mathemoeengtz0xxm

Markscheme

May 2022

Extended mathematics

On-screen examination

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The markscheme abbreviations:

• Bullet notation means award 1 mark - see example below



Error Carried Forward (ECF) marks

Errors made at any step of a solution affect all working that follows. In general, Error Carried Forward (ECF) marks are awarded after an error.

- a) ECF applies from one part of a question to a subsequent part of the question and also applies within the same part.
- b) If an answer resulting from **ECF** is inappropriate (*eg*, negative distances or sin*x* > 1) then subsequent marks should not be awarded.
- c) If a question is transformed by an error into a **simpler question** then **ECF** may not be fully awarded.
- d) To award ECF marks for a question part, there must be working present for that part.
- e) **ECF** is only applied to working which is correct. This means that all working subsequent to an error must be checked for accuracy.
- f) A misread (MR) is an error. ECF is normally awarded.

General points

- a) As this is an international examination, accept all **alternative forms of notation**, for example 1,9 as 1.9; 1,000 or 1.000. However, **DO NOT ACCEPT** incorrect mathematical notation x² for x² unless noted otherwise in the MS
- b) Accept notation errors in intermediate steps.
- c) Ignore further working after a correct answer **unless** it indicates a lack of mathematical understanding **i.e. if the further working contradict the correct answer**, then that last mark cannot be awarded.
- d) In the case when a correct result is obtained using incorrect seen method, do not award the mark for the result.
- e) Where candidates have written two solutions to a question, mark the first solution.
- f) In the markscheme, equivalent examples of numerical and algebraic forms or simplified answers will generally be written in the notes preceded by OE (Or

Equivalent) e.g.
$$\frac{1}{2}$$
 OR 1/2 OR 0.5 OR 2 ÷4 ; $\frac{x}{2}$ OR x / 2 or x ÷ 2 ; 0.23 OR 23%

- g) In the markscheme, information provided in brackets indicate detail that may be seen in a candidate response but is not necessary to award the marks.
- h) Special case marks **SC** can be allocated instead of but not in addition to the marks prescribed in the markscheme.
- i) Accept seeing equation not in-line.
- j) Calculator screenshots are accepted as working steps. And when a calculator screenshot is taken, accept not seeing the whole operation.
- k) In task 2 and 3 where the markscheme is set out in a table then, unless noted otherwise, awarding the highest mark in a category includes all the lower marks in that category. It is probably best to look for the top category mark answer and if you don't find it look at the next mark down.
- I) ACCEPT using the correct values regardless their previous result.
- m) Candidates will sometimes use methods other than those in the markscheme. Unless the question specifies a method, other correct methods should be marked in line with the markscheme. If in doubt, contact your team leader for advice.
- n) Unless noted otherwise, if a note in a part says to accept the answer without working for 1 mark less than total marks, then seeing the correct answer with any acceptable working step, award full marks. Example: If the note in a part worth 3 marks says "4.3(3...) without working award 2 marks", then seeing any acceptable working step and seeing 4.3(3...) as the answer award the 3 marks.

Q1	Answers	Notes	
	 .1 First and Second graph descriptions correct .2 First comparison (third and fourth graphs) both correct .3 Second comparison (fifth and sixth graphs) both correct .4 Third comparison (seventh and eighth graphs) both correct 	.1 #= Text/MCQ/Mini-Cloze Object Large v standard deviation #= Text/MCQ/Mini-Cloze Object Zero v standard deviation #= Text/MCQ/Mini-Cloze Object Different v mean Same v standard deviation #= Text/MCQ/Mini-Cloze Object Different v mean Same v standard deviation .3 Different v mean Different v standard deviation .4 #= Text/MCQ/Mini-Cloze Object Same v mean Different v standard deviation	4

Q2	Answers	Notes	Total
	$P(A) = \frac{18}{25}, P(A B)$	$=\frac{2}{3} \text{ and } P(A \cap B) = \frac{8}{25}$	
a	 .1 Correctly substitute into the conditional probability formula P(A B) = P(A∩B)/P(B) OR recognize that 8/25 is 2/3 of P(B) .2 Correct working step using their substitution into conditional probability formula OR correct calculations from 8/25 being the 2/3 of P(B). .3 Their correct answer after working steps using the conditional probability formula or the logic behind 8/25 being the 2/3 of P(B) 	.1 $\frac{2}{3} = \frac{8}{25} \div P(B) OE$ OR $\frac{8}{25}$ is $\frac{2}{3}$ of P(B) .2 (P(B)=) $\frac{8}{25} \div \frac{2}{3} OE$.3 (P(B)=) their $\frac{12}{25} OE$.3 ACCEPT only if their P is less than 1.	3
b	AM1 .1 Evidence of using the rule for independent events	AM1 .1 P(A \cap B)and P(A)×P(B) seen or $\frac{8}{25}$ and $\frac{18}{25}$ ×their $\frac{12}{25}$ seen OE	
	.2 Correctly calculate P(A) x theirP(B)	.2 their $\frac{216}{625}$ OE	
	.3 Correctly state their product does not equal to $P(A \cap B)$.3 their $\frac{216}{625} \neq \frac{8}{25}$ OE ACCEPT their $\frac{216}{625} \neq P(A \cap B)$.3 DO NOT ACCEPT if there is no calculated product	
	AM2 .1 Evidence of using P(A) and P(A B)	AM2 .1 $P(A) = P(A B)$ ACCEPT not seeing this step	3
	.2 $\frac{18}{25}$ and $\frac{2}{3}$ seen	.2 $\frac{18}{25}$ and $\frac{2}{3}$ seen	
	.3 Acknowledge that $\frac{18}{25}$ and $\frac{2}{3}$ are not equal	.3 $\frac{18}{25} \neq \frac{2}{3}$ or $\frac{18}{25}$ not equal to $\frac{2}{3}$ ACCEPT P(A) \neq P(A B)	
С			2

