1(a). Work out the size of the exterior angle of a regular 9-sided polygon.

_____ °

[2]

(b). Hence work out the size of the interior angle of a regular 9-sided polygon.

_____ °

[1]

2. In a regular polygon, the interior angle is fourteen times the exterior angle, $x°$.

Not to scale

Find x and hence find the sum of the interior angles of this polygon.

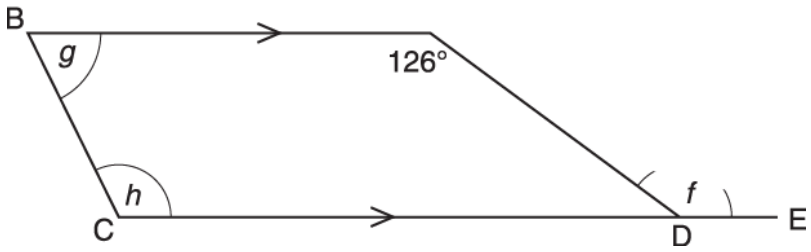
x = _____

sum of interior angles = _____ ° **[5]**

3(a). ABCD is a quadrilateral.

BA is parallel to CDE.

Angle *h* is **not** equal to 126°.



What is the mathematical name for quadrilateral ABCD?

_____ [1]

(b). Find the size of angle *f.*

Give a geometrical reason for your answer.

f = _____ ° because_____

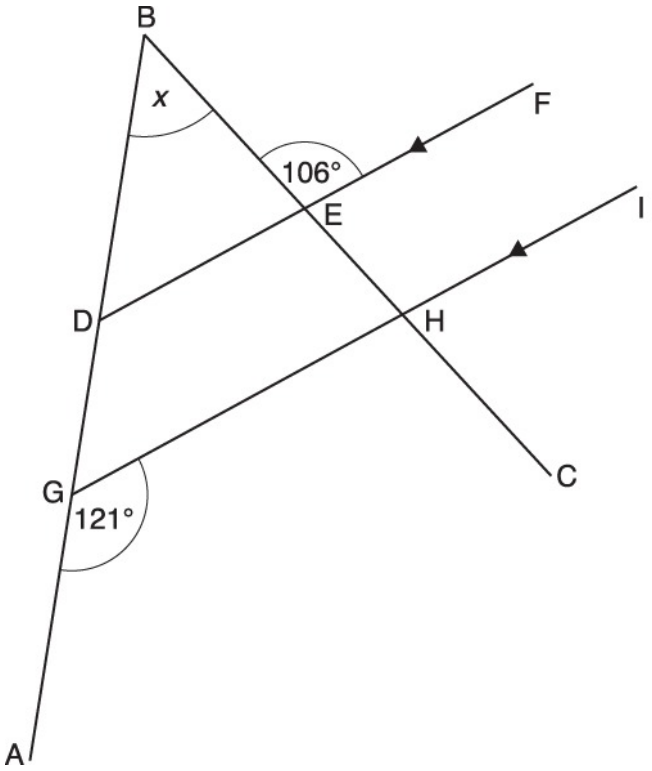
_____ [2]

(c). Angle *h* is 4 times the size of angle *g.*

Work out the size of angle *h.*

_____° [3]

4. * The diagram is made from four straight lines. DEF and GHI are parallel.



Not to scale

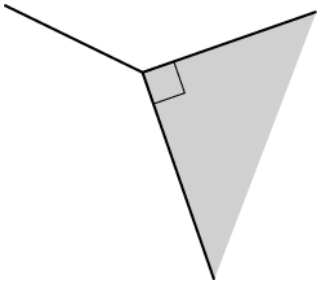
Calculate the size of angle *x*.

Give a reason for each stage of your working.

_____ ° **[5]**

5. A floor is tiled using a pattern of two different shaped tiles.
One of the shapes is a square and the other is a regular polygon.

At each vertex in the pattern, two of the polygon tiles and one square tile meet.



What shape is the regular polygon?
Show your reasoning clearly.

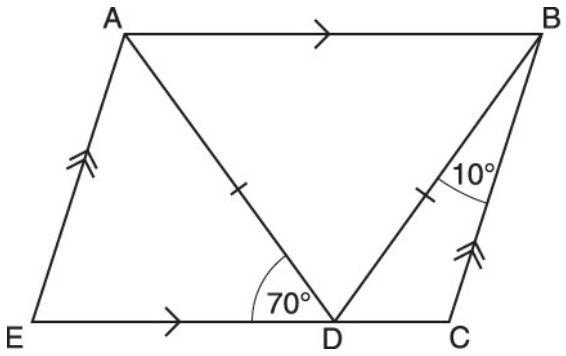
---

[4]

6. The diagram shows parallelogram ABCE.

D is a point on EC.

