

# GeoGenius

CONSTRUCTION KIT



INSTRUCTION AND ACTIVITY HANDBOOK

# GeoGenius

## Instruction and Activity Handbook

The world in which we live is made up of shapes and objects. The study of space and shape is called geometry. In developing a geometric sense of the world, it is important that children (both young and old) have a lot of opportunity to play with and build lots of different objects.

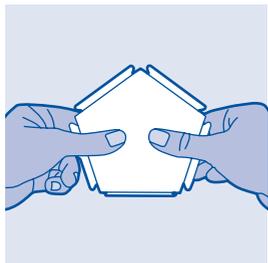
This kit has been developed to provide a fun-filled way of exposing children to the world of shapes and objects by enabling them to build an enormous range of objects easily and quickly.

**The GeoGenius construction kit consists of eight different geometric shapes (polygons):**

	Super Kit	Standard Kit
Equilateral triangle - Turquoise	240	80
Square - Green	120	28
Pentagon - Orange	60	12
Hexagon - Dark Blue	60	20
Octagon - Yellow	12	6
Decagon - Black	24	12
Isosceles triangle - Red	72	30
Rectangle - Purple	36	15

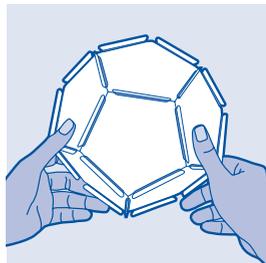
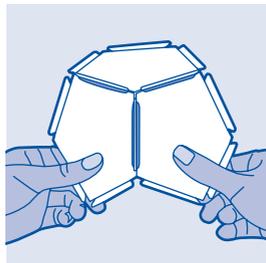
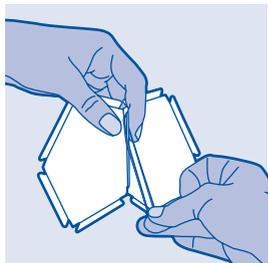
Each shape has tabs on each edge and by using size 12 elastic bands (supplied) the pieces can be joined together to make any number of geometric objects (polyhedra). The number of objects that can be made is limited only by your imagination.

## Getting started



### Step 1 – Folding the tabs

Fold each of the tabs along the crease (on the side of the shape) by gently pushing the piece onto a solid surface such as a table.



### Step 2 – Joining the pieces

1. Hold the tabs of two pieces together and place an elastic band around the two tabs to join the pieces.
2. Repeat as required to complete the shape that you are making.

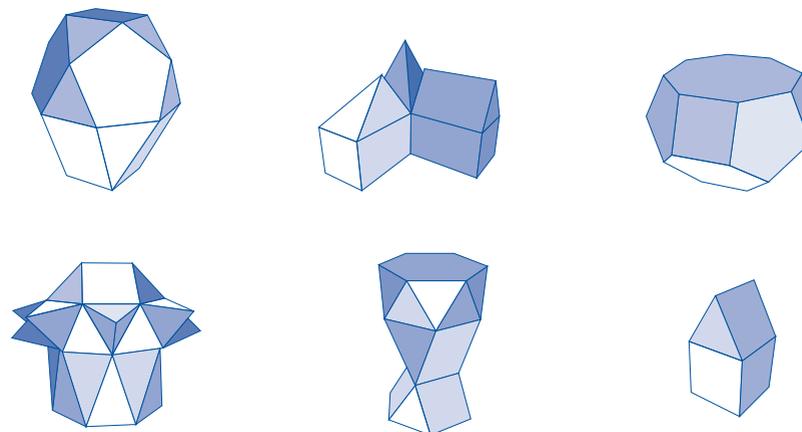


### Advanced instructions

When making certain more difficult objects and/or going around corners, it is sometimes easier to fold the tabs toward the inside of the object.

## Having fun with objects

Get a sense of how the pieces work and make any object that your imagination can come up with.



Above: Some examples of possible shapes

### Activity 1:

Submit a photo of the most interesting object you have made (including the types and numbers of pieces that you used to make the object) to [info@GeoGenius.co.za](mailto:info@GeoGenius.co.za) and have it published on our website! For some ideas of objects made by other people, visit our website [www.GeoGenius.co.za](http://www.GeoGenius.co.za).

Your creations are limited only by your imagination!



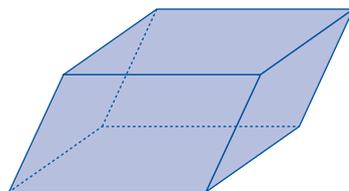
## Prisms, Pyramids and Antiprisms

We have names for different families of objects.

