

Chapter 6:

POLYHEDRAL STRUCTURES

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DEFINITION OF POLYHEDRA

The prime importance regular
geometric solids (POLATONIC
SOLIDS)

THE ARCHIMEDEAN SOLIDS
(SEMI-REGULAR POLYHEDRA)

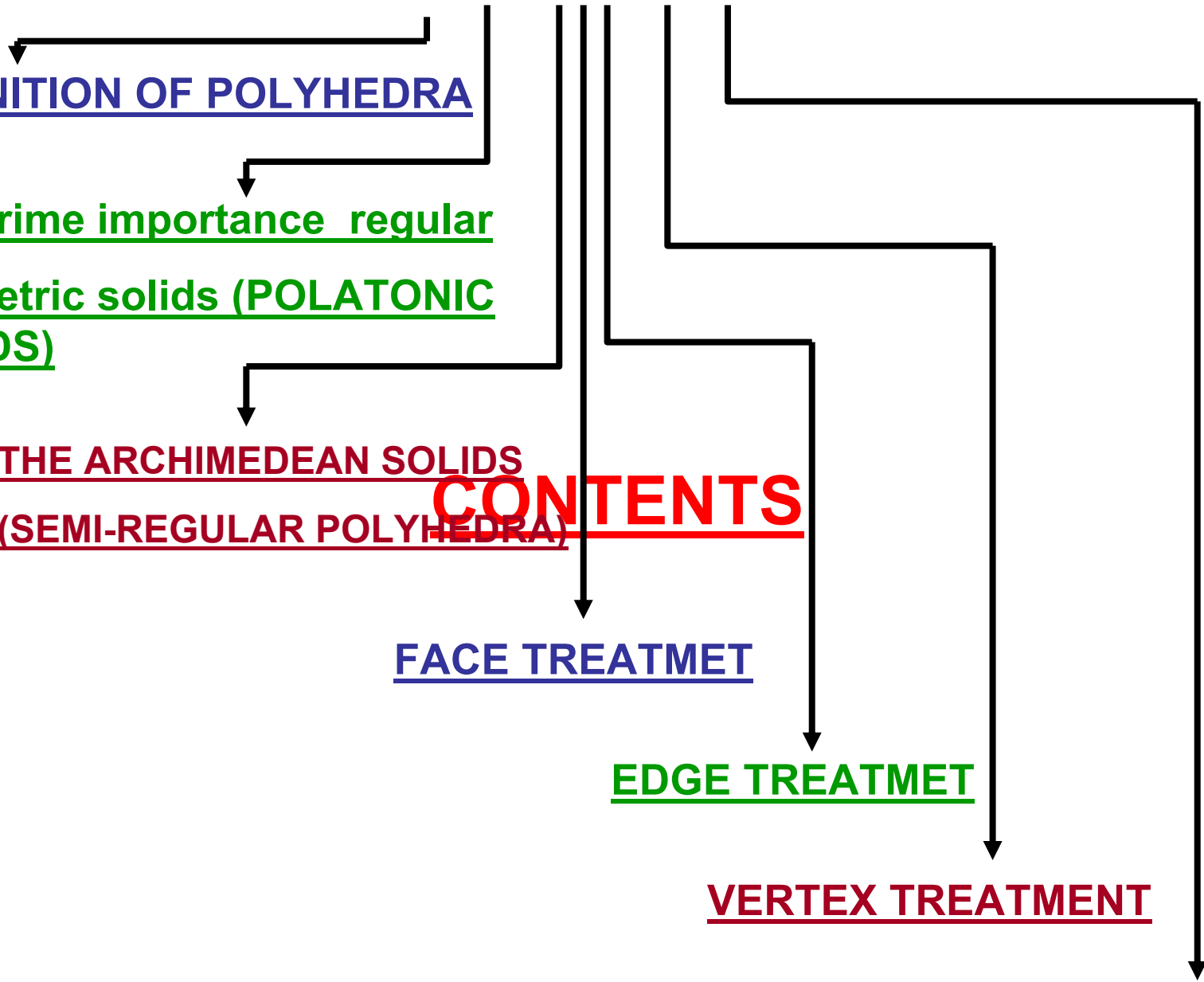
FACE TREATMET

EDGE TREATMET

VERTEX TREATMENT

JOINING OF POLYHEDRAL SHAPES

CONTENTS



Polyhedra are fascinating shapes, which can be adopted as basic structures in 3-dimensional design.

DEFINITION

The polyhedra divided into

**Regular polyhedra (Platonic solids)
&
Semi-regular polyhedra (archimedean solids)**

The prime importance regular geometric solids (POLATONIC SOLIDS) ARE:

1. THE TETRAHEDRON (4 faces)

(POLATONIC SOLIDS)

2. THE CUBE (6 faces)

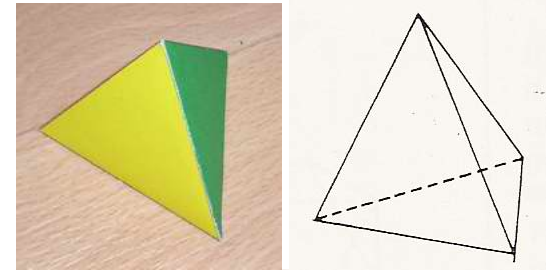
3. THE OCTAHEDRON (8 faces)

4. THE DODECAHEDRON (12 faces)

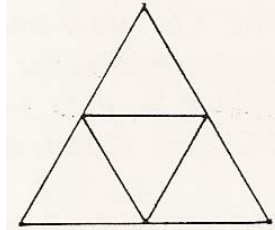
5. THE ICOSAHEDRON (20 faces)

A: Consists of:

4 faces 4 vertices 6 edges



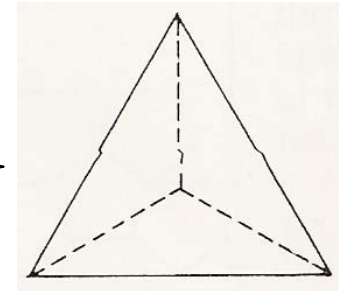
B: Each face is an equilateral triangle



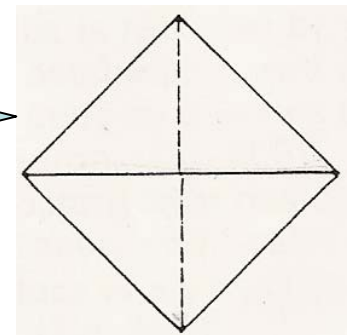
POLATONIC SOLIDS

1. The tetrahedron

C: If it rests on one of its faces, the plane view is an equilateral triangle



D: If it rests on one of its edges, the plane view is a square



E: It is the simplest among the platonic solids, but it is the strongest structure that can be made by man

A: It is the best known shape among the platonic solids

B: It contains the three primary directions for the establishment of the three basic views

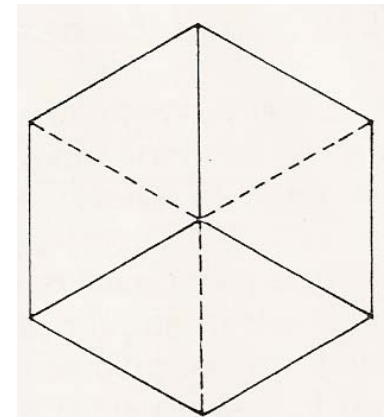
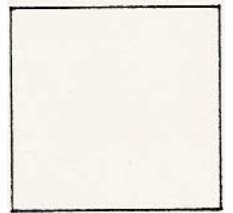
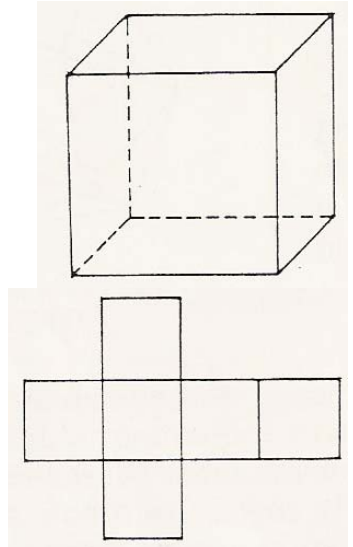
C: Consists of:

6 faces 8 vertices 12 edges

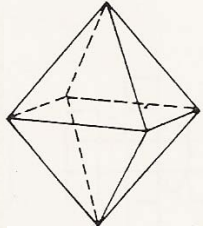
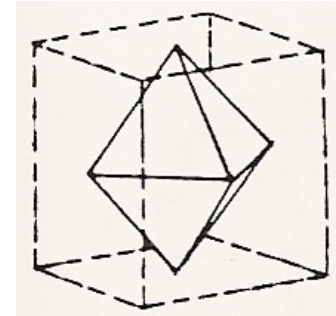
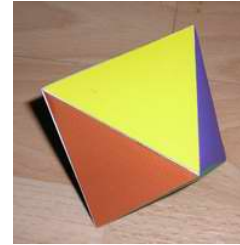
D: Each face is a square & all angles are right angles

E: If it rests on one of its faces, the plane view is a square

F: If it rests on one of its vertices, the plane view is a regular hexagon (6 sides)



A: It forms by replacement of each vertex of the cube by a face of the octahedron & each face of the cube by a vertex of the octahedron



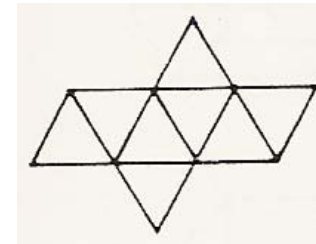
B: Consists of:

