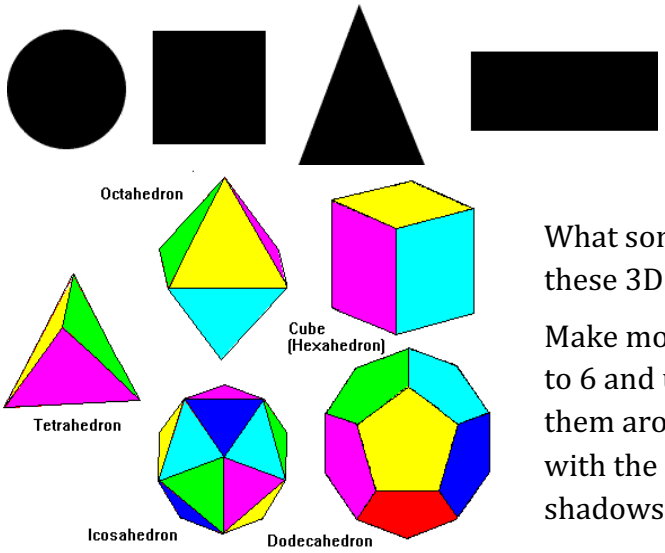
AIMSSEC

AFRICAN INSTITUTE FOR MATHEMATICAL SCIENCES
SCHOOLS ENRICHMENT CENTRE (AIMSSEC)
AIMING HIGH

SHADOWS ACTIVITY



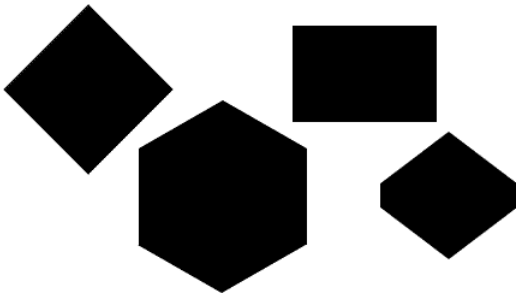
The picture shows some shadows cast by solid (3 dimensional 3D) objects as well as some flat (2 dimensional shapes. What could have made these shadows?

What sort of shadows can be made with these 3D objects?

Make models from the templates on pages 2 to 6 and use them to make shadows. Turn them around and make different shadows with the same object. Draw and label the shadows to record your discoveries.

HELP

Try making shadows of your hands and other objects.



NEXT

1. Which of these shapes could be the shadow of a cube? What objects could make these shadows?
2. Hold the solids at **different angles** to the wall. For example, it is possible to make a square shadow by holding a rectangular box at an angle to the wall.
3. Think about **ENLARGEMENT**. Cast smaller or larger shadows of the **same object** by using a torch. If you move the object nearer to the light source the image gets larger. If you move the object further from the light source the image gets smaller. Try it! This is how images are projected by a data projector. At the cinema you see very large images on the screen. Those images are projected from a projection room at the back of the cinema quite far away from the screen.

When lengths in the images are **twice the lengths** in the original object there is an enlargement of **SCALE FACTOR 2**. Investigate scale factors and how they are used.

(Adapted from a problem from the UKMT Maths Challenges)

