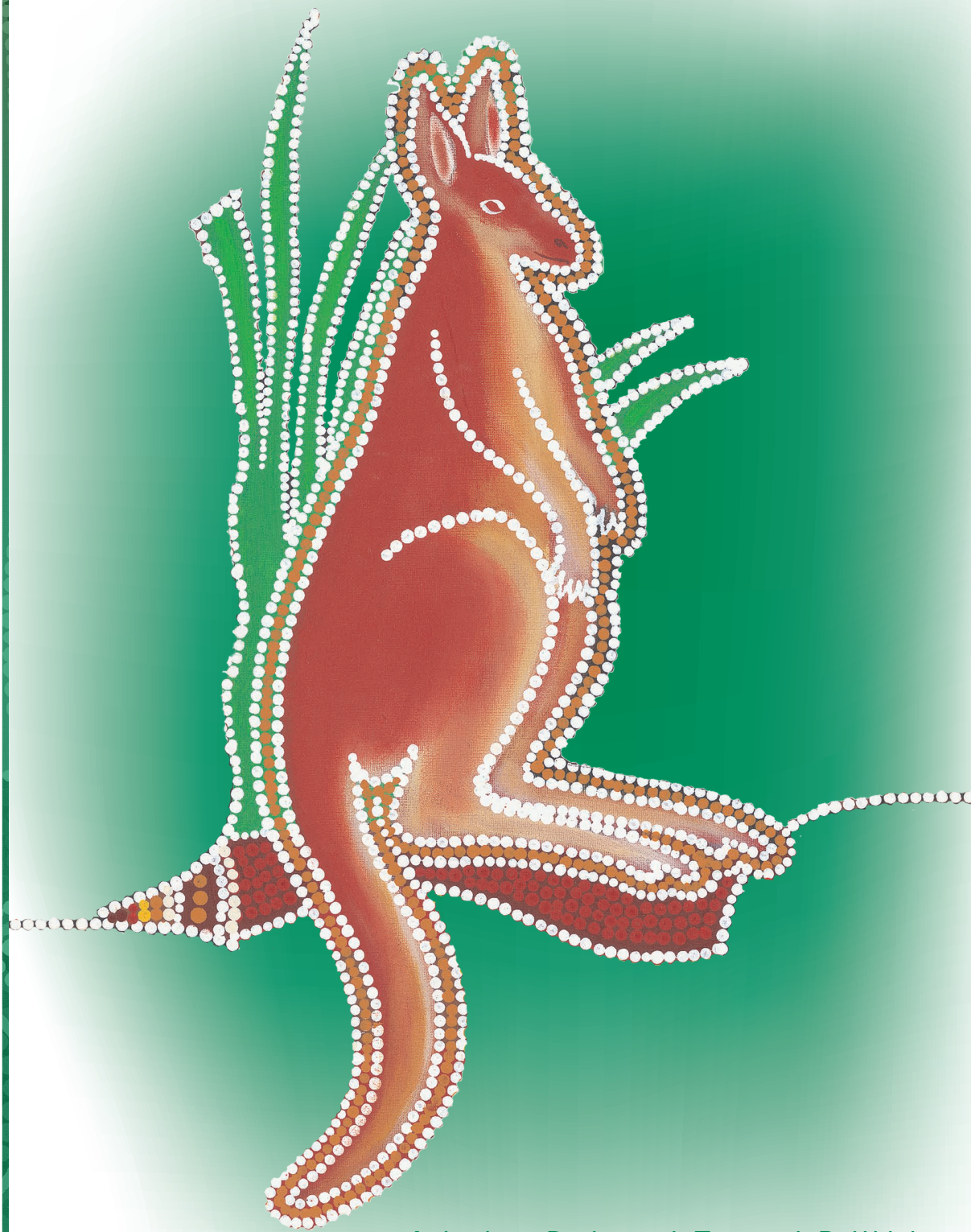
BOOK 8 - SPACE
Shapes

MATHS MATE

GREEN



A. Lorimer-Derham I. Tutos J. B. Wright

BOOK 8 - SPACE

Shapes

Sample pages include:

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MATHS MATE BLUE - BOOK 8
Space - Shapes

Key: Confused — Need help — Confident — Understood

After completing each lesson, place a ✕ on the appropriate traffic light to indicate how well you understood this work.

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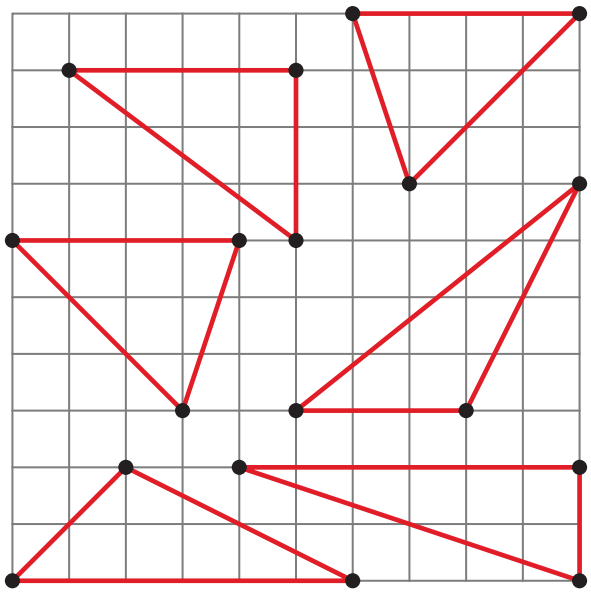
Satellites and Triangulation

Ellen the Rosella has placed satellites in the sky to create triangular regions of equal area to maximise internet coverage. Unfortunately she has lost the plans. Your task is to join groups of three dots (satellites) to create as many triangles as you can. In every puzzle it is possible to use all the dots to create triangles.

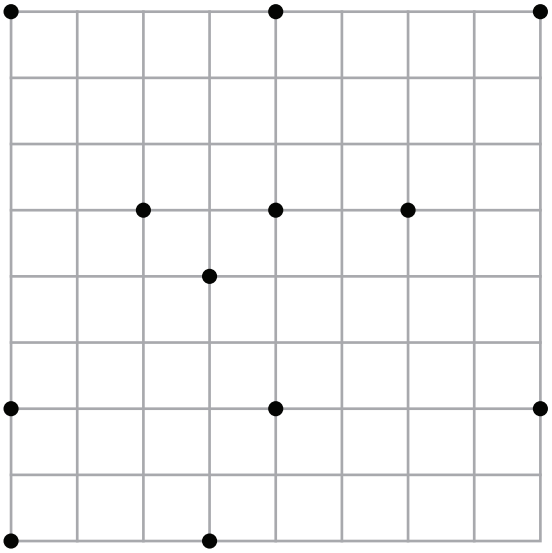
Keeping to the triangle theme, there are just three rules:

- You may not use the same dot for multiple triangles.
- Triangles must not overlap.
- Each triangle must have an area of **exactly 6 square units**.

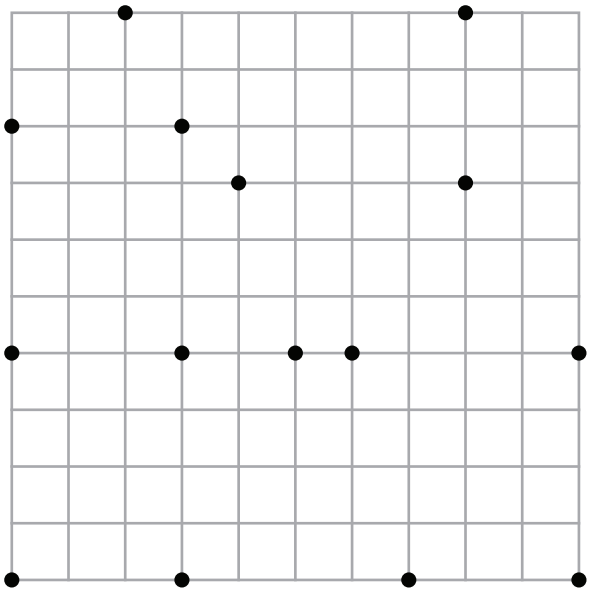
Below is an example of a fully solved puzzle.