8 faces

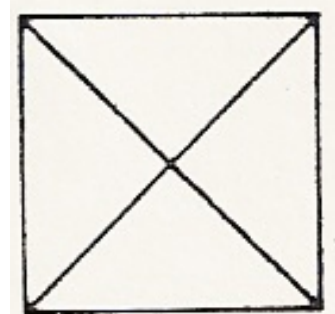
6 vertices POLATONIC SOLIDS

C: Each face is an equilateral triangle

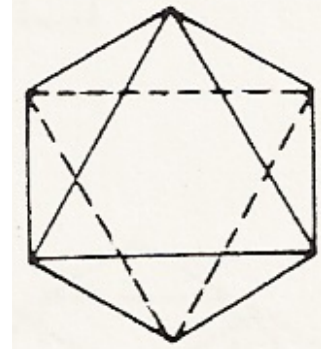
3. The Octahedron



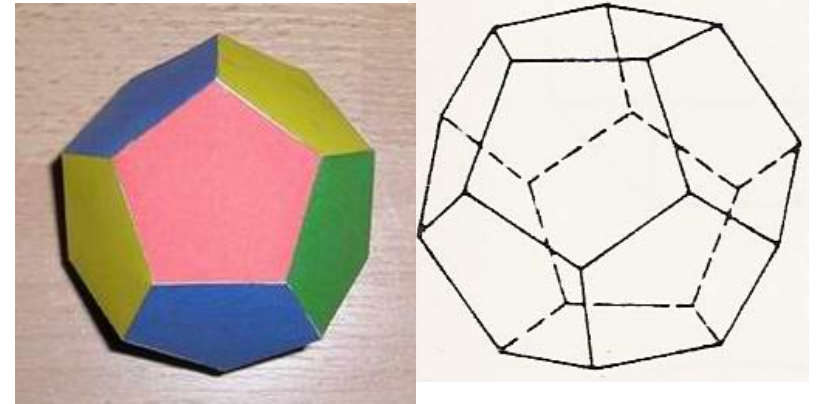
D: If it rests on one of its vertices, the plane view is a square



E: If it rests on one of its faces, the plane view is a hexagon (6 sides)



**A: It is composed of regular pentagons
(5 sides)**



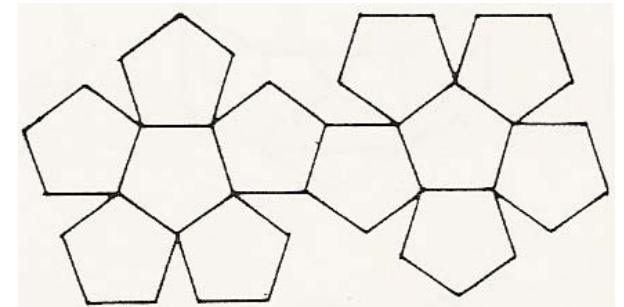
POLATONIC SOLIDS

**B: Consists of:
12 faces**

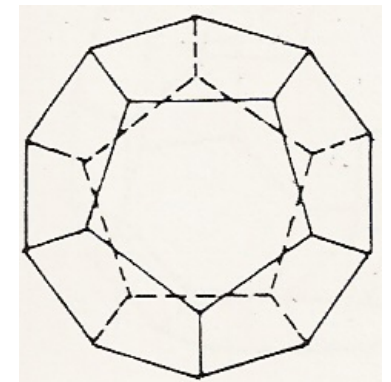
4. The dodecahedron

20 vertices

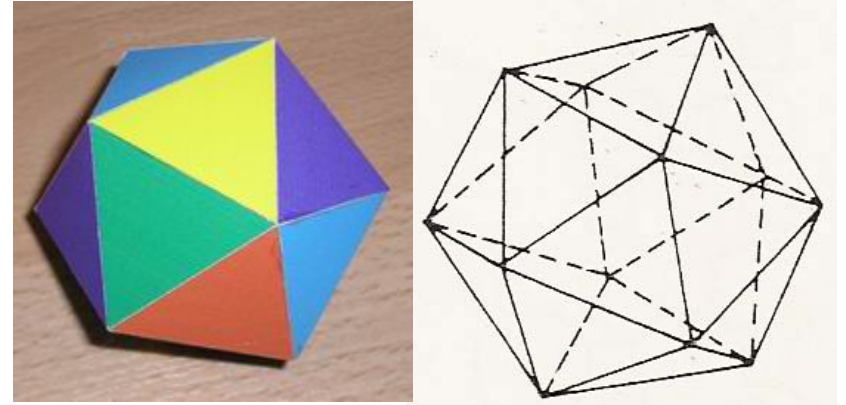
30 edges



**C: If it rests on one of its faces, the plane view is a regular
decagon (10 sides)**



A: Each face is an equilateral triangle

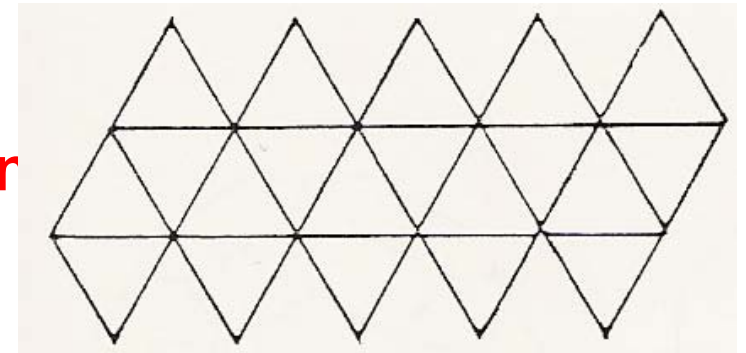


**B: Consists of:
20 faces**

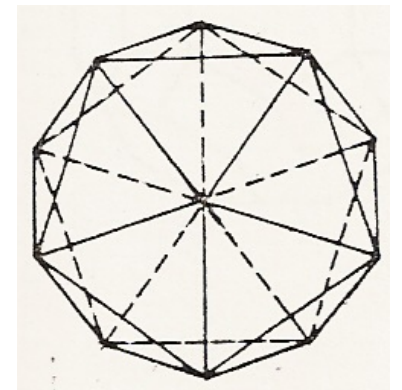
12 vertices

POLATONIC SOLIDS

30 edges



**C: If it rests on one of its vertices, the plane view is
a regular decagon (10 sides)**



(POLATONIC SOLIDS) ARE:

1. THE TETRAHEDRON (4 faces)

REVIEW

2. THE CUBE (6 faces)

3. THE OCTAHEDRON (8 faces)

4. THE DODECAHEDRON (12 faces)

5. THE ICOSAHEDRON (20 faces)

- * It is constructed of regular polygons

THE ARCHIMEDEAN SOLIDS

- * The difference between the platonic and the Archimedean solids is:

platonic solids	Is consists of	only one type of regular polygon
Archimedean solid	Is consists of	more than one type of regular polygon

1. The cub octahedron

2. The truncated octahedron

The simplest Archimedean solids

3. The rhombi cub octahedron

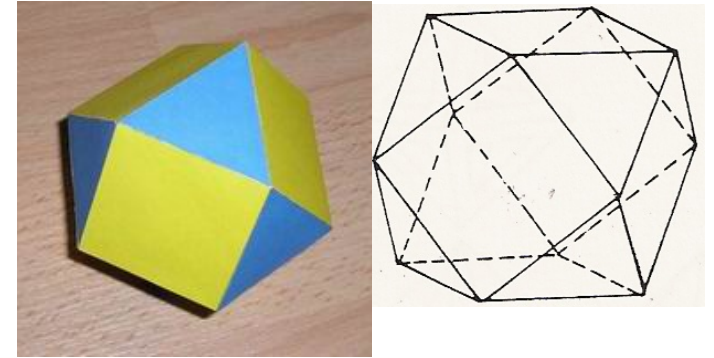
(small rhombi cub octahedron)

4. The great rhombi cub octahedron

(truncated cub octahedron)

A. It contains

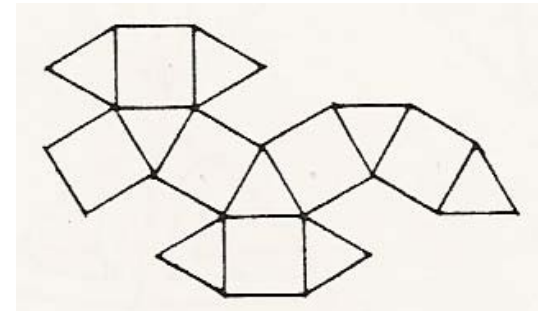
14 faces 12 vertices 24 edges



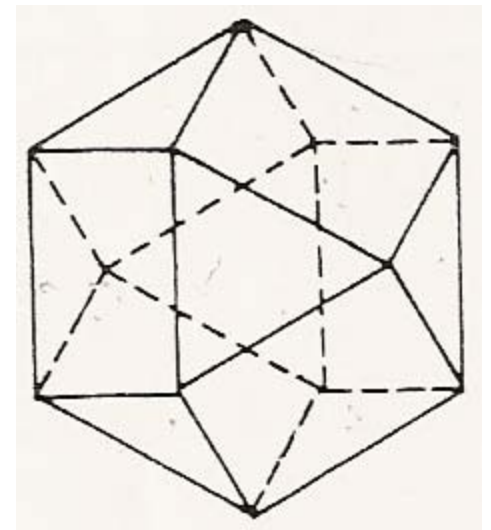
**B. Among the 14 faces, 8 are equilateral triangles
& 6 are squares**

