Geometry & Trigonometry · Unit G01 · Foundations

Name That Shape

Foundations · MYP 1–3 · 60 practice questions · Criteria A, B, C, D

The first unit of the Geometry & Trigonometry strand. Nothing here needs any number work beyond adding and dividing whole numbers of degrees — what it needs is precision with words, because in geometry the name of a shape is a claim about its properties.

A gate swings open. A roof meets a wall. A paving slab sits against its neighbour. Every one of those is an angle or a shape with a name, and the name is not decoration — it is what tells you which rule you are allowed to use next. This unit is where the vocabulary of geometry gets nailed down: what to call an angle, how to write it so nobody can misread it, and how to name a triangle, a quadrilateral or a polygon from the marks alone.

By the end of this unit you can

• Name any angle from its size: acute, right, obtuse, straight, reflex or a full turn

• Write and read three-letter angle notation, with the vertex in the middle every time

• Name a triangle two ways — by its sides and by its angles — from marks or from measurements

• Tell the six members of the quadrilateral family apart by their properties, not by their look

• Name polygons up to ten sides, and **describe** exactly what makes one regular

• Read ticks, arcs, right-angle squares and arrowheads, and give the most precise name the marks support

The one idea behind all of it

A shape’s name is a **claim about its properties**, not a description of how it looks on the page. “Rhombus” claims four equal sides. “Square”

claims four equal sides *and* four right angles. So the way to name anything is to read the marks — the ticks, the arcs, the little square, the arrowheads — and then say the most precise name that everything you can see supports. Turning the page does not change a single one of those marks, which is why a tilted square is still a square.

Read the marks → list the claims → give the most precise name. Three facts do most of the work: an angle is named by its size alone, against 90°, 180° and 360°; the middle letter of ∠ABC is the vertex; and regular means equal sides AND equal angles, because either one alone is not enough.

Every answer carries its unit — an angle is written with the degree sign. Anything that is not exact is given to 3 significant figures. Round, never truncate. One interior angle of a regular heptagon is 900° ÷ 7, which is 129° to 3 significant figures.

Where this unit sits

This is the first unit of the Geometry & Trigonometry strand. It builds the vocabulary every later unit leans on: G02 *Angle Arithmetic* calculates with the angles you learn to name here, G03 *Crossing Lines* adds the parallel-line properties to the arrowheads, and G05 *Cover the Surface* needs the quadrilateral family before it can choose an area formula.

No new number work. The arithmetic here is adding and dividing whole numbers of degrees, which Number Unit N01 *Know Your Numbers* already covers, and ordering values, which N08 *The Number Line* covers. If a degree total or a division of 360 feels shaky, go back to those two units rather than practising it here.

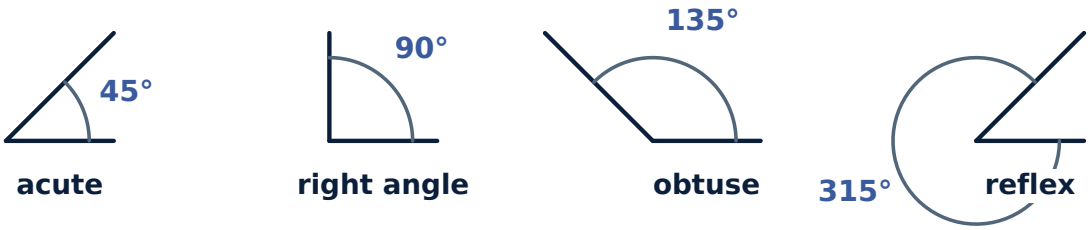
House rules. Every answer that is a size carries its unit: an angle is written with the degree sign, a length with cm or m. Answers that are not exact are given to 3 significant figures — rounded, never truncated. One interior angle of a regular heptagon is 900° ÷ 7, which is not a whole number of degrees, so it is written 129° to 3 significant figures.

Concept 1 · Angles, named by size

Acute, right, obtuse, straight, reflex, full turn - and nothing in between

Every angle has a name, and the name comes from one thing only: its size. Six names cover every angle there is, and the boundaries between them are 90°, 180° and 360°. An angle of 89° and an angle of 91° look almost identical and have different names, which is exactly why you compare rather than eyeball.

Four angles, named by size alone



Every arc is drawn from the two arms it sits between, and every size is measured off the model rather than typed in.

Worked example 1 · Sort the yard

1	A gate post makes an angle of 47° with the fence. Compare it with 90°.	**47° is less than 90°**
2	Name it.	**acute**
3	The gate opens until it lies flat against the fence: 180°.	**straight angle**
4	Swung right round the post and back: 360°.	**full turn**
5	Three quarters of the way round the post.	**270°**
6	270° is between 180° and 360°, so name it.	**reflex**

Six names, and the only thing you need to place any angle among them is where it sits against 90°, 180° and 360°.

Name	Size	What it looks like	Where you meet it
Acute	more than 0°, less than 90°	sharp, narrower than a corner of a page	the pitch of a roof, a slice of bread

Name	Size	What it looks like	Where you meet it
Right angle	exactly 90°	marked with a small square, never with an arc	a wall meeting a floor, a corner of a slab
Obtuse	more than 90°, less than 180°	open, wider than a corner but not flat	a laptop lid part-way open
Straight angle	exactly 180°	a straight line through the vertex	a door swung flat against the wall
Reflex	more than 180°, less than 360°	the arc goes the long way round	the outside of a gate’s swing
Full turn	exactly 360°	all the way round, back to the start	one complete turn of a wheel