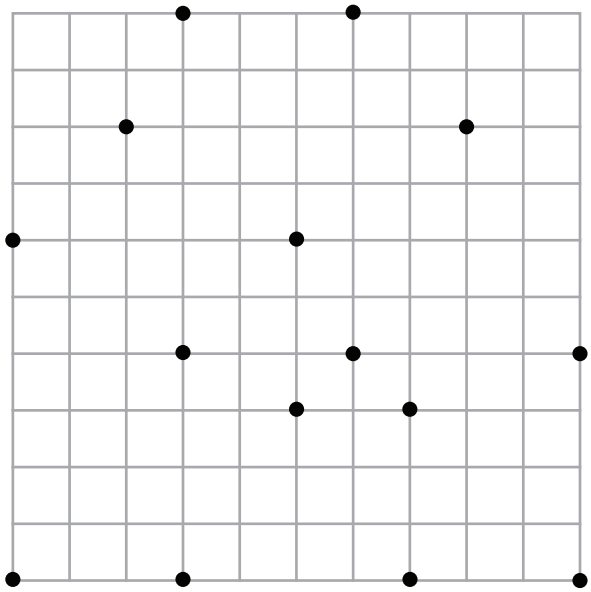
EASY #01



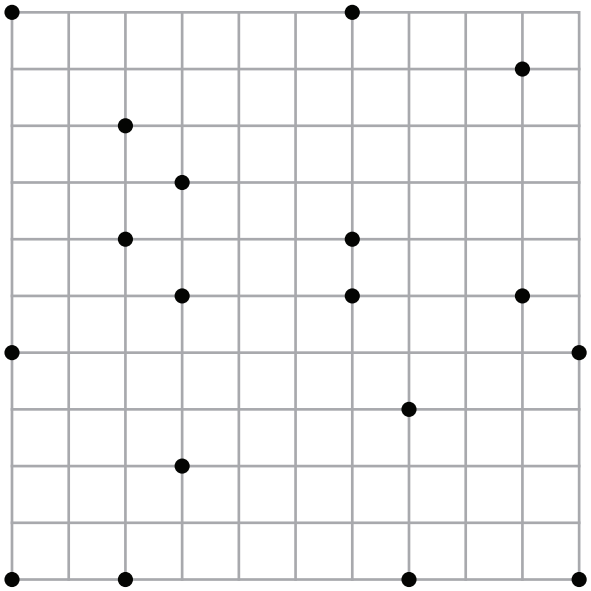
MODERATE #01



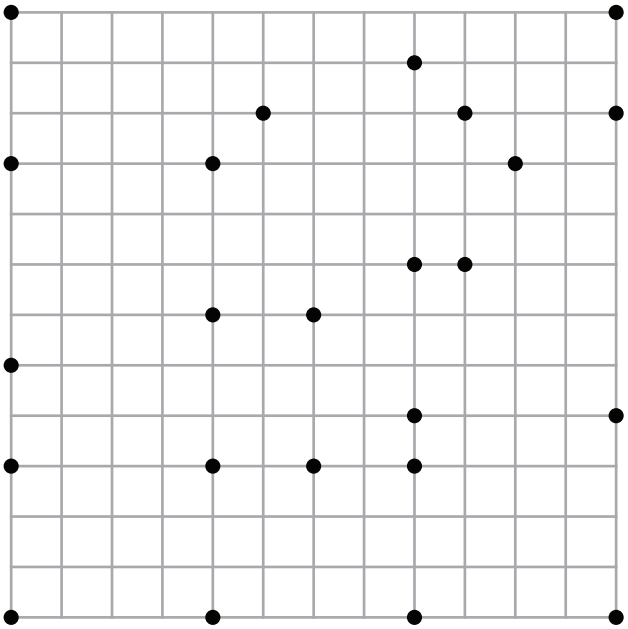
MODERATE #02



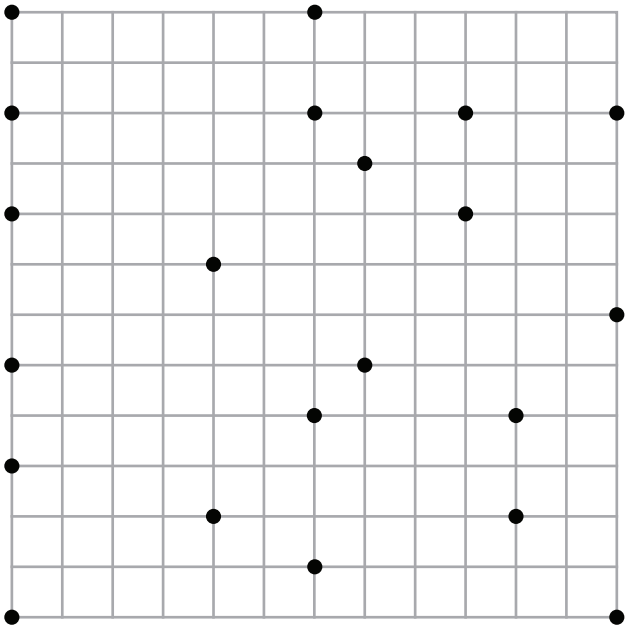
MODERATE #03



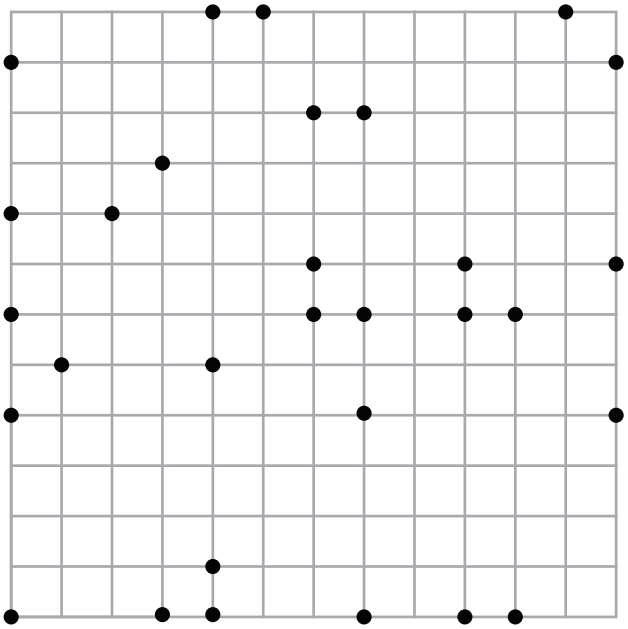
HARD #01



HARD #02



RIDICULOUS #01



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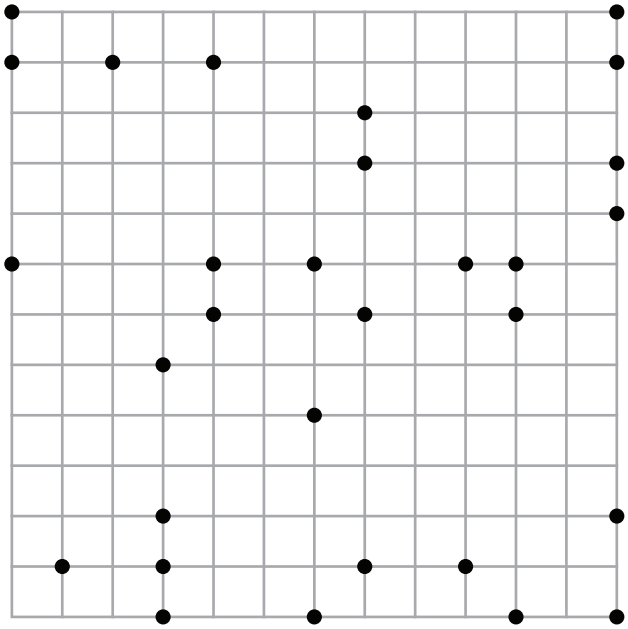
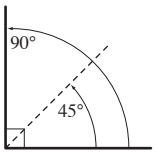


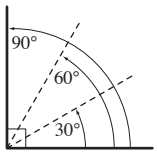
8.2.4 Estimating the Size of an Angle

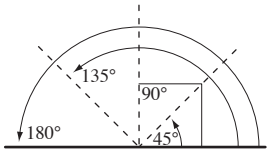
Without using a protractor, how could you accurately draw a 45° angle?

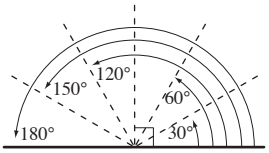
To estimate the size of an angle:

- Form a right angle (90°) with one ray of the given angle.
- Divide the right angle into halves or thirds.
- Halve these angles again if it helps.
- Compare the angle with your marked values.

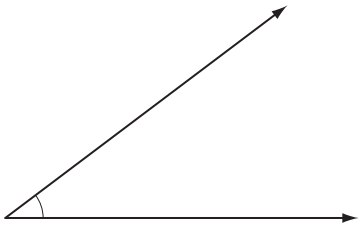




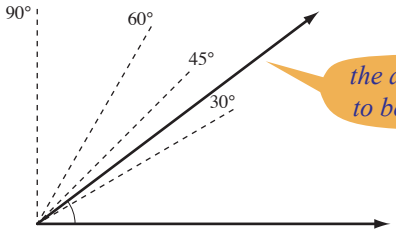




1. Without measuring, would you estimate that the size of this angle is closer to 35° or 50°?

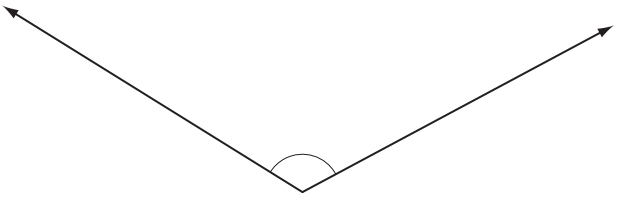


35°

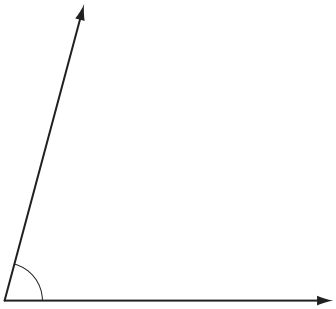


the angle appears to be close to 37°

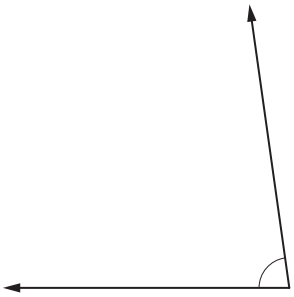
2. Without measuring, would you estimate that the size of this angle is closer to 125° or 140°?



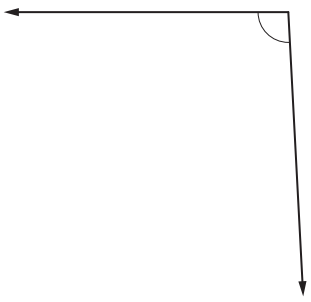
3. Without measuring, would you estimate that the size of this angle is closer to 75° or 90°?



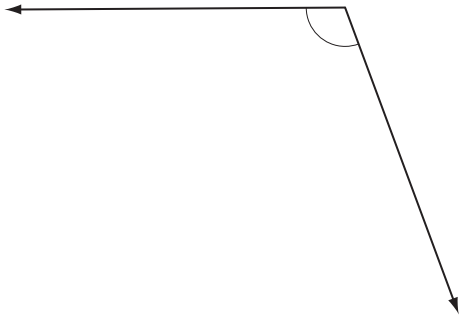
4. Without measuring, would you estimate that the size of this angle is closer to 70° or 80°?



