Mathematics Mastery

At home materials
Guidance Pack
Year 6 Weeks 5-9

Week	Pack	
Week 5	**Pack 1: Angles and shapes**	
	Session A) 90 and 180 degrees	☆
	Session B) 360 degrees	☆
	Session C) Describing polygons	☆
	Session D) Comparing shapes	☆
Week 6	**Pack 2: Triangles**	
	Session A) Creating triangles	☆
	Session B) Triangle symmetry	☆
	Session C) Describing triangles	☆
	Session D) Angles in triangles	☆
Week 7	**Pack 3: Quadrilaterals**	
	Session A) Creating quadrilaterals	☆
	Session B) Quadrilateral symmetry	☆
	Session C) Angles in quadrilaterals	☆
	Session D) Describing quadrilaterals	☆
Week 8	**Pack 4: Area**	
	Session A) What is area?	☆
	Session B) Area and arrays	☆
	Session C) Squared units	☆
	Session D) Exploring area	☆
Week 9	**Pack 5: Positive and negative numbers**	
	Session A) Negative numbers in context	☆
	Session B) Extending the number line	☆
	Session C) Comparing numbers	☆
	Session D) Greater than and less than	☆

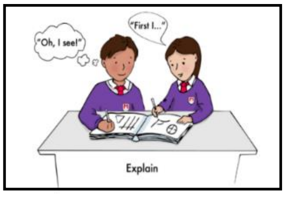
At home materials

Timing
Each session is 30 minutes
20 minute Talk Task and 10 minute independent activity
Use the front cover as a tick list for when the task has been compelted

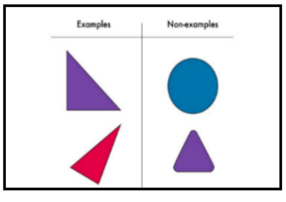
Session guidance
Get **them** talking and grow their language.

Get **them** to use equipment, manipulatives, models and images to show and explain.

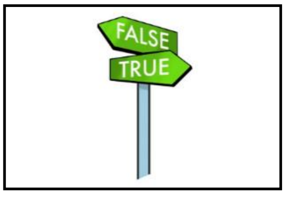
Challenge them to think mathematically. Use the 'Prompts for Thinking' listed below to help them to build up habits in the way they think about mathematical situations.



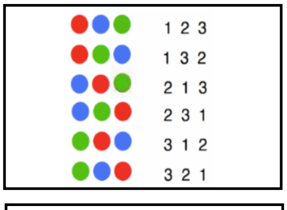
Reason it
Explain how you know. Focus on reasons rather than answers. What could you say, do, draw or write to help someone else understand?



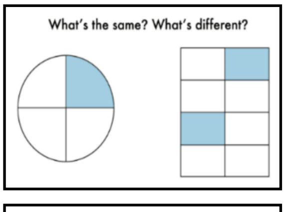
Generate examples and non-examples
What are the important features? What features are not important (e.g. colour)?



True or false?
If true, give examples to support your answer.
If false, give a counter example.



Find all possibilities
Have you found all the possible answers? How do you know? Did you work systematically?



What's the same? What's different?
Compare and contrast and look for connections.
How many different answers can you give?

Always, sometimes or never true?
Give examples to show if the statement is always, sometimes or never true. How do you know?

At home materials

Pack 1: Angles and shapes

Session A) 90 and 180 degrees

Session B) 360 degrees

Session C) Describing polygons

Session D) Composing shapes

Mathematics Mastery

Step-by-step

Pack 1: Angles and shapes	
Session A: $90°$ and $180°$	
Resources needed: Strips of card/paper, split pins, protractor, ruler	
The purpose of this session is to explore angles on a straight line and use knowledge of $90°$ and $180°$ to find unknown angles.	

Talk Task
Use two strips of paper and a split pin to create an angle maker that will allow you to explore angles on a straight line (see image on sheet). Ask learners to use it to create and estimate different angles.

Create an acute angle, estimate its size, what is the angle on the other side?

Repeat this a few times and pay attention to whether learners use the understanding that the angles on a straight line sum to $180°$. Draw attention to this by positioning the arm to show two right angles.

Challenge learners to decide if the statements on the sheet are always true, sometimes true or never true. Give them time to explore and encourage them to try and give a clear explanation for their choices. The first two statements are never true and the last statement sometimes true. The following are some possible explanations:

An acute angle is less than $90°$ so two acute angles will be less than $180°$.

An obtuse angle is greater than $90°$ so two obtuse angles will be more than $180°$.

Positioning the arm at two right angles shows the only time this is not true. Moving the arm shows that one angle becomes less than $90°$ as the other becomes greater than $90°$. If one is an acute angle, the other is an obtuse angle.

Look at the images on the sheet and talk about what you know and how you can use that to work out the value of the unknown angle. You may need to prompt learners to recognise the symbol for a right angle and that they know this is $90°$.

Use this as an opportunity to discuss different calculation strategies for each as well as a chance to review protractor skills by measuring to check.

Activity
The activity sheet provides further examples. You can choose to write in some of the values from the answer sheet so that the focus is on calculating or you can challenge learners to measure and calculate.
Extend the session by using a ruler and protractor to create and label different examples of angles on a straight line.

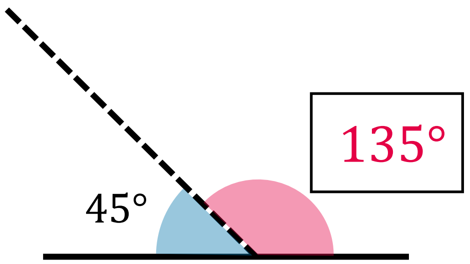
Video guidance

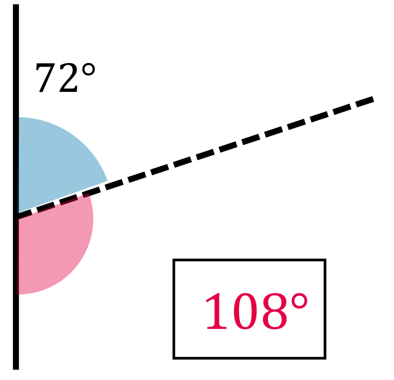
Pack 1 Session A

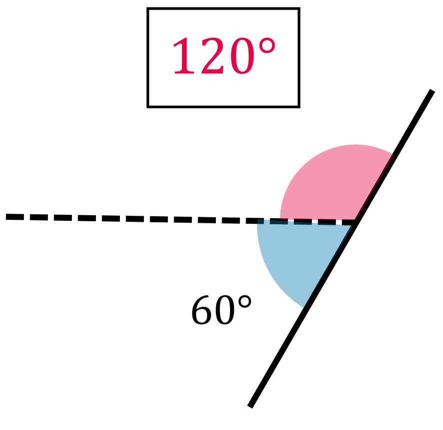
Activity: 90° and 180°

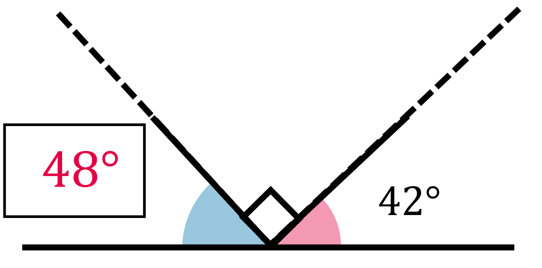
Answers

1) Calculate the missing angles



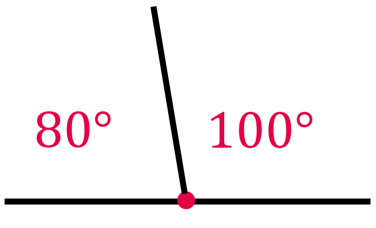


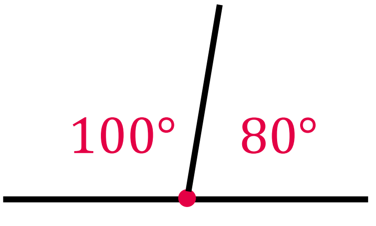




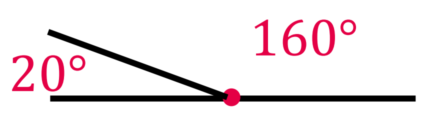
2) Draw a line to show approximately the angles

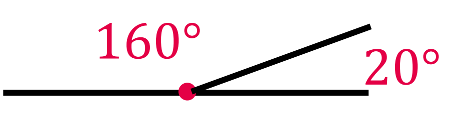
a) 80° and 100°





b) 20° and 160°





Mathematics Mastery

Step-by-step

Pack 14: Angles and shapes

Session B: $360°$

Resources needed: Strips of card/paper, split pin, 36 counters, protractor, ruler

The purpose of this session is to explore angles at a point using the fact that a full turn is $360°$ and knowledge of $180°$ and $90°$ to find unknown angles.

Talk Task

Look at the images on the sheet and discuss what you can see. The first two link with the previous session and learners should be able to identify two angles of $180°$ and four angles of $90°$.

Highlight that all the angles are showing a full turn and that each full turn is split into equal sections. Revise that a full turn is $360°$ and use this knowledge to discuss the value of the angles in each image.

To support with the multiplication and division knowledge needed to calculate the values, spend some time thinking about splitting 36 counter into equal rows and columns. 2 rows of 18 and 18 columns of 2, 3 rows of 12 and 12 columns of 3, 4 rows of 9 and 9 columns of 4, 6 rows or columns of 6.

$$36 = 2 \times 18 = 3 \times 12 = 4 \times 9 = 6 \times 6$$

Change the value of each counter to 10 and repeat to derive facts with a product of 360. 2 rows of 180 or 18 columns of 20, 3 rows of 120 and 12 columns of 30, 4 rows of 90 and 9 columns of 40, 6 rows or columns of 60.

$$360 = 2 \times 180 = 3 \times 120 = 4 \times 90 = 6 \times 60 = 9 \times 40 = 12 \times 30 = 18 \times 20$$

Look at the two sets of facts and discuss the role of zero as a place holder. It places each digit in a position that gives it a value that is ten times greater.

Return to the images on the sheet with these facts in hand. They can be used to work out a full turn split into six equal angles. For the image of a full turn split into 10 angles, this is an opportunity to revise multiplication and division by 10 and talk again about zero as a place holder.

Discuss the angles made by the division on a clock. Think about hours as well as minutes. Challenge learners to find other ways to split 360 and sketch diagrams.

Activity

The activity sheet provide similar examples to the previous session with learners using what they know about 360 to find the value of unknown angles. Learners will be using addition and subtraction and encourage them to explore different calculation strategies for each.

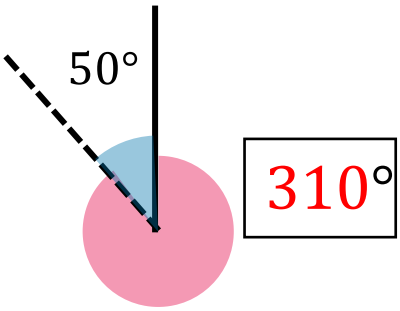
Video guidance

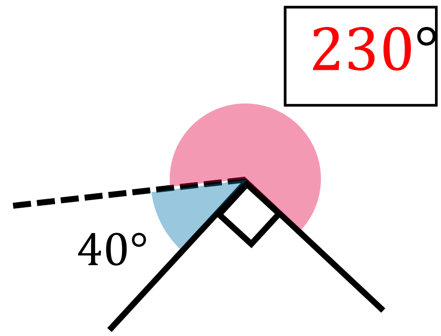
Pack 1 Session B

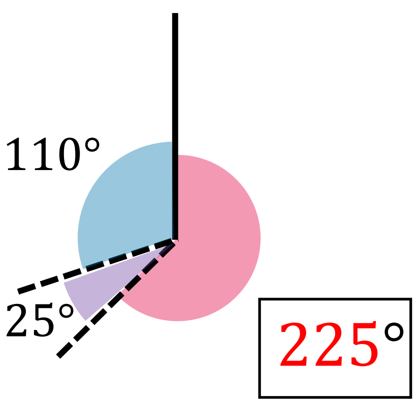
Activity: 360°

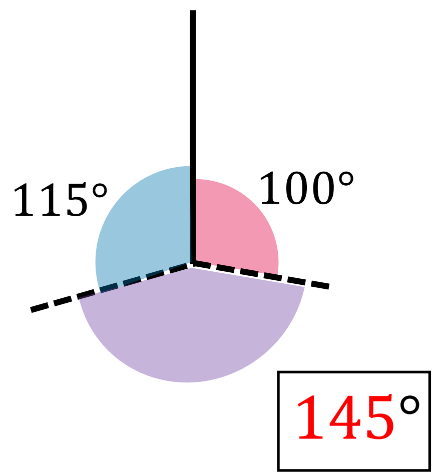
Answers

1) Calculate the value of the missing angles





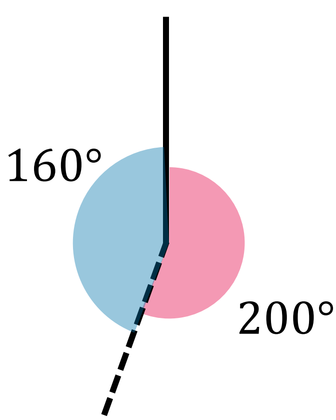


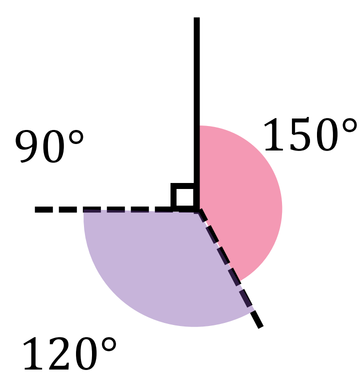


2) Sketch and label diagrams approximately showing the angles

a) 160° and 200°

b) 90°, 120° and 150°





Mathematics Mastery

Step-by-step

Pack 1: Angles and shapes

Session C: Describing polygons

Resources needed: Geoboard, elastic bands

The purpose of this session is to create lots of different shapes and think about the different ways that we describe and label them. Examples and non-examples of polygons are explored.