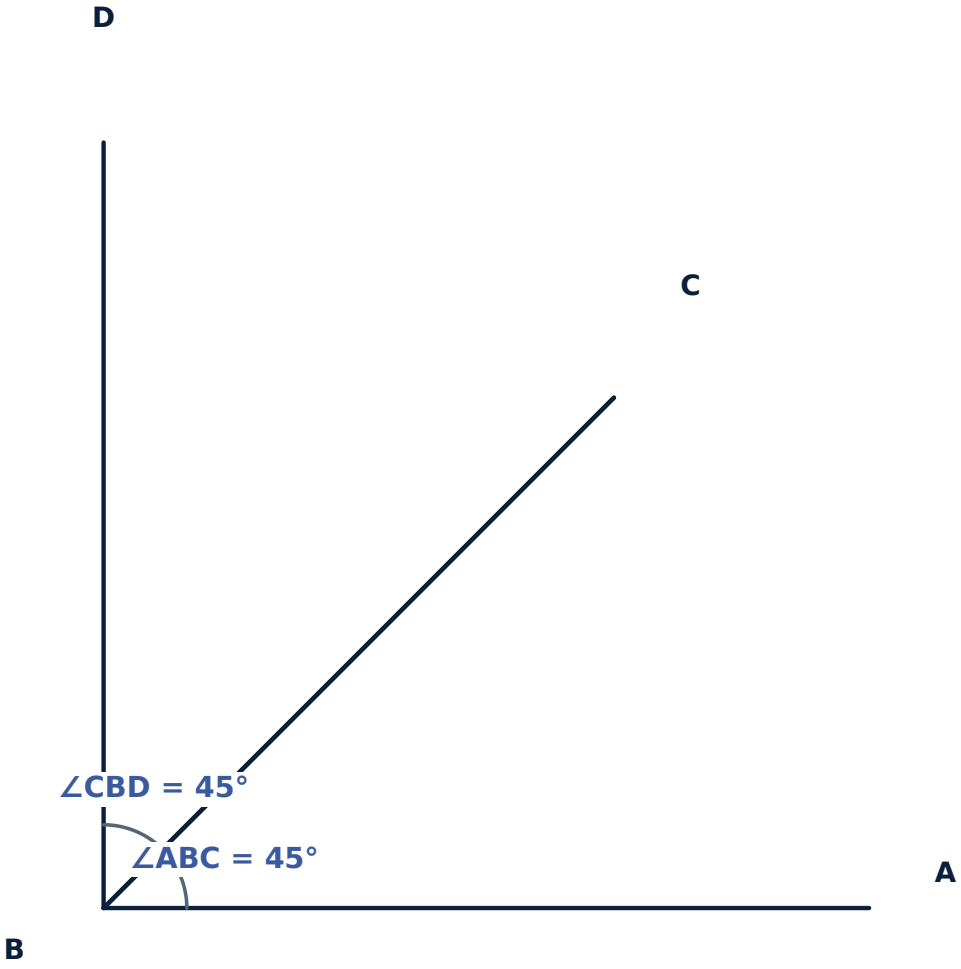
EXAMPLE A gate turns through three quarters of a full turn. A full turn is 360°, so the gate has turned 3 × 360° ÷ 4 = 270°. That is more than 180° and less than 360°, so it is a **reflex** angle — and the arc that marks it is drawn the long way round.

Concept 2 · Notation: the middle letter is the vertex

∠ABC is the angle at B, and the marks on a figure are part of the question

Two rays and a shared end point make an angle, and the shared end point is the **vertex**. Three-letter notation names the vertex in the middle: ∠ABC is the angle at B, between the arms BA and BC. Everything else on a figure — the ticks, the arcs, the little square, the arrowheads — is part of the question too, and nothing that is not marked may be assumed.

Reading the angle notation



The middle letter is always the vertex.

Four rays, two named angles. ∠ABC is the angle at B between BA and BC — not the angle at A.

Worked example 2 · Name and notate

1	Rays BA, BC and BD all leave the point B.	**B is the vertex of every angle here**
2	Write the angle between BA and BC.	**∠ABC**
3	Which letter is the vertex?	**the middle one, B**
4	Write the same angle the other way round.	**∠CBA**
5	∠ABC = 45° and ∠CBD = 45°, so add them.	**∠ABD = 90°**
6	Name ∠ABD.	**right angle**

∠ABC and ∠CBA are the same angle. ∠BAC is a different angle altogether, because the vertex moved to A.

The mark	What it claims	What it does NOT claim
One tick on two sides	those two sides are equal in length	nothing about any other side
Two ticks on another pair	that second pair are equal to each other	that they equal the single-ticked pair
Matching arcs at two vertices	those two angles are equal in size	that either of them is 90°
A small square at a vertex	that angle is exactly 90°	anything about the sides
Arrowheads on two sides	those two sides are parallel	that they are equal in length

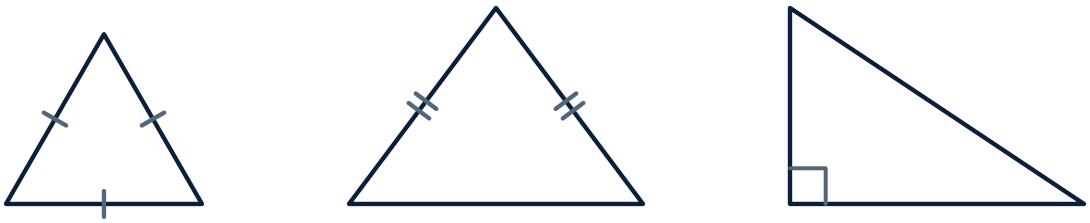
EXAMPLE Three rays leave the point B, with C between A and D. If ∠ABC = 62° and ∠CBD = 28°, then ∠ABD = 62° + 28° = 90°, which is a right angle and would be drawn with a small square. Notice that all three names share the middle letter B: one vertex, three angles.

Concept 3 · Triangles, by side and by angle

Every triangle has two names, and the marks tell you both

A triangle always has **two** names: one from its sides and one from its angles. Equilateral, isosceles and scalene count how many sides are equal. Acute-angled, right-angled and obtuse-angled look at the biggest angle. A triangle can be right-angled and isosceles at the same time, because those two names answer different questions.

Three triangles, three sets of marks



equilateral **isosceles** **scalene**

Three ticks, two ticks, none: the marks name the triangle by its sides before a single length is measured.

Worked example 3 · Which triangle is which

1	Triangle 1 carries a single tick on all three sides.	**all three sides equal**
2	Name it by its sides.	**equilateral**
3	Triangle 2 has sides 5 cm, 5 cm and 8 cm.	**exactly two equal**
4	Name it by its sides.	**isosceles**
5	Triangle 3 has angles 90°, 55° and 35°, which add to 180°.	**one angle is exactly 90°**
6	Name it by its angles, and by its sides.	**right-angled, and scalene**

Every triangle has both names. Marks give you the side name; angles give you the angle name; a question can ask for either.