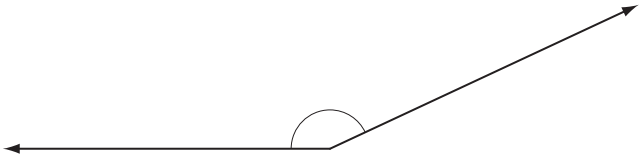
5. Without measuring, would you estimate that the size of this angle is closer to 95° or 110°?



6. Without measuring, would you estimate that the size of this angle is closer to 95° or 110°?



7. Without measuring, would you estimate that the size of this angle is closer to 155° or 170°?



8. Without using a protractor draw an angle of 45°.

9. Without using a protractor draw an angle of 20°.

ACTIVITY: DRAW THE ANGLE

Working in pairs, choose two cards from a deck containing the numbers 1 to 9 to create a two-digit number. For example a 1 and 8 can become 81 or 18 degrees.
As a pair, draw an angle without using a protractor, that is as close to that number as possible. After you have agreed on a drawing, measure your angle with a protractor.

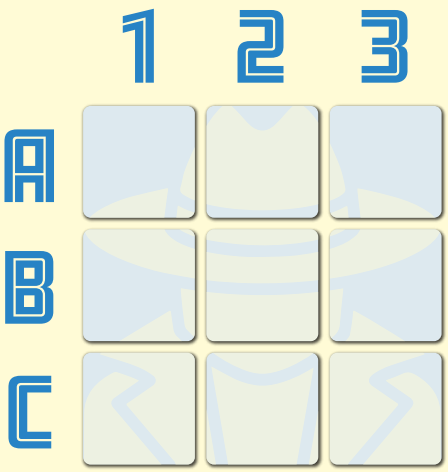
If you are within 5 degrees of the correct angle, you gain a point.
If not, you lose a point.

See how many points you can score in 10 minutes.

Sudo-clue: #01

Place the numbers 1 to 9 on the grid using these clues:

1. All the multiples of three belong in Column 2.
2. The 6 is in the bottom row but is not next to the 3.
3. The number 8 is diagonally left and below the largest number.
4. The number below the two is four times greater than it.
5. The largest prime number is in the top left corner.
6. The numbers in Column 3 are written in descending order from the top.



The Quadrilateral Games

Welcome to the quadrilateral triathlon. Arguably the most entertaining event of these games. Remember: *"As simple as it sounds, we all must try to be the best person we can: by making the best choices, by making the most of the talents we've been given".* - Mary Lou Retton (American gymnast and 1984 Olympic gold medalist).

In each of the 3 stages you must cover as much of the arena as possible using exactly two of each variation of the designated shapes whilst observing these rules.

- The four sides of each shape must begin and end on a dot.
- The four shapes may rest against one another but must not overlap.
- The shapes must have different side lengths to the other three shapes in that stage.

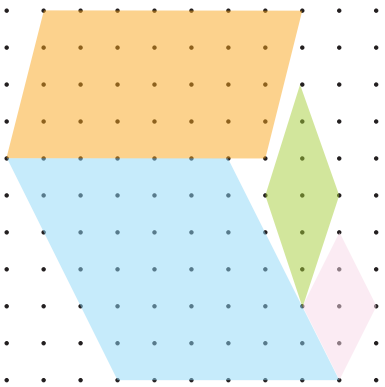
For example: *Using rectangles measuring 6 × 4 and 4 × 3 = disqualification. Using a rectangle measuring 6 × 4 and a trapezium with a base of 6 or 4 = disqualification.*

- The shapes must not protrude beyond the boundary of the arena.
- As you move through the three stages you can't use a shape from an earlier stage.

For example: *Using a square or rectangle in Stage 2 = disqualification.*

Your score for the team pursuit is the sum of your scores for the three stages. The world record for each individual stage is given. The highest total score wins the gold medal. Good luck.

EXAMPLE
THE PARALLELOGRAM & RHOMBUS



JUDGING - EXAMPLE SCORE

A legal attempt since:
- *no shapes overlap*
- *no shapes share a side length*
- *each shape sits entirely within the arena.*

Score:

Sandy parallelogram scores 7 × 4 = 28 points
Blue parallelogram scores 6 × 6 square = 36 points
Green rhombus scores $^1/_2 \times 2 \times 6 = 6$ points
Pink rhombus scores $^1/_2 \times 2 \times 4 = 4$ points

Total score 28 + 36 + 6 + 4 = 74% coverage or 74 points.

PRACTICE ARENAS

Use the practice arenas below to prepare your routines for your final attempts on the next page.

"The motto is faster, higher, stronger, not fastest, highest, strongest. Sometimes it's the trying that matters". - Bronte Barratt (Australian swimmer and 2008 Olympic gold medalist).

PRACTICE ARENA 1

PRACTICE ARENA 2

PRACTICE ARENA 3

STAGE 1
THE SQUARE
& RECTANGLE

STAGE 2
THE PARALLELOGRAM
& RHOMBUS

STAGE 3
THE TRAPEZIUM
& KITE

Current World Record
— 97% —

My Score:	
Square 1 =	
Square 2 =	
Rectangle 1 =	
Rectangle 2 =	
Total =	

Current World Record
— 82% —

My Score:	
Parallelogram 1 =	
Parallelogram 2 =	
Rhombus 1 =	
Rhombus 2 =	
Total =	

Current World Record
— 91% —

My Score:	
Trapezium 1 =	
Trapezium 2 =	
Kite 1 =	
Kite 2 =	
Total =	

TEAM SCORE	
STAGE 1	
STAGE 2	
STAGE 3	
EVENT TOTAL	

GOLD MEDAL
265 or more points

SILVER MEDAL
260 - 264.5 points

BRONZE MEDAL
250 - 259.5 points

COACH'S CORNER

A reshuffle of your quadrilaterals could make all the difference. See how high you can score by pairing the six quadrilaterals differently. The current world record is 277 points! Use scrap paper then copy your best effort onto the arenas below.

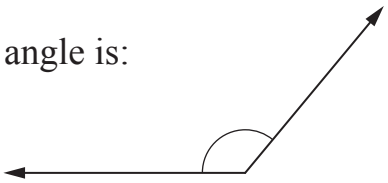
STAGE 1

STAGE 2

STAGE 3

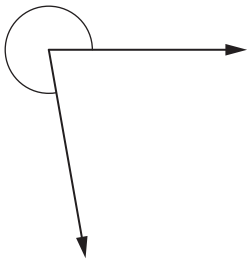
Multiple Choice

1. The size of the angle is:



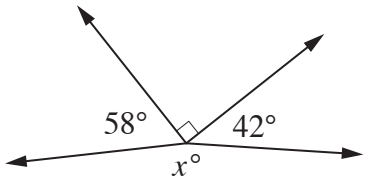
A 115° **B** 120° **C** 125° **D** 130°

2. The marked angle is:



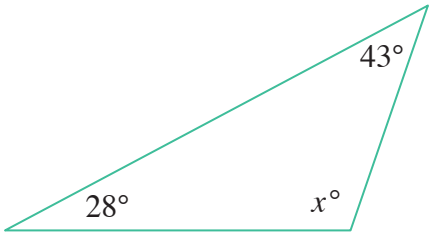
A acute
C straight
B reflex
D obtuse

3. The value of the angle labelled x° is:



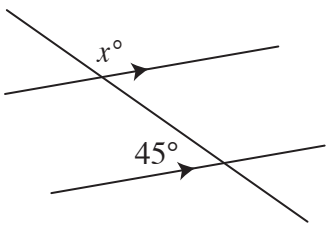
A 180° **B** 170° **C** 160° **D** 150°

4. The value of the angle labelled x° is:



A 109° **B** 119° **C** 115° **D** 105°

5. The value of the angle labelled x° is:

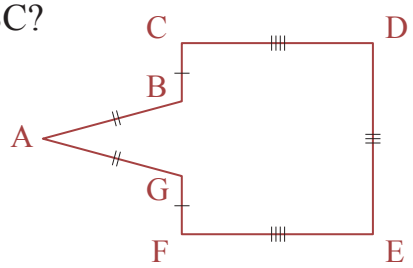


A 45° **B** 125° **C** 90° **D** 135°

6. The bearing of M from S is:

A 090°T **B** 180°T **C** 360°T **D** 270°T

7. Which other side is equal in length to side BC?



A EF **B** FG **C** CD **D** DE

8. This triangle is:

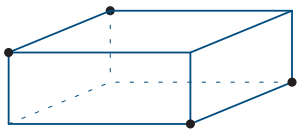
A scalene **B** right-angled
C equilateral **D** isosceles

9. Which shape is **not** a quadrilateral?

A  **B**  **C**  **D** 

10. Which property is true for a parallelogram?

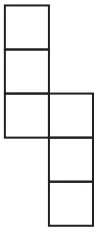
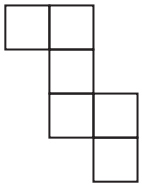
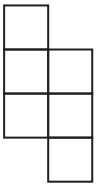
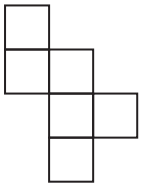
A all sides are equal
B all angles are equal
C diagonals are equal
D diagonals bisect each other



11. The shape of the cross-section of this prism through the marked points is a:

A triangle **B** parallelogram
C rectangle **D** rhombus

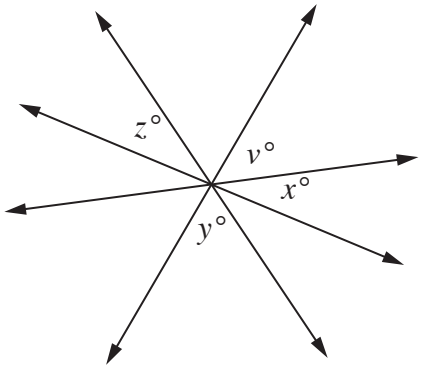
12. Which net cannot be used to make a cube?

