# Y8 UNIT 15 *Polygons* Lesson Plan 1 *Angles*

| *Activity* | | *Notes* |
|---|---|---|
| 1A | **Revising angles** | |
| | T: You must know lots of facts about angles. Let's see how many you can remember. | Mental work revising angles. |
| | - How many degrees are there around a point? *($360°$)*<br>- How many degrees are there around a point on a straight line? *($180°$)*<br>- How many degrees are there in a $\frac{1}{4}$ turn? *($90°$)*<br>- How many degrees are there between south and south-west? *($45°$)*<br>- What is the sum of the interior angles of a triangle? *($180°$)*<br>- What is the sum of the interior angles of a quadrilateral? *($360°$)*<br>- An angle round a point has size $230°$. What is the size of the other angle? *($130°$)*<br>- What two facts can you state about the angles and the sides in an equilateral triangle? *(The angles are all equal. The sides are all the same length)*<br>- What is the size of any angle in an equilateral triangle? *($60°$)*<br>- What is the length of any side in a equilateral triangle? *(?)* | Questions/answers, with OS 15.1 on OHP to show the main facts.<br>If T sees that many Ps are having difficulties, volunteer Ps can be asked to work out the solutions and write them on BB. Praising whenever possible.<br>Final question is a joke - to make Ps think. Praising. |
| 1B | **Practical work with angles** | |
| | T: Let's look at some of the angles on this slide.<br>**OS 15.2**<br>e.g.<br>$P_1$ (for angle *a*): Since the angles on a straight line add up to $180°$, we can write:<br>$126° + a = 180°$<br>So $a = 180° - 126°$<br>$a = 54°$<br>$P_2$ : ... angle *b* ($142°$)<br>$P_3$ : ... angle *c* ($60°$)<br>T: We've talked about the interior angles of a triangle; what other type of angle is shown in the third triangle? *(Exterior angle)*<br>T: What do we know about exterior angles? *(Interior angle + exterior angle $= 180°$ at each vertex)*<br>T: So, angle *d* ....?<br>$P_4$ (writes on BB): $50° + d = 180°$<br>$d = 180° - 50°$<br>$d = 130°$ | Whole class activity.<br>T encourages slower Ps to come to front, repeat the main facts and work on BB. T agrees, helps if necessary (using precise mathematical terms), and praises.<br>All Ps work in Ex.Bs. |
| | *16 mins* | |

| Y8 | UNIT 15 *Polygons* Lesson Plan 1 | *Angles* |
|---|---|---|
| ***Activity*** | | ***Notes*** |
| **2** | **Practice with angles**<br>**PB 15.1, Q1 (b)** ($b = 163°$)<br>**PB 15.1, Q2 (a)** (angle $= 36°$)<br>**PB 15.1, Q3 (c)** ($x = 34°$)<br><br>*24 mins* | Individual work.<br>Verbal checking, with explanations. During feedback, self-correction, praising, T can see where there are weaknesses; T then divides the class into two groups for the next Activity. |
| **3**<br>**(slower)** | **Practice**<br>**PB 15.1, Q1 (a)** ($127°$), **(c)** ($141°$)<br>**PB 15.1, Q2 (b)** ($61°$), **(c)** ($47°$)<br>**PB 15.1, Q3 (a)** ($131°$), **(d)** ($50°$) | T divides Ps into two groups according to their mistakes in Activity 2.<br>Those who had problems work as a group using BB and work through more questions from PB 15.1, Q1-3. |
| **3**<br>**(stronger)** | **Extra practice**<br>(a) What are the sizes of the angles in a right-angled isosceles triangle?<br>(b) In an isosceles triangle, one angle is of size $36°$. What are the sizes of the other two angles?<br>(c) In a triangles, the sizes of the sides are 3 cm, 4 cm and 5 cm. What can you say about its angles?<br><br><u>*Solutions*</u><br>*(a)* $90°$, $45°$, $45°$<br>*(b)* $36°$ and $108°$ or $72°$ and $72°$<br>*(c)* As (3, 4, 5) is a Pythagorean Triple, one of the angles is of size $90°$.<br><br>*36 mins* | Those who had no problems work individually on the questions given.<br>*Checking*: stronger Ps give solutions with explanations at BB in front of all Ps, so that slower Ps can also understand. |
| **4A** | **Mental reviewing of angles**<br>**OS 11.3** | OS 11.3 'Special Angles' is used as a basis for mental work naming angles according to their position.<br>T puts slide on OHP and then asks for the pairs of angles and their name. Ps volunteer, answer, T agrees, praises and makes a slower P repeat the answer. |
| **4B** | **Further practice**<br>**Extra Exercises 11.2, Q1 (a) and (b)** | Now the process is repeated, but using values for the angles. |
| **4C** | **Individual practice**<br>**Extra Exercises 11.1, Q1 (c) and (d)**<br><br>*45 mins* | Individual work. Ps each have a copy of the questions and work on it.<br>Verbal checking, with explanations.<br>Agreement, feedback, self-correction. Praising. |

