Markscheme

May 2022

Mathematics

On-screen examination

The markscheme notation:

• Bullet notation means award 1 mark – see example below

Example 1
.1 mark awarded and corresponding notes are aligned

b	.1 Show clear line of reasoning in the method .2 4	.1 45 and 49 seen **OE** *Ex:* $49 = 45 + x$ .2	**2**

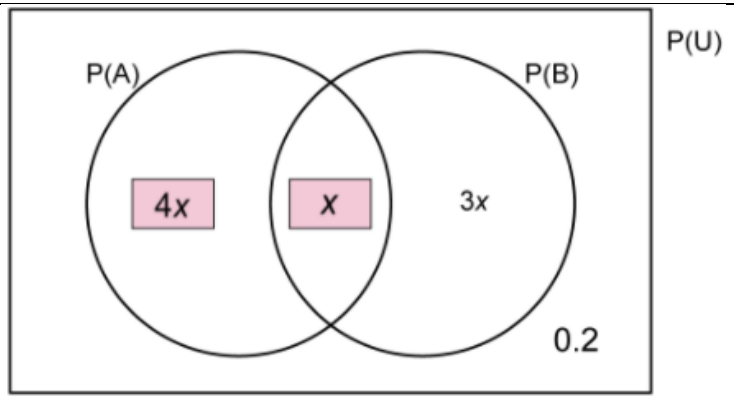
Error Carried Forward (ECF) marks

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 x^2 for x^2 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** $2 \div 4$ **;** $\frac{x}{2}$ **OR** $x / 2$ or $x \div 2$; 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.
l) 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	Total
a	Correctly place $4x$ and x		**1**
b	The correct answer	$(1-0.2=)0.8$	**1**
c	**AM1** .1 Correct equation .2 Divide their0.8 by 8 .3 The correct answer **AM2** .1 Correctly write a value for $4x$ and $3x$ .2 Subtract 0.7 from their0.8 .3 The correct answer	**AM1** .1 $4x+x+3x=$ their0.8 in part b) or $4x+x+3x+0.2=1$ .2 $\frac{\text{their0.8}}{8}$ .3 0.1 **AM2** .1 0.4 and 0.3 seen .2 their0.8 $-(0.4+0.3)$ .3 0.1	**3**

d	.1 The correct answer .2 The correct reason corresponding to .1 answer and their answer in part c)	.1 Not mutually exclusive ACCEPT They are not .1 ACCEPT they are inclusive .1 ACCEPT "No" only if it is part of a sentence .2 We see their0.1 in this part or in part c) AND we see one of the following reasons → $P(A \cap B) =$ their0.1 → $P(A \cap B) \neq 0$ → they both have x in common → intersection greater than 0 WTTE DO NOT ACCEPT if their0.1 is in terms of x DO NOT ACCEPT if part c) is 0 DO NOT ACCEPT if .1 is not awarded	**2**

Q2		Answers	Notes	Total
	a	**AM1** .1 Correctly substitute into Pythagoras .2 The correct value of AF **AM2** .1 Correctly substitute into trigonometric ratio OR sine rule .2 The correct value of AF	**AM1** .1 $(AF=)\sqrt{10^2-5^2}$ or $AF^2+5^2=10^2$ OE .2 $(AF=)8.66(...)$ ACCEPT 8.7 or 9 or $\sqrt{75}$ or $5\sqrt{3}$ .2 DO NOT ACCEPT 8.67 or 8.6 **AM2** .1 $\tan 30=\frac{5}{AF}$ or $\sin 60=\frac{AF}{10}$ or $\cos 30=\frac{AF}{10}$ OR $\frac{AF}{\sin 60}=\frac{5}{\sin 30}$ 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 $(AF=)8.66(...)$ ACCEPT 8.7 or 9 or $\sqrt{75}$ or $5\sqrt{3}$ .2 DO NOT ACCEPT 8.67 or 8.6	**2**

	b	**AM1 (AA or SAS)** .1 A correct reason for a pair of congruent angles .2 A correct reason for another pair of congruent angles (AA) OR The pair of congruent angles are in-between two pairs of proportional sides (SAS) **Continued on next page**	**AM1 (AA or SAS)** **Examples of correct reasons for pair of congruent angles:** → Angle EAD = Angle FAC or Angle A is common angle or same angle A WTTE. (They have to mention the angle A). ACCEPT angle A = angle A → Angle AED = Angle AFC or both right angle triangles or they both have a 90 degrees angle WTTE. ACCEPT both triangles are 30,90,60 WTTE → DE parallel to CF so Angle ADE= Angle ACF or FC is half AC so angle A=30 hence Angle ADE= Angle ACF=60 DO NOT ACCEPT they share same angle or they have a common angle DO NOT ACCEPT Angle EAD and FAC are similar DO NOT ACCEPT seeing only Angle ADE= Angle ACF without correct reasoning **Examples of correct reasons for congruent angles are in-between proportional sides:** → <u>If .1 awarded for Common angle A:</u> $\frac{AC}{AD} = \frac{10}{5} = 2$ and since ADF isosceles and DE perpendicular to AF so $\frac{AF}{AE} = 2$ (or by Thales, AD half AC and DE parallel to CF) **Continued on next page**	**2**

			→ <u>If .1 awarded for angle AED= angle AFC</u> Any two from: $\frac{AC}{AD}=\frac{10}{5}=2$ Angle A=30 so DE=2.5, so $\frac{FC}{DE}=\frac{5}{2.5}=2$ since ADF isosceles and DE perpendicular to AF so $\frac{AF}{AE}=2$ (or by Thales, AD half AC and DE parallel to CF) ACCEPT $\frac{AF}{AE}=\frac{8.66(...)}{4.33(...)}=2$ only if they calculated AE here or in part a) using trigonometry($5\cos 30$ OE)	
		AM2 (SSS) .1 Correctly state reasons for two pairs of corresponding sides being proportional .2 Correctly state reason for third pair of corresponding sides being proportional	**AM2 (SSS)** .1 Two from the reasons below .2 The third from the reasons below (first pair) $\frac{AC}{AD}=\frac{10}{5}=2$ (second pair) Angle A=30 so DE=2.5, so $\frac{FC}{DE}=\frac{5}{2.5}=2$ (third pair) since ADF isosceles and DE perpendicular to AF so $\frac{AF}{AE}=2$ (or by Thales, AD half AC and DE parallel to CF) ACCEPT $\frac{AF}{AE}=\frac{8.66(...)}{4.33(...)}=2$ only if they calculated AE here or in part a) using trigonometry($5\cos 30$ OE)	

	c	**AM1 (Using AF)** .1 The correct ratio seen or used .2 Correctly apply their ratio on their AF .3 The correct value of AE **AM2 (using DE)** .1 Correctly calculate DE .2 Correctly substitute their DE into Pythagoras .3 The correct value of AE **AM 3 next page**	**AM1 (Using AF)** .1 (ratio) 2 or 0.5 OE .2 $\frac{AE}{\text{their}AF} = \frac{1}{2}$ OE .3 (AE =) 4.3(3…) or $\frac{\sqrt{75}}{2}$ OE .3 ACCEPT 4.35 when using $\frac{8.7}{2}$ **AM2 (using DE)** .1 DE = 2.5 .2 $AE^2 + \text{their}2.5^2 = 5^2$ OE or 18.75 .3 (AE =) 4.3(3…) or $\frac{\sqrt{75}}{2}$ OE **Next page for AM 3**	**3**