1. The cub octahedron

THE ARCHIMEDEAN SOLIDS



**C. If it rests on one of the triangles faces, the plane
view is a hexagon (6 sides)**



A. It contains 14 faces 24 vertices 36 edges

B. It is obtained by chopping away the 6 vertices of an octahedron and replacing them by 6 square faces

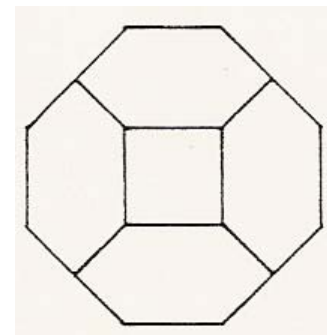
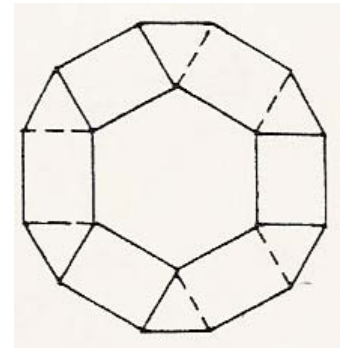
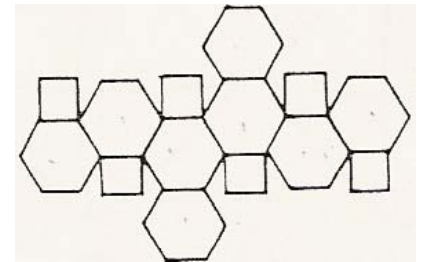
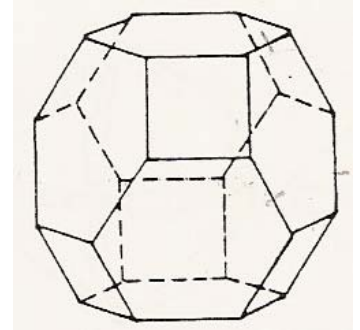
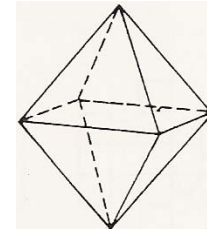
C. Among the fourteen faces, 8 are regular hexagon (six sides) and 6 are squares

THE ARCHIMEDEAN SOLIDS

2. The truncated octahedron

D. If it rests on one of the hexagonal faces, the plane view is a dodecagon (12 sides) with unequal adjacent sides.

E. If it rests on one of the square faces, the plane view is an octagon (8 sides) with unequal adjacent sides.



THE ARCHIMEDEAN SOLIDS

A. It contains 26 faces 24 vertices 48 edges

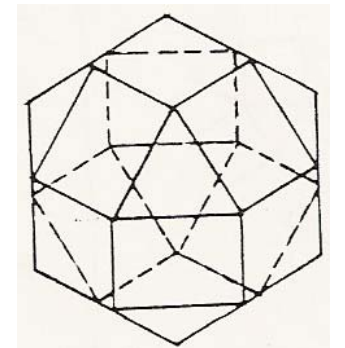
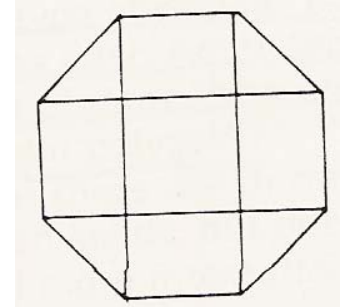
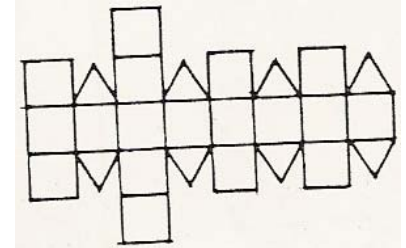
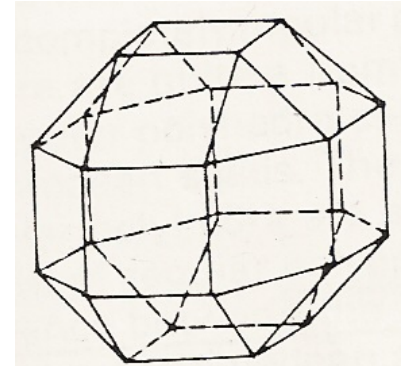
B. Among the 26 faces, 8 are equilateral triangles and 18 are squares

3. The rhombi cub octahedron

(small rhombi cub octahedron)

C. If it rests on one of the square faces, the plane view is a regular octagon (8 sides).

D. If it rests on one of the triangles faces, the plane view is a regular hexagon (6 sides)



THE ARCHIMEDEAN SOLIDS

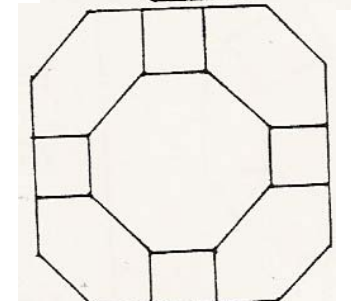
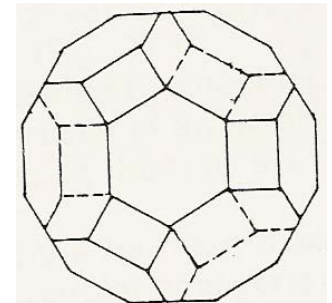
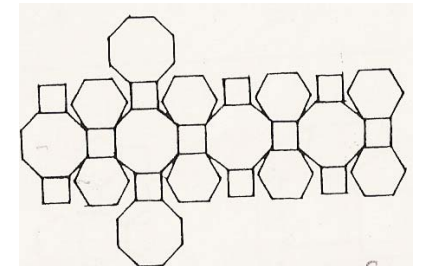
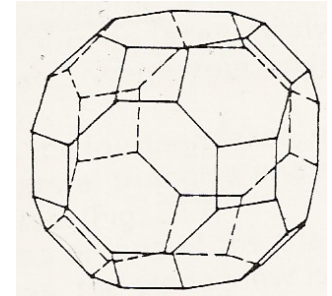
A. It contains 26 faces 48 vertices 72 edges

B. Among the 26 faces, 12 are squares, 8 are regular hexagons (6 sides) and 6 are regular octagons (8 sides)

4. The great rhombi cub octahedron

C. If it rests on one of the hexagonal faces, the plane view is a regular dodecagon (12 sides).

D. If it rests on one of the octagonal faces, the plane view is an octagon (8 sides) with unequal adjacent sides



The simplest Archimedean solids

1. The cub octahedron

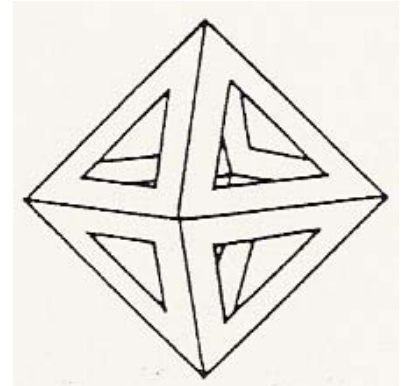
2. The truncated octahedron

REVIEW

**3. The rhombi cub octahedron
(small rhombi cub octahedron)**

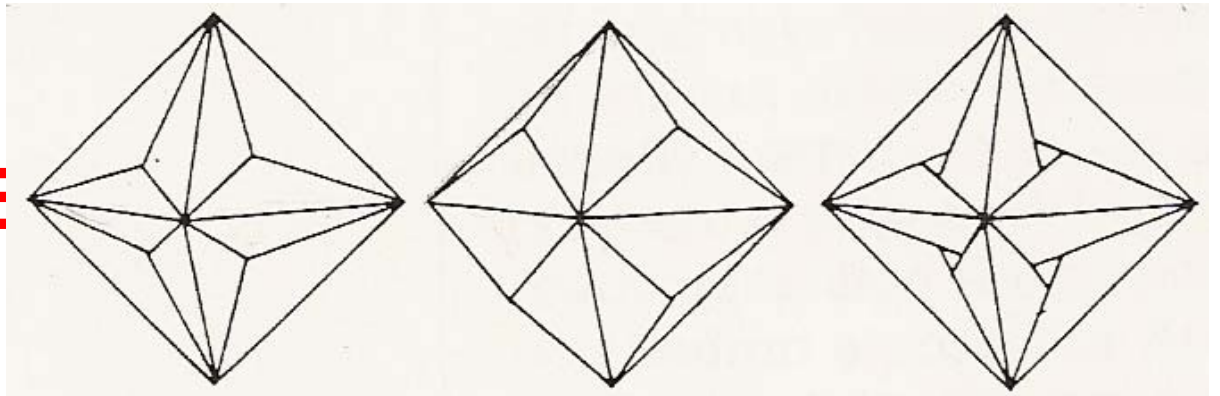
**4. The great rhombi cub octahedron
(truncated cub octahedron)**

The simplest face treatment of polyhedron is to make a negative shapes on some or all of the faces

