White Rose Maths

Summer - Block 2

Properties of Shape

Overview

Small Steps

- Measure with a protractor
- Draw lines and angles accurately (R)
- Introduce angles
- Angles on a straight line (R)
- Angles around a point (R)
- Calculate angles
- Vertically opposite angles
- Angles in a triangle
- Angles in a triangle – special cases
- Angles in a triangle – missing angles
- Angles in special quadrilaterals
- Angles in regular polygons
- Draw shapes accurately
- Draw nets of 3-D shapes

Notes for 2020/21

In this block children will build on learning from year 5 to look at properties of shape in detail, specifically angles.

There is time available after this block so it can span a longer period of time if needed.

Consider recapping the drawing of pie charts from the previous block when working with protractors.

Measure with a Protractor

Notes and Guidance

This step revisits measuring angles using a protractor from Year 5
Children recap how to line up the protractor accurately, and identify which side of the scale to read. They link this to their understanding of angle sizes.
Children read the measurement and practise measuring angles given in different orientations.
Angles are also related to compass points.

Mathematical Talk

Can we name and describe the 4 different types of angles? (right angle, obtuse, acute, reflex)

What unit do we use to measure angles?

Does it matter which side of the protractor I use?

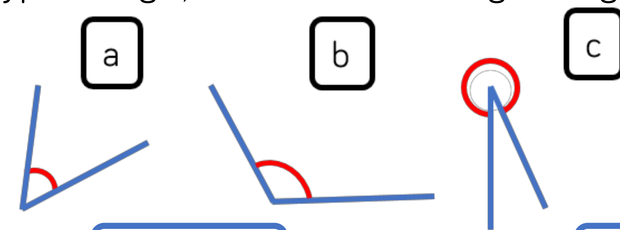
What mistakes could we make when measuring with a protractor?

How would I measure a reflex angle?

Look at a compass, what angles can we identify using the compass?

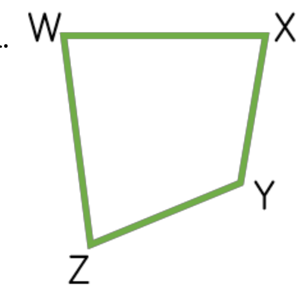
Varied Fluency

- Identify the type of angle, and measure the angle using a protractor.



Angle [ ] is an [ ] angle. It measures [ ]

- Estimate, then measure each of the angles at the vertices of the quadrilateral.

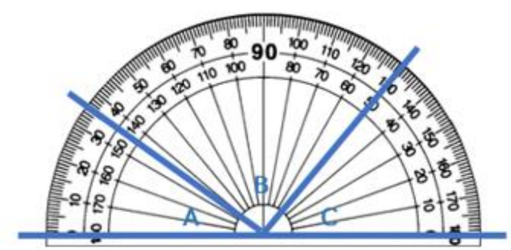


W: [ ] X: [ ]

Y: [ ] Z: [ ]

- Work out the size of each angle.

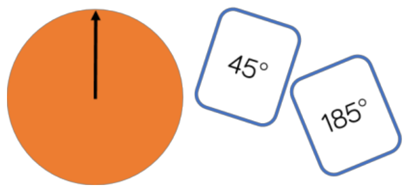
Explain how you found your answers.



Measure with a Protractor

Reasoning and Problem Solving

Cut out a circle and draw a line from the centre to the edge. Add a spinner in the centre.



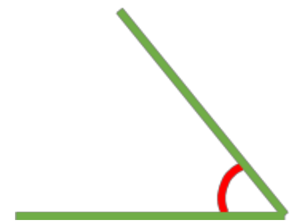
Put the arrow in the starting position as shown above. Turn over a flash card with an angle on.

Estimate the given angle by moving the spinner.

Check how close you are using a protractor.

Children could work in pairs and get a partner to check the accuracy of the angles made.

Alex measures this angle:



She says it is 130°

Explain what she has done wrong.

Alex is wrong because 130° is an obtuse angle and the angle indicated is acute.
She has used the wrong scale on the protractor. She should have measured the angle to be 50°

Drawing Accurately

Notes and Guidance

Children need to draw lines correct to the nearest millimetre. They use a protractor to draw angles of a given size, and will need to be shown this new skill.

Children continue to develop their estimation skills whilst drawing and measuring lines and angles. They also continue to use precise language to describe the types of angles they are drawing.

Mathematical Talk

How many millimetres are in a centimetre?

How do we draw a line that measures ___?

Explain how to draw an angle.

What's the same and what's different about drawing angles of 80° and 100° ?

How can I make this angle measure ___ but one of the lines have a length of ___?

Varied Fluency

R

Draw lines that measure:

4 cm and 5 mm	45 mm	4.5 cm

What's the same? What's different?

Draw:
- angles of 45° and 135°
- angles of 80° and 100°
- angles of 20° and 160°

What do you notice about your pairs of angles?

Draw:
- an acute angle that measures 60° with the arms of the angle 6 cm long
- an obtuse angle that measures 130° but less than 140° with the arms of the angle 6.5 cm long

Compare your angles with your partner's.

Drawing Accurately

Reasoning and Problem Solving

R

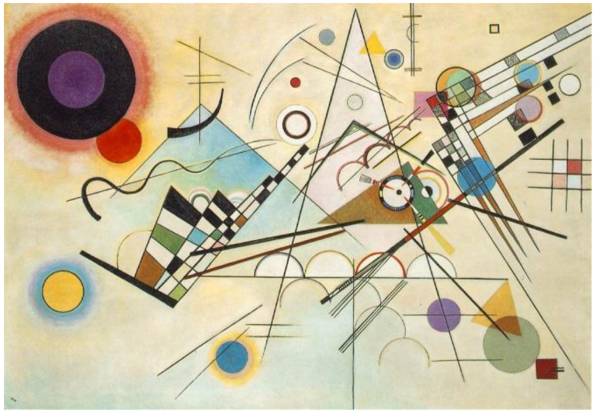
Draw a range of angles for a friend.
Estimate the sizes of the angles to order them from smallest to largest.
Measure the angles to see how close you were.

Always, sometimes or never true?

