Markscheme

November 2023

Mathematics

On-screen examination

33 pages

The markscheme may make use of the following abbreviation: OE – 'or equivalent'

The markscheme abbreviations:

• 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

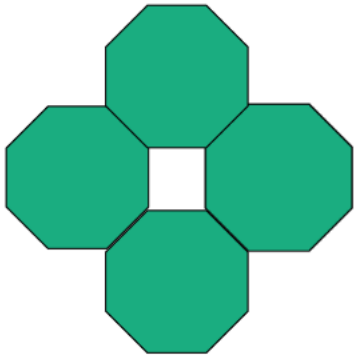
a) As this is an international examination, accept all **alternative forms of notation,** for example 1,9 as 1.9 ; 1,000 or 1.000. However, **DO NOT ACCEPT** incorrect mathematical notation x^2 for x^2 unless noted otherwise in the MS.
b) **ACCEPT** notation errors in intermediate steps.
c) Ignore further 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. However, it indicates what the candidate's result represents. Ex: if last mark is for the result: (AB)=5; this means we award the mark for seeing 5 as the result of calculating AB without necessarily seeing AB=5, but it does not mean we award the mark for seeing 5 representing another length
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 or working 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.
o) For "**show that**" questions, unless otherwise noted, every bullet point has to be seen in order to be awarded.

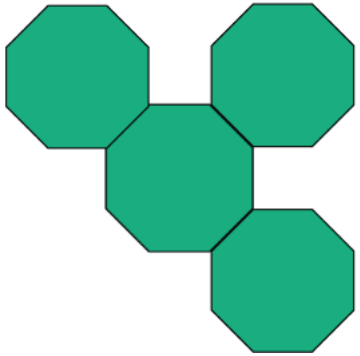
Q1		Answers	Notes	Total
	a	Correct angle	60 (degrees)	**1**
	b	Correct angle	120 (degrees) ACCEPT –120 (degrees)	**1**
	c	**AM1** .1 Correctly write the horizontal translation .2 Correctly write the vertical translation **AM2** .1 Correctly write the first rotation point and angle .2 Correctly write the second rotation and angle	**AM1** .1 to the right WTTE and 3 (units) .1 ACCEPT X+3 .2 upwards WTTE and $\sqrt{3}$ (units) .2 ACCEPT up WTTE and 1.7(32…) or root 3 .2 ACCEPT $Y+\sqrt{3}$ **AM2** .1 rotation about point $(2,\sqrt{3})$ of -120(degrees) or 120 clockwise .2 rotation about point $(3,2\sqrt{3})$ of 120(degrees) or 120 anticlockwise	**2**

	d	.1 Correctly relate interior angle to 360 for two regular shapes .2 Correctly relate interior angle to 360 for the third regular shape	.1 two from: (For the hexagon) $120 \times 3 = 360$ or $\frac{360}{120} = 3$ or $\frac{360}{3} = 120$ or 120 is a factor of 360 WTTE (For the square) $90 \times 4 = 360$ or $\frac{360}{90} = 4$ or $\frac{360}{4} = 90$ or 90 is a factor of 360 WTTE (For the triangle) $60 \times 6 = 360$ or $\frac{360}{60} = 6$ or $\frac{360}{6} = 60$ or 60 is a factor of 360 WTTE .2 the third from the above	**2**
	e	.1 4 connected octagons correctly touching **in two directions** .2 Exactly 8 connected octagons correctly touching **in two directions**	ACCEPT touching if the octagons are reasonably close (cannot take the square in-between) ACCEPT not seeing the squares (ignore the squares) .1 Ignore additional incorrectly touching octagons. See examples on the next pages .2 See examples on the next pages For bp1 and bp2: Count the connected octagons correctly touching either touching on the horizontal and vertical sides OR on the diagonal sides but not both. See examples on the next pages	**2**

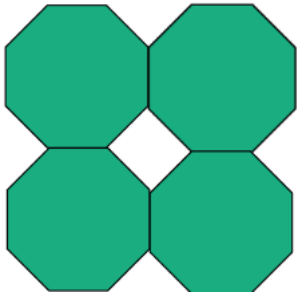
4 octagons correctly touching in two directions

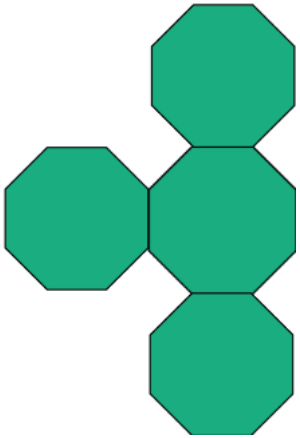
4 octagons correctly touching on diagonal sides



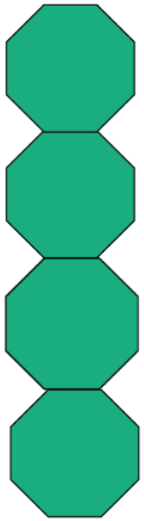


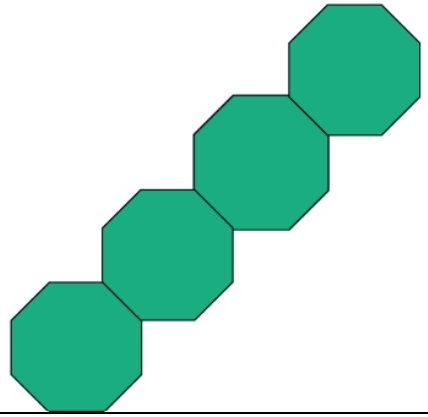
4 octagons correctly touching on the horizontal and vertical sides



