

Introduction

In computer games 3D characters and objects are made from thousands of triangles. The triangles are then given different colours to create the illusion of three dimensions. Computer programmers can write a piece of computer code to represent a triangle and then repeat this over and over again to represent much more complex shapes.

What's the point?

Triangles are the most basic polygon. By using triangles in areas as diverse as computer graphics and architecture, we can create sophisticated shapes that we would otherwise not be able to create.

Orientation

What I need to know

Key stage 3

G1

What I will learn

- Identify types of angles
- Recall and use properties of parallel and perpendicular lines
- Recall and use properties of angles
- Use angle properties of triangles
- Measure lines and angles

What this leads to

G3

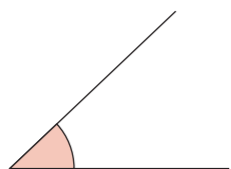
Check in

- 1 Measure this line in
a millimetres **b** centimetres.

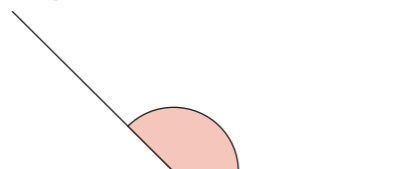


- 2 **Estimate** the size of these angles.

a

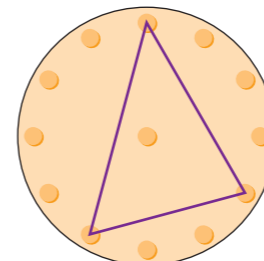


b



Rich task

You will need a circular pinboard.



A triangle has been made on a circular geoboard. Measure its angles. Investigate the angles in different triangles you can make on the pinboard. Can you find some rules?

G2.1 Measuring lines

This spread will show you how to:

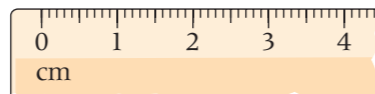
- Measure and draw lines to the nearest millimetre

Keywords

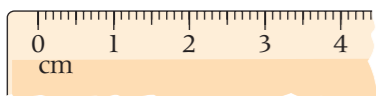
Centimetre
Diagonal
Length
Measure
Millimetre
Perimeter

p.134

A ruler **measures length** in **millimetres** (mm) or **centimetres** (cm).



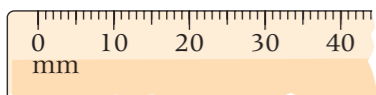
This line measures 2.5 cm or 25 mm.



$$10 \text{ mm} = 1 \text{ cm}$$

$$2.5 \text{ cm} = 2\frac{1}{2} \text{ cm}$$

This line measures 2.7 cm or 27 mm.



H	T	U	•	$\frac{1}{10}$	$\frac{1}{100}$
		2	•	7	

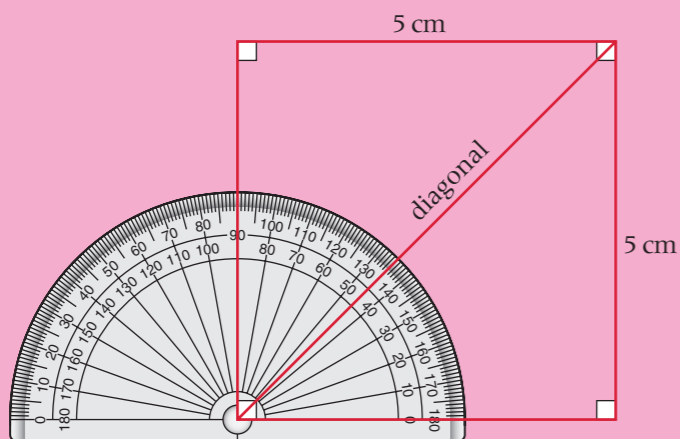
$$2.7 \text{ cm} = 2\frac{7}{10} \text{ cm}$$

To measure a line, line up the ruler so that the zero mark is at the start of the line.

You can construct shapes using a ruler and a protractor.

Example

Using a ruler and a protractor, construct a square of length 5 cm. Draw and measure the diagonal in **a** centimetres **b** millimetres.



a 7.1 cm

b 10 mm = 1 cm

$$10 \times 7.1 = 71 \text{ mm}$$

Use the ruler to draw the 5 cm lines.

Use the protractor to construct the 90° angles.