		AM3 (using trigonometry) .1 Correct angle EAD OR ADE seen or used .2 Correctly substitute their angle into a trig ratio .3 The correct value of AE	**AM3 (using trigonometry)** .1 angle EAD = 30 OR angle ADE =60 .2 $\cos(\text{their}30)=\frac{AE}{5}$ or $\sin(\text{their}60)=\frac{AE}{5}$ OE .3 (AE =) 4.3(3…) or $\frac{\sqrt{75}}{2}$ OE	

Q3		Answers	Notes	Total
	a	.1 The correct value of median .2 The correct weight of 12 candies using 15.19	.1 15.19 .1 ACCEPT seeing on the graph vertical line at 15.19 .2 $(15.19\times 12 =)182.28$ .2 ACCEPT 182 or 182.3 only if .1 is awarded	**2**
	b	.1 Subtract 10 and 120 from 150 .2 The correct value of n	.1 150 – 10 – 120 or 150-130 .2 20	**2**
	c	.1 Correctly add 10 to 120 .2 The correct value of k	.1 (120+10=)130 ACCEPT the top 20 WTTE .1 ACCEPT seeing on the graph horizontal line at 130 provided there are no confusions .2 15.26 ACCEPT]15.25, 15.26] .2 ACCEPT 15.25 only if .1 is awarded	**2**

	d	**AM1** .1 Multiply 6 % by 150 .2 Correctly subtract their 9 from 150 .3 Correctly write their corresponding weight **AM2** .1 Subtract 0.06 from 1 .2 Correctly multiply their 0.94 by 150 .3 Correctly write their corresponding weight	**AM1** .1 0.06×150 OE or 9 seen .2 $(150 - \text{their}9 =) \text{their}141$ ACCEPT the top 9 WTTE .2 ACCEPT seeing a horizontal line at [140,145] on the graph provided there are no confusions .3 (weight=) [15.3,15.31] ACCEPT their weight corresponding to their141, even if their141 is 9, but with error within ± 0.005 **AM2** .1 $1 - 0.06$ or 0.94 OE seen .2 $(\text{their}0.94 \times 150 =) \text{their}141$ ACCEPT the top 9 WTTE .2 ACCEPT seeing horizontal line at [140,145] on the graph provided there are no confusions .3 (weight=) [15.3,15.31] ACCEPT their weight corresponding to their141, even if their141 is 9, but with error within ± 0.005	**3**

<table>
<tr><th>Q4</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr>
<td></td>
<td>.1 Correctly select 2 answers

.2 Correctly select another 2 answers

.3 Correctly select a 5th answer

.4 Correctly select the 6th answer</td>
<td>
<table>
<tr><th></th><th>a</th><th>b</th><th>c</th></tr>
<tr><td>f(x)</td><td>Positive</td><td>Negative</td><td>Positive</td></tr>
<tr><td>g(x)</td><td>Negative</td><td>Negative</td><td>Negative</td></tr>
</table>
</td>
<td>4</td>
</tr>
</table>

<table>
<tr><th colspan="2">Q5</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>5</td><td>a</td><td>.1 Correctly determine an angle

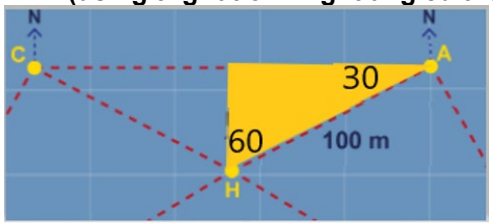
.2 Correctly apply the angle in .1

90 AG</td><td>
<table>
<tr><td>Using</td><td>.1Correctly determine an angle
ACCEPT seeing on the diagram</td><td>.2 Correctly apply the angle from .1</td></tr>
<tr><td>60</td><td>180-60 or 120</td><td>Correctly apply 120:
360-120-150
180-120+180-150
180-120+30</td></tr>
<tr><td>60</td><td>90-60 or 30</td><td>Correctly apply 30:
360-30-90-150
180-30-60</td></tr>
<tr><td>150</td><td>180-150 or 30</td><td>Correctly apply 30:
180-120+30

ACCEPT 60+30=90 only if they explain how they got the 60
Ex:
HAS=NHA
or Alternate (angle)
DO NOT ACCEPT
30+60 corresponding angle
30+60 opposite interior</td></tr>
<tr><td>150</td><td>360-150 or 210</td><td>Correctly apply 210:
210-(180-60)
210-120</td></tr>
<tr><td>150</td><td>150-90=60

Seeing only 60 do not award .1</td><td>Correctly apply 60:
180-60-(90-60)
180-60-30</td></tr>
</table>
DO NOT ACCEPT 150-60=90
DO NOT ACCEPT calculating BH assuming HAB=90 and then finding angles using trigonometry</td><td>2</td></tr>
</table>

	b	**AM1 (using Pythagoras)** .1 Correctly substitute into Pythagoras .2 The correct value of BH after correctly substituting into Pythagoras .3 Correctly round their BH to the nearest metre **AM2 (using cosine rule)** .1 Correctly substitute into cosine rule .2 The correct value of BH after correctly substituting into cosine rule .3 Correctly round their BH to the nearest metre	**AM1 (using Pythagoras)** .1 $BH^2 = 100^2 + 250^2$ or $(BH =)\sqrt{100^2 + 250^2}$ or 72500 OE .2 $(BH =)269(.258...)$ ACCEPT not seeing this step .3 (BH=)their269 .3 ACCEPT their correctly rounded BH only if their BH is not a whole number **AM2 (using cosine rule)** .1 $(BH^2 =)100^2 + 250^2 - 2 \times 100 \times 250 \times \cos 90$ .2 $(BH =)269(.258...)$ ACCEPT not seeing this step .3 (BH=)their269 .3 ACCEPT their correctly rounded BH only if their BH is not a whole number	**3**