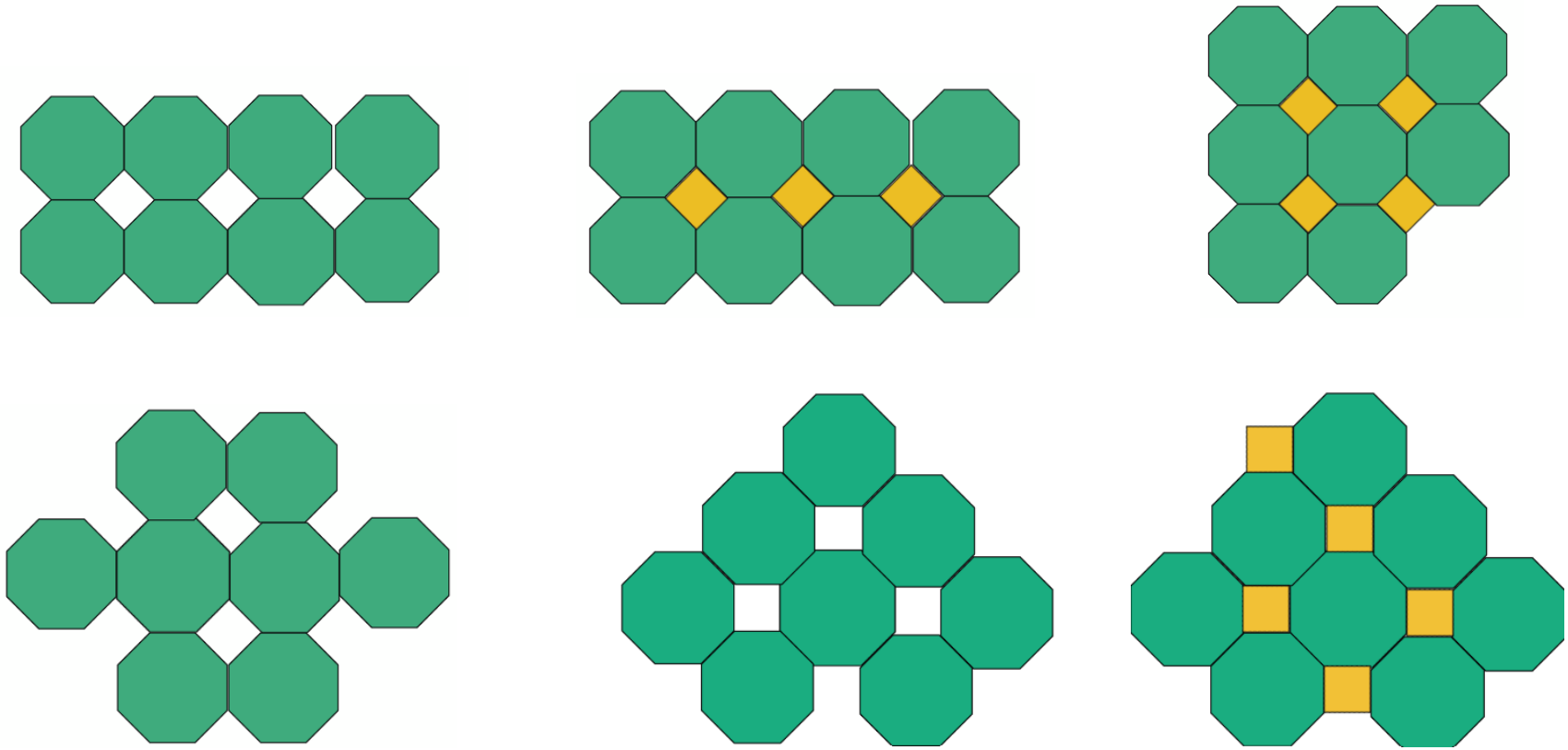


4 octagons correctly touching but in one direction only



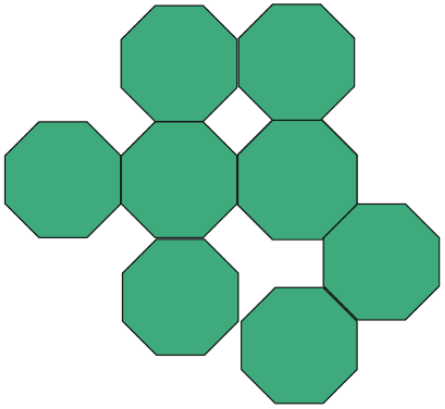


Examples for 2 marks

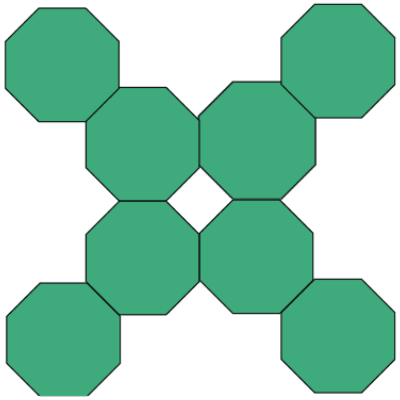


Examples for 1 mark

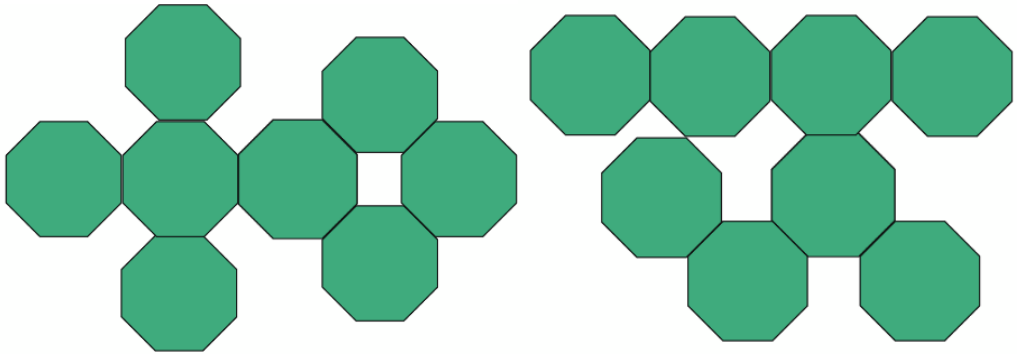
6 octagons correctly touching in two directions. (The 6 touching on horizontal and vertical sides and cannot add to them the 2 octagons touching on diagonal sides)



4 octagons correctly touching in two directions. (The 4 touching on horizontal and vertical sides and cannot add to them the 4 octagons touching on diagonal sides)

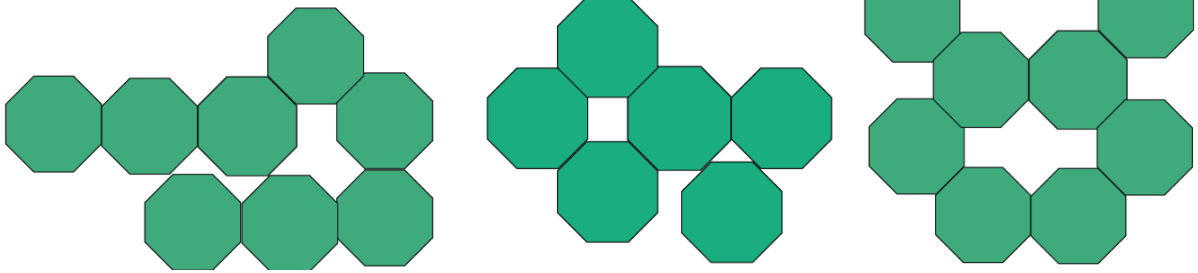


5 correctly touching octagons in two directions. (The 5 touching on horizontal and vertical sides and cannot add to them the three octagons touching on diagonal sides)



4 octagons correctly touching in two directions. (Cannot count touching horizontally and vertically with the ones touching diagonally)