RESOURCES

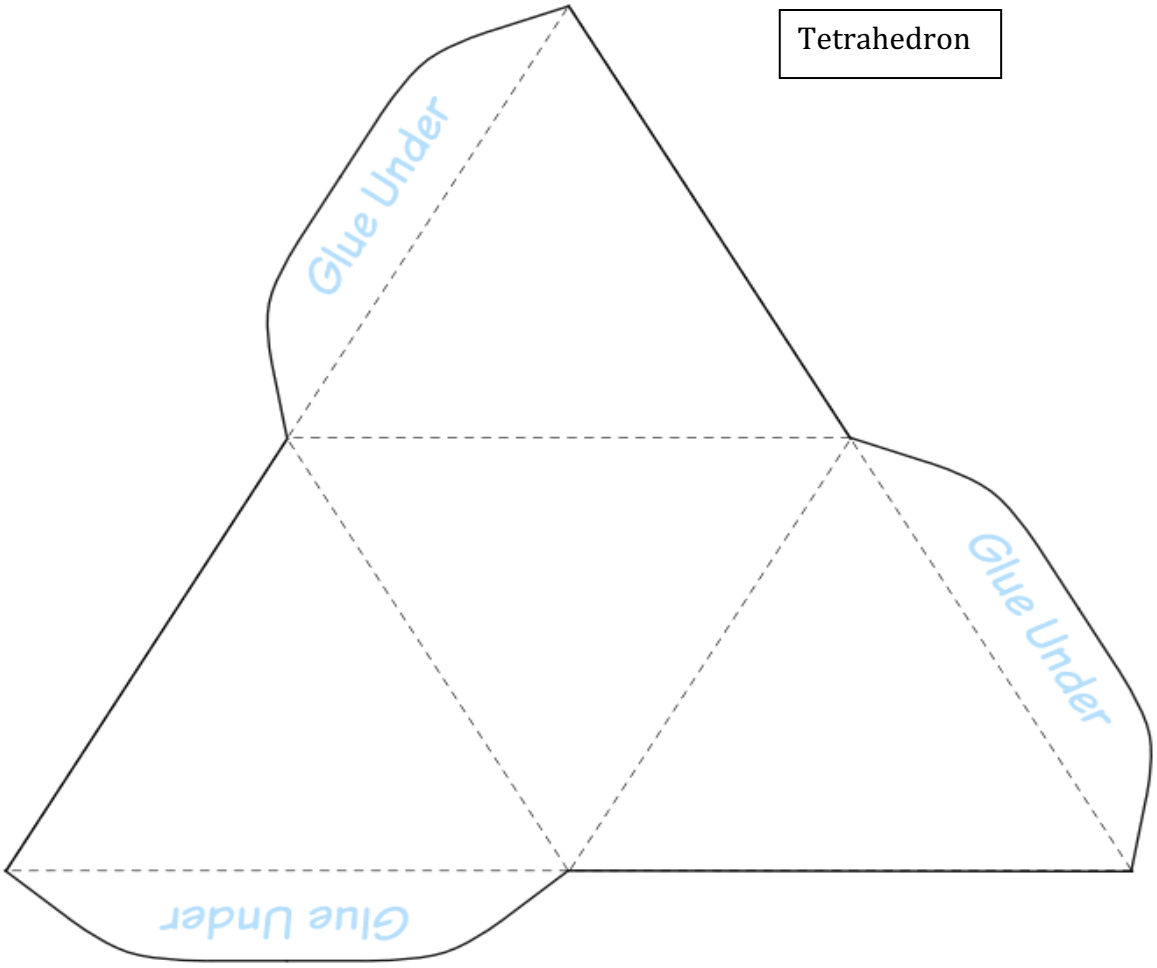
You can use sunlight or a torch or lamp to cast the shadows.
It is important to have solid objects for this activity. DO NOT do this activity using only pictures of solids. You must use actual solid objects. You can use anything in your house to make shadows, for example a mug, a coke can, a ball, a book. Collect solid objects from the kitchen or wherever you can find them, for example: packets and tins of various shapes.
Make models from scrap cardboard (see pages 2 - 6) then write their names on the solids to help you to remember the names. Print the names large and clear. You might hang your models from the ceiling. If you can't do that try to store them so that you can use them again.

