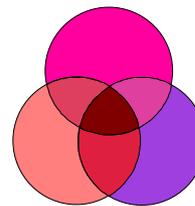


Crop Circle Geometry



UFO's, vandals or artists? Whoever makes crop circles can certainly do geometry!

Task A

In this task you will need access to the internet and paper and pencil to use for sketching. Read through the instructions (Nos 1 – 4) before you start using the computer so that you know what you will need to do and be able to choose the best designs for the task.

- 1 Go to one of the two websites whose addresses are given below and look at some of the crop circles listed.
- 2 Choose two of the crop circle designs and sketch them on paper.
- 3 Describe the designs using geometrical terms.
- 4 Say which of the two designs you prefer and why.

Crop Circle Websites

Look at The Noise Room Website or Busty Taylor's Website (or both if you've time).



The Noise Room Website

www.thenoiseroom.com

Choose Crop Circles and UFOs then one or more of the following options:

Discover the latest information on all this year's formations

This gives a table including date, place and thumbnail sketch of each crop circle. Selecting one of these sometimes gives an aerial photograph.

Look back at the formations of 1998

This gives a list of crop circles. Some have aerial photos, some have sketches and some are just described in words. Some of the best are listed below:

23 August Avebury



19 August	The Sanctuary near Avebury
10 August	Stanton St Bernard
8 August	Beckhampton
5 July	Danbury Hill, Nr Stockbridge
4 July	Dadford
19 June	Avebury Trusloe
18 June	Chisledon 2

Look back at the formations of 1997

Again this gives a list of crop circles. Some have aerial photos, some have sketches and some are just described in words. Some of the best are listed below:

20 August	Hackpen Hill
23 July	Silbury Hill
13 July	Bourton
9 June	Stonehenge
1 June	Winterbourne Bassett



Busty Taylor's Website

www.aviation-uk.com/cropper

This webpage gives a long list of files. Those ending with .jpg are aerial photographs or sketches of crop circles. Some of the best are listed below:

bugllb.jpg	starose4.jpg
buglld.jpg	9918.jpg
charlot9.jpg	9921.jpg
clan5.jpg	9925.jpg
eyeneck4.jpg	

Task B

This task involves constructing a geometrical design then studying its symmetries and transformations of some parts of it.

The instructions are given on separate sheets (pages 3 – 6).

Task C

Create a design of your own using geometrical equipment.

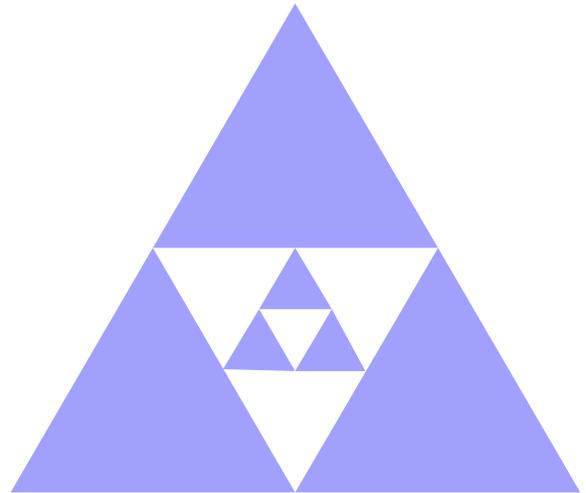
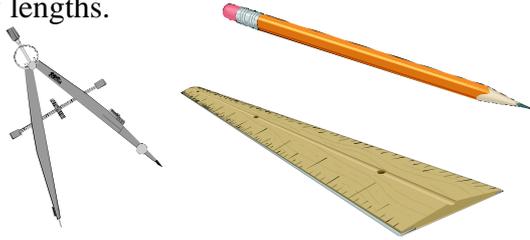
Write a list of instructions so that other people could recreate your design.

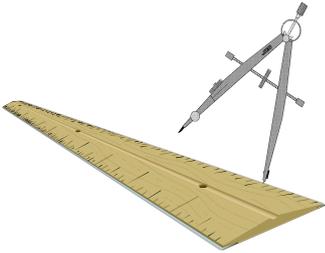
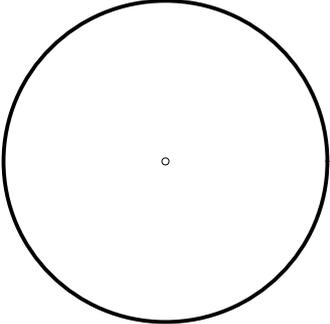
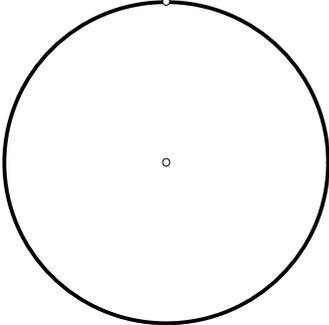
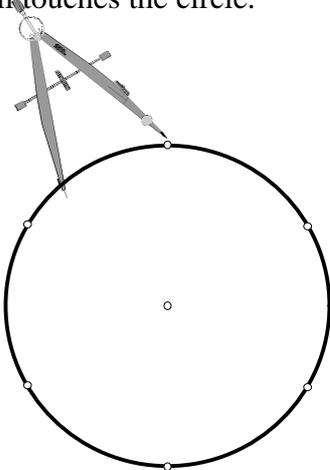
Describe your design in words. Include any symmetries.