	c	**AM1 (using trig ratio in right angled triangle)** .1 Correctly substitute half AC into a trig ratio .2 Correctly calculate half AC .3 Correctly double their .2 .4 Add their values for the correct route .5 Correctly add their values seen in their response for the correct route **AM2 (using cosine rule in triangle AHC)** .1 Correctly substitute into cosine rule .2 Correctly calculate AC^2 .3 Correctly calculate their AC using their cosine rule .4 Add their values for the correct route .5 Correctly add their values seen in their response for the correct route **AM3 next page**	**AM1 (using trig ratio in right angled triangle)**  .1 $\sin 60 = \frac{x}{100}$ or $\cos 30 = \frac{x}{100}$ .2 $100 \times \sin 60$ or $100 \times \cos 30$ or 86.6(025…) ACCEPT 87 .3 $2 \times \text{their}100 \times \sin 60$ or $2 \times \text{their}100 \times \cos 30$ or $2 \times$ their86.6(025) or their173(.20…) ACCEPT their174 .4 their269 + 250 + their173 + 250 + their269 .4 ACCEPT their269 + 250 + AC + 250 + their269 .5 their1211 ACCEPT 1212 **AM2 (using cosine rule in triangle AHC)** .1 $(AC^2 =)100^2 + 100^2 - 2 \times 100 \times 100 \times \cos 120$ OE .2 $(AC^2 =)30000$ or $AC = \sqrt{30000}$ OE .3 (AC=)their173(.20…) .3 ACCEPT their173(.20…) only if they used a cosine rule and not a cosine ratio considering triangle AHC right angled .4 their269 + 250 + their173 + 250 + their269 .4 ACCEPT their269 + 250 + AC + 250 + their269 .5 their1211 **Next page for AM 3 and marks without working**	**5**

		AM3 (using sine rule in triangle AHC) .1 Correctly substitute into sine rule .2 Correctly re-arrange for AC on one side after using sine rule correctly .3 Correctly calculate their AC using their sine rule .4 Add their values for the correct route .5 Correctly add their values seen in their response for the correct route	**AM3 (using sine rule in triangle AHC)** .1 $\frac{AC}{\sin 120} = \frac{100}{\sin 30}$ OE .2 $(AC =)100 \times \frac{\sin 120}{\sin 30}$ OE .3 (AC=)their173(.20…) .3 ACCEPT their173(.20…) only if they used a sine rule and not a sine ratio considering triangle AHC right angled .4 $\text{their}269 + 250 + \text{their}173 + 250 + \text{their}269$ .4 ACCEPT $\text{their}269 + 250 + AC + 250 + \text{their}269$ .5 their1211 **In any AM, in part c):** ACCEPT their269 seen on diagram and if not then their269 from part 5b ACCEPT the use of 270 instead of 269	

Q6		Answers	Notes	Total
	a	.1 Correct area for two from: square, circle or half mouth seen .2 Correct area for third seen .3 Subtract, at least, their circle from their square .4 The correct answer before rounding AG 196	.1 Two from: 20×20 or 400 , $7^2\pi$ or153.9(…) or 153.86 or 154, $\frac{100}{2}$ or 50 .2 Third from: 20×20 or400 , $7^2\pi$ or153.9(…) or 153.86 or 154, $\frac{100}{2}$ or 50 .3 their400 - their153.9(…) or their400 - their153.9(…) - their50 OE .3 ACCEPT only if .1 is awarded .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 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** .1 Correct length ratio .2 Correct area ratio .3 The correct fraction after applying the area ratio **AM 2 next page**	**AM1** .1 $\frac{37.6}{4.7}$ or 8 or $\frac{1}{8}$ OE .2 $(\frac{1}{8^2}=)\frac{1}{64}$ OE or $(8^2=)64$ OE ACCEPT $(\frac{37.6}{4.7})^2$ .3 $\frac{1184}{64}(=18.5)$ or $\frac{37}{2}$ OE ACCEPT $64\times18.5=1184$ .3 ACCEPT $\frac{1184}{(\frac{37.6}{4.7})^2}$	**3**

		AM2 .1 Correct length ratio .2 Correctly dividing areas .3 Correctly show that area ratio is the square of length ratio AG 18.5	**AM2** .1 $\frac{37.6}{4.7}$ or 8 or $\frac{1}{8}$ OE .2 $(\frac{1184}{18.5}=)64$ or $(\frac{18.5}{1184}=)\frac{1}{64}$ OE ACCEPT $\sqrt{\frac{1184}{18.5}}=8$ .3 $64=8^2$ or $\frac{1}{64}=(\frac{1}{8})^2$ or 64 is square of 8 WTTE .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	
	c	**AM1 (using equations)** .1 Correctly write the second equation .2 Correct step towards solving the correct equations .3 Correctly solve their equations for one unknown x OR y .4 Correctly write their corresponding value of the other unknown satisfying one of their equations .5 Correctly identify x=24 and y=6 **AM2 next page**	**AM1 (using equations) Note: only .3 and .4 are using their** .1 $2x+5y=80$ ACCEPT using inequality .2 correct substitution: $2x+5\times\frac{x}{4}=80$ or $2\times4y+5y=80$ 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 (x =) their $\frac{320}{13}$ or 24.61(...) OE OR (y =) their $\frac{80}{13}$ or 6.15(…) OE .4 (x =)their $\frac{320}{13}$ or 24.61(...) OE OR (y =) their $\frac{80}{13}$ or 6.15(…) OE .5 x = 24 and y =6 or 24 small (triangles) and 6 big (triangles) **Next page for AM 2, SC and marks without working**	**5**

		AM2 (using numbers) .1 Correctly calculate their area using their numbers of small and big triangles .2 Correctly calculate the area using 24 small triangles and 6 big triangles .3 Correctly calculate the area of painting left .4 Seeing their value of x is 4 times their value of y .5 Correctly identify x = 24 and y = 6 .	**AM2 (using numbers) Note: Only .1 and .4 are using their** .1 $(2\times \text{their}24+5\times \text{their}6=)\text{their}78$ .2 $(2\times 24+5\times 6=)78$ .3 $\left(80-78=\right)2$ (cm^2) .4 their24 is 4 times their6 .5 x = 24 and y = 6 or 24 small (triangles) and 6 big (triangles)	

