

ISBN-10: 1-874428-54-9

ISBN-13: 978-1-874428-54-1

Sample topic

from the

Y7 Big Edd Guide

to the National Curriculum

**You have permission to print off this topic
and try it with your students.**

This document contains the complete topic (p01-21) and answers (p22-25)

Teachers' notes, worksheets, Star Challenge answers, revision and assessment for this topic can be downloaded and printed off in the **Y7 Big Edd Resource Sample** document.



Big Edd

ENJOYMENT

The 'Maths is ...' Jugglers

Knowledge

Skills

Understanding

The Big Edd Guide

to the
National Curriculum

Topic 4 Shape

CONTENTS

- Section 1: Triangles
- Section 2: Rectangles and squares
- Section 3: Quadrilaterals
- Section 4: More polygons
- Section 5: Circles
- Section 6: Tessellations
- Section 7: High level challenges

Worksheets are required for :

- p07: Star Challenge 10 : Diagonals
- p10: Star Challenge 13 : Lost shapes
- Specialist papers that are in the Sample Resource Pack:
 - p1,7: 3 x 3 spotty paper
 - p3,8,17: 4 x 4 spotty paper
 - p9,14,16: triangular spotty paper

The Big Edd Guide (Y7) and The Fission Guide (Y8) are **the original texts** that motivated both Teachers and Students - and markedly raised the attainment, in so many schools.

These texts form a two year course. They deliver Levels 4–6 and dip into Level 7.

Big Edd and Fission provide **a sound broad based course** with **the accent on extension**, rather than acceleration. Basic techniques are taught/reinforced and plenty of practice given, but the accent is on problem-solving skills and enjoyment of mathematics. Students are encouraged and enabled to tackle difficult problems.



CONTENTS OF THE BIG EDD GUIDE

Topic Title	Main Sections	High Level Challenges	
Sum Number Fun	pp05 – 30	pp31 – 38	
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ANSWERS	pp275 – 304		

All the topics are independent.
They can be done in any order.

THE BIG EDD GUIDE

At the end of each topic is a section of
HIGH LEVEL CHALLENGES.

Able students are expected to tackle these Challenges
when they have finished a section
(rather than moving onto the next section).

They can also do them in their own time.

Some of these challenges have section labels.
These indicate which section should have been completed
before that challenge should be attempted.

At the end of the book is a section of
MISCELLANEOUS HIGH LEVEL CHALLENGES.

These are not linked to any topics in the book
and can be done at any times and in any order.
They range from short problems to fairly lengthy problems,
to linked sets of problems.

The **High Level Challenges** were first used in the highly successful *Big Edd Guide*.

At Tarporley High School, students in our two top sets loved them. Almost all top set students did every High Level Challenge. Many completed all 152 of them before the end of the year, and came back and asked for more. (So there are now 200 in *Headbanger*.)

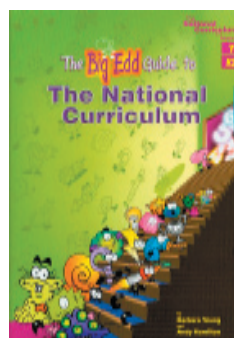
But, unexpectedly, many of the students in our two second sets tackled a lot of these problems with great enthusiasm. These students had successes with puzzles and problems that we had thought well beyond them. Confidence and motivation soared and, later, so did exam results.

Other schools using this material report similar reactions.

There are two versions of our Y7 National Curriculum Mathematics Course.

The mainstream course (*The Big Edd Guide*) is suitable for the upper 60% of students.

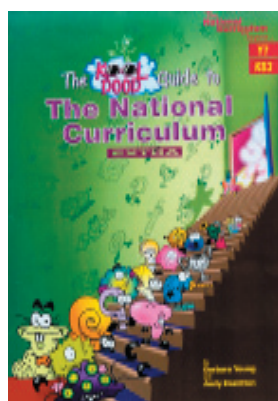
For able students, the *Big Edd Guide* contains **High Level Challenges** which are linked to the topics being studied and the **Miscellaneous High Level Challenges** which are independent of the topics being studied.



A5 text

ISBN-10: 1-874428-54-9

ISBN-13: 978-1-874428-54-1



A4 text

ISBN-10: 1-874428-72-7

ISBN-13: 978-1-874428-72-5

The **EXTRA** course (*The Kooldood Guide*) is suitable for the lower 60% of students.

For low attainers, the *Kooldood Guide* develops one idea at a time, before combining several ideas that have just been learnt. It also contains **EXTRA** rote practice exercises.

Order a **half price** copy of Y7 Big Edd and/or Y7 Kooldood using the Special Offer form which can be downloaded from the website www.mathsisjugglers.co.uk

The KOOLDOOD Guide **EXTRA**

An unusual approach to Mathematics for Low Attainers – that works !!

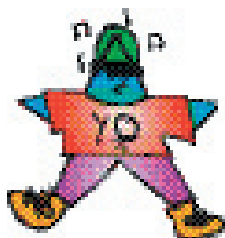
Students in our lower sets said

“We don’t want a course that only does the easy stuff (a ‘dumbo’ course).

We want to do the same work as everyone else.

- So, will you please:
- make the instructions and explanations clearer
 - introduce ideas more slowly and put in extra steps
 - put in extra practice
 - make the work interesting”

SO WE DID !



Our EXTRA texts for LOW ATTAINERS do not follow the route of so many other texts for these students.

Instead of giving them lots of easy material, we took the syllabus and delivered it in such a way that LOW ATTAINERS could understand and cope with the ideas and techniques.

We gave them what they had asked for !!

But we couldn’t have produced these texts had it not been for the active help of the students themselves. We started with the mainstream texts and students really enjoyed finding out what didn’t work for them - but, more importantly, WHY!! They quickly became expert at pinpointing where the material didn’t work for them and helping to find what would work for them.

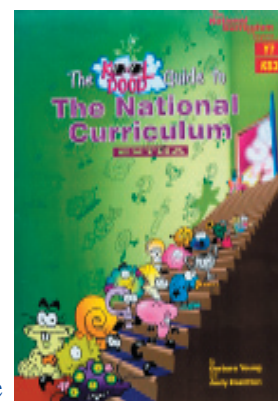
Devising ways that would work took a lot of working/trialling with LOW ATTAINERS, but we ended up with the EXTRA texts – which work exceptionally well, particularly with bottom sets, disaffected students and students at Pupil Referral Units.

This **EXTRA** course :

- has been specially developed for low attainers
- is a version of the Y7 mainstream course
- has lots of EXTRA practice on all techniques
- can be run alongside the mainstream course
- can stand on its own
- is suitable for the lower 50% of the ability range

Each student:

- takes responsibility for his/her own learning
- can decide how much practice (s)he needs to do for each technique
- can try Star Challenges when (s)he feels ready for them
- will be capable of taking the mainstream tests



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The authors firmly believe that all students can tackle the material in the mainstream course. However, some students need :

- more time to get to grips with the ideas and techniques involved
- lots of EXTRA practice
- one idea at a time introduced step-by-step
- to meet ideas and techniques over and over again

Most students in lower sets are underachieving.
This course aims to raise the level of achievement of these students.
Students can transfer to or from the mainstream course.

How does the Star Challenge system work ?

The number of stars is a measure of the difficulty of the Challenge.

So, one star denotes a basic fairly easy challenge.

However, students should not be discouraged from attempting any Challenges.

