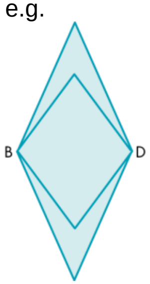
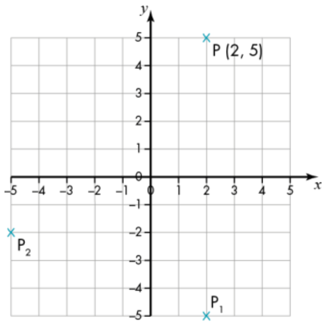
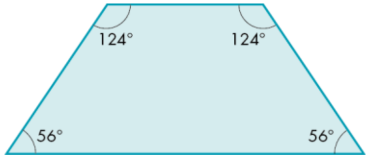
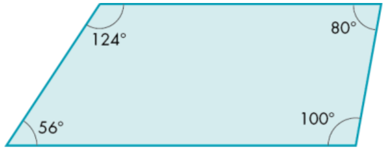
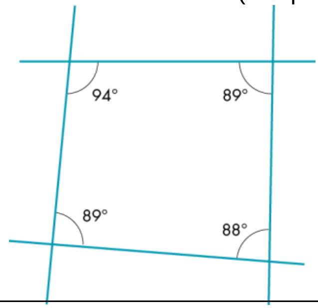
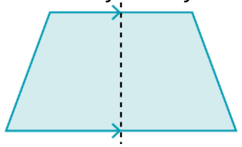
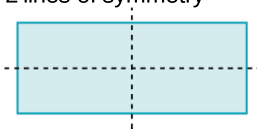
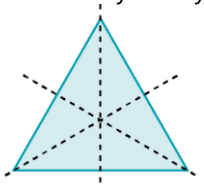
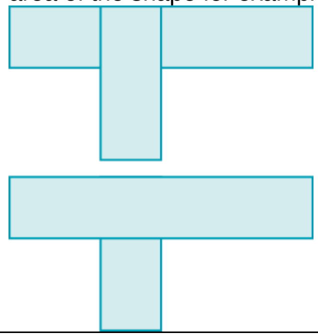
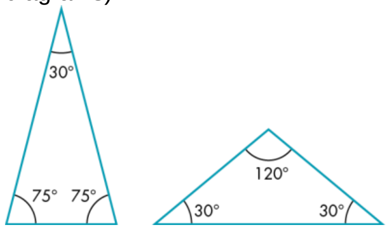
Guidance on the use of codes for this mark scheme	
M	Method mark
A	Accuracy mark
B	Mark awarded independent of method
C	Communication mark
P	Proof or process mark
cao	Correct answer only
oe	Or equivalent
ft	Follow through

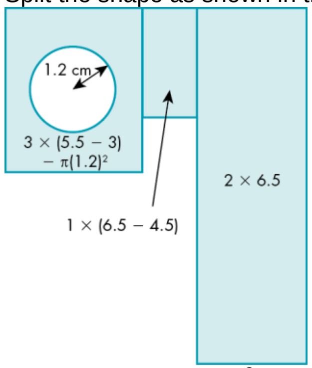
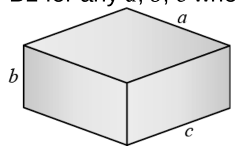
Question	Working	Answer	Mark	AO	Notes	Grade
1 a		$(b, -a)$	B1		B1 cao	B
b		$(-a, -b)$	B1		B1 cao	
c		$(-b, a)$	B1		B1 cao	
			3			
2		e.g. 	P3	3	P1 for correct reflection of small lengths P1 for correct reflection of large lengths P1 for complete correct diagram	B
			3			
3 a		(–5, –2)	P1 B1		P1 process of drawing a grid to assist B1 cao	B
b		$(-b, -a)$	B1		B1 cao	
			3			
4 a	(4, 3) → (–4, –3) in first reflection (–4, –3) → (–4, 3) in second	(–4, 3)	P1 B1		P1 finding first reflected point B1 cao	B
b		$(-a, b)$	B1		B1 cao	
			3			
5	Divide all points by 2 to give	(1, 1) (3, 1) (3, 2)	P1 B2	3	P1 for process of halving all points B2 if all three correct B1 if only two are correct	B
			3			

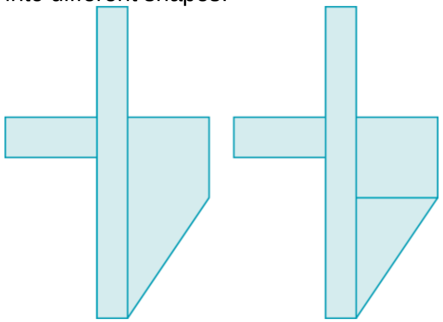
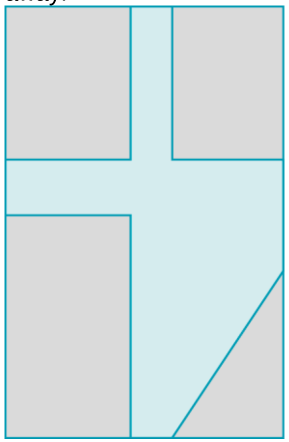
6 **a**		E.g. A rectangle is a special quadrilateral that has four right angles, and the opposite sides are of equal length. The mathematically important words are: quadrilateral, right angles, equal.	C1 C1	2	C1 for an accurate description C1 for suitable key words such as parallel, perpendicular, right angles, equal	B
b		Yes A square is a special type of rectangle, because it fits the definition in part **a**.	B1 C1		B1 for yes C1 for clear explanation	
c i		Two sides and two angles the same.	C1		C1 for a correct statement	
ii		All sides and angles the same.	C1		C1 for a correct statement	
iii		All sides and angles different.	C1		C1 for a correct statement	
			7			
7 **a i**		A kite has two pairs of equal adjacent sides.	C1	2 3	C1 for a correct statement.	B
ii		A parallelogram has opposite sides parallel and equal in length.	C1		C1 for a correct statement	
iii		A rhombus has four equal sides.	C1		C1 for a correct statement	
iv		A trapezium has a pair of opposite sides parallel. It is an Isosceles trapezium if the sides that are not parallel are equal in length and both angles coming from a parallel side are equal.	C1		C1 for a correct statement	
b		A rhombus has 4 equal sides with opposite sides parallel so this fits the definition of a parallelogram. Although opposite sides in a parallelogram must be equal, all four sides do not have to be equal so a parallelogram is not necessarily a rhombus.	C2		C1 for rhombus being parallelogram C1 for parallelogram not being rhombus	
c		There are two pairs of allied angles. Each pair adds up to 180°. So if you change the obtuse angle to acute, the other angle becomes obtuse.	C2		C1 for a correct statement C1 for use of diagrams to help	