Q7		Answers	Notes	Total
	a	**AM1** .1 Correctly subtract 1.1 or 1.5 from 6 .2 Divide by 0.4 .3 The correct number of tiers **AM2** .1 Correctly set an equation or an inequality .2 Correctly solve their equation .3 The correct number of tiers **AM3** .1 Multiply their number of tiers by 0.4 .2 Correctly calculate the height of tiers .3 The correct number of tiers	**AM1** .1 (6-1.1=) 4.9 or (6-1.5=)4.5 .2 $\frac{\text{their}4.9}{0.4}$ or 12.25 ACCEPT $\frac{\text{their}4.5}{0.4}$ or 11.25 .3 12 (tiers) **AM2** .1 $1.1+0.4n=6$ or $1.5+0.4n=6$ ACCEPT using inequality .2 (n=)their12.25 or their11.25 .3 12 (tiers) **AM3** .1 0.4 x their12 or 4.8 or 4.4 seen .1 ACCEPT repetitively adding 0.4 Ex: 1.1,1.5,1.9,..etc .1 ACCEPT the height increases by 0.4 each time WTTE .2 $(1.1+\text{their}4.8 \text{ or } 1.5+\text{their}4.4=)5.9$ .3 12 (tiers)	**3**

	b	**AM1** (Solving for x) .1 Correctly write the equation in terms of x .2 Correctly rearrange the equation .3 The correct value of x before rounding down x=5 AG **AM2** (using x=5) .1 Correctly set calculations for width .2 Correctly calculate one of: -width of sections and gaps -total width excluding gaps -the remaining distance .3 Correct argument that x=5 is the maximum possible in the width of 30	**AM1** (solving for x) .1 $3.5x+1.5\times(x-1)+2\times2=30$ OE ACCEPT using inequality .2 $5x=27.5$ ACCEPT $5x+2.5=30$ ACCEPT using inequality .3 $(x=\frac{27.5}{5}=)5.5$ **AM2** (using x=5) .1 Two from $\rightarrow 5\times3.5$ OE $\rightarrow 4\times1.5$ OE $\rightarrow 2\times2$ OE or $30-2\times2$ OE .2 One of the following is seen $\rightarrow(5\times3.5+4\times1.5+2\times2=)27.5$ ACCEPT width of sections and in-between gaps $(5\times3.5+4\times1.5=)23.5$ $\rightarrow(30-4\times1.5-2\times2=)20$ $\rightarrow(30-5\times3.5-4\times1.5-2\times2=)2.5$ .3 A corresponding argument from (WTTE): $\rightarrow\frac{27.5}{5}=5.5$ or add another section and recognise that total is more than 30 $\rightarrow\frac{20}{3.5}=5.7(1...)$ or add another section and recognise that total is more than 30 $\rightarrow$ Recognise 2.5 remaining	**3**

7d) total 10 marks

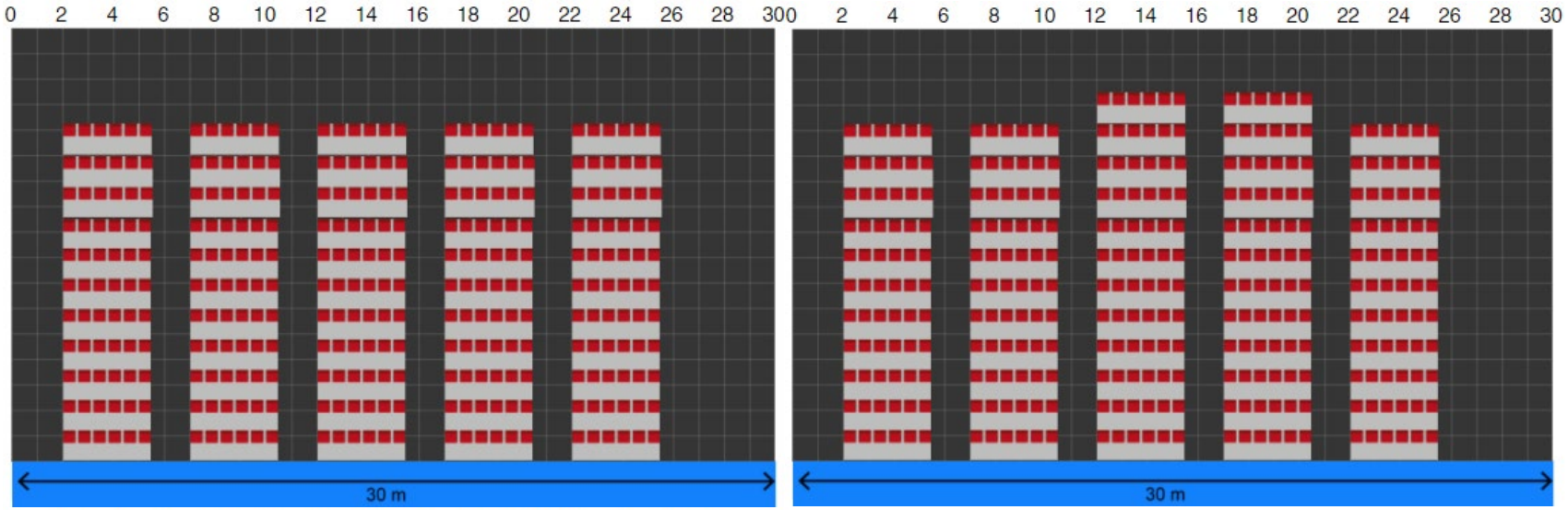
	(1 mark)	(2 marks)	(3 marks)	(4 marks)
Factors (F)	**Two** factors seen in factors box from (WTTE): - number of seats in a row or in a section, number of sections, or width of section(s) - number of tiers or height - total number of seats or capacity of theatre -width of theatre or space available -Gaps that must be left (either in-between or at the ends) ACCEPT using values for any of the above DO NOT ACCEPT only "number of seats" as a factor	**Three** factors seen in factors box from (WTTE): - 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 in-between or at the ends) ACCEPT using values for any of the above 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** Total seats per row: 5×6 or 30 ACCEPT $\frac{348}{12} = 29$ OE **OR** Total seats in one of their blocks Ex: 8×6 or 48 12×6 or 72 **OR** Number of sections of seats: $\frac{348}{6} = 58$	**Correct calculations related to the total number of seats in the range [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: $\frac{348}{30} = 11.6$ **OR** Number of blocks of seats: Their total number of seats divided by 6 times their number of tiers Ex: $\frac{348}{78}$ (78=6x13) more on next page	**Correct calculations for total number of seats in the range [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	**Correct calculations for a total number of 348 seats** **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 $29 \times 12 = 348$