For example, students may earn fewer stars from many two or three star challenges, with partially correct answers.

Students of lower ability can amaze you with what they can achieve, if they really want to tackle problems that you might think beyond them.

A true cautionary tale

Three very low ability students were working together. They had to. Mark was severely dyslexic - he could not read at all. Jason could read very well, but could make no sense of what he was reading. Matthew was very slow at everything. Between them, they could tackle problems.


Jason would read the question. Mark would explain what it was all about. Together the three of them would work out how to solve the problem.

One day they had done all the one star problems. They asked me if they could try the three star problem - The Chest of Drawers. It contained a mixture of fractions and decimals and both cm and mm. My first reaction was to tell them that it was too difficult for them - but I said they could try it, provided they accepted that they might not be able to do it.

About ten minutes later, they brought me the correct answer. I couldn't believe that they had solved such a complex problem. I changed the data (marked below in blue). They were back a few minutes later with the correct answer. Then I made a big mistake. I asked them to tell me how they had worked it out. I couldn't follow their explanation at all !!

From then on I never restricted the choice of Star Challenges of even the least able students.

Star Challenge

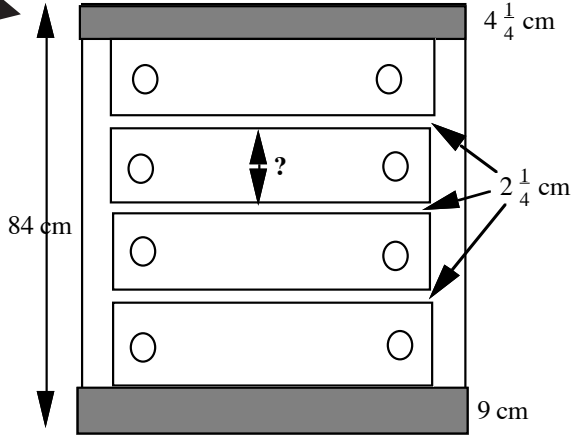


The chest of drawers

A chest of drawers 84 cm high has a 42.5 mm top and a 90 mm base. Four identical drawers fit in between, with 22.5 mm between each drawer.

Work out the height of each drawer in cm.

If the 22.5 mm gaps were reduced to 12.5 mm each, what would be the height of each drawer then?



What do schools do with the stars students earn for Star Challenges ?

One school:

- gives a house point for each star.
- has a commendation system and awards a commendation for so many stars. They also award stars for effort when the books are taken in each fortnight.
- gives a smiley face for 5 stars
- gives a Mars Bar for 10 stars
- gives a copy of one of a group of Chaos posters for 20 stars (very popular with low attainers)
-

It doesn't matter what you do. It is the sense of achievement that is most important.

However, a system that awards something for so many stars, then starts them collecting the next set of stars, means that students keep track of how many stars they have and how many more they need towards the next 'prize' – instead of (possibly invidious) comparisons of the total number of stars each student has.



THE NATIONAL CURRICULUM ...
... AND BEYOND ...

The Big Edd Guide *to the* National Curriculum

Big Edd

Shape

By the end of this topic, you should be able to:

- Level 3
 - classify triangles
- Level 4
 - recognise congruent triangles
 - make a tessellation
 - construct circles to fit given information
- Level 5
 - construct equilateral triangles
- Level 6
 - name geometric shapes
 - draw named quadrilaterals

Shape

Section 1: Triangles

In this section you will:

- learn what is meant by congruent shapes
- learn what is meant when you are asked to find 'different' shapes
- make and classify triangles.

DEVELOPMENT

D1: Congruent triangles

3x3 geoboard 3x3 spotty paper

These two triangles are **congruent triangles**.
They are the **same shape** and the **same size**.

1. Make 4 more triangles that are congruent to these two triangles. Draw them on the spotty paper.

2. Make 3 triangles that are congruent to this triangle. Draw them on the spotty paper.

Congruent means 'exactly the same'



- You must ask your teacher if your triangles are congruent, **BEFORE DOING D2**.

D2: Classifying triangles

3x3 geoboard 3x3 spotty paper

You can recognise triangles that are the same (congruent).
Now you are going to make triangles that are **all different**.

Task 1: There are 8 possible different triangles that can be made on a 3 x 3 geoboard. Make all 8.

When you have made them, ask your teacher to check that they are all different, before doing Task 2.

An **equilateral triangle** has 3 equal sides.

An **isosceles triangle** has two equal sides.

Scalene triangles have sides of different lengths.

Right angled triangles have one angle which is a right angle.

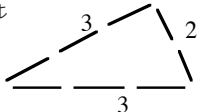
Task 2: Under each of your triangles, write what kind it is.

- Your teacher will need to check these.

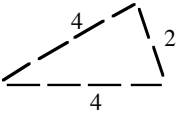
PRACTICE

P1: Matchstick triangles

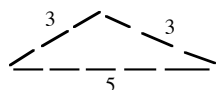
There is only one triangle that can be made with 8 matches. It is an isosceles triangle. It is a 3 3 2 triangle.



1. Make an equilateral triangle with 9 matches. Draw it.
2. Make a scalene triangle with 9 matches. Draw it.
3. Explain why you *cannot* make a 2 3 1 triangle?
4. This is an isosceles triangle made using 10 matches. Make a different triangle using 10 matches. Draw it. Under the triangle, write what kind it is.



5. This is one kind of triangle that can be made using 11 matches. Make three different triangles, each using 11 matches. Draw them. Under each triangle, write what kind it is.



• Check your answers.

Star Challenge

11 marks = 2 stars
9-10 marks = 1 star

6. Make three different triangles, each using 12 matches. Draw them. Under each triangle, write what kind it is.
 7. Imagine that you have a number of matches. You count the matches. How can you tell, just by the number, whether you can make an equilateral triangle? (2 marks)
- Your teacher will need to mark these.

(1 mark for each correct triangle. 2 marks for each correct classification.)

P2: Show me how...

Show me how...

1. ... to divide a square into 2 identical right-angled isosceles triangles using 1 straight line.
2. ... to divide a square into 4 identical right-angled isosceles triangles using 2 straight lines.
3. ... to divide a square into 8 identical right-angled isosceles triangles.
4. ... to divide a square into 16 identical right-angled isosceles triangles.
5. Copy and complete this table :

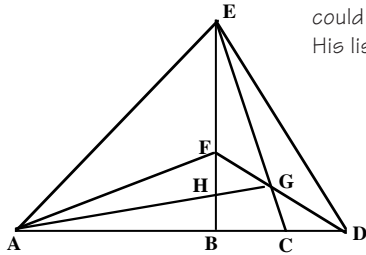
number of Δ s	2	4	8	16
number of lines	1			

6. How many lines would you use to divide a square into 64 right angled triangles ?
- Check your answers.

Star Challenge 2.2

23 triangles = 2 stars
15-22 triangles = 1 star

Can you beat Kazuo ?



Kazuo made a list of all the triangles he could find in this diagram.
His list started ABE
ABF
ABH
ACE.....
He found 15 triangles.
His sister, Mio, said that she could find 23 triangles.

How many can you find ?

[If you label your triangles in alphabetical order (that is ABE rather than EBA) it will make them easier to check.]

• Your teacher has the answers to this.

Star Challenge 3.3

5 marks = 2 stars
4 marks = 1 star

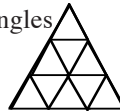
Equilateral triangle puzzles

Task 1:

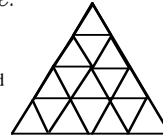


There are 5 equilateral triangles in this triangle.