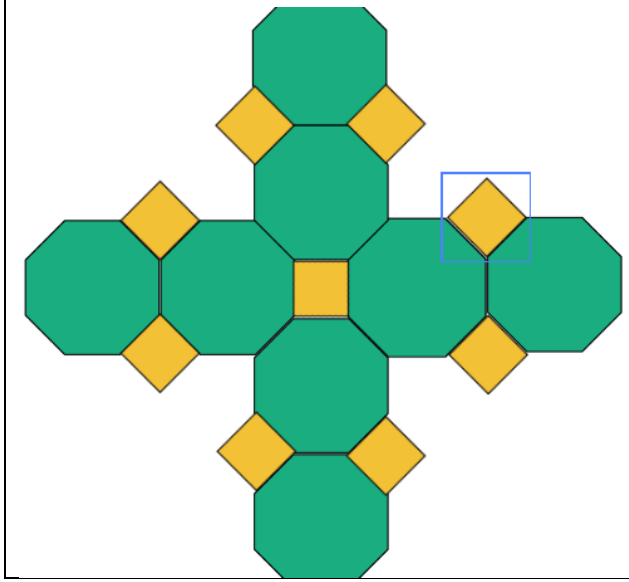
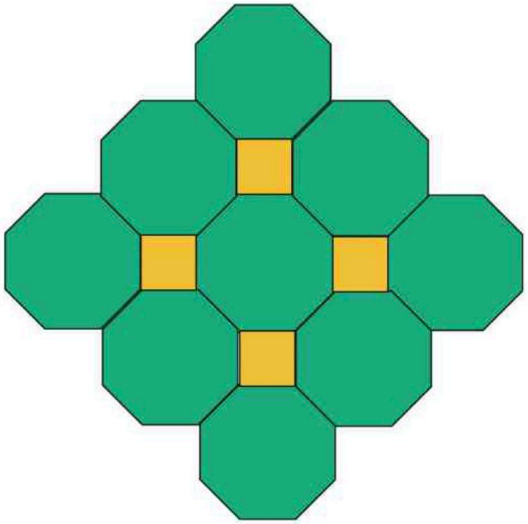
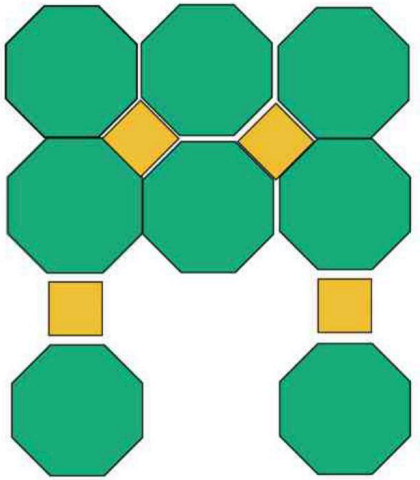
(1) (2) (3)



1) 4 touching horizontally and vertically

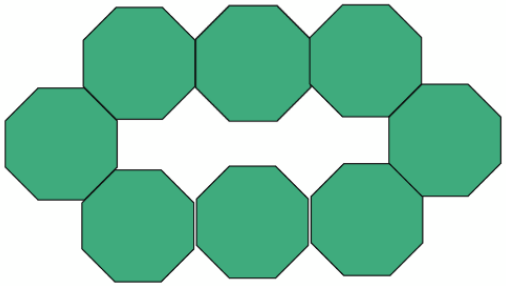
2) 4 touching diagonally

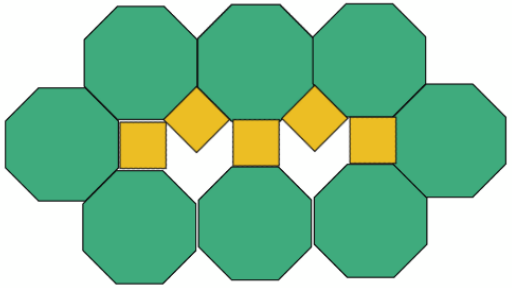
3) Two sets of 4 toucing diagonally

Further examples for 1 mark		
4 Octagons correctly touching diagonally in two directions	**9 Octagons correctly touching diagonally in two directions**	**6 Octagons correctly touching horizontally and vertically in two directions**
		

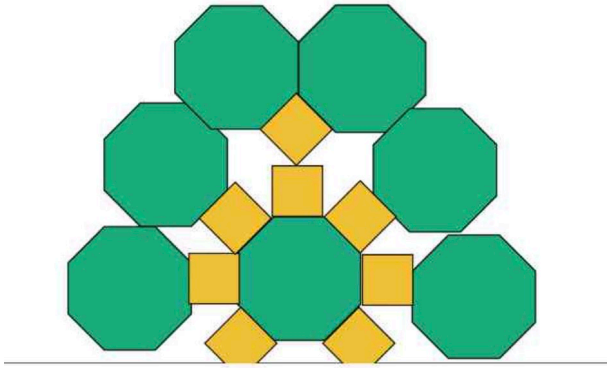
Examples for 0 marks

Two sets of 3 octagons correctly touching Horizontally and vertically
And two sets of 3 octagons correctly touching diagonally

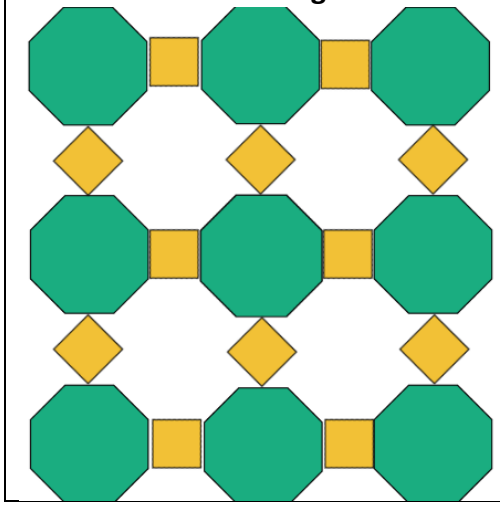


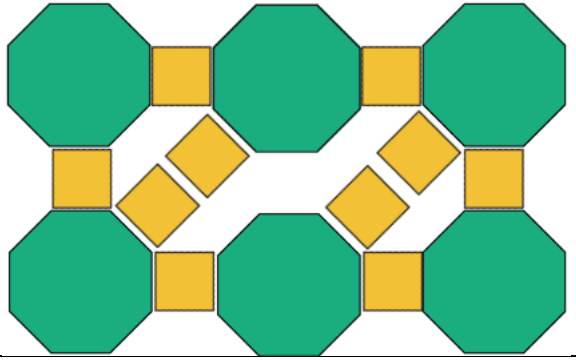


2 correctly touching horizontally and vertically.