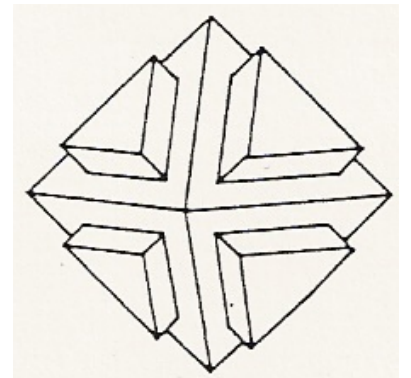


Each flat face can be replaced by a pyramidal shape

FACE



Separately constructed shapes can be attached to the faces of the polyhedron



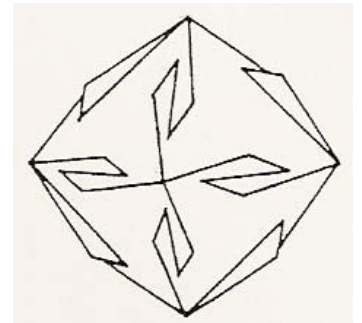
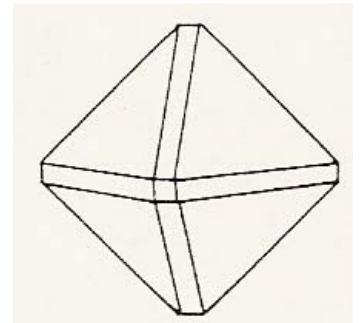
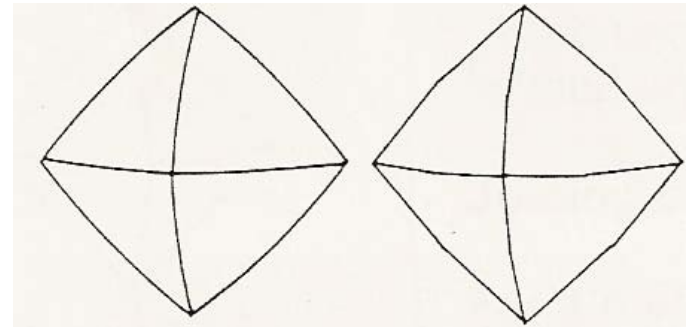
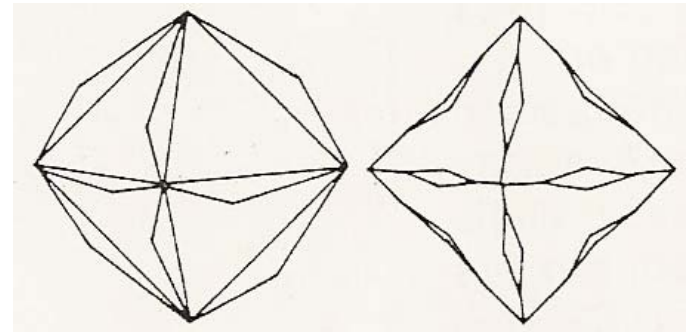
Along the edges of the polyhedron, shapes can be added or subtracted. When they are subtracted, faces are also affected because we can not remove anything from the edge without removing a part of the faces

Straight edges of the polyhedron can be curvilinear or bent

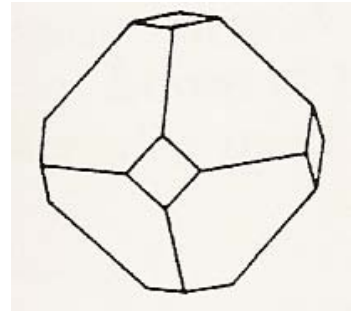
EDGE TREATMENT

Each single line edge can be replaced by double-or multi-line edge, and this will lead to the creation of new faces.

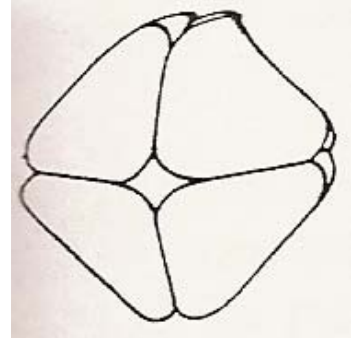
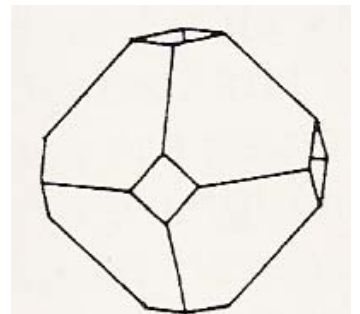
Interlocking of the face planes along the edges can take place in varied ways



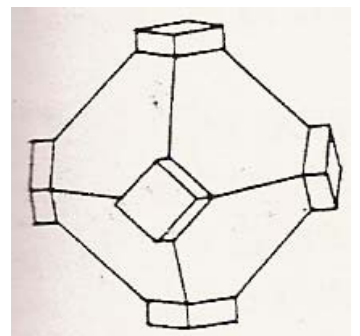
Vertex treatment normally affects all the faces. One way to treat vertices is by truncation



If the polyhedron is hollowed, truncation reveals a hole at each vertex. Such holes may be specially treated so that the borders are not just simple straight lines.

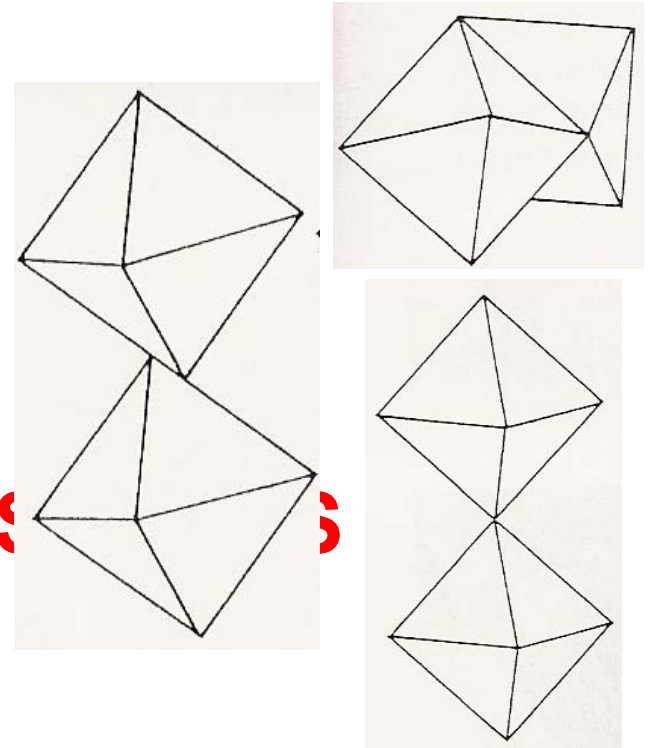


Additional shapes can be formed on the vertices

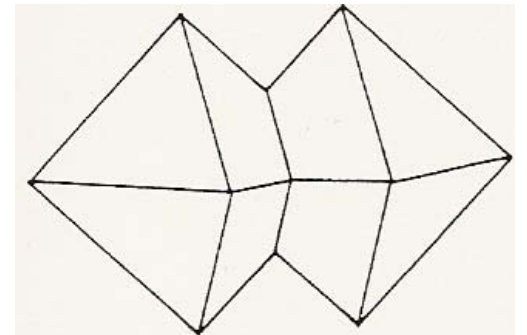


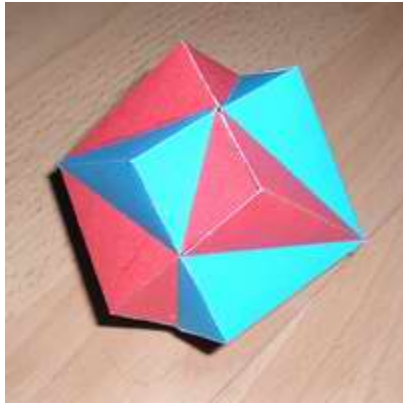
For more complicated structure, 2 or more polyhedral shapes can be joined together by face contact, edge contact or vertex contact

JOINING OF POLYHEDRAL SHAPES



For greater structural strength, or for design reasons, vertices can be truncated during vertex contact, edge flattened during edge contact, or the volume of one polyhedral shape made to penetrate the volume of another





Compound of 2 cubs

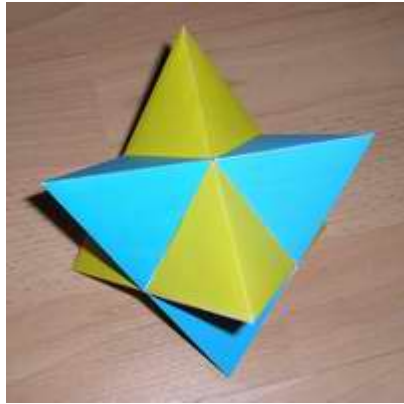
Other samples OF JOINING POLYHEDRAL SHAPES