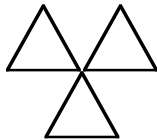
How many equilateral triangles are there in each of these two triangles ? (2 marks)



and



Task 2:



Arrange nine matches (as shown) to form three equilateral triangles.

Now move three matches only to make five equilateral triangles. (2 marks)

Task 3:

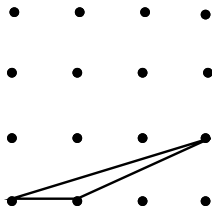
Arrange 6 matches to make 4 equilateral triangles. (2 marks)

• Your teacher has the answers to these.

Star Challenge 4.4.4

27 (or more) triangles = 3 stars
24-26 triangles = 2 stars
20-23 triangles = 1 star

Triangle challenge !



A class of 15 year-olds were asked to find as many different triangles as possible that could be made on a 4 by 4 geoboard.

They found 27 different triangles.

How many can you find ?

4x4 spotty paper

4x4 geoboard

• Your teacher has the answers to these.

Section 2: Rectangles and squares

In this section you will investigate some properties of rectangles and squares.

DEVELOPMENT

D1: Truths, untruths and halftruths

Small groups leading back to whole class discussion.

For each of these, state whether it is always true, never true, sometimes true ?

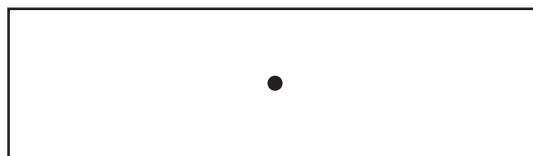
A1: A rectangle has 4 straight sides.	A2: Shapes that have 4 straight sides are rectangles.
B1: A rectangle has 2 pairs of equal sides.	B2: Shapes that have 2 pairs of equal sides are rectangles.
C1: The opposite sides of a rectangle are parallel.	C2: Shapes with opposite sides parallel are rectangles.
D1: A rectangle has 4 right angles.	D2: Shapes with 4 right angles are rectangles.
E1: A square is a rectangle.	E2: A rectangle is a square.



Headbanger

D2: Finding the exact centre of a rectangle

In a craft lesson, Sara needs to drill a hole exactly in the centre of a rectangular piece of metal.



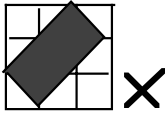
Find several different methods of getting the exact centre of the rectangle.

Get your teacher to draw each method on the board for you.

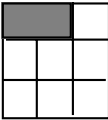
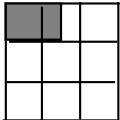
Discuss which is the best method.

D3: How many different rectangles can you find? Individual work

Rules: Rectangles must cover whole squares



Rectangles can go across or up/down - but not diagonally

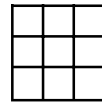



Task 1: Make 6 copies of this 3 by 3 grid.

There are six different shaped rectangles that you can draw on this grid. Find all 6.

Shade one on each grid.

- Check your answers.



Kooldood



Remember: a square is a rectangle

Star Challenge **5** **5**

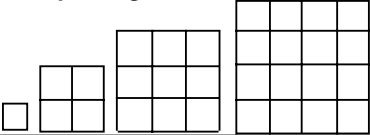
Task 2: There are 10 different rectangles that can be drawn on a 4 by 4 grid. How many can you find? Draw them!

- Your teacher has the answers to these.

PRACTICE

P1: Systematic counting

1. Copy and complete this table for each of the squares:



Number of 1 by 1 squares	1	4		
Number of 2 by 2 squares	0	1		
Number of 3 by 3 squares	0	0		
Number of 4 by 4 squares	0	0		
Total number of squares	1	5		

- Check your answers

Star Challenge **6**

- Without drawing it, predict the total number of squares in a 5 by 5 square.
- Without drawing it, predict the total number of squares in a 10 by 10 square.

- Your teacher has the answers to these.

Star Challenge

7/7

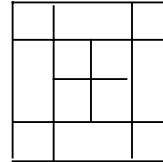
17 marks = 2 stars
11-16 marks = 1 star

Square problems

Task 1:

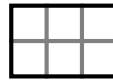
How many squares can you find in this diagram ?

You must not draw in any more lines. (3 marks)

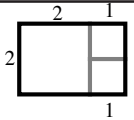


Task 2:

A 2 by 3 rectangle can be covered in squares in two different ways :



6 squares



3 squares

1. What is the smallest number of squares needed to cover a 2 by 4 rectangle ? Show how you do it. (2 marks: 1 for the number and 1 for the diagram)
2. What is the smallest number of squares needed to cover a 2 by 5 rectangle ? Show how you do it. (2 marks: 1 for the number and 1 for the diagram)
3. What is the smallest number of squares needed to cover an 8 by 6 rectangle? Show how you do it. (2 marks: 1 for the number and 1 for the diagram)
4. What is the smallest number of squares needed to cover a 10 by 6 rectangle? Show how you do it. (2 marks: 1 for the number and 1 for the diagram)
5. Show how you can cover an 8 by 5 rectangle with 5 squares. (3 marks)
6. Show how you can cover a 13 by 8 rectangle with just 6 squares. (3 marks)

• Your teacher will need to mark these.

Star Challenge

8/8

12-13 marks = 2 stars
6-10 marks = 1 star

Square dissections

This square has been dissected into four congruent smaller squares.

• Your teacher will need to mark these.



Dissect a square into 4 congruent pieces which are ...

1. ... rectangles (1 mark)
2. ... isosceles triangles (2 marks)
3. ... T shapes (3 marks)
4. ... L shapes (3 marks)
5. ... shapes bounded by two straight lines and two semicircles (4 marks)

This square has been dissected into four congruent shapes each bounded by one straight line and two quarter circles.

Section 3: Quadrilaterals

In this section you will make and classify quadrilaterals.

DEVELOPMENT

All individual work

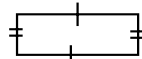


A **polygon** is a flat shape with straight sides
 A **triangle** is a polygon with 3 sides
 A **quadrilateral** is a polygon with 4 sides

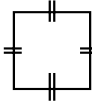
Star Challenge 9.9

30-32 marks = 2 stars
 22-29 marks = 1 star

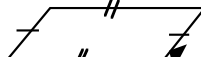
A **quadrilateral** has 4 straight sides



rectangle

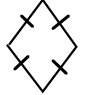


square

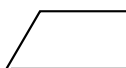


parallelogram

Sides with the same marking are equal in length.



rhombus (diamond)

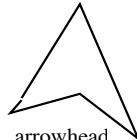


trapezium

A trapezium has just one pair of parallel sides.

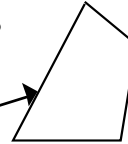


kite



arrowhead

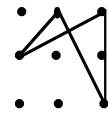
But, there are also quadrilaterals which have no name, for example



1 mark for each different quadrilateral
 1 mark for each correct name.

Classifying quadrilaterals

- There are 16 possible *different* quadrilaterals that you can make on a 3 by 3 geoboard. Find as many as you can. Draw them on 3 by 3 spotty paper.
 - You may ask your teacher to check that they are all different.
- Name as many of your quadrilaterals as possible. If they have no name, write "no name".
 - Your teacher will need to mark these.



This is a 'crossed quadrilateral'. It is not allowed.