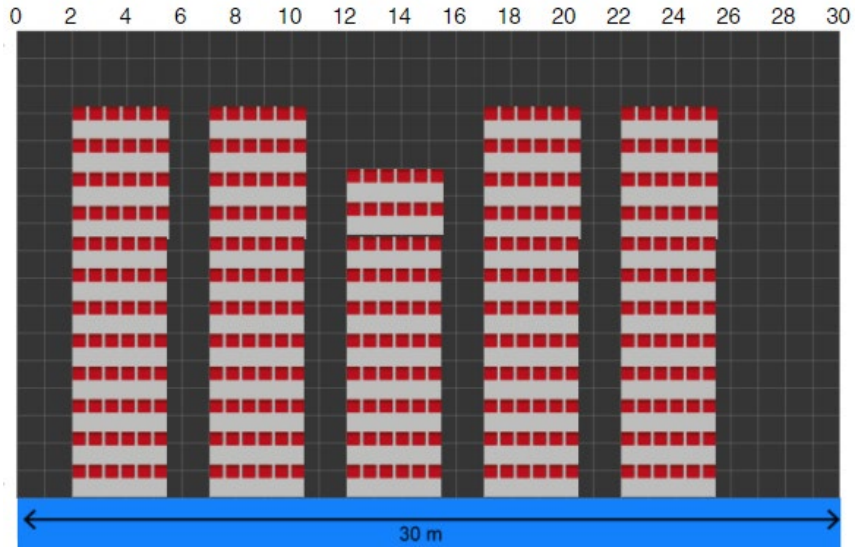
		ACCEPT correct combinations using blocks for a total in the range [120,420] Ex: 5 × 24 = 120 ACCEPT listing number of seats per block for a total in the range [120,420] Ex: 48,48,48,48,24,24,24,24 DO NOT ACCEPT 29 × 12=348	ACCEPT listing number of seats per block only if total is 348 Ex: 48,48,48,48,48,24,24,24,24,12 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 constraint(s) WTTE ACCEPT for the constraints if they list at least one constraint DO NOT ACCEPT if C0 and D0 are awarded	**Good justification** I made the best use (or didn't make the best use) of space within the constraint(s) WTTE ACCEPT for the constraints if they list at least one constraint **AND** 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		
Design (D)	**Two from:** Gaps between sections ≥1.5 Gaps left and right ≥2 330 ≤Total number of seats≤ 348 Tiers ≤12 ACCEPT number of seats seen in response box different from number on canvas ACCEPT error in the gaps up to 0.25 m DO NOT ACCEPT if their total number of seats on canvas is less than 120	**The four of:** Gaps between sections ≥1.5 Gaps left and right ≥2 330 ≤Total number of seats≤ 348 Tiers ≤12 ACCEPT number of seats seen in response box different from number on canvas ACCEPT error in the gaps up to 0.25 m		

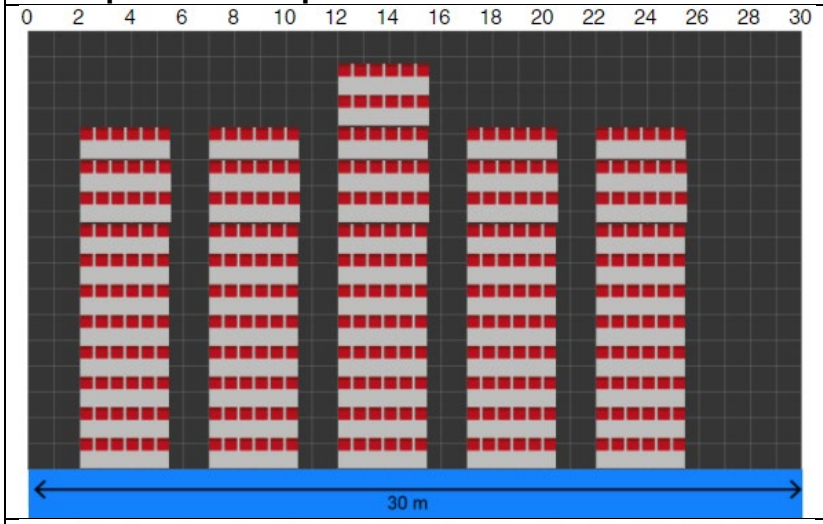
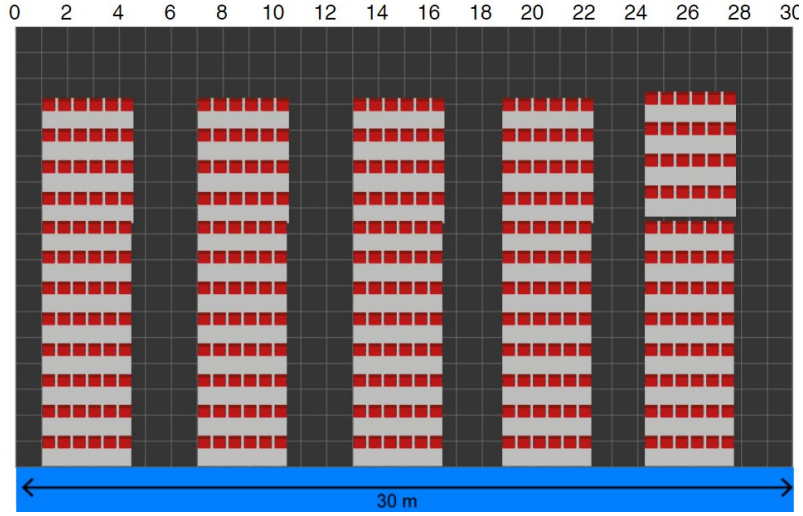
For examples of marks for the design (D) scroll down

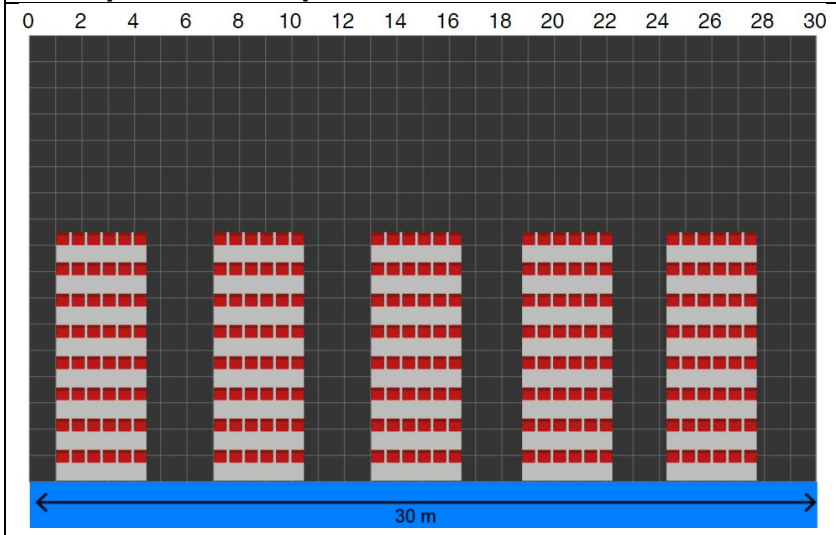
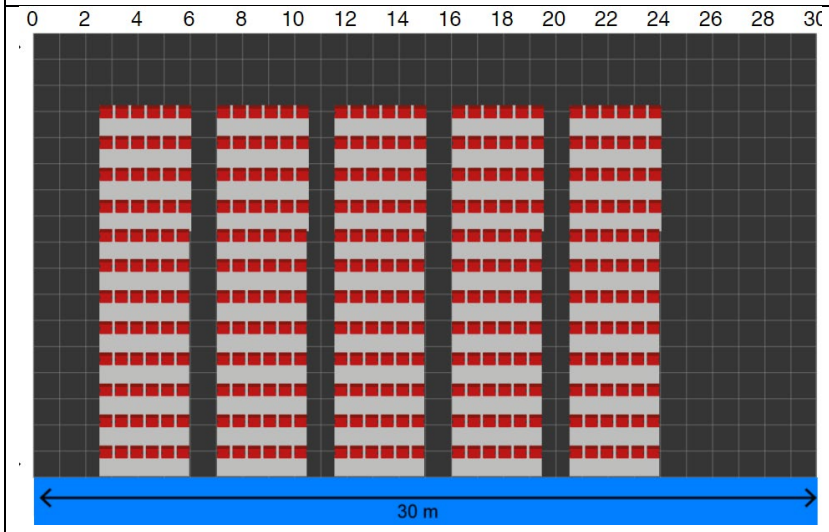
Accepted for D2