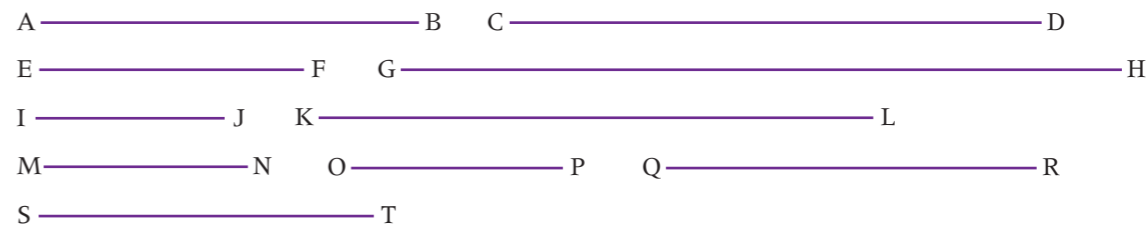
Grade G

Exercise G2.1

1 Measure the lengths of these lines in

a centimetres

b millimetres.



2 **a** Draw a line AB, so that AB = 9 cm.

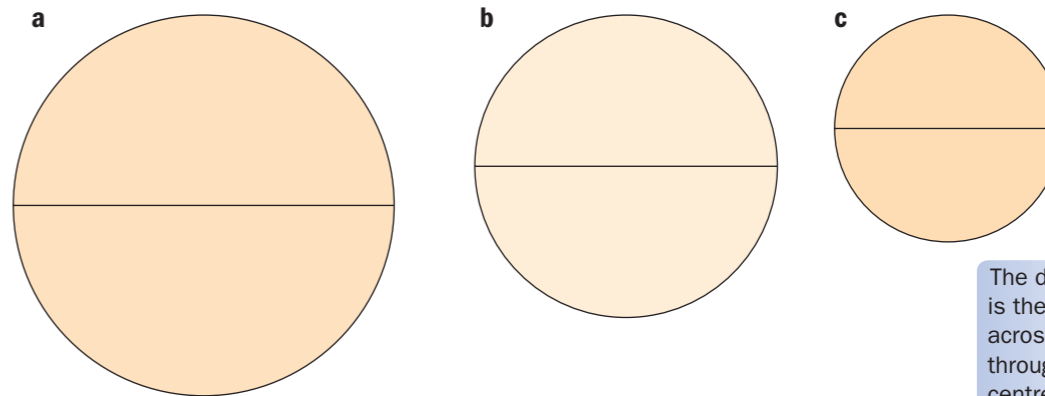
b Find the midpoint of AB and mark it with a cross.

3 **a** Draw a line CD, so that CD = 11.6 cm.

b Find the midpoint of CD and mark it M.

c Measure CM, stating the units of your answer.

4 Measure and state the diameter of each circle in centimetres.



The **diameter** is the distance across a circle through the centre.

5 Measure and calculate the perimeter of this rectangle in

a centimetres

b millimetres.

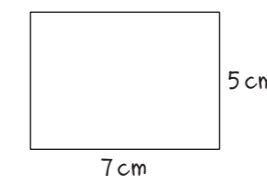


The **perimeter** is the **distance** round the edge of a shape.

6 Using a ruler and protractor, construct a rectangle of length 7 cm and width 5 cm. Draw and measure the diagonal in

a centimetres

b millimetres.



G2.2 Measuring angles

This spread will show you how to:

- Understand angle measure
- Measure and draw angles to the nearest degree
- Estimate the size of an angle in degrees

Keywords

Angle
Degrees ($^{\circ}$)
Estimate
Measure
Protractor

You can **measure** and draw an **angle** in **degrees** with a **protractor**.

A protractor measures angles up to 180° .

There are 180° in a half turn.

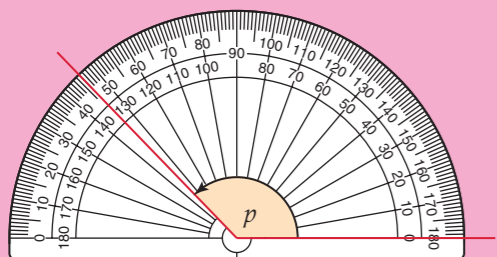
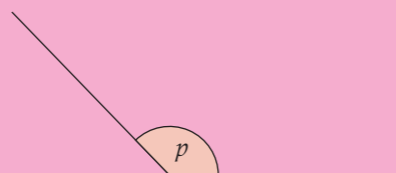


$^{\circ}$ means degrees.

- There are 180° on a straight line.

Example

Measure the size of angle p .



- 1 **Estimate** the size of angle p . (Guess 120° , as greater than 90° .)
- 2 Place the protractor over the angle.
- 3 The angle point should be at the cross in the protractor.
- 4 One arm of the angle should be along the zero line.
- 5 Start counting from this zero line.
 $p = 134^{\circ}$

You have to decide which scale to use, either the inner scale or the outer scale.

For this angle use the inner scale.

- You can measure a reflex angle by measuring the associated acute or obtuse angle.

