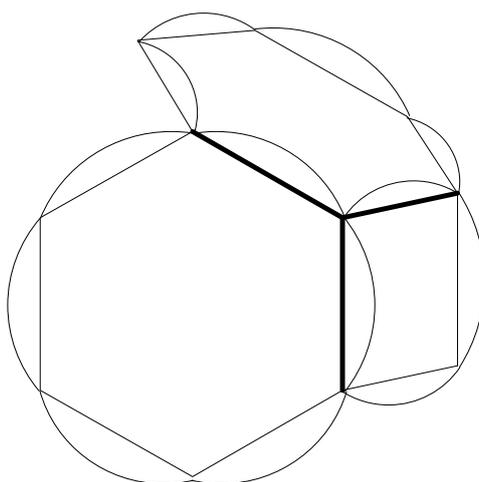


You will need:

6 Squares and 8 Hexagons.



Corner pattern:



SHH

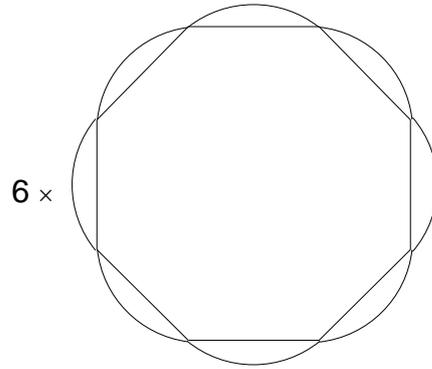
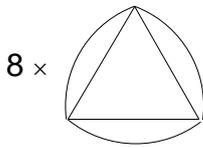
9. TRUNCATED CUBE

[Index](#)

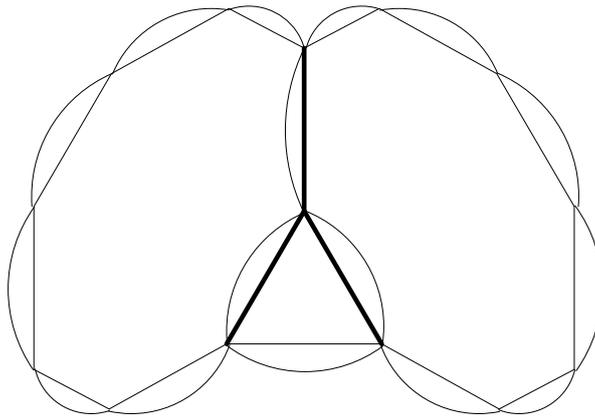
T_8O_6

You will need:

8 Triangles and 6 Octagons.



Corner pattern:



TOO

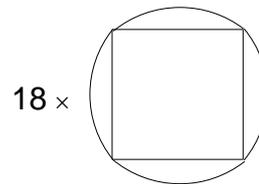
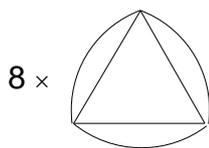
10. SMALL RHOMBICUBOCTAHEDRON

[Index](#)

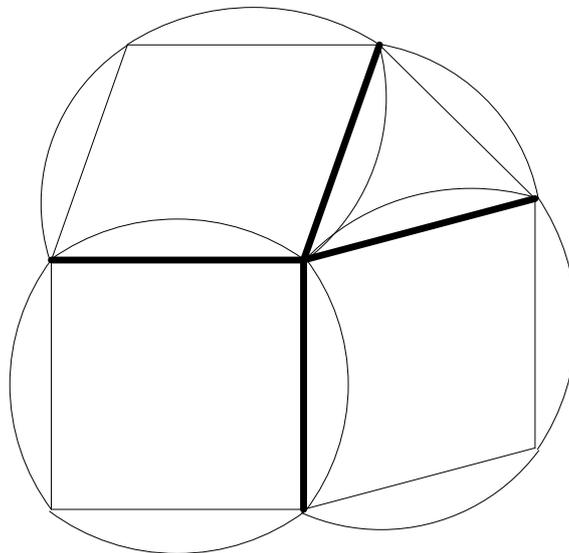
T_8S_{18}

You will need:

8 Triangles and 18 Squares.



Corner pattern:



TSSS

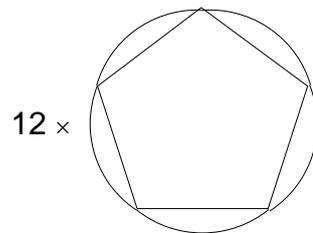
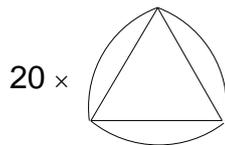
11. ICOSIDODECAHEDRON

[Index](#)

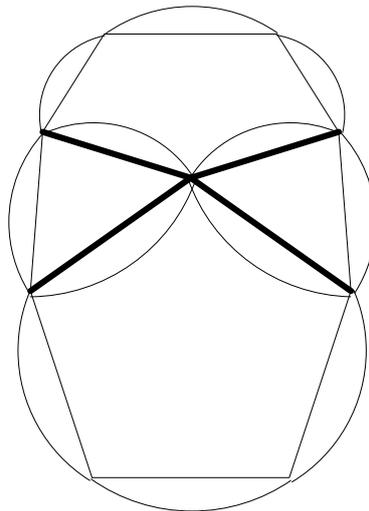
$T_{20}P_{12}$

You will need:

20 Triangles and 12 Pentagons.



Corner pattern:



TPTP

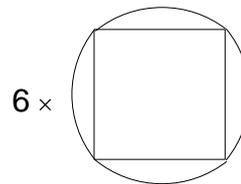
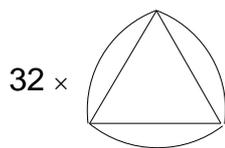
12. SNUB CUBE

[Index](#)