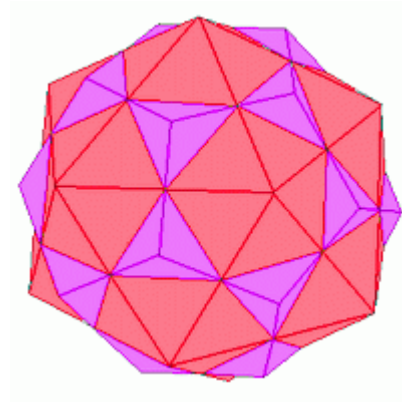
Compound of 3 cubs



Compound of 4 cubs



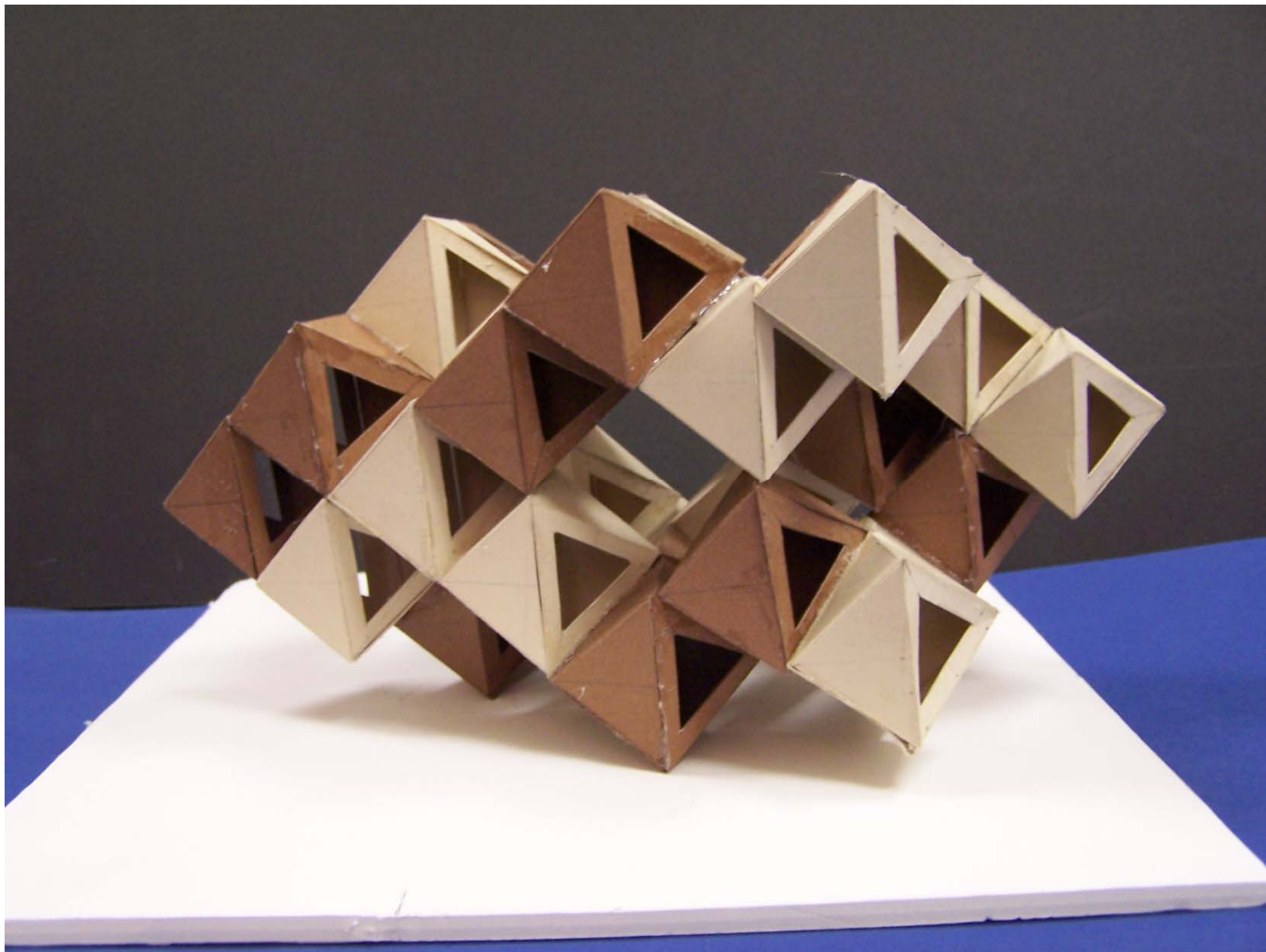
Compound of 2 tetrahedron

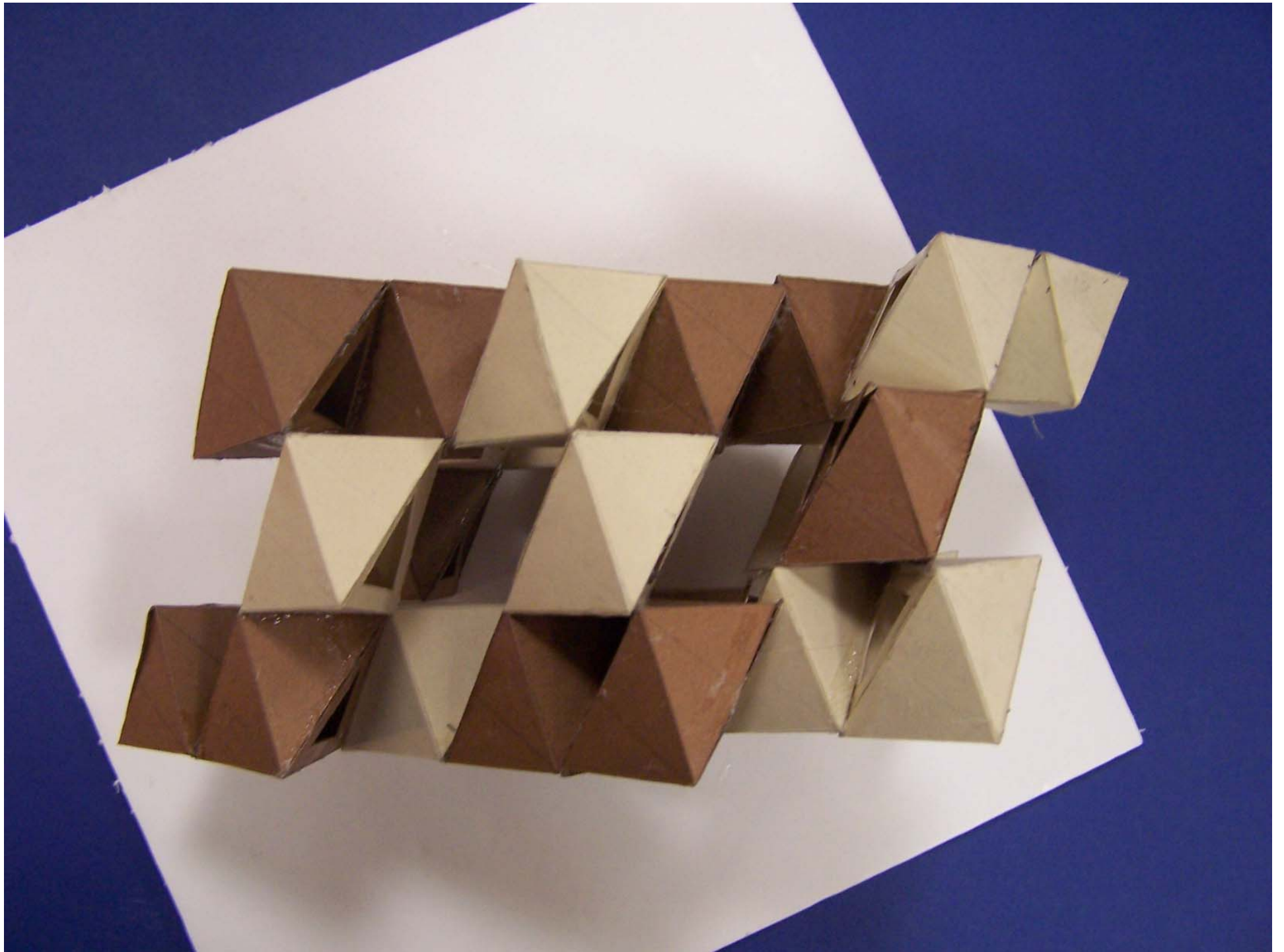


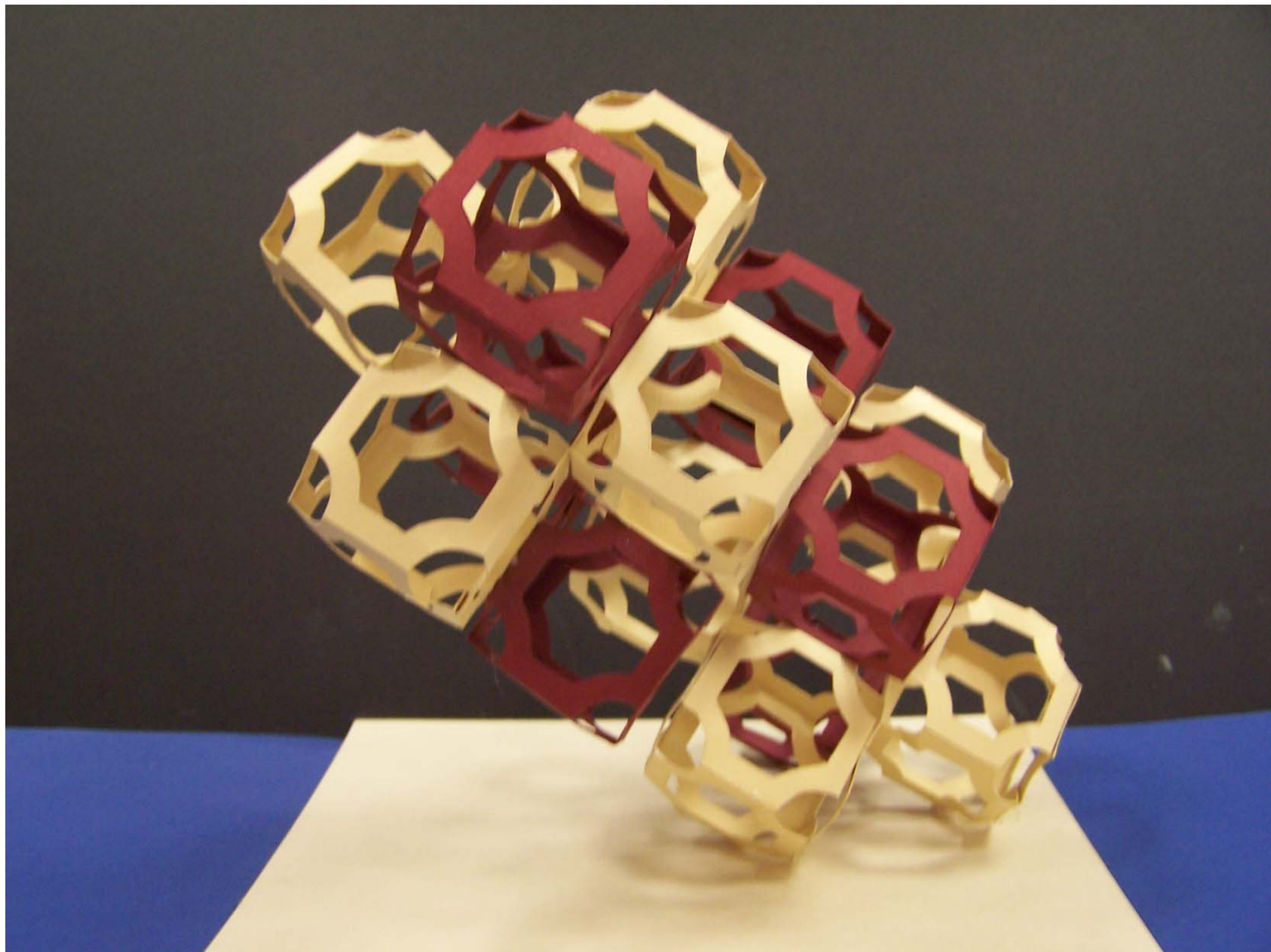
Compound of dodecahedron and icosahedron