Named by	Name	What it means	How the figure shows it
By its sides	Equilateral	all three sides equal	three single ticks; all three angles are 60°
By its sides	Isosceles	exactly two sides equal	two matching ticks; the two angles opposite them are equal
By its sides	Scalene	no two sides equal	no ticks match; all three angles are different
By its angles	Acute-angled	all three angles less than 90°	no square, no obtuse angle
By its angles	Right-angled	one angle exactly 90°	a small square at one vertex
By its angles	Obtuse-angled	one angle more than 90°	one angle visibly wider than a corner; there can only be one

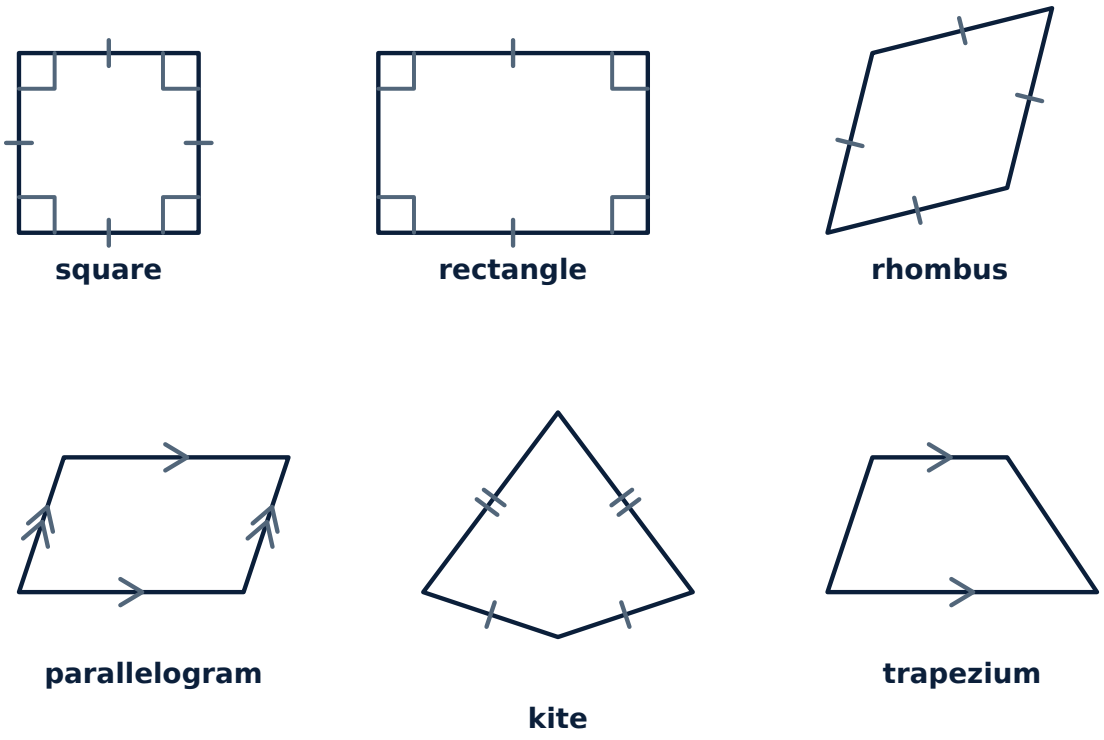
EXAMPLE A triangle has one angle of 90° and two equal sides. The three angles add to 180°, so the other two share 90° between them, and equal sides force equal angles: 45° each. The triangle is **right-angled** by its angles and **isosceles** by its sides, and both names are needed to describe it properly.

Concept 4 · The quadrilateral family

Square, rectangle, rhombus, parallelogram, kite, trapezium - and which is which

The six quadrilaterals form a ladder rather than six separate boxes. Going down it, each shape keeps fewer properties: a square has four equal sides and four right angles, a rectangle drops the equal sides, a rhombus drops the right angles, a parallelogram drops both, and a trapezium keeps only one pair of parallel sides. The answer to “name it” is always the most precise name the marks support.

The quadrilateral family, told apart by their marks



Six four-sided shapes. Nothing but the ticks, the right-angle squares and the arrowheads separates them.

Worked example 4 · The quadrilateral ladder

1	Shape P: four equal sides, four right angles.	**square**
2	Shape Q: four right angles, adjacent sides 6 cm and 4 cm.	**rectangle**
3	Shape R: four equal sides, no right angle.	**rhombus**
4	Shape S: two pairs of parallel sides, sides 5 cm and 3 cm, no right angle.	**parallelogram**
5	Shape T: two pairs of equal *adjacent* sides, no parallel pair.	**kite**
6	Shape U: exactly one pair of parallel sides.	**trapezium**

Read the ladder downwards and each shape drops one property. Read it upwards and each shape adds one. Every square is a rectangle; no rectangle with unequal sides is a square.

Name	Sides	Angles	Parallel	The test that names it
Square	all four equal	all four 90°	two pairs	four equal sides AND four right angles
Rectangle	opposite pairs equal	all four 90°	two pairs	four right angles, adjacent sides not equal
Rhombus	all four equal	opposite pairs equal	two pairs	four equal sides, no right angle
Parallelogram	opposite pairs equal	opposite pairs equal	two pairs	both pairs parallel, no right angle, sides not all equal
Kite	two pairs of equal *adjacent* sides	one pair of opposite angles equal	none	two adjacent pairs equal and no side parallel to another
Trapezium	no pattern required	no pattern required	exactly one pair	exactly one pair of parallel sides

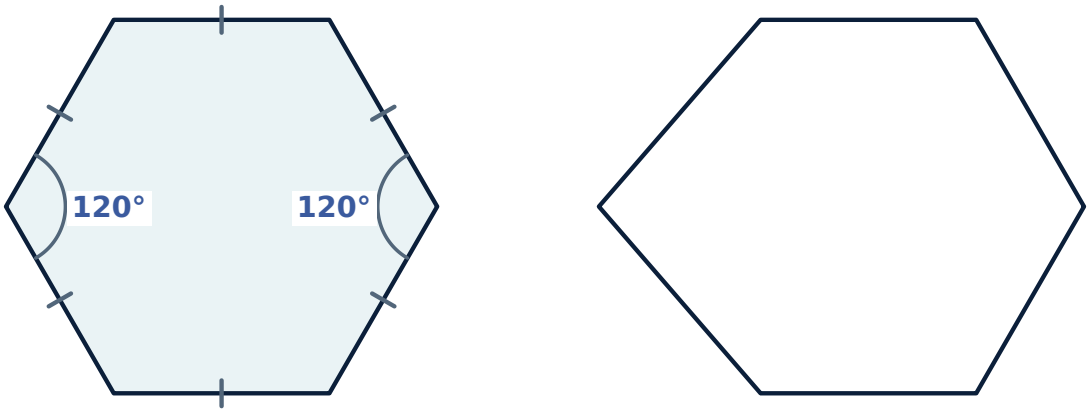
EXAMPLE A quadrilateral has vertices at (0, 0), (4, 0), (5, 3) and (1, 3). Going along the bottom side is 4 right and 0 up, and going along the top side is the same, so that pair is parallel and equal; the other pair matches too. But the sides are 4 units and √10 units, so they are not all equal, and no corner is square. Two pairs parallel and nothing more: a **parallelogram**.