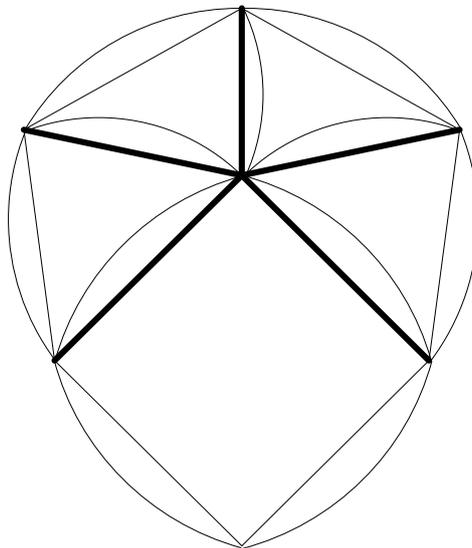
$T_{32}S_6$

You will need:

32 Triangles and 6 Squares.



Corner pattern:



TTTTTS

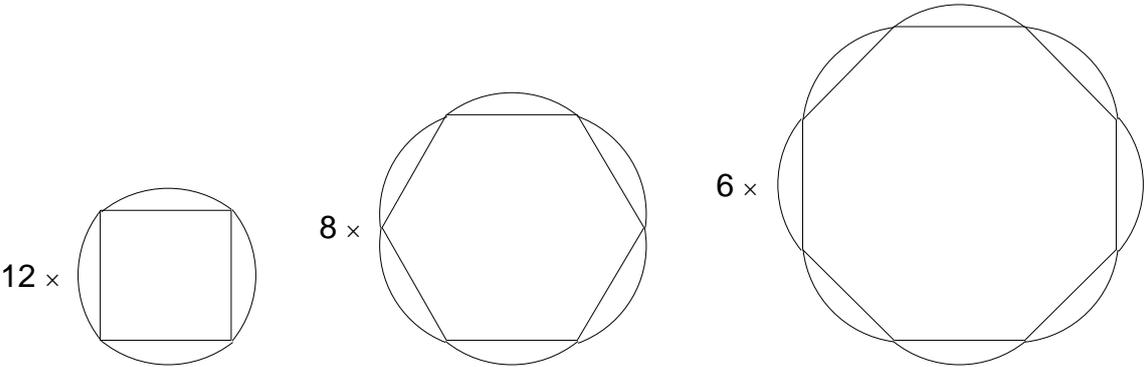
13. GREAT RHOMBICUBOCTAHEDRON

[Index](#)

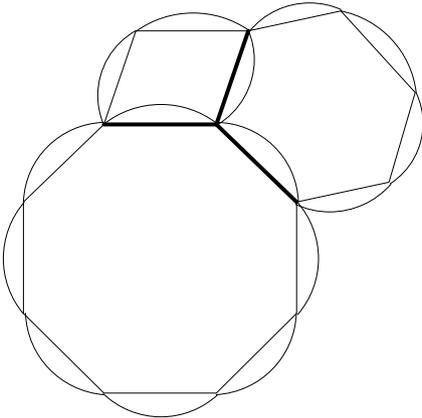


You will need:

12 Squares, 8 Hexagons and 6 Octagons.



Corner pattern:



SHO

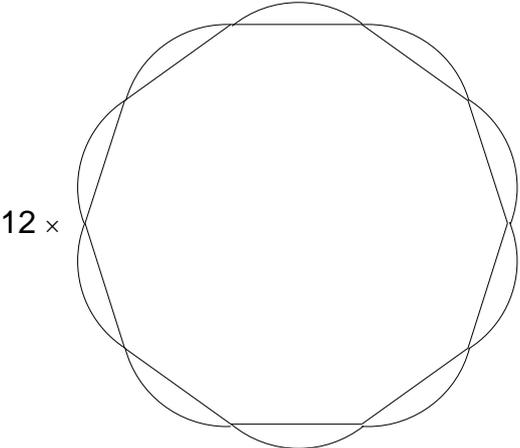
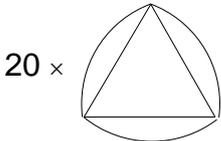
14. TRUNCATED DODECAHEDRON

[Index](#)

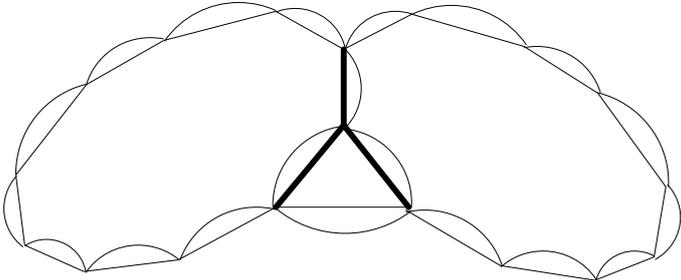
$T_{20}D_{12}$

You will need:

20 Triangles and 12 Decagons.



Corner pattern:



TDD

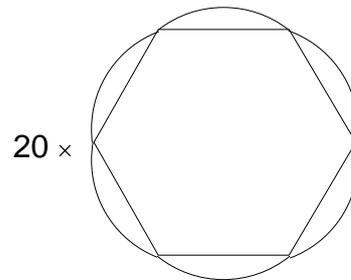
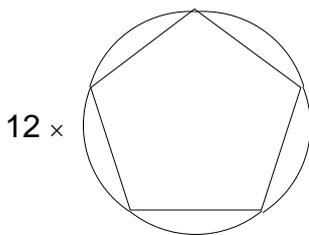
15. TRUNCATED ICOSAHEDRON

[Index](#)

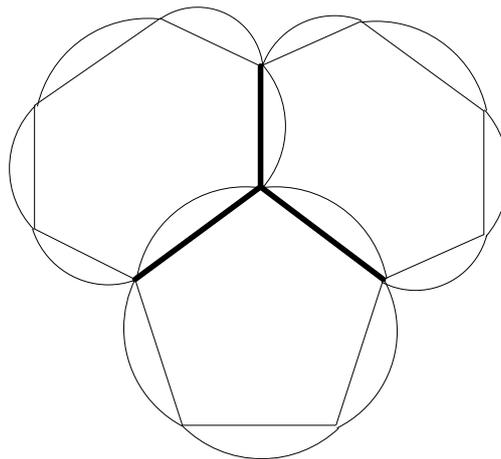
$P_{12}H_{20}$

You will need:

12 Pentagons and 20 Hexagons.



Corner pattern:



PHH

16. SMALL RHOMBICOSIDODECAHEDRON

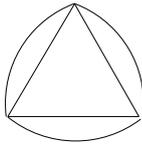
[Index](#)

$T_{20}S_{30}P_{12}$

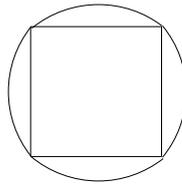
You will need:

20 Triangles, 30 Squares and 12 Pentagons.

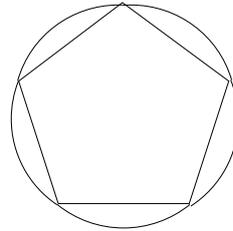
20 ×



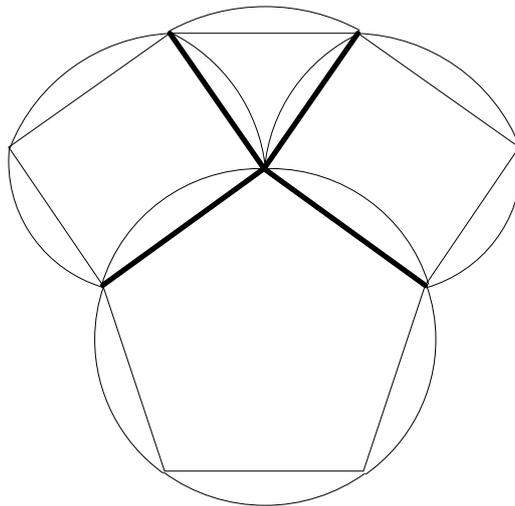
30 ×



12 ×



Corner pattern:



TSPS

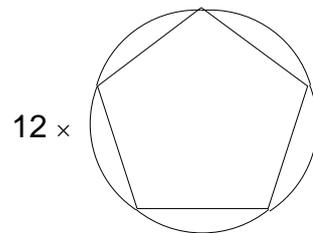
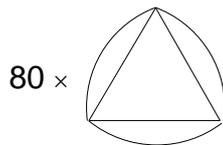
17. SNUB DODECAHEDRON

[Index](#)

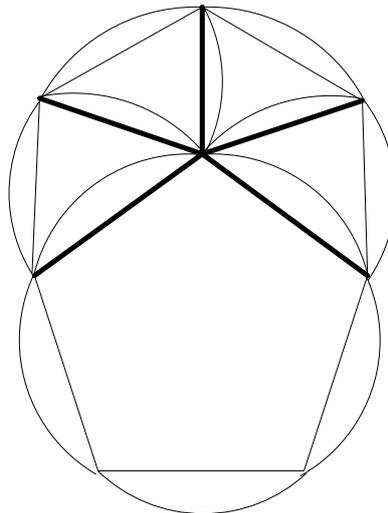
$T_{80}P_{12}$

You will need:

80 Triangles and 12 Pentagons.



Corner pattern:



TTTTP

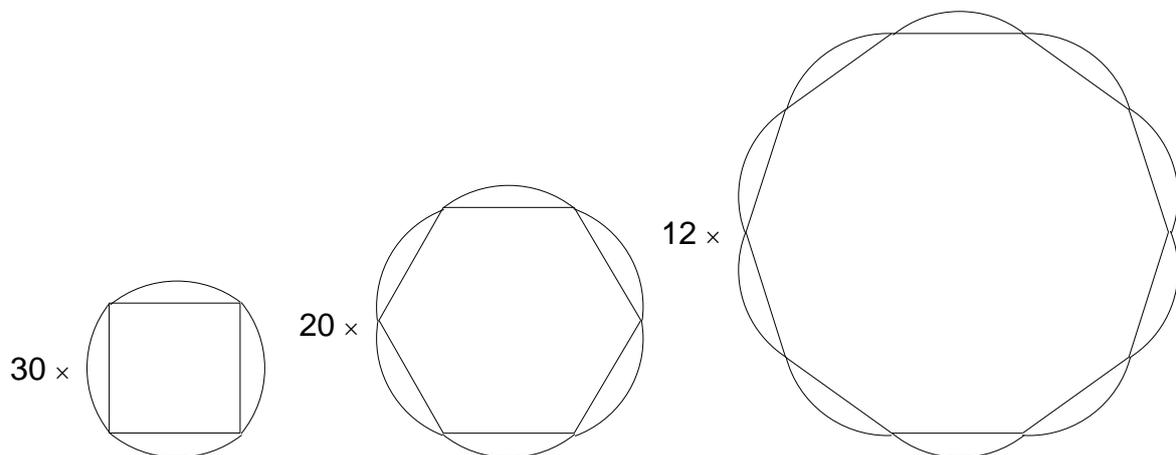
18. GREAT RHOMBICOSIDODECAHEDRON

[Index](#)

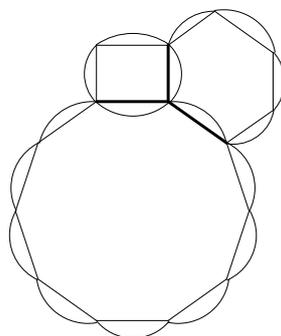
$S_{30}H_{20}D_{12}$

You will need:

30 Squares, 20 Hexagons and 12 Decagons.



Corner pattern:



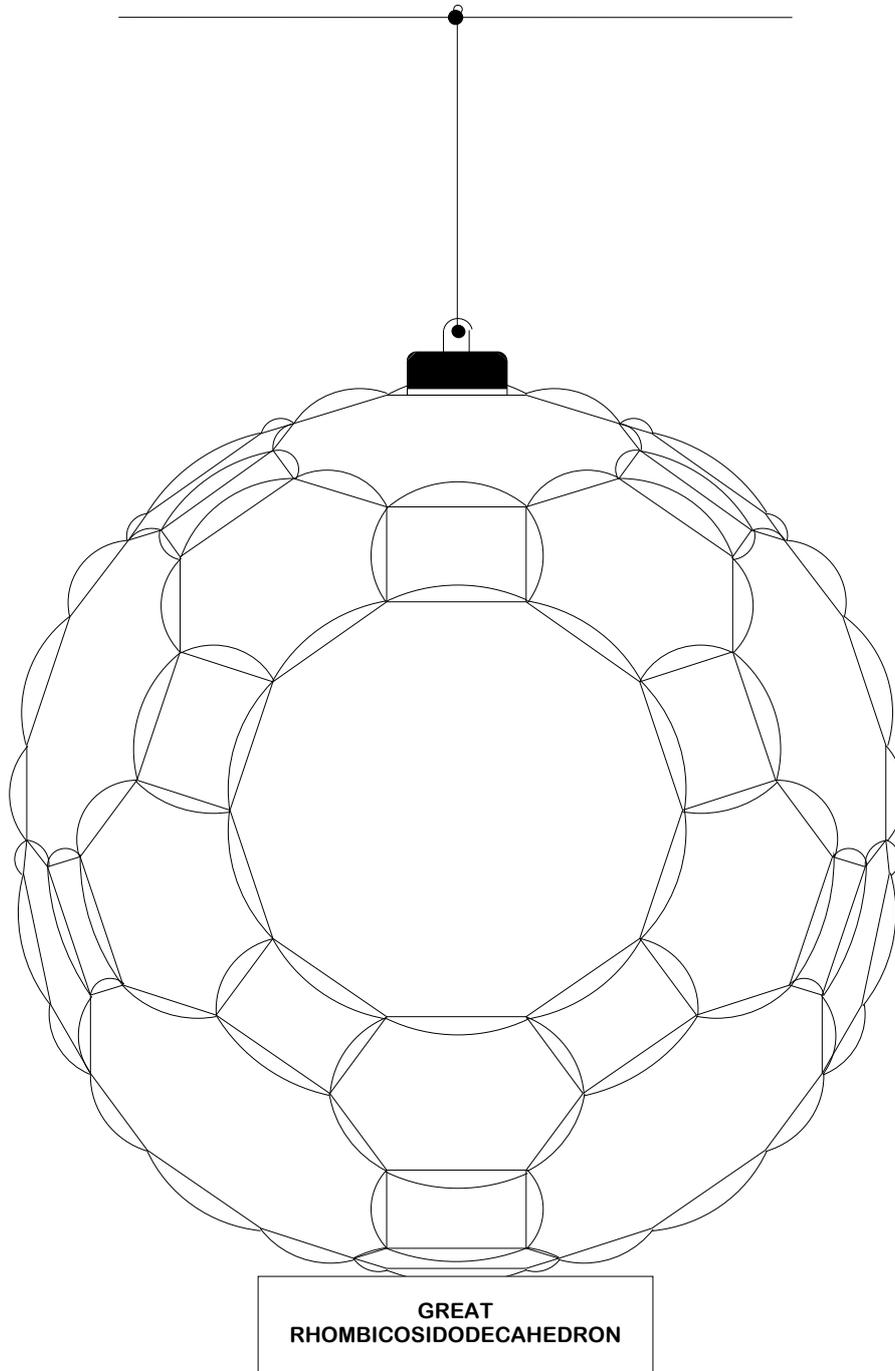
SHD

DISPLAYING MODELS

[Index](#)

A convenient way of displaying models without damaging them is to suspend them from a clip connected to a length of thread as shown below. The thread may then be pinned or tied to a higher point.

The labels in the centre section may be attached to models (e.g. using tape or glue).



MODELS SUMMARY

[Index](#)

The polyhedra in the table below are in order of complexity with regard to the number of tabs that must be cut around during construction of faces. i.e. The quickest to make is listed first, and the most time consuming last.

	Name	Formula	Corner pattern
1.	Tetrahedron♦	T_4	TTT
2.	Cube♦	S_6	SSS
3.	Octahedron♦	T_8	TTTT
4.	Truncated tetrahedron	T_4H_4	THH
5.	Cuboctahedron	T_8S_6	TSTS
6.	Dodecahedron♦	P_{12}	PPP
7.	Icosahedron♦	T_{20}	TTTTT
8.	Truncated octahedron	S_6H_8	SHH
9.	Truncated cube	T_8O_6	TOO
10.	Small rhombicuboctahedron	T_8S_{18}	TSSS
11.	Icosidodecahedron	$T_{20}P_{12}$	TPTP
12.	Snub cube	$T_{32}S_6$	TTTTS
13.	Great rhombicuboctahedron	$S_{12}H_8O_6$	SHO
14.	Truncated dodecahedron	$T_{20}D_{12}$	TDD
15.	Truncated icosahedron	$P_{12}H_{20}$	PHH
16.	Small rhombicosidodecahedron	$T_{20}S_{30}P_{12}$	TSPS
17.	Snub dodecahedron	$T_{80}P_{12}$	TTTTP
18.	Great rhombicosidodecahedron	$S_{30}H_{20}D_{12}$	SHD