.1 Correctly substitute into the addition rule $P(A \cup B) = P(A) + P(B) - P(A \cap B)$	$.1 \frac{18}{25} + \text{their} \frac{12}{25} - \frac{8}{25}$
.2 Their correct answer after using addition rule	.2 their $\frac{22}{25}$ OE 2 ACCEPT only if their P is less than 1 or equal to 1

Q3		Answers	Notes	Total
	а	AM1 .1 Correctly substitute into Pythagoras .2 The correct value of AF	AM1 .1 $(AF =)\sqrt{10^2 - 5^2}$ or $AF^2 + 5^2 = 10^2$ OE .2 ACCEPT 8.7 or $\sqrt{75}$ or $5\sqrt{3}$.2 DO NOT ACCEPT 8.67 or 8.6 or 9 AM2	
		AM2 .1 Correctly substitute into trigonometric ratio OR sine rule OR cosine rule	1 $\tan 30 = \frac{5}{AF}$ or $(AF=)10x\cos 30$ or $(AF=)10\sin 60$ OE OR $\frac{AF}{\sin 120} = \frac{5}{\sin 30}$ or $\frac{AF}{\sin 60} = \frac{5}{\sin 30}$ OE OR $(AF^2=)5^2+5^2-2(5)(5)\cos 120$ OE or $(AF^2=)10^2+5^2-2(10)(5)\cos 60$ OE .1 ACCEPT $(AF=)2\times 5\cos 30$ or $(AF=)2\times 5\sin 60$ or $AE=4.33()$ or EF=4.33()	2
		.2 The correct value of AF	.2 (AF =) 8.66() ACCEPT 8.7 or $\sqrt{75}$ or $5\sqrt{3}$.2 DO NOT ACCEPT 8.67 or 8.6 or 9	



AM1 (Using proportions)	AM1	
.1 Their correct ratio using AC and theirAF seen or used	.1 $\frac{\text{theirAF}}{\text{AC}} = \frac{\text{their8.66}}{10}$ (= 0.866) or $\frac{\text{AC}}{\text{theirAF}} = \frac{10}{\text{their8.66}}$ (= 1.1547) OE	
.2 Correctly apply their ratio on AC	.2 10 × their1.1547 or $\frac{10}{\text{their0.866}}$	
	.2 DO NOT ACCEPT if their ratio is 2 or $\frac{1}{2}$	
.3 Their correct value for AB	.3 (AB =) their 11.547(005) ACCEPT 11.5 or 11.55	
AM2 (trigonometry using AC) .1 Correct angle ABC OR BAC seen or used	AM2 .1 (BAC=)30 OR (ABC=) 60	
.2 Correctly substitute their angle into trigonometric ratio	.2 sin their 60 = $\frac{10}{AB}$ or cos their 30 = $\frac{10}{AB}$ OE ACCEPT $\frac{10}{AB}$ or $\frac{10}{AB}$ OE	3
.3 Their correct value for AB	sin their60 cos their30 .3 (AB=) their11.547(005) ACCEPT 11.5 or 11.55	
AM3 (trigonometry FB and AF or Pythagoras AC)	АМЗ	
.1 Correct angle BCF OR CBF seen or used	.1 (BCF=)30 or (CBF=)60	
.2 Correctly substitute their angle into trigonometric ratio	.2 tan their $30 = \frac{BF}{5}$ OE or sin their $60 = \frac{5}{BC}$ OE or BC = $\frac{5}{\cos \text{ their } 30}$ OE .2 ACCEPT (BF=) 2.89 or 2.9 or (BC=) 5.77	
.3 Their correct answer for AB using theirBF added to theirAF or using Pythagoras with AC and theirBC.	.3 (their8.66 + their2.89 =) their11.547(005) ACCEPT 11.5 or 11.55	

Q4	Answers			Notes		Total
	 .1 One correct .2 A second correct .3 A third correct .4 The fourth and fifth correct 		а	b	с	
		<i>f</i> (<i>x</i>)	4	0.5	1	4
		g(x)	8		-3	
		1	1			