Talk Task
Ask learners to use geoboards to show you what they know about 2-D shapes. Encourage them to make examples and think about the different ways to talk about the shapes. E.g. shape name, number of sides, angles, vertices.

Let the learners take the lead in where the discussion goes. Here are some questions to guide what to find out about:

- *Do they know the mathematical word for 'corners' is vertex or vertices when there is more than one?*
- *Do they know the shape names: triangle, quadrilateral, pentagon, … ?*
- *Do they know the names of any special quadrilaterals? E.g. rectangle, parallelogram, trapezium, kite, rhombus*

Think about the questions and prompts you can give to find out what they can do. Encourage them to make lots of examples of the same shape to create opportunities to talk about what is the same and what is different. Record some of your favourite shapes on the sheet.

To support with the investigations on the activity sheet, talk about the angles inside some of the shapes that are made. Revise the language of acute, obtuse and right angle and identify examples of each within shapes.

Towards the end of the session, focus attention on something that is similar about all of the shapes explored so far. Shapes made on the geoboard all have straight sides and three or more angles. They are polygons. At the end of the sheet are some non-examples, discuss why each one is <u>not</u> a polygon.

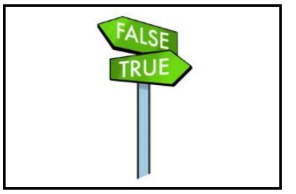
Activity
The activity sheet provides statements for leaners to investigate if true or false. There is space provided to draw examples of the true statements. When the statement is false, encourage them to draw something that is as close as they can get. The final question is more open and can be extended to thinking of questions to investigate.

Video guidance

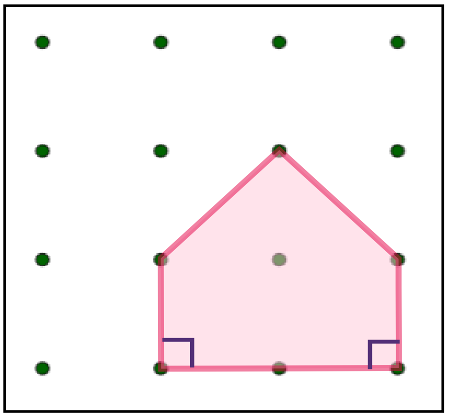
Answers

Pack 1 Session C

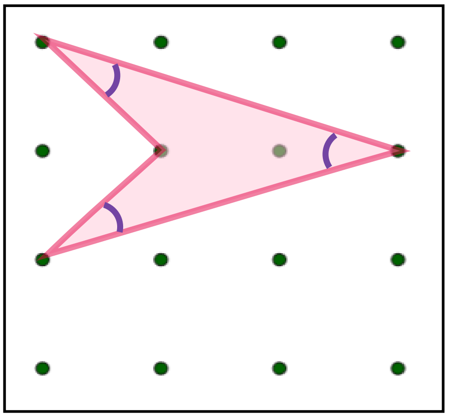
Activity: Describing polygons



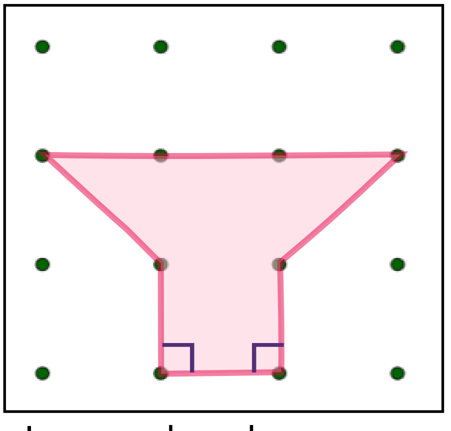
1) Is each one true or false? Show an example or if you think it is false, show how close you can get.



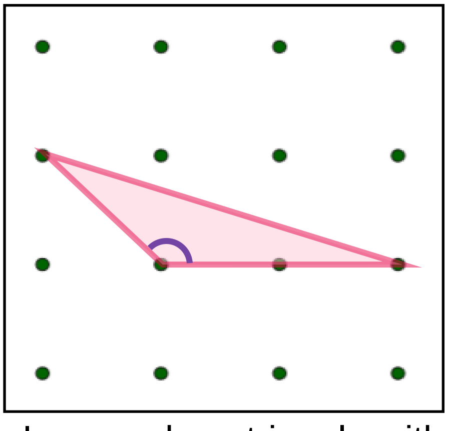
I can make a pentagon with two right angles



I can make a quadrilateral with three acute angles

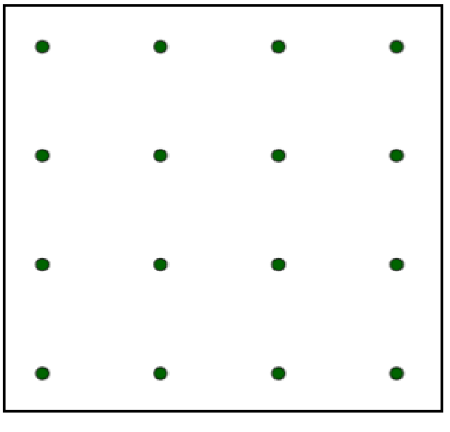


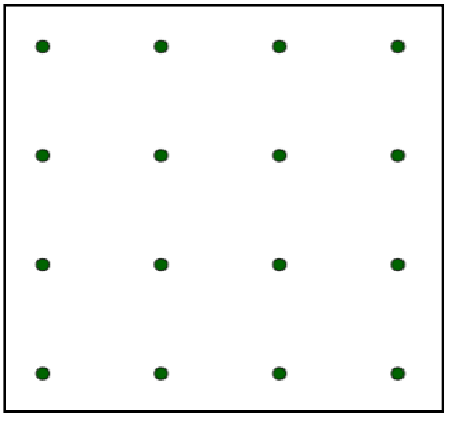
I can make a hexagon with two right angles



I can make a triangle with an acute angles

2) Write your own statements. One true and one false.





Mathematics Mastery

Step-by-step

Pack 1: Angles and shapes

Session D: Composing shapes

Resources needed: Scissors

The purpose of this session is to make and describe lots of different shapes, with a focus on reasoning about angles within them.

Talk Task
Cut up the five shapes at the bottom of the page and play around with the different shapes you can make by placing these together in different ways. Talk about the shapes created using the language and properties explored in the previous session: shape names, sides, angles, vertices.

Pause and focus on the properties of each of the five shapes that are being used to build. There is a square and the two smaller triangles fit inside. Ask learners to talk about what they know about the angles within these three shapes.

Every angle in the square is a right angle.

How can you convince me that these are 45 *degree angles in the triangles?*

Write the value of each angle onto the shapes and use the triangles to work out the angles within the larger triangle and the parallelogram The sheet shows how the two smaller triangles fit within them. The parallelogram has two angles that are $90 + 45 = 135$ degrees.

Label the angles within all of the shapes and return to using the pieces to compose lots of different shapes and describe their properties.

How many quadrilaterals can you make? How many hexagons can you make?

Working out the angles inside each shape is an opportunity to review a range of addition strategies.

If suitable you can extend this activity by exploring the angle sum of different polygons. Noticing that adding the four angles at each vertex of a quadrilateral gives a sum of 360 or that for a triangle the sum of the three angles is always 180 and for a hexagon the sum of the six angles is always 720. This will be a focus of later learning experiences.

Activity
The activity sheet provides a pattern of squares and equilateral triangles. Learners are to visualise, identify and shade in lots of different shapes on the pattern. Space is provided below for them to write what they know about the shapes they have found.

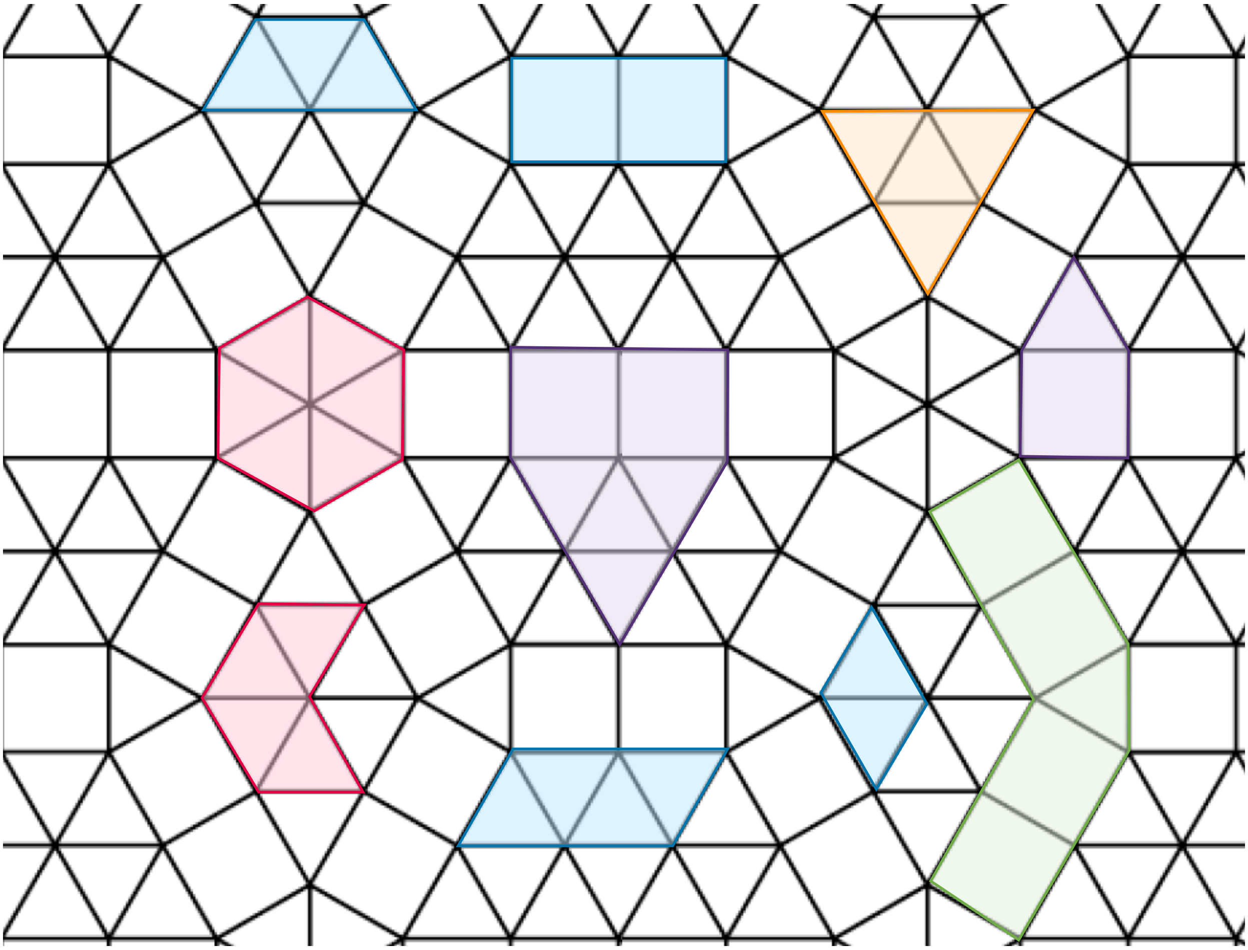
Video guidance

Answers

Pack 1 Session D

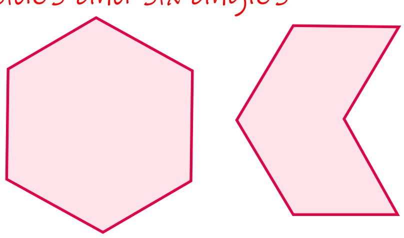
Activity: Composing shapes

Squares and equilateral triangles have been used to make a pattern.
How many different shapes can you find in the pattern? Shade some in.



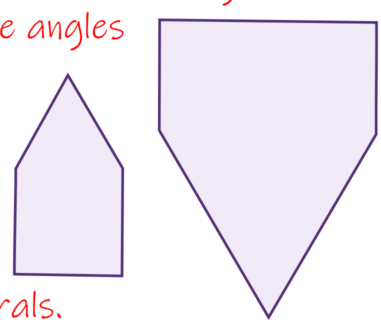
Write the names of the shapes you found.
What can you write about each shape?