- Two acute angles next to each other make an obtuse angle.
- Half an obtuse angle is an acute angle.
- 180° is an obtuse angle

- Sometimes
- Always
- Never

Use Kandinsky's artwork to practice measuring lines and angles.



Create clues for your partner to work out which line or angle you have measured.

For example, "My line is horizontal and has an obtuse angle of 110° on it."

Introduce Angles

Notes and Guidance

Children build on their understanding of degrees in a right angle and make the connection that there are two right angles on a straight line and four right angles around a point.

Children should make links to whole, quarter, half and three-quarter turns and apply this in different contexts such as time and on a compass.

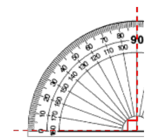
Mathematical Talk

If there are 90 degrees in one right angle, how many are there in two? What about three?

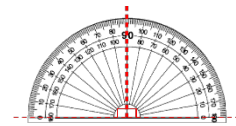
How many degrees are there in a quarter/half turn?

Between which two compass points can you see a right angle/half turn/three quarter turn?

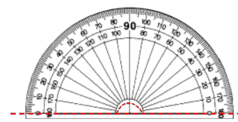
Varied Fluency



There are ☐ degrees in a right angle.



There are ☐ right angles on a straight line.



There are ☐ degrees on a straight line.

Complete the table.

Angle	Fraction of a full turn	Degrees
Right angle	$\frac{1}{4}$	90°
Straight line		
Three right angles		
Full turn		

Use a compass to identify how many degrees there are between:

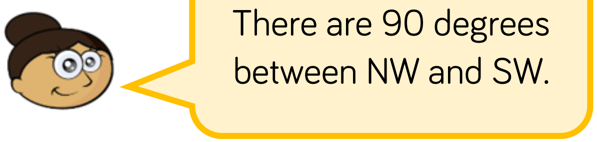
- North & South (turning clockwise)
- South & East (turning anti-clockwise)
- North-East and South-West (turning clockwise)

Introduce Angles

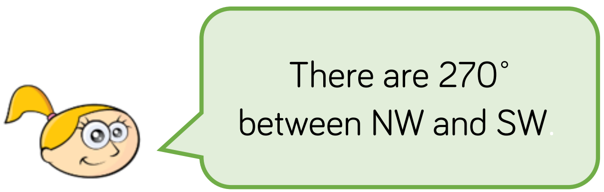
Reasoning and Problem Solving

Dora and Eva are asked how many degrees there are between North-West and South-West.

Dora says,



Eva says,



Who do you agree with?
Explain why.

They are both correct. Dora measured anti-clockwise whereas Eva measured clockwise.

If it takes 60 minutes for the minute hand to travel all the way around the clock, how many degrees does the minute hand travel in:

- 7 minutes
- 12 minutes

How many minutes have passed if the minute hand has moved 162°?

$360 \div 60 = 6$ so the minute hand travels 6° per minute.
7 minutes : 42°
12 minutes : 72°

162° : 27 minutes

Always, sometimes, never.

W to S = 90 degrees
NE to SW = 180 degrees
E to SE in a clockwise direction > 90°

Sometimes
Always
Never

Angles on a Straight Line

Notes and Guidance

Children build on their knowledge of a right angle and recognise two right angles are equivalent to a straight line, or a straight line is a half of a turn.
Once children are aware that angles on a straight line add to 180 degrees, they use this to calculate missing angles on straight lines.
Part-whole and bar models may be used to represent missing angles.

Mathematical Talk

How many degrees are there in a right angle?

How many will there be in two right angles?

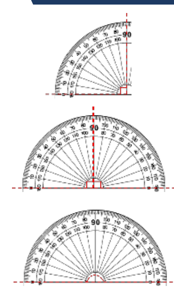
If we place two right angles together, what do we notice?

How can we calculate the missing angles?

How can we subtract a number from 180 mentally?

Varied Fluency

R

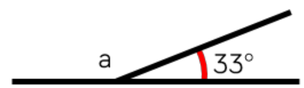


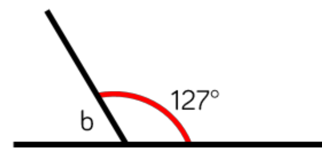
There are ______degrees in a right angle.

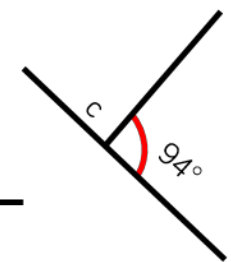
There are ______right angles on a straight line.

There are ______degrees on a straight line.

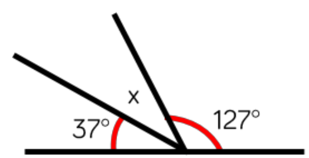
Calculate the missing angles.

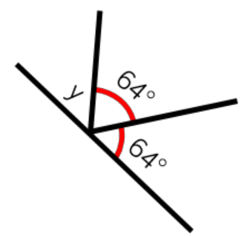


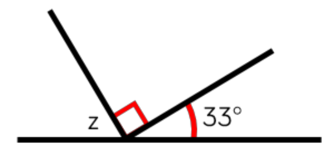




Calculate the missing angles.







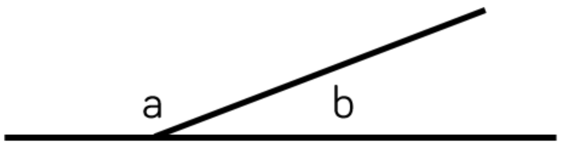
Is there more than one way to calculate the missing angles?

Angles on a Straight Line

Reasoning and Problem Solving

R

Here are two angles.



Angle b is a prime number between 40 and 50

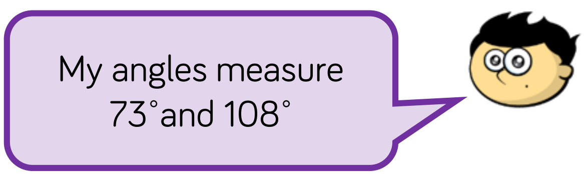
Use the clue to calculate what the missing angles could be.