Star Challenge 10

14-16 correct names = 1 star

Diagonals

On the worksheet are diagonals of quadrilaterals.

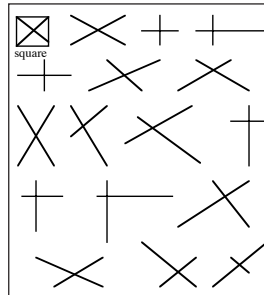
Draw the quadrilaterals.

The first one has been done for you.

Name the quadrilaterals.

There are two that have no name.

- Your teacher will need to mark these.



Inaspin

Star Challenge



38 marks = 4 stars
 34-37 marks = 3 stars
 30-33 marks = 2 stars
 28-29 marks = 1 star

Quadrilateral challenge

Make the following shapes.
 They must each fit on a 4 by 4 geoboard.
 Draw them on 4 by 4 spotty paper.
 Shade them in.

4x4 spotty paper
 4x4 geoboard

1. 4 different rectangles which are not squares. (4 marks)
2. 5 different squares (5 marks)
3. 4 different kites (4 marks)
4. 5 different arrowheads (there are at least 12) (5 marks)
5. 10 different parallelograms which are not rectangles or squares (10 marks)
6. one rhombus which is not a square (3 marks)
7. as many different trapezia as you can

TARGETS	8 trapezia	good	(4 marks)
	10 trapezia	very good	(5 marks)
	12 trapezia	excellent	(6 marks)
	14 or more	brilliant	(7 marks)

one trapezium
 two trapezia



• Your teacher has the answers to these.

Star Challenge



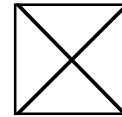
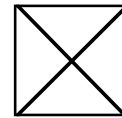
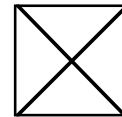
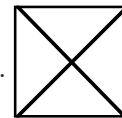
All correct = 1 star

Take 4 triangles and make ...



paste

1. Draw a square of side 8 cm on a piece of paper.
 Cut it out.
 Cut along the diagonals to make 4 right-angled triangles.
 Arrange the 4 pieces to make a **triangle**.
 Stick them in your book.
2. Draw and cut another square in the same way.
 Make a **rectangle** with the four triangles.
 Stick the rectangle in your book.
3. Draw and cut another square.
 Make a **parallelogram** from the triangles.
 Stick it in your book.
4. Draw and cut another square.
 Make a **trapezium** from the triangles.
 Stick it in your book.



• Your teacher has the answers to these.

Section 4: More polygons

In this section you will:

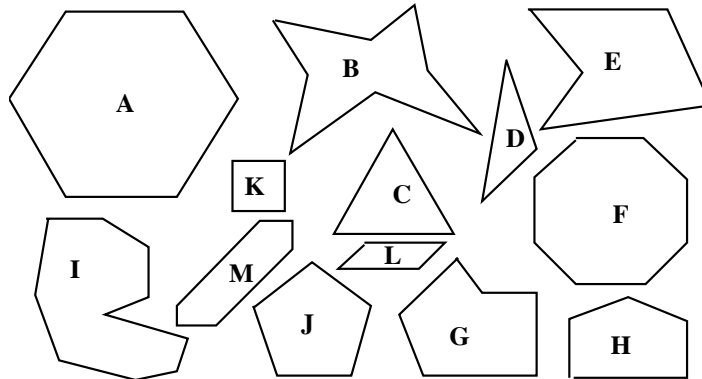
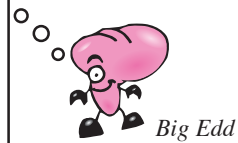
- learn to recognise different sorts of polygons
- construct equilateral triangles and regular hexagons.

DEVELOPMENT

All individual work

D1: Can you find ... ?

A **polygon** is a flat shape with straight sides
 A **triangle** is a polygon with 3 sides
 A **quadrilateral** is a polygon with 4 sides
 A **pentagon** is a polygon with 5 sides
 A **hexagon** is a polygon with 6 sides
 An **octagon** is a polygon with 8 sides
 A **decagon** is a polygon with 10 sides
 A **regular polygon** has equal sides and equal angles



Can you find...

(Write down their letters)

- | | | |
|----------------------------------|--------------------------|--------------------------|
| 1. ...3 pentagons | 2. ...3 hexagons | 3.2 octagons |
| 4. ...1 decagon | 5. ...2 quadrilaterals | 6. ...a regular octagon |
| 7. ...a regular hexagon | 8. ...a regular pentagon | 9. ...a regular triangle |
| 10. ...a regular quadrilateral ? | | • Check your answers. |

D2: Make a regular hexagon *triangular spotty paper* ✂ *paste*

1. Join some of the dots to make an equilateral triangle whose sides are 2 cm long. Make six of these equilateral triangles. Cut them out.
2. Make a regular hexagon with your six triangles. Stick it in your book.

• Check your shape with the answers.

D3: Compass constructions

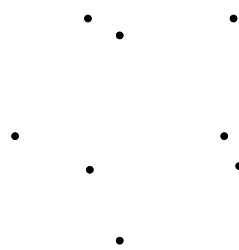


- Draw a line 4 cm long across the middle of your paper.
Using a pair of compasses, construct an equilateral triangle whose sides are 4 cm long.
Leave the compass marks on the diagram. If you need help, talk to your teacher.
- In the same way, construct 6 equilateral triangles with sides 4 cm long, so that they make a regular hexagon.
Leave the compass marks on the diagram. • Show the hexagon to your teacher.

Star Challenge 13 13

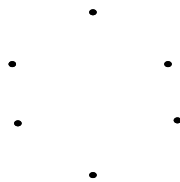
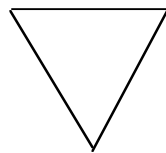
19-20 marks = 2 stars
15-18 marks = 1 star

1. These dots are the corners of two squares of this size. Find them.



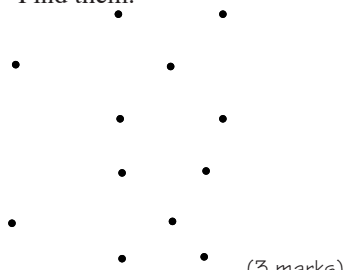
(2 marks)

2. These dots are the corners of two equilateral triangles of this size. Find them.



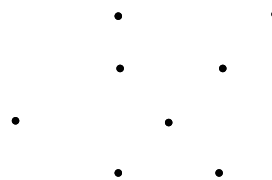
(2 marks)

3. These are the corners of three squares of different sizes. Find them.



(3 marks)

4. Find a square and a parallelogram here.



continued on the next page

5. Find a parallelogram and a right-angled triangle. (2 marks)

6. Find a regular hexagon and a square. (2 marks)

7. Find a right-angled isosceles triangle and a square. (2 marks)

8. Find a regular pentagon and a kite. (2 marks)

9. Find a parallelogram, a square and a right-angled triangle. (3 marks)

Section 5: Circles

In this section you will:

- use words associated with circles
- develop expertise with a pair of compasses.

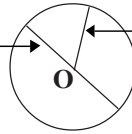
DEVELOPMENT

All individual work

D1: Introducing circles



Any line going right across the circle, through the centre, is called **the diameter**



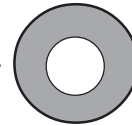
Any line going from the centre to the edge of the circle is called **the radius**

1. Put the point of the compass and its pencil 3 cm apart. Draw a circle with radius 3 cm.
2. Draw another circle with radius 5 cm.
3. What is the diameter of the circle you have just drawn ?
4. A circle has diameter 8 cm. What is its radius ?
5. Draw a circle with radius 4 cm.
6. Draw a circle with diameter 4 cm.