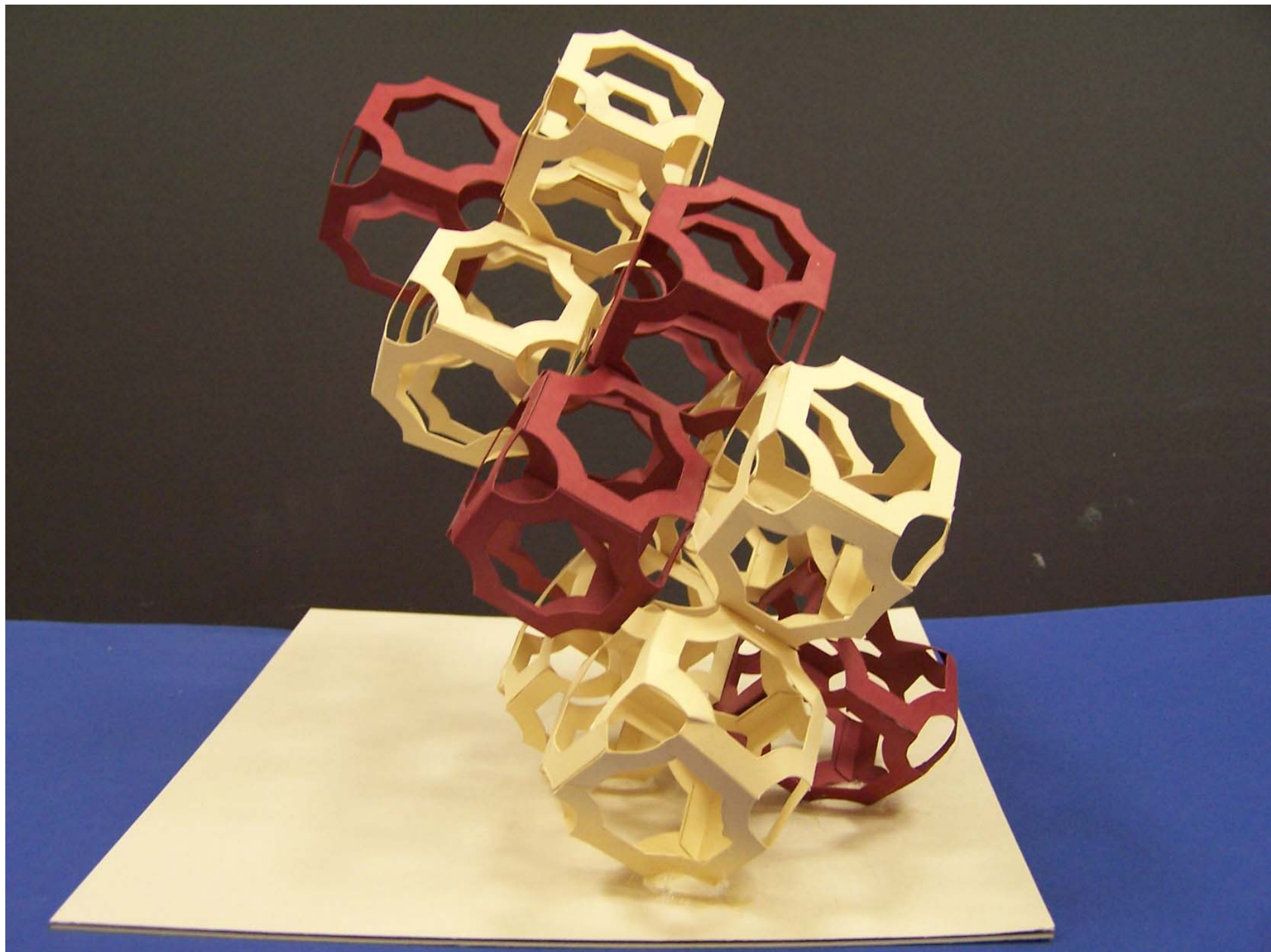


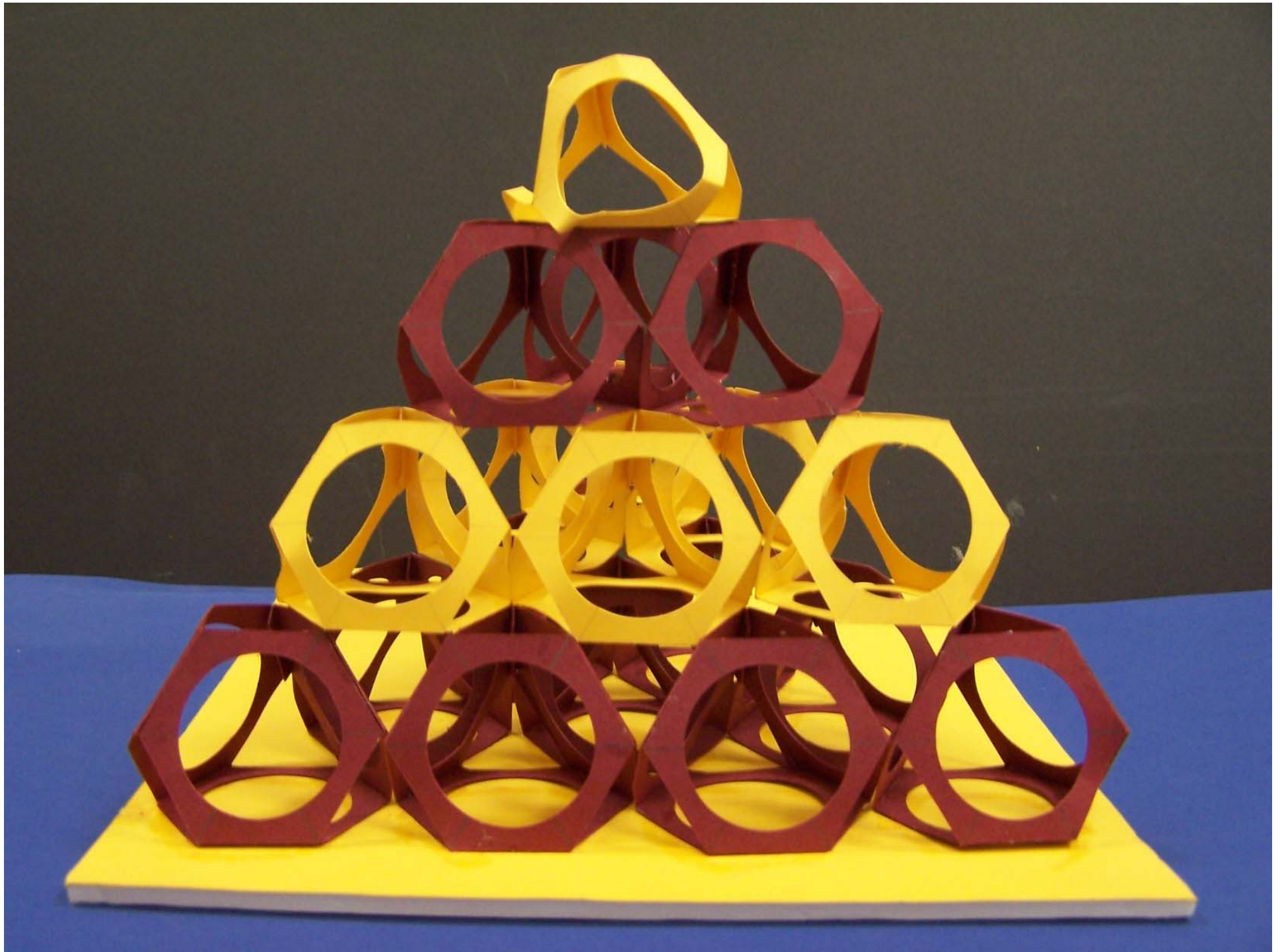
Compound of Cube and Octahedron

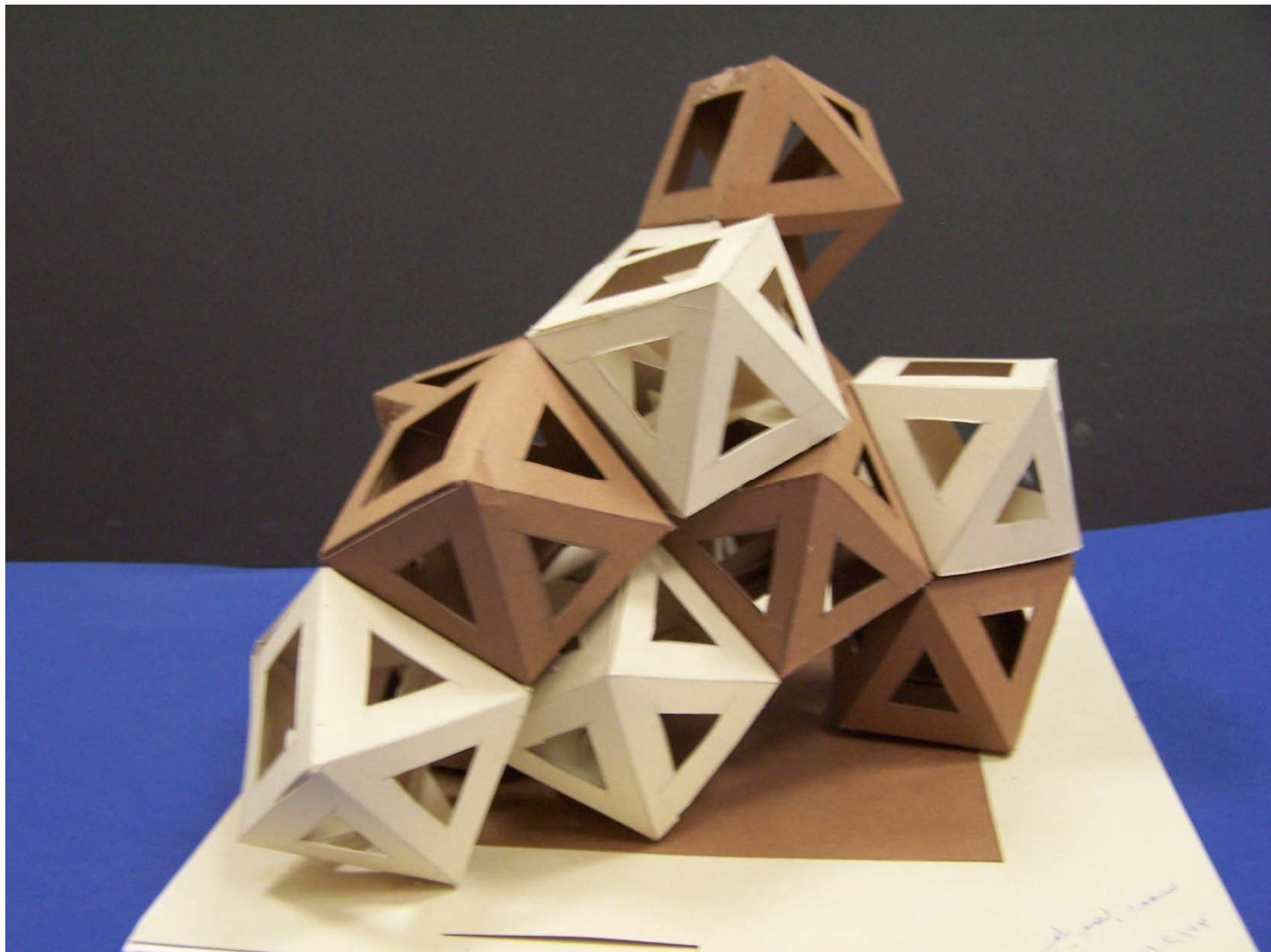