| **Y8** | **UNIT 15** ***Polygons*** Lesson Plan 1 | *Angles* |
|---|---|---|
| ***Activity*** | | ***Notes*** |
| **5** | **Set homework**<br>**PB 15.1, Q1 (d)**<br>**PB 15.1, Q2 (d)**<br>**PB 15.1, Q5**<br>**PB 15.1, Q6** | |

| **Y8** | **UNIT 15** ***Polygons*** Lesson Plan 2 | *Interior Angles in Polygons* |
|---|---|---|
| ***Activity*** | | ***Notes*** |
| **1** | **Checking homework**<br>**PB 15.1, Q1 (d)** *($50°$)*<br>**PB 15.1, Q2 (d)** *($49°$)*<br>**PB 15.1, Q5** *($a = 37°$, $b = 70°$)*<br>**PB 15.1, Q6** *($b = 47°$, $a = c = 133°$)*<br>e.g: **PB 15.1, Q1 (d)**<br>$P_1$: We can see five angles around a point. Since they must add up to $360°$, we find angle *d* by subtracting the sum of the other angles from $360°$.<br>That is $360° - 130° = 50°$.<br>etc. with $P_2$ - $P_4$<br>*8 mins* | Verbal checking of all homework exercises.<br>Each figure appears on OHP (one at a time) and a volunteer P repeats the fact they have reviewed in the previous lesson and gives the solution. Other Ps agree/correct; T praises.<br>Feedback, self-correction. Praising. |
| **2A** | **Angles in quadrilaterals**<br>T: In the last lesson we looked at angles in a triangle and the fact that they add up to $180°$. What about other polygons? We also said that angles in quadrilaterals add up to $360°$. Is there any connection between these two facts?<br>P (draws on BB while explaining):<br>Any quadrilateral can be divided into two triangles ... And the angles of the triangles include all the angles of the quadrilateral, so the angles of the quadrilateral add up to $2 \times 180° = 360°$. | Whole class activity.<br>Ps have stated the facts about the angles in quadrilaterals in Y7, Unit 5, but at that stage, no proof was given (except for stronger Ps). In Y8, Unit 6, all Ps were shown the proof. Now T makes Ps repeat it by encouraging and helping a slower P to contribute ... |
| **2B**<br><br>*(continued)* | **Angles in polygons**<br>**Y7 Activity 5.7**<br><br>T: What do you notice about the second and third columns of the table?<br>$P_1$: The number of triangles is 2 less than the number of sides of the polygon.<br>T: So how have you found the sum in the fourth column for each polygon?<br>$P_2$: We subtracted 2 from the number of sides, then multiplied the difference by $180°$. | ... then T encourages Ps to discover the general rule for the sum of the interior angles in any polygon, using this Activity from Y7.<br>Each P is given a Y7 Activity 5.7 sheet to work on and the task also appears on OHP.<br>Ps volunteer, come to BB to draw the next type of polygon, divide it (T suggests they draw lines each starting from the same vertex), show and mark the angles of the triangles, then fill in the appropriate row in the table. T agrees, praises; all Ps draw on their sheets and fill in the table.<br>Then the rule is stated. |

<table>
<tr><td>Y8</td><td>UNIT 15 Polygons Lesson Plan 2</td><td>Interior Angles in Polygons</td></tr>
<tr><td>Activity<br><br>2B<br><br>(continued)</td><td>T: How would you calculate the sum of the interior angles of a polygon with 100 sides?<br>$P_3$: I would subtract 2 from 100 ...<br>T: Why?<br>$P_3$: Because a polygon with 100 sides can be divided into 98 triangles with lines each starting from the same vertex.<br>T: Why?<br><br>T: And if the polygon has n sides?<br>P: The general rule for the sum of the interior angles for a polygon with n sides is $(n-2)\times 180°$.<br><br>22 mins</td><td>Notes<br><br>Here T can see what Ps have understood, and should wait for the answer from strongest Ps.<br>T will be justifiably pleased if a P discovers that $n-3$ suitable lines can be drawn and that they divide the polygon with n sides into $n-2$ triangles. It will not be surprising if no P reaches this conclusion! T should be content if Ps can state the general rule.<br>T writes the correct answer on BB (Ps in Ex.Bs) and praises.</td></tr>
<tr><td>3<br><br><br><br>Extension</td><td>Practice with angles in polygons<br><br>(1) Calculate the sum of the interior angles of a polygon with<br>(a) 10 sides,<br>(b) 102 sides.<br>(2) Is this statement true or false?<br>'The sum of the interior angles of a 20-sided polygon is twice the sum of the interior angles of a 10-sided polygon'<br><br>$P_1$: $(10-2)\times 180° = 8\times 180° = 1440°$<br>T: Can you tell me why you have subtracted 2 from 10 ?<br>$P_1$: Because a 10-sided polygon can be divided into 8 triangles by drawing lines connecting vertices (without crossing each other).<br>T: Can you show us at BB? ...<br>$P_2$: $(102-2)\times 180° = 100\times 180° = 18\,000°$<br>T: Why?<br>$P_2$: Because a 102-sided polygon can be divided into 100 triangles ...<br>T: Can you draw it on BB?<br>$P_2$: ?<br>T: OK, I'll take your word for it.<br>$P_3$: The answer to question (2) is no, since (writes on BB):<br>$(20-2)\times 180° = 18\times 180°$<br>which is not twice $8\times 180°$.<br>T: What can you change the number 20 to, to make this statement true? (18)<br><br>34 mins</td><td>Individual work, monitored, helped.<br><br>Checking at BB. Volunteer/encouraged slower Ps are called to BB to show their solutions. T also checks that they know why they subtract 2 from the number of sides.<br><br>Agreement, feedback, self-correction. Praising.</td></tr>
<tr><td>4A<br><br>(continued)</td><td>Calculating the size of angles of polygons<br>T: We'll have another look at regular polygons. What is the name given to a regular triangle?<br>$P_1$: Equilateral triangle.</td><td>Whole class activity.<br><br>Firstly, mental work to remind Ps of the most common polygons; questions/answers interactively ...</td></tr>
</table>