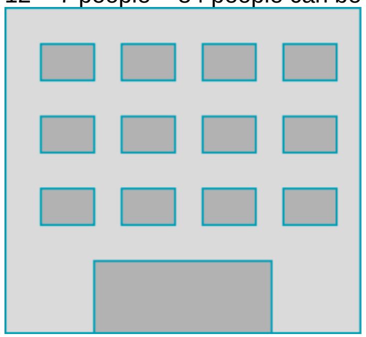
	d		Irregular (see example). If it was not irregular as one angle decreases the other would increase (see part **c**)	C2 **8**		C1 for a correct statement C1 for use of diagrams to help	
8	**a i**		Suitable sketch of a quadrilateral that has: 1 line of symmetry	B1	2	B1 for a correct shape	B
	ii		2 lines of symmetry	B1		B1 for a correct shape	
	iii		3 lines of symmetry	B1		B1 for a correct shape	
	iv		no lines of symmetry	B1		B1 for a correct shape	

	b		 1 line of symmetry – order 1 2 lines of symmetry – order 2 3 lines of symmetry – order 3 no lines of symmetry – order 1	B1 B1 B1 B1 **8**		B1 cao B1 cao B1 cao B1 cao	
9	a		Find the perimeter by adding up the distance around the edge. i.e. 10 + 2 + 5 + 3 + 2 + 3 + 3 + 2 = 30 cm	C2	2 3	C1 for clear explanation C1 for also showing it done	B
	b		Two different ways of working out the area of the shape for example: 	C2 **4**		C1 for first example. C1 for second example	
10	a	Length of side = x Then, using Pythagoras, $x^2 + x^2 = 20^2$ $2x^2 = 20^2$ $x = 20 \div \sqrt{2}$ = 14.142136 Perimeter = $4x$ = 56.568542	56.6 cm	M1 A1 M1 A1	3	M1 for using Pythagoras' theorem A1 for answer to at least 3 dp M1 for multiplying x by 4. A1 for answer to either 1 or 2 dp	B
	b		Side length x, so, using Pythagoras, $2x^2 = 8^2 = 64$ Area = x^2 = 64 ÷ 2 = 32 cm^2	P1 P1 **6**		P1 for process of using Pythagoras' theorem P1 for clear presentation showing given result	

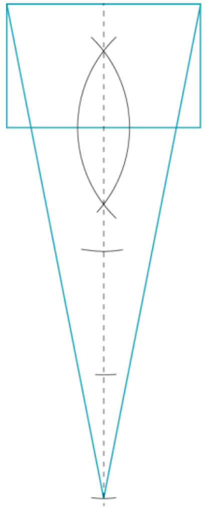
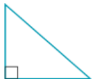
11 a		Stays the same – orientation, lengths and angles. Changes – the position on any grid.	C1 C1	2	C1 for a clear statement C1 for a clear statement	B
b		Stays the same – lengths and angles. Changes – the position on any grid, orientation.	C1 C1		C1 for a clear statement C1 for a clear statement	
c		Stays the same –lengths and angles. Changes – the position on any grid, orientation.	C1 C1 **6**		C1 for a clear statement C1 for a clear statement	
12		E.g. The trapezium has only one pair of opposite sides parallel, the parallelogram has two pairs of opposite sides parallel. The trapezium has rotational symmetry of order 1, the parallelogram has rotational symmetry of order 2.	C1 C1 **2**	2	C1 for a correct statement C1 for another correct statement	B
13		No. Need to know if it is the single angle or one of the repeated angles (see diagrams). 	B1 C1 **2**	2	B1 for no C1 for clear explanation	B
14		A is the only one with all the angles are the same/the only equilateral triangle. B is the only one with a right angle/the only right-angled triangle. C is the only scalene triangle.	C1 C1 C1 **3**	2	C1 for any possible reason C1 for any possible reason C1 for any possible reason	B

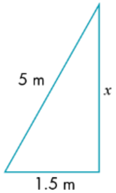
15	Split the shape as shown in the diagram.  Area = $3 \times 2.5 - \pi(1.2)^2 + 1 \times 2 + 2 \times 6.5$ = 7.5 - 4.52389 + 2 + 13 = 17.97611 cm^2	18.0 cm^2	P1 M1 A1 A1 **4**	3	P1 for process of splitting shape up M1 for method of finding area of each part A1 for answer to at least 3 dp A1 for answer to either 0, 1 or 2 dp	B
16 a		e.g. 1 cm × 1 cm × 24 cm 1 cm × 2 cm × 12 cm 2 cm × 3 cm × 4 cm	B3	2 3	B1 for each cuboid with a volume of 24 cm^3.	B
b		e.g. 2 cm × 3 cm × 4 cm	B1		B1 for any a, b, c where $2(ab + bc + ac) = 52$.  	
c		e.g. base 2 cm, height 12 cm base 4 cm, height 6 cm	B1 **5**		B1 for two lengths ad where $ab = 12$	
17	Using angles on a straight line: angle ADB = 180° – $2x$ Using angles in a triangle in triangle ADB: x + 34° + 180° – $2x$ = 180° –x + 34° = 0 x = 34° Using angles in a triangle in triangle BCD: $2x$ + 74° +angle BCD(A) = 180° angle BCD(A) = 180° – $2x$ – 74° = 180° – 68° – 74° = 38°	Angle BCA = 38°	P1 B1 P1 B1 **4**	2	P1 for finding x using angles in triangle and creating an equation B1 for x = 34° P1 for using angles in a triangle to find angle BCD B1 cao	B