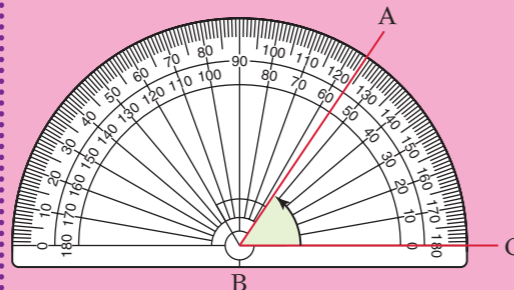
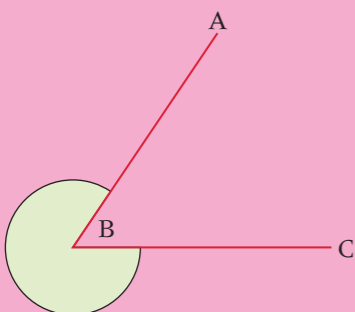
A full turn is 360° .

Angles at a point add to 360° .

Example

Measure the reflex angle $\hat{A}BC$.

The acute angle $\hat{A}BC = 56^{\circ}$.
So the reflex angle $\hat{A}BC$ is
 $360^{\circ} - 56^{\circ} = 304^{\circ}$



Exercise G2.2

Grade G

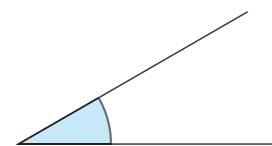
In questions 1–9, for each angle state

- a the type of angle – acute, right angle, obtuse or reflex
- b your estimate in degrees
- c the measurement in degrees.

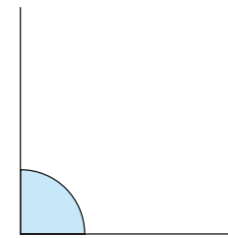
Set out your answers like this:

Question	Type of angle	Estimate	Measurement
1	acute	40°	30°
2			

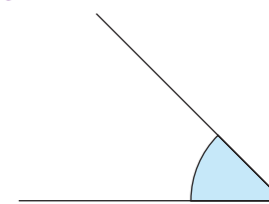
1



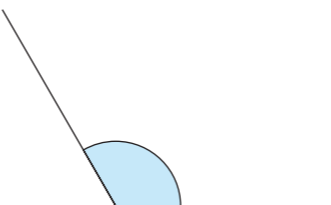
2



3



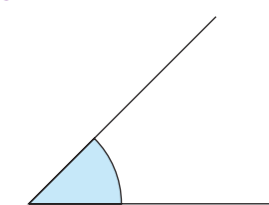
4



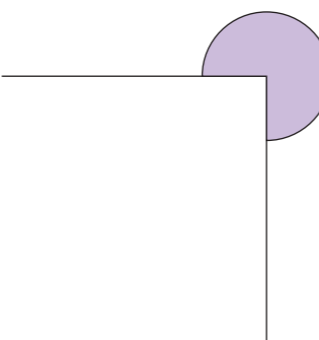
5



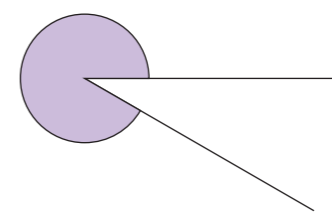
6



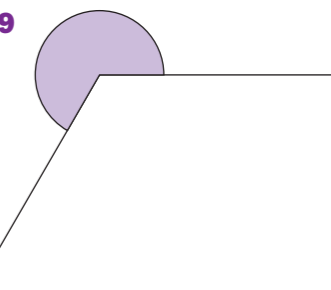
7



8



9



- 10 Draw and label these angles using a protractor. State whether each angle is acute, obtuse, reflex or a right angle.

- | | | | |
|-----------------|-----------------|-----------------|-----------------|
| a 40° | b 140° | c 90° | d 36° |
| e 144° | f 56° | g 124° | h 38° |
| i 142° | j 85° | k 300° | l 200° |
| m 320° | n 245° | o 265° | |

G2.3 Angles and lines

This spread will show you how to:

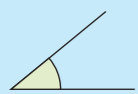
- Identify acute, obtuse, reflex and right angles
- Recall and use properties of parallel and perpendicular lines

An **angle** is a measure of turn. You measure the turn in **degrees**.

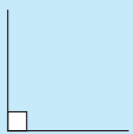
Amount of turn	$\frac{1}{4}$ turn	$\frac{1}{2}$ turn	$\frac{3}{4}$ turn	full turn
Angle in degrees	90°	180°	270°	360°

You can describe an angle by its size.

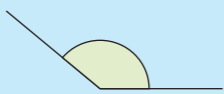
an **acute** angle is less than 90°



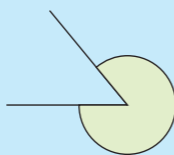
a **right angle** is exactly 90°



an **obtuse** angle is between 90° and 180°



a **reflex** angle is more than 180°



° means degrees.