Concept 5 · Polygons: naming them, and what regular means

Equal sides is half of it; equal angles is the other half

The number of sides gives a polygon its name, and this unit needs them up to ten. **Regular** is a much stronger word than most students use it as: it means all the sides are equal *and* all the angles are equal. A rhombus has four equal sides and is not a regular quadrilateral; the square is the regular one.

Equal sides AND equal angles, or it is not regular



regular hexagon **irregular hexagon**

Both shapes have six sides. Only the left one has six equal sides and six equal angles.

Worked example 5 · Regular or not

1	Hexagon 1: six ticks that match, six arcs that match.	**equal sides and equal angles**
2	Name it.	**a regular hexagon**
3	The six interior angles add to 720°, and they are equal.	**720° ÷ 6 = 120°**
4	Hexagon 2: six ticks that match, no arcs marked.	**equal sides only**
5	Can you call it regular?	**no — the angles are not known**
6	What single mark would settle it?	**matching arcs at all six vertices**

Equal sides alone is not regular. A rhombus has four equal sides and is not a regular quadrilateral; the square is.

Sides	Name	Angle sum	Interior	Exterior	Diagonals
3	triangle	180°	60°	120°	0
4	quadrilateral	360°	90°	90°	2
5	pentagon	540°	108°	72°	5
6	hexagon	720°	120°	60°	9
7	heptagon	900°	129°	51.4°	14
8	octagon	1080°	135°	45°	20
9	nonagon	1260°	140°	40°	27
10	decagon	1440°	144°	36°	35

The heptagon and the nonagon are the two rows whose interior angle is not a whole number of degrees, so those two are given to 3 significant figures.

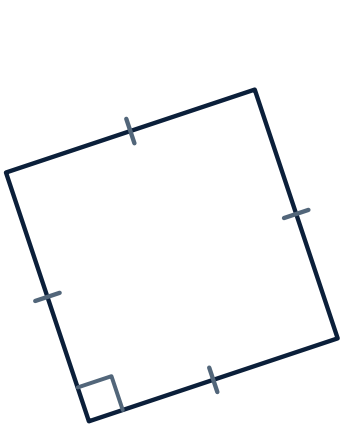
EXAMPLE A regular polygon has an exterior angle of 40°. The exterior angles of any polygon add to one full turn, 360°, and in a regular polygon they are all equal — so there are 360° ÷ 40° = 9 of them. The polygon is a **nonagon**, and its interior angle is 180° − 40° = 140°.

Concept 6 · Reading the marks, naming the shape

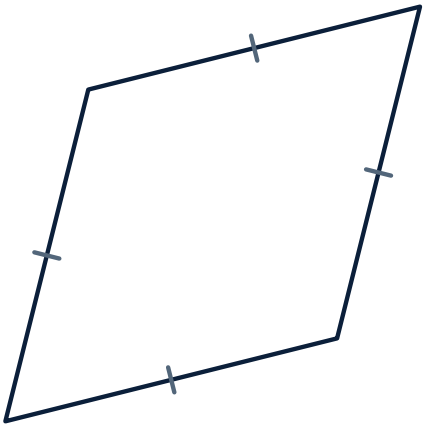
Ticks, arcs, right-angle squares and arrowheads decide the name - not what it looks like

This is where the unit is really tested. An exam figure gives you marks rather than measurements, and a diagram may be drawn deliberately out of proportion, so measuring it with a ruler answers the wrong question. Read the marks, list what they claim, and then say the most precise name that every claim supports.

Tilting changes nothing; the right angle decides



still a square



a rhombus, not a square

Four equal sides on both. The right-angle square on the left is the only difference that matters.

Worked example 6 · Marks first, name second

1	A four-sided shape is drawn leaning over.	**leaning tells you nothing**
2	It carries a single tick on all four sides.	**four equal sides**
3	So far the name could be...	**rhombus, or square**
4	It also carries a small square at one vertex.	**that angle is exactly 90°**
5	Four equal sides and a right angle.	**square**
6	Turn the page 30° and re-read the marks.	**still a square**

The tilted shape in the figure above has vertices at (0, 0), (3, 1), (2, 4) and (−1, 3). All four sides are √10 long and the corner at (0, 0) is a right angle, so it is a square however it is drawn.

EXAMPLE A four-sided shape is drawn leaning over, with one tick on each side and a small square at one corner. The ticks claim four equal sides, which alone would make it a rhombus; the small square claims one right angle, and in a rhombus one right angle forces all four. It is a **square**, and turning the page would not change a single one of those claims.

The naming routine

1. Read the marks before you read the picture — Ticks say “these sides are equal”. Arcs say “these angles are equal”. A small square says “exactly 90°”. Arrowheads say “these sides are parallel”. Anything not marked is not known.

2. Count the sides, then look at the angles — The number of sides gives the family name — triangle, quadrilateral, pentagon, hexagon. The sides and angles together give the exact member of that family.

3. Say the most precise name that is true — A square really is a rectangle and really is a rhombus, but “square” says more, so “square” is the answer. Never claim more than the marks support.

✓ **Check by turning it** — Turn the shape in your head. If the name changes, the name was wrong: no property of a shape depends on which way up it is drawn.

The mistakes that cost the most marks

Trap 1 · Reading ∠ABC as the angle at A

WRONG “∠ABC is the angle at A, because A is written first.” The student marks the wrong corner and every line after it is answering a different question.

RIGHT The **middle** letter is the vertex, always. ∠ABC is at B; ∠BAC is at A. If in doubt, trace the path A → B → C: the turn happens at B.

This costs whole questions in the papers, because a wrong vertex is not a small slip — it changes which angle you are talking about. Write the vertex letter down first, then build the three-letter name around it.

Trap 2 · Calling any four-sided shape a rectangle because it looks upright

WRONG “It has four sides and it is standing up straight, so it is a rectangle.” Nothing about being upright says a single angle is 90°.

RIGHT A rectangle claims **four right angles**. If the figure does not mark them — or state them — you cannot claim them. Four sides with two pairs parallel and no right angle is a **parallelogram**.

The same trap in reverse marks a parallelogram down when it really is a rectangle. Read the marks: right-angle squares are drawn, never assumed, and being upright is not a property.