Q5	Answers	Notes	Total
a	Important note: Candidates may use a correct method but not listed below. Mark it in-line with any of these methods. If in doubt contact your team leader for advice.		
	AM1 (55 as an alternate interior angle)	AM1	
	 1 Correctly subtract 55 from 180 2 Subtract the sum of 125 and 140 from 360 	·1 180 – 55 or 125 ·2 360 – (125 + 140) ACCEPT 140 + 125 + 95 = 360	
	95 AG	.2 ACCEPT 360 – 265 only if .1 is awarded	
	AM2 (55 as an alternate interior angle) ·1 Correctly subtract 140 from 360 ·2 Subtract the difference of 180 and 55 from 220	AM2 ·1 360 – 140 or 220 ·2 220 – (180 – 55) or 220 –125	
	95 AG		
	AM3 (supplementary angle and alternate interior angle).1 Correctly subtract 140 from 180.2 Add 55 and 40	AM3 .1 180 – 140 or 40 .2 55 + 40	2
	95 AG		
	 AM4 (complementary angle and alternate interior angle) .1 Correctly subtract 55 from 90 .2 Correctly subtract the sum of 35, 90 and 140 from 360 95 AG 	AM4 .1 90 – 55 or 35 .2 360 – (35 + 90 + 140) ACCEPT 270 – (150 + 35) ACCEPT 360 – 265 only if .1 is awarded	
	AM5 (bearing of H from A) .1 Correctly determine bearing of H from A .2 Correctly subtract 140 from 235	AM5 (bearing of H from A) .1 180 + 55 = 235 DO NOT ACCEPT only seeing 235 .2 235 – 140	
	95 AG		

b	·1 Correctly substitute into cosine rule	$\cdot 1 (x^2 =)100^2 + 250^2 - 2 \times 100 \times 250 \times \cos 95$ OE	
	·2 Correctly calculate the square of BH	·2 76857(.787) ACCEPT not seeing this step	
	·3 Correctly square root their result	·3 their 277(.232)	3
c	·1 Correctly identify the shortest route	·1 HABDCH or HCDBAH	
		ACCEPT HBACDH or HDCABH	
			1



.3 Correctly substitute into cosine rule to get BD or AC	.3 (BD ² =)their277 ² + their277 ² – 2(their277)(their277)cos their122 or (AC ² =)100 ² + 100 ² – 2(100)(100)cos110
	ACCEPT use of 110 in .3 for their BHD or 55 for half BHD (BD ² =)their277 ² + their277 ² - 2(their277)(their277)cos110
OR	OR
Correctly substitute into a correct trig ratio to get half BD or half AC	$\sin 61 = \frac{\text{halfBD}}{\text{their277}}$ or $\sin 55 = \frac{\text{halfBD}}{\text{their277}}$ or $\sin 55 = \frac{\text{halfAC}}{100}$ OE
OR	OR
correctly substitute into sine rule to get BD or AC	$\frac{BD}{\sin 122} = \frac{\text{their}277}{\sin 29} \text{ or } \frac{BD}{\sin 110} = \frac{\text{their}277}{\sin 35} \text{ or } \frac{AC}{\sin 110} = \frac{100}{\sin 35} \text{ OE}$
.4 Correctly calculate their BD or AC	.4 (BD=) Their484.5(393178) or 453.81(02325) seen (AC=) 163.8(30) Correct .4 implies .3
.5 Correctly add their values for their route	. 5 Correct answer 1184.5 or 1185 (100+250+their484.5+250+100=) their1184.5 or their 1185 (100+250+their453.8+250+100=) their1153.8 or their 1154 (their 277+250+their163.8+250+their 277=) their1217.8 or their 1218 .5 ACCEPT values for their route in part c) even if route is incorrect .5 DO NOT ACCEPT if their route is incomplete (ex : doesn't end at H)

Q6		Answers	Notes	Total
	а	.1 Correct area for two from: square, circle or half mouth seen	.1 Two from: 20×20 or 400 , $7^2 \pi$ or $153.9()$ or 153.86 or 154 , $\frac{100}{2}$ or 50	
		.2 Correct area for third seen	.2 Third from: 20 × 20 or 400 , $7^2 \pi$ or 153.9() or 153.86 or 154, $\frac{100}{2}$ or 50	
		.3 Subtract, at least, their circle from their square	.3 their400 - their153.9() or their400 - their153.9() - their50 OE .3 ACCEPT only if .1 is awarded	
		.4 The correct answer before rounding	.4 196.06() or 196.1 ACCEPT using $\pi = 3.14$ and reaching 196.14 or 196.1 .4 ACCEPT seeing evidence of correct rounding in intermediate steps	
		AG 196	Examples: 400 - 154 - 50 = 196 if $153.9()$ is seen in their response 400 - 204 = 196 if $203.9()$ is seen in their response	
				4