0 marks None touching





Q2		Answers	Notes	Total
	a	(SAS) AE = BE, ED = EC, and < AED = < BEC WTTE OE (SSS) AE = BE, ED = EC, and AD = BC OE <A=<B, <D=<C, and AE=BE OE .1 Two correct reasons .2 Third correct reason AG AED and BEC are congruent	**SC 1 mark for any of the followi**ng (sides are not named) SAS SSS (they have) equal sides or same sides or same length WTTE (they have) equal angles and one equal corresponding side WTTE (they are) reflection (or mirror) of each other or symmetrical WTTE	**2**
	b	.1 Two from: • Subtract correct y-coordinates • Subtract correct x-coordinates • Divide their difference in y by their difference in x .2 The correct gradient	.1 Two from:: • 10-4 or 4-10 or 6 or -6 • 9- -3 or -3-9 or 12 or -12 • $\frac{\text{their}(10-4)}{\text{their}(9--3)}$ .2 $\frac{6}{12}$ OE	**2**
	c	.1 Correct equation involving *x* and their gradient from b) .2 Correct value of *x*	.1 their $\frac{6}{12}=\frac{2--4}{x-1}$ OE or $\frac{8}{-4}=\frac{10-2}{9-x}$ OE or $9-x=-4$ OE .2 (*x* =)13	**2**
	d	.1 Correctly substitute into distance formula .2 Correctly calculate their length of AB after substitution into distance formula .3 Correctly write their AB in simplest surd form	.1 $\sqrt{(9--3)^2+(10-4)^2}$ OE .2 their$\sqrt{180}$ or their13.4(164...) .2 ACCEPT their AB correctly calculated after one mistake examples: $(\sqrt{(9--3)^2+(10-4)}=)12.2(47...)$ or $(\sqrt{(9--3)^2+(10-4)^2}=)48$ .3 their $6\sqrt{5}$ .3 DO NOT ACCEPT if their surd does not need simplification	**3**
	e	.1 Correctly substitute into mid-point formula for x OR y coordinates .2 Correct coordinates of point E	.1 $\frac{1+9}{2}$ or $\frac{-3+\text{their}13}{2}$ OR $\frac{10-4}{2}$ or $\frac{4+2}{2}$ .2 (5 , 3) OE ACCEPT 5,3	**2**

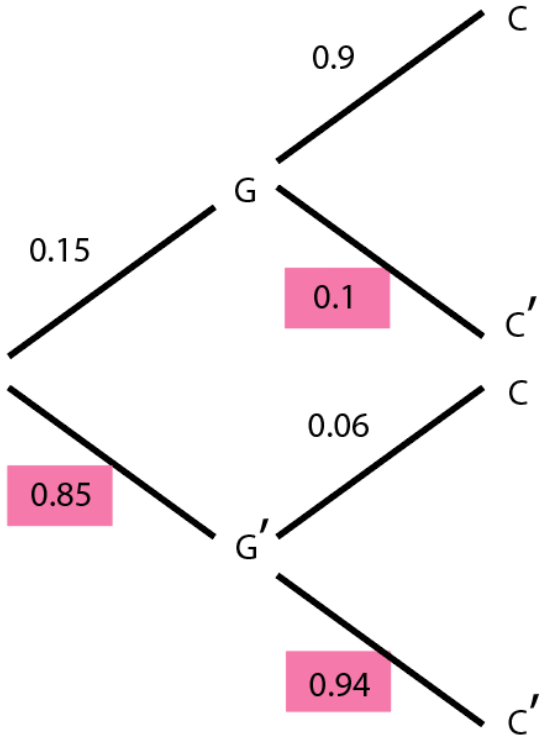
Q3		Answers	Notes	Total
	a	.1 Correctly write **the** first simultaneous equation .2 Correctly write **the** second simultaneous equation .3 Correct step towards solving **their** system including <u>at least one</u> correct <u>equation</u> .4 Correctly solve **their** equations for one unknown .5 Correctly write **their** corresponding unknown using one of **their** equations	.1 6x+3y = 12 ACCEPT using inequality .2 6x + 8x + 4y =19 or 14x + 4y =19 ACCEPT using inequality .3 correct operator for elimination. Example: $4\times(6x+3y=12)$ and $3\times(14x+4y=19)$ ACCEPT "4 times eq1 and 3 times eq2" or correct step for substitution y = 4-2x or x = 2-0.5y or 4y = 19-14x or 14x = 19-4y OE .3 DO NOT ACCEPT if their incorrect equation is not of similar complexity Ex: if their incorrect equation has coefficients of x and y both 1 6x+3y=6 and $3\times(x+y=5)$ OR substitute y=5 – x into 14x+4y=19 .3 DO NOT ACCEPT if they don't have two different equations .4 (x =) their0.5 OE OR (y =) their3 OE .5 (x =) their0.5 for their (y=)their3 OR their3 for their (x=)0.5 OE .5 ACCEPT seeing substitution of values for x and y that satisfy one of their equations Ex: $6\times1+3\times2=12$ **Note:** every bp has to be seen to award its mark Ex:	**5**
	b	.1 Correct time in hours OR in minutes .2 Correctly write their time in hours and minutes	.1 3.3 (hrs) ACCEPT $\frac{33}{10}$ OR 198 (mins) .2 their 3hours and their18 minutes .2 ACCEPT only if their bp1 is a decimal	**2**

Q4		Answers	Notes	Total
	a	2 (m)	ACCEPT (20,2) OE	**1**
	b	.1 Correctly substitute 0 and 18 into the parabola .2 Correctly re-arrange their equation to find a AG 0.04	.1 $a(0-20)^2+2=18$ or 18 = 400a+2 .2 (a =) $\frac{16}{400}$ ACCEPT 16=400a	**2**

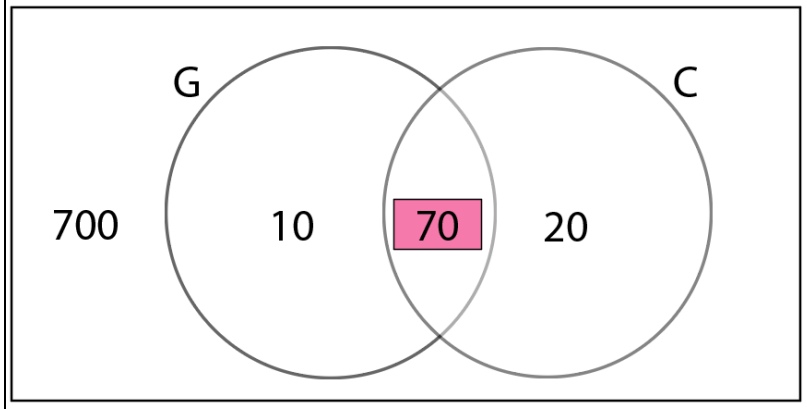
	c	**AM1 (working with $(x-20)$)** .1 Correctly substitute 3 into the equation .2 Correctly rearrange to have $(x-20)^2$ on one side .3 Correctly square root both sides of their quadratic from .2 .4 Correctly identify 25 **AM2 (expanding $(x-20)^2$)** .1 Correctly substitute 3 into the equation .2 Correct quadratic after expansion and multiplying by 0.04 .3 Correctly factorise their quadratic from .2 or correctly substitute their coefficients into quadratic formula .4 Correctly identify 25 **AM3 (working with numbers)** .1 Correctly substitute a value for x into the equation and calculate corresponding value of y .2 Correctly substitute 15 into the equation and equate with 3 .3 Correctly substitute 25 into the equation and equate with 3 .4 Correctly identify 25	**AM1** .1 $3 = 0.04(x-20)^2 + 2$ or $1 = 0.04(x-20)^2$ .2 $\frac{1}{0.04} = (x-20)^2$ or $25=(x-20)^2$ .3 x-20 =+-their5 OE ACCEPT $x-20 = \text{their}(\frac{1}{0.2})$ or x-20=their5 .4 (L=) 25 (m) **AM2** .1 $3=0.04(x-20)^2 + 2$ .2 $0.04x^2-1.6x+16+2 = 3$ or $x^2-40x+375=0$ OE .3 their (x-15)(x-25) or $\frac{-\text{their}1.6 \pm \sqrt{\text{their}1.6^2 - 4(0.04 \times \text{their}15)}}{2(0.04)}$ OE .3 In the case when their bp2 is in the form $ax^2 + c = 0$, ACCEPT correctly solving their quadratic for x^2 Ex: if their bp2 is $0.04x^2 + 10 = 0$ and $x^2 = \frac{-10}{0.04}$ .4 (L=) 25 (m) **AM3** .1 Ex: $0.04(10-20)^2 + 2 = 6$ .2 $0.04(15-20)^2 + 2 = 3$ .3 $0.04(25-20)^2 + 2 = 3$ .4 (L=) 25 (m) **For Any AM:** Seeing only bp2 implies bp1 (so award **2 marks**) Seeing only bp3 implies bp1 and bp2 (so award **3 marks**)	**4**