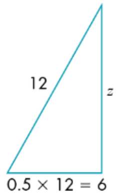
18		A is the only 6 sided shape/the only one with all sides the same shape. B is the only one not a prism/the only pyramid. C is the only one with a rectangular base.	C1 C1 C1 **3**	2	C1 for a valid reason C1 for a valid reason C1 for a valid reason	B
19		For example, split the compound shape into different shapes.  Work out the area of the large rectangle and subtract the areas that have been cut away. 	C1 C1 C1 **3**	3	C1 for first way C1 for another way using a different shape to the first C1 for a different way to the first two	**B**

20 **a**		False The missing lengths of the diagram have not been found to add on to the lengths given.	B1 C1	2	B1 for false C1 for clear explanation	B
b		False The parts have been assumed to have the same area, but they do not.	B1 C1 **4**		B1 for false C1 for clear explanation	
21	Based on the diagram 3 × 4 = 12 tables Room around length of tables is 20 – (4 × 3) = 8 m 8 m ÷ 5 gaps = 1.6 m which is more than 1.5 m Room around width of tables is 18 –(4 × 2) = 10 m 10 m ÷ 4 gaps = 2.5 m which is more than 1.5 m. So plenty of space around each table. 12 × 7 people = 84 people can be seated 	So based on the layout there would be enough seats.	P1 C1 C1 P1 B1 C1 **6**	3	P1 for process of looking for a suitable design and testing it C1 for a solution that works C1 for showing the solution works P1 for process of finding out number of people who can be seated B1 for correct number of people for the layout C1 for complete solution well explained Allow variations based on variations that fit with criteria, for example either side of stage	M
22		Height of cylinder and radius or diameter of cross section.	B1 B1 **2**	2	B1 for height B1 for radius	M

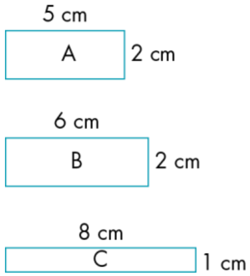
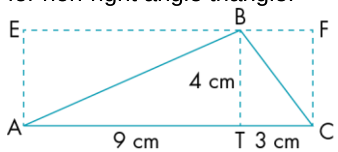
23 **a**	42° – 25°	17°	M1 A1	3	M1 method of subtracting A1 cao	M
b	$\frac{AB}{70} = \cos 25°$ AB = 70 × cos 25° = 63.441545	63.4 m	M1 A1		M1 correct trig statement A1 63.4 to either 0, 1 or 2 dp	
c	$\frac{CB}{70} = \sin 25°$ CB = 70 × sin 25° = 29.583278	29.6 m	M1 A1		M1 correct trig statement A1 63.4 to either 0, 1 or 2 dp	
d	$\frac{BD}{AB} = \tan 42°$ BD = AB × tan 42° = 57.123024 CD = BD – BC = 27.539745	27.5 m	M1 A1 P1 A1		M1 correct trig statement A1 63.4 to either 0, 1 or 2 dp P1 for process of subtracting A1 for 27.5 to either 0, 1 or 2 dp	
			10			
24 **a i**		80π m²: correct Area = $(8^2 \times \pi) + (4^2 \times \pi)$ = $64\pi + 16\pi = 80\pi$	C1	2 3	C1 for correct.	M
ii		208π m²: squared values on diagram multiplied by π and added	C1		C1 for valid reason	
iii		24π m²: multiplied radii by 2 instead of squaring them	C1		C1 for valid reason	
iv		48π m²: subtracting $4^2\pi$ from $8^2\pi$ instead of adding.	C1		C1 for valid reason	
			4			

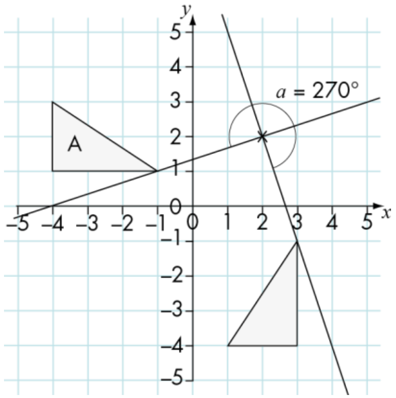
25			P1 P1 P1 P1 4	3	P1 for process of finding triangle with height 4 times greater than the rectangle P1 for constructing line bisector of base of rectangle P1 for stepping off 4 heights of rectangle P1 for completing correct triangle	M
26 a i		True 	C1	2	C1 for a clear diagram	M
ii		True 	C1		C1 for a clear diagram	
iii		False. Two obtuse angles will add up to more than 180° which is more than the sum of the angles in a triangle.	C1		C1 for clear explanation	
iv		True 	C1		C1 for a clear diagram	
v		False. Two right angles add up to 180° which is the sum of the angles in a triangle, so the third angle would have to be 0°.	C1		C1 for clear explanation	
b		If you draw a line between two parallel lines, the two allied angles formed add up to 180°, which gives nothing left for a third angle.	C1 C1 **7**		C1 for clear explanation C1 for clarity of the communication	