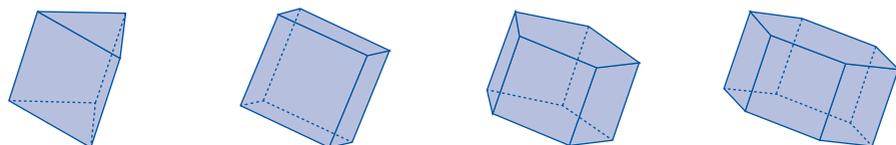
**PRISM** is the name given to an object with identical parallel polygon bases and other faces made of parallelograms.

If the sides of the prism are made using a rectangle, the prism is called a rectangular prism. The GeoGenius construction kit can be used to make rectangular prisms.

The name of a prism is determined by the name of the shape of the bases.



Above: Oblique Prism



The four rectangular prisms above are (L to R): a triangular-based prism, a square-based prism, a pentagonal-based prism, and a hexagonal-based prism.

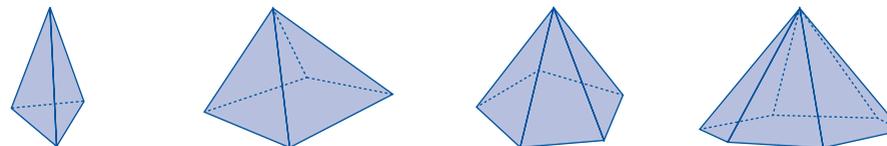
**PYRAMID** is the name given to an object with a polygonal base whose other faces are all triangles which meet at a point called the apex.

If the apex of the pyramid is above the centre of the base, the pyramid is called a right pyramid. The GeoGenius construction kit can be used to make right pyramids.



Left: Right Pyramid; Right: Oblique Pyramid

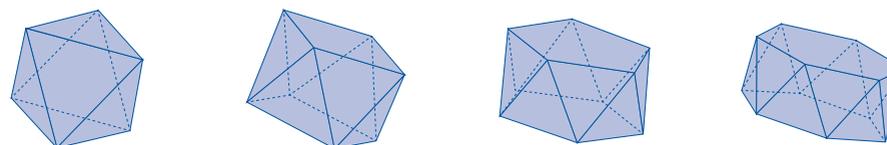
The name of a pyramid is determined by the name of the shape of the base.



The four right pyramids above are (L to R): a triangular-based pyramid, a square-based pyramid, a pentagonal-based pyramid, and a hexagonal-based pyramid.

**ANTIPRISM** is the name given to an object with identical, parallel polygonal bases joined by an alternating band of triangles. The GeoGenius construction kit can be used to make antiprisms.

The name of an antiprism is determined by the name of the shape of the bases.



The four antiprisms above are (L to R): a triangular-based antiprism, a square-based antiprism, a pentagonal-based antiprism, and a hexagonal-based antiprism.

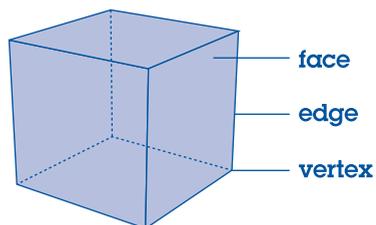
### Activity 2:

Use the GeoGenius construction kit pieces to make as many prisms, pyramids and antiprisms as you can.

## Prism, Pyramid and Antiprism Patterns

In order to complete this activity, you should be aware of the following vocabulary:

The 2-D shapes (polygons) used to make 3-D objects (polyhedra) are referred to as the faces of the object (polyhedron). The place where two faces of an object meet is called an edge. The place where the edges of an object meet is called a vertex.



Use shapes from the GeoGenius construction kit to make one of each of the following:

Prism	triangular-based, square-based, pentagonal-based, hexagonal-based
Pyramid	triangular-based, square-based, pentagonal-based, hexagonal-based
Antiprism	triangular-based, square-based, pentagonal-based, hexagonal-based

### Activity 3:

1. Use the above objects to complete the table below:

Prisms				
Number of sides in the base	3	4	5	6
Total number of faces				
Total number of edges				
Total number of vertices				
Pyramids				
Number of sides in the base	3	4	5	6
Total number of faces				
Total number of edges				
Total number of vertices				
Antiprisms				
Number of sides in the base	3	4	5	6
Total number of faces				
Total number of edges				
Total number of vertices				

2. Look for as many patterns as you can in the table and use these patterns to predict the missing values in the table below:

Prisms				
Number of sides in the base	8	10	15	20
Total number of faces				
Total number of edges				
Total number of vertices				
Pyramids				
Number of sides in the base	8	10	15	20
Total number of faces				
Total number of edges				
Total number of vertices				
Antiprisms				
Number of sides in the base	8	10	15	20
Total number of faces				
Total number of edges				
Total number of vertices				

3. Use the shapes from the GeoGenius construction kit to make one of each of the following and use these to check your predictions in the table above.