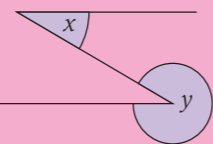
Keywords

- Acute
- Angle
- Degrees (°)
- Intersect
- Obtuse
- Parallel
- Perpendicular
- Reflex
- Right angle

Example

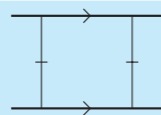
What type of angle is shown by the letter

a x **b** y ?



a x is acute. **b** y is reflex.

Parallel lines are always the same distance apart. Parallel lines are shown by sets of arrows.



Parallel lines never **intersect** (cross) each other.

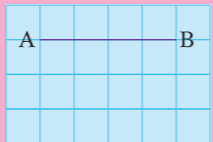
Perpendicular lines meet at a right angle.



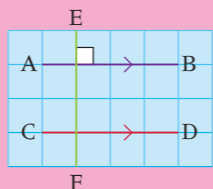
Example

A line AB is drawn on a grid.

- Draw another line that is parallel to AB. Label the line CD and mark with arrows (\rightrightarrows).
- Draw another line that is perpendicular to AB. Label the line EF and mark with a square (\perp).



CD is parallel to AB.
EF is perpendicular to AB.



Exercise G2.3

Grade G

1 How many right angles make up the angle shown in each diagram?

a

b

c

d

e

f

2 Choose one of these words to describe each angle.

acute right angle obtuse reflex

a

b

c

d

e

f

g

h

i

j

k

l

3 Choose one of these words to describe each angle.

acute right angle obtuse reflex

- a** 90° **b** 40° **c** 140° **d** 200° **e** 270° **f** 36°
g 137° **h** 248° **i** 302° **j** 33° **k** 96° **l** 239°



- Draw two lines that are parallel. Label them with \rightrightarrows .
- Draw two lines that are perpendicular. Label them with \perp .

DID YOU KNOW?



Perpendicular and parallel lines are all around you!

G2.4 Angle properties

This spread will show you how to:

- Recall and use properties of angles at a point, angles on a straight line, perpendicular lines and opposite angles at a vertex

Keywords

Angle
Degrees ($^{\circ}$)
Point
Straight line
Vertically opposite

- These are 360° in a full turn at a **point**.



- There are 180° on a **straight line**. This is a half turn at a point.



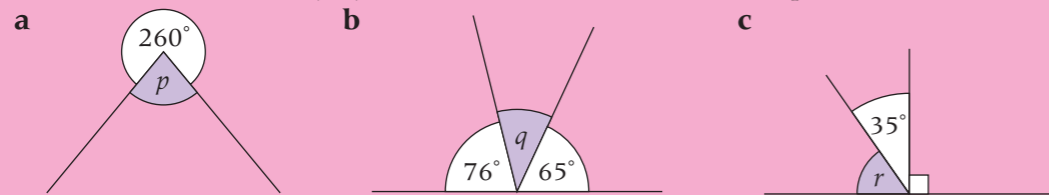
- There are 90° in a quarter turn at a point.



This information is useful for your Unit 1 assessment, as well as Unit 2.

Example

Calculate the values of p , q and r . Give a reason for each of your answers.

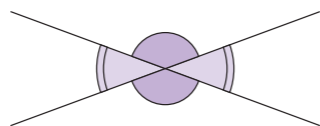


a $360^{\circ} - 260^{\circ} = 100^{\circ}$
 $p = 100^{\circ}$
(angles at a point add to 360°)

b $76^{\circ} + 65^{\circ} = 141^{\circ}$
 $180^{\circ} - 141^{\circ} = 39^{\circ}$
 $q = 39^{\circ}$
(angles on a straight line add to 180°)

c $35^{\circ} + 90^{\circ} = 125^{\circ}$
 $180^{\circ} - 125^{\circ} = 55^{\circ}$
 $r = 55^{\circ}$
(angles on a straight line add to 180°)

When two lines intersect they make four angles. The two acute angles are equal. The two obtuse angles are equal.



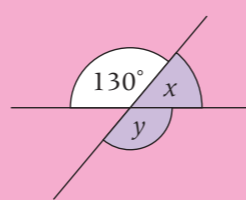
This topic is extended to alternate and corresponding angles on page 430.

- Vertically opposite** angles are equal.

Example

Calculate the values of x and y . Give a reason for each of your answers.