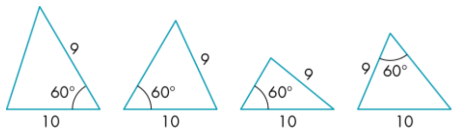
27 **a** **b**	$x = 180° - (90° + 15°)$ $= 180° - 105°$ Angle ACD = 15° Alternate angles BCD = 90° + 15°	 75° 105°	P1 A1 C1 P1 A1 **5**		P1 using angles in a triangle A1 cao C1 for recognition of alternate angles P1 for using angles in a triangle and adding A1 cao	M
28		Their interior angles are 120° and 3 × 120° = 360° This is the total of the angles around a point.	C1 **1**	2	C1 for a clear explanation	M
29	 Using Pythagoras $x^2 + 1.5^2 = 5^2$ $x^2 = 25 - 2.25$ $x = \sqrt{22.5} = 4.734165$	4.73 m	P1 M1 A1 A1 **5**	3	P1 for process of applying Pythagoras theorem M1 for correct Pythagoras statement A1 for $\sqrt{22.5}$ A1 for 4.73 correct to 2 or 3 dp	M
30 **a** **b**		Scale factor is 3 The side lengths of A are one-third the side lengths of C, so the scale factor will be $\frac{1}{3}$. Where the lines cross is the centre of enlargement, this point is (–18, 14)	B1 B1 C1 B1 **4**	2 3	B1 cao B1 for scale factor $\frac{1}{3}$ C1 for explaining the lines B1 for correct centre	M
31		The sum of the areas of the two smaller semicircles is equal to the area of the larger semicircle.	C1 **1**	2 3	C1 for a clear explanation	H
32		AC is 5 cm because, triangle ABC is a 5, 12, 13 special right-angled triangle. Triangle ACD is a right-angled triangle and a 3, 4, 5 triangle, giving DC the length 4.	C1 C1 **2**	2 3	C1 for explaining AC as being 5 cm C1 for completing the explanation for DC to be 4 cm	H

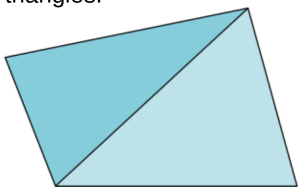
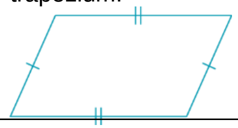
33	(Horizontal distance in air)^2 = $300^2 + 500^2$ = 340 000 Horizontal distance in air = $\sqrt{340\ 000}$ = 583.0952 m	583 m	P1 P1 A1 **3**	2	P1 for sorting one length by Pythagoras P1 for $\sqrt{340\ 000}$ A1 for answer correct to 1, 2 or 3 sf	H
34		Diameter 5 cm, height 13 cm Or Diameter 13 cm, height 5 cm	B1 B1 **2**	2	B1 for first correct set B1 for second correct set	H
35 a	$4x = 3(x + 3)$ $4x = 3x + 9$ $x = 9$ So perimeter of square is 4 × 9 = 36 cm	36 cm	P1 M1 A1	2 3	P1 for process of setting up equation M1 for $x = 9$ A1 cao	H
b	$y = \sqrt{9^2 + 9^2}$ $= \sqrt{162}$  $z^2 = 12^2 - 6^2$ $z^2 = 144 - 36 = 108$ $z = \sqrt{108}$	So y is greater	M1 A1 C1 M1 A1 B1 **9**		M1 for using Pythagoras' theorem A1 either surd form or answer C1 for creating suitable diagram to assist M1 for use of Pythagoras' theorem A1 for surd form or answer B1 cao provided evidence of calculation seen	
36		Each length is a multiple of 2.5, so by dividing by 2.5 we can see the ratio of all the sides. This gives us 3, 4, 5 and 6 The sides in the ratio 3, 4 and 5 will make a right-angled triangle, hence the one to be left out is the one that is 6 × 2.5 = 15 cm.	P1 C1 B1 **3**	2	P1 for process of finding ratio of sides C1 for explaining why the three chosen fit B1 for 15 cm provided explanation alongside	M
37		If all the shapes are congruent then they are identical in size, so they must have tessellated, all joining together and leaving no gaps.	C1 **1**	2	C1 for clear explanation	
38		Find the factor pairs of 60 to give 1 × 60, 2 × 30, 3 × 20, 4 × 15, 5 × 1, 6 × 10	P1 B1 **2**	3	P1 for process of looking for factor pairs B1 for all six stated	M

39	DE = 6 cm, CH = 7 cm, CG = 8 cm Side length of the square is 10 cm. Subtract area of triangles DEH, HCG, AEF and BFG from the area of the square. Area of DEH = 0.5 × 3 × 6 = 9 cm^2 Area of HCG = 0.5 × 7 × 8 = 28 cm^2 Area of AEF = 0.5 × 4 × 4 = 8 cm^2 Area of BFG = 0.5 × 2 × 6 = 6 cm^2 Area of square = 10 × 10 = 100 cm^2 So area of shaded shape = 100 – (9 + 28 + 8 + 6)= 100 – 51 = 49 cm^2	Area = 49 cm^2	P1 M1 M1 A1 **4**	3	P1 for process of finding missing lengths and marking them on diagram M1 for method of finding area of a triangle M1 for subtraction of areas A1 cao	M
40	The area of the garden is 6.5 × 4.8 = 31.2 m^2 The area of the small blue squares are 0.8^2 = 0.64 m^2 Four of them make one large blue square There are the equivalent of 12 small blue squares to be covered by topsoil. Area = 12 × 0.64 = 7.68 m^2 The volume of soil needed is 7.68 m^2 × 0.5 m = 3.84 m^3 Number of bags of topsoil needed = 3.84 ÷0.75 = 5.12 Assume she will need 5 bags. So will need about 5 bags Cost of topsoil = 5 × 73.30 = £366.50 4 slabs that cover 4 × 0.64 = 2.56 m^2 The grass needed is to cover 31.2 – (7.68 + 2.56) = 20.96 m^2 Use approximately 50 g per square metre. 50 g × 20.96 = 1048 g So assume 2 × 500g bags will be needed which will cost 2 × £19.99 = £39.98 Total cost will be £366.50 + £39.98 note no cost given for the paving stones.	£406.48	P1 P1 A1 A1 M1 A1 B1 B1 B1 P1 M1 A1 B1 A1 B1 C1 **16**	3	P1 for process of finding area of garden P1 for finding area of shaded squares A1 for 7.68 A1 for 3.84 M1 for dividing volume by 0.75 A1 for 5.12 B1 for stating 5 bags needed B1 for £366.50 B1 for 2.56 P1 for process of finding area of grass M1 for multiplying area by 50 A1 for 1048 B1 for stating 2 bags needed A1 for 39.98 B1 cao C1 for explaining that the stones are not included in the price.	M