b	AM1	AM1	
	.1 Correct length ratio	.1 $\frac{37.6}{4.7}$ or 8 or $\frac{1}{8}$ OE	
	.2 Correct area ratio	.2 $(\frac{1}{8^2} =)\frac{1}{64}$ OE or $(8^2 =)64$ OE ACCEPT $(\frac{37.6}{4.7})^2$	
	.3 The correct fraction after applying the area ratio	.3 $\frac{1184}{64}$ (= 18.5) or $\frac{37}{2}$ OE ACCEPT $64 \times 18.5 = 1184$	
	AG 18.5	.3 ACCEPT $\frac{1184}{(\frac{37.6}{4.7})^2}$	
	AM2	AM2	
	.1 Correct length ratio	.1 $\frac{37.6}{4.7}$ or 8 or $\frac{1}{8}$ OE	3
	.2 Correctly dividing areas	.2 $(\frac{1184}{18.5}) = (1184) = (\frac{18.5}{1184}) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) = (1184) $	
	.3 Correctly show that area ratio is the square of length ratio	.3 $64 = 8^2$ or $\frac{1}{64} = (\frac{1}{8})^2$ or 64 is square of 8 WTTE	
	AG 18.5	.3 ACCEPT ratio of area is the square of ratio of side or length ratio is the square root of area ratio WTTE	
		.3 DO NOT ACCEPT 64 is a multiple of 8	

С	AM1 (using equations)	AM1 (using equations) Note: only .3 and .4 are using their	
	.1 Correctly write the second equation	.1 $2x + 5y = 80$ ACCEPT using inequality	
	.2 Correct step towards solving the correct equations	.2 correct substitution: $2x + 5 \times \frac{x}{4} = 80$ or $2 \times 4y + 5y = 80$	
		OR correct coefficients for elimination. Example:	
		2x + 5y = 80 and $2x - 8y = 0$ or $8x + 20y = 320$ and $-5x + 20y = 0$	
		.2 DO NOT ACCEPT working with their equations from .1	
	.3 Correctly solve their equations for one unknown x OR y	.3 (x =) their $\frac{320}{13}$ or 24.61() OE OR (y =) their $\frac{80}{13}$ or 6.15() OE	
	.4 Correctly write their corresponding value of the other unknown satisfying one of their equations	.4 (x =)their $\frac{320}{13}$ or 24.61() OE OR (y =) their $\frac{80}{13}$ or 6.15() OE	
	.5 Correctly identify x=24 and y=6	.5 x = 24 and y = 6 or 24 small (triangles) and 6 big (triangles)	
	AM2 (using numbers)	AM2 (using numbers) Note: Only 1 and 4 are using their	5
	.1 Correctly calculate their area using their numbers of small and big triangles	$(2 \times \text{their} 24 + 5 \times \text{their} 6 =) \text{ their} 78$	
	.2 Correctly calculate the area using 24 small triangles and 6 big triangles	.2 $(2 \times 24 + 5 \times 6 =) = 78$	
	.3 Correctly calculate the area of painting left	.3 (80 – 78=) 2 (cm ²)	
	.4 Seeing their value of x is 4 times their value of y	.4 their24 is 4 times their6	
	.5 Correctly identify x=24 and y=6	.5 x = 24 and y = 6 or 24 small (triangles) and 6 big (triangles)	

Q7	Answers	Notes	Total
а	.1 Correctly substitute into Arithmetic Progression	.1 3.5 = 1.5 + 5d or $\frac{(3.5 - 1.5)}{5}$ OE	
	.2 The correct common difference	.2 0.4 OE	2
b	Correctly substitute their 0.4 AND 1.5 into the correct arithmetic sequence formula	(H _n =) 1.5 + their0.4(n–1) OE ACCEPT seeing u ₁ + their0.4(n–1) if u ₁ =1.5 is used in part c)	1
C	.1 Correctly substitute n = 12 in their H _n .2 Their correct answer	.1 (H ₅ =)1.5 + their0.4(12 –1) OE .2 their 5.9 (m) .2 ACCEPT only if their 5.9 is in the range]3.5 , 10]	2
d	 AM1 (solving for x) .1 Correctly set an equation in terms of x .2 Correctly rearrange the equation .3 The correct value for x before rounding down x=5 AG 	AM1 (solving for x) .1 3.5x + 1.5(x-1) + 2 × 2 = 30 OE ACCEPT using inequality .2 5x = 27.5 ACCEPT 5x + 2.5=30 ACCEPT using inequality .3 $(x = \frac{27.5}{5} =)5.5$	3

AM2 (using x=5)	AM2 (using x=5)
.1 Correctly set calculations for width	.1 Two from
	\rightarrow 5 × 3.5 OE
	\rightarrow 4×1.5 OE
	\rightarrow 2×2 OE or 30-2×2 OE
.2 Correctly calculate one of :	.2 One of the following is seen
ightarrow width of sections and gaps	\rightarrow (5×3.5+4×1.5+2×2=)27.5 ACCEPT width of sections and
	in-between gaps $(5 \times 3.5 + 4 \times 1.5 =)23.5$
→total width excluding gaps	$\rightarrow \qquad (30-4\times1.5-2\times2=)20$
\rightarrow the remaining distance	$\rightarrow \qquad (30-5\times3.5-4\times1.5-2\times2=)2.5$
3. Correct argument that $x = 5$ is the maximum possible in the	.3 A corresponding argument from:
width of 30	$\rightarrow \frac{27.5}{5} = 5.5$ or making calculations with x=6 and showing that total
	32.5 is more than 30
	$\rightarrow \qquad \frac{20}{3.5} = 5.7(1)$
	\rightarrow Recognise 2.5 remaining WTTE
	DO NOT ACCEPT $\frac{30}{6}$ =5