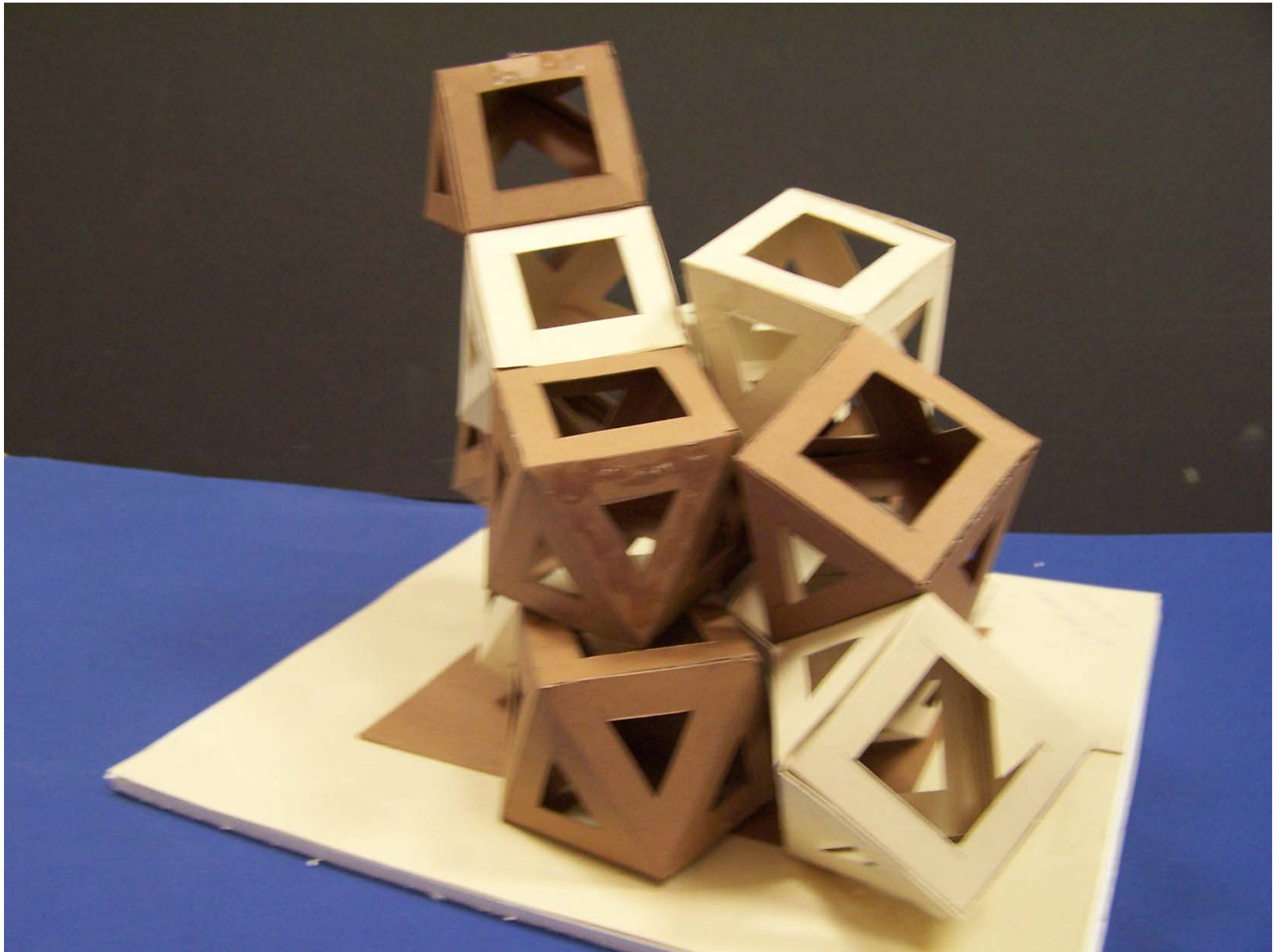


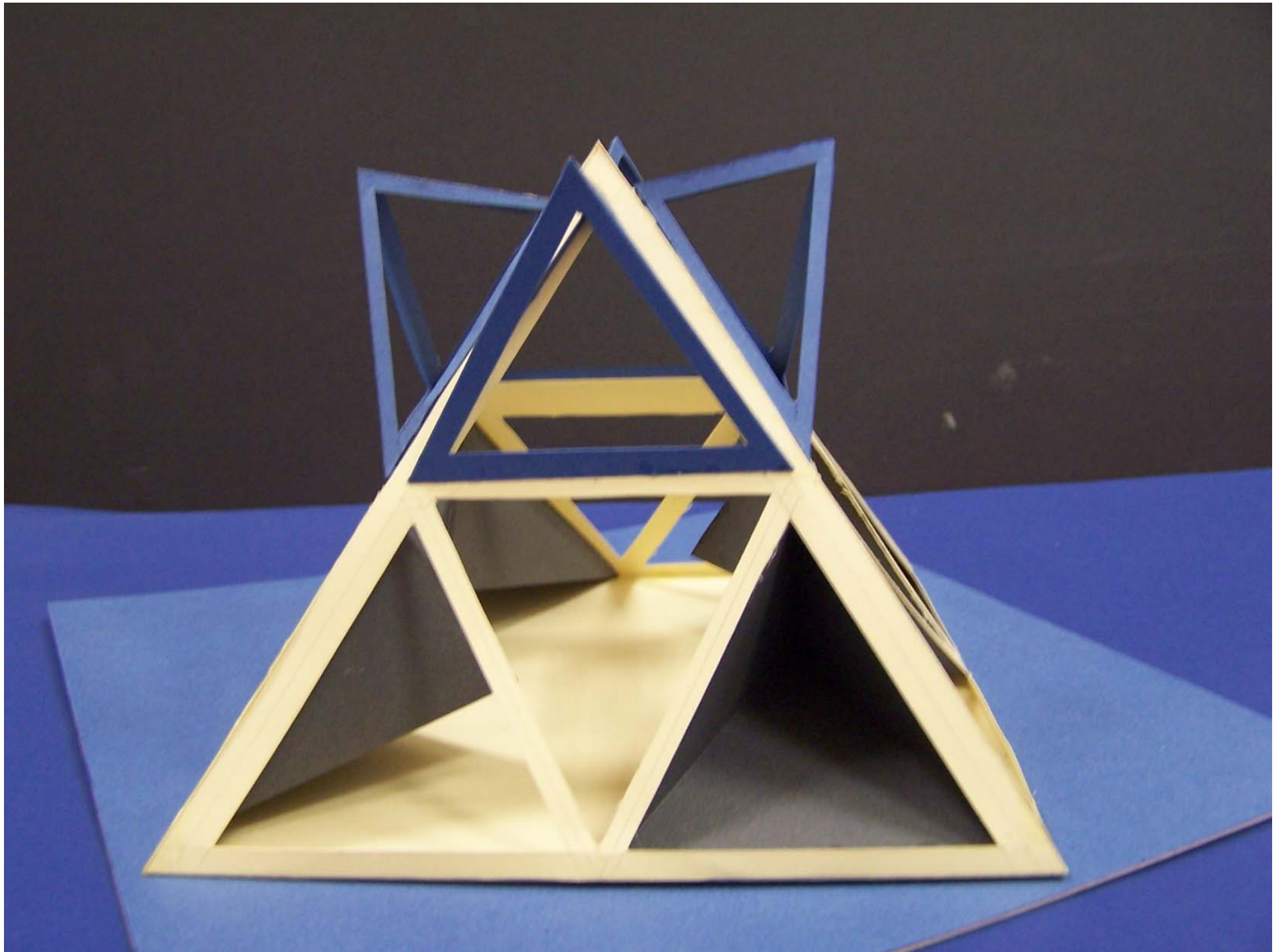


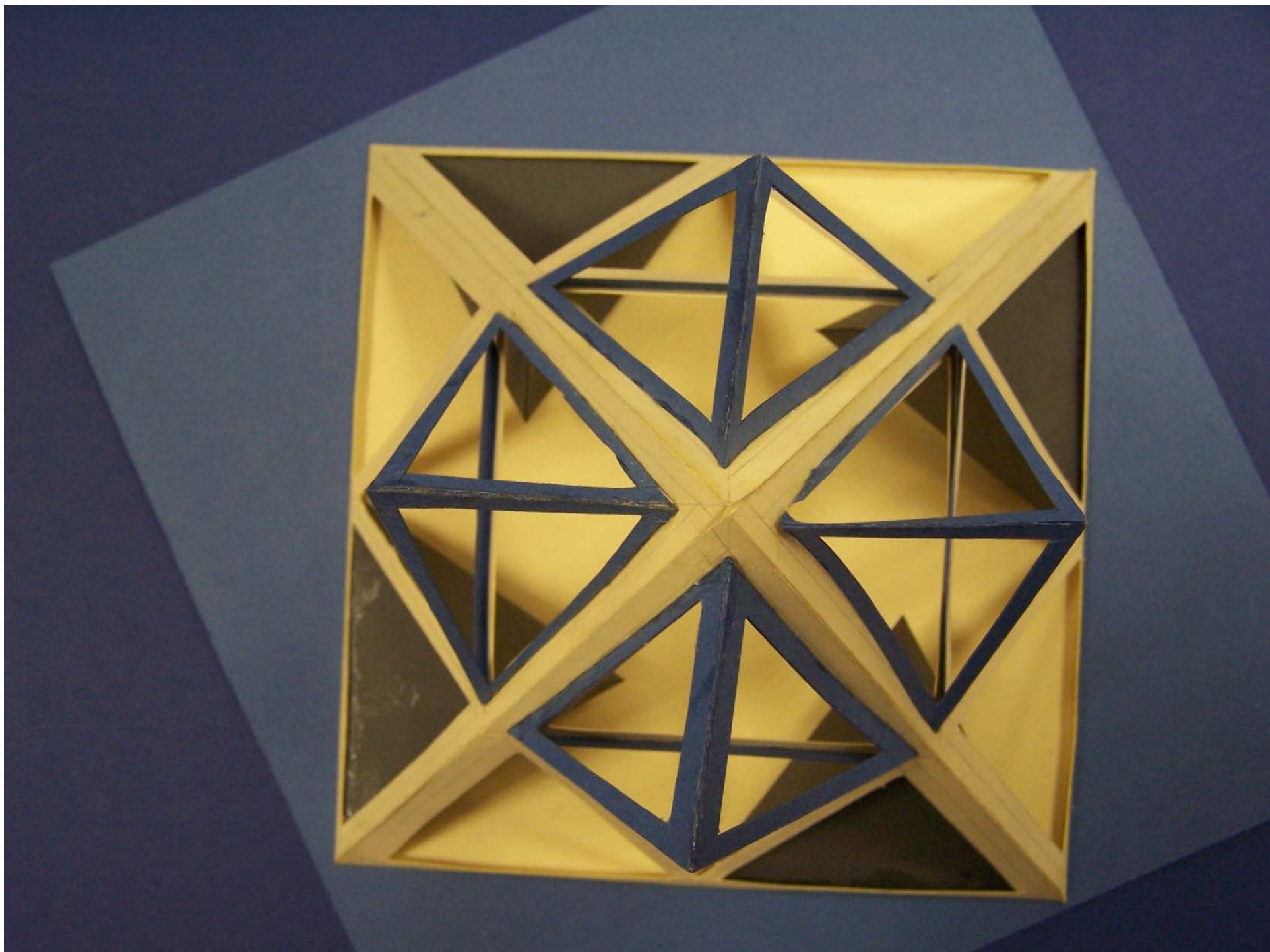