# Y8 UNIT 15 *Polygons* Lesson Plan 2

## *Interior Angles in Polygons*

***Activity*** | ***Notes***

**4A** *(continued)*

T: What is the size of each of the angles in an equilateral triangle?

$P_2$: $60°$

T: Why?

$P_3$: Because $180° \div 3 = 60°$.

T: Why have you divided by 3 ?

$P_4$: Because the angles of an equilateral triangle are equal.

T: What about angles in other shapes?

Ps: The angles of any regular polygon are equal.

T: What is the name given to a regular quadrilateral?

$P_5$: A square.

T: What size is each of its angles?

Ps: $90°$

T: How could I calculate this if I didn't know it?

$P_6$: The sum of the interior angles of any quadrilateral is $360°$. If the quadrilateral is regular, we can find the size of its angles by dividing the sum by 4.

**4B**

**Interior angles of other polygons**

T: What is the size of the interior angle of a regular

(a) pentagon, (b) octagon,

(c) 10-sided polygon?

$P_1$ (writes on BB and explains):

Sum $= (5-2) \times 180° = 3 \times 180° = 540°$

One angle $= 540° \div 5 = 108°$

etc, $P_2$, $P_3$

*Notes:* ... then using the rule to calculate (at BB and in Ex.Bs) for other polygons.

Volunteer P comes and explains, then T encourages (and helps) slower Ps to calculate at BB. Agreement. Praising.

*41 mins*

**5**

**Individual work**

T: Calculate the size of the interior angle of a regular

(a) hexagon, (b) 18-sided polygon,

(c) *n*-sided polygon.

<u>*Solutions:*</u>

(a) $\dfrac{(6-2) \times 180°}{6} = 120°$

(b) $\dfrac{(18-2) \times 180°}{18} = 160°$

(c) $\dfrac{(n-2) \times 180°}{n} = 180° - \dfrac{360°}{n}$

*Notes:* Individual work, monitored, helped.

*Checking*: T writes solutions on BB; Ps correct their work. Feedback. Praising.

*45 mins*

**Set homework**

**(1) PB 15.2, Q3 (b), (a)**

**PB 15.2, Q4 (b), (a)**

**(2) PB 15.2, Q5**

**Extension**

**(3) What happens to the interior angle of a regular *n*-sided polygon as $n \to \infty$ ?**

# Y8 UNIT 15 *Polygons* Lesson Plan 3

## *Exterior Angles in Polygons*

***Activity***

**1**

**Checking homework**

**(1) PB 15.2, Q3 (b)** *(1800°),* **(a)** *(150°)*

**PB 15.2, Q4 (b)** *(3240°),* **(a)** *(162°)*

*Notes:* T has asked two Ps to write down solutions to part (1) of homework as soon as they arrive.
Agreement/correction.
Self-correction, feedback. Praising.

**(2) PB 15.2, Q5**

P: First, we have to calculate the sum of the interior angles:

$$(5-2)\times 180° = 540°$$

Then we divide this sum by 5 to get one angle, since this is a regular pentagon.

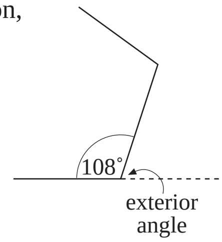
$$540° \div 5 = 108°$$

We know that, at any vertex, for any polygon,

interior angle + exterior angle = 180°

so the size of one exterior angle is:

$$180° - 108° = 72°$$




*Notes:* Then T asks a volunteer P to explain solution of part (2), which will include a recap of work covered in the previous lesson.