f	See table below	10

7f	(1 mark)	(2 marks)	(3 marks)	(4 marks)
Factors (F)	Two factors seen in factors box from:	Three factors seen in factors box from:	i	
	 number of seats in a row or in a section, number of sections, or width of section(s) number of tiers or height total number of seats or capacity of theatre width of theatre or space available gaps that must be left (either inbetween or at the ends) 	 number of seats in a row or in a section, number of sections, or width of section(s) number of tiers or height total number of seats or capacity of theatre width of theatre or space available gaps that must be left (either inbetween or at the ends) 		
	ACCEPT using values for any of the above ACCEPT WTTE DO NOT ACCEPT only 'number of seats' as a factor	ACCEPT using values for any of the above ACCEPT WTTE DO NOT ACCEPT only 'number of seats' as a factor		

Cal (C)	Correct calculations for their number of seats in a row or in a block	Correct calculations related to the total number of seats in the range [120,420]	Correct calculations for total number of seats in the range [330,360]	Correct calculations for a total number of 348 seats
	block Total seats per row: $5 \times 6 \text{ or } 30$ ACCEPT $348/12 = 29 \text{ OE}$ OR Total seats in one of their blocks Ex: $8 \times 6 \text{ or } 48$ $12 \times 6 \text{ or } 72$ OR Number of sections of seats: 348/6=58	[120,420] Total number of seats 30 multiplied by their number of tiers: Example: $30 \times 4=120$ OR Number of tiers: Their total number of seats divided by 30 Ex: 348/30=11.6 OR Number of blocks of seats: Their total number of seats divided by 6 times their number of tiers Ex: 348/78 (78=6 × 13) ACCEPT correct combinations using blocks for a total in the range [120,420] Ex: 5 × 24 = 120 ACCEPT listing number of seats per block for a total in the range [120,420] Ex: 48,48,48,48,24,24,24,24 DO NOT ACCEPT 29 × 12=348	[330,360] EITHER $11 \times 30 = 330$ OR $12 \times 30 = 360$ ACCEPT if they make further step and reach total number of seats in the range [330,360] Ex: $12 \times 30 - 10 = 350$ ACCEPT correct combinations using blocks for a total of 330 or 360 $66 \times 5=330$ or $72 \times 5=360$ OE ACCEPT listing number of seats per block only if total is 348 Ex: 48,48,48,48,48,24,24,24,24,12 ACCEPT if they make further step and reach total number of seats in the range [330,360] Ex: $12 \times 30 - 10 = 350$ OE	EITHER $11 \times 30 = 330$ then $330+3 \times 6=348$ OR $12 \times 30 = 360$ then $360 - 2 \times 6 = 348$ OR ACCEPT correct combinations using blocks for a total of 348 Ex: $72 \times 3 + 66 \times 2 = 348$ OE or $72 \times 4 + 60 = 348$ OE or $48 \times 5 + 24 \times 4 + 12 = 348$ OE DO NOT ACCEPT $29 \times 12=348$
			DO NOT ACCEPT 29 × 12=348	

Justify (J)	Weak justification Awareness of effect of constraints I made the best use (or didn't make the best use) of space within the	Good justification I made the best use (or didn't make the best use) of space within the constraint(s) WITE	
	ACCEPT for the constraints if they list at least one constraint	ACCEPT for the constraints if they list at least one constraint	
		I have blocks of different sizes that do not exceed 12 tiers WTTE (seen on canvas or in calculations)	
	DO NOT ACCEPT if C0 and D0 are awarded	DO NOT ACCEPT if C0 and D0 are awarded	
Design (D)	Two from: Gaps between sections ≥ 1.5 Gaps left and right ≥ 2 $330 \le Total$ number of seats ≤ 348 Tiers ≤ 12	The four of: Gaps between sections ≥ 1.5 Gaps left and right ≥ 2 $330 \le Total$ number of seats ≤ 348 Tiers ≤ 12	
	ACCEPT number of seats seen in response box different from number on canvas	ACCEPT number of seats seen in response box different from number on canvas A	
	ACCEPT error in the gaps up to 0.25m	CCEPT error in the gaps up to 0.25m	
	DO NOT ACCEPT if their total number of seats on canvas is less than 120		

For examples of marks for the design (D) scroll down

Accepted for D2

Gaps between sections \geq 1.5 AND Gaps left and right \geq 2 AND 330 \leq Total number of seats \leq 348 AND tiers \leq 12



Examples for accepted D1	Reason
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30	Gaps between sections ≥ 1.5 Gaps left and right ≥ 2 $330 \le Total$ number of seats ≤ 348
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30	Gaps between sections ≥ 1.5 tiers ≤ 12

Examples for accepted D1	Reason
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30	Gaps between sections ≥ 1.5 tiers ≤ 12
< → 30 m →	
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30	Gaps left and right ≥ 2
	tiers ≤ 12
30 11	