A  **B**  **C**  **D** 

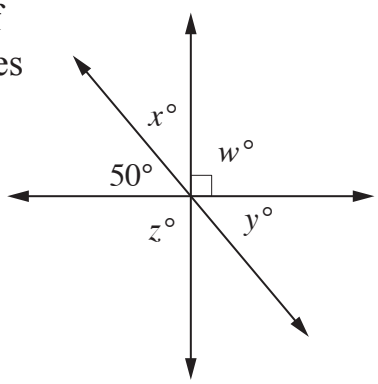
Short Answer

1. Draw a reflex angle of 200°

2. Label all remaining angles in the diagram. Use the letters $v°$, $x°$, $y°$ or $z°$.



3. Find the value of the missing angles in the diagram.



a) $w° =$ .....

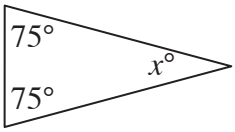
b) $x° =$ .....

c) $y° =$ .....

d) $z° =$ .....

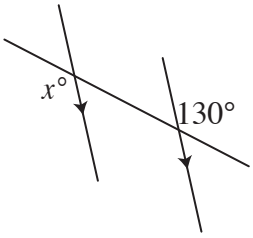
4. Find the value of the angles labelled $x°$.

a)



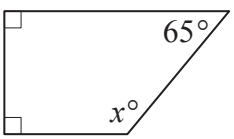
$x° =$ .....

b)



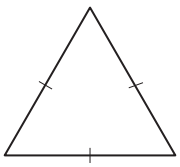
$x° =$ .....

c)



$x° =$ .....

5. Which two options describe the triangle?



- ☐ right-angled
- ☐ acute-angled
- ☐ scalene
- ☐ equilateral

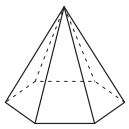
6. Name and sketch the quadrilateral whose sides are all equal and whose diagonals are **not** equal.

7. Describe the shape by writing the number of:

a) vertices (V) = ...

b) faces (F) = ...

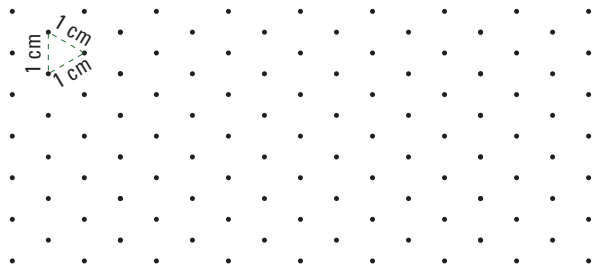
c) edges (E) = ...



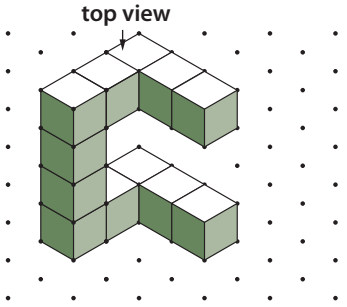
d) Verify Euler's formula by completing the statement:

F + V − E = 2

8. Draw a rectangular prism of length 3 cm, width 1 cm, and height 2 cm.

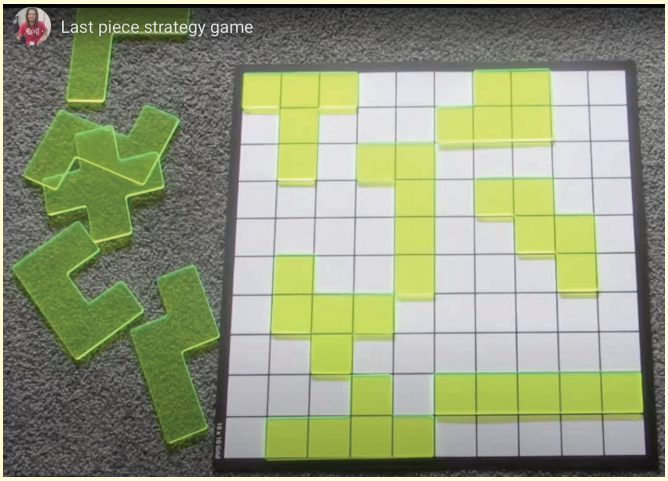


9. Use the blank grid to draw the top view of the solid. All cubes are visible.



Last Piece

Last Piece is a simple, two-player game. You need a 10 by 10 square board and a set of pentominoes (shapes made by joining five identical squares together side-to-side). There are 12 different pentominoes.
Strategically place pieces to create or block space to outwit your opponents and be the last player to place a piece on the board.
Players will visualise and experiment to see whether their shape fits by rotating, reflecting and translating shapes.



Instructions at: thinksquare.com.au/games/last-piece/

Guess the Angle, Guess the Shape

A guessing game with a creative twist. Players ask ‘yes/no’ questions to work out their opponents’ secret shape.
Here’s the twist: once a type of question has been asked (e.g. “Does your shape have three sides?”), the same type of question can no longer be used for the rest of the game.

Instructions at: thinksquare.com.au/games/guess-the-number/

GUESS THE...

This package of 'Guess the' games are designed to develop mathematical vocabulary across a wide range of topics. Throughout each game, players must use and interpret mathematical terminology to both ask and answer yes/no questions.

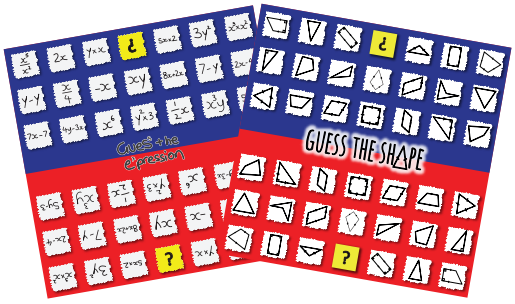
Once a type of question is asked, for example: "Is your number higher than 6?", that type of question (higher/lower) cannot be used again. This makes students consider alternative terminology and causes them to think more deeply about the properties their remaining options share.

Teacher tips:

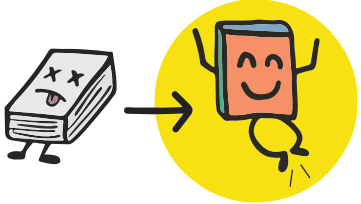
For longer lasting game boards, print and laminate the A3 sheets or print smaller A4 versions and place them inside laminate pockets.

For less experienced learners teachers can write a bank of terminology on the board for players to choose from (quadrilateral, parallel, right angle, scalene etc).

Contents



1. Blank Guess the game (make your own)
2. Guess the Number (1-20)
3. Guess the Fraction, Decimal, Percentage
4. Guess What's in my Wallet (Australian money)
5. Guess the Time
6. Guess the Decimal
7. Guess the Directed number
8. Guess the Shape
9. Guess the Angle
10. Guess the Indices (powers and square roots)
11. Guess the Expression



Enjoyed this game?

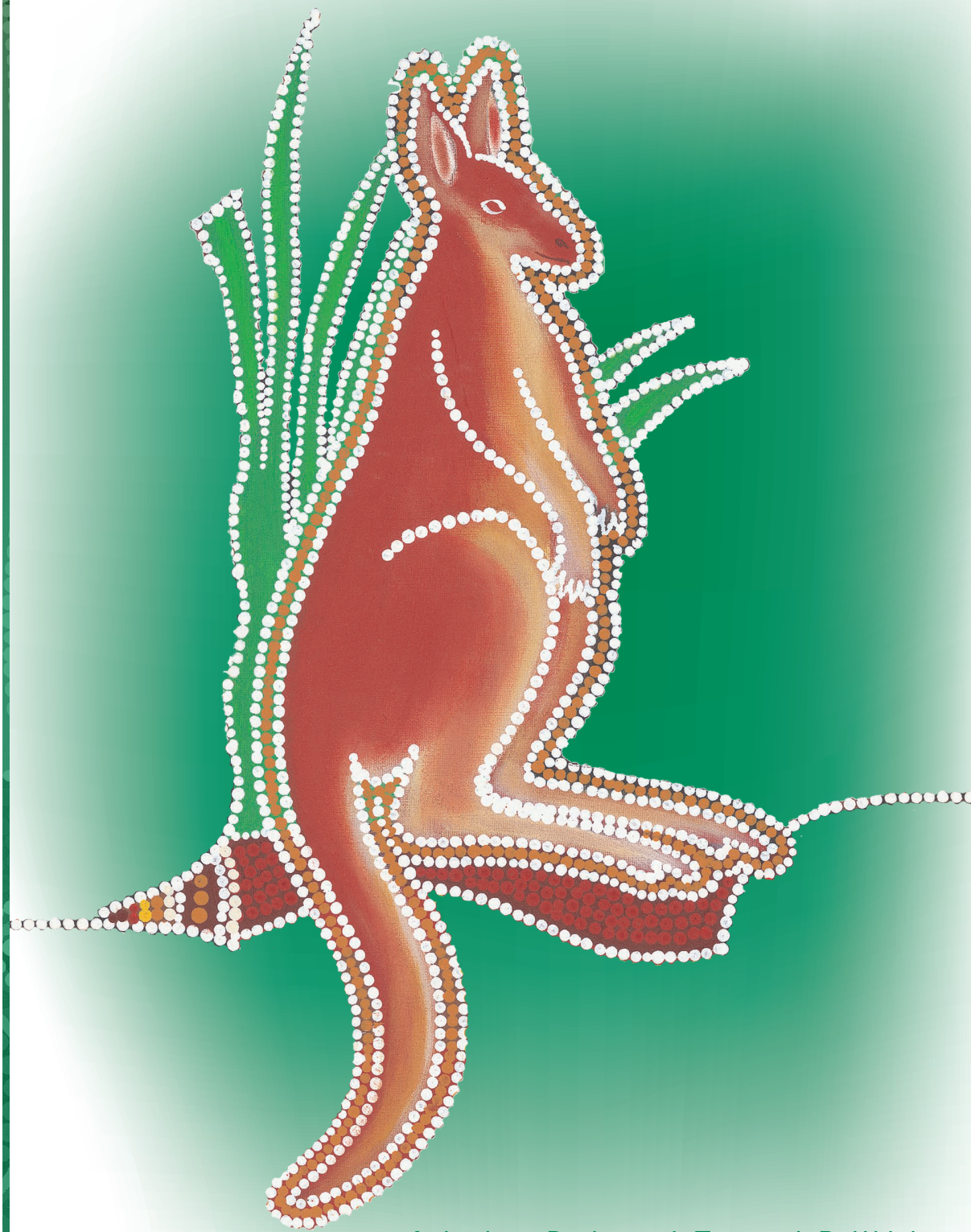
There are hundreds more games, puzzles and rich activities just like this in the Maths Mate Year 7 & 8 textbooks.