AD = BD, angle ADE = 70° and angle CBD = 10°.



Not to scale

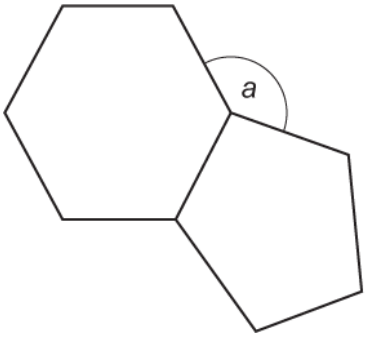
Work out angle BCD.

Give a reason for each angle you work out.

Angle BCD = _____ ° **[4]**

7(a). Imran joins two tiles together as shown below.

One tile is a regular hexagon and the other tile is a regular pentagon.



Not to scale

Show that angle *a* is 132°.

---

[3]

(b). Imran thinks that another tile in the shape of a regular polygon will fit **exactly** into angle *a*.

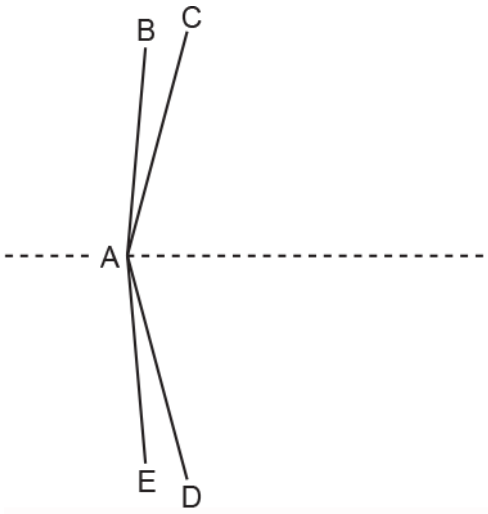
Is Imran correct?

Show your reasoning.

---

[3]

8. Angle BAE is part of a regular 18-sided polygon.
Angle CAD is part of a regular 10-sided polygon.
The dashed line through A is a line of symmetry of both polygons.



Not to scale

Work out angle BAC.

---------- ° **[5]**

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Part marks and guidance	
1	a		40° final answer	2	**B1** for 140 or 40 seen or **M1** for 360 ÷ 9 oe	Eg 180 – 180 × 7 ÷ 9 <u>Examiner's Comments</u> Many candidates showed the correct calculation of 360 ÷ 9 = 40. It was clear that there was some confusion about the term 'exterior angle' because the correct answer of 40 was often spoilt by subtraction from either 180° or 360°. Some candidates thought that the sum of the exterior angles was 180 which led to the incorrect answer of 20°. Candidates who initially tried to find the interior angle were rarely successful, because even if they did remember that there were $n - 2$ triangles, they made errors in the subsequent arithmetic or gave 1260, the sum of the interior angles, as their answer.
	b		140°	1	Or **FT** 180 – *their* 40	FT *their* 40 if < 180 <u>Examiner's Comments</u> Many candidates knew the link between exterior angles and interior angles and so gained a follow through mark even if their previous answer had been incorrect. Visualisation of the polygon and its interior and exterior angles may have helped candidates identify which angle should have been 40° and which 140°.
			Total	3		
2			12	2	**M1** for $x + 14x = 180$ or 180 ÷ 15 oe	

Question			Answer/Indicative content	Marks	Part marks and guidance	
			5040	3	**M1** for 360 ÷ *their x* And **M1** for ((*their* 30 – 2) × 180 or 14 × 12 × *their* 30 If **M0** then **SC1** for 168	Not dep on first **M1** **Examiner's Comments** This question was only fully answered correctly by a minority of candidates. There was more success in the first part with many able to see that $15x = 180$ and so proceed, but a common mistake seen was to try and use $14x = 180$ or $14x = 360$, or simply try to estimate how many sides the shape had and then use that. Even for those who were able to correctly calculate $x = 12$, many were only able to show that the interior angle was 168°. Many quoted that the sum of interior angles = $(n – 2) \times 180$ but didn't know to use n = 360/exterior angle.
			Total	5		