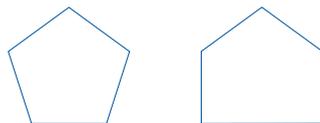
Prism	octagonal-based, dodecagonal-based
Pyramid	octagonal-based, dodecagonal-based
Antiprism	octagonal-based, dodecagonal-based

4. Develop and justify a formula that could be used to calculate each of the following for: prisms, pyramids and antiprisms respectively:

- The number of faces in a prism/pyramid/antiprism with an n-sided base.
- The number of edges in a prism/pyramid/antiprism with an n-sided base.
- The number of vertices in a prism/pyramid/antiprism with an n-sided base.

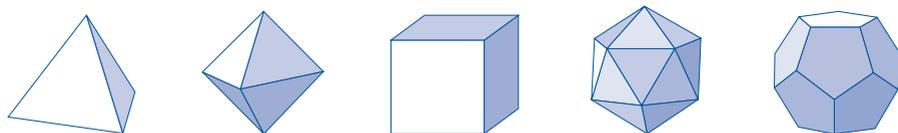
## Platonic Solids

If all of the sides of a shape are the same length and all of the angles of the shape are the same size, then the shape is called regular or regular polygon. There are 6 regular shapes (polygons) in the GeoGenius construction kit: an equilateral triangle, a square, a regular pentagon, a hexagon, an octagon and a decagon.



Above Left: Regular Pentagon  
Right: Irregular Pentagon

Platonic solid is the name given to an object that has identical, regular shapes (polygons) for all of its faces. These solids are named after the ancient Greek philosopher, Plato.



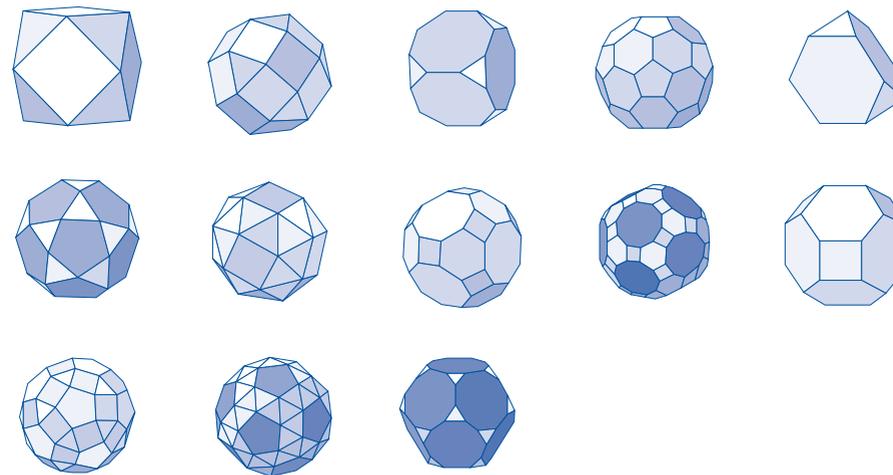
L-R: Tetrahedron, Octahedron, Cube (Hexahedron), Icosahedron, Dodecahedron

It can be shown that there are only five possible objects which have the property that all of their faces are made from identical regular polygons.

### Activity 4:

Use the shapes (polygons) in the GeoGenius construction kit to make each of the Platonic solids.

## Archimedean Solids



Back Row: Cuboctahedron, (Small) Rhombicuboctahedron, Truncated Cube, Truncated Icosahedron, Truncated Tetrahedron  
Middle Row: Icosidodecahedron, Snub Cube, Truncated Cuboctahedron, Truncated Icosidodecahedron, Truncated Octahedron  
Front Row: (Small) Rhombicosidodecahedron, Snub Dodecahedron, Truncated Dodecahedron

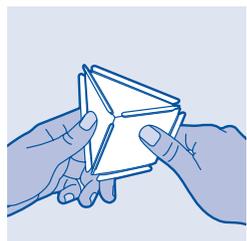
The collection of solids made from regular polygonal sides of two or more types that meet in a uniform pattern around each vertex are called the Archimedean solids. The solids are named after Archimedes who is the first person to have described them. It can be shown that there are exactly 13 possible Archimedean Solids.

### Activity 5:

Use the shapes (polygons) in the GeoGenius construction kit to make each of the Archimedean solids.