Bring your textbook to life at **mathsmate.net**

BOOK 9 - SPACE
Transformations and Congruence

MATHS MATE

GREEN



A. Lorimer-Derham I. Tutos J. B. Wright

BOOK 9 - SPACE

Transformations and Congruence

Sample pages include:

Table of Contents _____ p12

Opening Puzzle - Formula Fun Race _____ p13

Sample Lesson, with opener and Sudo-clue puzzle _____ p15

Activity - Remote Control Spy _____ p17

Book 7 Review _____ p19

Game - Pentris, Spell It _____ p21

MATHS MATE GREEN - BOOK 9
Space - Transformations and Congruence

Key: Confused — Need help — Confident — Understood

After completing each lesson, place a ✕ on the appropriate traffic light to indicate how well you understood this work.

Shelly the Turtle's Congruence Quest 1
Formula Fun Racing 2

9.1 Transformations

9.1.1 Identifying and Drawing Lines of Symmetry in 2D Shapes 4
9.1.2 Identifying Rotational Symmetry in 2D Shapes 5
Upside Down Crossword 6
9.1.3 Recognising and Drawing Reflections on a Cartesian Plane 7
Reflections on Sport 8
9.1.4 Recognising and Drawing Translations on a Cartesian Plane 10
9.1.5 Describing and Drawing Rotations on a Cartesian Plane 12
Remote Control Spy 14
9.1.6 Drawing Enlargements and Reductions on a Cartesian Plane 16
Pentris 16
Grid Scale Drawing 17
9.1.7 Enlargements and Area 18

9.2 Congruent Shapes

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9.2.2 Investigating the Congruence Tests for Triangles 21
9.2.3 Applying Congruence Tests 24
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9.3 Similar Shapes

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Formula Fun Racing 30

9.4 Book 9 Review

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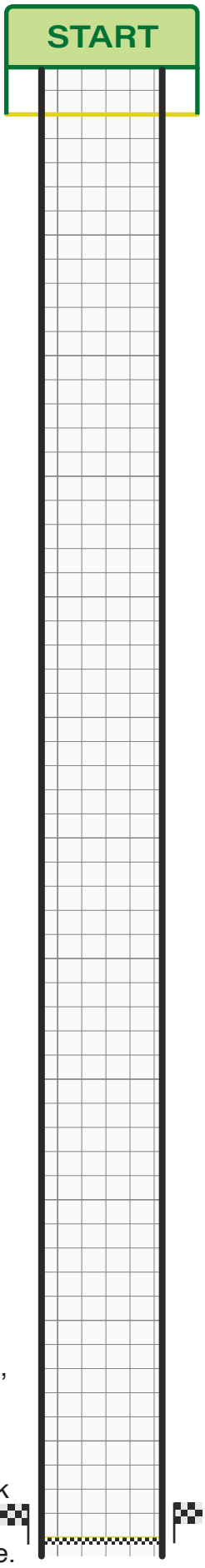
BOOK 9 - ANSWERS 34
Spell it 37

Formula Fun Racing

The Shelly Racing Team needs a racing engineer. Your task is to work with their drivers to plan the perfect driving lines for each race track.

Where does the driver begin braking? Where is the ultimate apex for each corner? Can you help?

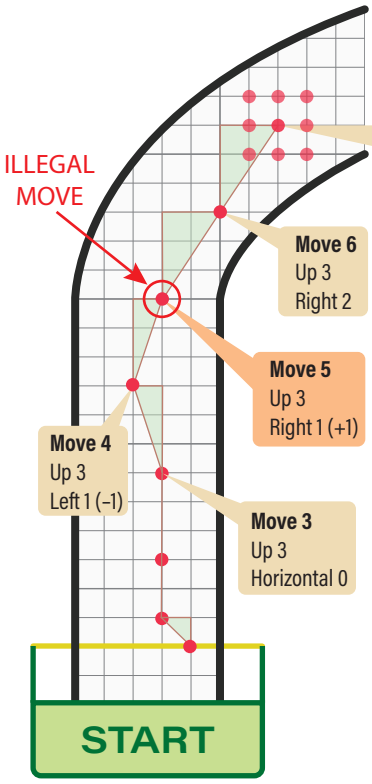


Rules

1. Each move represents 1 second and is made up of a vertical and a horizontal component. Each of these components can be varied by up to 1 space each move.
2. If you rule a straight line from the start of your move to the end of your move, the line must not touch either edge of the race track.
3. Begin on the yellow line under the start sign. Move 1 space on your first move.

Example Below

Move 1 was up 1 space and left 1 space. **Move 2** was straight up 2. **Move 3** was straight up 3. **Move 4** was up 3 and left 1. **Move 5** was up 3 spaces, which is legal, but the change from left 1, to right 1, is a change of 2, and therefore is illegal.



In **Move 6**, the car moves up 3 spaces and right 2 spaces.

A simple way to show a legal move is to lightly mark the spot where you would finish if you repeated your last move. Your 9 choices include that spot, as well as the 8 spots surrounding it. See **Move 7** as an example.

The number of moves taken represents your time in seconds. Count every move from the start line including the move that takes you to, or across, the finish line. Each track assigns a grade based on your time. See the back page to convert these grades to Driver Ratings.

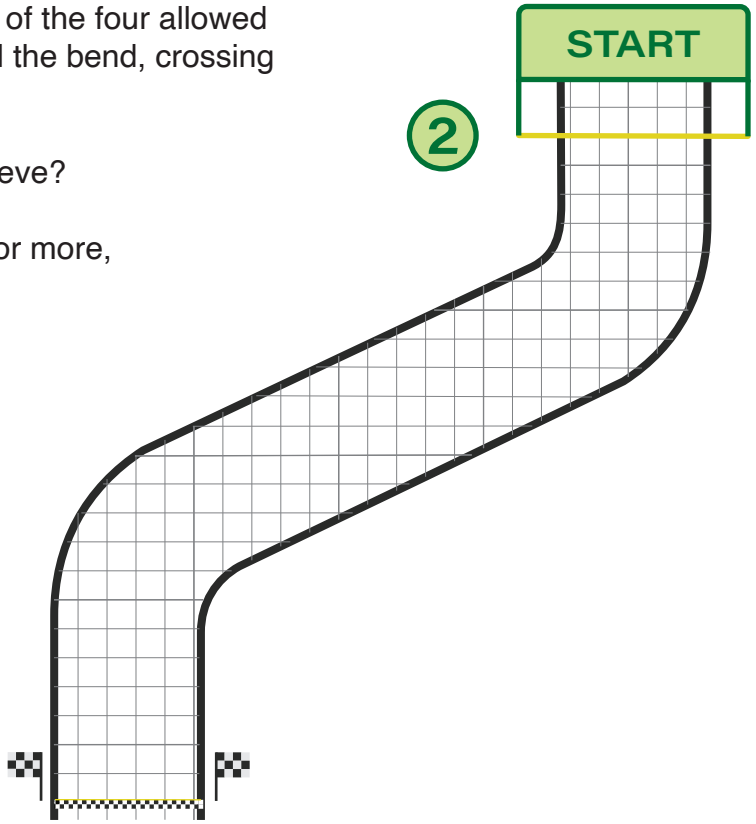
Challenge 1. a) Starting at rest on the yellow line, accelerate down the track, crossing the chequered line as quickly as you can. What is the fastest time you can achieve? A = 11 s, B = 12 s, C = 13 s, D = 14 s or more.

Challenge 1. b) Starting at rest on the yellow line, accelerate down the track before slowing down to a stop right on the chequered line. What is the fastest time you can achieve? A = 15 s, B = 16 s, C = 17 s, D = 18 s or more.

Challenge 2. Starting at rest on one of the four allowed points on the yellow line, race around the bend, crossing the finish line as quickly as you can.

What is the fastest time you can achieve?