• Check your answers.

D2: Concentric circles

1. Draw a circle with radius 6 cm. Label its centre O.
Draw another circle, with the same centre O, with radius 4 cm.
Shade the ring formed between the two circles.
2. Two circles with the same centre are called **concentric circles**.
Draw two concentric circles, one of radius 4 cm and the other of radius 3 cm.
3. Draw two concentric circles, one of *radius* 5 cm and the other of *diameter* 6cm.



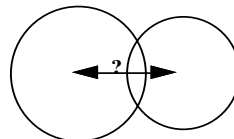
Star Challenge 14

• Check your answers.

5-6 correct = 1 star

Touching and overlapping circles

1. Draw two circles, each with radius 3 cm, whose centres are 6 cm apart.
2. Draw two circles, each with radius 3 cm, whose centres are 5 cm apart.
3. Draw two circles, each with radius 3 cm, whose centres are 7 cm apart.
4. Draw two circles, each with radius 4 cm, that just touch each other.
5. Draw two circles, one with radius 3 cm, and one with radius 4 cm, that just touch each other. How far apart are their centres.
6. If two circles with radii 15cm and 20 cm are to be drawn so that they just touch each other, at what distance apart must you put the centres ?



• Your teacher will need to mark this.

Section 6: Tessellations

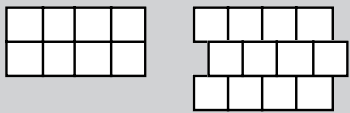
In this section you will:

- learn what is meant by a tessellation;
- experiment to find which shapes tessellate.

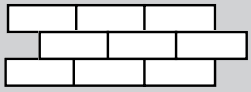
DEVELOPMENT

D1: Why not ?

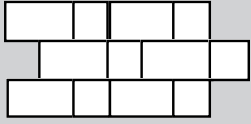
A **tessellation** is a regular repeating pattern with no gaps



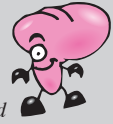
Here are two tessellations of squares



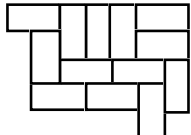
Here are two tessellations of rectangles

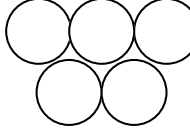


This is a tessellation of squares and rectangles



Big Edd








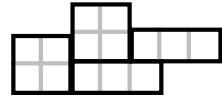
- 

Why is this not a tessellation ?
- 

Why do circles not tessellate ?

PRACTICE

P1: Tessellating squares and rectangles

- Make a tessellation using at least 8 of these  
Colour the tessellation to show the pattern clearly.
- Make a different tessellation using at least 8 of these 
Try and make it a more interesting pattern. Colour it.
- Make a tessellation using at least 8 of  and  together.
Colour the tessellation to show the pattern clearly.
- Make a tessellation using at least 8 of  and  together.
- A tessellation starts like this: 
Copy it and continue it to cover about $\frac{1}{4}$ of your page.
Use colour to show the pattern.

• Show your tessellations to your teacher.

Star Challenge 15

2-3 correct Tasks = 1 star

Tessellating triangles and hexagons



Task 1: Draw a triangle on a piece of card.
Cut it out.
Draw round the triangle on a piece of paper.
Make a tessellation with at least 6 copies of your triangle.
Do you think all triangles tessellate ?

Task 2: Make a tessellation using at least 8 equilateral triangles.
Use triangular spotty or triangular lined paper.
Colour the tessellation to show the pattern clearly.
Stick the tessellation into your book.



Task 3: Make a tessellation using at least 8 hexagons.
Use triangular spotty or triangular lined paper.
Colour the tessellation to show the pattern clearly.
Stick the tessellation into your book.

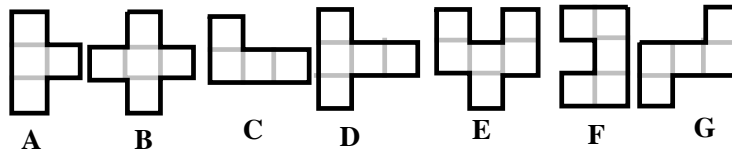


• Show your tessellations to your teacher.

8-10 marks = 2 stars
5-8 marks = 1 star
plus 1 star for a good display

Star Challenge 16

Now try these ...



Task 1: Make a tessellation with shape A.
Use at least 12 copies of the shape.
Colour the tessellation to show the pattern clearly. (2 marks)

Task 2: It is possible to make tessellations with four of the other shapes.
Experiment with each of these shapes.

For each shape that *will* tessellate, make a tessellation.
Use at least 12 copies of the shape.

Colour the tessellations to show the patterns clearly.
(2 marks for each correct tessellation)

Task 3: Make a display of your tessellations that is good enough to go on the classroom wall.

• Show your tessellations and your display to your teacher.

High Level Challenge Section

EXTENSIONS

YOUR TEACHER HAS THE ANSWERS TO THESE.

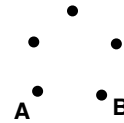
Ch 1: Going round in circles

SECTION 1

7-8 correct = 2 stars
6 correct = 1 star

- Draw 5 dots roughly in the form of a circle. Label two dots that are next to each other A and B. How many triangles can you make that have A, B and one other dot as its corners ?
- Repeat the experiment with 9 dots. How many triangles can you make this time ?
- Complete this table:

Number of dots	6	7	9	10	12
Number of triangles using A, B and one other dot					
- Explain in words how, given the number of dots, you could say how many triangles there are.
- If there are n dots (n is an unknown number), how many triangles would there be ?
- Now let us make the rules more difficult. How many triangles can you make using any three dots, provided at least two of them are next to each other ?
- Using the same condition, how many triangles can you make using a circle of 10 dots ?
- If you have a circle with n dots, how many triangles can you make with the same condition ?



SECTION 1

1 star for a solution to Puzzle No.1,
plus
2 stars for a solution to Puzzle No. 2

Ch 2: MacMahon Tile Puzzles

Puzzle number 1



Take a square. Divide it into 4 right angled isosceles triangles by drawing the diagonals of the square. This is a MacMahon tile.

Make 24 tiles. You will need 3 colours.

- For each tile
- colour in all the isosceles triangles
 - use 1, 2 or 3 colours

Each tile must be different. There are 24 different ways of colouring the tiles.

Puzzle number 2

Take the set of MacMahon tiles. Arrange them to make a 4 by 6 rectangle so that:

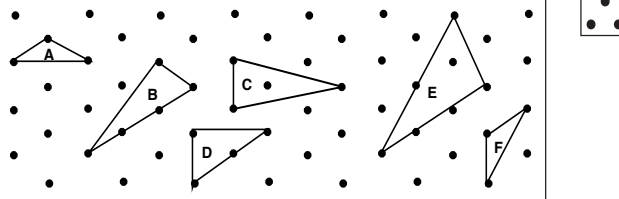
- edges that touch have the same colour
- the outside edge of the rectangle is the same colour all round

Ch 3: Investigating 3-dot triangles

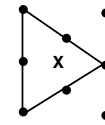
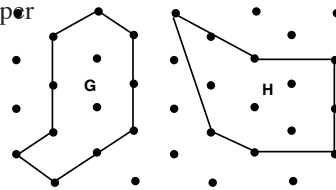
4 correct = 2 stars
3 correct = 1 star

SECTION 1

Only A and F are 3-dot triangles.