While P is giving the explanation, T draws a regular pentagon on BB, marking an exterior angle on it, and showing the connection between the interior and exterior angles.
Agreement, self-correction. Praising.
Further questions follow ...

T: What can you say about the exterior angles of a regular polygon? *(They are all equal)*

T: Why? *(Because the interior angles are all the same size)*

T: Can you give me the sum of the exterior angles of a regular pentagon? *(5 × 72° = 360°)*

**Extension**

**(3)** As $n \to \infty$, interior angle $180° - \dfrac{360°}{n} \to 180°$, i.e. a straight line.

*Notes:* Agreement. Praising.

*7 mins*

**2A**

**Exterior angles of regular polygons**

T: Can you calculate the sum of the exterior angles of any regular polygon?

Ps: Yes.

T: Let's repeat what to do.

P: 1. Calculate the sum of the interior angles.
2. Divide this sum by the number of sides/angles to get the size of one interior angle.
3. Calculate the size of one exterior angle.
4. Multiply this by the number of sides to get their sum.

*Notes:* Whole class activity.

T makes a slower P repeat (with help) how to calculate the sum of the exterior angles of a regular polygon ...

| *Number of Sides* | *Sum of Interior Angles* | *Interior Angles* | *Exterior Angles* | *Sum of Exterior Angles* |
|---|---|---|---|---|
| 3 | 180° | | | |
| 4 | 360° | | | |
| 5 | 540° | 108° | 72° | 360° |
| 6 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |

*Notes:* ... then T draws a table on BB (or it can be pre-prepared on OHP) and encourages slower Ps to come to BB, calculate and fill in the table (one row for each P).
The row for the pentagon can be shown as it has just been calculated.
The rows for the triangle, hexagon and nonagon can be filled in as a whole class activity, then ...

*(continued)*

| Y8 | UNIT 15 *Polygons* Lesson Plan 3 | *Exterior Angles in Polygons* |
|---|---|---|
| ***Activity*** | | ***Notes*** |
| **2A** *(continued)* | | ... individual work to complete the table.<br>*Checking*: Ps dictate results, T agrees, fills in the table.<br>Feedback, self-correction. Praising. |
| **2B** | **Exterior angles of polygons**<br>T: What do you observe?<br>Ps: For all the regular polygons, the exterior angles add up to $360°$.<br>T: Will this be the same for a 20-sided or a 40-sided regular polygon?<br>Ps: Yes.<br>T: Why?<br>Ps: ?<br>T: Let's look at a regular hexagon ... I'll write and then you can tell me the results to fill in. | Discussion of the results, stating the rule. (*The exterior angles of any polygon add up to* $360°$.)<br>T puts OS 15.3 on OHP, with the lower half covered., and writes on BB ... |

| **T:** (writes on BB): | **Ps:** (say the results): |
|---|---|
| interior angle + exterior angle | $= 180°$ |
| total of interior + exterior angles | $= 6 \times 180°$ |
| total of interior angles | $= (6-2) \times 180° = 4 \times 180°$ |
| total of exterior angles | $= 6 \times 180° - 4 \times 180°$<br>$= 2 \times 180°$ |

*Notes:* ... volunteer (probably stronger) Ps suggest/dictate what to write as answer.

Praising at the end.

T: Where have we used the fact that this is a *regular* hexagon?
Ps: Nowhere.
T: So?
Ps: It's also true for irregular hexagons.
T: Let's look at it for *any* polygon.

*Notes:* If there are any very strong Ps in the class, T can ask them to give the general answer ...

| **T:** | **Ps:** |
|---|---|
| interior + exterior | $180°$ |
| total interior + exterior | $n \times 180°$ |
| total interior | $(n-2) \times 180°$ |
| total exterior | $n \times 180° - (n-2) \times 180° = 360°$ |

*Notes:* ... and at the end, T can give a practical proof of the rule (see p 56 of Y8B PB and also the figure on OS 15.3).

*27 mins*

| **3A** *(continued)* | **A quicker method for calculating exterior angles**<br>T: In your homework you had to calculate the size of the exterior angle of a regular pentagon. How did you do this?<br>$P_1$: We calculated the sum of the interior angles, using the formula $(n-2) \times 180°$.<br>$P_2$: Then we calculated the size of one interior angle. | A short discussion and mental work, questions/answers interactively ... |
|---|---|---|

| **Y8** | **UNIT 15** ***Polygons*** Lesson Plan 3 | *Exterior Angles in Polygons* |
|---|---|---|
| ***Activity*** | | ***Notes*** |

**3A** *(continued)*

$P_3$: Finally we subtracted it from $180°$ to get the size of the exterior angle.

T: Do you think this is a long process?

Ps: Yes!

T: Can you suggest another way of doing it?

$P_4$: Since the exterior angles of a polygon add up to $360°$, for a regular polygon we can find the size of one exterior angle by dividing $360°$ by the number of angles/sides.