Constructing a Geometrical Design

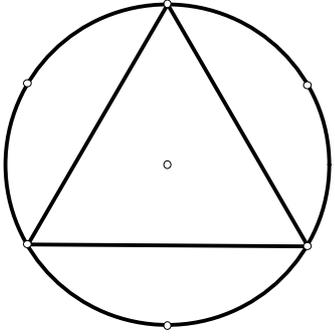
To complete this design use **only** a pair of compasses, a pencil and a straight edge – you do not need to use a ruler to measure any lengths.



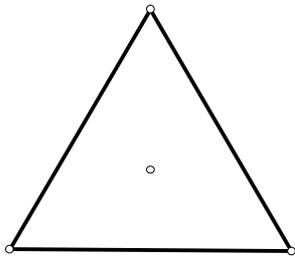
<p>1 Set your compasses to a fixed length and do not alter them.</p> 	<p>2 Draw a circle</p> 
<p>3 Choose a point on the circle.</p> 	<p>4 Use your compasses to step round the circle. Make a mark at each point where your pencil touches the circle.</p> 



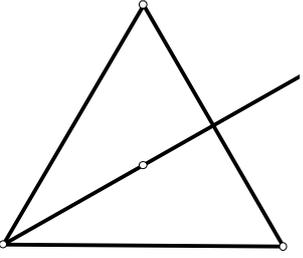
5
Join three of the points to form an equilateral triangle.



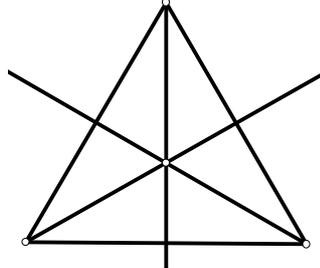
6



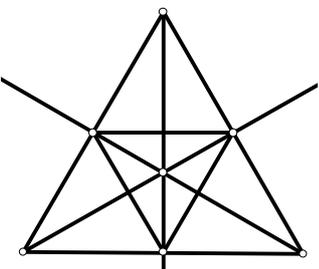
7
Draw a line passing through a vertex of the triangle and the centre of the circle.



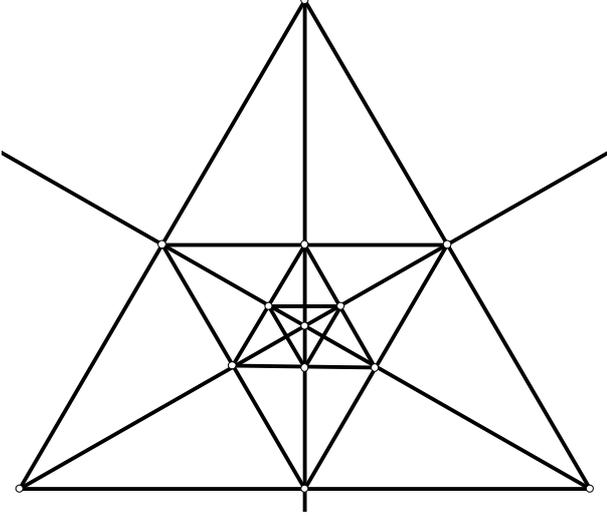
8
Draw the other two lines that do this.



