18 GEOMETRY AND MEASURES: ANGLES

LEARNING OBJECTIVES

- Apply the properties of angles at a point, on a line, vertically opposite, corresponding and alternate
- Calculate and use the sum of angles in polygons

SPECIFICATION LINKS

- G1, G3

STARTER ACTIVITY

- **Colour it in; 5 minutes; page 120**
  Full instructions are given on the activity sheet.

MAIN ACTIVITIES

- **Using angle properties; 15 minutes; page 121**
  Remind the student of the properties of angles on a straight line, round a point and in a triangle, vertically opposite angles, corresponding and alternate angles, and co-interior angles. Ask the student to work through the activity.
- **Polygons; 25 minutes; page 122**
  For question 1, encourage the student to calculate the sum of the internal angles of the polygons by splitting them into triangles. Show the student how to draw on the external angles and measure them and find their sum. Question 2 requires discussion rather than written work. Encourage the student to communicate using the correct mathematical terms, illustrating the discussion with diagrams.

PLENARY ACTIVITY

- **10 facts, 2 minutes; 5 minutes**
  Ask the student to write down 10 facts they can remember about angles in two minutes. Discuss their answers.

HOMEWORK ACTIVITY

- **Time to revise; 45 minutes; page 123**
  Full instructions are given on the activity sheet.

SUPPORT IDEA

- **Using angle properties** Encourage the student to mark every angle they know rather than just trying to find the missing angles. You may wish to support the student by providing 'fact cards' of the angle properties they can use – illustrate these with diagrams.

EXTENSION IDEA

- **Polygons** Extend question 2a) by asking the student to find a formula that connects the number of sides of a polygon to the sum of the internal angles.

PROGRESS AND OBSERVATIONS

STARTER ACTIVITY: COLOUR IT IN

TIMING: 5 MINS

LEARNING OBJECTIVES

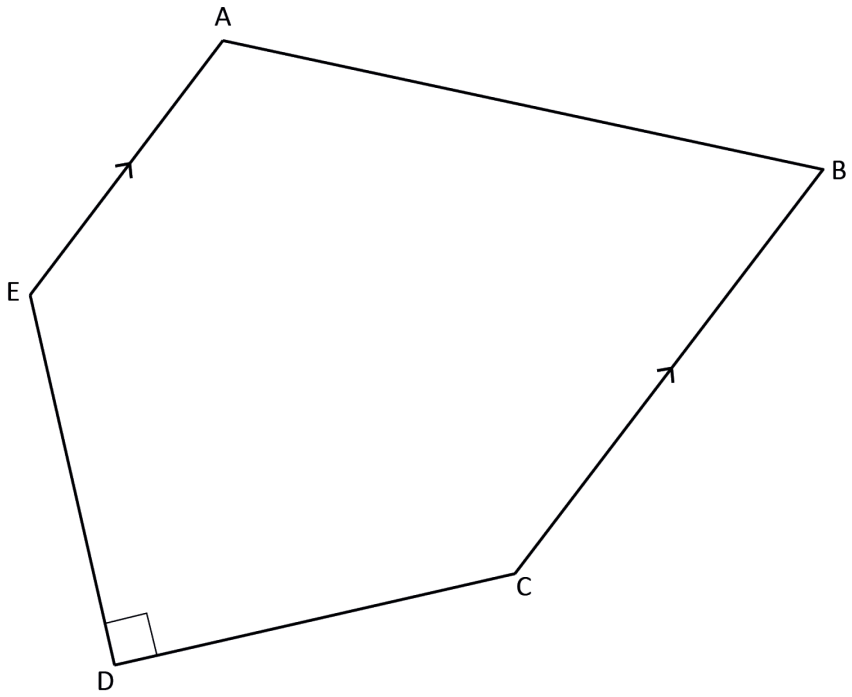
- Use conventional terms and notation

EQUIPMENT

- coloured pencils
- protractor

1. On the shape below, colour:

a) side AB red
b) a pair of parallel sides blue
c) a right angle orange
d) angle BCD green
e) a pair of perpendicular sides yellow
f) an acute angle pink
g) an obtuse angle purple.



2. What is the name of the shape? .....

3. Measure the angles. Which is the largest angle? .....

MAIN ACTIVITY: USING ANGLE PROPERTIES — TIMING: 15 MINS

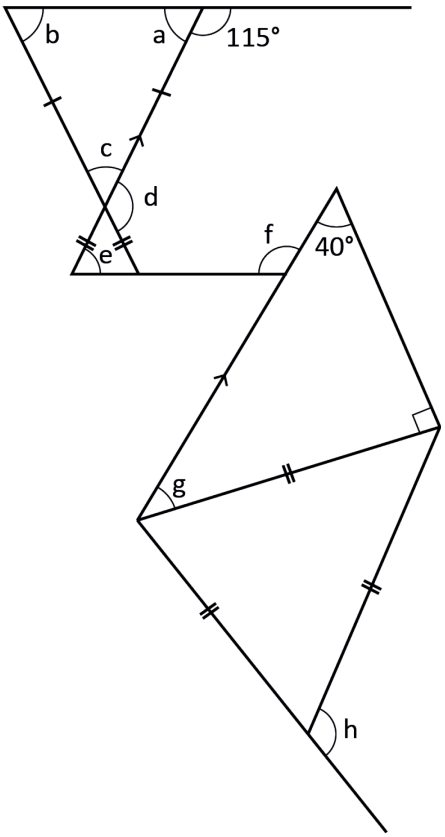
LEARNING OBJECTIVES

- Apply the properties of angles at a point, on a line, vertically opposite, corresponding and alternate

EQUIPMENT

none

1. Calculate the size of each of the labelled angles. For each angle, explain your reasoning. The diagram isn't drawn to scale, so you'll need to use angle rules rather than a protractor!



a = ...

b = ...

c = ...

d = ...