$b = 41^\circ$, $a = 139^\circ$

$b = 43^\circ$, $a = 137^\circ$

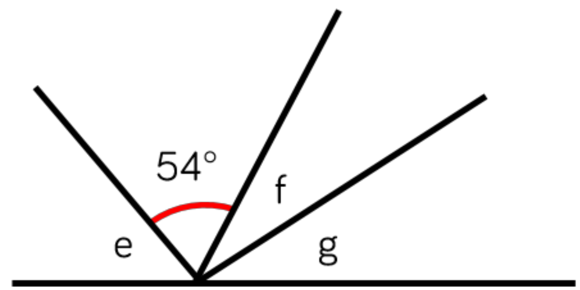
$b = 47^\circ$, $a = 133^\circ$

Jack is measuring two angles on a straight line.



Explain why at least one of Jack's angles must be wrong.

His angles total more than 180°.



- The total of angle f and g are the same as angle e
- Angle e is 9° more than the size of the given angle.
- Angle f is 11° more than angle g

Calculate the size of the angles.

Create your own straight line problem like this one for your partner.

$e = 63^\circ$

$f = 37^\circ$

$g = 26^\circ$

White Rose Maths

Angles around a Point

Notes and Guidance

Children need to know that there are 360 degrees in a full turn. This connects to their knowledge of right angles, full turns and compass points.

Children need to know when they should measure an angle and when they should calculate the size of angle from given facts.

Mathematical Talk

How many right angles are there in $\frac{1}{4}, \frac{1}{2}, \frac{3}{4}$ of a full turn?

If you know a half turn/full turn is 180/360 degrees, how can this help you calculate the missing angle?

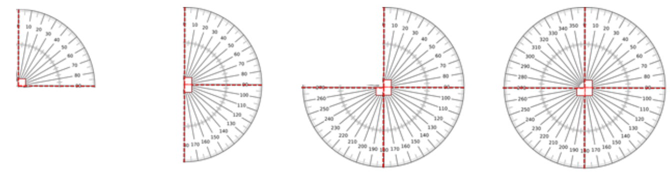
What is the most efficient way to calculate a missing angle? Would you use a mental or written method?

When you have several angles, is it better to add them first or to subtract them one by one?

Varied Fluency

R

Complete the sentences.



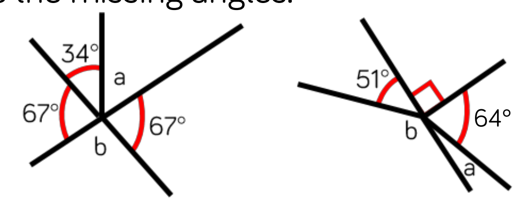
$\frac{1}{4}$ of a turn = 1 right angle = 90°

$\frac{1}{2}$ of a turn = __ right angles = ____°

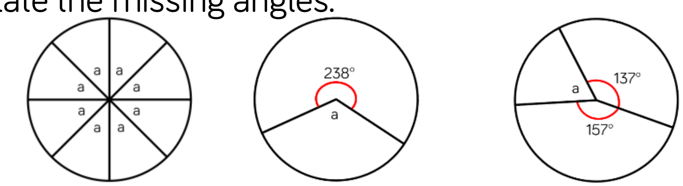
$\frac{\square}{\square}$ of a turn = 3 right angles = ____°

A full turn = __ right angles = ____°

Calculate the missing angles.

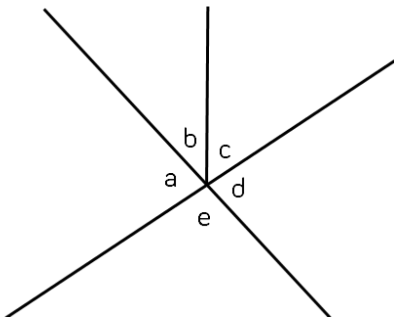


Calculate the missing angles.



Angles around a Point

Reasoning and Problem Solving



$a + b + c + d + e = 360^\circ$
$d + e = 180^\circ$
Write other sentences about this picture.

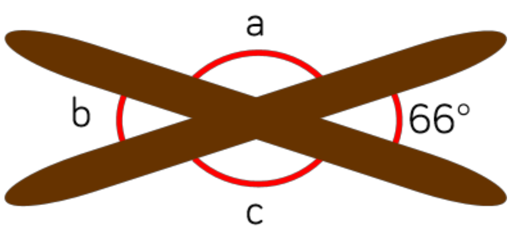
Various answers e.g.

$a + b + c = e + d$

$360^\circ - e - d = 180^\circ$

Etc.

Two sticks are on a table.
Without measuring, find the three missing angles.



$a = 114^\circ$

$b = 66^\circ$

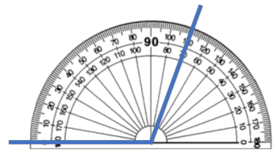
$c = 114^\circ$

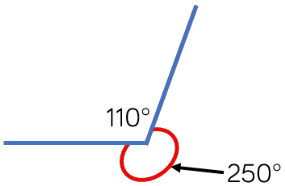
Eva says,

My protractor only goes to 180 degrees, so I can't draw reflex angles like 250 degrees.

Rosie says,

I know a full turn is 360 degrees so I can draw 110 degrees instead and have an angle of 250 degrees as well.





Use Rosie's method to draw angles of:
- 300°
- 200°
- 280°

Calculate Angles

Notes and Guidance

Children apply their understanding of angles in a right angle, angles on a straight line and angles around a point to calculate missing angles.

They should also recognise right angle notation and identify these on a diagram. Children then use this information to help them calculate unknown angles.

Mathematical Talk

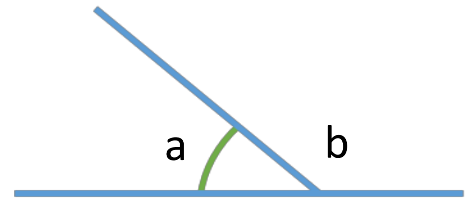
What do we know about a and b? How do we know this?

Which angle fact might you need to use when answering this question?

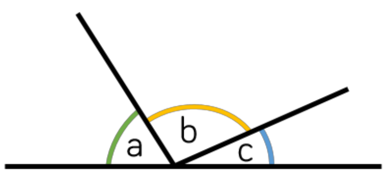
Which angles are already given? How can we use this to calculate unknown angles?