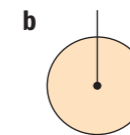
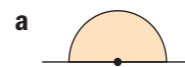
$x = 180^{\circ} - 130^{\circ} = 50^{\circ}$ (angles on a straight line add to 180°)
 $y = 130^{\circ}$ (vertically opposite angles are equal)



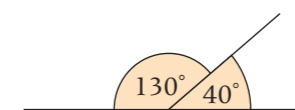
Exercise G2.4

Grade F

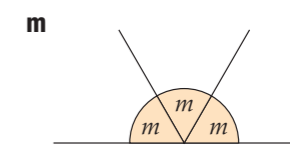
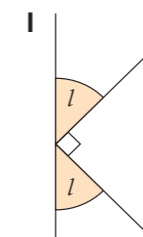
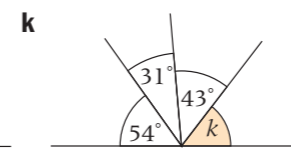
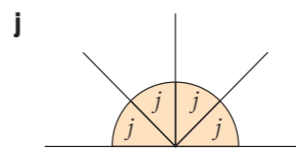
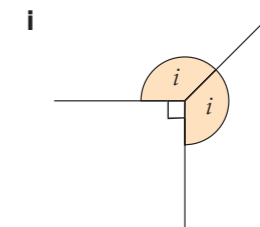
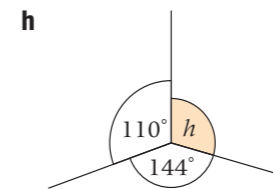
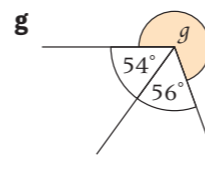
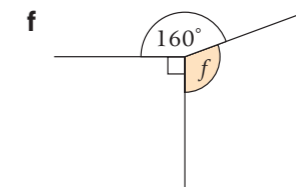
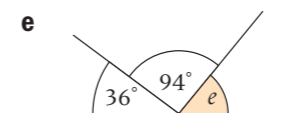
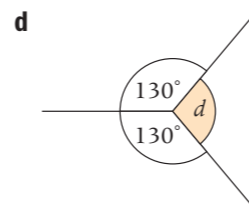
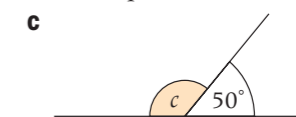
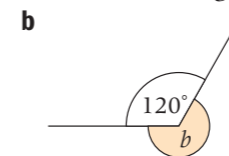
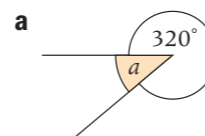
- 1 Give the values in degrees of the coloured angles.



- 2 This diagram is wrong. Explain why.

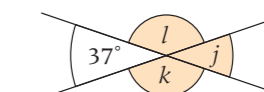
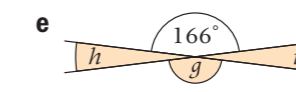
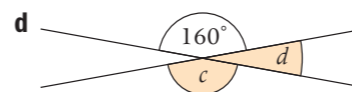
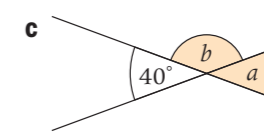
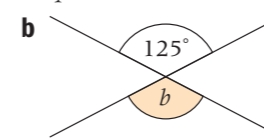
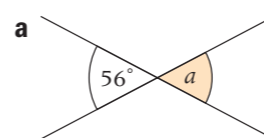


- 3 Calculate the size of the angles marked by letters in each diagram. Give a reason for each answer. The diagrams are not accurately drawn.



- 4 Calculate the size of the angles marked by letters in each diagram. Give a reason for each of your answers.

These diagrams are not drawn to scale.



G2.5 Angles in a triangle

This spread will show you how to:

- Use angle properties of equilateral, isosceles and right-angled triangles

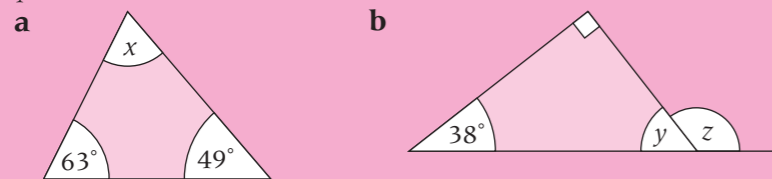
- There are 180° on a straight line.

You can draw any triangle ... tear off the corners ... and put them together to make a straight line.



- The angles in a **triangle** add to 180° .