	d	.1 Correctly substitute into the correct trig ratio .2 Correctly calculate their d for their trig ratio	.1 $\sin 40 = \frac{25}{d}$ OE or $\cos 50 = \frac{25}{d}$ OE .2 their 38.89(30…) ACCEPT 38.9(…) or 39(.06) (m) .2 ACCEPT only if their seen trigonometric operation involves side=25 and angle=40 or 50 .2 ACCEPT using the rounded value of the trig function only if bp1 is awarded Ex: 41.6(…) or 42	**2**

Q5	Answers	Notes	Total
a	.1 correct probability .2 correct statement	$P(G' \cap C)$ Probability of selecting a person who does not have two red hair genes and has red hair $P(G' \cap C')$ Probability of selecting a person who does not have two red hair genes and does not have red hair .1 $P(G' \cap C)$ ACCEPT $P(G \cap C')$ ACCEPT using g instead of G and c instead of C .2 (Probability of selecting a person who) does not have two red hair genes and does not have red hair .2 ACCEPT no red hair genes and no red hair WTTE .2 ACCEPT not have two genes and not have red hair WTTE .2 ACCEPT no red hair genes nor red hair WTTE .2 ACCEPT no red hair genes or red hair WTTE .2 ACCEPT neither red hair genes nor red hair WTTE .2 ACCEPT neither red hair genes and red hair WTTE	2

	b	correctly write 0.85, 0.1 and 0.94 in the appropriate place		**1**
	c	.1 multiply the P(G) by P(C) .2 the correct result	.1 0.15 x 0.9 OE .2 0.135 OE	**2**
	d	.1 multiply their P(G') by P(C) .2 add their0.135 to theirbp1 .3 correctly calculate their result after adding **their** probabilities	.1 their0.85 x 0.06 or 0.051 .2 their0.135+ theirbp1 .2 ACCEPT their0.135+ theirbp1+other probabilities .2 ACCEPT their0.135 from part c) or calculated here in part d) .2 ACCEPT theirbp1 being a probability being without working .3 their0.186 OE .3 ACCEPT only if bp1 or bp2 are awarded	**3**

	e	.1 multiply their d) by 15500	.1 Their 0.186 x 15500	**2**

		.2 correctly write their result as a whole number after multiplying a probability by 15500	.2 Their 2883 .2 ACCEPT their whole number to be a rounding up or down for their result	
	f	A with correct reason	A (is better) because it has a larger sample or more values WTTE (so is more reliable) ACCEPT "the other" or "the first" instead of A DO NOT ACCEPT reasoning related to irrelevant measures Ex: mean, mode, median, IQR, or range	**1**
	g	correctly write 70 in the appropriate place		**1**
	h	.1 correct P(C) OR ratio	.1 $(\frac{1}{N}=)\frac{90}{800}$ or 0.1125 OE OR 90:800 .1 ACCEPT ratio in any notation Ex: 90 to 800 .1 ACCEPT their90 used in bp1 instead of 90 only if it is equal to 20+their70 from (g)	**3**
		.2 correctly write their N that satisfies **their** ratio $\frac{\text{their90}}{800}=\frac{1}{N}$ before rounding	.2 $(\frac{800}{\text{their90}}=)\text{their8.88(8...)}$ ACCEPT $\frac{\text{their90}}{800}=\frac{1}{\text{their8.88(8...)}}$ OE .2 ACCEPT (N=)8.88 or 8.9 .2 ACCEPT their90 used in bp2 being any number	
		.3 correctly round up their N	.3 their 9 .3 ACCEPT only if their bp2 needs rounding .3 ACCEPT only if bp1 or bp2 awarded	

	l	correctly subtract their11.25 from their18.6 from d)	(their18.6-their11.25=) their7.(35)(%) ACCEPT their11.25 even if it is incorrect ACCEPT only if percentage ACCEPT positive or negative Ex: (18.6-20=)-1.4(%) DO NOT ACCEPT their7.35(%) without working	**1**

Q6	Answers	Notes	Total
a	30<A ≤40	ACCEPT in any notation Ex: 30<A<40 or 30≤A<40 or 30≤A≤40 30 – 40 30 to 40 DO NOT ACCEPT 31≤A≤40 OE	**1**
b	.1 Correct mid-interval values .2 Add the product of their mid-interval values by frequency .3 Divide **their sum** by 331 .4 Correctly divide **the sum of their <u>products</u>** by 331	.1 5,15,25,35,45,55 ACCEPT seeing only four correct .2 $5\times59+15\times72+25\times54+35\times126+45\times15+55\times5$ OE or 8085 .2 ACCEPT seeing only four correct products OE added .3 $\frac{\text{their sum}}{331}$ ACCEPT their sum being any sum .4 their 24.(425...) ACCEPT only if 0<their24.(425…)<60 .4 DO NOT ACCEPT if it is the result of a sum divided by 331 Ex: ((5+15+25+35+45+55)/331=)0.54(38…)	**4**
c	.1 Apply the ratio on 72 .2 Correct operation based on the data 115 AG	.1 $72\times\frac{7}{9}$ OE OR $72\times\frac{2}{9}$ OE .1 ACCEPT “9 is 72 so 7 is” OE .2 56+59 or 59+72-16 or 131-16 ACCEPT 115-59=56 or 131-115=16 .2 ACCEPT in words. Ex: add 56 to 59 **Note:** Seeing only bp2 award **1 mark**	**2**
d	.1 Multiply 1400 or 90 by 15% OE .2 Correct result	.1 0.15x1400 or 210 or 0.15x90 or 13.5 OE ACCEPT 1400x90 or 126000 .2 (0.15x1400x90=)($)18900	**2**