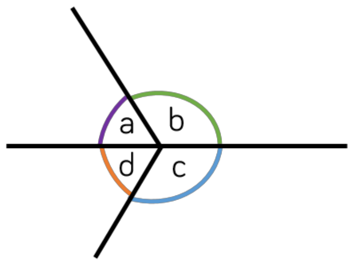
Varied Fluency

- a + b = ☐
  b + a = ☐
  ☐ − a = b
  ☐ − b = a

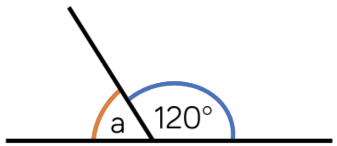


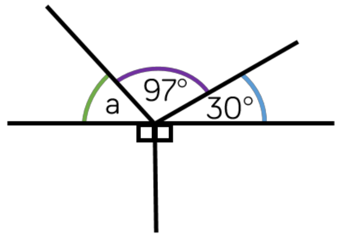
- How many number sentences can you write from the images?





- Calculate the missing angles.



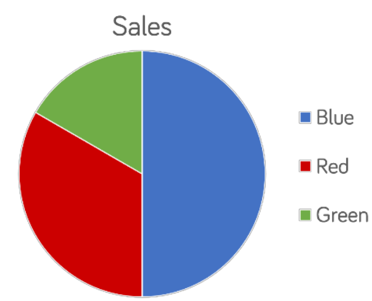


Calculate Angles

Reasoning and Problem Solving

There are five equal angles around a point. What is the size of each angle? Explain how you know.	72° because $360 \div 5 = 72$
Four angles meet at the same point on a straight line. One angle is 81° The other three angles are equal. What size are the other three angles? Draw a diagram to prove your answer.	$180 - 81 = 99°$ $99 \div 3 = 33°$

Here is a pie chart showing the colour of cars sold by a car dealer.



The number of blue cars sold is equal to the total number of red and green cars sold.

The number of red cars sold is twice the number of green cars sold.

Work out the size of the angle for each section of the pie chart.

Blue : 180°
Red : 120°
Green : 60°

Vertically Opposite Angles

Notes and Guidance

Children recognise that vertically opposite angles share a vertex. They realise that they are equal and use practical examples to show this.

They continue to apply their understanding of angles on a straight line and around a point to calculate missing angles.

Mathematical Talk

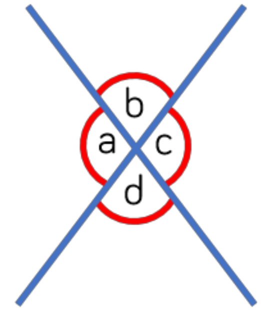
What sentences can we write about vertically opposite angles in relation to other angles?

How can we find the missing angle?

Is there more than one way to find this angle?

Varied Fluency

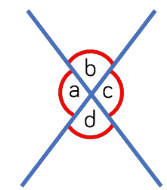
- Take a piece of paper and draw a large 'X'.
  Mark the angles on as shown.
  Measure the angles you have drawn.
  What do you notice about angles b and d?
  What do you notice about angles a and c?
  Is this always the case?
  Investigate with other examples.



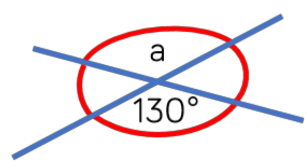
- Use the letters from the diagram to fill in the boxes.

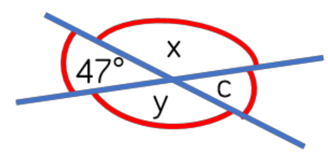
□ = □ □ = □

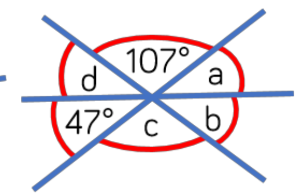
□ + □ = 180° □ + □ = 180°



- Find the size of the missing angles.





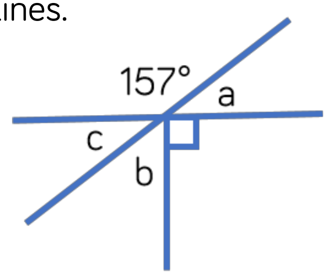


Is there more than one way to find them?

Vertically Opposite Angles

Reasoning and Problem Solving

The diagram below is drawn using three straight lines.



Whitney says that it's not possible to calculate all of the missing angles.

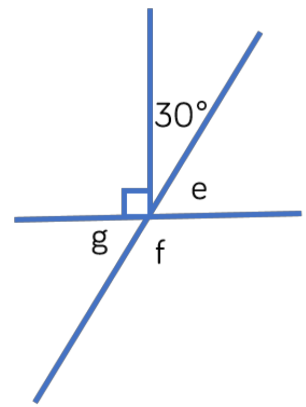
Do you agree? Explain why.

I disagree because:
180 – 157 = 23
so a = 23°
because angles on a straight line add up to 180°

Angles a and c are equal because they are vertically opposite so
c = 23°

Angles around a point add up to 360° so
b = 67°

The diagram below is drawn using three straight lines.



Amir says that angle g is equal to 30° because vertically opposite angles are equal.

Do you agree? Explain your answer.

Find the size of all missing angles.
Is there more than one way to find the size of each angle?

Amir is wrong because g is vertically opposite to e, not to 30° so g would actually be 60°

e = 60°
g = 60°
f = 120°
There are multiple ways to find the size of each angle.

Angles in a Triangle (1)

Notes and Guidance

Children practically explore interior angles of a triangle and understand that the angles will add up to 180 degrees.

Children should apply their understanding that angles at a point on a straight line add up to 180 degrees.

Mathematical Talk

What's the same and what's different about the four types of triangle?

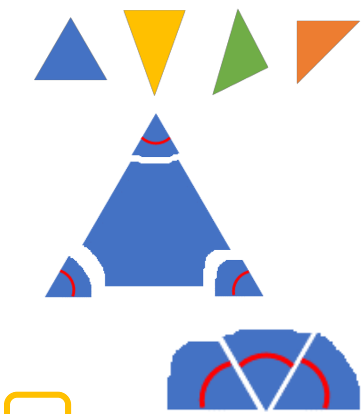
What do the three interior angles add up to? Would this work for all triangles?

