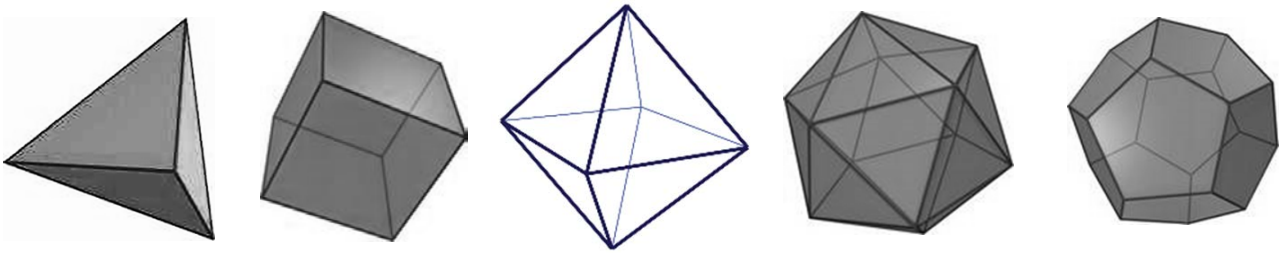
# PLATONIC SOLIDS



These are the Platonic Solids.
A Platonic solid is a three dimensional shape where all the faces are the same regular polygon.
They can be found in the world around us in the form of crystals, micro-organisms and molecules.
There are only five platonic solids.
We can make models of the platonic solids using paper, sticky tape and string.
There is a separate instruction sheet on the website which explains how this is done.

## HELP

The first three platonic solids are quite easy to make. The last two are more challenging. Work together with other learners to try and complete this activity. Use the internet to watch videos which help us to understand how the platonic solids fit together. Here is the link for one of these;
https://www.youtube.com/watch?v=RbbaGGmaO6U&feature=youtu.be&list=PLZLVDM_hxHkDCSMUzoDOyQh1B4u9j7aGW

## NEXT

Why are there only 5 platonic solids? The faces in the 5 platonic solids are congruent triangles, congruent squares or congruent pentagons. What happens if you try to make a platonic solid from congruent hexagons?

# GUIDE FOR PARENTS FOR HOMELEARNING

## SOLUTION

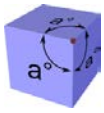
Check that each of the platonic solids you have made has the correct properties that are listed on the instruction sheet. These refer to the number of faces, the number of edges and the number of regular polygons at each vertex.

**Why are there only 5 platonic solids?**

The simplest reason there are only 5 Platonic Solids is this:

At each vertex **at least 3 faces** meet (maybe more).

When we add up the internal angles that meet at a vertex, it must be **less than 360 degrees**.

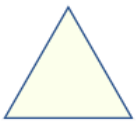



Because at 360° the shape flattens out!


And, since a Platonic Solid's faces are all identical **regular** polygons we get:

A regular triangle has internal angles of 60°, so we can have:

- 3 triangles (3×60°=180°) meet.
- 4 triangles (4×60°=240°) meet or
- 5 triangles (5×60°=300°) meet.

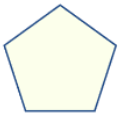


A square has internal angles of 90°, so there is only:

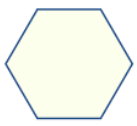
- 3 squares (3×90°=270°) meet.

A regular pentagon has internal angles of 108°, so there is only:

- 3 pentagons (3×108°=324°) meet



A regular hexagon has internal angles of 120°, but 3×120°=360° which **won't work** because at 360° the shape flattens out.



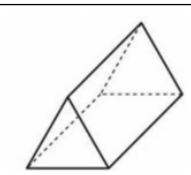
So a regular pentagon is as far as we can go.

## Diagnostic Assessment This should take about 5–10 minutes.

Sometimes you may want to use this at the start of a session to find out how much your learners already know.

Sometimes you may want to use this at the end of a session before you go on to something else, to find out how much your learners have learned and understood.

1. Show this question and say:
   **"Put up 1 finger if you think the answer is A, 2 fingers for B, 3 fingers for C and 4 fingers for D".**



1. How many vertices do I have?
   a) 12
   b) 9
   c) 5
   d) 6

   The correct answer is d)

   Other answers that reveal possible misconceptions:
   a) Cannot visualise the 3D shape from the picture.
   b) Possibly confused vertices with edges.
   c) Possibly confused vertices with faces

2. Name the shape
   I have 10 vertices, 2 pentagonal faces, 5 rectangular faces and 15edges.
   a) Heptagon
   b) Pentagonal Pyramid
   c) Pentagon
   d) Pentagonal prism

   The correct answer is d)

   Other answers that reveal possible misconceptions:
   a) Confusing a 7 sided polygon with a 3D shape with 7 faces
   b) Confusing a pentagonal pyramid with a pentagonal prism
   c) Confusing 2D and 3D shapes

**2.** Notice how the learners respond. Ask them all to explain why they gave their answer and DO NOT say whether it is right or wrong but simply thank the learner for giving the answer.

**3.** It is important for learners to explain the reason for their answer otherwise they may just make a guess.

4. Try to make sure that other learners listen to these reasons and try to decide if their own answer was right or wrong.