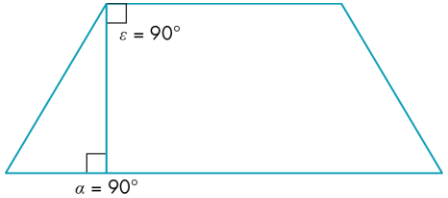
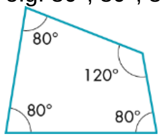
41		Sometimes An example of when not true and an example of when true Shape A: perimeter = 14 cm, area = 10 cm^2 Shape B: perimeter = 16 cm, area = 12 cm^2 Shape C: perimeter = 18 cm, area = 8 cm^2 Statement true for A and B, but false for B and C 	B1 B2 C1 **4**	2	B1 for sometimes B1 for example that shows it can be true B1 for example that shown it can be false C1 for clear communication of both	M
42		True Demonstration of proof of area triangle equal to half area of rectangle true also for non-right angle triangle.  Area of triangle ABT = half of AEBT = half of 36 cm^2 = 18 cm^2 Area of triangle CTB = half of CTBF = half of 12 cm^2 = 6 cm^2 Area of triangle ABC = 18 + 6 = 24 cm^2 $= \frac{1}{2} \times 4 \times 12$	B1 C1 C1 **3**	2 3	B1 for true C1 for clear explanation C1 for concise communication with clear diagrams	M

43		A rotation of 90°anticlockwise around point (2, 2)	P1 A1 A1 C1 **4**	3	P1 for a process of finding the centre of rotation. A1 for indicating 90° anticlockwise (or 270° clockwise) A1 for indicating centre of rotation as (2, 2) C1 for full, clear description providing all information needed	M
44	Area of front and back = 2 × 12 × 25 = 600 m^2 Area of sides = 2 × 12 × 12 = 288 m^2 Area of openings = 40 × 2 × 1 = 80 m^2 Total area to be painted = 600 + 288 – 80 = 808 m^2 With 2 coats of paint area = 2 × 808 = 1616 m^2 Number of litres of paint needed = 1616 ÷ 16 = 101 litres. Number of cans of paint = 101 ÷ 10 = 10.1 So 11 cans are needed. Cost of paint = 11 × £25 = £275 Assume painters work 5 days per week. Number of days = 2 × 5 = 10 Cost of painters = 10 × 3 × 120 = £3600 Total cost = £275 + £3600 + £500 = £4375 Add 10%: £4375 × 1.1 = £4812.50 Add 20% VAT: £4812.50 × 1.2 = £5775	The builder should charge the council £5775.	M1 M1 A1 M1 A1 M1 A1 M1 A1 A1 M1 M1 A1 C2 **14**	2 3	M1 for correct formula for area of rectangle M1 for correct method of finding total surface area A1 for 808 cao M1 for correct method of finding number of cans A1 for correct number of cans used M1 for method of finding cost of cans A1 for 275 cao M1 for method of calculating cost for two days A1 for 3600 cao A1 for 4375 cao M1 for correct calculation of 10% M1 for correct calculation of 20% A1 for correct total cost 5775 C1 for clear explanation marks with structure and technical use of language in explanation and C1 for stating any necessary assumptions	M

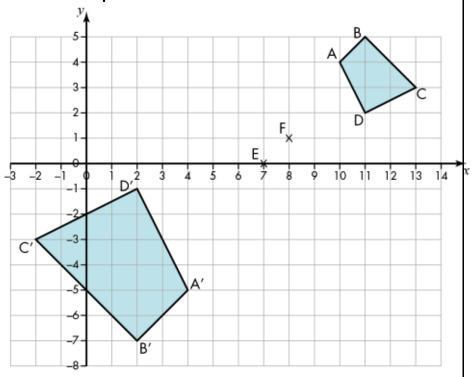
45	**a**	Area of face = 4^2 = 16 m^2 Area of circle = πr^2 Using π= 3.142, area = $\pi 1.2^2$ = 4.52448 m^2 Remaining surface area of front face = 16 – 4.52448 = 11.47552 m^2 Total remaining surface area: front and back = 2 × 11.47552 = 22.95104 m^2 Area of other four sides = 4 × 16 = 64 m^2 Total = 64 + 22.95104= 86.95104 m^2	87.0 m^2	M1 M1 A1 A1 A1 A1 A1	3	M1 for the correct method of finding area of a rectangle M1 for correct method of finding area of a circle A1 for correct area of circle A1 for correct area of face with circle A1 for correctly combining front and back A1 for correct area of the other 4 sides A1 for correct total area, rounded to 2 ,3 or 4 sf	M
	b	Volume of original cuboid = 4^3 = 64 m^3 Volume of cylinder = πrh = $\pi r^2 4$ = 4.52448 × 4 = 18.09792 m^3 Remaining volume = 64 – 18.09792 = 45.90208 m^3	45.9 m^3	M1 A1 M1 A1 A1		M1 for correct method for finding volume of cube A1 for 64 M1 for correct method for finding volume of cylinder A1 for a correct volume of cylinder (any rounding) A1 for correct total volume, rounded to 2,3 or 4 sf	
	c	Light blue paint = outside area ÷ coverage of 1 litre of paint = 87 ÷ 9 = 9.666 Surface area inside cylinder = $2\pi rh$ 2 × 3.142 × 1.2 × 4 =30.1632 m^2 30.1632 ÷ 9 = 3.3515	Light blue = 9.7 litres Dark blue = 3.4 litres	M1 A1 M1 A1 A1 **17**		M1 for dividing total outside surface by 9 A1 for correct answer rounded to 1,2,3 or 4 sf M1 for correct method of finding curved surface area A1 for a correct surface area (any rounding) A1 for correct answer to 2,3 or 4 sf	
46			Yes, he is correct This is one of the conditions for being able to draw a triangle	C1 **1**	2 3	C1 for clear communication that he is correct	M
47				B4 **4**	3	B1 for each different possible triangle shown and clearly labelled	M
48		Draw the locus. 	d The locus is none of these as it is a point.	B1 C1 C1 **3**	3	B1 for stating d is the only correct option C1 for a clear explanation of why C1 for clear communication using diagrams to illustrate answer	M