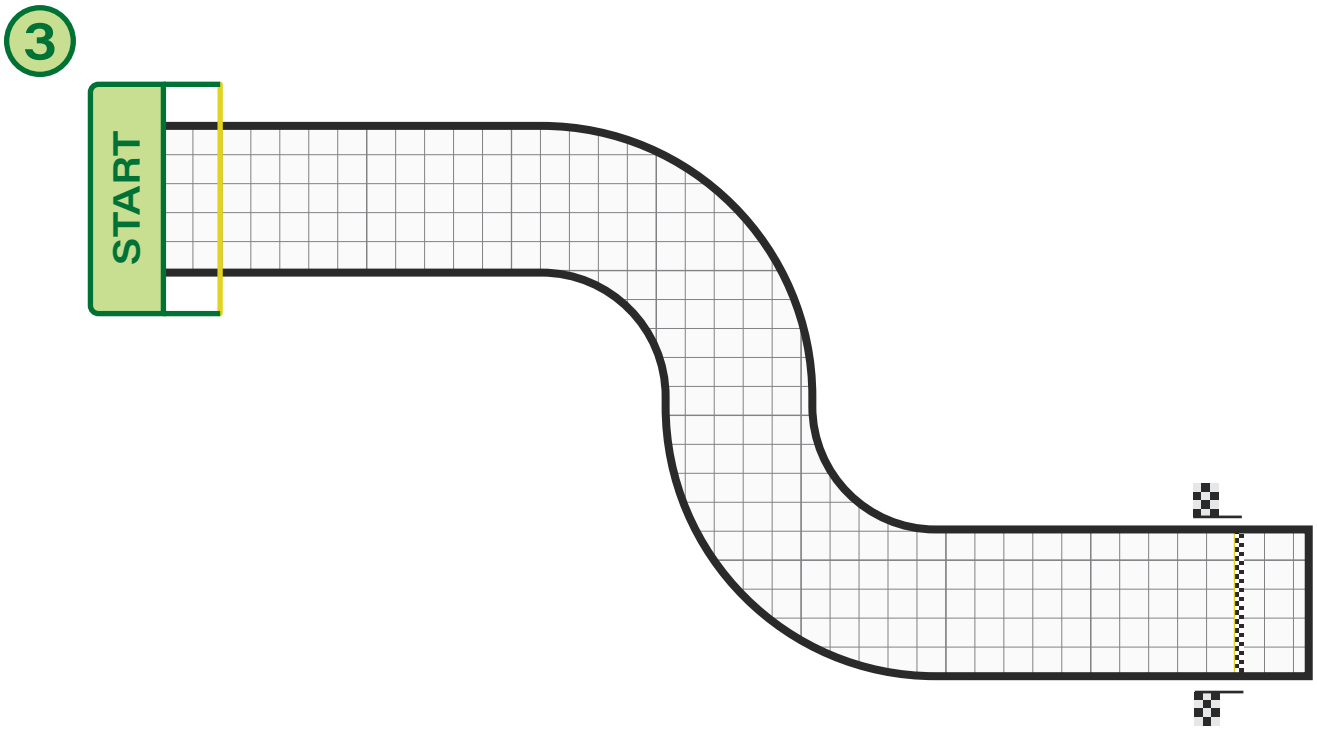
A = 9 s, B = 10 s, C = 11 s, D = 12 s or more,
E = includes an illegal move.



Challenge 3. Starting at rest on one of the four allowed points on the yellow line, race around the bend, crossing the finish line as quickly as you can.

What is the fastest time you can achieve?

A = 11 s, B = 12 s, C = 13 s, D = 14 s or more, E = includes an illegal move.

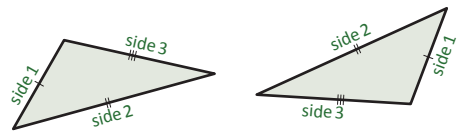


9.2.3 Applying Congruence Tests

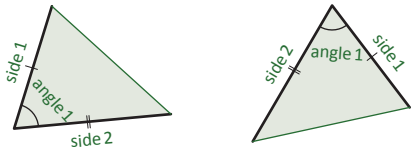
Any quadrilateral with parallel lines can be divided into three triangles where two are congruent. Prove this is either true or false.

The congruence tests are used to prove that two triangles are identical.

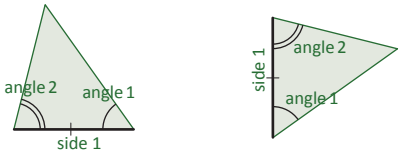
1. Side-Side-Side (SSS)



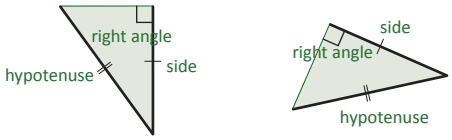
2. Side-Angle-Side (SAS)



3. Angle-Side-Angle (ASA)

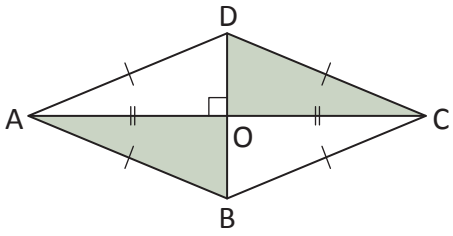


4. Right angle-Hypotenuse-Side (RHS)



Hint: *The symbol for "is congruent to" is similar to the equal sign (=), but with an extra line (≡)*

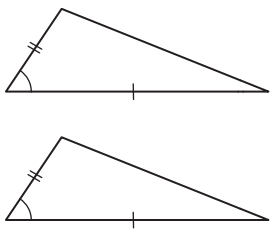
Example: *Which congruence test (SSS, SAS, ASA, RHS) can be applied to show that triangle AOB is congruent to triangle COD?*



Triangles AOB and COD are right-angled.
AB = CD (hypotenuse)
AO = OC (side)
⇒ *The statement ΔAOB is congruent to ΔCOD can be made based on the **RHS** test.*
ΔAOB ≡ ΔCOD

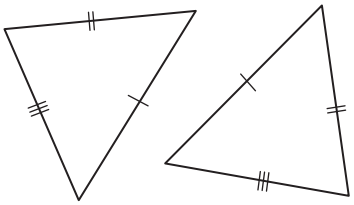
1. For each pair of triangles, determine if they are congruent. If they are, state the congruence test (SSS, SAS, ASA or RHS) that proves that they are congruent.

a)

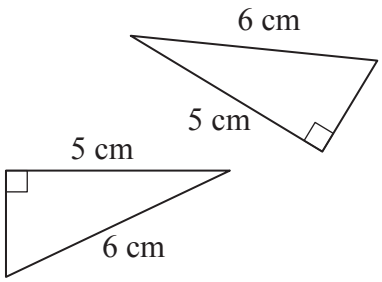


SAS

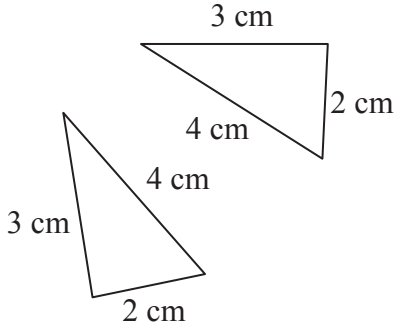
b)



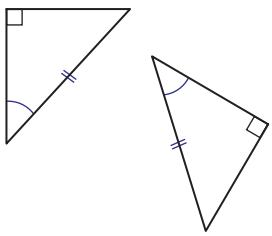
c)



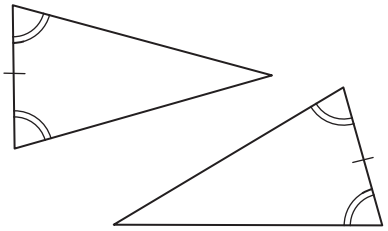
d)



e)

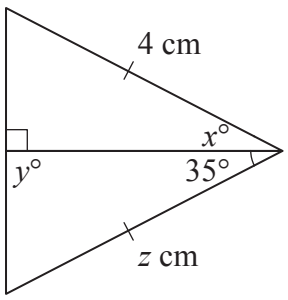


f)



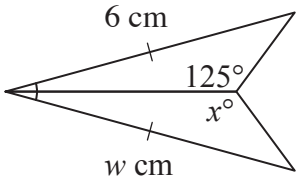
2. For each pair of triangles, state the congruence test that proves they are congruent. Use the fact that they are congruent to find the value of each pronumeral.

a)

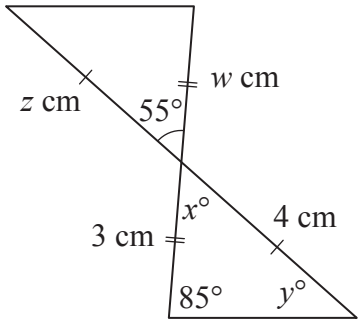


RHS
$x^\circ = 35^\circ$
$y^\circ = 90^\circ$
$z = 4$ *cm*

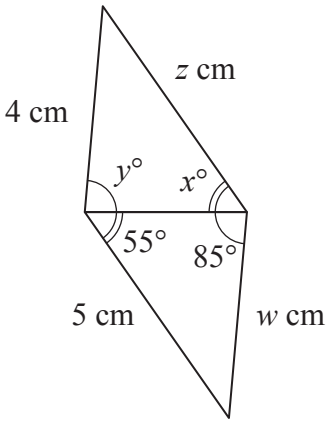
b)



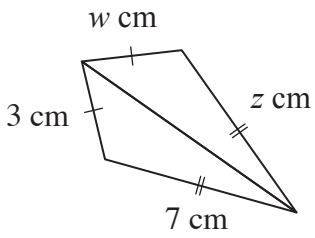
c)



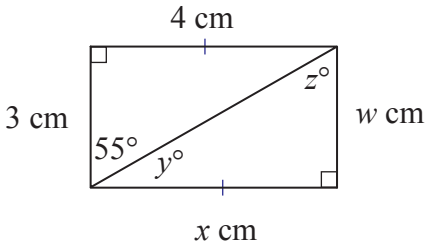
d)



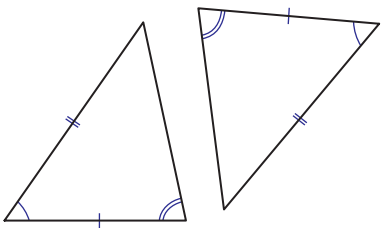
e)



f)



Quest 5 What two congruence tests could be used to prove that these triangles are congruent?



A SSS & SAS **B** SSS & ASA **C** SSS & RHS
D RHS & SAS **E** ASA & RHS **F** ASA & SAS

Now use the code breaker inside the back cover to obtain the fifth code letter.

Sudo-clue: #01

Place the numbers 1 to 9 on the grid using these clues:

1. The sum of the numbers in each row and the sum of the numbers in each column is the same.
2. The last number in Row B divided by the first number in Row A gives the smallest prime number possible.
3. The numbers in Row C are prime.