6	e		10

Mark	1	2
Identify factors (F)	**Two** from the four factors below mentioned in the factors box • Number of children or number of users of playground ACCEPT under 14 ACCEPT using numbers even if incorrect. Ex: there are 56 children • Number of adults or number of users of fitness centre ACCEPT above 14 ACCEPT using numbers even if incorrect. Ex: there are 200 adults • Needed area per child or children per m^2 ACCEPT area or size of playground ACCEPT using numbers even if incorrect. Ex: $50m^2$ for 24 children or 3 m^2 per child • Cost ACCEPT money spent ACCEPT using numbers even if incorrect. Ex: ($)15 per m^2 for playground or ($)1000 for fitness	**Three** from the four factors mentioned in the factors box
	ACCEPT Factors that WTTE Ex: "not everyone is going to use the playground" is WTTE for the 1st factor Ex: "not everyone uses the fitness: is WTTE for the 2nd factor The use of "residents scheduled for" instead of "number of". The use of the word "gym" instead of "fitness centre". "Number of people" or "Number of residents in apartments" or "Number of users" instead of either the 1st factor or the 2nd factor but not both "Number of children in $15m^2$" instead of either the 1st factor or the 3rd factor but not both "People under 14 and older" as the 1st factor only "cost of maintenance for the playground/recreational area" as the 4th factor only "Residents scheduled for the playground and for the gym" as the 1st and 2nd factors	
	DO NOT ACCEPT Incomplete factors (using just a word). Examples: Number or Age or Area or recreational area or maintenance or children or adults Factors related to budget. Example: Maintenance budget or number of apartments or the ($)1400 or the 15% or ($)18900 "Budget of the recreational area"	

	1	2	3	4	5
Calc. (C) **ACCEPT rounding in calculations**	**Weak** attempt to calculate maintenance cost for area of playground (involves **one** correct operation) Ex: • 6 in 15 so 115 is… • $\frac{6}{15}=0.4$ OE • $\frac{15}{6}=2.5$ OE • $\frac{115}{6}=19.16...$ OE or 20 • $15\times115=1725$ • Multiply area by 2 Ex: $15\times2=30$ Ex: 115x2=230	**Good** attempt to calculate maintenance cost for area of playground (involves **two** correct operations) Ex: • $(\frac{15}{6}\times115$ or $\frac{115}{0.4}=)287.5$ **ACCEPT [285,300]** • $(\frac{115}{6}\times2=)38.33...$ **ACCEPT [38,40]** • $(15\times115\times2=)$ ($)**3450** • (30/6=)($)**5** Note: For all the above, only one more remaining operation is needed to reach the maintenance cost.	Correctly calculate the maintenance cost for the area of playground $(\frac{15}{6}\times115\times2=)($)575$ Ex: $(15\times2\times19=)($)570$ $(15\times2\times20=)($)600$ $(290\times2=)($)580$ **ACCEPT [570,600]**	Correctly calculate the maintenance cost for the area of playground monthly or yearly (monthly) **ACCEPT [570,600]** (yearly) **ACCEPT [1770,1800]** **AND** Correctly identify the maintenance cost for area of fitness ($)**1200**	Correctly calculate the total cost for recreation area monthly or yearly (monthly) (600+1200=) **ACCEPT [1770,1800]** (yearly) (600x12+1200x12=) **ACCEPT [21240,21600]**
	OR Correct number of fitness centre users $(331-115=)216$ **OR** Correctly identify the maintenance cost for area of fitness based on their number of adults Their($)1200 (for their216 adult)	**OR** Correctly identify the maintenance cost for area of fitness ($)**1200**	**OR** **Good** attempt to calculate maintenance cost for area of playground (involves **two** correct operations) AND Correctly identify the maintenance cost for area of fitness ($)**1200**		

Mark	1	2
Accuracy (A)	Correct sensible rounding seen in any calculation and ACCEPT not seeing the value before rounding Ex: Round their19.1666 to their 19.2 or their19 or their20 ACCEPT 115/6=19.2 Round their 287.5 to 285 or 288 or 290 or 300	
	ACCEPT Rounding up or down No rounding of exact calculations leading to whole numbers only if C3 is achieved "my calculations do not need rounding" WTTE and C1 or C2 achieved with a result of a whole number	
	DO NOT ACCEPT Insensible rounding. In particular, rounding to two decimal places. Ex: 19.16666 = 19.17	

<table>
<tr><th>Mark</th><th>1</th><th>2</th></tr>
<tr><td>Justify (J)</td><td>ACCEPT ONLY IF C1 is achieved

Justify suitability by comparing their calculations of maintenance cost to their budget from d)
Ex:
Maintenance cost exceeds the budget so not good WTTE
Maintenance cost is less than budget so it is fine WTTE
The suitable budget should be $\text{their}1800\times12=(\$)\text{their}21600$ per year WTTE
The suitable budget should be $(\frac{\text{their}1800}{90}=)(\$)\text{their}20$ per apartment per month WTTE
ACCEPT
<u>Incorrect justification</u> by comparing correct monthly maintenance cost with their yearly budget
Ex: 1800 less than 18900, <u>so it is suitable</u>

OR
The correct cost and their corresponding (monthly or yearly) budget seen OE without comment (at least C4 achieved)
Ex: seeing the cost as ($)1800 and the budget as (their18900/12=)($)their1575
Ex: seeing the cost as ($)21240 and the budget as their ($)18900
Ex: the remaining for fitness is 1575-575=($)1000 and we see cost fitness ($)1200
OR
General justification of suitability
Ex:
-The spaces calculated are just estimates so calculations are estimates
-Collect more money for maintenance just in case
-Number of persons in each category will vary overtime and hence the areas need to consider being a bit bigger for the future use. WTTE
- Some families may get new babies and children number increases so we need to have the recreation spaces a bit bigger
-Some of the children will become adults soon so we need to have the fitness spaces a bit bigger</td><td>ACCEPT ONLY IF C4 is achieved

Justify suitability by comparing the correct calculations of maintenance cost to their budget from d)

The maintenance cost exceeds budget so not good WTTE
The maintenance cost is less than budget so it is fine WTTE
The suitable budget should be $1800\times12=(\$)21600$ per year WTTE
The suitable budget should be $(\frac{1800}{90}=)(\$)20$ per apartment per month WTTE
ACCEPT
<u>Correct justification implied</u> by comparing correct monthly maintenance cost with their yearly budget
Ex: The monthly cost is 1800 and the budget is 18900 <u>so not suitable</u>

DO NOT ACCEPT
Justification by comparing monthly value with yearly value
Ex: 1800 less than 18900 so it is suitable</td></tr>
<tr><td></td><td colspan="2">NOTE
ACCEPT Seeing just the word ”budget” when comparing instead of their actual value in part (d). Check their value in part (d) when marking the justification</td></tr>
</table>