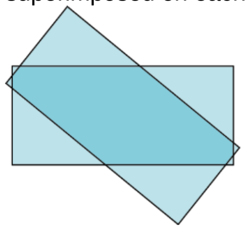
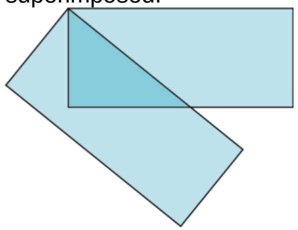
49	Angles in a in triangle add up to 180° You can split any quadrilateral into two triangles.  Therefore the interior angles of any quadrilateral = 2 × 180º		C1 C1 B1 **3**	2	C1 for clear explanation C1 for communication with clear diagram B1 for showing inter angles of quadrilateral = 2 × 180°	M
50		A line of symmetry has the same number of vertices on each side of the line so there is an even number of vertices and therefore an even number of sides.	C2 C1 **3**	2	C1 for line of symmetry and number of vertices link C1 for reference to even number of vertices o.e. C1 for use of diagram to illustrate answer	M
51 a **b** **c**		Suitable diagram, e.g.  Suitable diagram, e.g. as part **a** In a parallelogram opposite sides are equal. In a trapezium at least one set of opposite sides are parallel. Therefore every parallelogram is also a trapezium. 	B1 B1 B1 C1 **4**	2 3	B1 for a correct diagram B1 for a correct diagram B1 for a correct diagram of a parallelogram C1 for a correct explanation alongside the diagram	M
52		Always true For any polygon to go around the outside of the shape you must turn through 360° to get back to where you started. Therefore the external angles of every polygon sum to 360º.	B1 C1 P1 **3**	2	B1 for always true C1 for a satisfactory explanation P1 for use of diagram to illustrate answer	

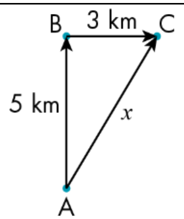
53	Ratio = 6 : 5 : 7 6 + 5 + 7 = 18 Sum of the angles in a triangle = 180° So 180° ÷ 18 = 10° Therefore the angles are: 6 × 10° = 60° 5 × 10° = 50° 7 × 10° = 70° Check 60° + 50° + 70° = 180°	60°, 50°, 70°	M1 C1 M1 B3 P1 **7**	2	M1 for summing parts of ratio C1 for clear statement regarding angle sum of triangle M1 for dividing 180° by 18 B1 for each correct angle found P1 for showing the checking of answer sum to 180°.	
54 a **b**		Interior angle of a equilateral triangle is 60° Interior angle of a square is 90° Interior angle of a regular hexagon is 60° All three are factors of 360º so these shapes will tessellate around a point. This is not true for other regular polygons as their interior angles are not factors of 360. Interior angle of a regular octagon is 135º Interior angle of a square is 90º Using a similar argument to part **a**: 2 × 135° + 90° = 270° + 90° = 360º	C1 C1 C1 C1 P1 **5**	2	C1 for clear explanation of all three shapes C1 for use of clear diagrams alongside the explanation C1 for clear explanation C1 for clear explanation P1 for use of clear diagrams alongside the explanation	
55		All three sides (SSS) Two sides and the included angle (SAS) Two sides and another side angle (SSA) Two angles and a side (ASA, or AAS)	B4 **4**	3	B1 for each correct statement	M

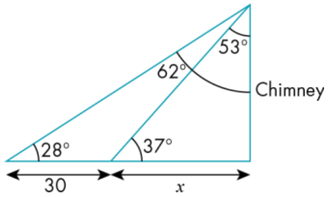
56 **a**		True In a parallelogram opposite sides are parallel. In a rhombus opposite sides are parallel and all sides are the same length. So a rhombus is a type of parallelogram. In a square all sides are the same length. So a rhombus with right angles must be a square.	B1 C1 C1	3	B1 for true C1 for clear explanation CB1 for clear explanation	M
b		True A rhombus must be a parallelogram (part **a**) but a parallelogram does not all sides the same length so it does not have to be a rhombus.  	B1 C1 P1		B1 for true C1 for clear explanation P1 for clear use of diagram alongside the explanation	
c		True Using the diagram of a trapezium above, you see each pair of angles are allied angles, each pair adding up to 180°, so each pair can only have a maximum of one acute angle, hence the whole shape can have no more than two acute angles.	B1 C1 P1		B1 for true C1 for clear explanation P1 for clear use of diagrams alongside the explanation	
d		True A quadrilateral can have three acute angles, e.g. 80°, 80°, 80° and 120°  	B1 C1 P1		B1 for true C1 for clear explanation alongside a clear diagram P1 for clear use of a correct diagram	
			12			