Trap 3 · Assuming a shape drawn tilted is no longer a square

WRONG “It is on its corner, so it must be a rhombus, or a diamond.” “Diamond” is not a mathematical name at all.

RIGHT Turning a shape changes no length and no angle. The tilted shape with vertices (0, 0), (3, 1), (2, 4) and (−1, 3) has four sides of $\sqrt{10}$ and a right angle at (0, 0): it is a **square**.

Every property that names a shape — equal sides, equal angles, parallel pairs — survives turning it. That is why the check at the end of the routine is “turn it and read the marks again”.

Practice · Fluency · 24 questions

P1	An angle measures 47°. **Name** it.
P2	An angle measures 133°. **Name** it.
P3	An angle measures 215°. **Name** it.
P4	An angle measures 90°. **Name** it.
P11	In ∠PQR, **state** which vertex the angle is at.
P12	In triangle ABC, **write** the angle at B using three-letter notation.
P13	**State** what a small square drawn at a vertex tells you.
P14	**State** what two matching arcs at two different vertices tell you.
P21	A triangle has sides 5 cm, 5 cm and 8 cm. **Name** it by its sides.
P22	A triangle has sides 6 cm, 7 cm and 9 cm. **Name** it by its sides.
P23	A triangle has sides 4 cm, 4 cm and 4 cm. **Name** it by its sides.
P24	A triangle has angles 90°, 55° and 35°. **Name** it by its angles.
P31	A quadrilateral has four equal sides and four right angles. **Name** it.
P32	A quadrilateral has two pairs of parallel sides, no right angle and adjacent sides of different lengths. **Name** it.
P33	A quadrilateral has exactly one pair of parallel sides. **Name** it.
P34	A quadrilateral has four equal sides and no right angle. **Name** it.
P41	**Name** a polygon with 7 sides.
P42	**Name** a polygon with 9 sides.
P43	**State** the two conditions a polygon must meet to be called regular.
P44	**Name** a polygon with 10 sides.
P51	A triangle carries a single tick on each of its three sides. **Name** it.

P52 A quadrilateral carries arrowheads on one pair of opposite sides only. **Name** it.

P53 A quadrilateral carries single arrowheads on one pair of opposite sides and double arrowheads on the other pair, with no right angle marked. **Name** it.

P54 A triangle carries a small square at one vertex and a single tick on two of its sides. **Name** it two ways.

Practice · Applied · 24 questions

P5 A door swings from closed until it lies flat against the wall, turning through 180°. **Name** the angle it has turned through.

P6 A gate turns through three quarters of a full turn. **Calculate** the angle and **name** it.

P7 **Name** each of these four angles: 89°, 91°, 180°, 359°.

P8 Two angles at a point make a full turn together. One of them is 125°. **Calculate** the other and **name** it.

P15 In quadrilateral DEFG, **write** the angle at F in three-letter notation, in both possible orders.

P16 A student writes “∠ABC = 90°” and marks the square at vertex A. **Describe** the error.

P17 Triangle ABC has one tick on AB and one tick on BC. **Describe** what the marks claim, and **name** the triangle by its sides.

P18 Rays BA, BC and BD leave the point B with C between A and D. ∠ABC = 62° and ∠CBD = 28°. **Calculate** ∠ABD and **name** it.

P25 A triangle has angles 40°, 60° and 80°. **Name** it by its angles, and **state** the check you used.

P26 A triangle has angles 25°, 130° and 25°. **Name** it by its angles and by its sides.

P27 A triangle has one angle of 90° and two equal sides. **Determine** the other two angles and **name** the triangle two ways.

P28 **Describe** whether a triangle can be both equilateral and right-angled.

P35 A quadrilateral has four right angles, and two adjacent sides both measure 5 cm. **Name** it as precisely as you can.

P36 A quadrilateral has two pairs of equal adjacent sides, one pair of equal opposite angles, and no parallel sides. **Name** it.

P37 **State** whether every square is a rectangle, and whether every rectangle is a square.

P38 Three angles of a quadrilateral are 85°, 95° and 85°. **Determine** the fourth and **describe** what the four angles suggest.

P45 **Determine** the sum of the interior angles of a hexagon.

P46 **Determine** one interior angle of a regular octagon.

P47 **Determine** one exterior angle of a regular decagon.

P48 A hexagon has six equal sides, but two of its angles measure 100°. **Describe** whether it is regular.

P55 A quadrilateral carries a single tick on all four sides and matching arcs at one pair of opposite vertices, with no right angle marked. **Name** it.

P56 A quadrilateral carries arrowheads on both pairs of opposite sides and a small square at one vertex, and its adjacent sides are not equal. **Name** it.

P57 A four-sided shape is drawn leaning over, with a single tick on all four sides and a small square at one vertex. **Describe** why it is still a square.

P58 Two triangles are drawn: the first has a single tick on all three sides, the second has a single tick on two sides only. **Describe** the difference the marks make.

Practice · Challenge · 12 questions

P9 The hands of a clock at 4 o’clock. **Calculate** the smaller angle between them and **name** it.

P10 Two angles on a straight line: one is five times the other. **Determine** both, and **name** each.

P19 Three rays leave B with C between A and D. ∠ABD = 118° and ∠ABC = 47°. **Determine** ∠CBD and **name** it.

P20 A four-sided shape has two ticks on each of two *adjacent* sides and one tick on each of the other two. **Describe** what the marks alone claim, and **name** the most likely shape.

P29 **Determine** whether sides of 3 cm, 4 cm and 8 cm can make a triangle, and **describe** your reasoning.

P30 The angles of a triangle are in the ratio 1 : 2 : 3. **Determine** the three angles and **name** the triangle by its angles and by its sides.

P39 A quadrilateral has vertices A(0, 0), B(4, 0), C(5, 3) and D(1, 3). **Name** it as precisely as you can and **describe** how the coordinates prove it.

P40 A quadrilateral has vertices P(0, 0), Q(3, 1), R(2, 4) and S(−1, 3). **Name** it as precisely as you can.

P49 A regular polygon has an exterior angle of 40°. **Determine** the number of sides and **name** it.

P50 One interior angle of a regular polygon is 144°. **Determine** the number of sides and **name** it.