MAKING MODELS OF THE 5 REGULAR SOLIDS

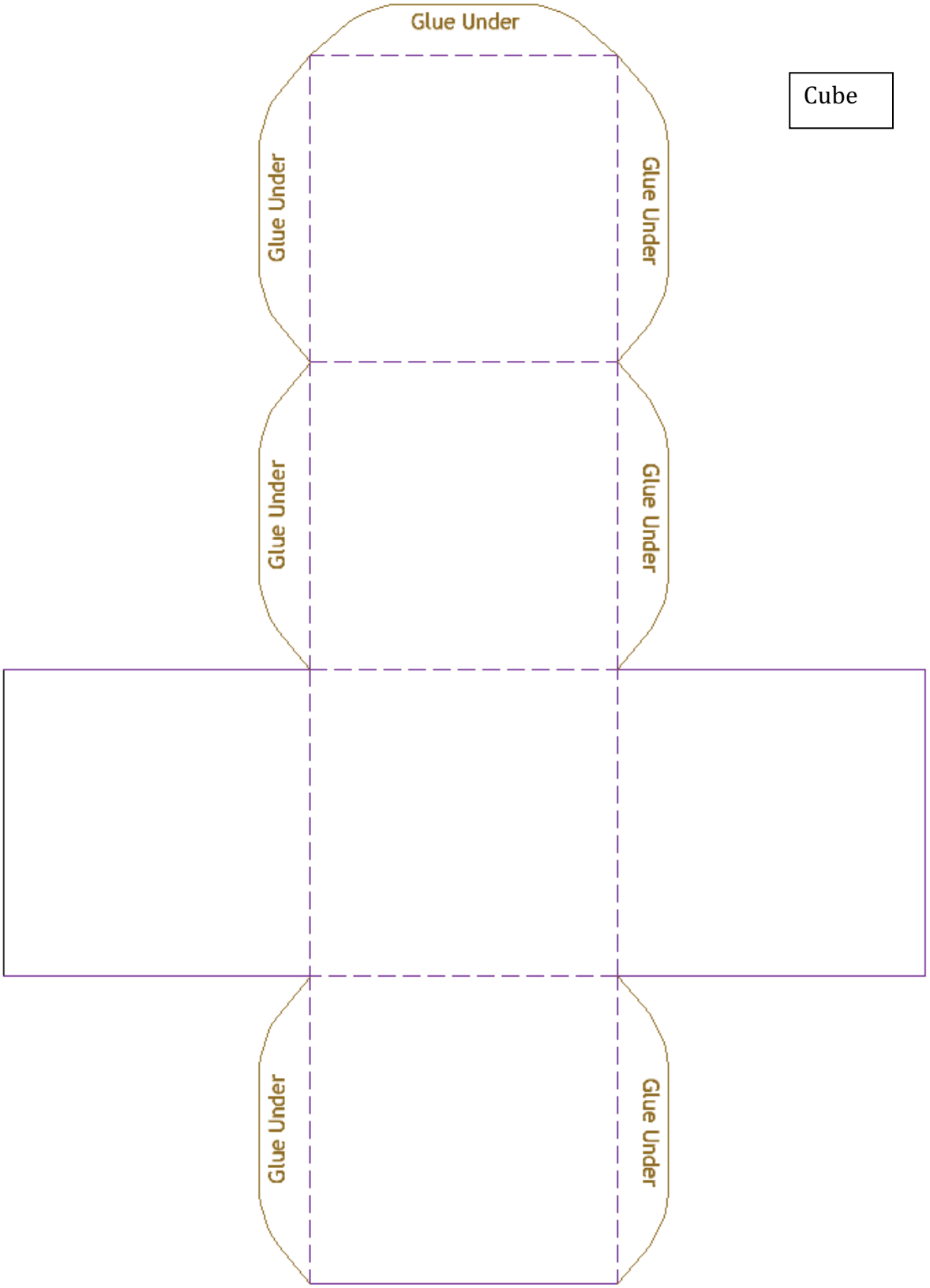
http://www.mathsisfun.com/platonic_solids.html

You can use scrap card (empty packets from your kitchen) to make the models using the nets below. Prick through the points on the nets and then copy the net onto your scrap card by joining the points you have drawn. For example you need to prick through 6 points for the 6 vertices of a tetrahedron.
Then cut out your net, crease all the edges and stick the flaps down to hold the solid in shape. Young learners will need help with this.