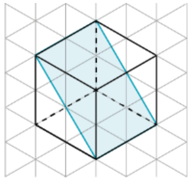
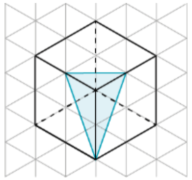
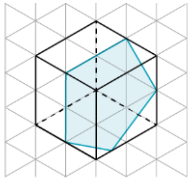
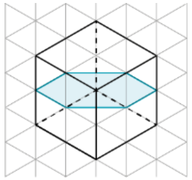
57		Look at what sides and/or angles you have been given and what you need to calculate. Use Pythagoras, theorem when you need to work out one side lengths and you know the other two side lengths. Otherwise use sine, cosine or tangent when you need to work out an angle or a side.	 C1 C1 **2**	3	 C1 for clear Pythagoras explanation C1 for clear right angled trig explanation	M
58 a i **ii** **b i** **ii**		A suitable simple reflection A mirror line that is parallel to one of the sides of the shape A suitable simple rotation A centre of rotation that is not on an extension of one of the sides of the shape.	B1 C1 B1 C1 **4**	2 3	B1 for a diagram of a simple reflection C1 for a clear explanation B1 for a diagram of a simple rotation C1 for a clear explanation	M

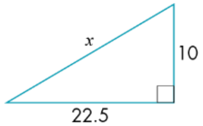
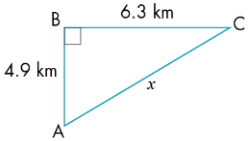
59 a		The lengths change as does the position of the shape The angles stay the same. For example 	C1 C1 C1	2	C1 for clear statement C1 for clear statement C1 for use of a clear example	B
b		Scale factor and centre of enlargement.	B1 B1		B1 cao B1 cao	
c		Find the centre of enlargement by choosing two points on the original shape and their image points. Draw straight lines joining these points on the original image and the corresponding points on the image. Where the lines cross is the centre of enlargement. Work out the scale factor found by dividing the length of a side on the image by the length of the corresponding side on the original shape. OR by dividing distance of a point on the image from the centre of enlargement by the distance of a corresponding point on the original shape from the centre of enlargement.	C1 C1 **7**		C1 for clear explanation C1 for clear explanation	

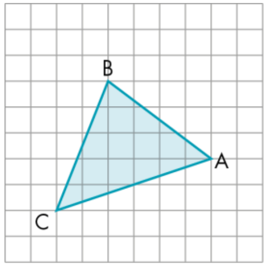
60 a		When a shape has been translated the orientation is the same. When it has been reflected its orientation is different.	C2 P1	2	C1 for comment about orientation staying the same in translation B1 for comment about orientation being different in rotation P1 for a clear diagram alongside the explanation	
b		Rotating a rectangle about its centre: all the vertices move and the shapes remain superimposed on each other. 	C1 P1		C1 for clear explanation P1 for good diagram alongside explanation	
		Rotating about one of its vertices: all the other vertices move and as the angle increases the shapes will no longer be superimposed. 	C1 P1		C1 for clear explanation P1 for use of diagram to illustrate explanation	
			7			
61	Cross-sectional area is a quarter of circle with radius 1.5 cm and a rectangle 1.5 cm by 6.5 cm Area of quarter circle = $\frac{1}{4}\pi 1.5^2$ = 1.7671459 cm^2 Area of rectangle 1.5 × 6.5 = 9.75 cm^2 Total area = 1.7671459 + 9.75 = 11.517146 cm^2 Total volume of wood =11.517146 × 12 000 = 138 205.75 cm^2 Convert this to m^2 by dividing by 1 000 000 = 0.13820575 m^2	138 000 cm^2 or 0.14 m^2	M1 A1 B1 B1 M1 A1	2 3	M1 for method of finding area of the quadrant A1 for any rounding to 4 or more sf B1 for 9.75 B1 for any rounding to 4 or more sf M1 for method of finding volume A1 for correct answer rounded to either 2 or 3 sf Accept alternative cubic metre answer given correctly to 2 or 3 sf	M
			6			

62 a		14 faces: the same as the number of polygons in the net.	B1 C1	2	B1 for the 14 faces C1 for clear explanation	
b	Triangle 11 will move round to sit next to face 13, square 4 will move round to be next to face 12, leaving face 2 opposite to face 13.	13	B1 C1 P1		B1 for face 13 C1 for clear explanation P1 for use of diagrams alongside the explanation	
c		I would create the shape first then draw what I see from above as the plan and from the side as the elevation. Once created, I can measure the lengths and angles concerned.	C2 **7**		C1 for an explanation of the plan C1 for explanation of elevations	
63	Circumference of wheel = πd = $\pi \times 68$ = 213.6283 cm 10 km = 10 × 1000 × 100 cm = 1 000 000 cm Number of revolutions = 1 000 000 cm ÷ 213.6283 cm = 4681.028	4681 complete rotations	M1 A1 B1 M1 A1 **5**	2	M1 for method of calculating circumference of wheel A1 for full unrounded answer B1 for use of 1 000 000 as a conversion factor either way round M1 for correct division with common units A1 for cao	M
64	 $x^2 = 5^2 + 3^2 = 34$ $x = \sqrt{34}$ = 5.8309519	x = 5.8 km	C1 C1 M1 M1 A1 **5**	2	C1 for use of a correct diagram C1 for explanation of how and why using Pythagoras' theorem M1 for correct application of Pythagoras' theorem M1 for correct method of finding hypotenuse A1 for correct rounding to 2 or 3 sf	M