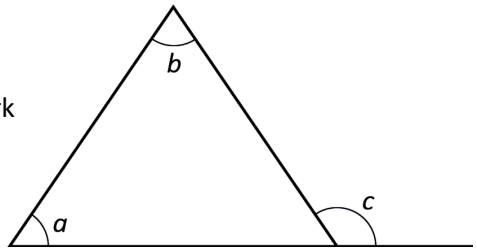
e = ...

f = ...

g = ...

h = ...

2. The triangle opposite has three angles labelled *a*, *b* and *c*.



a) Choose two angles smaller than 90° for *a* and *b*, and use them to work out the size of angle *c*.

.....

b) Does $a + b = c$? .....

c) Try this for other values of *a* and *b*. What do you notice? Can you explain your observation?

.....

.....

MAIN ACTIVITY: POLYGONS

TIMING: 25 MINS

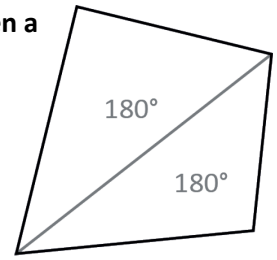
LEARNING OBJECTIVES

- Calculate and use the sum of angles in polygons

EQUIPMENT

- ruler
- protractor

1. Amelia draws a quadrilateral and splits it into two triangles by drawing a line between a pair of opposite vertices.



Since the angles in a triangle add up to 180°, Amelia works out that the angles in a quadrilateral add up to 360°.

Use Amelia's method to work out the sum of angles in the polygons in the table below.

Measure the exterior angles to work out the sum of the exterior angles of a polygon.

Name of shape	Number of sides	Sum of interior angles	Sum of exterior angles
triangle	3	180°	360°
quadrilateral	4	360°	
pentagon	5		
hexagon	6		
heptagon	7		
octagon	8		
nonagon	9		
decagon	10		

2. Discuss the answers to each of these questions with your tutor.

a) How could you find the sum of the interior angles of a polygon with *n* sides?

.....

b) How could you find the sum of the exterior angles of a polygon with *n* sides?

.....

c) What is the size of one of the external angles of a regular pentagon? .....

d) What is the size of one of the internal angles of a regular nonagon? .....

e) Explain how you know that regular octagons and squares tessellate together.

.....

f) Explain how you know that pentagons and nonagons will not tessellate.

.....

HOMEWORK ACTIVITY: TIME TO REVISE

TIMING: 45 MINS

LEARNING OBJECTIVES

- Apply the properties of angles at a point, on a line, vertically opposite, corresponding and alternate
- Calculate and use the sum of angles in polygons

EQUIPMENT

- index cards/large piece of paper
- coloured pens
- ruler

1. There are lots of facts you will need to remember about angles for the exam.

Make a set of flash cards or a large poster listing all the facts you have covered in this lesson.

You must include facts about:

- angles on a straight line
- angles round a point
- angles in a triangle
- vertically opposite angles
- corresponding angles
- alternate angles
- co-interior angles
- angles in a quadrilateral
- angles in a polygon
- sum of exterior angles of a polygon
- angles in a regular polygon.

18 ANSWERS

STARTER ACTIVITY: COLOUR IT IN

1. Check student's diagram. 2. pentagon 3. A = 115°, B = 65°, C = 140°, D = 90°, E = 130°; angle C is largest

MAIN ACTIVITY: USING ANGLE PROPERTIES

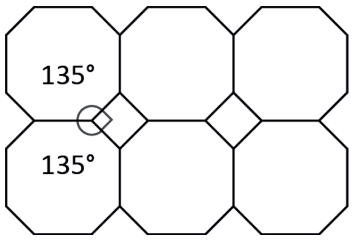
1. a = 65° (angles on a straight line sum to 180°)
b = 65° (the two angles at the base of the equal sides in an isosceles triangle are equal)
c = 50° (angles in a triangle sum to 180°)
d = 130° (angles on a straight line sum to 180°)
e = 65° (angles on a straight line sum to 180° *or* vertically opposite angles are equal, and the two angles at the base of the equal sides in an isosceles triangle are equal)
f = 115° (co-interior angles sum to 180°)
g = 50° (angles in a triangle sum to 180°)
h = 120° (angles in an equilateral triangle are all 60°, and angles on a straight line sum to 180°)
2. a)–c) $a + b = c$ because the sum of the angles in a triangle = 180°, so $c = 180° – (180° – (a + b))$

MAIN ACTIVITY: POLYGONS

1.

Name of shape	Number of sides	Sum of interior angles	Sum of exterior angles
triangle	3	180°	360°
quadrilateral	4	360°	360°
pentagon	5	540°	360°
hexagon	6	720°	360°
heptagon	7	900°	360°
octagon	8	1080°	360°
nonagon	9	1260°	360°
decagon	10	1440°	360°

2. a) $(n – 2) \times 180°$ or two less than the number of sides multiplied by 180°
b) The external angles of all polygons sum to 360°.
c) 360° ÷ 5 = 72°
d) 1260° ÷ 9 = 140°
e) The internal angle of a regular octagon is 135°. You can put two octagons together with one square at a vertex, since 135 + 135 + 90 = 360° (see diagram).
f) The internal angle of a pentagon is 108°, and the internal angle of a nonagon is 140°. No combination of these will add up to 360°.



HOMEWORK ACTIVITY: TIME TO REVISE

1. Check student's flashcards or poster.

GLOSSARY

Parallel
Two lines are parallel if they remain the same distance apart. Parallel lines never meet.

Perpendicular
Two lines are perpendicular if the angle between them is 90°.