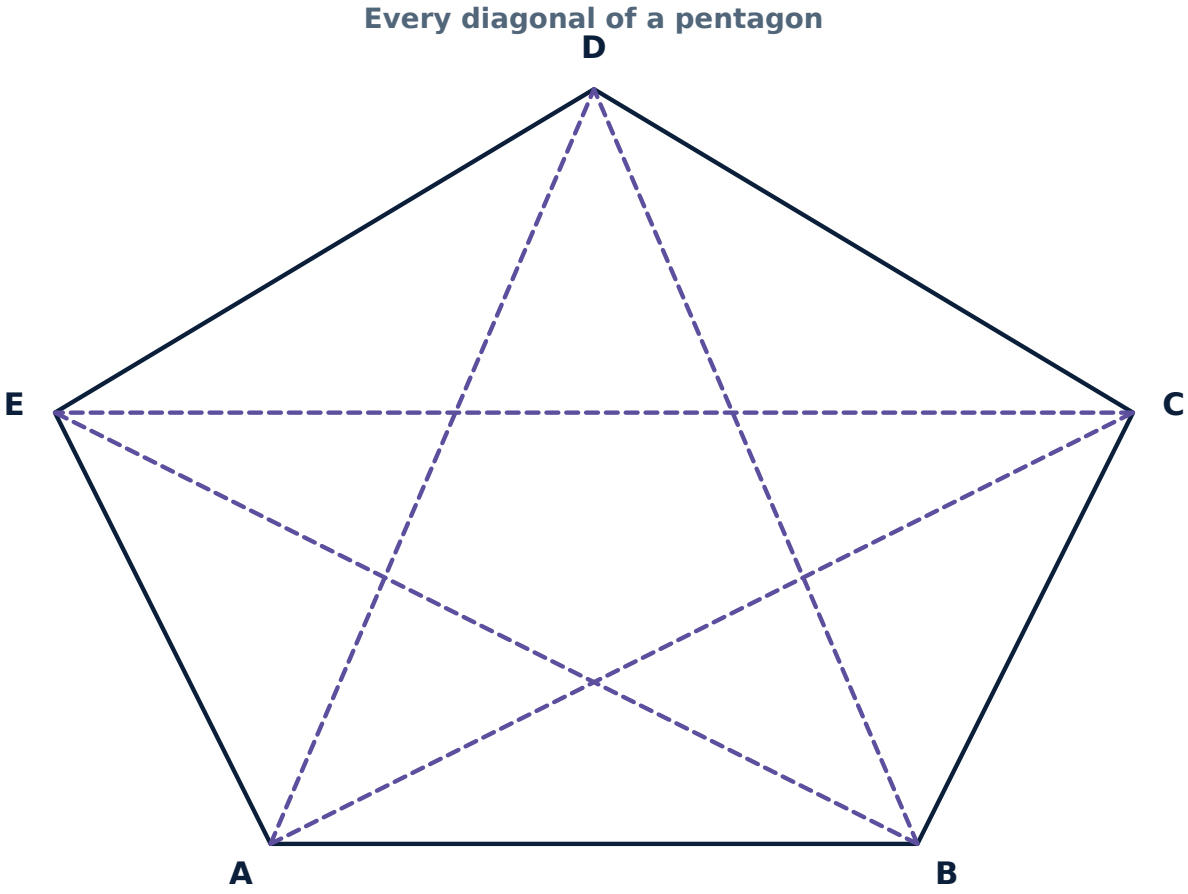
P59 A quadrilateral carries arrowheads on one pair of opposite sides, and matching single ticks on the two sides that are *not* parallel. **Name** it as precisely as you can.

P60 A pentagon is drawn with a single tick on all five sides and no arcs anywhere. **Determine** whether you can be sure it is regular, and **describe** the mark that is missing.

Criterion B · Investigating patterns

How many diagonals?

A **diagonal** joins two corners of a polygon that are not already joined by a side. A triangle has none at all. A quadrilateral has two. After that they build up fast, and the question is **how fast, and why**. You need nothing but a pencil, a ruler and a careful count — but you do need to be systematic, because the easiest way to get this wrong is to count the same diagonal twice.



Five vertices, five diagonals.

A diagonal joins two vertices that are not already joined by a side. Count them here, then predict the octagon.

Part 1 · structured

Sides	Polygon	Diagonals	Jump from the row above
3	triangle	0	—
4	quadrilateral	2	2

Sides	Polygon	Diagonals	Jump from the row above
5	pentagon		
6	hexagon		
7	heptagon		

1. **Predict**, before you draw anything, whether doubling the number of sides doubles the number of diagonals. Write your prediction down; you will be asked to compare it with what you find.

2. **Complete** the table by drawing each polygon and counting its diagonals for 3, 4, 5, 6 and 7 sides. Draw every diagonal in a different colour from the sides so you can see what you are counting, and work round the vertices in order so that nothing is counted twice.

3. **Identify** the pattern. Look at the jump from each row to the next and **describe** what those jumps do. Then **describe** how many diagonals leave a single vertex in each of your polygons, and why that number is not the number of sides.

4. **Determine** a general rule for the number of diagonals of a polygon with n sides. Write it as a formula in n, not in words alone.

5. **Test and verify** your rule on two polygons that are not in the table: one with 8 sides, and one with 12 sides. For the octagon, check your rule by drawing and counting as well — a rule tested only on the numbers it was built from has not been tested.

6. **Justify** your rule. **Describe** why each vertex contributes exactly $n - 3$ diagonals, and **describe** why the total then has to be halved. Say what would go wrong if you forgot the halving.

Part 2 · open

Now you choose what to investigate. Take one of these openings or propose your own. You decide which polygons to try, how many you need, how to record what you find and how you will test it.

1. From one corner only. **Investigate** how many diagonals leave a single vertex, and how many triangles those diagonals cut the polygon into. **Determine** a rule for each, **test** both, and **describe** how your triangle rule connects to the interior-angle sum $180° \times (n - 2)$.

2. Diagonals that escape. A polygon does not have to be convex. **Investigate** how many of the diagonals fall *outside* a dented polygon — try several five-sided and six-sided shapes with one corner pushed in.

Determine whether the total number of diagonals changes, and **describe** what does change.

3. Where they cross. Draw a convex polygon whose diagonals never meet three at a time. **Investigate** how many crossing points the diagonals make inside it for 4, 5 and 6 sides, **predict** 7, and **determine** a rule. **Describe** the connection between a crossing point and a choice of four corners.

Whichever you choose, take it through the same ladder: **predict**, **identify** the pattern, **determine** a general rule, **test and verify** it on polygons you have not already drawn, and **justify** why it must be true.

Marked out of 8 against Criterion B. Completing the table earns the lower bands; the general rule in n, the test on the octagon and the twelve-sided polygon, and the justification are what reach levels 5–8. Part 2 must show your own choice of method.