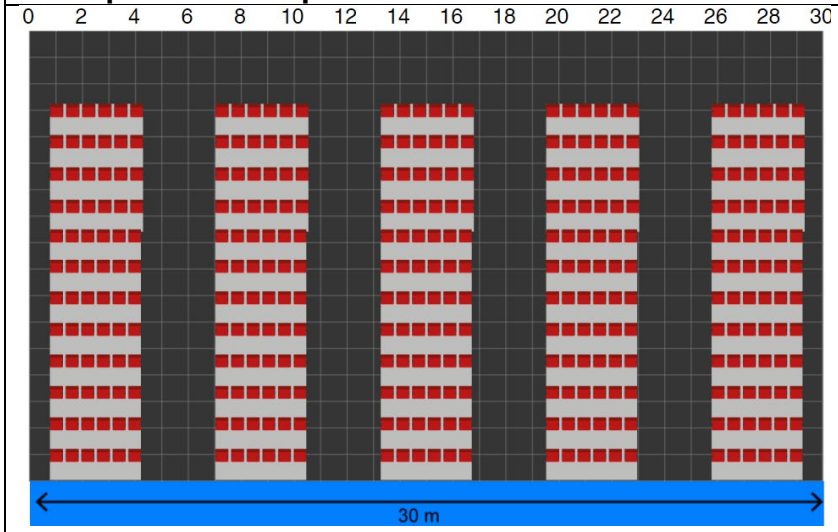
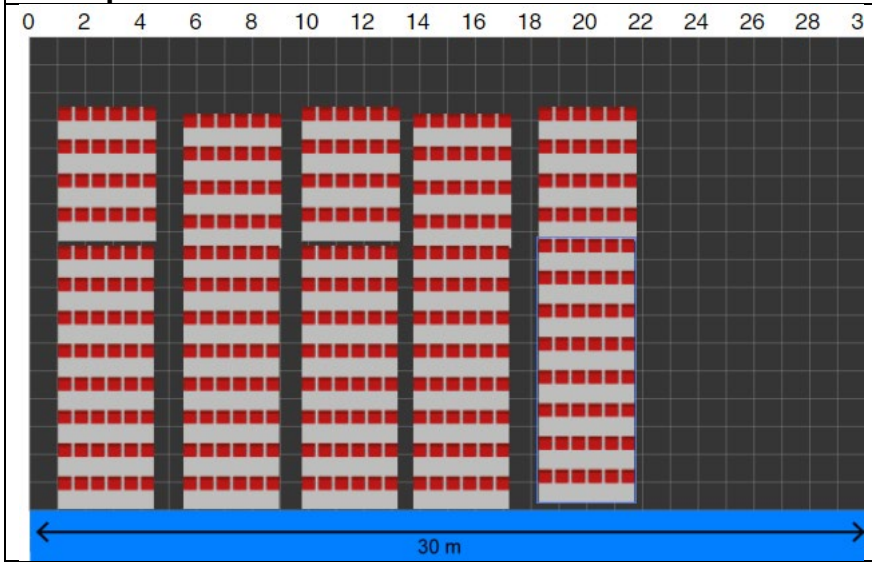
Gaps between sections ≥ 1.5 AND Gaps left and right ≥ 2 AND $330 \leq$ Total number of seats ≤ 348 AND tiers ≤ 12

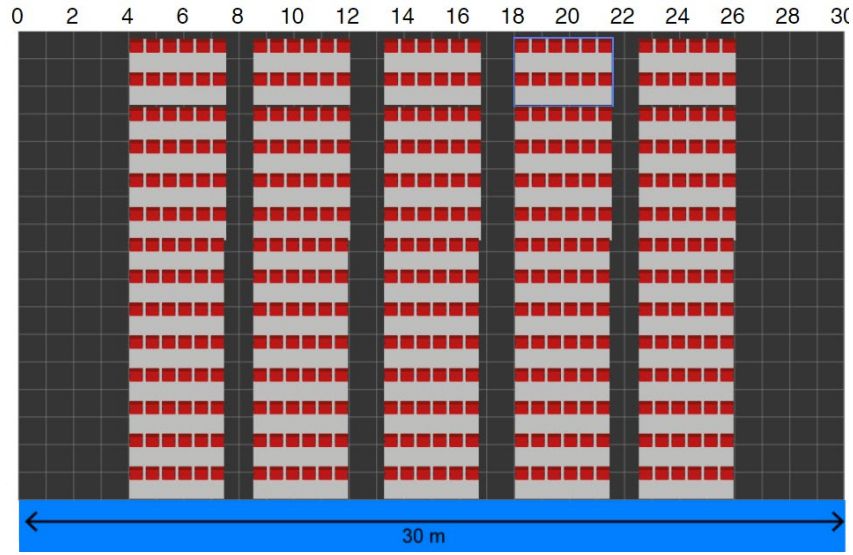




Examples for accepted D1	Reason
	Gaps between sections ≥ 1.5 Gaps left and right ≥ 2 $330 \leq$ Total number of seats ≤ 348
	Gaps between sections ≥ 1.5 tiers ≤ 12

Examples for accepted D1	Reason
	Gaps between sections ≥ 1.5 tiers ≤ 12
	Gaps left and right ≥ 2 tiers ≤ 12

Examples for accepted D1	Reason
	Gaps between sections ≥ 1.5 tiers ≤ 12
Examples for D0	**Reason**
	Only tiers ≤ 12