Tetrahedron



Cube


Glue Under
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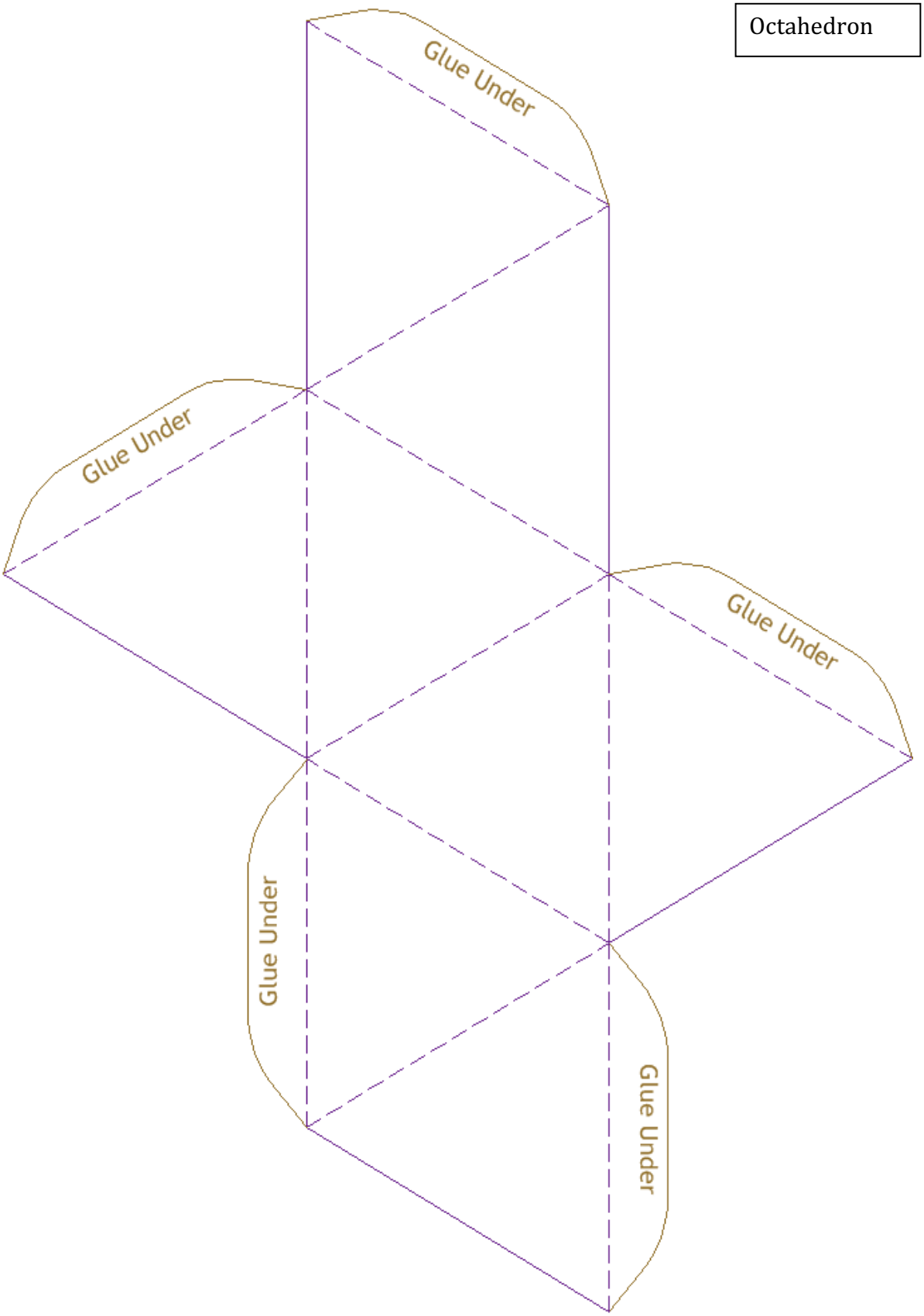
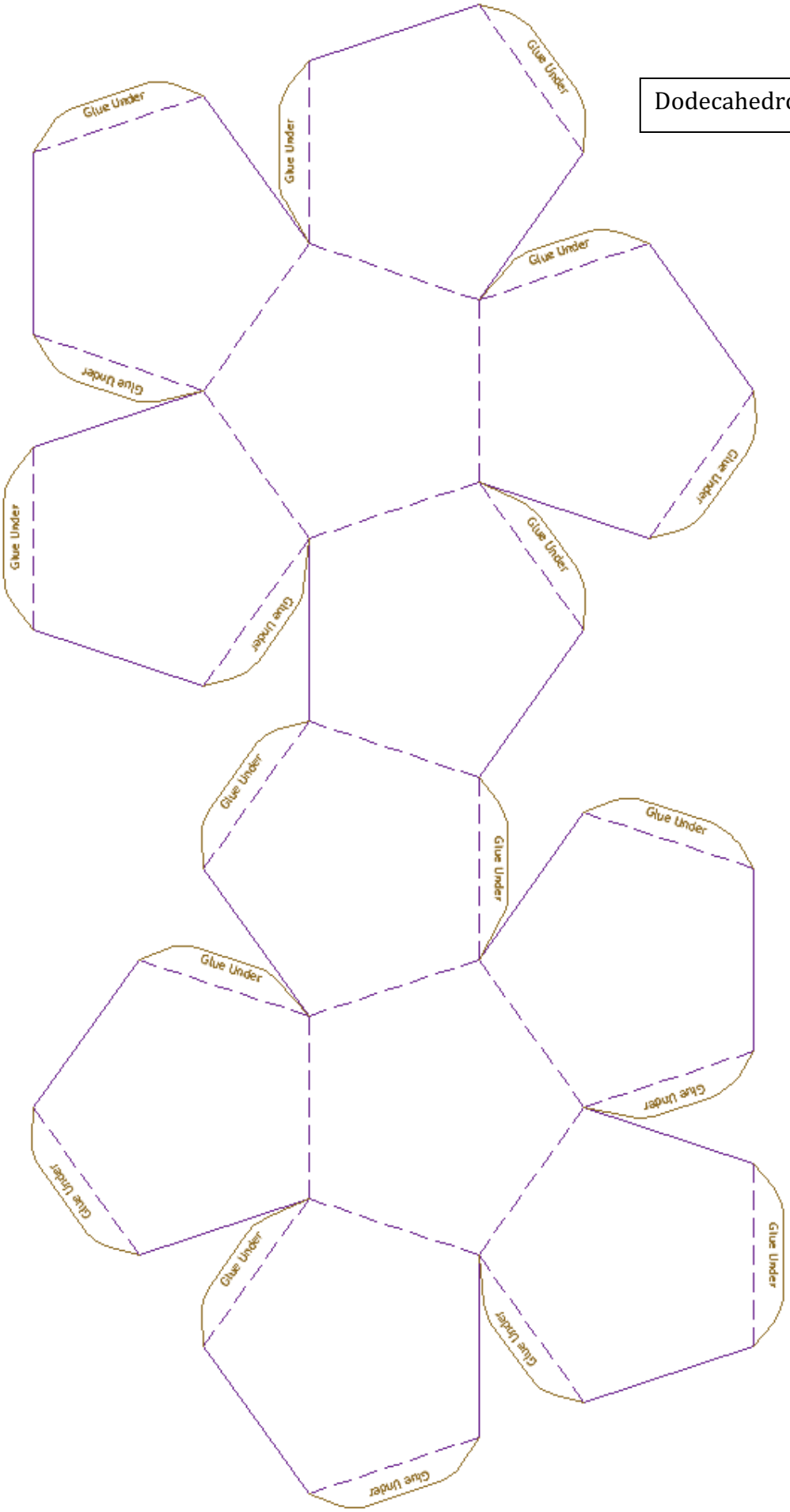