9
Use the points where these lines cut the original triangle to draw a new equilateral triangle.

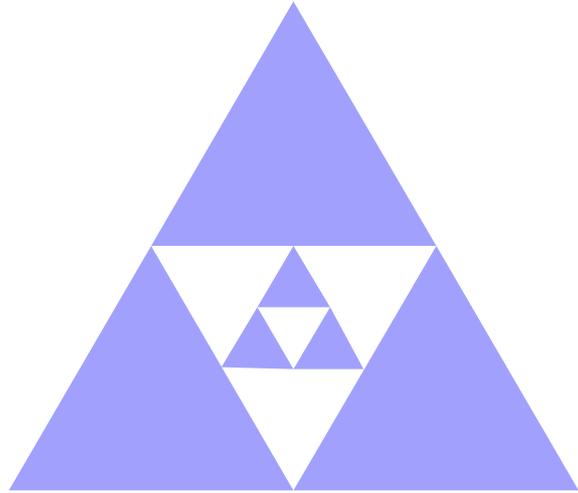


10
Continue the design by drawing triangles inside triangles.

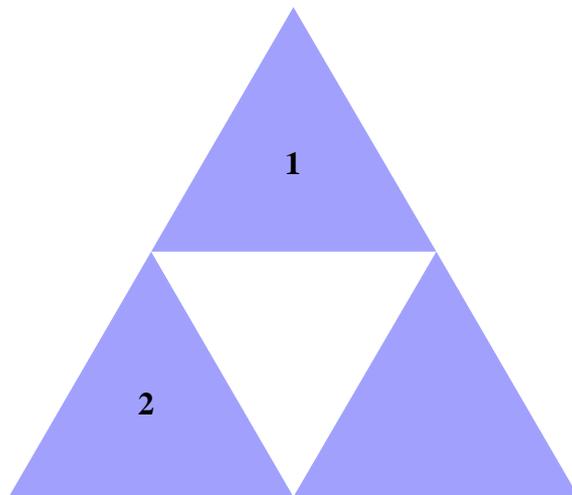



Symmetry and Transformations in the Geometrical Design

- 1 Draw all the lines of symmetry on the design given below.
- 2 What is the order of rotational symmetry of the design?
Find and mark the centre of rotation, O.

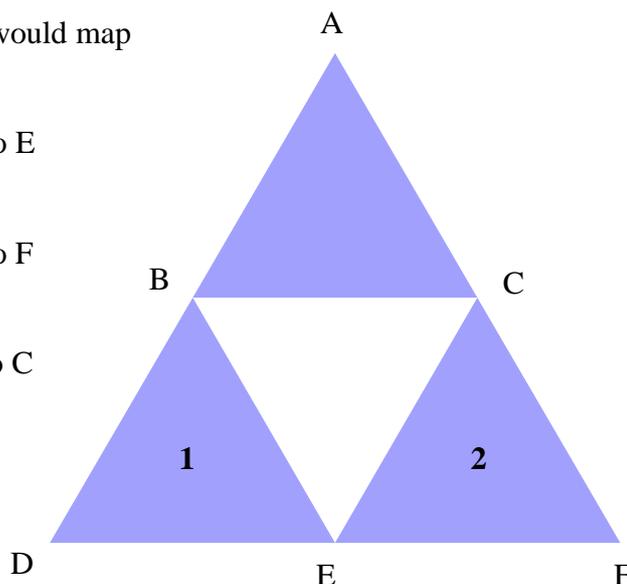


- 3 Which of these geometrical transformations could be used to map triangle 1 onto triangle 2?
 - a) translation
 - b) rotation
 - c) reflection

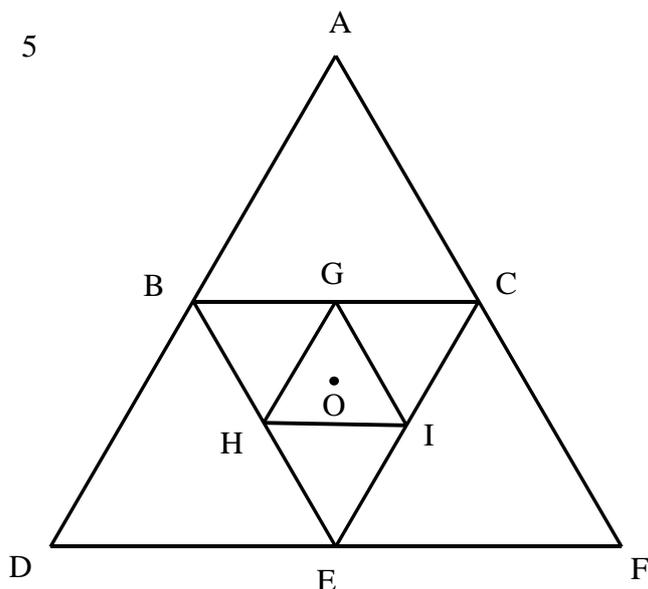


4 Describe fully the transformation that would map triangle 1 onto triangle 2:

- a) so that B maps onto C, D maps onto E and E maps onto F
- b) so that B maps onto C, D maps onto F and E maps onto E
- c) so that B maps onto F, D maps onto C and E maps onto E



5



Give the centre and scale factor for each of these enlargements:

- a) triangle ABC maps onto triangle ADF
- b) triangle CEF maps onto triangle ADF
- c) triangle GHI maps onto triangle ABC
- d) triangle GHI maps onto triangle CEF

6 Use the diagram given in question 5.

- a) In each of parts (i) to (vi) describe fully a transformation that would map triangle BGH onto the triangle given. Note that the order of the letters is important. For example, in part (i) B must map onto H, G onto I and H onto E, in part (ii) B must map onto I, G onto G and H onto H.
 - (i) triangle HIE
 - (iii) triangle HGI
 - (v) triangle BCE
 - (ii) triangle IGH
 - (iv) triangle EIH
 - (vi) triangle IEH
- b) More than one transformation is required to map triangle BGH onto triangle BCA. Describe a combination of two transformations that could be used.