Remember, you should communicate in an organized and coherent manner.

Criterion D · Applying maths in real-life contexts

Which slabs will pave the patio?

A hardware yard in Gaborone has been asked to quote for paving a patio, and it has sent over its order sheet. The sheet lists five slab shapes, and **it tells you a great deal more than you need**. Two questions have to be answered before anything is ordered: **which of the five shapes will cover the patio with no gaps**, and **how many slabs the job takes**. Neither question is about price, and neither is about how the slabs look.

The order sheet (illustrative figures, written for this task)

- **The patio:** a rectangle, 4.8 m by 3.6 m
- **Slab A:** square, 300 mm by 300 mm
- **Slab B:** rectangle, 600 mm by 300 mm
- **Slab C:** regular hexagon, 200 mm side
- **Slab D:** regular pentagon, 200 mm side
- **Slab E:** equilateral triangle, 300 mm side
- **Pallets:** 60 slabs to a pallet, whichever shape
- **Bedding sand:** 4 bags for every square metre of patio
- **Yard hours:** 07:30 to 17:00, deliveries on Tuesdays and Thursdays
- **The yard gate:** 2.4 m wide
- **Cutting:** the yard will cut slabs to order, two working days

These figures are illustrative. The yard, the patio and the slab list are an invented illustrative example written for the task. It is not taken from any business, price list or publication, and no organisation, person or source is named or implied. What is authentic is the shape of the problem: paving really is chosen by whether the slabs fit together with no gaps.

The patio, and one slab



One 0.3 m square slab against the whole patio.

The patio is a rectangle and the slab is a square. Both lengths divide by 0.3 m exactly, which is what makes the count come out whole.

One interior angle of each slab shape



square **rectangle** **hexagon** **pentagon** **triangle**

Only 90°, 120° and 60° divide 360° exactly. That is the whole test.

Identify which entries on the order sheet actually matter for the two questions, and **describe**, item by item, why the others cannot affect either answer — deal with the yard hours, the bedding sand, the gate width and the cutting service by name. *(Strand i — identifying the relevant elements)*

Select the property that decides whether a shape tiles, and **describe** why it is the right test. Say what has to be true of the angles where several slabs meet at one point, and **describe** the strategy you will use to count the slabs. *(Strand ii — selecting appropriate strategies)*

Apply them. **Calculate** one interior angle of each of the five slab shapes, and decide for each whether it tiles. Then **calculate** how many Slab A squares cover the patio, and how many Slab B rectangles would instead. *(Strand iii — applying the strategy)*

Describe the accuracy of your answers. The patio is given in metres and the slabs in millimetres, so **describe** the conversion you had to do and what would have gone wrong without it. Then **describe** what it tells you that both slab counts come out as whole numbers, and what you would have had to do if they had not. *(Strand iv — accuracy of the solution)*

Describe whether your answer makes sense for a real patio. Work out how many full pallets the square slabs need, and **describe** at least two things the calculation ignores that a paver would not — and say what you would tell the customer to order. *(Strand v — does it make sense in context)*

Submit: your list of which entries matter and which do not, the interior angle of each of the five slab shapes with your verdict for each, both slab counts, the number of pallets, and written answers for strands i, iv and v. **Marked out of 8** against Criterion D at Foundations level, where the command term is **describe**. State every angle in degrees and every length in metres, and give any answer that is not exact to 3 significant figures.

Answers

How the P-numbers run. The 60 practice items are numbered P1 to P60 in the order they appear in the lesson — ten per concept, and inside each concept four Fluency, then four Applied, then two Challenge. The same P-number identifies the item in the lesson, in this key and in the teacher pack, so the numbers inside each tier below step in blocks of ten rather than running consecutively: Fluency is P1–P4, P11–P14, P21–P24 and so on; Applied is P5–P8, P15–P18, …; Challenge is P9–P10, P19–P20, … Angles are given with the degree sign, and any angle that is not a whole number of degrees is given to 3 significant figures.

Fluency · F-tier (24)

P1	**acute**
P2	**obtuse**
P3	**reflex**
P4	**right angle**
P11	**Q**
P12	**∠ABC**
P13	**that angle is exactly 90°**
P14	**those two angles are equal in size**
P21	**isosceles**
P22	**scalene**
P23	**equilateral**
P24	**right-angled**
P31	**square**
P32	**parallelogram**
P33	**trapezium**
P34	**rhombus**
P41	**heptagon**

P42	**nonagon**
P43	**all its sides equal and all its angles equal**
P44	**decagon**
P51	**equilateral**
P52	**trapezium**
P53	**parallelogram**
P54	**right-angled and isosceles**

Applied — fully worked (24)

P5 straight angle

180° is exactly half a full turn, and the two arms lie in one straight line through the vertex. That is a straight angle — not an obtuse angle, which must be less than 180°.

P6 270°, reflex

A full turn is 360°, so three quarters is 3 × 360° ÷ 4 = 270°. That is more than 180° and less than 360°, so it is reflex.

P7 acute, obtuse, straight angle, reflex

The only comparisons that matter are with 90°, 180° and 360°. 89° is just under 90° so it is acute; 91° is just over, so it is obtuse. Two degrees apart, two different names.

P8 235°, reflex

Angles at a point add to 360°, so the other is 360° − 125° = 235°. Since 235° is between 180° and 360° it is reflex — the arc goes the long way round.

P15 ∠EFG and ∠GFE

The vertex letter goes in the middle, and the other two are the neighbouring vertices, in either order. Both names describe the same angle.

P16 the middle letter is the vertex, so ∠ABC is at B, not at A

Reading the first letter as the vertex is the commonest notation error in the whole strand. Trace A → B → C: the turn happens at B, so the square

belongs at B.

P17 AB = BC, so the triangle is isosceles

Matching ticks claim equal lengths and nothing else. Two equal sides is the definition of isosceles; the third side is not claimed to be equal to anything, so the triangle is not equilateral.

P18 90°, a right angle

The two angles share the vertex B and the arm BC, and C lies between A and D, so they add: 62° + 28° = 90°. An angle of exactly 90° is a right angle, and would be drawn with a small square rather than an arc.

P25 acute-angled; the three angles add to 180°

40 + 60 + 80 = 180, so the three angles can belong to one triangle. The largest of them is 80°, which is less than 90°, so every angle is acute and the triangle is acute-angled.