T: Who can do this calculation for a regular pentagon?

$P_5$: Exterior angle $= 360° \div 5 = 72°$.

T: ..for a regular pentagon?

$P_6$: Exterior angle $= 360° \div 9 = 40°$.

T: ... for a regular octagon?

$P_7$: Exterior angle $= 360° \div 8 = 45°$.

**3B**

**Individual work with exterior angles**

T: Now you can eavh do some work on your own. Calculate the exterior angle of a regular

(a) dodecagon,

(b) 18-sided polygon,

(c) 30-sided polygon.

Then check each result by calculating one interior angle and seeing whether or not the exterior angle and the interior angle add up to $180°$.

*Notes:* ... then individual work, monitored, helped.

T may give Ps a table to help their work:

| *Number of Sides* | *Exterior Angles* | *Interior Angles* | *Checking* |
|---|---|---|---|
| 12 | | | |
| 18 | | | |
| 30 | | | |

e.g:

$P_1$: Exterior angle $= 360° \div 12 = 30°$.

$P_2$: The sum of the interior angles

$$= (12 - 2) \times 180° = 1800°.$$

From here, one interior angle

$$= 1800° \div 12 = 150°.$$

$P_3$: $30°$ and $150°$ add up to $180°$.

etc.

*Notes:* Checking at BB by Ps. Agreement, feedback, self-correction. Praising.

**3C**

**A quicker method for calculating interior angles**

T: Which of the three columns was the most difficult to find out?

Ps: The one with the interior angles.

T: Can you suggest a quicker way to calculate the size of an interior angle in a regular polygon?

$P_1$: Using the exterior angle? ...

T: Good! Tell us how you would do this for a regular hexagon.

*Notes:* Finally, mental work again.

*(continued)*

| Y8 | UNIT 15 *Polygons* Lesson Plan 3 | *Exterior Angles in Polygons* |
|---|---|---|
| ***Activity*** | | ***Notes*** |
| **3C** *(continued)* | $P_2$: Exterior angle $= 360° \div 6 = 60°$<br>$\Rightarrow$ interior angle $= 180° - 60° = 120°$<br>T: Now for a regular 20-sided polygon ...<br>$P_3$: Exterior angle $= 360° \div 20 = 18°$<br>$\Rightarrow$ interior angle $= 180° - 18° = 162°$<br>T: ... for a regular triangle?<br>$P_4$: $60°$<br>*40 mins* | Praising whenever possible. |
| **4** | **Determining the number of sides of a regular polygon**<br>T: Let's do this inversely. Can you tell me which regular polygon has exterior angles of $36°$ ?<br>$P_1$: Since $n \times 36° = 360°$, $n = 360° \div 36° = 10$, it must be a regular decagon.<br>T: Which regular polygon has exterior angles of $24°$ ?<br>$P_2$: $n \times 24° = 360° \Rightarrow n = 360° \div 24° = 15$, so it is a 15-sided polygon.<br>T: And which has interior angles of $170°$ ?<br>Ps: ? ...<br>$P_3$: ... first calculate the size of an exterior angle:<br>$180° - 170° = 10°$<br>then do the calculation in the same way as before:<br>$360° \div 10° = 36$<br>so it must be a regular 36-sided polygon.<br>*45 mins* | Whole class activity.<br><br>Volunteer Ps come to BB to write and explain their solution.<br>Agreement, praising; all Ps write in Ex.Bs. |
| | **Set homework**<br>**PB 15.2, Q2**<br>**PB 15.2, Q6**<br>**PB 15.2, Q7** | |
| | | |