Q7		Answers	Notes	Total
	a	The correct operations on the numbers 28 AG	4x7 or 7+7+7+7 ACCEPT incorrect notation Ex: 7*7 ACCEPT in words, Ex: four times seven or four by 7 WTTE ACCEPT 28/4=7 only if they mention that 7 is the side of the square WTTE DO NOT ACCEPT other operations Ex: 20+8 or 14+14 DO NOT ACCEPT substitution in the general rule: 4+3x8 or 8x4-4 DO NOT ACCEPT substitution in the recursive rule: 28=20+8	**1**

<table>
<tr>
<td></td>
<td>b</td>
<td>Correctly place 36 and 44</td>
<td>
<table>
<tr><th>Stage (n)</th><th>Number of new squares added (P)</th></tr>
<tr><td>1</td><td>4</td></tr>
<tr><td>2</td><td>12</td></tr>
<tr><td>3</td><td>20</td></tr>
<tr><td>4</td><td>28</td></tr>
<tr><td>5</td><td>36</td></tr>
<tr><td>6</td><td>44</td></tr>
</table>
</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>c</td>
<td>.1 correctly describe one pattern for P in words

.2 correctly describe a second pattern for P in words</td>
<td>ACCEPT complete terminology only, for example (below are four different descriptions)
multiples of 4, divisible by 4
increasing by 8, adds 8, goes up by 8, moving up by 8
difference 8, common difference 8, linear with difference 8, arithmetic with difference 8
second difference is zero

DO NOT ACCEPT incomplete terminology, for example: Arithmetic, linear, increasing by a constant, constant difference

DO NOT ACCEPT general description, for example:

Integers, whole numbers, positive, even numbers, divisible by 2, multiples of 2

DO NOT ACCEPT the rule in words or description related to n for example:
8 times n minus 4, n multiplied by 8 minus 4, WTTE
DO NOT ACCEPT
n goes up by 1
It is increasing
general rules in terms of n, example: P = 8n-4

Note, in the case when they have more than two different patterns:
If two are accepted and the rest are all correct: award 2 marks
Ex: even numbers and adds 8 and Second difference is zero and it is 8 times n then subtract 4.
Ex: multiples of 2 and 4 and linear and increases by 8 and divisible by 4

If two are accepted and any of the rest is incorrect: award 1 mark
Ex: increases by 4 and Second difference is zero and it is divisible by 8

If only one is accepted, ignore the rest and award 1 mark</td>
<td>2</td>
</tr>
</table>

	d	.1 the correct general rule .2 the correct simplified general rule with correct notation	.1 (P =) $8n$-4 or (P =) $4(2n–1)$ or P =$8x$-4 or P =4+8(n-1) or P=8xn-4 or P=8*n-4 .2 P = $8n$-4 or P=$4(2n$-1) ACCEPT P = ($8n$-4) or P = –4+ $8n$ ACEEPT using P_n instead of P ACCEPT P=n8-4 ACCEPT using p and N DO NOT ACCEPT description in words **SC 1 mark in 8d and consequently mark 8e as appropriate** If NR in 8d and correct general rule seen in 8c or 8e If they write in 8d the rule in terms of u_1 and d Ex: $u_1 + (n-1)$d then in 8e, when they test or verify, they directly use 4 instead of u_1 and 8 instead of d	**2**
	e	·1 Correctly substitute $n \geq 5$ into their general rule ·2 Correctly calculate their value of P after substituting $n \geq 5$ ·3 Recognize that their result is the same as the correctly predicted value	.1 Ex: 8x5-4 ·2 Ex: 36 .3 “the same as when we continue the pattern” WTTE and states how. Ex: For n=7, 52 is obtained from pattern of adding 8 to 44 For n=7, 52-8=44 ·3 ACCEPT if their value from .2 is the same as their value in the table in part b) or seen here in part e) Ex: we see their calculated P=36 and we see P=36 in their table **SC for 1 mark** Correctly test their general rule by applying the steps of verification mentioned in the left column with a value of $n \leq 4$ **SC for 1 mark** verify with $n \geq 5$ the correctly described pattern or recursive rule from part c) or d)	**3**
	f	The correct operations on the numbers 53 AG	7x7+4 or 7^2+4 ACCEPT incorrect notation Ex: 7^2+4 ACCEPT in words Ex: seven times seven plus four or square of side 7 then add 4 WTTE DO NOT ACCEPT other operations Ex: 53x1 or 29+24 DO NOT ACCEPT substitution in the general rule: $4(4^2)$-4(4)+5 DO NOT ACCEPT substitution in the recursive rule: 29+8x4 OE	**1**

Glossary for task 3

Term used	**Clarification**
General rule	Rule in terms of only n (if they use x, it is still general rule but penalise in notation)
The general rule	The correct general rule in terms of only n (if they use x, it is still the general rule but penalise in notation)
Their general rule	Incorrect rule but in terms of only n (if they use x, it is still their general rule but penalise in notation)
Their rule	Correct rule not in terms of only n
Recursive rule	$U_n = U_{n-1} + d$ or $U_{n+1} = U_n + d$ Ex: $A_n=A_{n-1}+8n$

We accept subsequent use of their general rule (when marking D,T, V,J, N, and L) provided it is of similar complexity. In general, the complexity of the rule depends on its form. The table below shows examples.

The general rule	ACCEPT for their general rule	DO NOT ACCEPT for their general rule
$P = 8n - 4$	linear	constant
$A=(2n-1)^2+4$	Qudratic or exponential	Linear or constant

Stage number (n)	Area of shape (A)
1	5
2	13
3	29
4	53
5	85
6	125
7	173
8	229

<table>
<tr><th>Mark</th><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>Predictions (P)</td><td>Correctly predict two terms for A
ACCEPT whether in the table or in the response box
ACCEPT additional incorrect predictions</td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Description (D)

ACCEPT incorrect terminologies, notation errors, non-simplified rule, or rule in words but penalize in notation (N)

Ignore additional incorrect patterns</td><td>Correctly describe a pattern in words for A (or the recursive rule for A: $A_{n+1} = A_n + 8n$)
Examples of different patterns: <u>(can be seen anywhere in the response)</u>
Odd numbers
Difference (or increase) is multiple of 8
Difference (or the increase) is even or multiple of 4
The increase increases by 8 or what I add increases by 8
Difference increases by 8, increase of the difference by 8
Second difference 8
It is quadratic

ACCEPT patterns described with incorrect terminologies or recursive rule with incorrect notation but penalise in notation (N).
Ex:
<u>the</u> odd numbers
uneven numbers
increases by the 8 times table
(A=)A+8n or X=X+8n or the rule is A+8n</td><td>Correctly describe two patterns in words for A (or one pattern and the recursive rule for A)</td><td>Correctly describe two patterns in words for A (or one pattern and the recursive rule for A) AND
Valid attempt to write down a general rule for A</td><td rowspan="2">Correctly describe two patterns in words for A (or one pattern and the recursive rule for A)