Does the type of triangle change anything?

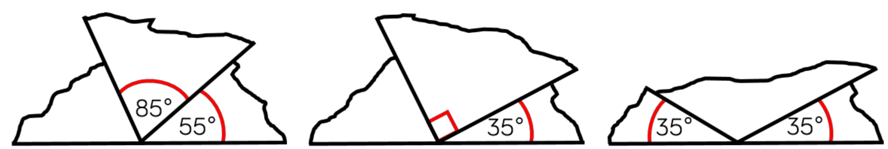
Does the size of the triangle matter?

Varied Fluency

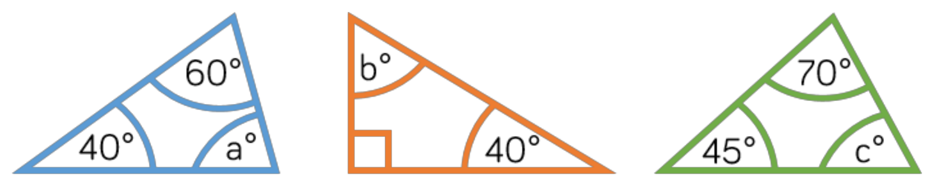
- Use different coloured pieces of card to make an equilateral, isosceles, scalene and right-angled triangle.
  Use a protractor to measure each interior angle, then add them up. What do you notice?
  Now take any of the triangles and tear the corners off. Arrange the corners to make a straight line.
  The interior angles of a triangle add up to



- Calculate the missing angles and state the type of triangle that these corners have been torn from.



- Calculate the missing angles.



Angles in a Triangle (1)

Reasoning and Problem Solving

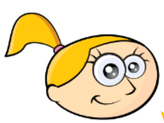
Amir says,

My triangle has two 90° angles.

Can Amir be correct? Can you demonstrate this?

Amir can't be correct because these two angles would add up to 180 degrees, and the third angle can't be 0 degrees.

Eva says,



My triangle is a scalene triangle. One angle is obtuse. One of the angles measures 56°
The obtuse angle is three times the smallest angle.

Work out the size of each of the angles in the triangle.

The interior angles of Eva's triangle are 56°, 93° and 31°

True or False?

A triangle can never have 3 acute angles.

False
Children could use multiple examples to show this.

Angles in a Triangle (2)

Notes and Guidance

Children are introduced to hatch marks for equal lengths. They concentrate on angles in right-angled triangles and isosceles triangles.

Children use their understanding of the properties of triangles to reason about angles.

Mathematical Talk

How can we identify sides which are the same length on a triangle?

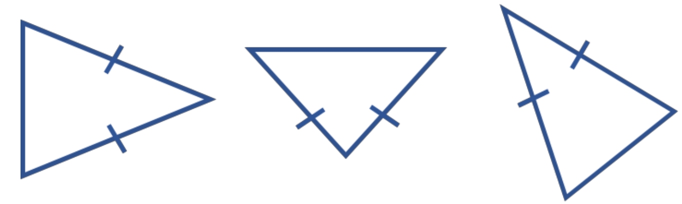
How can we use the use the hatch marks to identify the equal angles?

If you know one angle in an isosceles triangle, what else do you know?

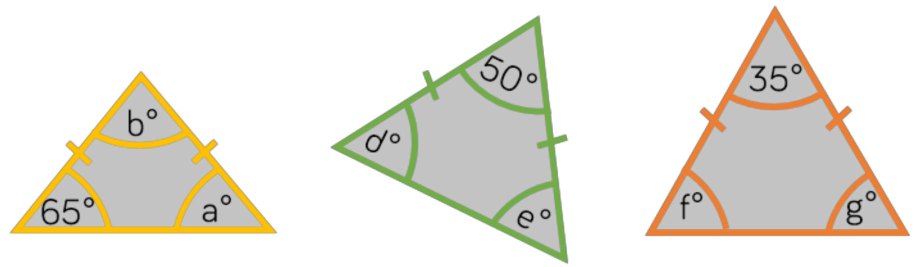
Can you have an isosceles right-angled triangle?

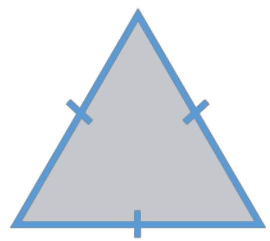
Varied Fluency

- Identify which angles will be identical in the isosceles triangles.



- Calculate the missing angles in the isosceles triangles.



- 

What type of triangle is this?
What will the size of each angle be?
How do you know?
Will this always be the same for this type of triangle?
Explain your answer.

White Rose Maths

Angles in a Triangle (2)

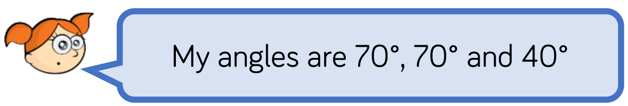
Reasoning and Problem Solving

I have an isosceles triangle.
One angle measures 42 degrees.

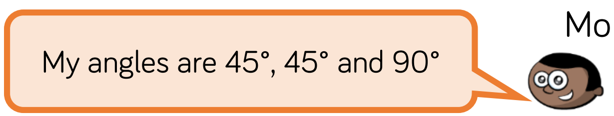
What could the other angles measure?

The angles could be:
42°, 42°, 96°
or
42°, 69°, 69°

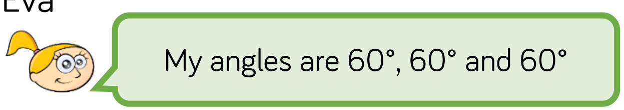
Alex



Mo



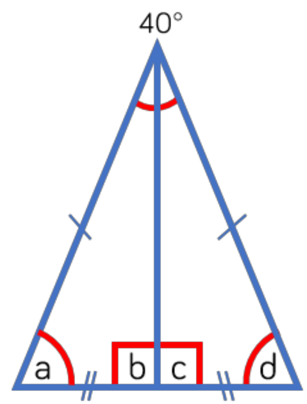
Eva



What type of triangle is each person describing?
Explain how you know.