P26 obtuse-angled, and isosceles

130° is more than 90°, so the triangle is obtuse-angled — and no triangle can have two such angles, because two would already pass 180°. The two 25° angles are equal, so the sides opposite them are equal and the triangle is isosceles.

P27 45° and 45°; right-angled and isosceles

The angles add to 180°, so the other two share 180° − 90° = 90°. Equal sides mean equal opposite angles, so each is 90° ÷ 2 = 45°. The triangle is right-angled by its angles and isosceles by its sides.

P28 no: an equilateral triangle has three 60° angles

Equilateral means all three sides equal, which forces all three angles equal. Three equal angles adding to 180° must each be 180° ÷ 3 = 60°, and 60° is not 90°. So no equilateral triangle contains a right angle.

P35 square

Four right angles alone would make it a rectangle. In a rectangle opposite sides are equal, so if two *adjacent* sides are also equal then all four are — and four equal sides with four right angles is a square. Say “square”, because it says more than “rectangle”.

P36 kite

Equal *adjacent* sides is what separates a kite from a parallelogram, where the equal sides are opposite each other. No parallel pair rules out the trapezium as well, so kite is the only name left that fits every clue.

P37 yes; no

A rectangle is defined by its four right angles, and a square has four right angles, so every square really is a rectangle. The reverse fails as soon as the adjacent sides differ: a 6 cm by 4 cm rectangle has four right angles but not four equal sides.

P38 95°; opposite angles are equal, so it could be a parallelogram

The angles of a quadrilateral add to 360°, so the fourth is 360° − (85° + 95° + 85°) = 95°. Two pairs of equal opposite angles is a property of a parallelogram — but only a suggestion, because the angles alone do not tell you the sides.

P45 720°

A hexagon splits into 6 − 2 = 4 triangles from one vertex, and each triangle contributes 180°: 4 × 180° = 720°. The rule is 180° × (n − 2).

P46 135°

The eight interior angles add to 180° × (8 − 2) = 1080°, and in a regular octagon they are all equal, so each is 1080° ÷ 8 = 135°.

P47 36°

The exterior angles of any polygon add to one full turn, 360°. A regular decagon has ten equal ones, so each is 360° ÷ 10 = 36°. Check: the interior angle is 180° − 36° = 144°.

P48 no: regular needs equal angles as well as equal sides

In a regular hexagon every interior angle is 120°, so an angle of 100° rules it out at once. Equal sides on their own are not enough — the same trap that makes a rhombus not a regular quadrilateral.

P55 rhombus

Four matching ticks claim four equal sides. With no right-angle square anywhere you cannot claim 90°, so “square” would be claiming more than the marks support. Four equal sides and no right angle is a rhombus.

P56 rectangle

Both pairs parallel makes it at least a parallelogram, and in a parallelogram one right angle forces all four. Adjacent sides that differ rule out the square, so the most precise true name is rectangle.

P57 turning changes no length and no angle, so it is still a square

The marks say four equal sides and one right angle, and in a rhombus one right angle forces all four. None of that depends on which way up the shape is drawn, so the name does not change when it leans. “Diamond” is not a mathematical name.

P58 the first is equilateral, the second is only isosceles

Three matching ticks claim all three sides equal, which also forces all three angles to be 60°. Two matching ticks claim only that two sides are equal; the third side is unmarked, so nothing is claimed about it and the triangle is isosceles.

Challenge — fully worked (12)

P9 120°, obtuse

The twelve hour marks share 360° equally, so one hour mark is 360° ÷ 12 = 30°. At 4 o’clock the hands are four marks apart: 4 × 30° = 120°. It is between 90° and 180°, so it is obtuse. The reflex angle on the other side is 240°.

P10 150° (obtuse) and 30° (acute)

Angles on a straight line add to 180°. Six equal parts make 180°, so one part is 180° ÷ 6 = 30°. The small angle is 30° and the large one is 5 × 30° = 150°. Check: 30° + 150° = 180°.

P19 71°, acute

Because C is between A and D, ∠ABC and ∠CBD add to ∠ABD. So ∠CBD = 118° − 47° = 71°, which is less than 90° and so acute. Note that ∠DBC names the same angle.

P20 two pairs of equal adjacent sides, so a kite

The marks claim that one pair of sides that meet at a vertex are equal to each other, and the other pair are equal to each other but not necessarily to the first pair. That is exactly a kite. It could also be a rhombus, but only if the two tick counts matched, which they do not.

P29 no: 3 + 4 = 7, which is less than 8

Two sides have to be able to reach across the third. Here the two short sides together are 3 + 4 = 7 cm, which is shorter than the 8 cm side, so they cannot meet: the shape does not close. This is the triangle inequality, and it has to hold for all three pairings.

P30 30°, 60°, 90°; right-angled and scalene

The ratio gives 1 + 2 + 3 = 6 equal parts sharing 180°, so one part is 180° ÷ 6 = 30°. The angles are 30°, 60° and 90°. One of them is exactly 90° so it is right-angled, and because all three angles differ all three sides differ, so it is scalene.

P39 parallelogram

Going along AB is 4 right and 0 up; going along DC is also 4 right and 0 up, so AB and DC are equal and parallel. Going along AD is 1 right and 3 up, the same as BC, so that pair matches too. But AB is 4 units and AD is √10 units, so the sides are not all equal, and the corner at A is not square. Two pairs parallel, nothing more: a parallelogram.

P40 square

Each side steps 3 one way and 1 the other, so all four sides are the same length, √10. Going along PQ is 3 right and 1 up; going along QR is 1 left and 3 up. Those two turns are at right angles to each other, so the corner at Q is 90°. Four equal sides and a right angle: a square, drawn tilted.

P49 9 sides, a nonagon

The exterior angles add to 360° and they are all equal, so the number of them is 360° ÷ 40° = 9. Nine sides is a nonagon, and its interior angle is 180° − 40° = 140°.

P50 10 sides, a decagon

Work with the exterior angle, because those always add to 360°. The exterior angle is 180° − 144° = 36°, so there are 360° ÷ 36° = 10 of them. Ten sides is a decagon.

P59 an isosceles trapezium

Exactly one parallel pair makes it a trapezium. The extra claim is that the two non-parallel sides are equal, and a trapezium with that property is called isosceles — the same word doing the same job as it does for triangles.

P60 no; matching arcs at all five vertices are missing

Five equal sides is only half of regular. Without any angle marked, the pentagon could be a squashed one whose angles differ, exactly as a rhombus has four equal sides without being a regular quadrilateral. The missing mark is a matching arc at every vertex, which would claim all five angles equal — 108° each.