Examples for accepted D1	Reason
	Gaps between sections \geq 1.5
	tiers ≤ 12
30 m	
Examples for D0	Reason
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 3	Only
	tiers ≤ 12
30 m	

	Only Gaps left and right ≥ 2
30 m	
	Only Gaps between sections ≥1.5
	Note that the gap on the right is >2 but the gap on the left no. So not acceped
✓ 30 m	

	Answers		Notes	Total
8	a	.1 Correctly describe a second pattern in words .2 Correctly describe a second pattern in words	ACCEPT complete terminology only, for example (below are four different descriptions) (<i>T</i>) goes up by 4, increases by 4, moves up by 4, adds 4 They are odd numbers Linear with difference 4, arithmetic with difference 4, Constant difference 4 Second difference is zero DO NOT ACCEPT incomplete terminology, for example: Arithmetic, linear, increasing by a constant, constant difference, the odd numbers DO NOT ACCEPT the rule in words, for example: 4 times n then subtract 3 The difference between 4n and 3 DO NOT ACCEPT <i>n</i> goes up by 1 It is increasing general rules in terms of <i>n</i> , example: $T = 4n - 3$ More than two different patterns, all correct award (2 marks) Ex: adds 4 and Second difference is zero and it is 4 times <i>n</i> More than two different patterns, with any incorrect award (1 mark) Ex: adds 4 and Second difference is zero and it is 4 times <i>n</i>	2

b	 •1 The correct general rule •2 The correct simplified general rule with correct notation 		·1 $4n - 3$ or $T = 4^*n - 3$ or $u_n = 4n - 3$ or $t = 4n - 3$ or $T = 2n + 2n - 3$ or $T = 4x - 3$ ·2 $T = 4n - 3$ or $T_n = 4n - 3$ DO NOT ACCEPT description in words	
C	·1 Correctly substit ·2 Correctly calcula ·3 Recognize that is correct pattern. See Stage (n) 1 2 3 4 5 6	ute $n \ge 5$ into their general rule ate their value of <i>T</i> after substituting $n \ge 5$ their result is the same as when continuing the table below Number of triangles (<i>T</i>) 1 5 9 13 17 21	•1 Ex: $4 \times 5 - 3$ •2 Ex: 17 (for the <i>n</i> = 5) •3 Same as value I predicted in table (and we find the candidate has 17 in the table for <i>n</i> = 5) OR same as when we continue the pattern and explains how 17 is obtained from pattern of adding 4 to 13 •3 ACCEPT seeing the 17 in the table and seeing their calculated <i>T</i> = 17 when <i>n</i> = 5	3
d	621AM1·1 Correctly substitute into trig ratio OR correctly substitute 4 and 8 into Pythagoras OR Correctly recognize ratio of 30-60-90 triangle of 1: $\sqrt{3}$: 2.·2 Correctly calculate height of triangle <i>h</i> ·3 Correctly substitute values in area of triangle formula OR Correctly calculate area of triangle using decimals AND show that $16\sqrt{3}$ equals the same, using decimals. $16\sqrt{3}$ AG		AM1 .1 $\sin 60 = \frac{h}{8}$ OR $\cos 30 = \frac{h}{8}$ OR $h = \sqrt{8^2 - 4^2}$ ACCEPT $\tan 60 = \frac{h}{4}$ Accept not seeing this step. .2 $\frac{8\sqrt{3}}{2}$ or 6.93 OE ACCEPT $8\sin 60$.3 $\frac{1}{2} \times 8 \times \frac{8\sqrt{3}}{2}$ OE OR Both (A=) 27.71(281) AND $16\sqrt{3} = 27.71(281)$	3

		AM2 using $\frac{1}{2}$ ab sinC	AM2 using $\frac{1}{2}$ ab sinC	
		.1 Correctly substitute into the area of triangle formula using sin	.1 $(A=)\frac{1}{2} \times 8 \times 8 \times \sin 60$	
		.2 Correctly calculate area of triangle .3 Show that $16\sqrt{3}$ equals the same	.2 (A=) 27.71(28) .3 $16\sqrt{3} = 27.71(28)$	
		$16\sqrt{3}$	Showing $16\sqrt{3}$ using other values in the table or using the geometric progression, award 0 marks.	
8	е	Scroll down for the marking grid		23

Mark		1		2			3	4	5
Predict ions (P)	Co on OF two	orrectly predict e value for A R o value for <i>L</i>		Correctly predict two values for <i>A</i> OR one value for <i>A</i> and values for <i>L</i>	d two	Correctly pr two values f AND two values f	edict for A for L		
		Stage (n)	Side length of outer triangle (L)	Area (A)	Are	a (A)			
		1	1	$\frac{\sqrt{3}}{4}$	0.4330)127019	_		
		2	2	√3	1.732	050808			
		3	4	4√3	6.928	320323	_		
		4	8	16√3	27.71	281292	_		
		5	16	64√3	110.8	512517			
		6	32	256√3	443.4	050067			
		7	64	1024√3	1773.	620027			
		8	128	4096√3	7094.	480108			