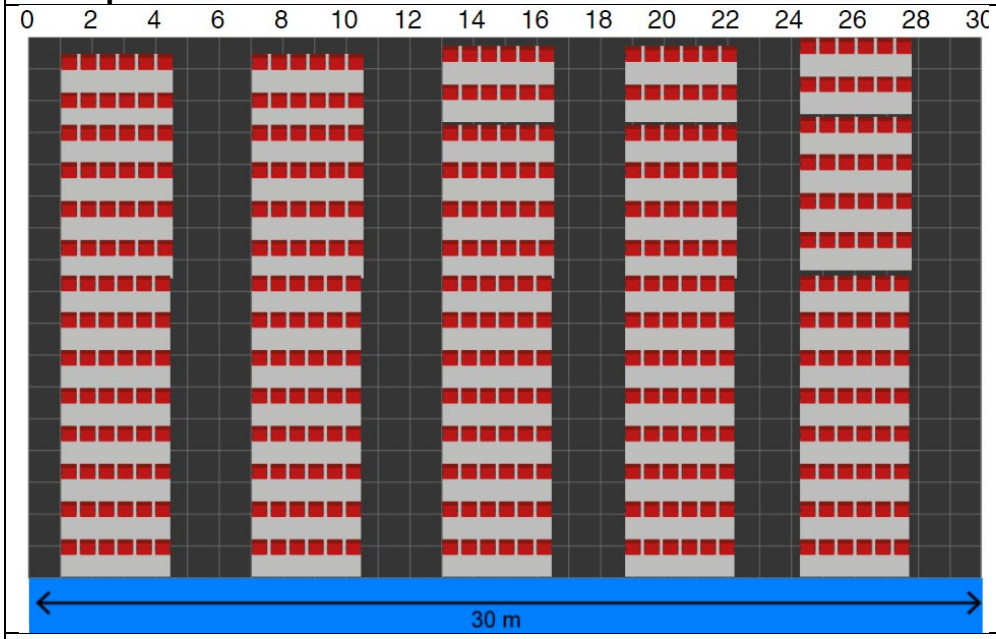


Only

Gaps left and right ≥ 2

Examples for D0

Reason



Only

Gaps between sections ≥ 1.5

Note that the gap on the right is >2 but the gap on the left no. So not accepted

<table>
<tr><th colspan="3">Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>8</td><td>a</td><td>Recognize there are <u>four</u> triangles and an <u>outer one</u></td><td>4 triangles inside a big one WTTE
Examples to ACCEPT
1 is outline for all 4 triangles
4 small and 1 big
4 triangles in one triangle
4 triangles make up (or joined to make) the 5th
A big triangle and 4 sub-triangles
4 triangles that create a perimeter of a new one
3 triangles added to original then an outer one

Examples that we DO NOT ACCEPT
it starts by one and adds 4 each time WTTE
all dots connected to create a big triangle
triangles all together make 5
A big triangle and small triangles
entire triangle counted as one and includes sub-triangles</td><td>1</td></tr>
<tr><td></td><td>b</td><td>Correctly place 17 and 21</td><td><table><tr><th>Stage
(n)</th><th>Number of triangles
(T)</th></tr><tr><td>1</td><td>1</td></tr><tr><td>2</td><td>5</td></tr><tr><td>3</td><td>9</td></tr><tr><td>4</td><td>13</td></tr><tr><td>5</td><td>17</td></tr><tr><td>6</td><td>21</td></tr></table></td><td>1</td></tr>
<tr><td></td><td>c</td><td>·1 Correctly describe one pattern in words
·2 Correctly describe a second pattern in words

More on next page</td><td>ACCEPT complete terminology only, for example (below are four different descriptions)
(T) 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</td><td>2</td></tr>
</table>

			The difference between 4*n* and 3 DO NOT ACCEPT *n* goes up by 1 It is increasing general rules in terms of *n*, 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 *n* minus 3 More than two different patterns, with any incorrect award **(1 mark)** Ex: adds 4 and Second difference is zero and it is 4 times *n*	
	d	·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=4*n*-3 or T=2*n*+2*n*-3 or T=4*x*-3 ·2 $T = 4n - 3$ or $T_n = 4n - 3$ DO NOT ACCEPT description in words	**2**
	e	·1 Correctly substitute $n \geq 5$ into their general rule ·2 Correctly calculate their value of *T* after substituting $n \geq 5$ ·3 Recognize that their result is the same as the correctly predicted value	·1 Ex: $4 \times 7 - 3$ ·2 Ex: 25 (for the $n = 7$) .3 "the same as when we continue the pattern" WTTE and states how Ex: For *n*=7, 25 is obtained from pattern of adding 4 to 21 ·3 ACCEPT if their value from .2 is the same as their value in the table in part a) or seen here in part e)	**3**
	f	3×8 or $8 + 8 + 8$ 24 AG	ACCEPT in words Ex: It is the tripple of 8 or 3 times 8 DO NOT ACCEPT 2×12 OE	**1**

8	**g**		**23**

Mark	1	2	3	4	5
Predictions (P)	Correctly predict one value for P **OR** two values for L	Correctly predict two values for *P* **OR** one value for *P* and two for *L*	Correctly predict two values for *P* **AND** two values for *L*		
Description (D)	Correctly describe a pattern in words or recursive rule or rule (for *L or P)* **Examples for *L* and *P*:** Value doubles WTTE The difference doubles Increasing by multiplying by 2 Exponential Geometric Goes up by the previous number **Examples for *L*:** All even except 1 Add 1 then add 2 then add 4,...etc OE The recursive rule for *L* Ex: $L(n)=L(n\text{-}1)\times 2$ **Examples for *P*:** All even except 3 Add 3 then add 6 then add 12,..etc OE Multiples of 3 The recursive rule for P Ex: $P(n)=P(n\text{-}1)\times 2$ DO NOT ACCEPT *P* is increasing *P* is triple of *L* or Valid attempt to write down a general rule for *L* Examples: $L = 2^n$ DO NOT ACCEPT $L=2n$ or The rule for *P:* $P=3L$ Ignore additional incorrect patterns (for Notation see N)	Correctly describe a pattern in words or recursive rule or rule for *L* and for *P* **OR** Correctly describe a pattern in words or recursive rule or rule (for *L* or *P*) and valid attempt to write down a general rule for *L* Ignore additional incorrect patterns (for Notation see N)	Correctly describe a pattern in words or recursive rule or rule for *L* and for *P* and valid attempt to write down general rule for *L* **OR** Correctly write down the general rule for *L* $L = 2^{n-1}$ **OR** Valid Attempt to write down a general rule for *P* Examples: (seeing in their rule added or multiplied by something) $P = 3\times 2^n$ $P = 2^n + 2n$ DO NOT ACCEPT $P = 2^n$ $P = 2\times 3^n$ or $P = 3\times 1.86^n$ $P = 3\times$ their general rule for *L* $P = 3n$ Ignore additional incorrect patterns (for Notation see N)	Correctly describe a pattern in words or recursive rule or rule (for *L* or *P*) and correctly write down the general rule for *L* **OR** Correctly describe a pattern in words (for *L* or *P*) or recursive rule or rule for L and valid attempt to write down a general rule for *P* **OR** Correctly write down the general rule for *P* $P = 3\times 2^{n-1}$ or $P = 1.5\times 2^n$ Ignore additional incorrect patterns (for Notation see N)	Correctly describe a pattern in words or recursive rule or rule for *L* and for *P* **AND** Correctly write down the general rule for *P* Ignore additional incorrect patterns (for Notation see N)