Hexagons have six straight sides and six angles

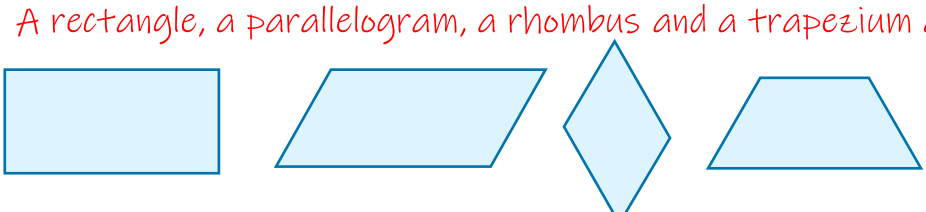


A heptagon has seven straight sides and seven angles

Pentagons have five straight sides and five angles



Polygons with four straight sides are called quadrilaterals.
A rectangle, a parallelogram, a rhombus and a trapezium are all quadrilaterals



At home materials

Pack 2: Triangles

Mathematics Mastery

Step-by-step

Pack 2: Triangles

Session A: Creating triangles

Resources needed: Ruler, large pieces of paper, scissors

The purpose of this session is to create and describe the properties of lots of different triangles using a variety of language.

Talk Task
Introduce triangles by asking learners to think about the statement at the top of the sheet. Try out lots of examples to decide if it is sometimes, always or never true. Use this as an opportunity to focus on the skill of using a ruler to accurately draw straight lines. Pay attention to how the ruler is being positioned and held and work with learners to find a position that allows them to be accurate.

Provide large sheets of paper and longer rulers and encourage lots of different triangles to be created. By thinking about the different ways to arrange three dots, learners might realise that if all of the dots are in line then a triangle will not be made and instead a straight line is formed. Therefore the statement is sometimes true.

Use the triangles created and the ones on the sheet to discuss the properties of triangles and any words that learners have prior experience with e.g. *sides, vertices, angles,...* There are some non-examples on the sheet to discuss why they are not triangles. Triangles have three straight sides. The three sides meet to make three angles. Talk about the angles within the different triangles and identify them as acute, obtuse or right angles.

Extend the experience with a ruler by measuring some of the side lengths of some of the triangles. Ask learners to describe and compare the side lengths. E.g. *The same length, nearly the same length, one short and two long, …*

If they have not come up in discussion, introduce the words, equilateral, isosceles and scalene and talk about what they mean, finding examples of each.

Equilateral triangle – all sides are equal length, all angles are equal size

Isosceles triangle – two side are equal length, two angles are equal size

Scalene triangle – no sides are equal length, no angles are equal size

Activity
The activity sheet provide a grid of dots for learners to create different triangles. Then they describe angle within triangles and you can prompt them to write down other properties such as symmetry. Extend the activity by practising using a protractor to measure some of the angle within triangles.

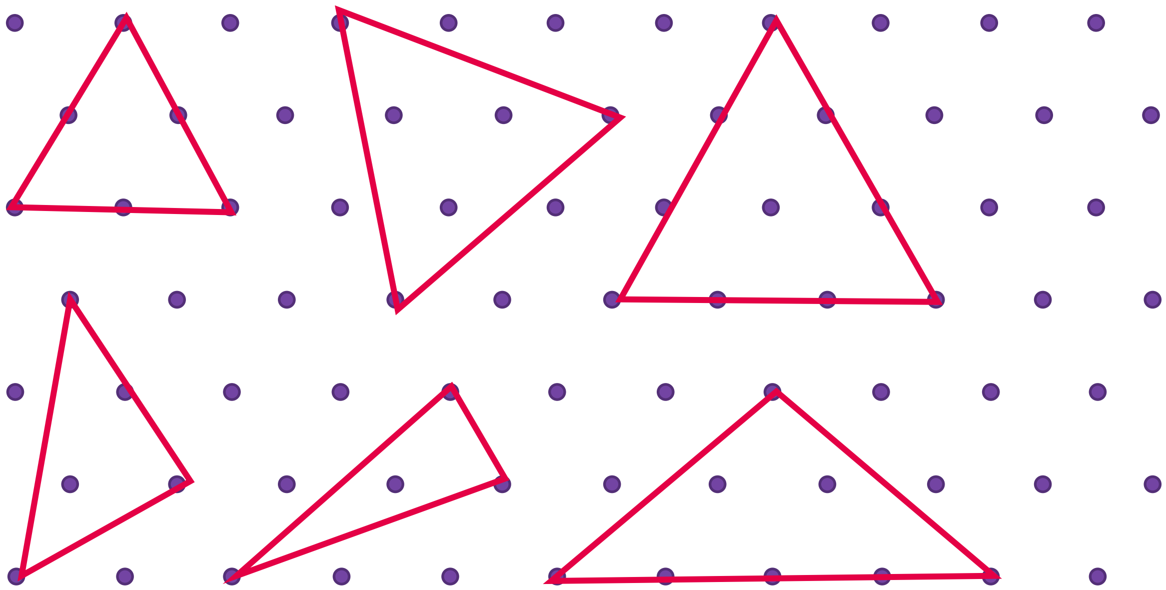
Video guidance

Pack 2 Session A

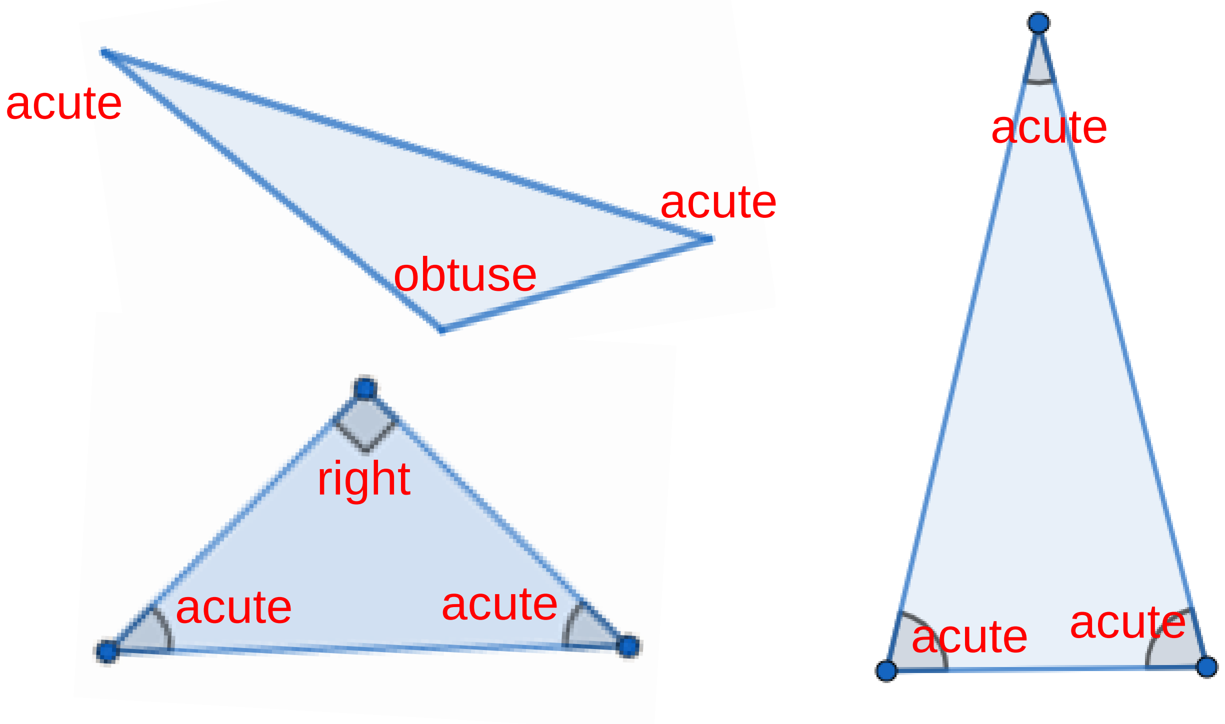
Answers

Activity: Creating triangles

1) Use a ruler to join dots to create triangles. How many different ones can you make?



2) Describe the angles as acute, obtuse or right angle.



Mathematics Mastery

Step-by-step

Pack 2: Triangles

Session B: Triangle symmetry

Resources needed: Scissors, ruler, protractor

The purpose of this session is to describe properties of triangles, using symmetry to find equal sides and angles and classify as isosceles or equilateral.

Talk Task

The sheet provides two sets of triangles. Working with each set in turn, cut them up and discuss what is the same and what is different about them. Encourage learners to think about all the different language they can use to describe them.

The first set contains equilateral triangles of different sizes and orientations. Explore the symmetry of each and use folding and rotating to convince yourselves that all of the sides are of equal length and that all of the angles are equal. Think about different ways to explain how you know. For example, *folding along the three lines of symmetry shows how each side lines up with another. They must all be the same length.*

You can use this as an opportunity to practise using a ruler and a protractor to measure. Ask learners to explain out loud how to use these tools accurately. Attach the word equilateral to these types of triangles and practise saying: *This is an equilateral triangles. All three sides are the same length. All three angles are the same, 60 degrees.*

The second set contains isosceles triangles of different sizes and orientations. Explore the symmetry of each and use folding and rotating to convince yourselves that each triangle has two sides that are equal length and two angles that are the same size. Again you may want to take the opportunity to use a ruler and protractor to check. Attach the word isosceles to these triangles and practise saying: *This is an isosceles triangle. It has two sides that are the same length. It has two angles that are the same size.*

The triangles explored all have either three lines of symmetry or one line of symmetry. Introduce the activity on the sheet by asking learners to think about if there are triangles with two lines of symmetry or zero lines of symmetry or four. Encourage them to sketch examples on the activity sheet.

Activity

The activity sheet provides triangles for learners to identify properties and label as equilateral or isosceles. Then they explore finding triangles with two or zero lines of symmetry. It is not possible for a triangle to have two lines of symmetry. Think about different ways to show and explain why.

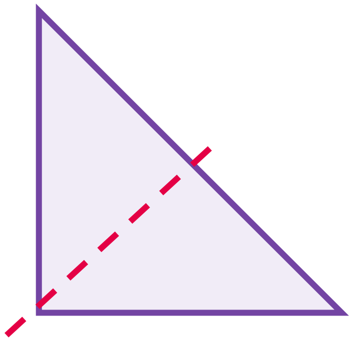
Video guidance

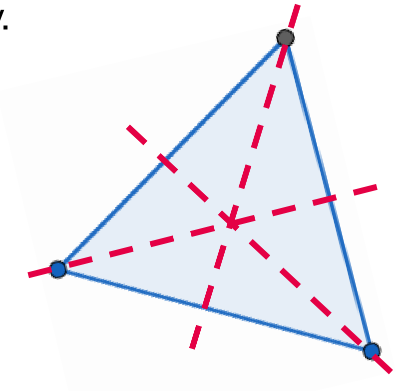
Pack 2 Session B

Activity: Triangle symmetry

Answers

1) Draw on lines of symmetry. Name each shape as equilateral or isosceles and describe its symmetry.



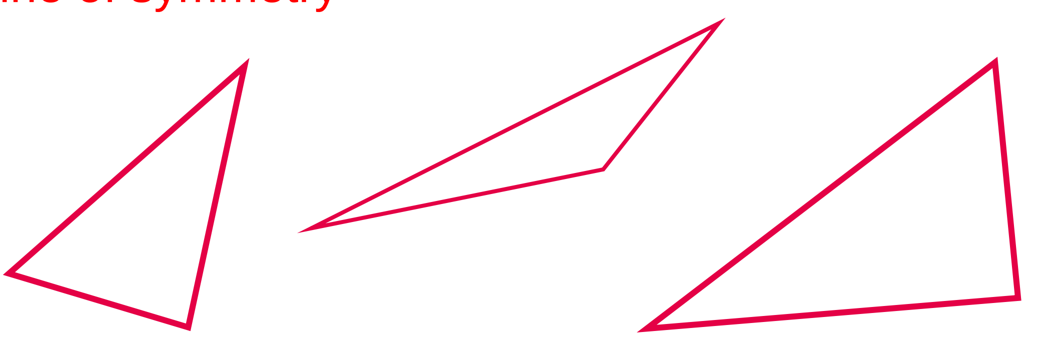


This is an isosceles triangle. It has one line of symmetry and rotational symmetry of order 1

This is an equilateral triangle. It has three lines of symmetry and rotational symmetry of order 3

2) Are there triangles with two lines of symmetry? Are there triangles with no lines of symmetry? Use the space below to sketch and write your ideas.

A triangle with all sides different will not have a line of symmetry



For there to be a line of symmetry, there must be two or three angles the same size and two or three sides the same length.

Mathematics Mastery

Step-by-step

Pack 2: Triangles

Session C: Describing triangles

Resources needed: Geoboards

The purpose of this session is to create, describe and classify triangles using a variety of language.

Talk Task

Challenge learners to use geoboards to create as many different triangles as they can. There are often two sides to a geoboard, one with pegs arranged in a square grid and another with pegs arranged in triangles. Different triangles can be made on each side and both should be explored. The sheet provides some examples to discuss or recreate and uses the triangular side because it is possible to make equilateral triangles. Across the session, prompt learners to think about why it is hard to make an equilateral triangle on a square grid.

Ask learners to describe the properties of the triangles as they create them. By this session, they have experience with a range of language and properties and you should take the time to ensure learners use the vocabulary lots. Build on the previous session and identify triangles that are isosceles and those that are equilateral. Discuss the word we use to describe triangles that are neither (scalene) and identify lots of examples of these.

Create a triangle that is identical to one already made but in a different orientation and ask leaners to decide if this is a different triangle. Challenge them to create a triangle in a different orientation thinking about how to make sure it is the same. These experiences link to future learning on transformations such as reflection and rotation.