Descri ption	Correctly describe a pattern in words (for <i>L or A</i>)	Correctly describe a pattern in words for <i>L</i> and for A	Correctly describe a pattern in words for <i>L</i> and	Correctly describe a pattern in words (for L or A) and correctly write down the	Correctly describe a pattern in words for <i>L</i> and for <i>A</i>
(D)	Examples for <i>L</i> : Value doubles WTTE	See patterns in D1	down general rule for <i>L</i> in terms of <i>n</i>	general rule for L	AND
	The difference doubles Increasing by multiplying by 2	OR		OR	Correctly write down the general rule for A in terms of
	All even except 1 It is exponential or geometric Add 1 then add 2 then add	Correctly describe a pattern in words (for <i>L</i> or <i>A</i>)	OR	Correctly describe a pattern in words (for <i>L</i> or <i>A</i>) and valid	n
	4,etc OE	and valid attempt to write down general rule for <i>L</i> in terms of <i>n</i>	Correctly write down the general rule for <i>L</i> in terms of <i>n</i> $L = 2^{n-1}$	general rule for A in terms of	
	DO NOT ACCEPT L is increasing		CR	OR	
	Examples for A :			Correctly write down the	
	Value quadruples WTTE The difference quadruples It is exponential or geometric		Valid attempt to write down general rule for <i>A</i> in terms of <i>n</i>	general rule for A in terms of n	
	All multiples of $\sqrt{3}$		Examples:	$A = 2^{2n-4}\sqrt{3}$ or	
	DO NOT ACCEPT A is increasing <i>n</i> goes up by 1		seeing in their rule 4 ⁿ added or multiplied by something	$A = \frac{4^n}{16}\sqrt{3} \qquad \text{or}$	
	$\sqrt{3}$ is always there		$4^n \times \sqrt{3}$		
	Length squared times $\sqrt{3}$ There is a common ratio		$A = \frac{1}{2} \times 2^n \times 2^n \times \frac{\sqrt{3}}{2}$	$A = 4^{n-1} \frac{\sqrt{3}}{4}$ or	
	OR		$A = \sqrt{3L}$ $A = u_1 \times 4^{n-1}$	$A = 4$ $\sqrt{3}$	
	Valid attempt to write down general rule for <i>L</i> in terms of n				
	Ex.: $L = 2^n$ DO NOT ACCEPT L=2n				
	Ignore additional incorrect patterns	Ignore additional incorrect patterns	Ignore additional incorrect patterns	Ignore additional incorrect patterns	Ignore additional incorrect patterns
	(for Notation see N)	(for Notation see N)	(for Notation see N)	(for Notation see N)	(for Notation see N)

Testin	Attempt to test their general	Correctly test their general		
a		rule for A only in terms of n		
(Ť)	rule for A using $n \le 4$	using $n < A$		
(1)				
	Correctly substitute in their	Correctly coloulate their		
	general rule for A value of $n \le 4$			
	2 7	value for A in their		
	OR	general rule using		
		<i>n</i> ≤ 4		
	Correctly test their general rule			
	for L or described pattern or	AND		
	recursive rule	Recognize that their		
		correctly calculated value		
	OR	for A is the same as the		
		given value.		
	Correctly test their rule for A or			
	described pattern or recursive			
	rule			
	ACCEPT testing their general	ACCEPT seeing their		
	rule for A in terms of L	correctly calculated value for		
		A and the given value in the		
		table being equal		
Verifyi	Attempt to verify their general	Correctly calculate their	Correctly calculate their	
ng	rule for A using $n \ge 5$	value for A in their general	value for Ain their general	
(V)	Ex:	rule only in terms of n using	rule only interms of nusing	
	correctly substitute in their	their $n \ge 5$	$n \ge 5$	
	general rule value of <i>n</i> ≥ 5		AND	
			Recognize that their	
	OR		correctly calculated value	
			for A is the same as their	
	Correctly verify their described		predicted value obtained by	
	pattern or their rule (e.g.		continuing the pattern	
	recursive rule)			
	ACCEPT verifying their rule for		ACCEPT seeing their	
	A in terms of <i>L</i>		correctly calculated value for	
			A and their predicted value in	
			the table being equal	

Jı	ustify/pr oof (J)	Attempt to justify a correct described pattern or their general rule	Correctly justify the general rule for A in relation to geometry in terms of L or height of triangle (h)	Attempt to justify the general rule for <i>A</i> in relation to geometry in terms of <i>n</i>	Correctly justify the correct general rule for <i>A</i> geometrically in terms of <i>n</i>	
		Substitute at least two other values of <i>n</i> in <i>A</i> and say they are the same or the rule works OR Seeing $A = 0.5 \times L \times h$ OE DO NOT ACCEPT	$A = \frac{1}{2}L \times L \times \frac{\sqrt{3}}{2}$ or $A = 0.5 \times L \times L \times \sin 60 \text{ OE}$ or $A = 0.5 \times 2^{n-1} \times h$	Examples using area of triangle but including errors : $\frac{2^{n-1} \times 2^{n-1} \sqrt{3}}{2}$ $\frac{2^{n-2} \times 2^{n-2} \sqrt{3}}{2}$ $2^n \times 2^n \sqrt{3}$	Using the area of a triangle $A = \frac{B \times h}{2} \text{ or } \frac{a \times b \times \sin C}{2}$ $\frac{2^{n-1} \times 2^{n-2} \sqrt{3}}{2}$ or	
		OR	OR	$\frac{2 \times 2 \sqrt{3}}{2}$	$\frac{2^{n-1}\times 2^{n-1}\times \frac{\sqrt{2}}{2}}{2}$	
		Recognize it is geometric progression and define first term $\frac{\sqrt{3}}{4}$ or ratio 4, WTTE	Recognize it is geometric progression and define first term $\frac{\sqrt{3}}{4}$ and ratio 4, WTTE	ACCEPT seeing the justification inside their work and not separate at the end	ACCEPT seeing the justification inside their work and not separate at the end	
		DO NOT ACCEPT if D1 not achieved	DO NOT ACCEPT if D3 not achieved	DO NOT ACCEPT if D3 not achieved	DO NOT ACCEPT if D4 not achieved	