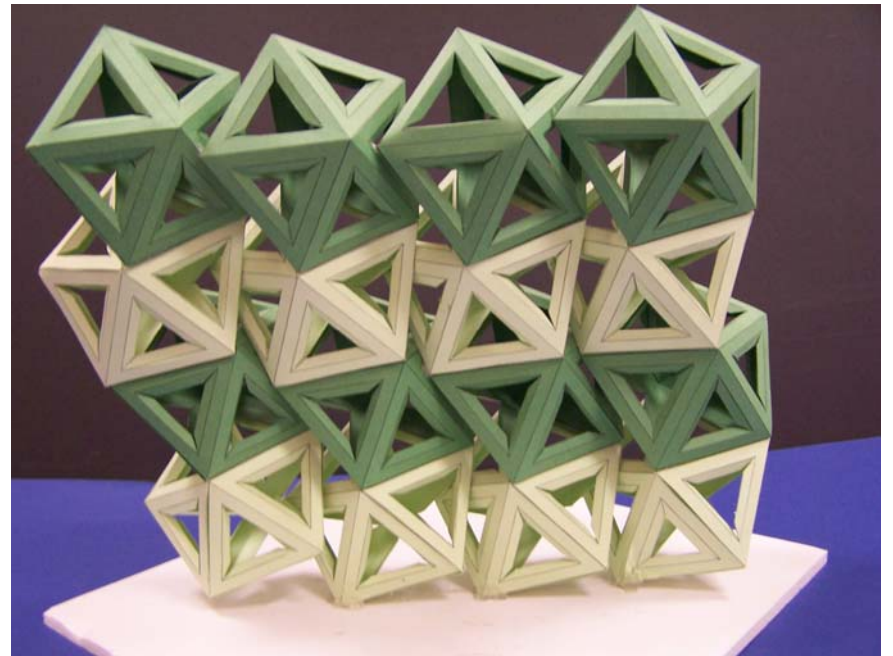
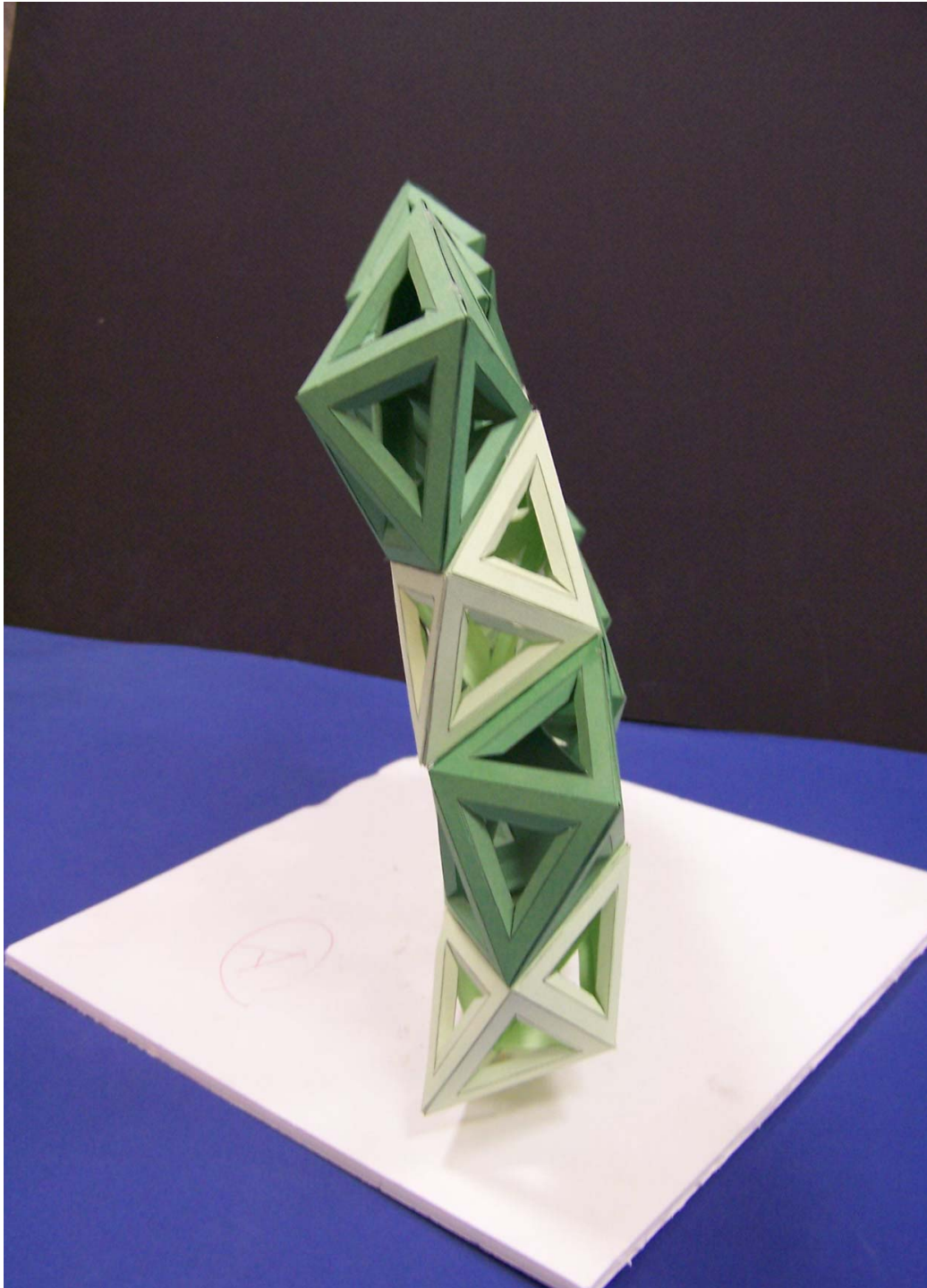


















Shanghai TV Tower





تم بحمد الله