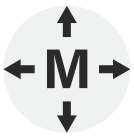
	1	2	3
A			
B			
C			

Remote Control Spy

Welcome agent.

Your mission is to move the coloured shape into the shaded area using the least number of commands. Ensure that at no point your shape leaves the grid. Be careful to avoid contact with any bombs, however you may flip over them providing no part of the shape lands in a grid where a bomb is located. The end position is indicated on the same grid by the grey squares.

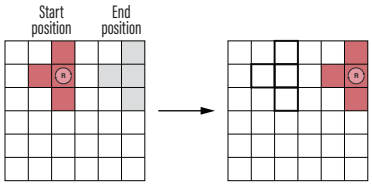
There are 4 commands you can use to navigate each mission, they are:



Translation

Must specify direction of movement (N,S,E,W) and number of units.

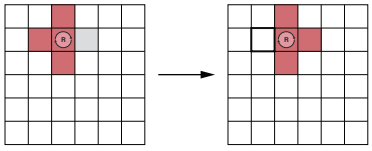
You must have room and not bump into things.



translate (east 3)

Rotation

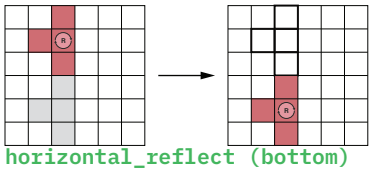
Must specify how many degrees to rotate and which direction, clockwise or anti-clockwise. Your craft will rotate around the point marked on each shape by the rotation symbol. This symbol must start and finish in the same square of the shape.



rotate (180°)

Horizontal Reflection

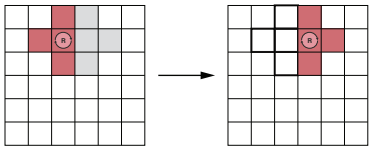
The shape is flipped along a horizontal axis, on either the top or bottom edge. Imagine the edge you're flipping on acting like a door hinge.



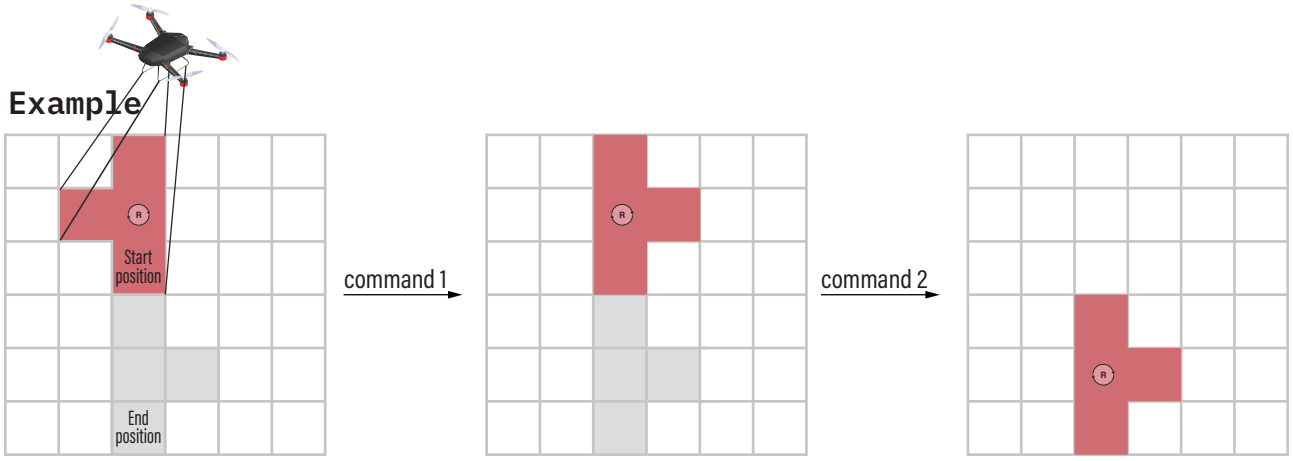
horizontal_reflect (bottom)

Vertical Reflection

The shape is flipped along a vertical axis, on either the left or right edge. Imagine the edge you're flipping on acting like a door hinge.



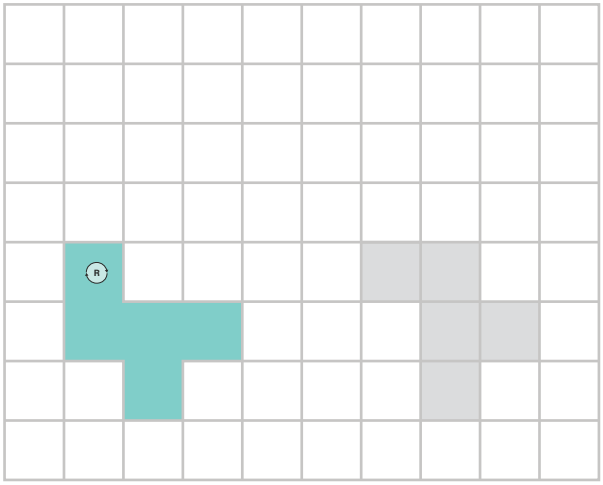
vertical_reflect (right)



{ command 1: *rotate (180°)* }

{ command 2: *translate (south 3)* }

* **Missions can be completed with a command to spare.**



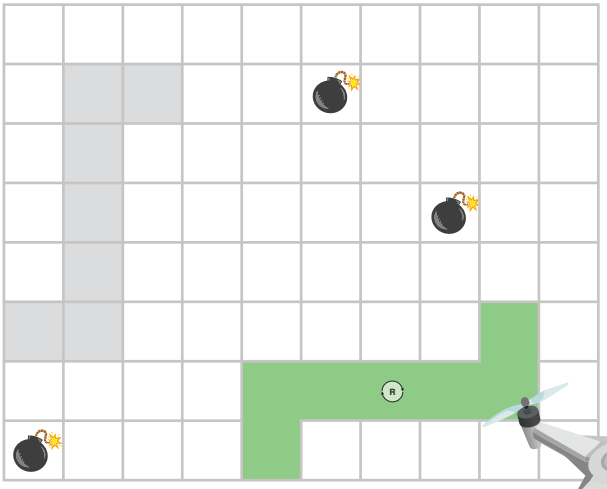
{ command 1: _____ }

{ command 2: _____ }

{ command 3: _____ }

{ command 4: _____ }

{ command 5: _____ }

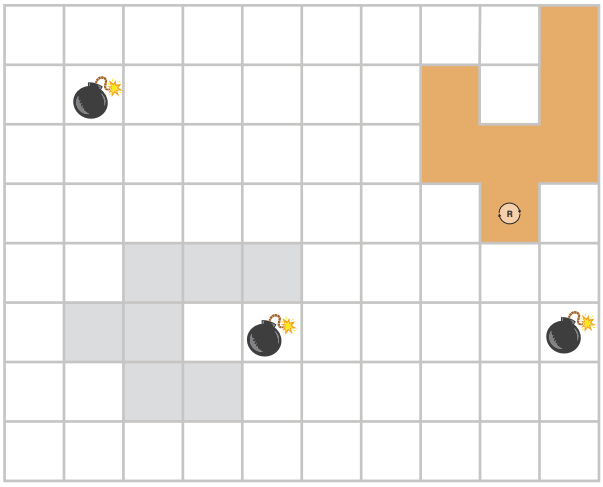


{ command 1: _____ }

{ command 2: _____ }

{ command 3: _____ }

{ command 4: _____ }



{ command 1: _____ }

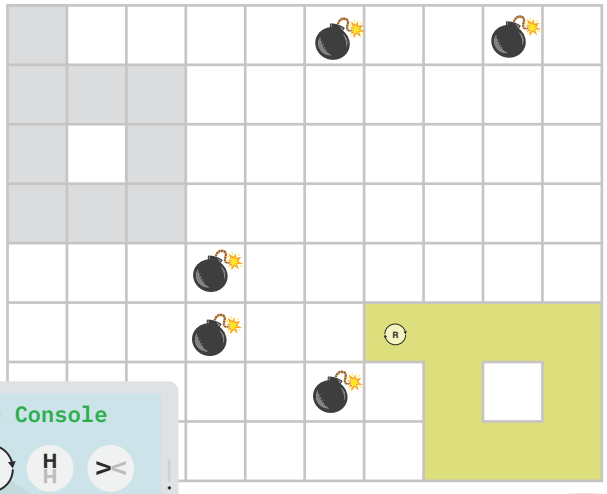
{ command 2: _____ }

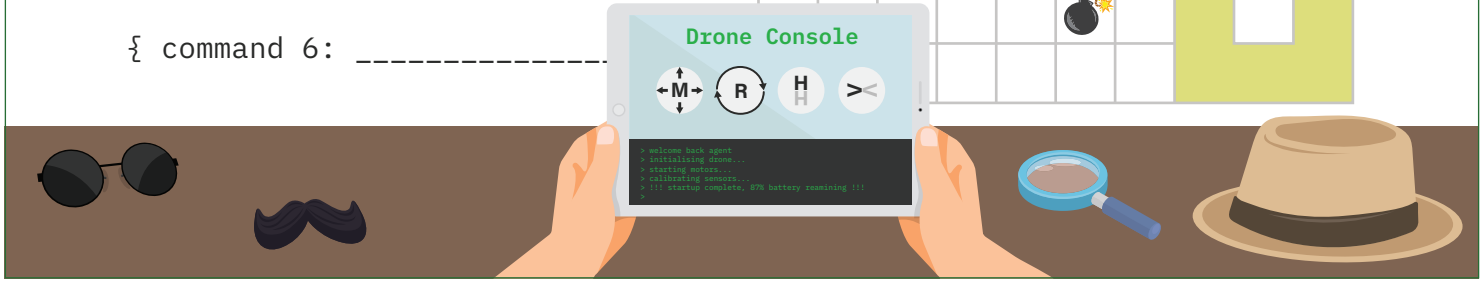
{ command 3: _____ }

{ command 4: _____ }

{ command 5: _____ }

{ command 6: _____ }





Multiple Choice

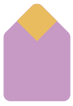
1. Which letter has only horizontal symmetry?