65	 Let c = the height of the chimney $\frac{x}{c}$ = tan 53° $x = c$ tan 53° $\frac{30+x}{c}$ = tan 62° 30 + x = c tan 62° x = c tan 62° – 30 Combining equations to eliminate x: c tan 53° = c tan 62° – 30 Rearrange to get c on one side of the equation 30 = c tan 62° – c tan 53° 30 = c (tan 62° – tan 53°) $c = \frac{30+x}{c}$ 30/(tan 62° – tan 53°) = 54.182761 m	54.2 m	C1 M1 A1 M1 A1 M1 M1 A1 **8**	2	C1 for clear correct diagram used M1 for correct use of trig with x, c and angle 53° or 37° A1 for correct equation having x as subject M1 for correct use of trig with x, c and angle 62° or 28° A1 for correct equation in format to combine with first equation M1 for correctly eliminating x M1 for correct equation with c as subject A1 for correct answer rounding to 2 or 3 sf	M
66 a		It is always true	B1	2	B1 for always true	M
b		If you include the option of 1 × 1 × a then you can build a cuboid for any number of cubes. You can only make one cuboid for a prime number of cubes because this is the only option as the only factors of a prime number are 1 and itself	C1 C1	3	C1 for clear explanation C1 for clear explanation using primes	
c		You can make more than one cuboid if the individual number of cubes has more than 3 factors not including itself E.g. 30 (factors 1, 2, 3 and 5)	C1 C1 **5**		C1 for clear explanation for when more than 1 cuboid could be made C1 for use of examples to illustrate the explanations	

67 a		Yes 	B1 P1	2	B1 for yes P1 for clear diagram or explanation	M
b		Yes 	B1 P1		B1 for yes P1 for clear diagram or explanation	
c		Yes 	B1 P1		B1 for yes P1 for clear diagram or explanation	
		Yes 	B1 P1		B1 for yes P1 for clear diagram or explanation	
			8			
68	If cuboid has dimensions x, y and t The surface area = $2(xy + xt + yt)$ Volume = xyt Double the lengths gives dimensions as $2x$, $2y$ and $2t$ So surface area = $2(2x \times 2y + 2x \times 2t + 2y \times 2t)$ $= 2(4xy + 4xt + 4yt)$ $= 8(xy + xt + yt)$ Which is 4 times the first area And $V = 2x \times 2y \times 2t$ $= 8xyt$ which is 8 times the first volume.	False	B1 C1 C1 P1 C1 B1 C1 B1	2	B1 for false C1 for surface area with either specific lengths or a generalisation C1 for volume with either specific lengths or a generalisation P1 for showing correct follow through of double the lengths C1 for a correct statement of surface area with their data B1 for 4 times area C1 for a correct statement of volume with their data B1 for 8 times volume	H
			8			

69	 Consider just half the shape, where *x* is a length of string. Use Pythagoras $x^2 = 10^2 + 22.5^2 = 606.25$ $x = \sqrt{606.25}$ $= 24.622145$ Two lengths of string will be 49.244289 cm Subtract the original 45 cm Gives extension as 4.244289	4.2 cm	M1 M1 M1 A1 A1 A1 **6**	2	M1 for clear diagram M1 for correct statement using Pythagoras' theroem M1 for correct method of applying Pythagoras A1 for full answer A1 for double the initial *x* A1 for rounded answer of either 2 or 3 sf	H
70	Let AC = *x*, the new length of road.  Using Pythagoras $x^2 = 4.9^2 + 6.3^2 = 63.7$ $x = \sqrt{63.7}$ $= 7.981228$ Current distance = 4.9 + 6.3 = 11.2 km Saving = 11.2 – 7.981228 = 3.218772 km	3.22 km	C1 M1 M1 A1 B1 M1 A1 **7**	2	C1 for use of a diagram to assist the explanation M1 for clear statement of Pythagoras' theorem M1 for correctly applying Pythagoras' theorem A1 for full answer B1 for 11.2 M1 for subtracting lengths A1 for correct rounding to 2 or 3 sf	H

71		Yes $\theta = \sin^{-1}\frac{12}{15} = 53.13$ = 53° to the nearest degree. = 50° to 1 sf 12 cm has range of 11.5 cm to 12.5 cm 15 cm has range of 14.5 cm to 15.5 cm Smallest ratio for sine is $\frac{11.5}{15.5}$ $\sin^{-1} 0.7419$, $\theta = 47.9°$ Largest ration for sine is $\frac{12.5}{14.5}$ $\sin^{-1} 0.8621$, $\theta = 59.5°$ So there are values that round to 12 cm and 15 cm which will give an angle that rounds to 50°.	B1 P1 P1 B1 C1 **5**	2	B1 for yes P1 for showing that using trig and rounding can give 50° P1 for showing the ranges of lengths of the sides B1 for showing the least possible value of the angle given the ranges. C1 for final summary explaining that it is possible	H
72	$AB^2 = 2^2 - 1^2$ $= 4 - 1 = 3$ $AB = \sqrt{3}$	$\sqrt{3}$ cm	M1 A1 C1 **3**	2	M1 for correct statement of Pythagoras theorem A1 for 3 C1 for a clear communication of the method used	H
73		$\begin{pmatrix} 6 \\ 2 \end{pmatrix}$	B1 B1 **2**	2	B1 for correct diagram B1 for correct vector	H
74		No To work out the return vector, multiply each component by –1 The return vector is $\begin{pmatrix} 3 \\ -2 \end{pmatrix}$	B1 B1 C1 **3**	2	B1 for no B1 for a clear explanation of what Joel should have done. C1 for correct vector	H