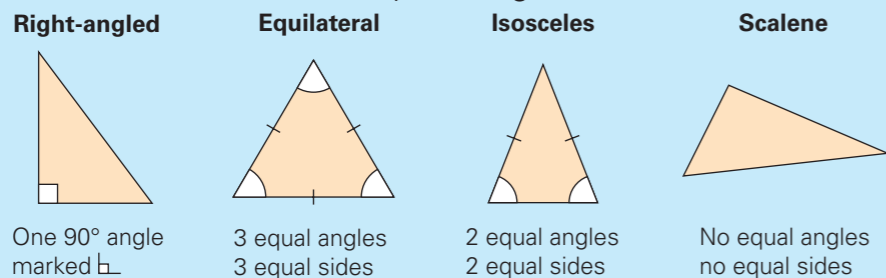
Calculate the values of x , y and z . Give a reason for each of your answers.



a $63^\circ + 49^\circ = 112^\circ$
 $180^\circ - 112^\circ = 68^\circ$
 $x = 68^\circ$
 (angles in a triangle add to 180°)

b $38^\circ + 90^\circ = 128^\circ$
 $180^\circ - 128^\circ = 52^\circ$ (angles in a triangle add to 180°)
 $y = 52^\circ$
 $180^\circ - 52^\circ = 128^\circ$ (angles on a straight line add to 180°)
 $z = 128^\circ$

- You should know these names for special triangles

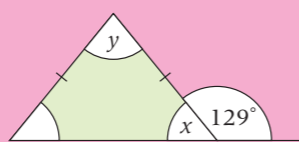


For an equilateral triangle each angle is 60° as $180^\circ \div 3 = 60^\circ$

Lines with the same mark are equal length.

Calculate the values of x and y . Give reasons for your answers.

$180^\circ - 129^\circ = 51^\circ$
 $x = 51^\circ$ (angles on a straight line add to 180°)
 $51^\circ + 51^\circ = 102^\circ$
 $180^\circ - 102^\circ = 78^\circ$
 $y = 78^\circ$ (angles in a triangle add to 180°)



As the triangle is isosceles, two of the angles are equal.

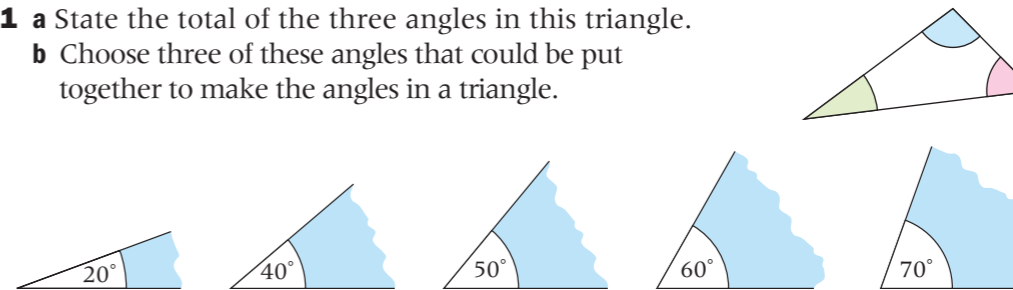
Keywords
 Angle
 Degrees ($^\circ$)
 Equilateral
 Isosceles
 Right-angled
 Scalene
 Triangle