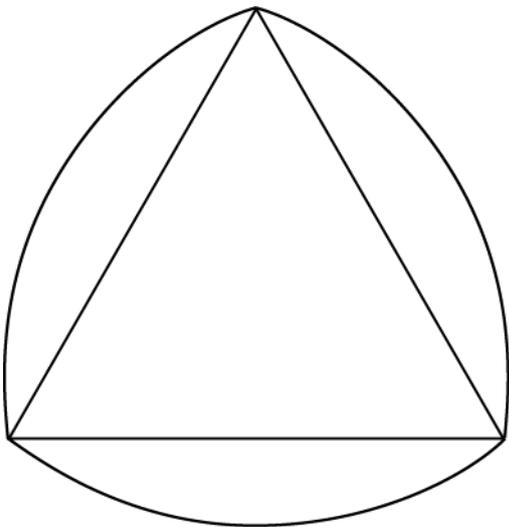
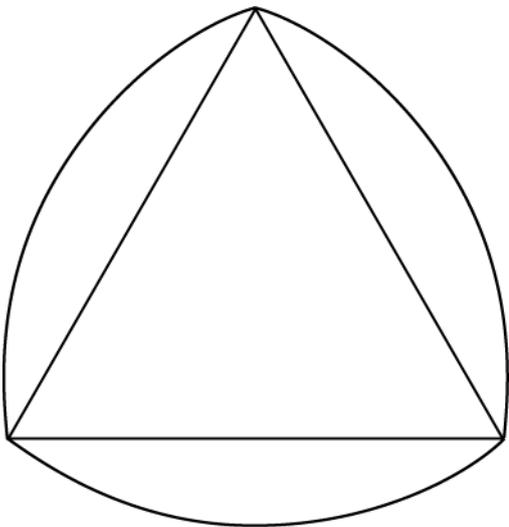
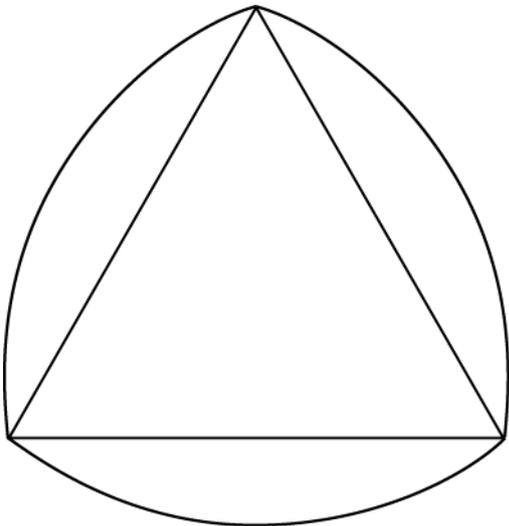
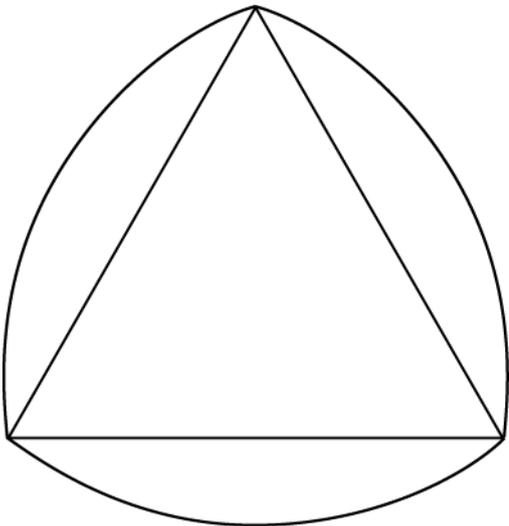
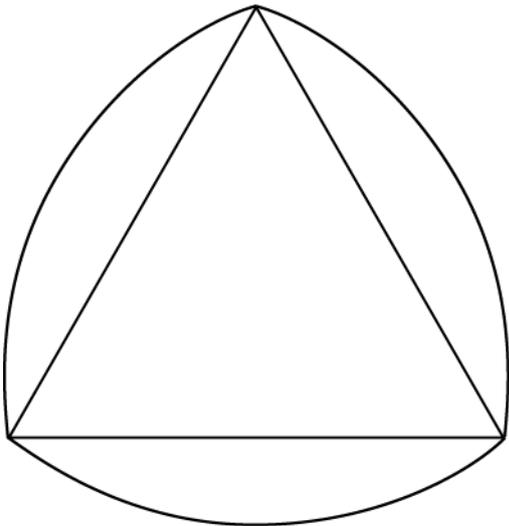
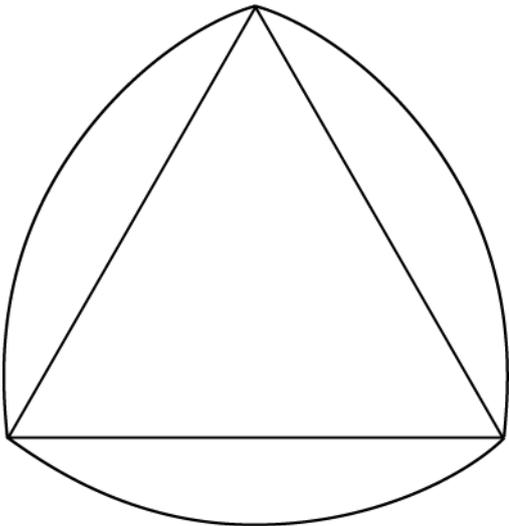
♦ = Platonic solid.

Centre to vertex distances for faces of side length 6.5 cm.

T = Triangle	3.7 cm
S = Square	4.6 cm
P = Pentagon	5.5 cm
H = Hexagon	6.5 cm
O = Octagon	8.4 cm
D = Decagon	10.5 cm