Focus on angles within triangles, reviewing the language acute, obtuse and right angles. Find examples of triangles that have right angles and talk about why an equilateral triangle cannot have a right angle. The shapes at the bottom of the sheet can help with this. The regular hexagon is made up of six equilateral triangles that meet to make a full turn of $360°$. This can be used to identify that the equilateral triangles have $60°$ angles. The square shows that two right angles will not meet to make a third angle. Work out the angles of the triangles within.

Activity

The activity sheet provides dots grids for learners to create different triangles and classify them. Encourage learners to mark on any other properties they can identify. Then learners complete a two-way grid, drawing triangles into each section to demonstrate their understanding of types of triangles.

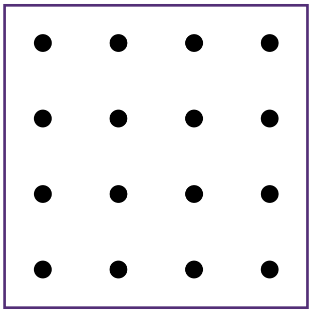
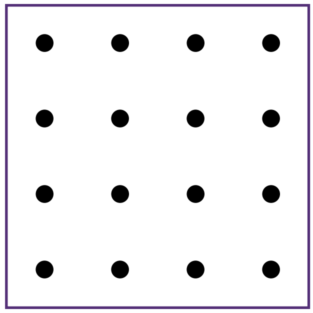
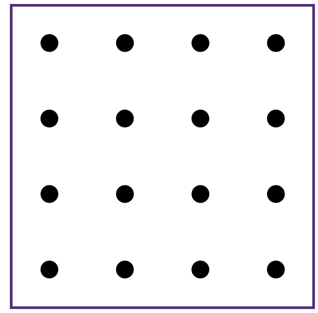
Video guidance

Pack 2 Session C

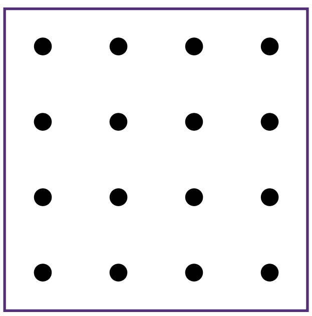
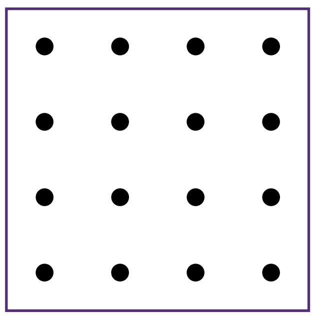
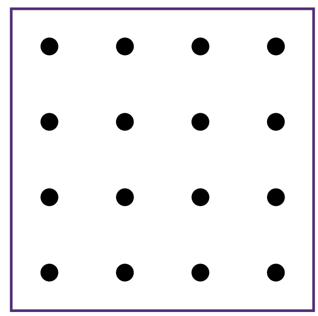
Activity: Describing triangles

Answers

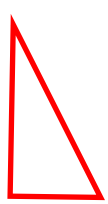
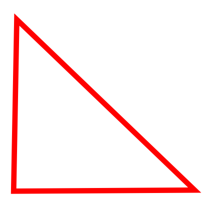
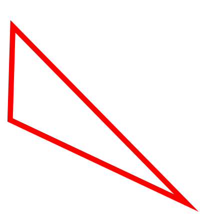
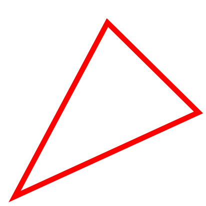
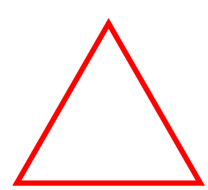
1) Join dots to make different triangles. Write isosceles or scalene to describe each triangle.

Check that triangles are labelled correctly.
Check that each is a different triangle.

2) Try to draw a triangle for each section of the table.

	Scalene	Isosceles	Equilateral
Has a right angle			Not possible
No right angle			

Mathematics Mastery

Step-by-step

Pack 2: Triangles

Session D: Angles in triangles

Resources needed: Scissors, paper and ruler to draw triangles.

The purpose of this session is to explore angles within triangles allow learners to convince themselves that angles in a triangle always sum to $180°$

Talk Task

Across this session you want to provide experiences where learners can convince themselves that the angles in a triangle sum to $180°$. This may have already come up in previous sessions and they may already know this as a fact. This session is about giving them time to build this understanding for themselves and explore different ways of thinking about this.

On the Talk Task sheet there are sets of three identical triangles with the matching angles marked in the same colour. Cut them out and ask learners to arrange three triangles to make a straight line. There are different ways to do this and each way involves one of each angle coming together to form $180°$. Revise that angles that meet on a straight line sum to $180°$ and so these angles sum to that amount.

Ask learners if they can convince themselves and you that this is true for all triangles; the three angles will always add to $180°$. Link to the previous session where you established that an equilateral triangle has $60°$ angles and that three of these adds to $180°$. The square was split into isosceles triangles that had two $45°$ angles and a right angle which sums to $180°$.

Explore other ways to show this and create you own triangles to investigate with. Another way is to tear each angle off a triangle and arrange them to show that they make a straight line and sum to $180°$.

The two blue triangles at the end of the sheet can be used to fold down the angles and see that they meet along a side length to make a straight line. The triangles are marked with the lines you need to fold along to show this.

Practise making use of this knowledge and revise using a protractor. Measure two of the angles within a triangle and then calculate the value of the final angle.

Activity

The activity sheet provides experiences to apply knowledge that angles in a triangle sum to $180°$. Learners calculate missing angles and then think of two different ways to work out the missing angles. They then link to previous sessions and think about the triangles within a regular polygon.

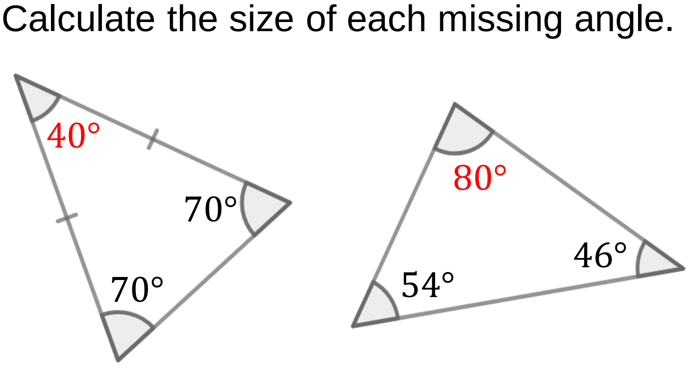
Video guidance

Pack 2 Session D

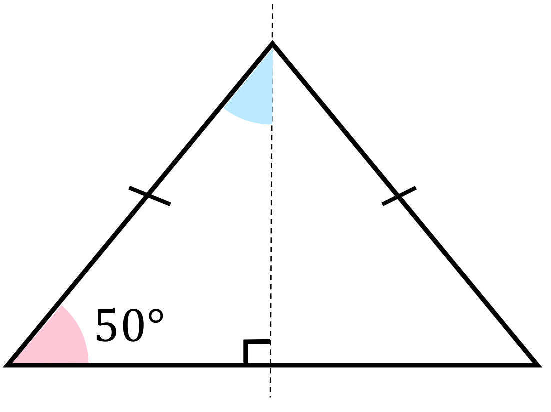
Activity: Angles in triangles

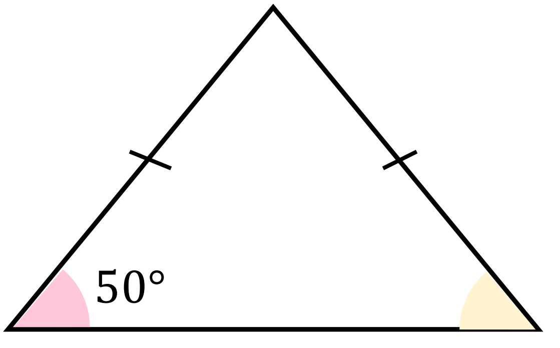
Answers

1) Calculate the size of each missing angle.



2) Write descriptions of two different ways to find the angles in this isosceles triangle. Write each angle in the triangles.

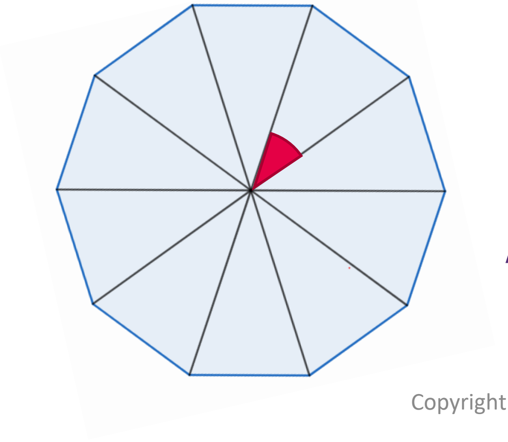


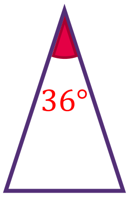


The marked angle at the top is 40° because $50 + 90 + 40 = 180$. It is symmetrical so the other side has the same angles

An isosceles triangle has two equal angles. The other two angles must be 50° and 80°.

3) This regular decagon is split into ten identical triangles. What information can you write about the triangle?





Isosceles triangle

1 line of symmetry

Rotational symmetry of order 1

Ten of these triangles meet at a point so one angle must be 36°

The other two angle must sum to 144°. They are equal angles so each must be 72°

Mathematics Mastery

At home materials

Pack 3: Quadrilaterals

Session A) Creating quadrilaterals

Session B) Quadrilateral symmetry

Session C) Angles in quadrilaterals

Session D) Describing quadrilaterals

Mathematics Mastery

Step-by-step

Pack 3: Quadrilaterals
Session A: Creating quadrilaterals
Resources needed: Scissors, paper to sketch shapes on
The purpose of this session is to use triangles to create a range of quadrilaterals and describe their properties using a variety of language.

Talk Task

Cut up the two equilateral triangles and use symmetry to convince yourselves that they are equilateral triangles. Fold along lines of symmetry and rotate one triangle on top of the other to show equal angles and sides.

Cut each triangle along the dotted line and talk about the properties of the triangles you now have. Challenge learners to move the triangles around to create as many different shapes as they can. Make sketches of the shapes, naming them and describing their properties.

Focus attention on examples that have four sides and discuss the word quadrilateral. A quadrilateral is a polygon with four straight sides and four angles. Connect to other words with ‘qua’ or ‘quad’ that have a connection with four. A quad bike has *four* wheels, a quarter is one of *four* equal parts.

Take the time to find out which special quadrilaterals learners know the names of and what properties they can identify about these shapes. The Talk Task in session D has descriptions that you can use to support you in finding out how familiar learners are with these shapes.

- Side lengths - when they are all equal, when there are pairs of equal sides
- Parallel or perpendicular sides
- Angle size. For angle size you can write on the angles for each triangle linking to knowledge of equilateral triangles to identify them as 60, 90 and 30. This can deepen discussions of angles beyond saying if they are acute, obtuse or right angles.
- Symmetrical properties are the focus of a later session (it might be tricky to discuss here as the shapes are in bits)

Repeat the experience with the rectangle.

Activity

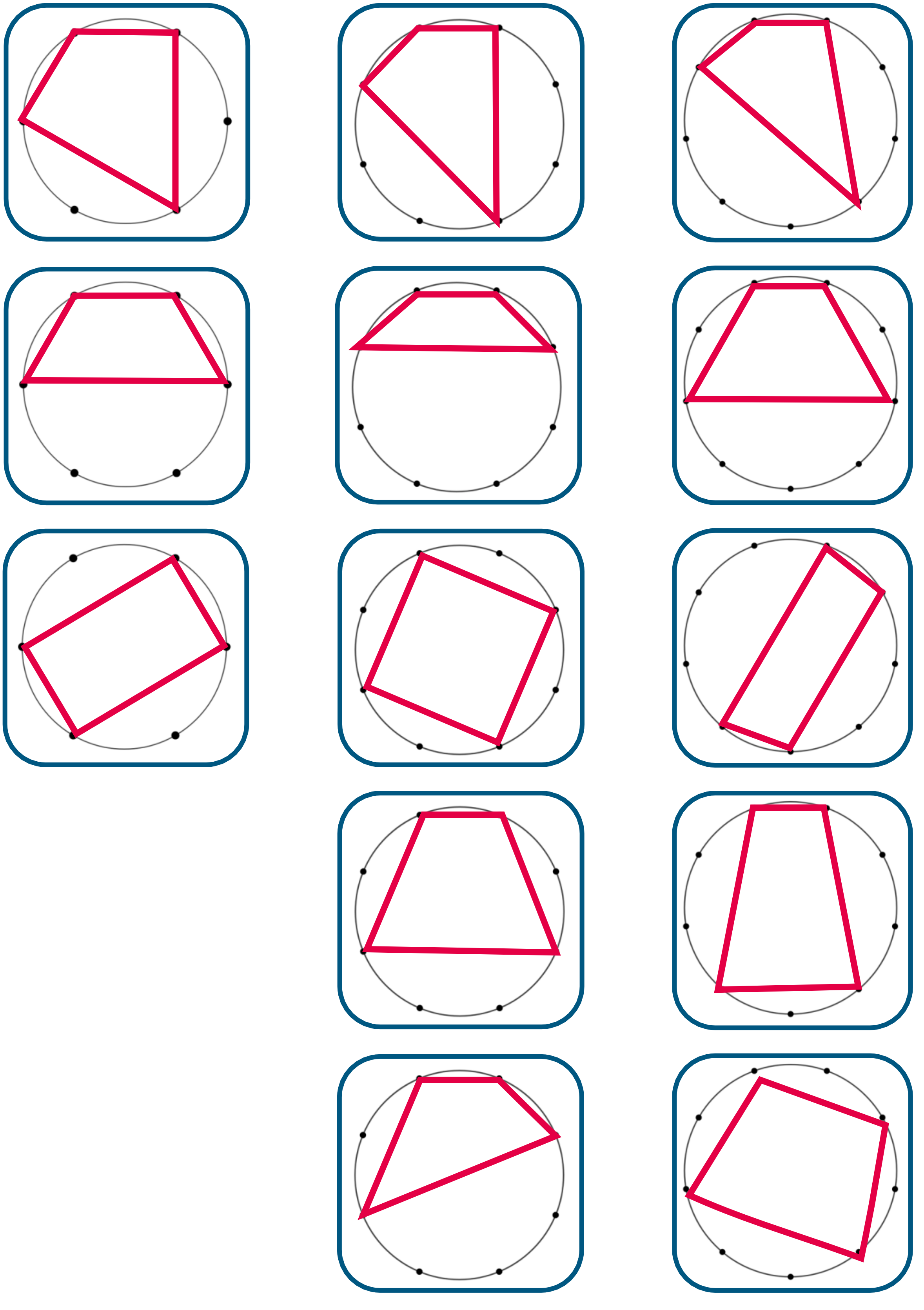
The activity sheet provides circles with equally spaced dots for learners to join and create different quadrilaterals. Encourage them to name as many as they can and record properties they can identify. Explore how the different number of dots can change which quadrilaterals you can make.