Alex is describing an isosceles triangle.
Mo is describing an isosceles right-angled triangle.
Eva is describing an equilateral triangle.

How many sentences can you write to express the relationships between the angles in the triangles?
One has been done for you.



40° + a + d = 180°

Possible responses:
20° + a + b = 180°
20° + c + d = 180°
b = 90 °
c = 90 °
b = c
a = d
etc.

Children could also work out the value of each angle.

Angles in a Triangle (3)

Notes and Guidance

Children build on prior learning to make links and recognise key features of specific types of triangle. They think about using this information to solve missing angle problems.

They should also use their knowledge of angles on a straight line, angles around a point and vertically opposite angles.

Mathematical Talk

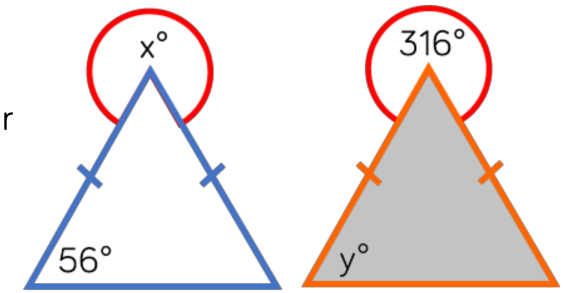
Is it sensible to estimate the angles before calculating them? Are the triangles drawn accurately?

Can you identify the type of triangle? How will this help you calculate the missing angle?

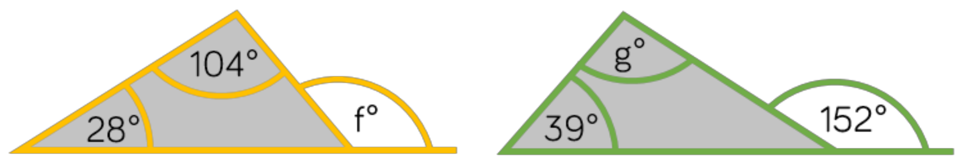
Which angle can you work out first? Why? What else can you work out?

Varied Fluency

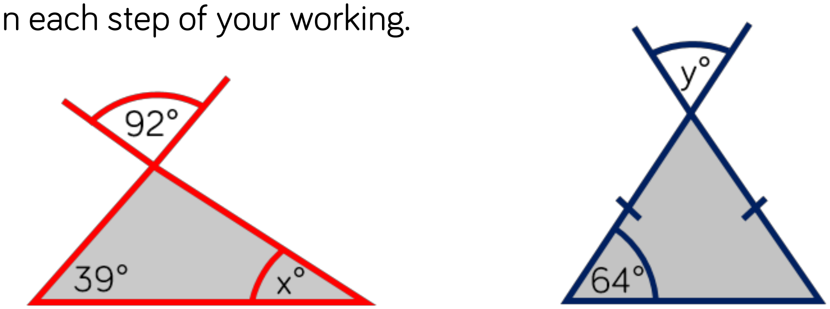
- Work out the value of x and y.
  Explain each step of your working.



- Work out the value of f and g.
  Explain each step of your working.



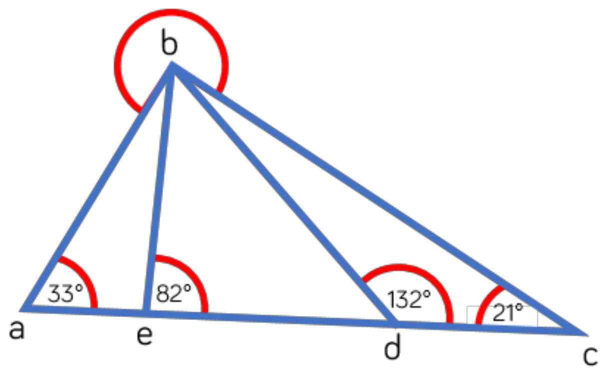
- Work out the value of x and y.
  Explain each step of your working.



Angles in a Triangle (3)

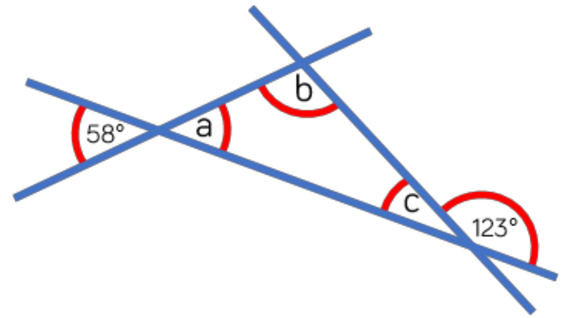
Reasoning and Problem Solving

Calculate the size of the reflex angle b.



234°

Calculate the size of angles a, b and c.



Give reasons for all of your answers.

a is 58 degrees because vertically opposite angles are equal.

c is 57 degrees because angles on a straight line add up to 180 degrees.

b is 65 degrees because angles in a triangle add up to 180 degrees.

Angles in Quadrilaterals

Notes and Guidance

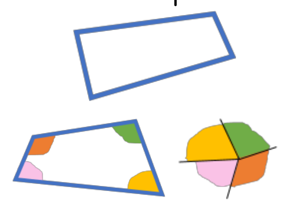
Children use their knowledge of properties of shape to explore interior angles in a parallelogram, rhombus, trapezium etc. They need to learn that angles in any quadrilateral add up to 360°. If they are investigating by measuring, there may be accuracy errors which will be a good discussion point.
Children need to have a secure understanding of the relationship between a rectangle, a parallelogram, a square and a rhombus.

Mathematical Talk

Is a rectangle a parallelogram? Is a parallelogram a rectangle?
What do you notice about the opposite angles in a parallelogram?
Is a square a rhombus? Is a rhombus a square?
What do you notice about the opposite angles in a rhombus?
What is the difference between a trapezium and an isosceles trapezium?
If you know 3 of the interior angles, how could you work out the fourth angle?

Varied Fluency

- Take two quadrilaterals.