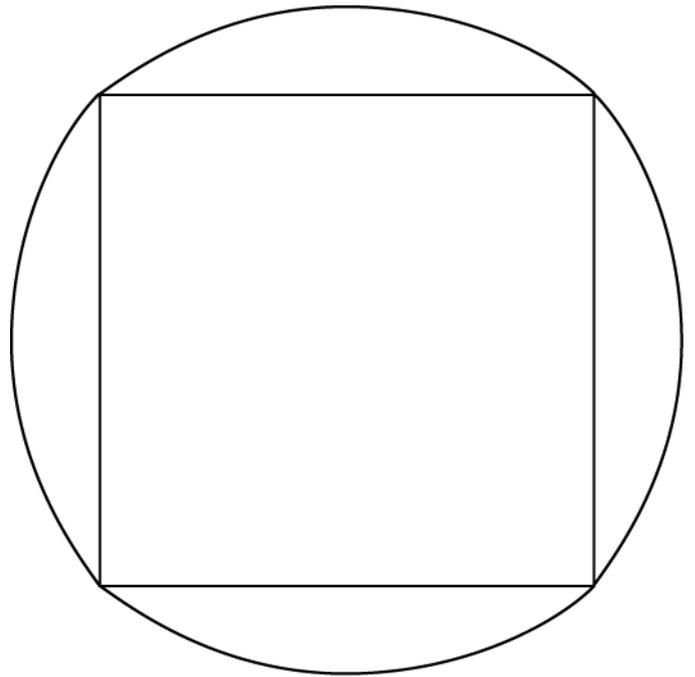
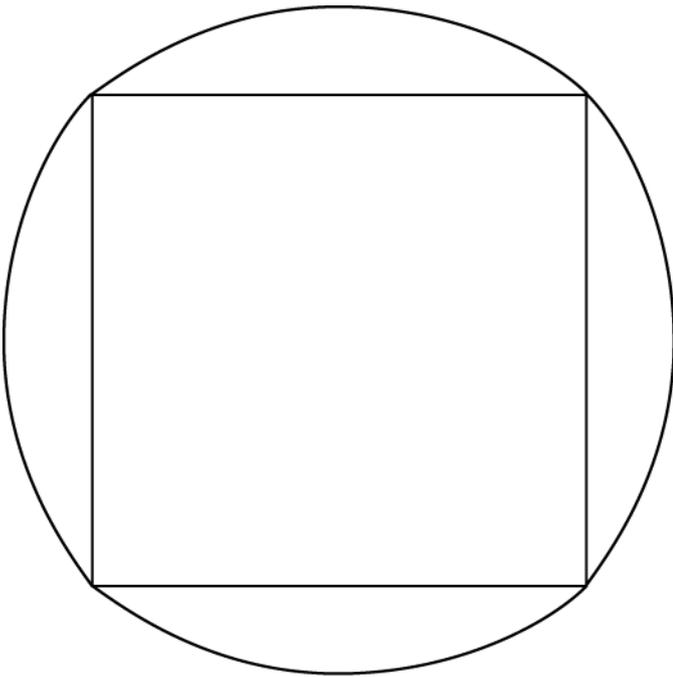
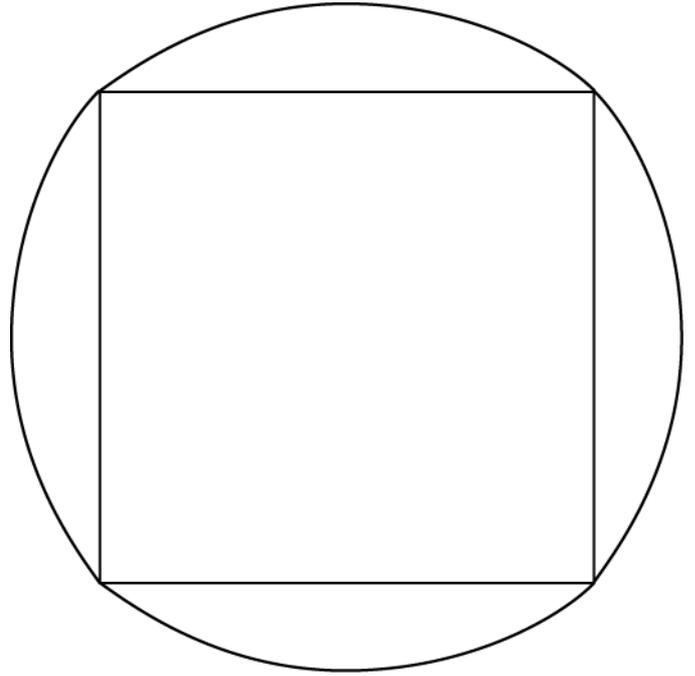
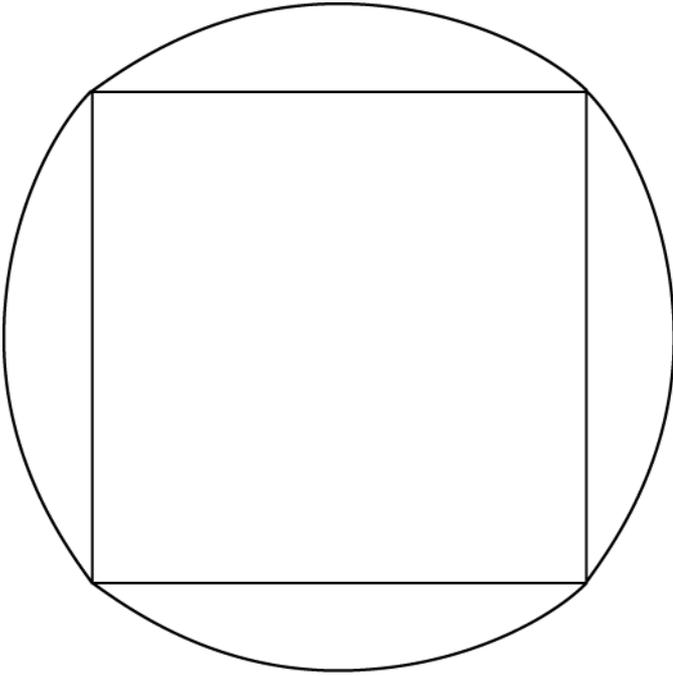
TRIANGLE TEMPLATES

[Index](#)