- Copy shape G onto triangular spotty paper and divide it up into 3-dot triangles. Count the number of triangles. Make two more copies of G and divide each one up into 3-dot triangles. Count the number of triangles.
- Repeat the instructions given for G, for shape H.
- What do you notice about the number of 3-dot triangles in G and H? Do you think this will be true for any shape? Test your answer by making a shape of your own. Split it up into 3-dot triangles in three different ways. Say whether you were right.
- Draw the equilateral triangle X onto your spotty paper. Make several copies of it. In how many different ways can you split the equilateral triangle into 3-dot triangles?



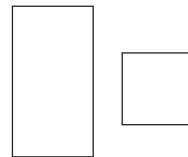
SECTION 2

1 star for a solutions to Q1 & nQ2
plus
1 star for solutions to each of Q3-5

Ch 4: Mega-challenging problem

In each of the following cases

- you start with a square and a rectangle
- you may cut the square into 2 pieces only but you must not cut the rectangle at all
- combine the 2 pieces of the square with the rectangle to make the given, larger, rectangle
- show both how you cut the square and how the pieces fit together.



- Make a 2 by 5 rectangle from a 3 by 3 square and a 1 by 1 rectangle.
- Make a 3 by 6 rectangle from a 4 by 4 square and a 2 by 1 rectangle.
- Make a 4 by 7 rectangle from a 5 by 5 square and a 3 by 1 rectangle.
- Make a 5 by 8 rectangle from a 6 by 6 square and a 4 by 1 rectangle.
- Make a 9 by 12 rectangle from a 10 by 10 square and an 8 by 1 rectangle.

SECTION 3 All correct = 2 stars

Ch 5: The ultimate polygon challenge

Find the polygon that can be made on a 4 by 4 geoboard with the largest number of sides.

4x4 spotty paper
4x4 geoboard

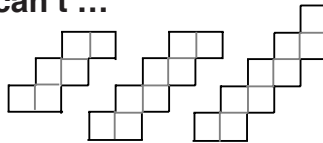
SECTION 3

All correct = 1 star

Ch 6: I bet you can't ...



Optimistic



Pesymistic

1. ... cut the first staircase into 2 pieces that will fit together to make a rectangle.
2. ... cut the second staircase into 2 pieces that will fit together to make a parallelogram.
3. ... cut the third staircase into 3 pieces that will fit together to make a square.

All correct = 1 star

Ch 7: Dissections of an equilateral triangle

SECTION 4

This equilateral triangle has been dissected into three congruent isosceles triangles.

This equilateral triangle has been dissected into three congruent shapes, each bounded by two curves and a straight line.

Construct two equilateral triangles with sides 4 cm long.

Task 1: Dissect one triangle into 3 congruent kites.

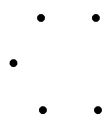
trapezia is the plural of trapezium

Task 2: Dissect one triangle into 3 congruent trapezia.

SECTION 4

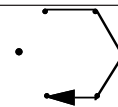
16 hexagons = 2 stars
14-15 hexagons = 2 stars
12-13 hexagons = 1 star

Ch 8: Crossed hexagons



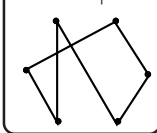
In your book, mark the six corner dots of a regular hexagon as here.

You could make a regular hexagon if you joined them up round the outside.



BUT.. if you joined them up in a different order you could get a crossed hexagon.

For example:



Make as many *different* crossed hexagons as you can.

You can visit each dot once only.

You start and end at the same point.

Reflections are allowed but ...

...only if they are not rotations.

Ch 9: Tetrahexes

sheet of hexagons

P

Task 1: 10 correct = 1 star

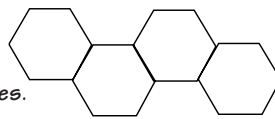
Task 2: 2 correct = 1 star

4 correct = 2 stars

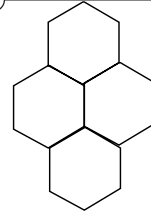
SECTION 4

If you join 4 hexagons together, edge to edge, you can make different shapes.

Two of them are



and



These shapes are called **tetrahexes**.

Task 1: There are 10 possible different tetrahexes.

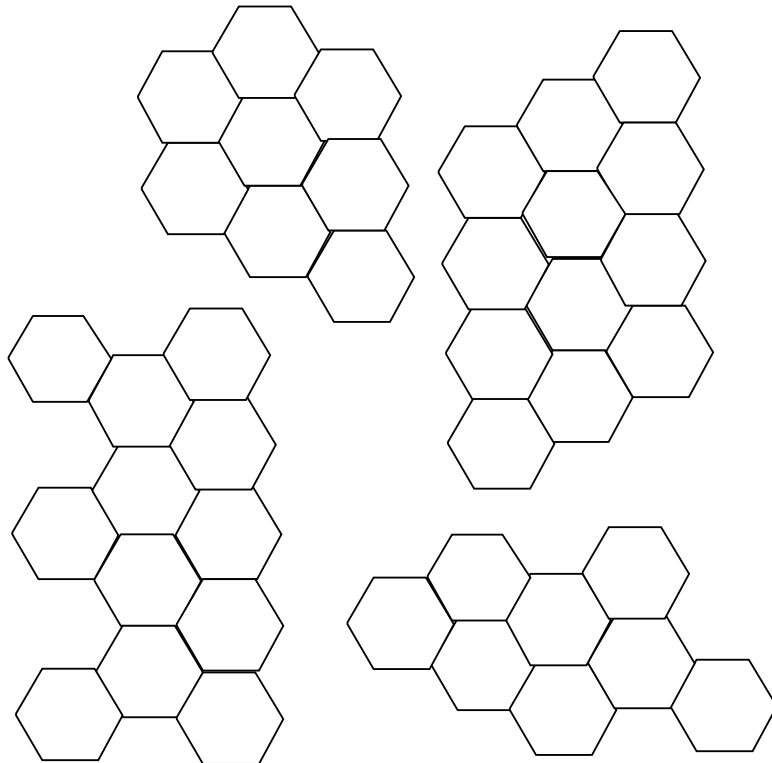
In this problem the rules are slightly different :

- if one tetrahex can be *turned round* to fit on another tetrahex, it is the same.
- if one tetrahex can be *turned over* to fit on another tetrahex, it is different.

Find all 10 tetrahexes.

Colour each one in a different way.

Task 2: The ten tetrahexes can be fitted together to make these four shapes. Make the shapes with your tetrahexes and stick them in your books.



SECTION 5

All correct = 1 star

Ch 10: Compass capers

1. Draw a line 4 cm long across the middle of the page.
Construct an equilateral triangle with sides 4 cm long.
Label the corners of the triangle A,B and C.
2. Construct three circles, each with radius 4 cm, whose centres are A,B and C.
3. Extend the line AB past B until it meets the other side of the circle.
Label the end of this line D.
4. Extend the line AC past C until it meets the other side of the circle.
Label the end of this line E.
5. In exactly the same way
 - extend BC to the point F
 - extend BA to the point G
 - extend CA to the point H
 - extend CB to the point I
6. Join up the points DEFGHID in order with straight lines.
What is the name of this shape ?
7. How many equilateral triangles are there ?