Video guidance

Pack 3 Session A

Activity: Creating quadrilaterals

Answers



Mathematics Mastery

Step-by-step

Pack 3: Quadrilaterals
Session B: Quadrilateral symmetry
Resources needed: Paper, ruler
The purpose of this session is to create, describe and explore the symmetrical properties of quadrilaterals.

Talk Task

Create quadrilaterals by folding paper and making cuts, then opening the cut shape and describing the properties of the shape created. Start by folding a sheet of paper in half and making two cuts into the folded edge. The shapes created will be quadrilaterals with at least one line of symmetry and is therefore a perfect opportunity to review understanding of symmetry. Explore the rotational symmetry of each shape and decide if it has rotational symmetry of order 1, 2 or 4. Repeat this several times challenging learners to decide which shapes they can and cannot make, taking the time to talk about why.

Then fold the paper into quarters and make one cut to remove the folded corner. Again explore the possible shapes that can be made and describe their properties.

The Talk Task sheet in session D has a list of properties of special quadrilaterals that you can use as a reference to guide discussions. If learners do not know these names, then tell them this information and spend time making sense of these words. Ask them to find examples and explain how they know it is an example. Finding and explaining non-examples is also useful because explaining why a shape is not a rhombus involves thinking about what a rhombus is.

Continue to create and discuss quadrilaterals using the lines marked on the bottom of the sheet. Choose four points on the lines and join them, repeating this to explore the different quadrilaterals that can and cannot be made. The marked lines become the diagonals of the quadrilateral and different diagonals can create different shapes. Discuss the properties of the shape providing lots of opportunities for learners to build confidence with the language of geometry.

Activity

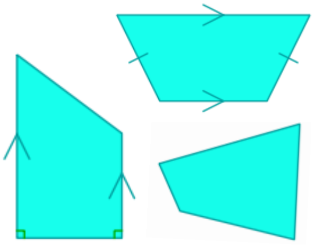
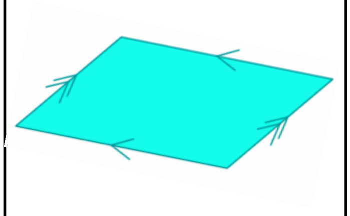
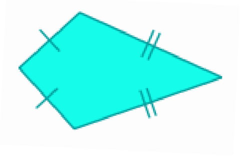
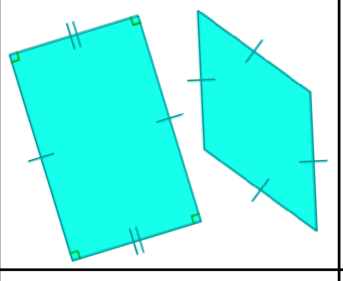
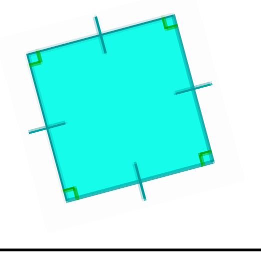
The activity sheet is an opportunity to consolidate the discussions and experiences in the Talk Task. Learners work out the symmetrical properties of the quadrilaterals and decide where to place them in the table. If two-way tables are unfamiliar, take the time to discuss how it works. Extend the task by sketching different shapes on the grid.

Video guidance

Pack 3 Session B

Activity: Quadrilateral symmetry

Answers

	Rotational order of 1	Rotational order of 2	Rotational order of 4
0 lines of symmetry			
1 line of symmetry			
2 lines of symmetry			
4 lines of symmetry			

Mathematics Mastery

Step-by-step

Pack 3: Quadrilaterals	
Session C: Angles in quadrilaterals	
Resources needed: Scissors, split pins, strips of paper	
The purpose of this session is to explore angles within quadrilaterals, revising understanding of acute, obtuse, reflex and right angles and reasoning about when an angle combination is not possible.	
Talk Task Cut out the strips on the sheet and connect them together with split pins. Use this to explore angles within quadrilaterals, playing around by moving the three sides and connecting with a fourth strip. Make and describe a variety of different quadrilaterals, revising the properties and names explored so far in this pack. Create sketches of the different shapes you create labelling them with information to show the properties you notice. Focus attention on the angles being formed within the shapes you make. Create a rectangle and identify right angles using this as the basis for adjusting to explore smaller acute angles and larger obtuse angles. Look at the statements on the sheet and find examples of quadrilaterals with each types of angle. Creating quadrilaterals with a reflex angle can be tricky to visualise at first and the lengths of the strips might make it awkward to create. The statements are true, however if you vary them and make them more precise you can explore further. Can a quadrilateral have …all acute angles? …all obtuse angles? …all reflex angles? There are lots of opportunities to encourage learners to explain why or why not, using the strips and sketches to support their reasoning. Encourage them to explore and try to decide what the limits are for each type of angle, including right angles. Is it possible to have …exactly one right angle? …exactly two? …exactly three? Throughout this activity, take the opportunity to revise the names and properties of the different quadrilaterals you create, including symmetric properties.	
Activity The activity sheet provides further statements for learners to explore with space to record their thoughts. Encourage them to explore how they might decide if each statement is possible and think about what knowledge of quadrilaterals they can use to help them.	Video guidance

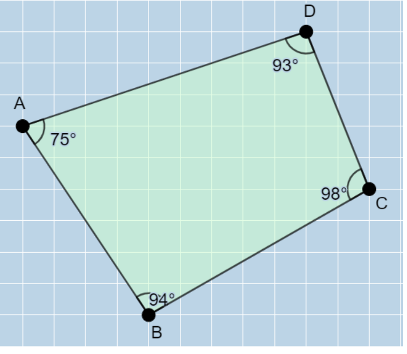
Pack 3 Session C

Activity: Angles in quadrilaterals

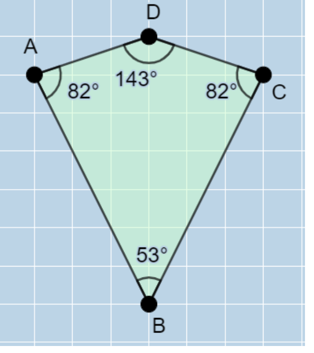
Answers

Which of the following angle combinations are possible? Sketch examples and label with information.

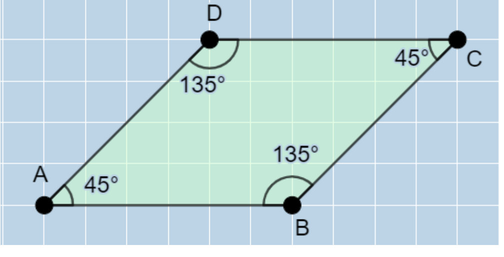
3 obtuse angles, 1 acute angle



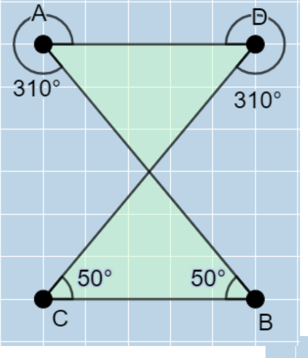
3 acute angles, 1 obtuse angle



2 acute angles, 2 obtuse angles

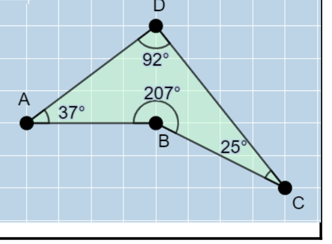


2 acute angles, 2 reflex angles



A complex quadrilateral can have two reflex angles and two acute angles. These are not yet expected to be understood.

Learners will be able to find examples with one reflex and one obtuse.



What other angles are possible? What angles are not possible?

Encourage them to explore and reason. Do not worry about being certain about any, the purpose is to explore, think and describe properties.

Mathematics Mastery

Step-by-step

Pack 3: Quadrilaterals

Session D: Describing quadrilaterals

Resources needed: Ruler

The purpose of this session is to bring together the sessions in this pack by describing and defining special quadrilaterals, noticing connections.

Talk Task

The names we use to label special quadrilaterals do not reveal the connections between them. For example, a square is a rectangle. It is a rectangle that has equal length sides. We give a different name to this group of rectangles.

There are lots of other examples of this and discussing definitions provides great opportunities for learners to think about the importance of precise language.

Read the short description of a rectangle and use this to discuss the least amount of information that is needed to define a special quadrilateral. Identify other properties of a rectangle that could be included in a description (opposite sides are parallel, opposite sides are equal, two lines of symmetry, rotation symmetry of order two) and talk about if you need any of that. Do you even need to know if there are four right angles? Is it enough to know that there are three?

Read the other descriptions, sketching a few examples of each and identifying other properties that could be included in the description. Language to clarify: equilateral, like with triangle, means equal sides; adjacent means 'next to'.

Discuss if the speech bubble statements are always true, sometimes true or never true, thinking about what information you need to help you decide.

- As already discussed above, a square is a rectangle.
- A square has two pairs of parallel sides and equal opposite angles and so it is a parallelogram. It is a parallelogram with right angles and equal sides.
- A rhombus is an equilateral parallelogram. A square is a rhombus. It is a rhombus with all angles equal.
- As above, a rectangle (square) is always a parallelogram. This statement is sometimes true because a parallelogram is not always a rectangle.

Activity

The activity sheet provides space for learners to return to the activity in session A, building quadrilaterals with triangles. This time there is more choice as they are using dots on circles as their options. Encourage them to explore options and record information about the shapes they create.

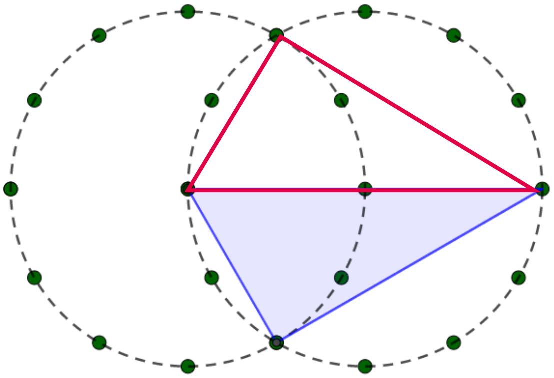
Video guidance

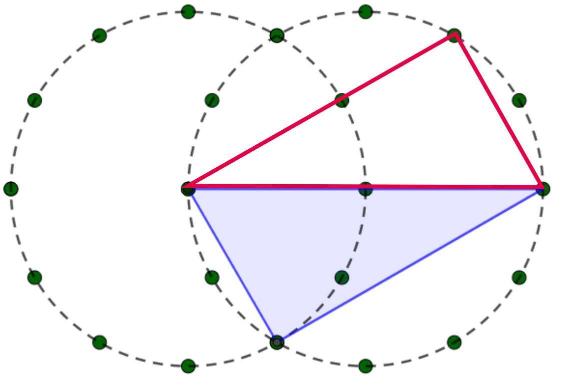
Pack 3 Session D

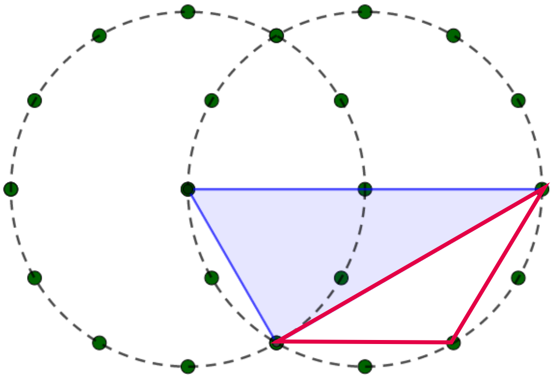
Activity: Describing quadrilaterals

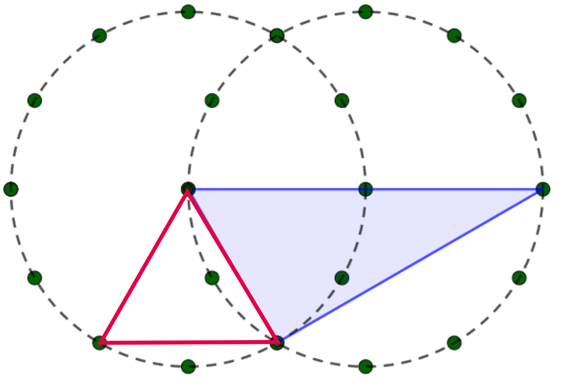
Answers

Draw another triangle to create a quadrilateral and label with information.