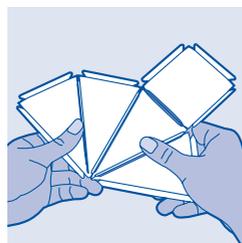
## Making nets of objects

Rather than making an object from individual faces as we do when we use the GeoGenius construction kit, it is also possible to do so by cutting out what is called the net of the object and folding and pasting this together. The GeoGenius construction kit is a powerful tool that can be used to design the nets of objects. To do so, simply follow the steps below:



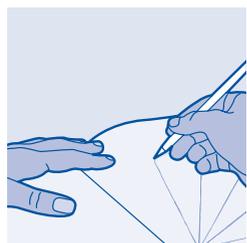
### Step 1

Make the object that you want to design a net for using the pieces of the GeoGenius construction kit. In the illustration we are making a net for a square-based pyramid.



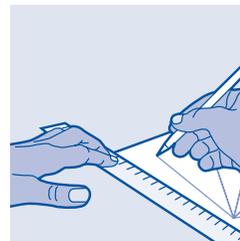
### Step 2

Carefully remove elastic bands from the object one by one until you can completely flatten the entire surface of the object. Make sure not to remove so many elastics that the pieces come loose.



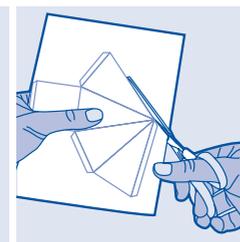
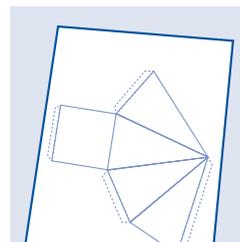
### Step 3

Make a rough sketch of the net of the object.



### Step 4

Make an accurate drawing of the net on a piece of light cardboard. You might want to use the pieces from the GeoGenius construction kit to trace around, however, leave off the tabs as you do so.

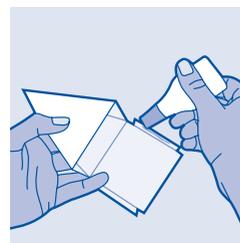


### Step 5

Add glue tabs to the net that you have created. Put one on every second edge.

### Step 6

Cut out the net and crease (score) the fold lines of the net.



### Step 7

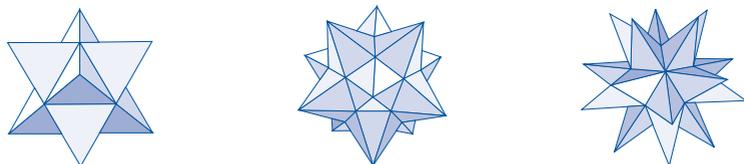
Assemble and glue the object that you have made.

## Activity 6:

1. *Make nets for and construct a range of different objects.*
2. *Use the GeoGenius construction kit to explore how many different nets you can use to make a particular shape.*

## Making stellated objects

By extending the edges or faces of an object until they meet again we can create what are called stellated objects – stellated because they look like stars.



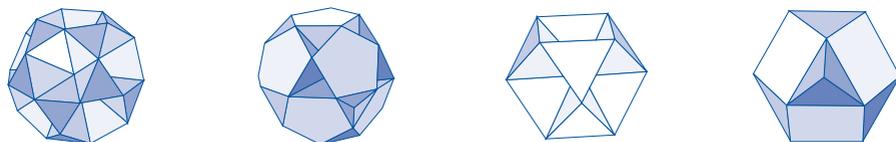
Above (L-R): Stellated Octahedron, Stellated Dodecahedron, Stellated Icosahedron

### Activity 7:

Use the pieces in the GeoGenius construction kit to make the objects above.

## Making faceted objects

By removing solid pieces from a polyhedron, it is possible to make what are known as faceted polyhedron.



Above (L-R): Faceted Icosahedra and Faceted Cuboctahedra

### Activity 8:

Use the pieces in the GeoGenius construction kit to make the faceted objects above.