Teacher Notes

Unit Intermediate Level, Solving problems in shape and space

Skills used in this activity:

- finding information from the internet
- sketching and constructing geometrical designs
- describing geometrical designs using geometrical terms and symmetry
- describing transformations

Preparation For the class you need:

- internet access
- worksheets (pages 1 – 6) for each student
- plain paper, tracing paper
- compasses, rulers, pencils etc. for construction work

Notes on the Activity

This activity consists of three tasks. You may wish to do the tasks in separate sessions. Task A requires students to look at some of the pictures of crop circles which are available on the internet. (Please note that websites are often updated – you may need to alter the worksheet occasionally.) Students are asked to sketch two patterns, describe them in geometrical terms and say which of the two they prefer. It is important that students have met the geometrical terms they may need (possibilities given below).

Geometrical terms

Angles – acute, right angle, obtuse, reflex

Triangles – equilateral, isosceles

Quadrilaterals – square, rectangle, rhombus, parallelogram, trapezium, kite

Polygons – regular, pentagon, hexagon, heptagon, octagon, nonagon, decagon

Lines and line segments – parallel, perpendicular

Other terms – bisect, bisector, perpendicular bisector, mid-point, similar, congruent

Task B involves construction work, symmetry and transformations and in Task C students are asked to produce their own design, describe it in words and write instructions to show how it was done.

N.B. It should be emphasised to students that farmers are usually not happy about the appearance of crop circles on their land and that it is a criminal offence to destroy crops. Any student wanting to try making a real crop circle must have the permission of the owner of the land.

Alternatives/Extensions

Students could be asked to draw *accurate* scale drawings where the dimensions of the crop circles are known. However the constructions are often very difficult and students working at Intermediate Level are likely to need help with the most of them. A complex construction that can be used with more able students is given in the activity **Pentagon** (also available from the Nuffield website).

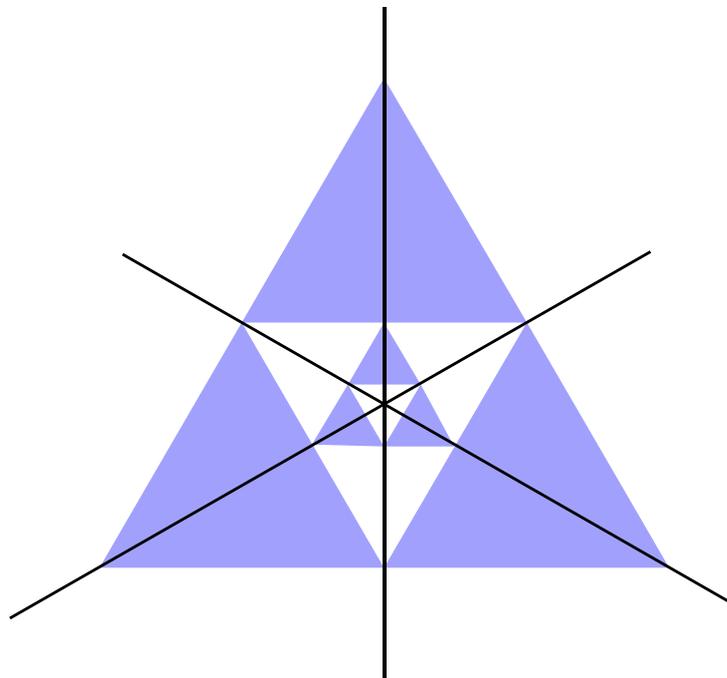


Answers to Symmetry and Transformations in the Geometrical Design

1 Lines of symmetry are as shown.

2 Order of rotational symmetry 3.
Centre of rotational symmetry, O,
is the point of intersection of the
lines of symmetry.

3 a, b, c are all possible.



4 a) translation to the right by a distance equal to DE
b) reflection in AE
c) clockwise rotation of 120° about E (or anti-clockwise rotation of 240° about E)

5 a) enlargement, centre A, scale factor 2
b) enlargement, centre F, scale factor 2
c) enlargement, centre O, scale factor 4
d) enlargement, centre B, scale factor 2.

6 a) (i) translation in the direction of and equal in distance to BH
(ii) reflection in GH
(iii) anti-clockwise rotation of 60° about G
(or clockwise rotation of 300° about G)
(iv) reflection in HC
(v) enlargement, centre B, scale factor 2
(vi) clockwise rotation of 120° about H
(or anti-clockwise rotation of 240° about H)

b) enlargement, centre B, scale factor 2 and reflection in BC
(either order)