Communication criteria

Mark	1	2	3	
	Correct notation of their general rule	Correct notation of the general rule for <i>L</i> or <i>A</i>	Correct notation of the general rule for A	
	OR	OR	AND	
	Correct terminology describing a pattern	The notation of <u>the general</u> rule for <i>L</i> or <i>A</i> includes errors AND Correct terminology describing a pattern in words	Correct terminology describing pattern in words for <i>A</i>	
	DO NOT ACCEPT if they don't have any rules	DO NOT ACCEPT if they don't have the general rule	DO NOT ACCEPT if they don't have the general rule for A	
	and they don't describe any patterns correct	For notation of the general rule for <i>L</i> , $L = 2^{n-1}$	For notation of the general rule for A $A = 4^{(n-2)}\sqrt{3}$ or $A = 4^{(n-2)} \times \sqrt{3}$	
Notation and terminology (N)		ACCEPT using <i>Un</i> instead of L only if they mention that $L = U_n$ ACCEPT non simplified rules ex: $L = \frac{2^n}{2}$ OE	ACCEPT using <i>Un</i> instead of A only if they mention that $A = U_n$ ACCEPT non simplified rules ex: $A = \frac{1}{2} \times 2^{2n-2} \times \frac{\sqrt{3}}{2}$ or $A = 4^{n-1} \frac{\sqrt{3}}{4}$ OE	
		DO NOT ACCEPT Using * for multiplication Using / for division Using ^ for power Using x instead of n "the rule for L is:" instead of " L ="	DO NOT ACCEPT The Using * for multiplication Using / for division Using ^ for power Using x instead of <i>n</i> "the rule for <i>A</i> is:" instead of " <i>A</i> ="	

Continued on next page

Mark	1	2	3
Communication			DO NOT ACCEPT if D4 not awarded
(L)	At least three from the following items	At least four of the following items are seen:	At least four of the following items are seen:
	are seen:	· describe a pattern in words (for L or A)	· describe a pattern in words
Organisation and	· describe a pattern in words	write a general rule (for L or A)	· write the general rule for A
coherence	· write a rule	\cdot test their general rule (for L or A)	· test the general rule for A
	· test their general rule or rule or recursive	\cdot verify their general rule (for L or A)	· verify the general rule for A
Can be awarded	rule or pattern	· justify their general rule (for L or A)	· justify the general rule for A
even if there are	· verify their general rule or rule or recursive		
errors in their	rule or pattern		
descriptions	· justify their general rule or rule or recursive	AND	AND
and working.	rule or pattern	For coherence, they identify the processes	For coherence, they identify the processes
		correctly. At least one from the following:	correctly. At least two from the following:
Different items		· test	· test
can be		· verify	· verify
considered		·justity	·justify
seen (or		_	F
identified for		EX:	EX:
coherence) if		\rightarrow FOR test:	\rightarrow FOR test:
they include		they say test and they test using value(s) of	they say test and they test using value(s) of
errors but not if			
awarded 0		S For vorify:	Eor vorify:
marks		they say "verify" and they verify using value(s) of	\rightarrow 1 of verify. they say "verify" and they verify using value(s) of
		n>5 only	n>5 only
			neo only
		\rightarrow For test and for verify:	\rightarrow For test and for verify:
		they say 'test and verify' and they test using	they say 'test and verify' and they test using
		value(s) of <i>n</i> ≤4 and then verify using	value(s) of <i>n</i> ≤4 and then verify using
		value(s) of <i>n</i> ≥5	value(s) of <i>n</i> ≥5
		\rightarrow For justify:	\rightarrow For justify:
		they say "justify" or "my rule works because" WTTE	they say "justify" or "my rule works because"
		and their justification is seen	WTTE and their justification is seen
		\rightarrow For justify:	\rightarrow For justify:
		they substitute at least two values of <i>n</i> and say "the	they substitute at least two values of <i>n</i> and say
		rule justified or "it works" WITE	"the rule justified" or "it works" WITE
		\rightarrow For justify:	\rightarrow For justify:
1		I hey justify the general rule for A geometrically	I ney justify the general rule for A geometrically