| **Y8** | **UNIT 15** ***Polygons*** Lesson Plan 4 | *Symmetry 1* |
|---|---|---|
| ***Activity*** | | ***Notes*** |
| **1** | **Checking homework**<br>**PB 15.2, Q2 (a)** Exterior angle $= 45°$, interior angle $= 135°$<br>**(b)** Exterior angle $= 36°$, interior angle $= 144°$<br>**PB 15.2, Q6** 30 sides<br>**PB 15.2, Q7 (a)** (i) 12 (ii) 72 (iii) 20 (iv) 60<br>**(b)** Interior angle $= 123°$, Exterior angle $= 57°$<br>No. of sides $= \dfrac{360}{57}$ which is not an exact integer, so a regular polygon not possible.<br>*8 mins* | Verbal checking, reviewing topics form the previous two lessons. T also asks for alternative ways to get the results, wherever possible (e.g. Q2). |
| **2**<br>**2A** | **Symmetry**<br>**Introducing symmetry**<br>T: You can stop looking at regular polygons for a while and look at me instead! Do you think that I am symmetrical? Can I be divided into two similar pieces? Where would you draw the cutting line? Can you draw another cutting line?<br>If a shape has a cutting line as my outline has, we call that the 'line of symmetry'. | Whole class activity revising Ps practical knowledge of symmetry.<br>Questions/answers interactively (light-hearted), letting Ps answer individually or in chorus. |
| **2B** | **Drawing lines of symmetry**<br>**OS 15.4**<br>*14 mins* | Now Ps look at shapes (OS appears on OHP).<br>Volunteer Ps come to OHP and draw lines of symmetry (each P draws only one line). T says nothing, allowing Ps to discuss amongst themselves and arrive at the correct answers. T keeps order, agrees at the end and praises. |
| **3** | **Lines of symmetry**<br>**PB 15.3, Q1 (drawing only the lines of symmetry)**<br>*24 mins* | Individual work, monitored, helped.<br>Checking at BB: T sketches the shapes on BB, one at a time; volunteer P comes out and draws as many lines of symmetry as possible. Other Ps agree/suggest correct/complete.<br>Feedback, self-correction, praising for each shape. |
| **4A**<br><br>*(continued)* | **Discussing shape in PB 15.3, Q3 (a)**<br>T (after putting shape on OHP):<br>What do you think about this shape? ... It's nice, isn't it? Does it have any lines of symmetry? ... No. In spite of this, we feel that there is a symmetry about it, don't we? What activity does this shape suggest? ... Would you like to spin it? Where would be the point of rotation? ... How many part turns can you make with the shape when it will be identical to its starting position, in one complete rotation of $360°$ ? Show me what you mean ...<br>etc. | Whole class activity.<br>T puts pre-prepared OS of PB 15.3, Q3 (a) on OHP and initiates the idea of rotational symmetry by indicating the difference between the two types of symmetry.<br>Questions/answers interactively, letting Ps answer spontaneously. |

| **Y8** | **UNIT 15** ***Polygons*** Lesson Plan 4 | *Symmetry 1* |
|---|---|---|
| ***Activity*** | | ***Notes*** |
| **4A** *(continued)* | | T also introduces the idea of 'centre of rotation' and the 'order of rotational symmetry'. |
| **4B** | **Rotational symmetry**<br>**OS 15.5** | Ps look at other shapes (OS appears on OHP).<br>Volunteer Ps mark the centre of rotation and show and state the number of times in one rotation of $360°$.<br>T waits for correction, agrees, praises.<br>Finally, T can ask Ps to draw the lines of symmetry of each shape, then observe and state the differences. (Centre of rotation $\Leftrightarrow$ crossing of lines of symmetry.) |
| | *36 mins* | |
| **5** | **Individual work**<br>**PB 15.3, Q1 (rotational symmetry)** | Individual work, monitored, helped.<br>T asks Ps to draw these shapes again in their Ex.Bs, and suggests that they mark the centre of symmetry and then connect this with the vertices, when finding the order of rotational symmetry for each one.<br><br>Checking at OHP: T puts an OS showing the shapes onto OHP, with the centre of symmetry marked on each shape.<br>Feedback, self-correction. Praising.<br>Then T asks volunteer Ps to explain the order of rotational symmetry. (Connecting vertices with the centre of rotation can be helpful as part of the explanation.)<br>Agreement, feedback, self-correction. Praising. |
| | *45 mins* | |
| | **Set homework**<br>**PB 15.3, Q2**<br>**PB 15.3, Q4** | |

# Y8 UNIT 15 *Polygons* Lesson Plan 5 *Symmetry 2*

| *Activity* | | *Notes* |
|---|---|---|
| 1 | **Checking homework**<br>**PB 15.3, Q2** | The shapes in Q2 appear on OHP. T asks (points to) Ps to show and draw solutions at OHP.<br>Agreement, feedback, self-correction. Praising.<br>Then a volunteer P is asked to come to BB and compare equilateral, isosceles and scalene triangles by showing solution of Q4. |

| | *Order of Rotational Symmetry* | *No. of Lines of Symmetry* |
|---|---|---|
| (a) | 4 | 4 |
| (b) | 1 | 1 |
| (c) | 2 | 2 |
| (d) | 2 | 2 |
| (e) | 2 | 2 |
| (f) | 1 | 1 |

**PB 15.3, Q4**

| | *Order of Rotational Symmetry* | *No. of Lines of Symmetry* |
|---|---|---|
| Equilateral | 3 | 3 |
| Isosceles | 1 | 1 |
| Scalene | 1 | 0 |

*7 mins*

**2A** **Symmetry of regular polygons**

T: So a regular 3-sided polygon has 3 lines of symmetry, and has rotational symmetry of order 3. Is this a coincidence, or can we say something similar about other regular polygons too?

What do we call a regular 4-sided polygon? Please draw one on BB ... Can you draw in the lines of symmetry and give its order of rotational symmetry? ... Where do the lines of symmetry cross the sides? ... And for an equilateral triangle? ... Why ...

*Notes:* Whole class activity, preparing for individual work and examining the symmetry properties of the squares (PB 15.3, Q5).