Exercise G2.5

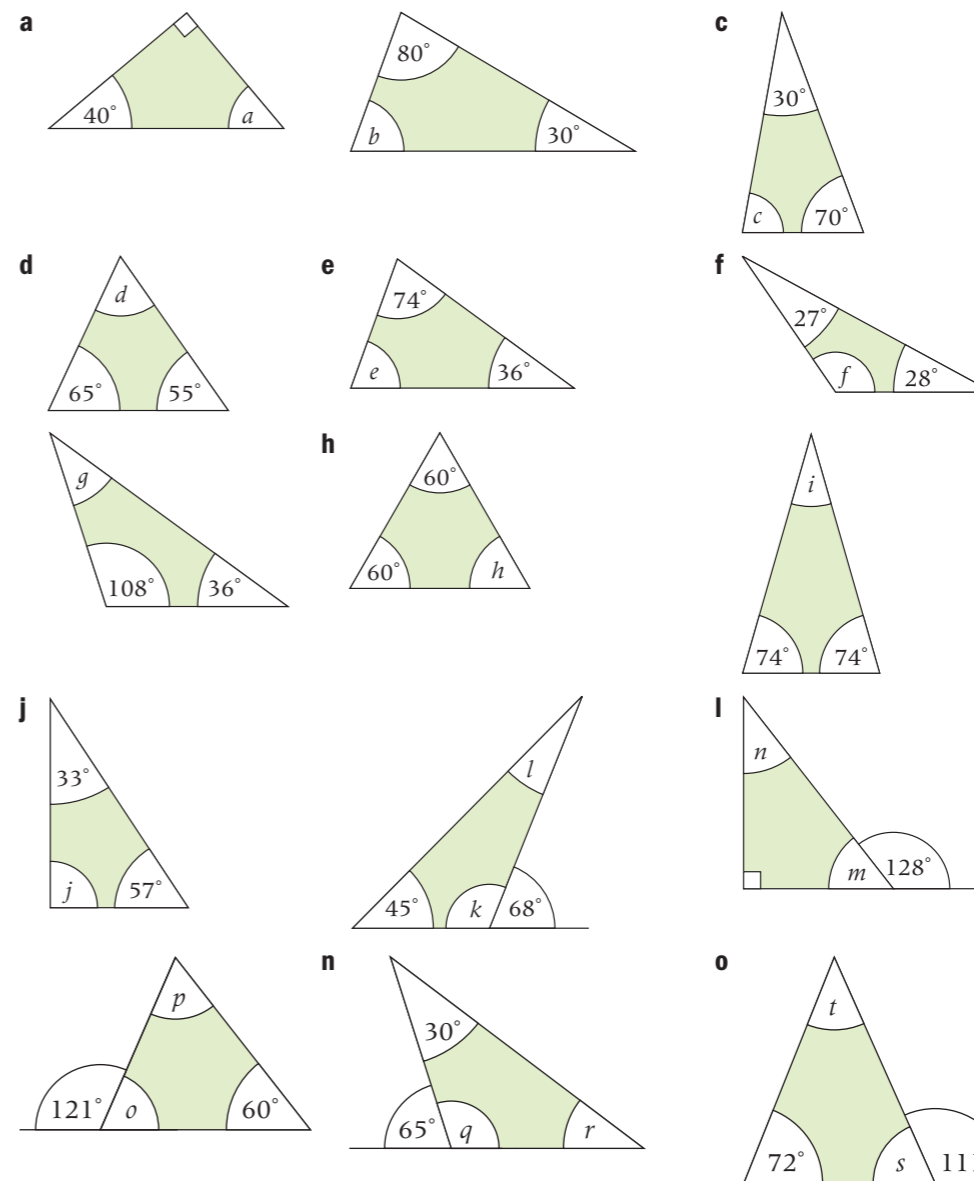
Grade E

A03 Problem

- 1 a** State the total of the three angles in this triangle.
b Choose three of these angles that could be put together to make the angles in a triangle.



- 2** Calculate the size of the unknown angles in each diagram. The diagrams are not drawn to scale.



- 3** List any triangles in question 2 that are right-angled isosceles.

Unit 2

G2.6 Properties of triangles

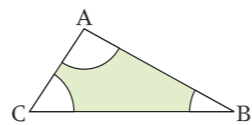
This spread will show you how to:

- Know the properties of right-angled, equilateral, isosceles and scalene triangles
- Know that the angles in a triangle add to 180°
- Understand similarity and congruence

Keywords

Congruent
Equilateral
Isosceles
Right-angled
Scalene
Similar
Triangle

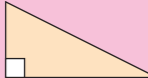

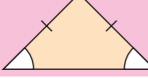

- The angles in a triangle add to 180° .



$$\angle A + \angle B + \angle C = 180^\circ$$

p.260

You need to know the properties of these triangles.

Triangle	Properties	Reflection symmetry	Rotational symmetry
Right-angled 	One 90° angle marked \perp	No lines of symmetry	Order 1
Equilateral 	3 equal angles 3 equal sides	3 lines of symmetry	Order 3
Isosceles 	2 equal angles 2 equal sides	1 line of symmetry	Order 1
Scalene 	No equal angles No equal sides	No lines of symmetry	Order 1

You will learn about reflection and rotational symmetry on pages 254–257.

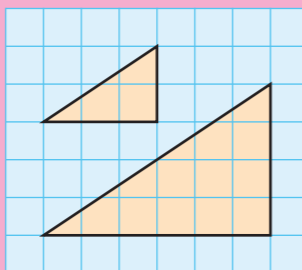
- **Similar** shapes are the same in shape but differ in size.

- **Congruent** shapes are the same size and shape.

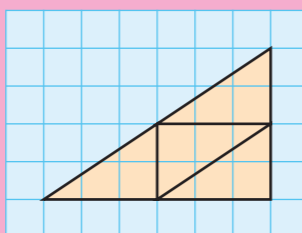
Example

Here are two similar triangles.

- State the type of triangle.
- How many small congruent triangles will fit inside the large triangle?
- Draw the arrangement.



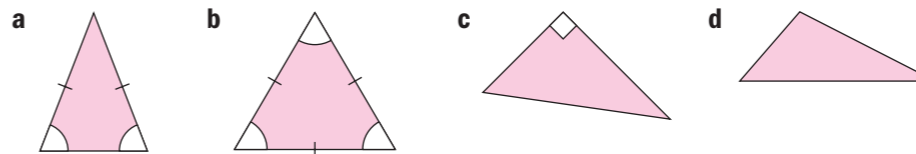
- a Right-angled scalene triangle b 4 c



Exercise G2.6

Grade E

- 1 State the type of each triangle.