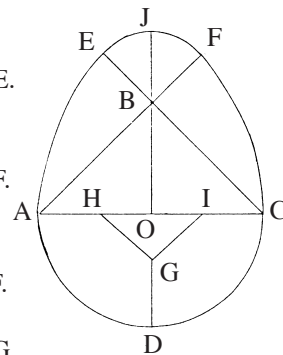
1 star for correct egg
1 star for own bird

Ch 11: The Magic Egg tangram



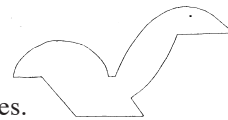
SECTION 5

1. Draw a circle with radius 6 cm, centre O.
2. Draw and label the diameters AC and BD at right angles to each other.
3. Join A to B and continue the line on past B.
Join C to B and continue the line on past B.
4. Put the point of your compass on C.
With radius CA, draw the arc of the circle AE.
Do not go past E.
5. Put the point of your compass on A.
With radius AC, draw the arc of the circle CF.
Do not go past F.
6. Put the point of your compass on B.
With radius BE, draw the arc of the circle EF.
7. Put the point of your compass on D.
With the same radius as BE, mark the point G.
8. Draw a circle, centre G, going through D.
9. Draw GH and GI.
10. Extend OB to the point J.



Your magic egg is now complete.

11. Cut out the magic egg.
Cut along the lines in the diagram to make 9 pieces.
12. Use all of the pieces to make a bird
of your own design. Stick it in your book.



Ch 12: A famous combinatorial problem

Task 1 correct = 1 star
 Task 2 correct = 1 star
 Task 3 correct = 2 stars

Combinatorics is a branch of mathematics.

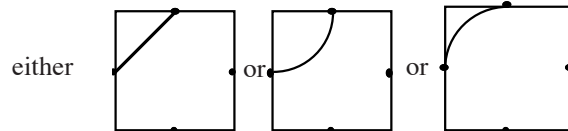
One kind of problem that is often tackled is that of finding all possible arrangements of a given type.

This particular problem is one that is generally attributed to the British mathematician Percy A. MacMahon.

Draw 24 square tiles with sides 4 cm long.

For each square tile

- mark the midpoints of each side
- join the midpoints of each side with one of these three lines



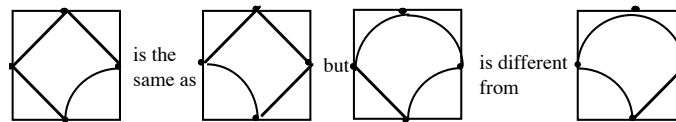
The curves are quarter circles with centres at either the corner or the centre of the square.

There are 24 possible different patterns.

Rotations are not allowed.

Reflections are allowed but only if they are not rotations too.

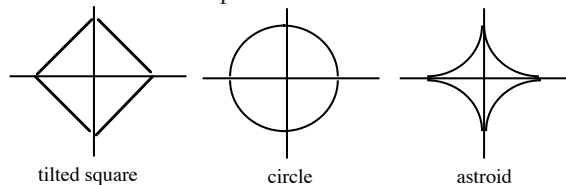
For example :



Task 1: Find all the 24 different tiles.
 Use 3 colours to colour same-shaped corner sections.

Task 2: Cut out the 24 patterned tiles.
 Make a rectangle from the tiles matching same-coloured edges.
 There are many possible solutions.


Task 3: In the rectangles you made, the corners of the tiles should show one of these three patterns:


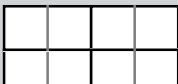



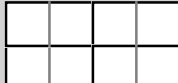
Now, make a rectangle where the colours on the edges of the tiles match *and* there are equal numbers of each of these patterns at the corners.



All correct = 1 star



Ch 13: Repli-tiles

Four dominoes like this  will fit together to make

 and  are both twice as long as they are wide.

 and  are **similar shapes**.

 is a **repli-tile** of 

-  is a right tromino.
 Put four of these together to make a repli-tile of the right tromino.
 Draw it.
 Shade the four trominoes so that you can see where they are.
-  A tetromino is made from 4 squares.
 This is the square tetromino. Make a repli-tile of it.
 Shade in the smaller tetrominoes,
 so that you can see where they are.

Polyominoes are shapes made from fitting squares together, edge-to-edge.

A **domino** is made from 2 squares.

A **tromino** is made from 3 squares.

A **tetromino** is made from 4 squares.

A **pentomino** is made from 5 squares.

A **hexomino** is made from 6 squares.



Yerwat

Do you know that a domino is sometimes ...

... a light cloak often worn with a half-mask at a masquerade (a masked ball)

... a half-mask worn at a masquerade

One star for each correct repli-tile

Ch 14: The ultimate repli-tile challenge !

- There are five tetrominoes. One is given in Ch 13. Find the other four.
- It is possible to make repli-tiles of three of these four tetrominoes. Try to find all three repli-tiles.

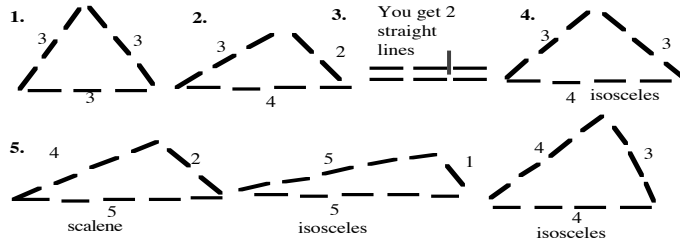
Warning : Do not assume that you will always need four copies of each tile.

One of these repli-tiles, at least, needs 16 copies.

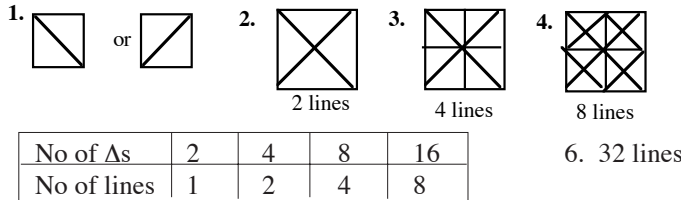
Shape Answers

Section 1: Triangles p100

P1: Matchstick triangles



P2: Show me how



Section 2: Rectangles and squares p103

D1: Truths, untruths and halftruths

- A1: always true A2: sometimes true
 B1: always true B2: sometimes true
 C1: always true C2: sometimes true
 D1: always true D2: always true
 E1: always true E2: sometimes true

D3: How many different rectangles can you find ?

Task 1:



P1: Systematic counting

1.	1	4	9	16
	0	1	4	9
	0	0	1	4
	0	0	0	1
	1	5	14	30

Section 4: More polygons p108

D1: Can you find ?