Question			Answer/Indicative content	Marks	Part marks and guidance	
3	a		Trapezium	1	Examiner's Comments Many could recognize the given shape as a trapezium but the common wrong answers were rhombus and parallelogram.	
	b		126 Alternate angles	B1 B1	 Condone 'Z' but not 'alternating' Examiner's Comments The angle was generally given correctly and it was pleasing to see the number of candidates that could use the correct terminology of 'alternate angles'. Some weaker candidates used contradictory multiple terms such as 'corresponding Z-angle'. A handful of candidates incorrectly thought that 'parallel lines' was sufficient reason.	 Not with contradictory comments
	c		144	3	**B1** for $g + h = 180$ soi **M1** for $180 \div 5$ or 36 seen	eg by ADC = 54°
			Total	6		

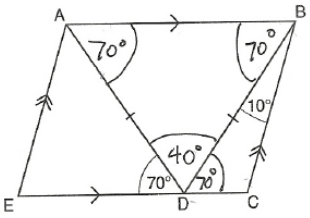
Question			Answer/Indicative content	Marks	Part marks and guidance	
4			Clear method including - DGH = 59° Angles on a straight line = 180° BDE = 59° Corresponding [angles] DEB = 74° Angles on a straight line = 180° x = 180 – 59 – 74 = 47° Angles in a triangle = 180°	5	'line' & either 'angles' or 180° Condone F angles	
			As above but with either • no more than 2 missing/wrong reasons or • no more than 1 arithmetic slip • lack of clarity	4-3	For lower mark either • 47 found NFWW with more than 2 reasons missing/wrong or • full method with no more than 2 arithmetic slips or • full method with 2 missing/wrong reasons and 1 arithmetic slip	
			Either • 2 correct angles found or • 1 angle found with reason	2-1	For lower mark 1 angle found without reason	
			Nothing of any worth	0		
					Examiner's Comments This QWC question was answered well by many candidates. Most showed a good understanding of the rules of angles although many struggled to explain them adequately. The best explained reasons were for angles in a triangle and angles on a straight line, the problematic ones concerned angles in parallel lines. There is still common use of F and Z angles	

Question			Answer/Indicative content	Marks	Part marks and guidance	
					instead of the correct names and many think it is enough to say they are parallel lines and not state the explicit rule they are using. A lot of answers were well laid out with clear sequential reasoning which generally looked like this: DGH = 59° Angles on a straight line = 180° BDE = 59° Corresponding angles are equal DEB = 74° Angles on a straight line = 180° x = 180 – 59 – 74 = 47° Angles in a triangle = 180° but there is still a significant number of candidates who need to improve the layout of their work to ensure they get full credit for this type of question. Candidates should not assume that the 'angle C' is uniquely defined. The weaker candidates did not give many or any reasons in their working, and did not know how to communicate their understanding well. Few candidates did not write their angles on the diagram, and the majority were able to achieve at least 2 marks. Answer: 47°	
			Total	5		

Question			Answer/Indicative content	Marks	Part marks and guidance	
5			Use of 360° at point Or use of symmetry to halve 90°	B1	e.g. 360 – 90 seen or angles summing to 360 seen	implied by 270 seen
			[Angle in each polygon =] 135[°]	B1	or exterior angle is 45	
			Number of sides = 360 ÷ (180 – *their* 135)	B1	or identifying polygon has 8 sides or 180(n – 2) = 135n used	condone poor notation for division e.g. 45 ÷ 360 if intention clear

Question			Answer/Indicative content	Marks	Part marks and guidance	
			Octagon	B1	**Examiner's Comments** Some candidates showed clear and complete reasoning to reach the correct answer of octagon. Unfortunately many candidates just appeared to guess the name of a polygon and gave an answer such as hexagon or pentagon with no calculations or reasoning at all. Some candidates tried to justify an answer using a sketch, which often led to an incorrect answer such as triangle or trapezium, and even those that did lead to the correct answer of octagon seldom showed anything on their sketch that could be rewarded with any more than minimum credit. Those candidates who decided to work with angles usually subtracted the 90° angle in the square from 360° and reached 270° which was then divided by two to reach 135°. Having reached this interior angle of the polygon though, many did not then know how to find the number of sides and a number of trial and error methods were seen, which sometimes led to the correct answer.	All marks independent
			Total	4		