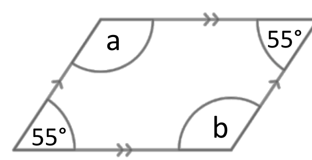
For the first quadrilateral, measure the interior angles using a protractor.
For the second, tear the corners off and place the interior angles at a point as shown.

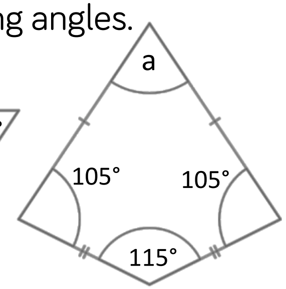
What's the same? What's different? Is this the case for other quadrilaterals?

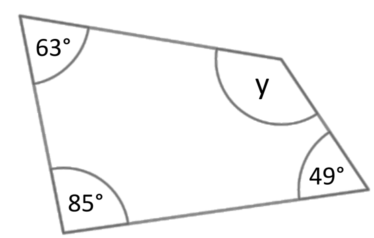
- Here are two trapeziums. What's the same? What's different?

Can you draw a different trapezium?
Measure the interior angles of each one and find the total.

- Calculate the missing angles.



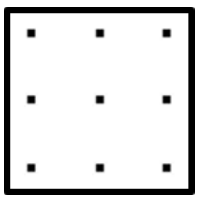




Angles in Quadrilaterals

Reasoning and Problem Solving

How many quadrilaterals can you make on the geoboard?



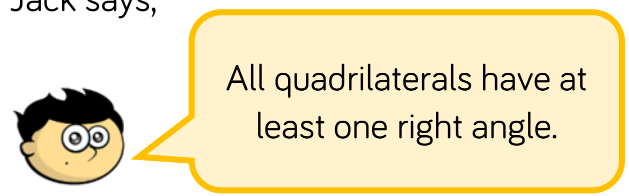
Identify the names of the different quadrilaterals.

What do you notice about the angles in certain quadrilaterals?

If your geoboard was 4 × 4, would you be able to make any different quadrilaterals?

There are lots of different quadrilaterals children could make. They should notice that opposite angles in a parallelogram and rhombus are equal.
They should also identify that a kite has a pair of equal angles, and some kites have a right angle.
On a larger grid, they could draw a trapezium without a right angle.

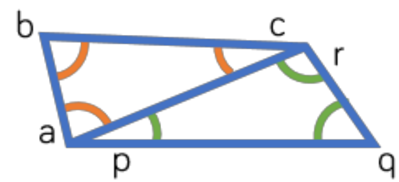
Jack says,



Draw two different shapes to prove Jack wrong. Measure and mark on the angles.

Examples:
Trapezium (without a right angle)
Rhombus
Parallelogram

This quadrilateral is split into two triangles.



Use your knowledge of angles in a triangle to find the sum of angles in a quadrilateral.

Split other quadrilaterals into triangles too. What do you notice?

Children should find that angles in all quadrilaterals will always sum to 360 degrees.

Angles in Polygons

Notes and Guidance

Children use their knowledge of properties of shape to explore interior angles in polygons.

Children explore how they can partition shapes into triangles from a single vertex to work out the sum of the angles in polygons.

They use their knowledge of angles on a straight line summing to 180° to calculate exterior angles.

Mathematical Talk

What is a regular polygon? What is an irregular polygon?

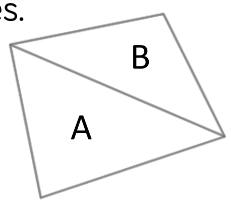
What is the sum of interior angles of a triangle?

How can we use this to work out the interior angles of polygons?

Can we spot a pattern in the table? What predictions can we make?

Varied Fluency

- Draw any quadrilateral and partition it into 2 triangles.
What do the interior angles of triangle A add up to?
What do the interior angles of triangle B add up to?
What is the sum of angles in a quadrilateral?



- Use the same method to complete the table.

Shape	No. of sides	No. of triangles	180 × no. of triangles	Sum of internal angles
Quadrilateral	4	2	180 × 2	360°
Pentagon	5	3		
Hexagon				
Heptagon				

What do you notice?
Can you predict the angle sum of any other polygons?

Angles in Polygons

Reasoning and Problem Solving

Use the clues to work out what shape each person has.

Dora

My polygon is made up of 5 triangles.

The sum of my angles is more than 540° but less than 900°

Tommy

Alex

The sum of my angles is equivalent to the sum of angles in 3 triangles.

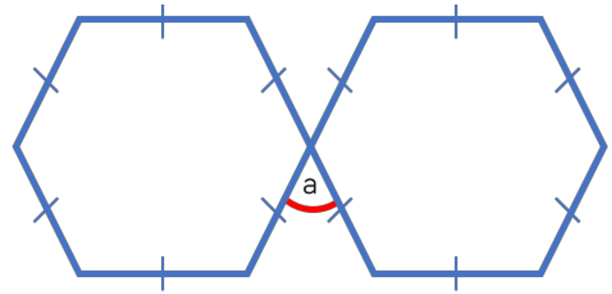
What is the sum of the interior angles of each shape?

Dora:
Heptagon – 900°

Tommy:
Hexagon – 720°

Alex:
Pentagon – 540°

Here are two regular hexagons.



The interior angles of a hexagon sum to 720°
Use this fact to work out angle a in the diagram.

60°

Drawing Shapes Accurately

Notes and Guidance

Children begin by drawing shapes accurately on different grids such as squared and dotted paper. They then move on to using a protractor on plain paper.

Children use their knowledge of properties of shapes and angles, as well as converting between different units of measure.

Mathematical Talk

What do you know about the shapes which will help you draw them?

How can we ensure our measurements are accurate?

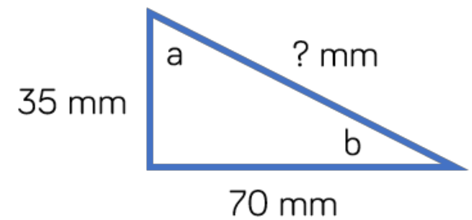
How would you draw a triangle on a plain piece of paper using a protractor?

Varied Fluency

On a piece of squared paper, accurately draw the shapes.