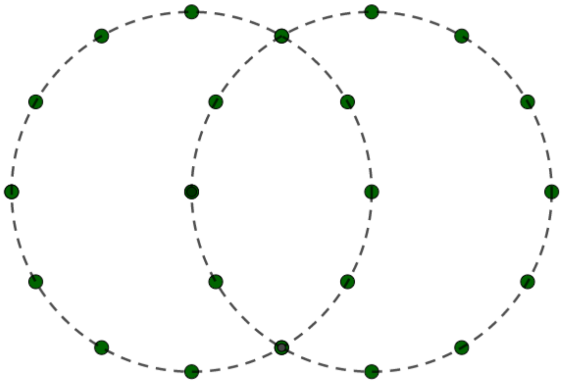


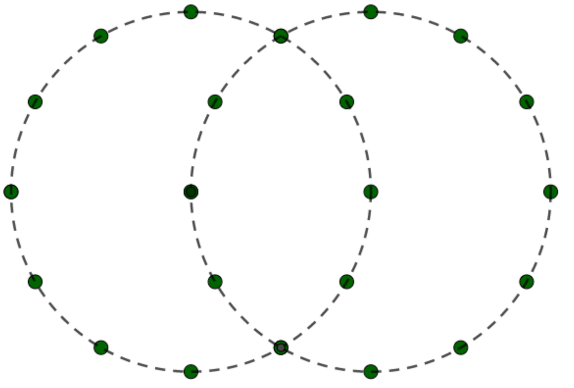






Build different quadrilaterals with two triangles and label with information.





Mathematics Mastery

At home materials

Pack 4: Area

Session A) What is area?

Session B) Area and arrays

Session C) Squared units

Session D) Exploring area

Mathematics Mastery

Step-by-step

Pack 20: Area

Session A: What is area?

Resources needed: Scissors

The purpose of this session is to understand that area is a measure of surface and that it is measured in square units.

Talk Task

Talk about the word area using the prompts on the sheet to shape and guide the discussion. Talk about different things that you can measure the area of and recognise that all of these are describing a surface.

The word dimension can start discussions about the difference between length and area. Length is a measure of one dimension and area is a measure to two dimensions.

Use this as an opportunity to find out what experience learners have with area, squares units and calculating the area of rectangles. Can they explain why we don't measure area in centimetres and metres? Can they describe what a squared centimetre is and why they are useful for measuring area?

Learners might know about multiplying length and width to calculate the area of rectangles. Can they talk about how this connects with arrays and multiplication?

The second half of the sheet has situations that involve thinking about area. Working out the size of the shutters for a window involves thinking about how much wood is needed to cover the window. Talk about how you would work this out, discussing which measurements you would take and what you would do with them. The idea of coordinating height and width to think about area will be built on in later sessions.

The grid is made up of squared centimetres and can be used to estimate the area of the leaf. Discuss how to imagine rearranging section to make up whole squares, marking the sections to keep track of what you do.

The image of Canada can be used to think about area on a much larger scale. The square beside the map shows the size of a million squared kilometres. Use this to estimate the size of Canada by sketching on squares or visualising rearranging sections to make up a square. Canada covers 9.985 million km^2 and so you should be able to fit the land into nearly ten of the squares.

Activity

The activity sheet provides another leaf on a grid for the area to be estimated and then space for learners to create a leaf with a given area. For the second question, they use the piece of paper to estimate to area of the top of a table. Support them to make a sketch what they work out.

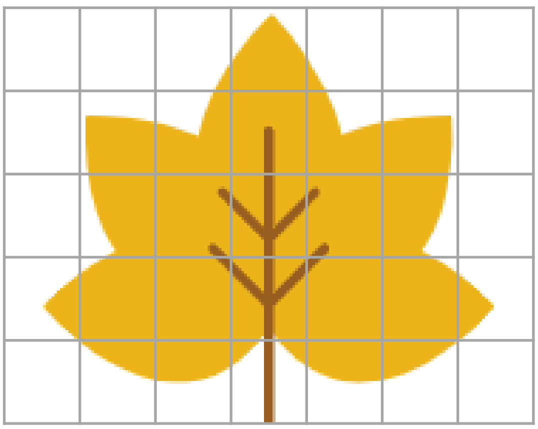
Video guidance

Pack 4 Session A

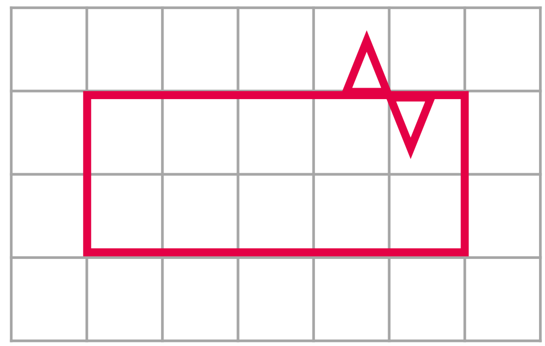
Answers

Activity: What is area?

1) Decide the area of this leaf using the grid of squares. Then draw a leaf with an area of approximately 14 cm^2

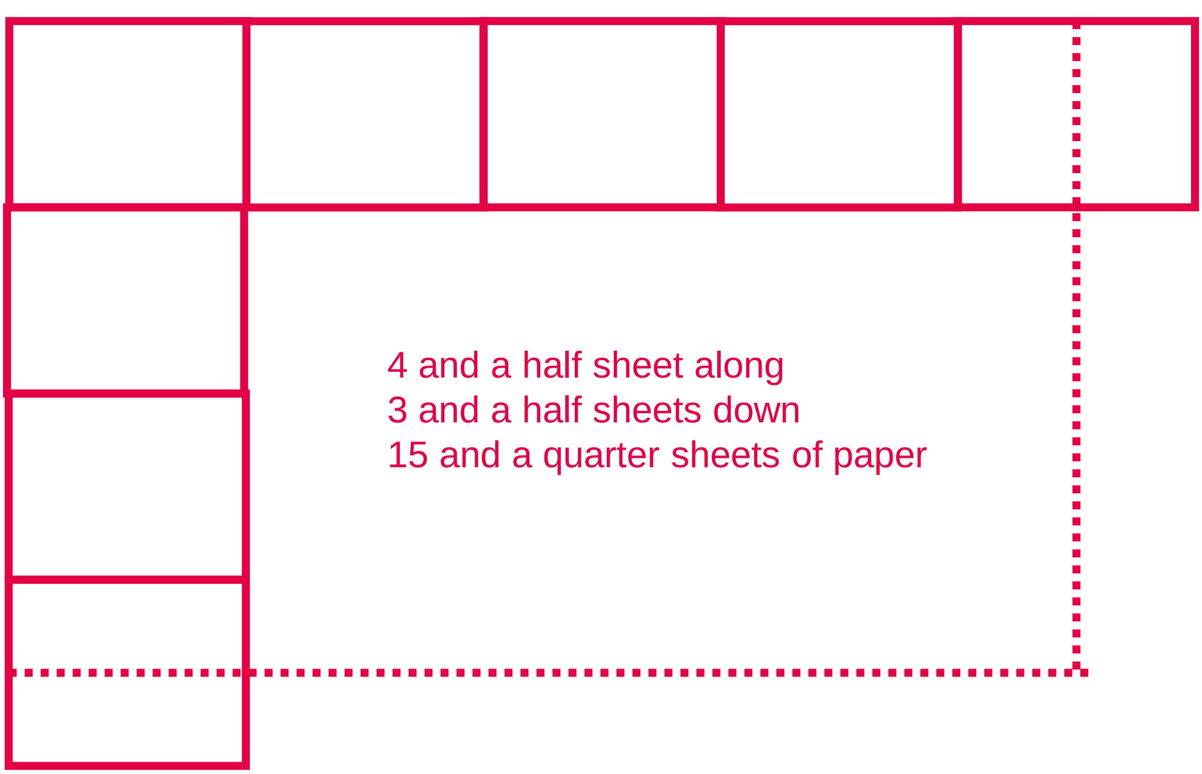


Approximately 13 cm^2



Encourage learners to mark out 14 squares and play with rearranging them to make a leaf.

2) How many of this sheet of paper will cover the table you are working on? Draw a sketch to show how you worked it out.



Mathematics Mastery

Step-by-step

Pack 4: Area	
Session B: Area of rectangles	
Resources needed: Squared paper, geoboards or online version available from Maths Bot (https://mathsbot.com/manipulatives/geoboard)	
The purpose of this session is to connect experiences with multiplication and arrays to understanding of how to calculate the area of rectangles.	

Talk Task

Arrays of objects arranged in rows and columns have been used to represent and make sense of multiplication. Any size rectangle can be broken down into grids of squares that form an array. This can be used to understand why the area of a rectangle can be calculated by multiplying the length by the width.

This session appeared in an earlier pack on multiplication to develop understanding of the area model as a representation of multiplication. It is returned to here because finding the area of rectangles underpins lots of strategies for calculating the area of a variety of shapes.

Discuss what is the same and what is different between the images of counters, squares and rectangles on the sheet. There are opportunities to revise commutativity ($3 \times 4 = 4 \times 3$) and to discuss both multiplication and division. Ask learners to use these images to explain why multiplication can be used to calculate the area of rectangles. The words length, width, breadth and height can all be used to describe the dimensions of the rectangle.

Notice that there is a change in the units you are working with. You start with lengths measured in centimetres and calculate to find an area described in squared centimetres. Check that learners have a sense of the change in dimension. Area is a measure of two dimensions, of how much surface is covered, and so the units it is measured in are squared units.

The rectangles at the end of the sheet can be used to apply understanding and discuss how to use the information given. The first rectangle has some 1 cm squares within the rectangle shown which can be used to work out the side lengths and visualise the area. The second rectangle gives the area and one side length. Discuss why division can be used to work out the other side length.

Activity

The activity sheet provides similar experiences with the area of rectangles. For the second question, provide squared paper to support learners in identifying different rectangles with the same area. A geoboard is also a useful tool but pay attention to the units you are saying if it is not 1 cm grid.

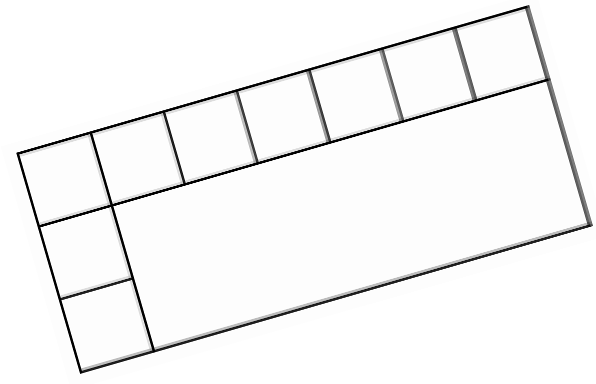
Video guidance

Pack 4 Session B

Activity: Area and arrays

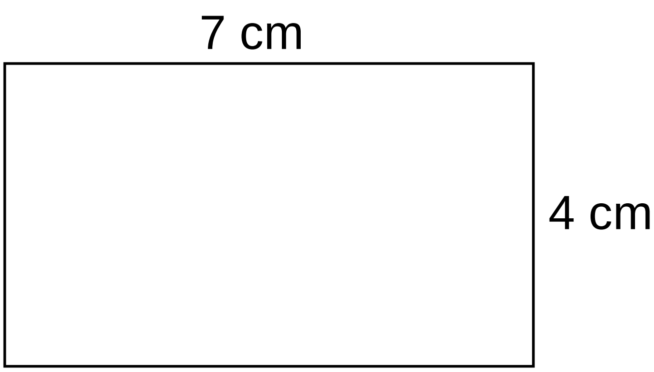
Answers

1) Work out and write down the area of each shape



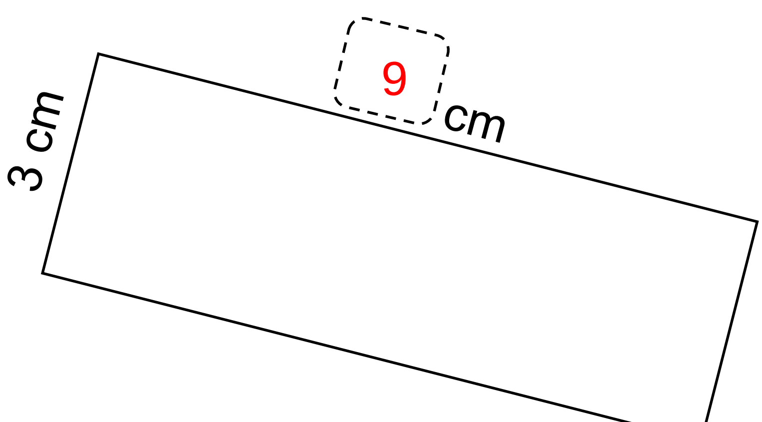
Area:

21 cm^2



Area:

28 cm^2



Area:

27 cm^2

2) For each area, sketch a different shape with the same area.