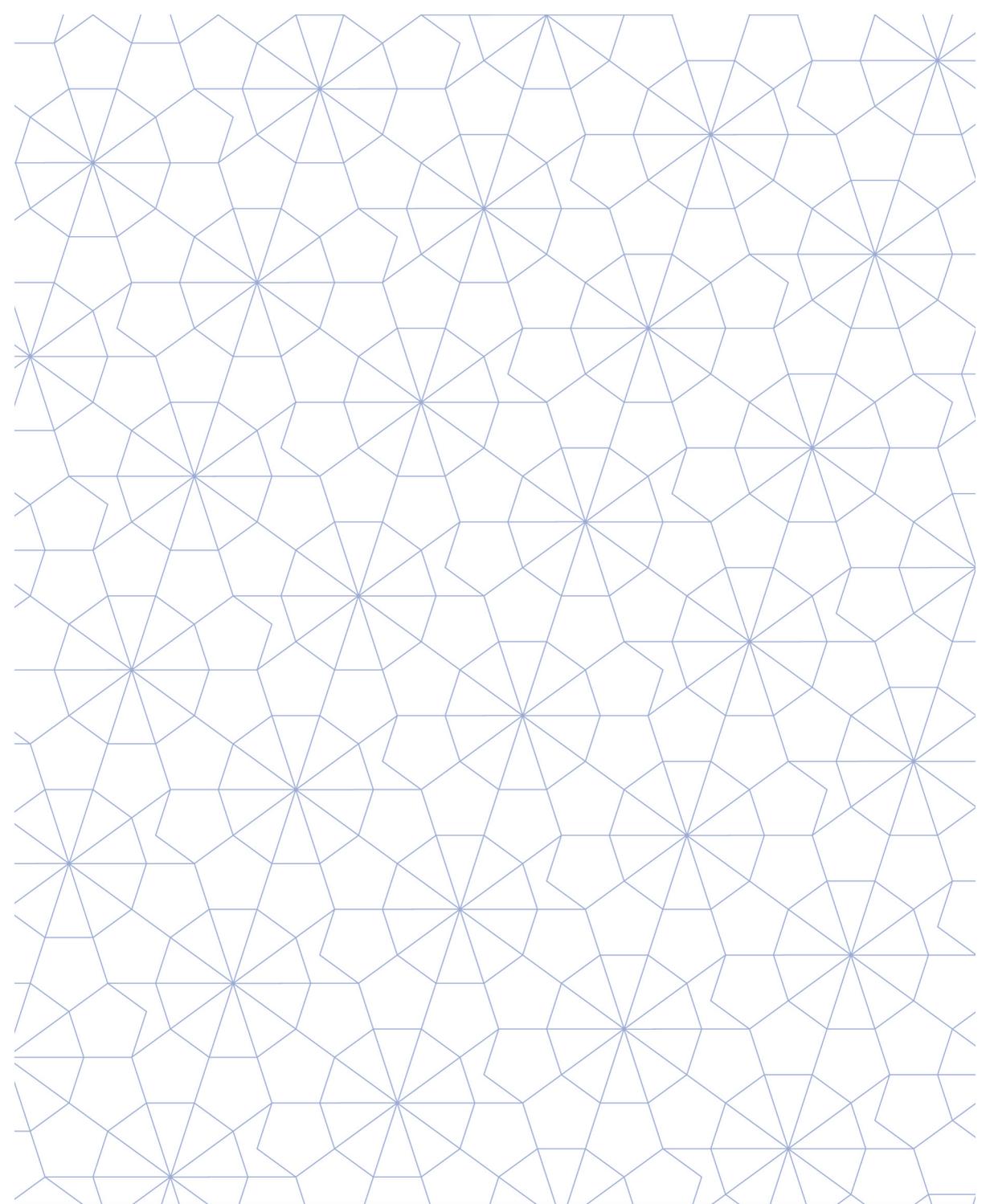
## Extra Tips

The following table may help with the building of the Platonic and Archimedean solids.

Type	Name(s)	# of 	# of 	# of 	# of 	# of 	# of 
p	Tetrahedron	4					
p	Hexahedron (Cube)		6				
p	Octahedron	8					
p	Dodecahedron			12			
p	Icosahedron	20					
$\alpha$	Truncated Octahedron (Mecon)		6		8		
$\alpha$	Cuboctahedron (Dymaxion)	8	6				
$\alpha$	Truncated Cuboctahedron		12		8	6	
$\alpha$	Snub Cube	32	6				
$\alpha$	(Small) Rhombicuboctahedron	8	18				
$\alpha$	Truncated Cube	8				6	
$\alpha$	Truncated Icosahedron (Soccer Ball)			12	20		
$\alpha$	Icosidodecahedron	20		12			
$\alpha$	Truncated Icosidodecahedron		30		20		12
$\alpha$	Snub Dodecahedron	80		12			
$\alpha$	(Small) Rhombicosidodecahedron	20	30	12			
$\alpha$	Truncated Dodecahedron	20					12
$\alpha$	Truncated Tetrahedron	4			4		

### Handy Hint:

You can buy additional or replacement elastic bands at most stationery stores – the best size to buy is the size 12 elastic band.



To order additional kits and/or sets of particular pieces, please send an email to [info@GeoGenius.co.za](mailto:info@GeoGenius.co.za) or visit [www.GeoGenius.co.za](http://www.GeoGenius.co.za)