AND

Correctly write down the general rule for A</td></tr>
<tr><td>OR
Valid attempt to write down a general rule for A
Ex: $A = (2n-1)^2$ or $4n^2$
Ex: An exponential rule that satisfies one value for n</td><td>OR
Correctly describe a pattern in words for A (or the recursive rule for A) AND valid attempt to write down a general rule for A.</td><td>OR
Correctly write down the general rule for A</td></tr>
<tr><td colspan="4">DO NOT ACCEPT

Descriptions of how squares are added
Goes up by 8,16,24,…
Recursive rule in words
Second difference constant</td></tr>
</table>

Mark	1	2	3
Testing (T)	Attempt to test their general rule for A using $n \leq 4$ Ex: Substitute in their general rule for A value of $n \leq 4$	Correctly test their general rule for A using $n \leq 4$ Ex: Correctly calculate their value for A in their general rule using $n \leq 4$ **AND** Recognise that their correctly calculated value for A is the same as the given value.	
	OR Correctly test their described pattern or their rule (e.g. the recursive rule for A or their linear rule for A)		
		ACCEPT seeing their correctly calculated value for A and the given value in the table being equal	
Verifying (V)	Attempt to verify their general rule for A using $n \geq 5$ Ex**:** Correctly substitute in their general rule for A value of $n \geq 5$	Correctly calculate their value for A in their general rule using $n \geq 5$	Correctly calculate their value for A in <u>the general rule</u> using $n \geq 5$ **AND** Recognise that their correctly calculated value for A is the same as the correct predicted value obtained by continuing the pattern
	OR Correctly verify their described pattern or their rule (e.g. the recursive rule for A or their linear rule for A)		**ACCEPT** seeing their correctly calculated value for A and the correctly predicted value in the table being equal

Mark	1	2	3	4
Justify/ proof (J)	**ACCEPT only if D1 is achieved**	**ACCEPT only if they have a general rule for *A***	**ACCEPT only if they have the correct general rule for *A***	**ACCEPT only if they have the correct general rule for *A***
	Attempt to justify <u>their</u> general rule aligned with their notation for <u>their</u> general rule or recursive rule by attempting to find coefficients using any method	Correctly justify <u>the</u> general rule aligned with their notation for <u>the</u> general rule for *A* by correctly finding coefficients of quadratic using any method	Attempt to justify geometrically the general rule for *A* Divide the general rule of *P* by 4 or recognize (*L*=)2*n*-1 then add 4 Divide the general rule of *P* by 4 or recognize (*L*=)2*n*-1 and square it or multiply by itself but forget to add 4	Correctly justify geometrically the general rule for *A* Divide the general rule of *P* by 4 or recognize (*L*=)2*n*-1 ,square it or multiply by itself, then add 4
	OR Weak attempt to justify <u>their</u> general rule for *A* geometrically by saying big square added to 4 squares WTTE and we see 4 added in their general rule	**OR** Weak attempt to justify <u>the</u> general rule for *A* geometrically by Squaring incorrect length of square in terms of *n* and add 4 or using numbers Ex: in 5th stage, area= $9^2 + 4 = 85$ which is the same as using my rule $4(5)^2 - 4(5) + 5 = 85$		
	OR Substitute at least two other values of *n* in their general rule for *A* and say they are the same or hence the rule works WTTE			

<table>
<tr><th>Mark</th><th>1</th><th>2</th><th>3</th></tr>
<tr><td rowspan="4">Notation and terminology (N)</td><td>ACCEPT only if D1 achieved</td><td>ACCEPT only if D3 achieved</td><td>ACCEPT only if D3 achieved</td></tr>
<tr><td rowspan="2">Correct notation of <u>their</u> general rule for A</td><td>Correct notation of <u>the general</u> rule for A in simplest form
$A = (2n-1)^2 + 4$ or $A = 4n^2 - 4n + 5$
ACCEPT using A_n or An instead of A</td><td rowspan="2">Correct notation of <u>the general</u> rule for A in simplest form (see examples in N2)
AND
Correctly describe one pattern in words for A using correct terminology or correct recursive rule for A using correct notation</td></tr>
<tr><td>OR
The notation of <u>the general</u> rule includes errors or not simplified or in words (see examples in N1) <u>AND</u> Correctly describe one pattern in words for A using correct terminology or correct recursive rule for A using correct notation</td></tr>
<tr><td rowspan="2">OR
The notation of <u>the general</u> rule includes errors or not simplified or in words Ex:
A=(2n-1)^2+4 or A=4xn^2-4n+5
The rule for A is $(2n-1)^2 + 4$
$A = (2n-1)(2n-1) + 4$
or the square of $(2n-1)$ then add 4</td><td>ACCEPT
using U_n instead of A only if they mention that
$A = U_n$</td><td>ACCEPT
using U_n instead of A only if they mention that
$A = U_n$</td></tr>
<tr><td>DO NOT ACCEPT
using * for multiplication
using / for division
using ^ for power
using x instead of n</td><td>DO NOT ACCEPT
using * for multiplication
using / for division
using ^ for power
using x instead of n</td></tr>
<tr><td>OR
Correctly describe one pattern in words for A using correct terminology or correct recursive rule for A using correct notation
$A_n = A_{n-1} + 8n$ or $A_{n+1} = A_n + 8n$</td><td>DO NOT ACCEPT
if they don't have the general rule for A</td><td>DO NOT ACCEPT
if they don't have the general rule for A</td></tr>
</table>

Mark	1	2	3
Communication (L) Organisation and coherence Can be awarded even if there are errors **For items:** Describing pattern and writing rule can be considered an item even if D0 awarded	**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 (at least T1) • verify their general rule or rule or recursive rule or pattern (at least V1) • justify their general rule or rule or recursive rule or pattern (at least J1)	**ACCEPT only if they have a general rule** **At least four** of the following **items** are seen: • describe a pattern in words • write a general rule • test their general rule (at least T1) • verify their general rule (at least V1) • justify their general rule (at least J1) **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 substitute in their general rule value(s) of $n \leq 4$ only • **For verify:** they say “verify” and they substitute in their general rule value(s) of $n \geq 5$ only • **For justify:** They say “justify” and they write a justification **Note for coherence:** If they say “test and verify” and they substitute in their general rule value(s) of $n \leq 4$ followed by value(s) of $n \geq 5$, consider it as only one identified process	**ACCEPT only if they have the general rule for *A*** **The following two items must be seen** : • write the general rule for *A* • justify the general rule (at least J2) **AND** **At least two** of the following **items** are seen: • describe a pattern or rule in words • test the general rule (at least T1) • verify the general rule (at least V1) **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 substitute in the general rule for A value(s) of $n \leq 4$ only • **For verify:** they say “verify” and they substitute in the general rule for A value(s) of $n \geq 5$ only • **For justify:** They say “justify” and they write a justification **Note for coherence:** If they say “test and verify” and they substitute in the general rule value(s) of $n \leq 4$ followed by value(s) of $n \geq 5$, consider it as only one identified process