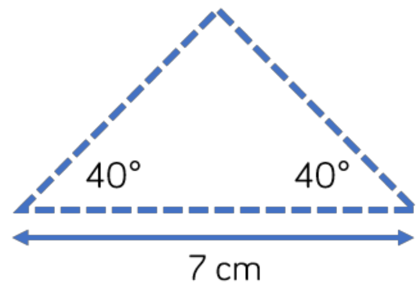
- A square with perimeter 16 cm.
- A rectangle with an area of 20 cm^2.
- A right-angled triangle with a height of 8 cm and a base of 6 cm.
- A parallelogram with sides 3 cm and 5 cm.

Draw the triangle accurately on squared paper to work out the missing length. Measure the size of angles A and B.



Rosie has been asked to draw this triangle on plain paper using a protractor.

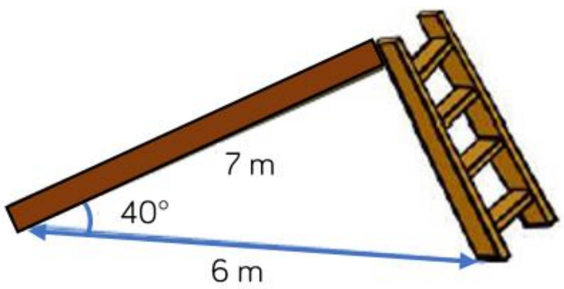
Create a step-by-step plan to show how she would do this.



Drawing Shapes Accurately

Reasoning and Problem Solving

Mr Harrison is designing a slide for the playground.



Use a scale of 1 cm to represent 1 m.

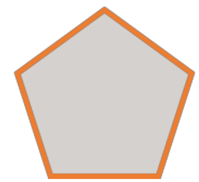
Draw a scale diagram.

Use the diagram to find out how long Mr Harrison needs the ladder to be.

Children will have to use the scale to give their answer in m once they have measured it in cm.

The ladder should be approximately 4.5 m

What is the size of each interior angle of the regular shape below.



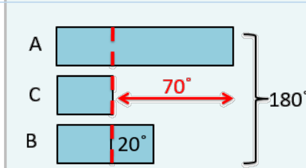
Accurately draw a regular pentagon with side length 5 cm.

108°

Eva has drawn a scalene triangle.
Angle A is the biggest angle.
Angle B is 20° larger than angle C.
Angle C is the smallest angle, and it is 70° smaller than angle A.

Use a bar model to help you calculate the size of each angle, then construct Eva's triangle.

Is there more than one way to construct the triangle?



Angle A: 100°
Angle B: 50°
Angle C: 30°
These angles would work with different side lengths.

Nets of 3-D Shapes

Notes and Guidance

Children use their knowledge of 2-D and 3-D shapes to identify three-dimensional shapes from their nets.

Children need to recognise that a net is a two-dimensional figure that can be folded to create a three-dimensional shape.

They use measuring tools and conventional markings to draw nets of shapes accurately.

Mathematical Talk

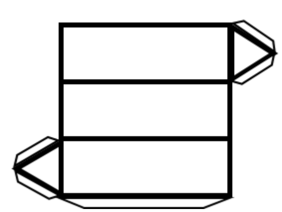
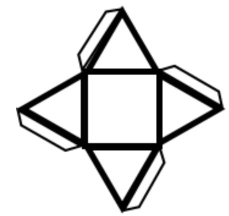
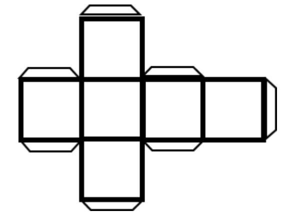
Looking at the faces of a three-dimensional shape, what two-dimensional shapes can you see?

What is a net? What shape will this net make? How do you know? What shape won't it make?

If you make this net, what would happen if you were not accurate with your measuring?

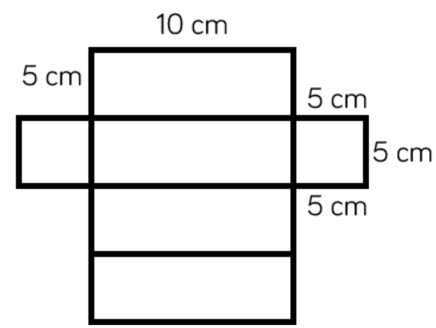
Varied Fluency

- What three-dimensional shape can be made from these nets?

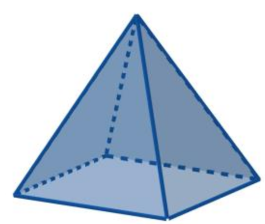




Identify and describe the faces of each shape.

- Accurately draw this net. Cut, fold and stick to create a cuboid.



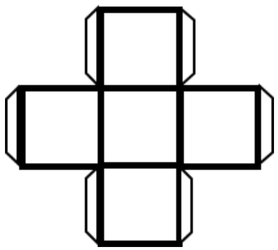
- Draw possible nets of these three-dimensional shapes.




Nets of 3-D Shapes

Reasoning and Problem Solving

Dora thinks that this net will fold to create a cube.



Do you agree with Dora?
Explain your answer.

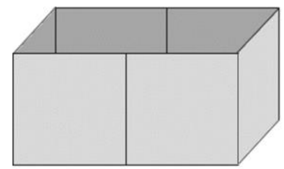
Dora is incorrect because a cube has 6 faces, this net would only have 5

Use Polydron to investigate how many different nets can be made for a cube.

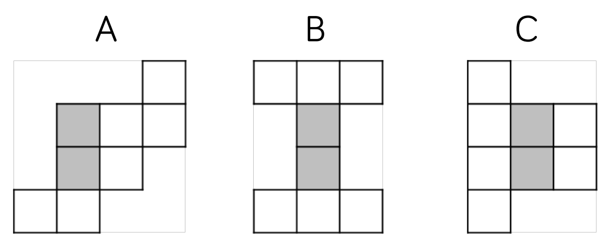
Is there a rule you need to follow?
Can you spot an arrangement that won't work before you build it?
How do you know why it will or won't work?
Can you record your investigation systematically?

There are 11 possible nets.

Here is an open box.



Which of the nets will fold together to make the box?
The grey squares show the base.



B and C