Mathematics Mastery

Step-by-step

Pack 4: Area
Session C: Squared units
Resources needed: An accessible measuring tool: metre stick, trundle wheel, tape measure, clipboard.
The purpose of this session is to measure the area of something large and work with squared metres as well as squared centimetres.

Talk Task

Select some suitable surfaces that you can measure the area of. This could be the floor of a classroom, a section of a playground or outdoor space. You need something that is suitable for measuring in metres and squared metres.

Provide learners with measuring tools such as metre stick and trundle wheel and challenge them to decide what they area is. Support them to think and decide what to measure and what to do with those measurements. Encourage them to apply what they understand about the area of rectangles from the previous session.

Help them to make sketches and diagrams of the space they are measuring and prompt them to use the words length, width and breadth to describe dimensions.

To keep things simple to start with, round measurements to the nearest metre. Then you can imagine squared metres marking out a rectangular surface and describe the area. Once you have decided on a sensible estimate of the area you could work to make it more accurate by working with metres and centimetres.

Focus attention on the relationship between squared metres and squares centimetres using the incorrect reasoning on the sheet. Mark out a square that is one metre by one metre and think about how many squared centimetres cover that space.

Recognise that 1 m^2 cannot be 100 cm^2 and is in fact 10 000 cm^2. Challenge learners to mark out a space that is 120cm by 1m and think about how to describe the area. This provides an opportunity to reason that 1.2 m^2 is 1m^2 and 2000 cm^2. Repeat with other examples.

Activity

The activity sheet asks learners to demonstrate understanding of the difference between length and area. They then calculate the area of a rectangle with mixed units and think about situations when different squared units are suitable.

Video guidance

Pack 4 Session C

Answers

Activity: Squared units

1) Decide if the following involve thinking about **length** or **area**.

Distance I travel to school ______________

Turf for a football pitch ______________

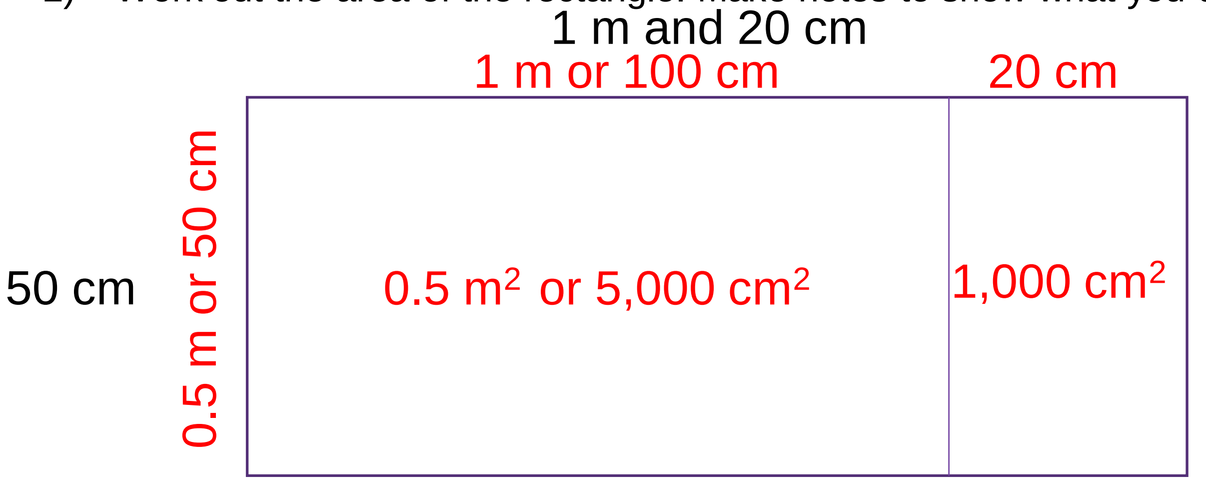
Paint needed to cover a wall ______________

Fence needed to go around a park ______________

Length of a pencil ______________

Tiles to cover a bathroom floor ______________

2) Work out the area of the rectangle. Make notes to show what you did.



3) Write an example of when you might use each of these units

cm^2 squared centimetres

m^2 squared metres

km^2 squared kilometres

Mathematics Mastery

Step-by-step

Pack 4: Lines, length and perimeter

Session D: Exploring perimeter

Resources needed: Scissors

The purpose of this session is to explore the area of rectangles and shapes made up of rectangles, providing plenty of opportunities to calculate and reason.

Talk Task

Repeat a session from an earlier pack on perimeter but this time with a focus on area. Each of the small rectangles on the sheet measures 2 cm by 3 cm. Nine of them have been arranged in a rectangle. Explain this to learners and ask them to tell you about the area of the small rectangles and the are of the large rectangles.

Explain that we are going to play around with making shapes with the same area and taking away the smaller rectangles and explore shapes with a smaller area. The sheet has suggestions of shapes to look at and you should cut out the rectangles and give them to learners to play with and move around.

For the shapes you explore, sketch a small example and label with side lengths and the area. Discuss different strategies for calculating the area of the different shapes you have made, for example, cutting them in different ways or subtracting a section from a larger rectangle.

Gather together examples of different shapes with the same area and talk about what is the same and what is different between them. All of the shapes you have made can be split into rectangles and these shapes are called compound rectangles or rectilinear shapes.

This is a chance to revise and include discussion of the perimeter as well. In the previous pack, this situation was used to explored wen the perimeter remains the same and when it changes. You can return to this line of thinking while also paying attention to what happens to the area.

Activity

The activity sheet provides more rectilinear shapes that learners can use to calculate area. Make sure learners realise that some of the lengths are missing and need to be worked out. Encourage them to mark onto the shape to show how they have worked out the area. Provide additional paper for them to extend the activity and choose where to go next.

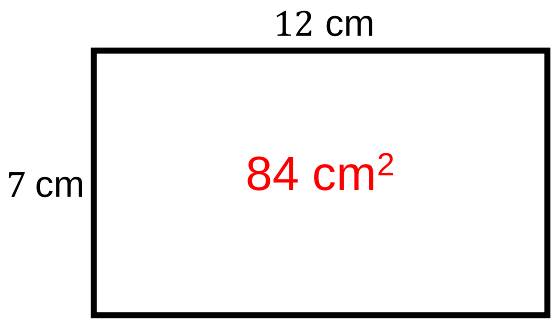
Video guidance

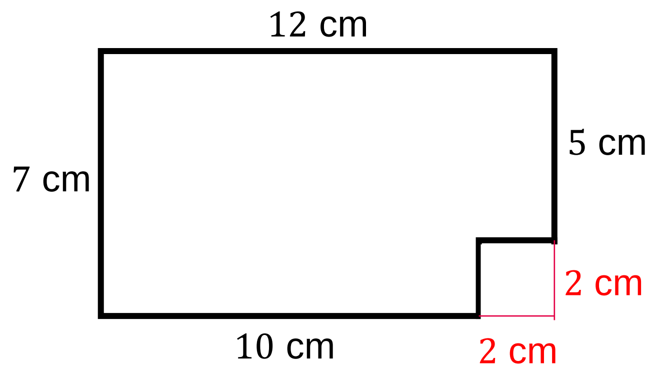
Pack 4 Session D

Activity: Exploring area

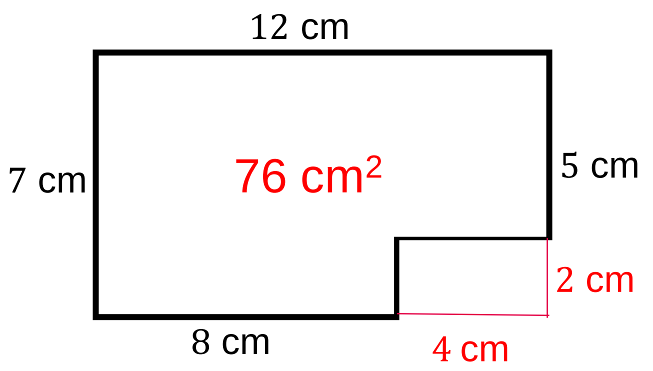
Answers

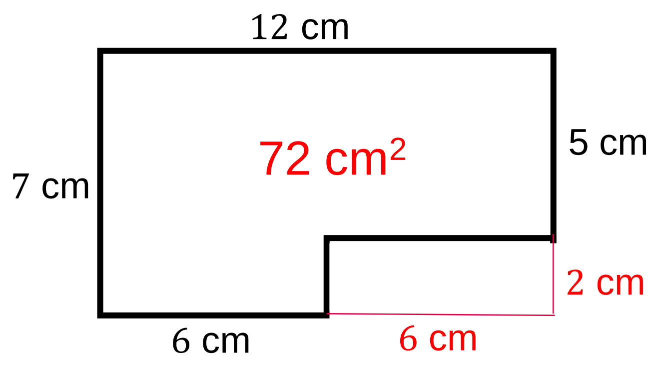
Work out the area of each shape. Remember to include missing lengths

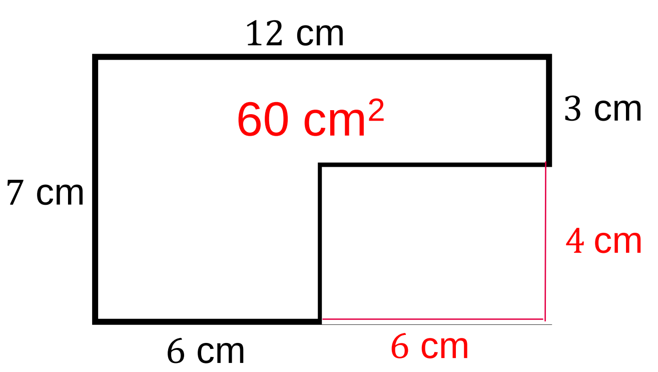




$84 - (2 \times 2) = 80\ cm^2$







Where could you go next?

At home materials

Pack 5: Positive and negative numbers

Session A) Negative numbers in context

Session B) Extending the number line

Session C) Comparing numbers

Session D) Greater than and less than

Mathematics Mastery

Step-by-step

Pack 5: Positive and negative numbers	
Session A: Negative numbers in context	
The purpose of this session is to relate negative numbers to everyday experiences and explore what negative, positive and zero mean in each example.	

Talk Task
Use the images and text on the sheet to discuss where negative numbers appear in everyday life. For each example discuss what positive means, what negative means and what zero means. For example, in the lift of a building: *Positive means above ground, negative means below ground and zero means ground level (sometimes labelled G).*

Discuss the words 'minus' and 'negative' with a focus on exploring the benefit of using the word negative. Minus is often what is said when describing negative values but the word can be confused with subtraction. Negative pairs up with positive to show a connection. Set each other the challenge of saying 'negative'.

Encourage pupils to think of any other contexts where positive and negative values are used and to take the time to make sense of what they mean and what zero means.

Other examples you could discuss include:

- Gains and losses
- Time (before and after a given starting point)
- Above and below par in golf
- Goal difference in football tables

Summarise the session by thinking about how to describe what numbers with a negative symbol represent. Reference should be made to the importance of what zero represents; that it is a chosen point – whether that is a height, a temperature, an amount of money or no money.

The "-" tells us it is less than zero and the number tells us by how much.

Activity
The activity sheet repeats an activity from Pack 5: Addition key facts. It involve describing the position of a robot as it moves east and west on a number line. This time the task is shifted along the number line to involve negative numbers. If they completed this task with positive numbers, reflect on the similarities to increase confidence that they already have the necessary skills to work with negative numbers.

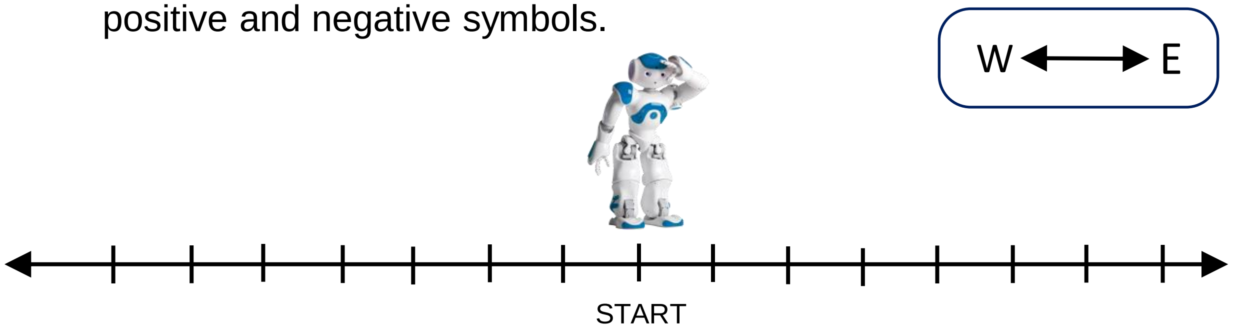
[Video guidance](#)

Pack 5 Session A

Activity: Positive and negative numbers

Answers

1) Describe the position of the robot after each movement using positive and negative symbols.