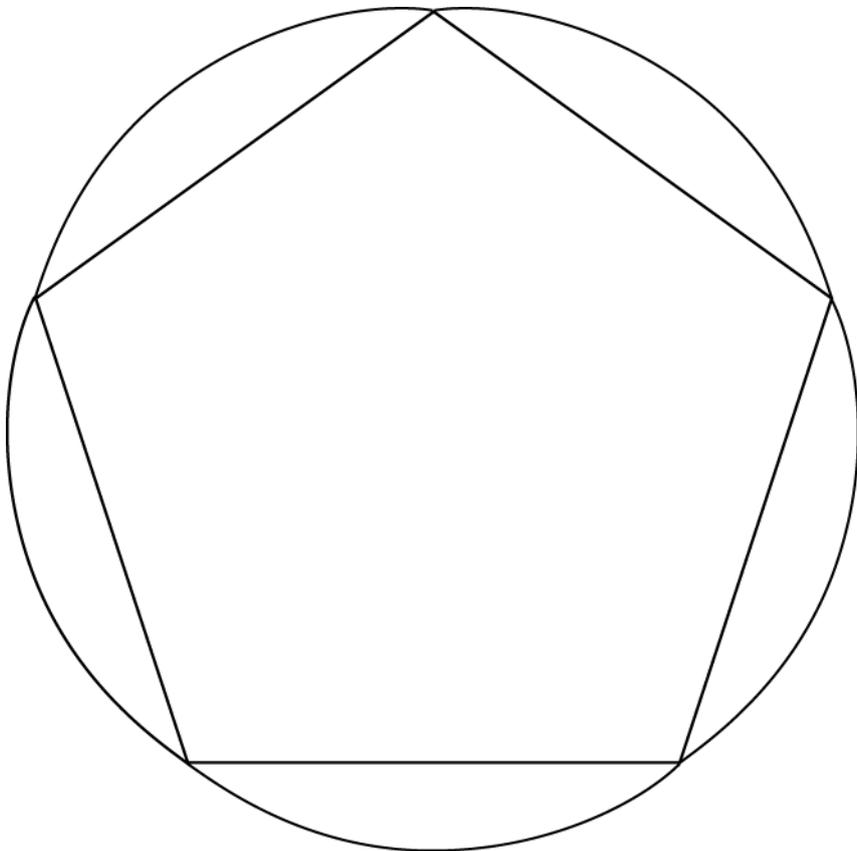
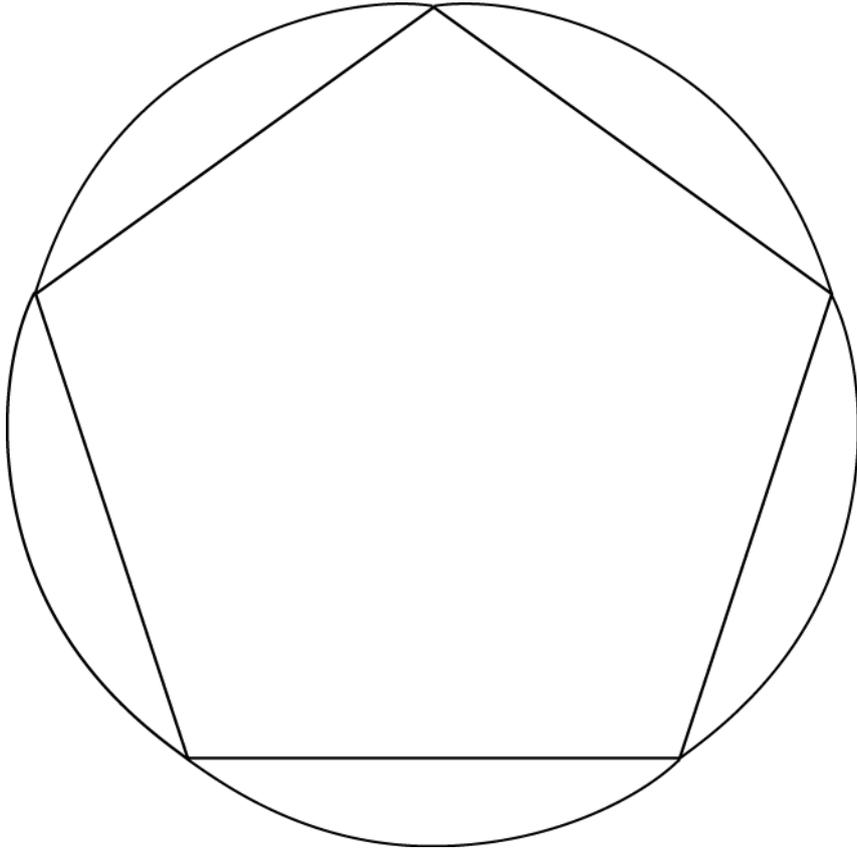
SQUARE TEMPLATES

[Index](#)