- 2 State the type of each triangle, if the sides of the triangle are

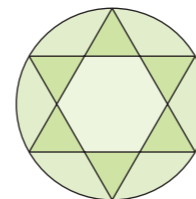
- 8 cm, 8 cm, 8 cm
- 6 cm, 7 cm, 8 cm
- 3 cm, 5 cm, 5 cm

- 3 Calculate the third angle of the triangle and state the type of each of these triangles.

- $30^\circ, 60^\circ$
- $70^\circ, 40^\circ$
- $60^\circ, 60^\circ$
- $35^\circ, 65^\circ$
- $45^\circ, 45^\circ$

AC Problem

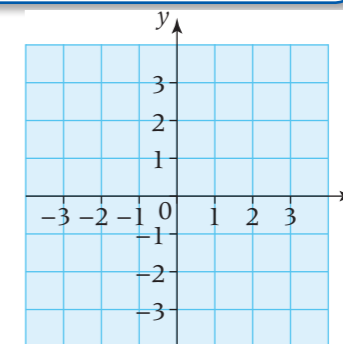
- 4 How many equilateral triangles are in this pattern?



- 5 Plot and join up each set of points on a separate copy of this grid.

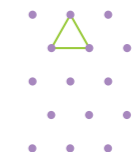
- $(-2, -1), (-2, 2), (0, 2)$
- $(-2, -3), (-1, 0), (0, -3)$
- $(1, -2), (3, 2), (1, 3)$
- $(1, -3), (3, -3), (3, -1)$

In each case, state the type of triangle.



A03 Problem

- 6 Using three more congruent (identical) equilateral triangles, draw a larger similar equilateral triangle on isometric paper.



Summary

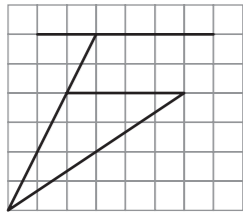
Check out

You should now be able to:

- Identify acute, obtuse, reflex and right angles
- Understand and use properties of parallel and perpendicular lines
- Understand and use properties of angles at a point, on a straight line and of opposite angles at a vertex
- Identify and use the properties of right-angled, equilateral, isosceles and scalene triangles
- Know that the angles in a triangle add to 180°
- Identify congruent shapes
- Measure lines and angles

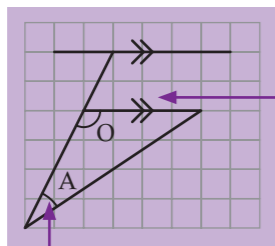
Worked exam question

Here is a diagram drawn on a square grid.



- a** Mark, with arrows (\gg), a pair of parallel lines. (1)
b Mark, with the letter A, an acute angle. (1)
c Mark, with the letter O, an obtuse angle. (1)

(Edexcel Limited 2007)

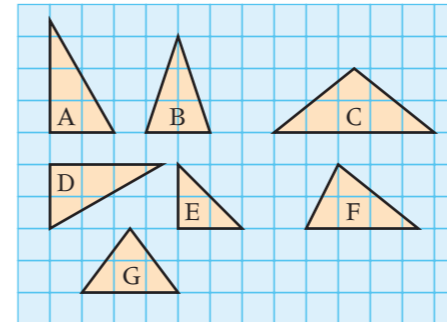


There are other possible answers.

Use an arc to show the angle and the letter to mark the angle.

Exam questions

- 1** Here are some triangles on a grid.



Two of these triangles are congruent.

- a** Write down the letters of these two triangles. (1)

One of these triangles is both right-angled and isosceles.

- b** Write down the letter of this triangle. (1)

(Edexcel Limited 2007)

- 2 a**

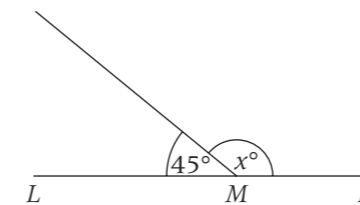


Diagram NOT accurately drawn

LMN is a straight line.

- i** Work out the value of x . (2)
ii Give a reason for your answer. (2)

- b**

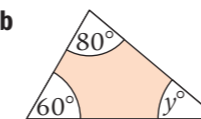


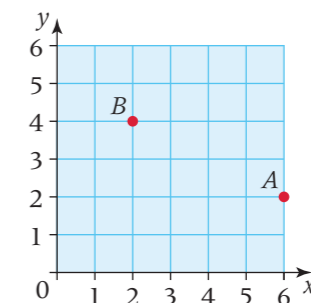
Diagram NOT accurately drawn

Work out the value of y . (2)

(Edexcel Limited 2008)

A03

- 3** The points A and B have coordinates $(6, 2)$ and $(2, 4)$ respectively. Write the coordinates of a third point C so that ABC is an isosceles right-angled triangle.



(3)