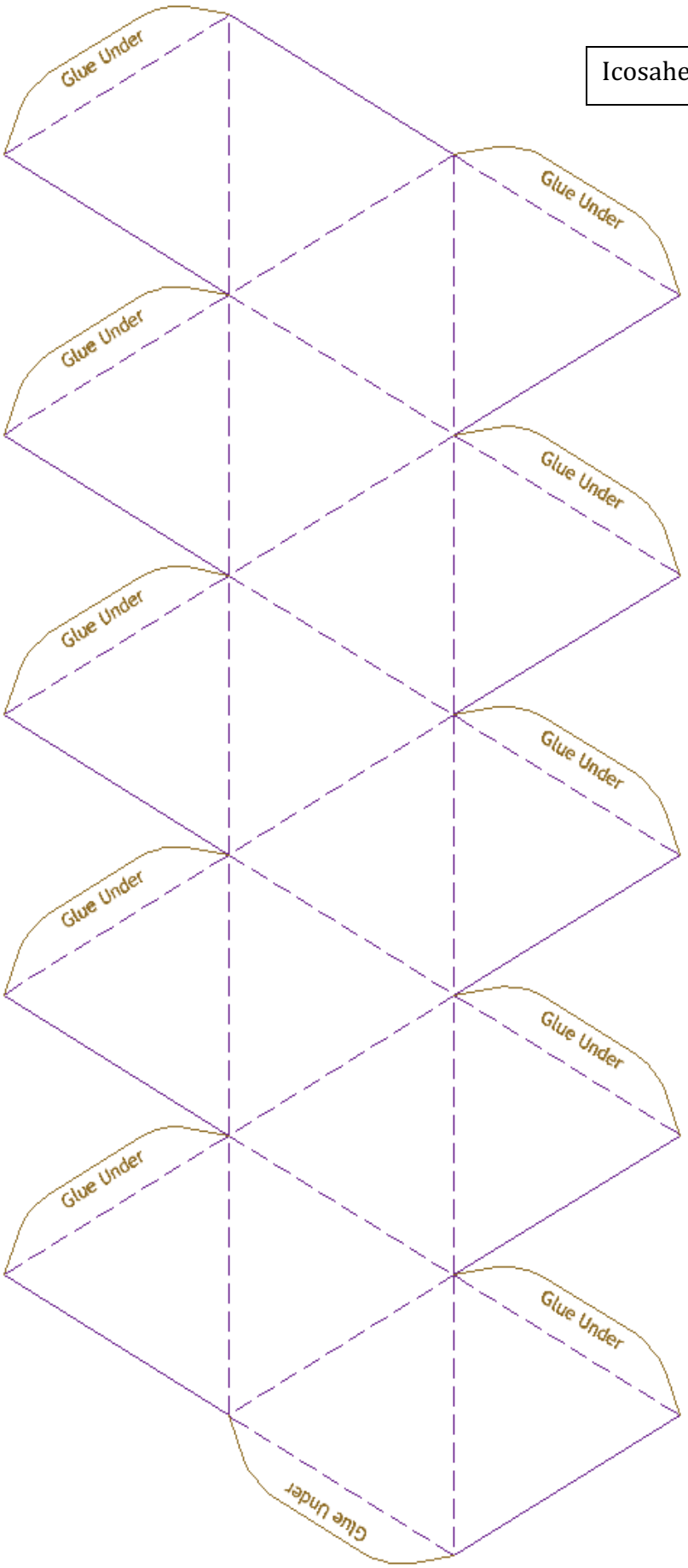
Octahedron