Also comparing the points where the lines of symmetry cross the sides in an equilateral triangle (odd number of sides) and in a square (even number of sides).

**2B** **Individual practice**

T: Now work through these questions on your own.

**Activity 15.3**

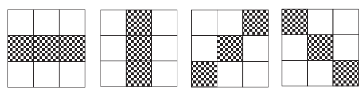
*Notes:* Individual work, monitored, helped.

Each P has a copy of Activity 15.3 to work on.

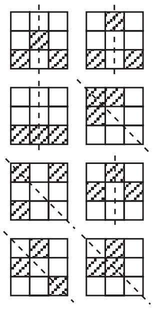
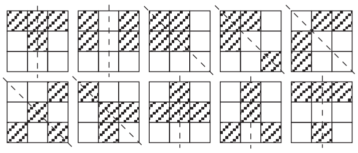
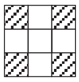
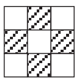
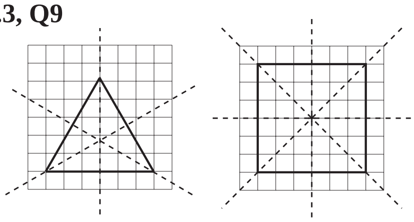
Verbal checking, giving:

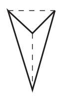
- the places where the lines of symmetry cross the sides if the number of sides is odd or even,
- the order of rotational symmetry and the number of lines of symmetry of any regular polygon.

*20 mins*

| **Y8** | **UNIT 15** ***Polygons*** Lesson Plan 5 | *Symmetry 2* |
|---|---|---|
| ***Activity*** | | ***Notes*** |
| **3** | **Further work with rotational symmetry**<br>**PB 15.3, Q3**<br>T: Open your book at p 63. We've already looked at the shape in Q3 (a). Now compare it with the shape in Q3 (b).<br>Study the two shapes and describe their symmetries.<br>*24 mins* | Whole class activity.<br>T gives 1 or 2 minutes to see/examine the two shapes.<br>Discussion follows; Ps determine that the first figure has no lines of symmetry, and has rotational symmetry (of order 6), while the second shape has both lines of symmetry and rotational symmetry.<br>Agreement. Praising. |
| **4** | **Drawing shapes with symmetry properties (working in pairs)**<br>T: Now you can design some shapes with different symmetry properties.<br>**PB 15.3, Q7**<br>**PB 15.3, Q8**<br>*34 mins* | Ps work in pairs.<br>T organises pairs by seating and lets Ps discuss/control/correct their ideas in their pairs.<br>T walks among Ps, monitoring, helping and checking.<br>Praising at the end. T points to Ps to draw some of the most interesting solutions on BB.<br>Praising again. |
| **5** | **Individual work with lines of symmetry**<br>**Activity 15.2**<br>*45 mins* | Another task for developing Ps' creativity, this time as individual work.<br>Each P has a copy of Activity 15.2 and works in Ex.B.<br>After 8 minutes, T stops the work but does not check all the answers.<br>*For Q1*, T can ask how many more ways Ps have found. T praises Ps giving a large number and then asks all Ps to continue with this at home until they have found 32.<br>*For Q2*, four Ps can be asked to draw the patterns on BB.<br><br>Agreement, feedback, self-correction. Praising.<br>*Q3* will probably not be completed by all Ps, so it can be part of the homework. |
| | **Set homework**<br>**(1) Completing Activity 15.2, Q1 and Q3.**<br>**(2) PB 15.3, Q9** | |

# Y8 UNIT 15 *Polygons* Lesson Plan 6 *Symmetry 3*

| *Activity* | | ***Notes*** |
|---|---|---|
| **1** | **Checking homework**<br>**(1) Completing Activity 15.2, Q1**<br>Each of these patterns can be be rotated to give 4 different squares with only one line of symmetry.<br><br>**Activity 15.2, Q3**<br>**(a)** 10 basic designs<br><br>**(b)** None **(c)** None<br>**(d)**  or  | T puts a pre-prepared OS showing the different solutions to Q1 on OHP. (Two solutions are different if they cannot be turned into each other.)<br>Discussion, feedback, self-correction. Praising.<br>Then checking/discussion of Q3. |
| | **(2) PB 15.3, Q9**<br>e.g:<br><br>*Odd* number of sides – lines of symmetry through vertex and middle of opposite side.<br>*Even* number of sides – lines of symmetry through middle of opposite sides, or diagonal vertices.<br>*8 mins* | When checking part (2) of homework, two volunteer Ps come to BB, draw polygons with an even/odd number of sides and review the points they have learnt in the previous lesson by comparing the symmetries (including the positions of the lines of symmetry). |
| **2** | **Revision of properties of quadrilaterals**<br>T: At the beginning of this year we looked at some of the properties of quadrilaterals. Now we're going to look at the symmetry properties of quadrilaterals.<br>First of all, let's see if you can remember what we've already done. | Whole class activity. |
| | **OS 15.7**<br>e.g.<br>T: What is the name of quadrilateral 'A'?<br>$P_1$: Parallelogram.<br>T: Are you sure? ... Look at it more carefully ... What are the properties of a parallelogram?<br>$P_1$: Two pairs of parallel sides ...<br>T: Are both pairs of sides parallel here?<br>$P_1$: No.<br>T: So?<br>$P_1$: This is a trapezium.<br>T: List the properties of a trapezium.<br>$P_2$: Only two sides are parallel.<br>$P_3$: The angles on both non-parallel sides add up to $180°$.<br>etc. | OS appears on OHP.<br>T points to a volunteer P to name the first quadrilateral, then asks Ps to list as many properties as they can (one P, one property).<br>T agrees, praises and asks for the next quadrilateral. |
| *(continued)* | | |