1. E, J, H 2. A, G, M 3. B, F 4. I 5. K, L
 6. F 7. A 8. J 9. C 10. K

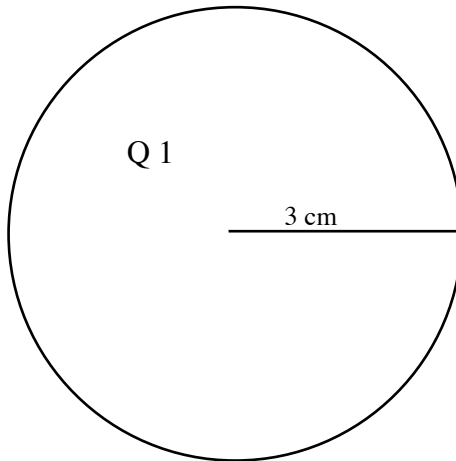
D2: Make a regular hexagon



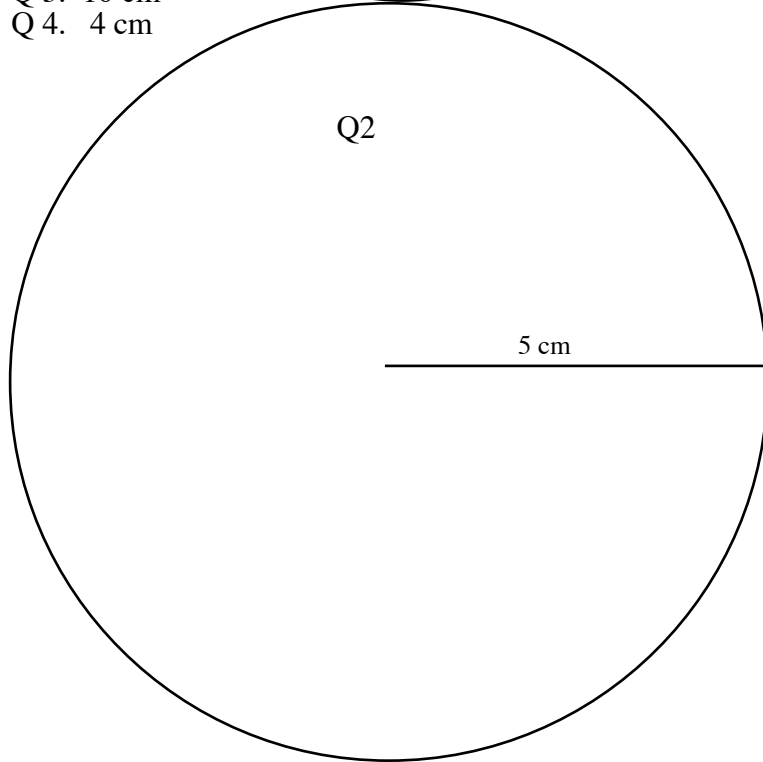
Section 5: Circles **p111**

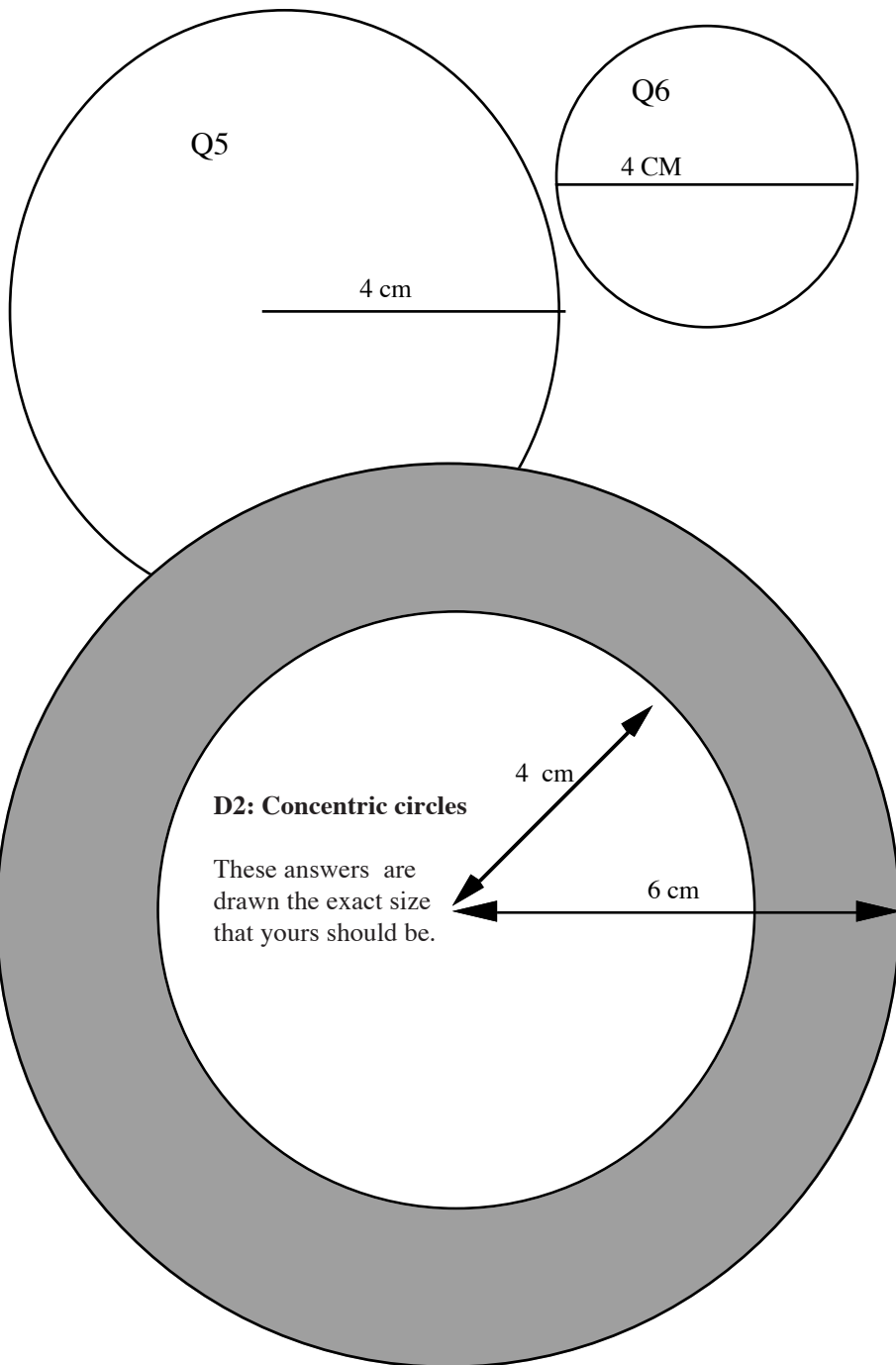
D1: Introducing circles

These answers are drawn the exact size that yours should be.

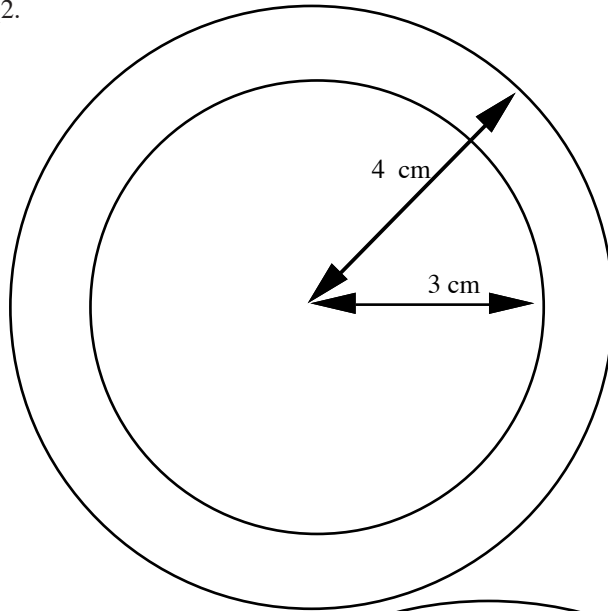


Q 3. 10 cm
Q 4. 4 cm





Q2.



Q3.