From START, move two steps east. $+2$

From START, move two steps west -2

a) From START, move 5 steps east. $+5$

b) From START, move 3 steps west -3

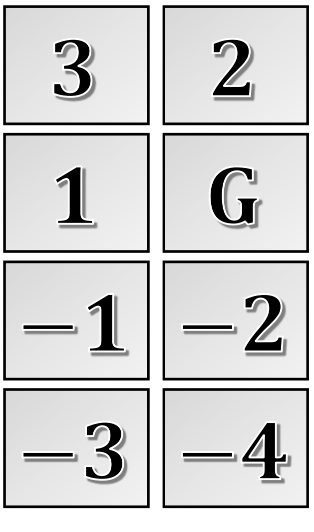
c) From START, move 2 steps east and then 4 steps east $+6$

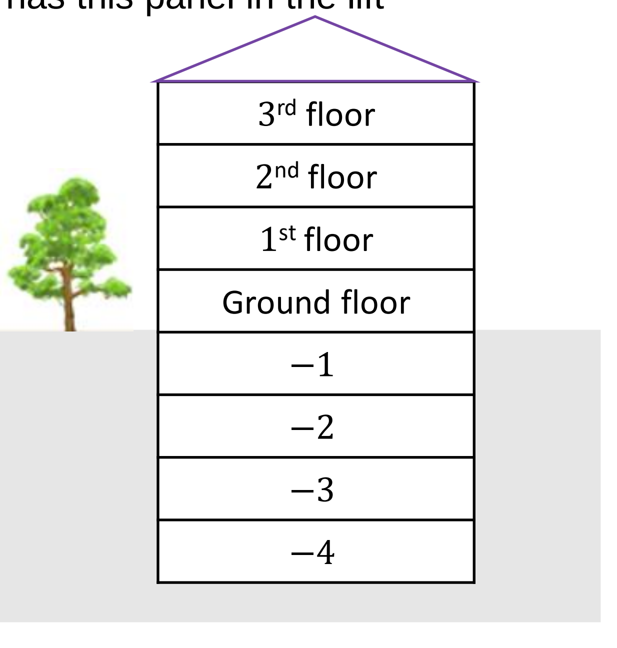
d) From START, move 2 steps west and then 3 steps west -5

e) From START, move 3 steps east then 4 steps west -1

f) From START, move 1 steps west then 4 steps east $+3$

2) Sketch a picture of a building that has this panel in the lift





Mathematics Mastery

Step-by-step

Pack 5: Positive and negative numbers
Session B: Extending the number line
Resources needed: A way to sketch number lines
The purpose of this session is to extend the number line so that negative numbers can be positioned. Both vertical and horizontal number lines are used.

Talk Task

A partially completed horizontal number line is presented. Ask pupils what other information could be recorded. Following their lead, place positive and negative values onto the line and discuss the values shown by the arrows. The arrow to the left is not a whole number. Although decimals and fractions are not the focus, this is included to support pupils in understanding that the line is continuous, any point can be described – not just the marks for whole numbers.

Discuss the temperatures that are described and what the information means. *What would it be like to go to these places?*

Ask pupils to use the vertical number line to position all three values.

How can we label the vertical number line to show the relationship between these values?

This will involve deciding the value of each mark so that all three values can be placed on the line. Give pupils time to think and try out some possible values. Marking the number line in steps of 5 from $35℃$ to $-20℃$ allows all of the temperatures to be placed on the line.

Discuss other information that can be placed on the number line and what that means in the context of temperature. Do they know of places that have temperatures between the given values?

Remember to continue to establish the habit of referring to values below zero with the word ‘negative’ rather than ‘minus’ as this can reduce confusion when adding and subtracting with these values.

Activity

The activity sheet involves reading and identifying positive and negative values on number lines. The first activity involves matching information to describe the position of divers and birds when zero is the surface of the water. Then pupils position values on a partially labelled number line that is marked with steps of two.

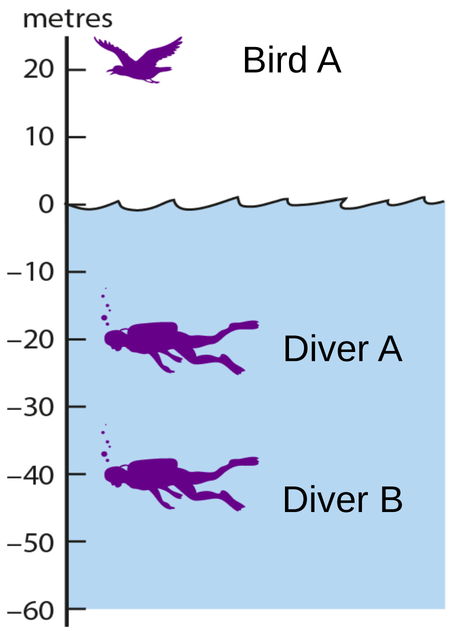
Video guidance

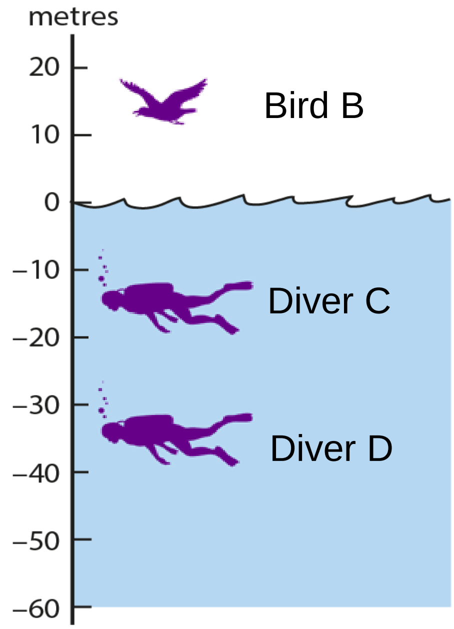
Pack 5 Session B

Activity: Extending the number line

Answers

1) Use the images to match the information.

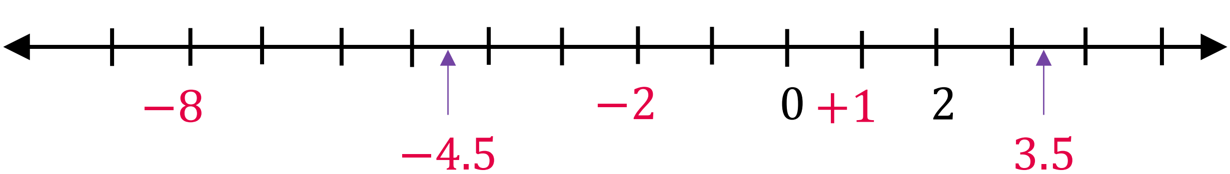




Bird A	33 m below sea level	15 m
Bird B	20 m above sea level	−15 m
Diver A	20 m below sea level	−33 m
Diver B	15 m above sea level	20 m
Diver C	15 m below sea level	−40 m
Diver D	40 m below sea level	−20 m

2) Mark the position of each value on the number line.

a) -2 b) 3.5 c) $+1$ d) -4.5 e) -8



Mathematics Mastery

Step-by-step

Pack 5: Positive and negative numbers
Session C: Comparing numbers
Resources needed: A way to sketch number lines
The purpose of this session is to compare and order positive and negative numbers. Real life contexts are used to provide ways to visualise the relationships and decide if values are greater or less.

Talk Task
The prompts on the sheet provide opportunities to compare positive and negative numbers. For each situation, review what positive means, what negative means and what zero means and connect the ideas of 'greater than' and 'less than' to each example.

For the building: *positive means above ground, negative means below ground and zero means ground level (sometimes labelled G). Discuss the situation and c*onnect that the floor is above and the number is greater e.g. -2 is greater than -4. Also discuss that if the floor is below then the number is less e.g. -4 is less than -2.

For the temperature: *zero is a chosen point, positive is warmer than that, negative is colder than that.*

This situation is more open as no value is given. Encourage pupils to speak in sentences to describe different possible changes in temperature. Connect that colder means a value that is less e.g. -7 is less than -3. Also discuss that warmer means a greater value e.g. -3 is greater than -7.

For the submarine: *positive means above the water, negative means below the water and zero means the surface of the water.*

The situation is also open and involves two changes. Discuss possible depths that the submarine could have travelled to. Highlight that unless it is a flying submarine, the value cannot go above zero. Connect movement towards the surface with greater values and movement away from the surface with values that are less e.g. -50 is greater than -80, -100 is less than -80.

Activity
The activity sheet provides similar experiences with comparing positive and negative numbers. The first question is open and pupils can choose values. Then they delete words to complete sentences. The final set of questions is more abstract and a number line is provided to support.

Video guidance

Pack 5 Session C

Activity: Comparing numbers

Answers

1) Complete the sentences

-3 ℃ is warmer than -4 ℃

-3 ℃ is colder than -1 ℃

-3 ℃ is warmer than -4 ℃

-5 ℃ is colder than -4 ℃

There are many possible answers to these questions

2) Delete a word to make each sentence correct

-3 ℃ is warmer ~~/ colder~~ than -4 ℃

-3 ℃ is ~~warmer /~~ colder than -1 ℃

-3 ℃ is higher ~~/ lower~~ than -4 ℃

-3 ℃ is greater ~~/ less~~ than -4 ℃

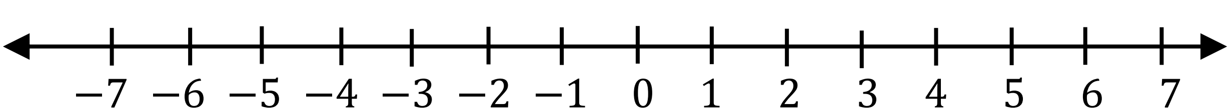
3) Write the numbers from smallest to largest. The number line can help.

a) $6, \ -2, \ 3, \ -5$ $\qquad$ $-5, \quad -2, \quad 3, \quad 6$

b) $-3, \ 4, \ 0, \ -7$ $\qquad$ $-7, \quad -3, \quad 0, \quad 4$

c) $1, \ -9, \ -2, \ 3$ $\qquad$ $-9, \quad -2, \quad 1, \quad 3$

d) $-1, \ -5, \ -8, \ -3$ $\qquad$ $-8, \quad -5, \quad -3, \quad -1$



Step-by-step

Pack 5: Positive and negative numbers	
Session D: Greater than and less than	
Resources needed: n/a	
The purpose of this session is to build on the previous session comparing and ordering positive and negative values. The symbols for 'is greater than' > and 'is less than' < are used to describe relationships.	

Talk Task

Challenge pupils to think about each statement and decide if it is always, sometimes or never true.

- A positive number is **always** greater than a negative number.
- A positive number is **never** equal to a negative number.
- A positive number is **never** less than a negative number.
- A negative number is **sometimes** greater than a negative number. It depends on the numbers.

Discuss each one and use the number line to support explanations and reasons. You want to build confidence understanding that for a horizontal number line:

- Numbers to the right are greater
- Numbers to the left are less

This understanding will mean you are able to avoid the errors made in the two speech bubbles. Discuss these and think about what you can do, say and write to help the people understand.

Discuss the symbols at the end of the sheet. The language of these symbols has been used throughout the session. Find out previous experience with these symbols and then write statements using these symbols to record the relationships that you have described with words.

Activity

The activity sheet provides experience with creating statements of inequality.

For the final activity, pupils sketch number lines and estimate the position of different values. You may need to simplify this if pupils are unsure. For example, *sketch a line that has -5 at one end and 5 at the other, where is zero? Where is* $2, -3, \ldots$

[Video guidance]

Pack 5 Session D

Answers

Activity: Greater than and less than

1) Choose the correct symbol, **>** or **<**, to complete each.
Then choose **always** or **never** to complete the sentences.

$-1 < 2$	$1 > -2$
$-2 < 2$	$2 > -2$
$-3 < 2$	$3 > -2$
$-4 < 2$	$4 > -2$

A negative number is *always* less than a positive number

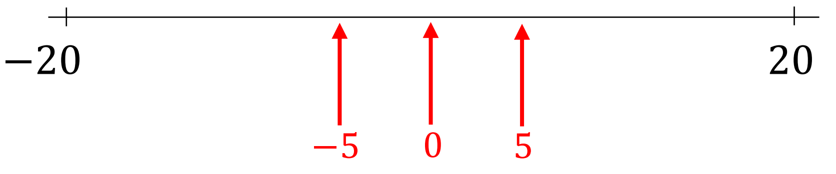
A positive number is *never* less than a negative number

2) Choose the correct symbol, > or < or =, to complete each.

$2 < 5$	$-2 > -5$	$21 > 19$	$-21 < -19$
$3 < 6$	$-3 > -6$	$21 > 20$	$-21 < -20$
$4 < 7$	$-4 > -7$	$21 > 21$	$-21 = -21$
$24 < 27$	$-24 > -27$	$21 > 22$	$-21 > -22$

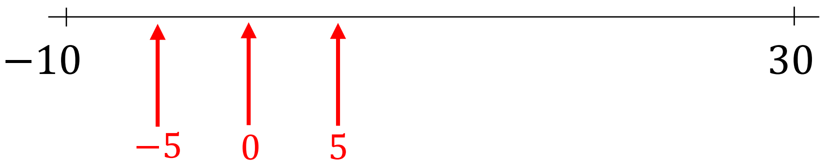
3) Mark the position of zero, five and negative five on each number line.

a)



b)

c)



Loved a session?

Got some ideas for improvements?

Spotted a typo?

Let us know your feedback [here]