Testing (T)	Attempt to test their general rule for P using $n \leq 4$ Correctly substitute in their general rule for P a value of $n \leq 4$ **OR** Correctly test their general rule for L or described pattern or recursive rule **OR** Correctly test their rule for P or described pattern or recursive rule ACCEPT testing the rule $P=3L$ or testing their general rule for L	Correctly test their general rule for P using $n \leq 4$ Correctly calculate their value for P in their general rule using $n \leq 4$ **AND** Recognize that their correctly calculated value for P is the same as the given value. ACCEPT seeing their correctly calculated value for P and the given value in the table being equal			
Verifying (V)	Attempt to verify their general rule for P using $n \geq 5$ Correctly substitute in their general rule for P a value of $n \geq 5$ **OR** Correctly verify their general rule for L or described pattern or recursive rule **OR** Correctly verify their rule for P or described pattern or recursive rule ACCEPT verifying the rule $P=3L$ or verifying their general rule for L	Correctly calculate their value for P in their general rule using $n \geq 5$	Correctly calculate their value for P in their general rule using $n \geq 5$ **AND** Recognise that their correctly calculated value for P is the same as their predicted value obtained by continuing the pattern ACCEPT seeing their correctly calculated value for P and their predicted value in the table being equal		

Justify/ proof (J)	Weak attempt to justify their general rule (for *L* or *P*) or described pattern or rule or recursive rule Examples: trying at least two more values and arguing as justification that they are the same or rule works or seeing their rule for $P=3\times$ their general rule for *L* OE DO NOT ACCEPT if D2 not achieved	Good attempt to justify their general rule (for *L* or *P)* Examples <u>seen as justification</u>: We multiply by 2 every time or It is geometric with ratio 2 or They have a rule for *L* in terms of *n* and they say there is 3 in the rule of *P* because *P*=3*L* OE DO NOT ACCEPT if D3 not achieved	Correctly justify the general rule for *L* Examples: First term is 2^0, second is 2^1 so it makes sense that *n*th term is 2^{n-1} OE or recognize it is geometric progression with ratio 2 and first term 1 **OR** correctly justify the general rule for *P* algebraically Examples: First term is 3×2^0, second is 3×2^1 so it makes sense that nth term is $3\times 2^{n-1}$ OE or They assume $P=a\times 2^n$ and substitute to find the correct value of *a* or recognize it is geometric progression with ratio 2 and first term 3 ACCEPT seeing the justification inside their work and not separate at the end DO NOT ACCEPT if D3 not achieved	Correctly justify the general rule for *P* in relation to geometry Correctly justify the general rule for *L* AND recognise *P*=3*L* OE ACCEPT seeing the justification inside their work and not separate at the end DO NOT ACCEPT if D4 not achieved	

Communication criteria

Mark	1	2	3
Notation and terminology (N)	Correct notation of <u>their general</u> rule **OR** Correct terminology describing a pattern **OR** The notation of <u>the general</u> rule for L or P includes errors DO NOT ACCEPT if they don't have any rules and they don't describe correctly any pattern	Correct notation of <u>the general</u> rule for L or P **OR** The notation of <u>the general</u> rule for L or P includes errors and Correct terminology describing a pattern in words DO NOT ACCEPT if they don't have the general rule for L or P For notation of the general rule for L $L = 2^{n-1}$ ACCEPT Using U_n instead of L only if they mention that $L = U_n$ non simplified rules ex : $L = \frac{2^n}{2}$ OE DO NOT ACCEPT using * for multiplication using / for division using ^ for power Using x instead of n The rule for L is 2^{n-1}	Correct notation of <u>the general</u> rule for P **AND** Correct terminology describing pattern in words for P DO NOT ACCEPT if they don't have the general rule for P For notation of the general rule for P $P = 3 \times 2^{n-1}$ or $P = 3(2)^{n-1}$ or $P = 3.2^{n-1}$ $P = 3\ 2^{n-1}$ ACCEPT using U_n instead of P only if they mention that $P = U_n$ non simplified rules ex: $P = \frac{3}{2} \times 2^n$ DO NOT ACCEPT using * for multiplication using / for division using ^ for power Using x instead of n The rule for P is $3 \times 2^{n-1}$

Mark	1	2	3
Communication (L) Organisation and coherence Can be awarded even if there are errors **Different items can be considered seen (or identified for coherence) if they include errors but not if awarded 0 marks**	**At least three** from the following items are seen: · describe a pattern in words · write a rule · test their general rule or rule or recursive rule or pattern · verify their general rule or rule or recursive rule or pattern · justify their general rule or rule or recursive rule or pattern (at least J1 awarded)	DO NOT ACCEPT if they don't have a general rule (in terms of n) **At least four** of the following items are seen: · describe a pattern in words (for L or P) · write a general rule (for L or P) · test their general rule (for L or P) · verify their general rule (for L or P) · justify their general rule (for L or P) (at least J1 awarded) **AND** For coherence, they identify the processes correctly. **At least one** from the following: · test · verify · justify Ex: • **For test:** they say "test" and they test using value(s) of $n \leq 4$ only • **For verify:** they say "verify" and they verify using value(s) of $n \geq 5$ only • **For test and for verify:** they say 'test **and** verify' and they test using value(s) of $n \leq 4$ **and** then verify using value(s) of $n \geq 5$ • **For justify: At least J1 awarded**	DO NOT ACCEPT if they don't have The general rule for P **At least four** of the following items are seen: · describe a pattern in words · write the general rule for P · test the general rule for P · verify the general rule for P · justify the general rule for P (at least J2 awarded) **AND** For coherence, they identify the processes correctly. **At least two** from the following: · test · verify · justify Ex: • **For test:** they say "test" and they test using value(s) of $n \leq 4$ only • **For verify:** they say "verify" and they verify using value(s) of $n \geq 5$ only • **For test and for verify:** they say 'test **and** verify' and they test using value(s) of $n \leq 4$ **and** then verify using value(s) of $n \geq 5$ • **For justify: At least J2 awarded**

The table of values and rules:

Stage (n)	Side length of outer triangle (L)	Perimeter (P)
1	1	3
2	2	6
3	4	12
4	8	24
5	16	48
6	32	96
7	64	192
8	128	384

	Side length of outer triangle (L)	Perimeter (P)
General rules	$L = 2^{n-1}$	$P = 3 \times 2^{n-1}$