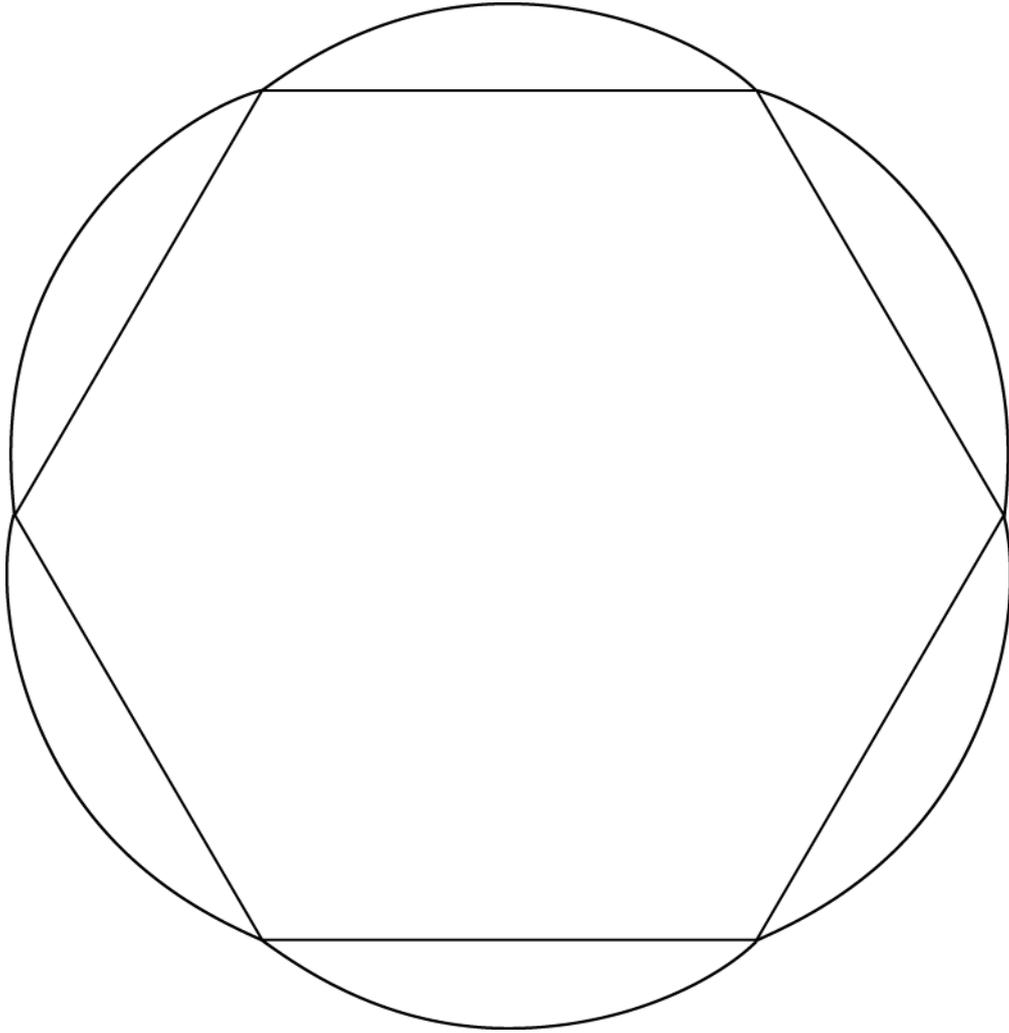
PENTAGON TEMPLATES

[Index](#)



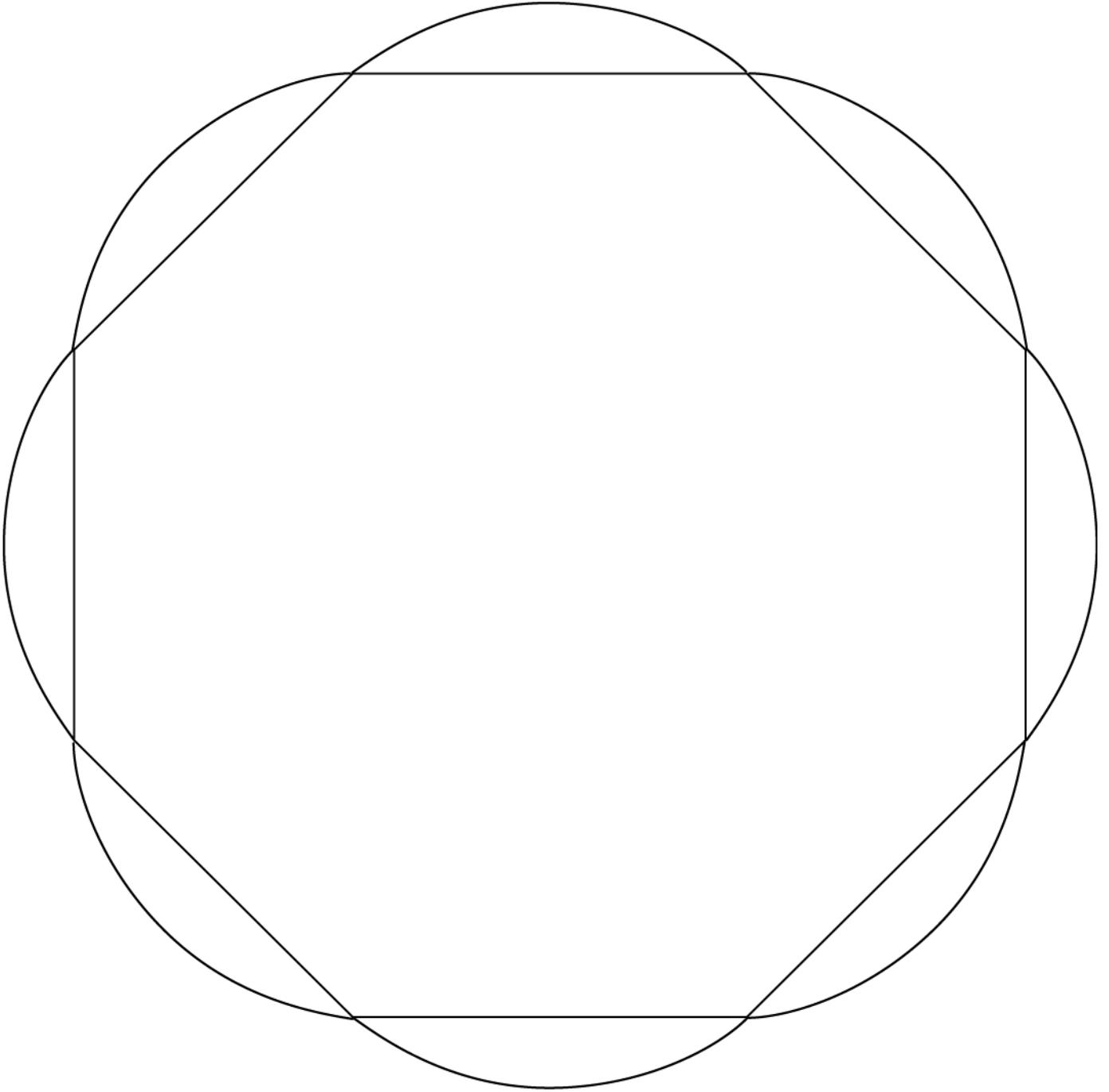
HEXAGON TEMPLATE

[Index](#)



OCTAGON TEMPLATE

[Index](#)



HALF DECAGON TEMPLATE

[Index](#)