Dodecahedron



Icosahedron



NOTES FOR TEACHERS

SOLUTION

There are lots of solutions here.

Disc	Square	Triangle	Rectangle	
could be the shadow of:				
a circular plate (2D) a sphere a cylinder a cone. It could even be the shadow of a rugby ball if the longest axis of the ball is at right angles to the wall.	a flat (2D) square a cube a square prism (which is a special cuboid).	a flat (2D) triangle a tetrahedron (triangular pyramid) other pyramids a triangular prism a cone	a flat (2D) rectangle a cuboid a cylinder or any prism	Have you got any other ideas?

Why do this activity?

This activity helps learners to make connections between abstract ideas and concrete objects that they can handle and look at from different directions. It uses the learners' own experience of actually handling objects and experimenting.

Young children need a lot of experiences of working with concrete materials for their brains to develop powers of visualization and abstract thinking.

Learning objectives

In doing this activity students will have an opportunity to:

- learn the properties of 3D solids through handling the solids and discussing their properties;
- learn the properties of Platonic Polyhedra by making models and experimenting with making shadows;
- learn about transformations, similarity and scale factors by making shadows.

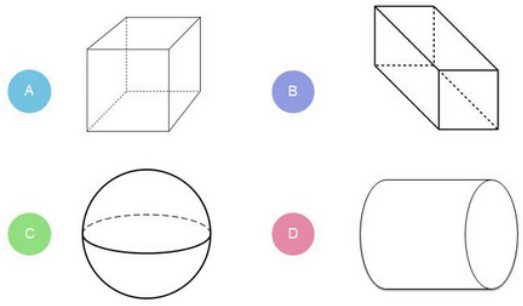
Generic competences

In doing this activity students will have an opportunity to **develop visualization** and skill to interpret or create images to represent concepts and situations.

Diagnostic Assessment This should take about 5–10 minutes.
Write the question on the board, say to the class:

"Put up 1 finger if you think the answer is A, 2 fingers for B, 3 for C and 4 for D".

Either ask: Which 3D shape is different from the others? Why?
or
Which 3D shape is not a prism?



1. Notice how the learners respond. Ask a learner who gave answer A to explain why he or she gave that answer and DO NOT say whether it is right or wrong but simply thank the learner for giving the answer.

2. Then do the same for answers B, C and D. Try to make sure that learners listen to these reasons and try to decide if their own answer was right or wrong.

3. Ask the class **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.

C. is the correct answer. Learners may say that the sphere is different because it has no flat faces, which is a good reason. Alternatively they might say that the other 3 shapes are all prisms. They are 'the same all the way through' or 'have the same cross section', that is if you cut them parallel to the end face the cut will always be the same shape.

Common Misconceptions

Many learners will just guess so it is important that they give reasons for their answers.
If the class has not met the word 'prism' they can still talk about the properties of the shapes and what happens if you cut through the shape. https://diagnosticquestions.com

Suggestions for teaching

Work as a class, encourage discussion and invite suggestions but do not indicate whether the suggestions are right or wrong. Instead invite the learners to say what might cast the shadow and then let them choose and test the solids that they think will make the shadow from the collection on display. They can check if their choice was correct by using sunlight or a torch to cast the shadow. Make lists on the board of the different objects that could have made each shadow.

Older learners can be expected to know the names and the properties of the shapes. This can be used as a revision activity for learners of any age. Many older learners have missed out on developmental experiences like this when they were younger, so this will also help them to make connections between concrete experience and abstract ideas.

Key questions

1. Can you think of any 2D objects that would cast a shadow like this?
2. Can you think of any 3D objects that would cast a shadow like this?
3. Can you see any objects on display that would cast this shadow?
4. Do you know the name of this object?
5. Are there any other objects that would cast this shadow?
6. Is the shadow the same size as the object?
7. Why does it make a difference if we hold the object nearer to the torch?
8. Does it make a difference if we turn the object around, if we hold the object at different angles to the wall?

Follow up

Viewing Cubes https://aiminghigh.aimssec.ac.za/grades-4-to-6-viewing-cubes/

Viewing Cubes Again https://aiminghigh.aimssec.ac.za/years-4-6-viewing-cubes-again/

How do you see it? https://aiminghigh.aimssec.ac.za/years-4-to-9-how-do-you-see-it/

MATHS TOYS

Go to the **AIMSSEC AIMING HIGH** website for lesson ideas, solutions and curriculum links: http://aiminghigh.aimssec.ac.za
Subscribe to the **MATHS TOYS YouTube Channel**
https://www.youtube.com/c/mathstoys
Download the whole AIMSSEC collection of resources to use offline with the **AIMSSEC App** see https://aimssec.app or find it on Google Play.

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 school years up to Secondary 5 in East Africa.
New material will be added for Secondary 6.
For resources for teaching A level mathematics (Years 12 and 13) see https://nrich.maths.org/12339
Mathematics taught in Year 13 (UK) & Secondary 6 (East Africa) is beyond the SA CAPS curriculum for Grade 12

	Lower Primary Approx. Age 5 to 8	Upper Primary Age 8 to 11	Lower Secondary Age 11 to 15	Upper Secondary Age 15+
South Africa	Grades R and 1 to 3	Grades 4 to 6	Grades 7 to 9	Grades 10 to 12
East Africa	Nursery and Primary 1 to 3	Primary 4 to 6	Secondary 1 to 3	Secondary 4 to 6
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