A T **B** C **C** M **D** H

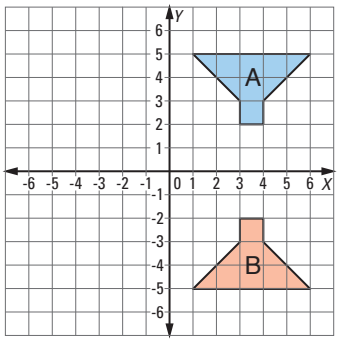
2. How many lines of symmetry does this shape have?

A 0 **B** 1
C 2 **D** 3

3. Which shape does **not** have rotational symmetry?

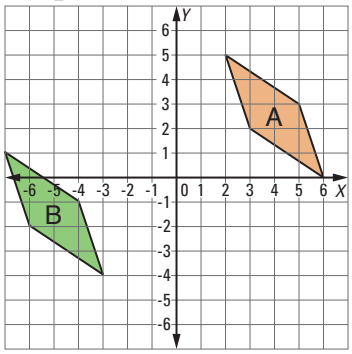
A  **B**  **C**  **D** 

4. Shape A is reflected in what feature to produce shape B?



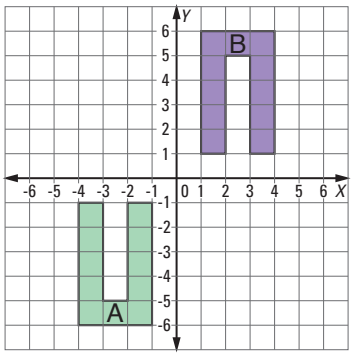
A the point (3,2) **B** the point (4,0)
C the x-axis **D** the y-axis

5. Which translation has moved shape A to shape B?



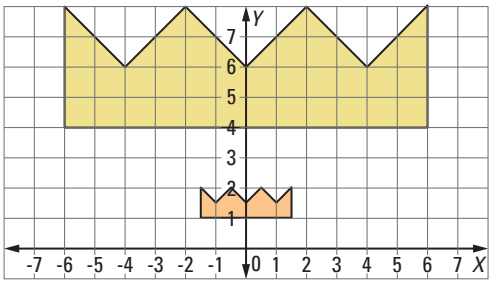
A 9 units right and 4 units up
B 4 units right and 9 units up
C 9 units left and 4 units down
D 4 units left and 9 units down

6. How many degrees clockwise has shape A been rotated by to produce shape B?



A 45° **B** 60° **C** 90° **D** 180°

7. The coordinates of the vertices of the large shape have been divided by what number to produce the reduced shape?

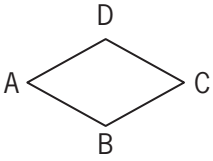


A 4 **B** 3 **C** 2 **D** 1

8. The ratio of the original area to the area of the enlarged shape is:

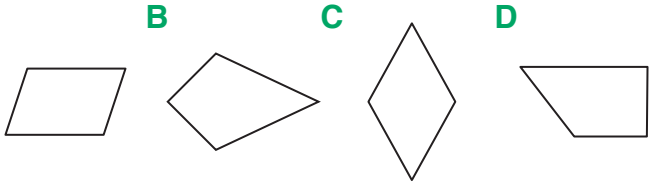
A 1 : 20 **B** 1 : 16 **C** 1 : 12 **D** 1 : 8

9.

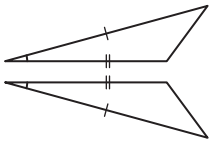


Which shape below is congruent to ABCD?

A **B** **C** **D**



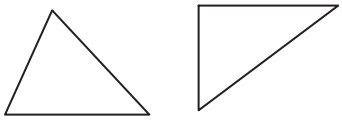
10. Which congruence test proves that these triangles are congruent?



A ASA **B** SSS

C RHS **D** SAS

11. These triangles are:



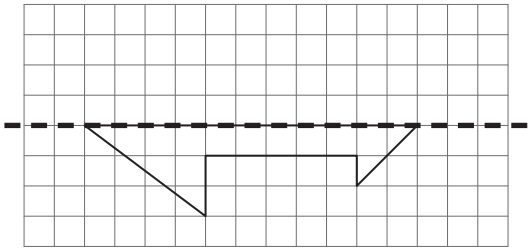
A congruent **B** similar

C obtuse-angled **D** neither

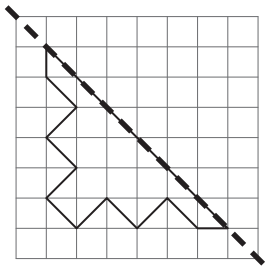
Short Answer

1. Complete the shapes so that they have a line of symmetry shown by the dotted line.

a)

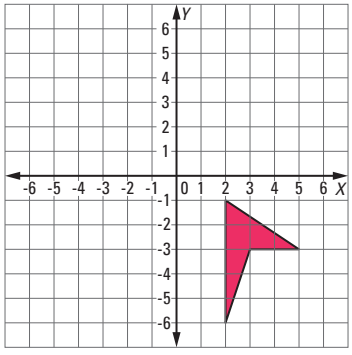


b)

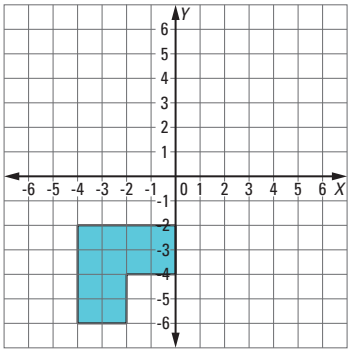


2. Draw the following transformations:

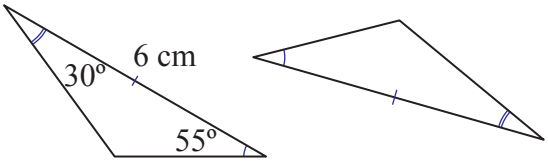
a) Reflection in the y-axis, followed by a translation of 3 units right and 4 units up.



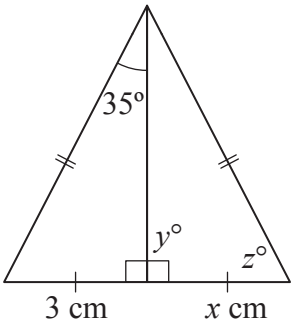
b) Rotation of 90° clockwise around the point (0,–2), followed by a reflection in the y-axis.



3. The angle-side-angle (ASA) congruence test shows that these triangles are congruent. Fill in the known angles and side length on the second triangle.



4. For this pair of triangles, state the congruence test that proves that they are congruent. Use this test to find the value of each pronumeral.



test: _____

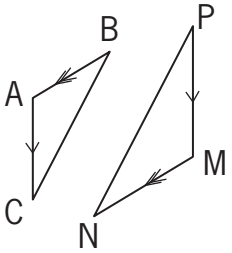
x = _____

$y°$ = _____

$z°$ = _____

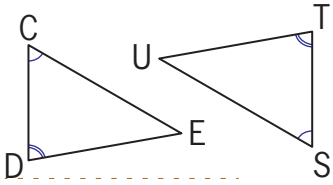
5. Complete the ratios of corresponding sides for these similar triangles.

a)



$\frac{AB}{\square} = \frac{BC}{\square} = \frac{AC}{\square}$

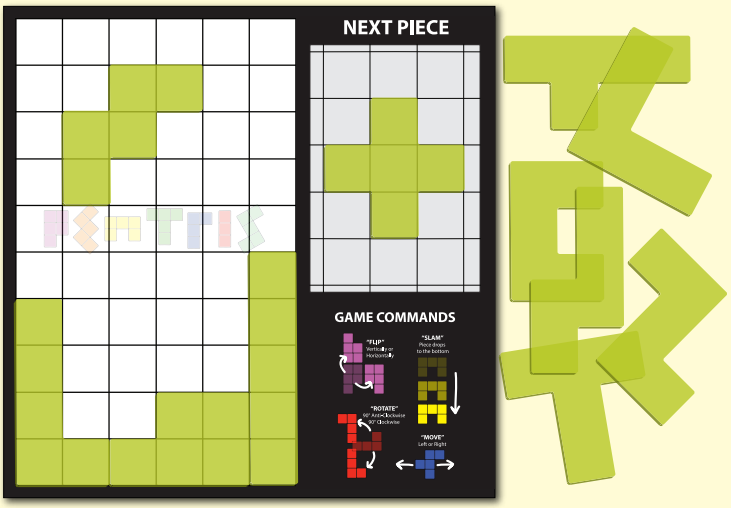
b)



$\frac{\square}{ST} = \frac{\square}{TU} = \frac{\square}{SU}$

Pentris

Weird shapes are falling from the sky! Program your computer (partner) to flip, rotate and move each piece to fit as many as you can into the grid. a need a set of pentominoes (shapes made by joining five identical squares together side-to-side). There are 12 different pentominoes.
Communicate quickly and collaborate as a team or choose nasty pieces and compete against your partner.
Highest score wins the game.

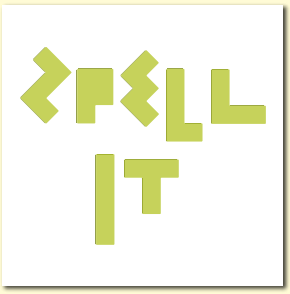


Instructions at: thinksquare.com.au/games/pentris/

Spell it

You'll figure it out as you flip, rotate and get creative with the 12 pentomino pieces to create recognisable words for your teammates. Play first to 20, or high score wins.

Use our online tool to generate random words.



Instructions and word generator at: thinksquare.com.au/games/spell-it/