5. **Ask the learners again to vote for the right answer by putting up 1, 2, 3 or 4 fingers. Notice if there is a change and who gave right and wrong answers**

https://diagnosticquestions.com

## Why do this activity?

It is important for learners to see and handle solid shapes for themselves because pictures in a book or diagrams on the chalkboard can be meaningless without handling the 3D shape. Repeated reference to the names of the shapes and to their properties will help the learners to visualise and to remember them.

The rolled paper stick models help learners to count the numbers of edges and vertices. The sticks make the edges and the points where the sticks are tied together make the vertices of the solids.

This activity encourages the learners to think about why there are only 5 platonic solids. They will think about the number of faces that meet at a vertex and about the total of the internal angles that meet at the vertex. The concrete models will help the learners to understand why the total of the internal angles that meet at a vertex must be less than 360°. As a result they will be able to explain why there are only 5 platonic solids.

## Learning objectives

In doing this activity students will have an opportunity to:
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Learn the names and properties of the five platonic solids
Have experienced the confidence created by collaborative practical work
Understand why there are only five platonic solids

## Generic competences

In doing this activity students will have an opportunity to:

*Examples of possible objectives:*

- **think mathematically,** reason logically and give explanations;
- **think flexibly**, be creative and innovative and apply knowledge and skills;
- **visualize** and develop the skill of interpreting and creating visual images to represent concepts and situations;
- **work and learn independently** and prepare for lifelong learning;
- **work in a team**:
    - collaborate and work with a partner or group
    - have empathy with others, listen to different points of view
    - develop leadership qualities;
- **communicate** in writing, speaking and listening according to the audience:
    - exchange ideas, criticise, and present information and ideas to others
    - analyze, reason and record ideas effectively;
- **develop life skills and consideration for others**
    - show social responsibility – to work for the good of the community
    - to compete competitively and fairly with respect for others.

## Suggestions for homelearning

This activity ranges in difficulty level from straightforward to challenging. Making the stringy sticks and constructing the first three platonic solids can be achieved by a wide age range of learners. When they have completed the models, ask the learners, to count the total number of vertices and the total number of edges. Ask them to count the number of faces in the model and to identify the regular polygon which the faces are made from. Finally ask them to establish how many faces meet at each vertex.

Completing the last two platonic solids is challenging for learners and adults. I suggest you try to complete them yourself before your child attempts them. In this way you can ask appropriate questions to help them to visualise how the various parts of the model come together. Keep checking that the child's model has the appropriate number of faces around each vertex.

If you also have difficulty completing the last two platonic solids use the help section in this guide to watch some recordings on the internet of how this is done.

Once the five platonic solids have been made use them to help the learners understand why there are only five.

Starting with the tetrahedron, ask your child what are the size of the internal angles of the triangular faces. Why are the three angles the same size? When the three angles come together at the vertex, what is the sum of the three angles at the vertex?

Do this for each of the platonic solids.

What polygons have we used in the platonic solids?

Then ask them to imagine a platonic solid where each face was a hexagon. You could have some hexagons made from stringy sticks. We know that the minimum number of faces around a vertex is three. If we tried this with a hexagon what would be the total for the angles at the vertex. Discuss why a total of 360° results in a flat shape. Place the three hexagons together so that there are three meeting at a vertex. This demonstrates that the shape will be flat. Compare this with the models of the five platonic solids to emphasise the point.

## Key questions

1. What are the total number of vertices and edges of each platonic solid?
2. What is the total number of faces in the platonic solid?
3. What regular shape makes up the faces of the platonic solid?
4. How many faces meet at each vertex?
5. What is the total of the three angles which meet at the vertices of the tetrahedron?
6. What is the total of the three angles which meet at the vertices of the cube?
7. What is the total of the four angles which meet at the vertices of the octahedron?
8. What is the total of the five angles which meet at the vertices of the dodecahedron?
9. What is the total of the three angles which meet at the vertices of the icosahedron?
10. If we tried to make a platonic solid from hexagons and three hexagons met at each vertex what would be the total of the angles at the vertex.
11. Why would this be a problem?

## Follow up

https://nrich.maths.org/1393

Note: The Grades or School Years specified on the AIMING HIGH Website correspond to Grades 4 to 12 in South Africa and the USA, to Years 4 to 12 in the UK and up to Secondary 5 in East Africa. New material will be added for Secondary 6.
For resources for teaching A level mathematics see https://nrich.maths.org/12339
Note: The mathematics taught in Year 13 (UK) and Secondary 6 (East Africa) is beyond the school curriculum for Grade 12 SA.

| | Lower Primary or Foundation Phase Age 5 to 9 | Upper Primary Age 9 to 11 | Lower Secondary Age 11 to 14 | Upper Secondary Age 15+ |
|---|---|---|---|---|
| South Africa | Grades R and 1 to 3 | Grades 4 to 6 | Grades 7 to 9 | Grades 10 to 12 |
| USA | Kindergarten and G1 to 3 | Grades 4 to 6 | Grades 7 to 9 | Grades 10 to 12 |
| UK | Reception and Years 1 to 3 | Years 4 to 6 | Years 7 to 9 | Years 10 to 13 |
| East Africa | Nursery and Primary 1 to 3 | Primary 4 to 6 | Secondary 1 to 3 | Secondary 4 to 6 |