| **Y8** | **UNIT 15** ***Polygons*** Lesson Plan 6 | *Symmetry 3* |
|---|---|---|
| ***Activity*** | | ***Notes*** |
| **2**<br>*(continued)* | T: Which special quadrilateral is missing from the sheet?<br>*(The square)*<br>T: We've mentioned lots of properties. What can you say about the properties of a square?<br>*(Almost all these properties are true for the square)*<br>T: Why? *(It's a special type of quadrilateral)*<br>T: What do you mean?<br>*(Squares are special cases of rectangles; rectangles are special cases of parallelograms and parallelograms are special trapeziums)*<br>T: And what about kites?<br>*(Squares are special rhombuses, which are special cases of kites)*<br>*18 mins* | Discussion at the end of the lesson.<br><br>Praising whenever possible. |
| **3**<br><br><br><br><br><br>**Extension** | **Special quadrilaterals**<br>**Activity 15.4**<br>T: Let's see how many properties you have managed to note. You can see some properties in the table that we haven't discussed before. They are quite straightforward. You can draw anything in the shapes on your sheet that will help you find the properties.<br><br>T: Can you draw a special quadrilateral in which the diagonals do not bisect each other?<br>**(e.g.**  **)**<br>*32 mins* | Individual work.<br>Each P has a copy of Activity 15.4.<br>(Before the lesson, T should correct the label on the row which reads "Longer diagonal bisects shorter diagonal". This is true for the figures in Activity 15.4, but for general application it should read "The diagonals bisect each other".<br>T monitors Ps' work, helps slower ones. Verbal checking with explanations, drawing on BB if necessary (mainly for the properties not mentioned before), listing properties of the shapes.<br>Agreement, feedback, self-correction, praising, shape by shape. |
| **4** | **Revision of work with quadrilaterals**<br>T: We've covered almost everything concerning quadrilaterals in this unit. Let's look at quadrilaterals again, this time finding their symmetry properties.<br>**Activity 15.1**<br>*41 mins* | Whole class activity.<br>T puts Activity 15.1 on OHP and each P has a copy.<br>First a short review, filling in the rows for the isosceles triangle, equilateral triangle and square. Then Ps come to OHP to show the lines of symmetry, centres of rotational symmetry and to state the orders of rotational symmetry for these and for the other shapes.<br>All Ps listen, drawing on their own sheet, filling in the boxes in their table and suggesting corrections when necessary.<br>Agreement, feedback, self-correction. Praising. |

| **Y8** | **UNIT 15** ***Polygons*** Lesson Plan 6 | *Symmetry 3* |
|---|---|---|
| ***Activity*** | | ***Notes*** |

**5**

**Revision of angles**

T: We have a few spare minutes to review the first topic we looked at in this unit: let's see what we've learnt about angles.

(1) An angle on a straight line has size $30°$.
What is the size of the other angle?
$(180° - 30° = 150°)$

(2) Two angles around a point have sizes $120°$ and $100°$.
What is the size of the third angle?
$(360° - (120° + 100°) = 140°)$

(3) Two angles in a triangle are $50°$ and $60°$.
What is the size of the third angle?
$(180° - (50° + 60°) = 70°)$

(4) Determine the size of the exterior angle of a triangle next to the interior angle of $70°$.
$(180° - 70° = 110°)$

(5) What is the sum of the interior angles of a polygon?
$(360°)$

(6) What is the sum of the interior angles of a pentagon?
$((5 - 2) \times 180° = 540°)$

(7) Calculate the size of the exterior angle of a regular decagon. $((360° \div 10) = 36°)$

(8) Give two ways to determine the size of the interior angles of a regular hexagon.
*(a)* $360° \div 6 = 60°$ *and* $180° - 60° = 120°$
*(b)* $(6 - 2) \times 180° = 720°$ *and* $720° \div 6 = 120°$

Notes: Mental work, encouraging slower Ps to answer.

Agreement. Praising.

*45 mins*

**Set homework**
**PB 15.4, Q2**
**PB 15.4, Q3**
**PB 15.4, Q4**