Question			Answer/Indicative content	Marks	Part marks and guidance	
6			∠BCD = 100°	B2	Or **B1** for two correct angles found	Angles may be indicated on diagram 100 marked on diagram can be one angle for B1, but for B2 must be identified as angle BCD.
			Correct relevant reason seen	M1	**Relevant reasons are:** alternate [angles] isosceles [triangle] Co-interior/allied [angles] … 180 [angles in] triangle [is/equals/adds to] 180 [angles on a straight] line [is/equals/adds to] 180	 Condone Z angle for alternate Condone C angle … 180 for co-interior Condone isos for isosceles Where 180 is required in reason, this may be seen in the relevant calculation

Question			Answer/Indicative content	Marks	Part marks and guidance	
			Two relevant reasons linked with correct angles **and** no reasons linked incorrectly with angles	A1	Any of the relevant angles must be correct if stated **A0** if any reason used incorrectly or angles stated incorrectly **Examiner's Comments** In this part, many candidates gained at least 2 marks for finding angle BCD = 100°. Although the question asked for reasons to be stated, a number of candidates gave no reasons at all. To gain full credit, as well as stating the correct value for BCD candidates needed to link relevant reasons using correct key words with the correct angles and not use any incorrect reasons. Many candidates did state at least one correct reason, although reasons were not always clearly linked with the correct angle and many included incorrect reasons such as corresponding angles rather than alternate angles. Reasons such as 'all angles add to 180°' are not acceptable and 'alternate segment' is not acceptable when 'alternate angles' is required. A number of candidates thought that triangle ABD was equilateral which led to no correct angles being found.	 Diagram shows relevant angles
			Total	4		

Question			Answer/Indicative content	Marks	Part marks and guidance		
7	a		360 ÷ 5 **and** 360 ÷ 6	M1	or for ((5 – 2) × 180) ÷ 5 oe **and** ((6 – 2) x 180) ÷ 6 oe	M1 allow 540 ÷ 5 and 720 ÷ 6 but not for just 108 and 120 Allow recovery of missing brackets from answers nfww for B1 do not allow if e.g. 60 is shown as int angle of hexagon	
			[Ext angle =] 72 **or** 60 seen	B1	or [Int angle =] 120 **or** 108 seen		
			60 + 72 [= 132] or 360 – (108 + 120) [=132]	A1	with no errors seen		

Examiner's Comments

This question assessed candidates' ability to explain their reasoning in the context of angles of polygons. There were many clear correct and concise answers to part (a) using either the exterior angles or interior angles of a hexagon and pentagon. As this was a 'Show that…' question it is very important that candidates show every step of their working clearly and without errors. A few showed values such as 60° and 72° and 108° and 120°, but did not show how these were obtained. Others showed the correct method but then made errors, for example, by marking the interior angles of the polygons as 60° and 72°.

Question			Answer/Indicative content	Marks	Part marks and guidance		
	b		[ext angle =] 180 – 132 oe or $\frac{180(n-2)}{n} = 132$ oe	M1	Or [Int angle =] ((7 – 2) × 180) ÷ 7 oe	M1 implied by 48 or 128 to 129	
			360 ÷ (180 – 132) oe soi Or for 360 ÷ 8 oe **and** 360 ÷ 7 oe Or for 48 × 7 **and** 48 × 8	M1	Or [Int angle =] ((8 – 2) × 180) ÷ 8 oe	M1 implied by 135 Division can be implied from a correct conclusion e.g. 360 is not a multiple of 48 gets M1A1 M1 Implied by 45 and 51 to 52	
			No and correct conclusion	A1		e.g. explains that 360 ÷ 48 gives non -integer answer or 128 is 7 sided polygon and 135 is 8 sided polygon so No	
					Examiner's Comments Part (b) proved to be more difficult for candidates and here there was more confusion about interior and exterior angles, with a number stating that the interior angle sum was 360°. There were a number of successful approaches		

Question			Answer/Indicative content	Marks	Part marks and guidance	
					including finding the exterior angle as 48° and showing that this was not a factor of 360° or calculating the interior angle of a 7-sided and 8-sided regular polygon and showing that 132 lay between these two values and so it was not possible.	
			Total	6		
8			8	5	**B3** for 20 and 36 **M1** for (36 – 20) ÷2 **OR** **M2** for 180 – (360 ÷18) soi by 160 or **M1** for 360 ÷18 soi 20 and **M2** for 180 – (360 ÷10) soi by 144 or M1 for 360 ÷10 soi 36	accept any correct method
					Examiner's Comments Candidates needed to work out the interior angles of both polygons. Many did in fact do this. However the angle required was half the difference of these angles.	
			Total	5		