

Markscheme

November 2023

Mathematics

On-screen examination



33 pages

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

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 sinx > 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 \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.
- I) 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
	а	Correct angle	60 (degrees)	1
	b	Correct angle	120 (degrees) ACCEPT –120 (degrees)	1
	С	AM1 .1 Correctly write the horizontal translation .2 Correctly write the vertical translation	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 + $\sqrt{3}$	2
		AM2 .1 Correctly write the first rotation point and angle .2 Correctly write the second rotation and angle	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	

d	.1 Correctly relate interior angle to 360 for two regular	.1 two from:	
	shapes	(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
	.2 Correctly relate interior angle to 360 for the third regular shape	.2 the third from the above	
е		ACCEPT touching if the octagons are reasonably close (cannot take the square in-between) ACCEPT not seeing the squares (ignore the squares)	
	.1 4 connected octagons correctly touching in two directions	.1 Ignore additional incorrectly touching octagons. See examples on the next pages	2
	.2 Exactly 8 connected octagons correctly touching in two directions	.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	





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)







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," ae="BE" and="" oe<br="">.1 Two correct reasons .2 Third correct reason AG AED and BEC are congruent</a=<b,>	SC 1 mark for any of the following (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 	.1 Two from:: • 10-4 or 4-10 or 6 or -6 • 93 or -3-9 or 12 or -12 • $\frac{\text{their}(10-4)}{\text{their}(93)}$	2
	.2 The correct gradient	$\frac{12}{12}$ DE	
С	.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 $\sqrt{(93)^2 + (10-4)^2}$ OE .2 their $\sqrt{180}$ or their 13.4(164) .2 ACCEPT their AB correctly calculated after one mistake examples: $(\sqrt{(93)^2 + (10-4)} =)12.2(47)_{OF} (\sqrt{(93)^2} + (10-4)^2 =)48$.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 $\frac{-3 + \text{their13}}{2}$ OR $\frac{10-4}{2}$ or $\frac{4+2}{2}$.2 (5,3) OE ACCEPT 5,3	2

Q3	5	Answers	Notes	Total
а		.1 Correctly write the first simultaneous equation	.1 6x+3y = 12 ACCEPT using inequality	
		.2 Correctly write the second simultaneous equation	.2 $6x + 8x + 4y = 19$ or $14x + 4y = 19$ ACCEPT using inequality	
		.3 Correct step towards solving their system including <u>at least</u> one correct <u>equation</u>	t.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 Function is a substitute of the substitute of	
			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	5
		.4 Correctly solve their equations for one unknown	.4 (x =) their0.5 OE OR (y =) their3 OE	
		.5 Correctly write their corresponding unknown using one of their equations	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: $6 \times 1+3 \times 2 = 12$	
			Note: every bp has to be seen to award its mark Ex:	
b		.1 Correct time in hours OR in minutes	.1 3.3 (hrs) ACCEPT $\frac{33}{10}$ OR 198 (mins)	
		.2 Correctly write their time in hours and minutes	.2 their 3hours and their18 minutes .2 ACCEPT only if their bp1 is a decimal	2

Q4	Ļ	Answers	Notes	Total
	а	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

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С	AM1 (working with $(x-20)$)	AM1	1
	.1 Correctly substitute 3 into the equation	.1 3 = $0.04(x-20)^2 + 2$ or 1 = $0.04(x-20)^2$	
	.2 Correctly rearrange to have (x-20) ² on one side	.2 $\frac{1}{0.04} = (x - 20)^2$ or $25 = (x - 20)^2$	
	.3 Correctly square root both sides of their quadratic from .2	.3 x-20 =+-their5 OE ACCEPT $x - 20 = their(\frac{1}{0.2})$ or x-20=their5	
	.4 Correctly identify 25	.4 (L=) 25 (m)	
	AM2 (expanding $(x - 20)^2$)	AM2	
	A mz (expanding $(x - 20)$)	.1 3=0.04(x-20) ² + 2	
	.2 Correct quadratic after expansion and multiplying by 0.04	.2 $0.04x^2$ -1.6x+16 +2 = 3 or x ² -40x+375=0 OE	
	.3 Correctly factorise their quadratic from .2 or correctly substitute their coefficients into quadratic formula	.3 their (x-15)(x-25) or $\frac{-\text{their1.6} \pm \sqrt{\text{their1.6}^2 - 4(0.04 \times \text{their15})}}{2(0.04)} \text{ OE}$	
		.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
	.4 Correctly identify 25	.4 (L=) 25 (m)	
	AM3 (working with numbers) .1 Correctly substitute a value for x into the equation and calculate corresponding value of y	AM3 .1 Ex: 0.04(10-20) ² + 2 = 6	
	.2 Correctly substitute 15 into the equation and equate with 3	.2 $0.04(15-20)^2 + 2 = 3$	
	.3 Correctly substitute 25 into the equation and equate with 3	.3 $0.04(25-20)^2 + 2 = 3$	
	.4 Correctly identify 25	.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)	

C	d	.1 Correctly substitute into the correct trig ratio	.1 sin 40 = $\frac{25}{d}$ OE or cos 50 = $\frac{25}{d}$ OE	
		.2 Correctly calculate their d for their trig ratio	.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
а		P(G'∩C)	Probability of selecting a person who does not have two red hair genes and has red hair	
		P (G′ ∩ C′)	Probability of selecting a person who does not have two red hair genes and does not have red hair	
	.1 correct probability .2 correct statement	.1 P(G' \cap C) ACCEPT $P(G \cap C')$ ACCEPT .2 (Probability of selecting a person who) .2 ACCEPT no red hair genes and no red .2 ACCEPT not have two genes and not h .2 ACCEPT no red hair genes nor red hair .2 ACCEPT no red hair genes <u>or</u> red hair .2 ACCEPT neither red hair genes nor red .2 ACCEPT neither red hair genes and red	Tusing g instead of G and c instead of C does not have two red hair genes and does not have red hair hair WTTE nave red hair WTTE r WTTE WTTE d hair WTTE d hair WTTE	2

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b	correctly write 0.85, 0.1 and 0.94 in the appropriate place	$\begin{array}{c} 0.9 \\ 0.15 \\ 0.16 \\ 0.06 \\ 0.85 \\ 0.94 \\ 0.9$	1
С	.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)	.1 their0.85 x 0.06 or 0.051	
	.2 add their0.135 to theirbp1	.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
	.3 correctly calculate their result after adding their probabilities	.3 their0.186 OE .3 ACCEPT only if bp1 or bp2 are awarded	

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	
ł	f A with correct reason	<u>A (</u> is better) because it has a <u>larger sample</u> 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 .2 correctly write their N that satisfies their ratio $\frac{\text{their90}}{800} = \frac{1}{N}$ before rounding .3 correctly round up their N	.1 $\left(\frac{1}{N}\right) = \frac{90}{800}$ 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) $\left(\frac{800}{\text{their90}}\right) = \text{their8.88(8)}_{ACCEPT} \frac{\text{their90}}{800} = \frac{1}{\text{their8.88(8)}}_{OE}$.2 ACCEPT (N=)8.88 or 8.9 .2 ACCEPT (N=)8.88 or 8.9 .2 ACCEPT their90 used in bp2 being any number .3 their 9 .3 ACCEPT only if their bp2 needs rounding .3 ACCEPT only if bp1 or bp2 awarded	3

I	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(%)	1
		DO NOT ACCEPT their7.35(%) without working	

Q6	Answers	Notes	Total
а	30 <a td="" ≤40<=""><td>ACCEPT in any notation Ex: $30 < A < 40$ or $30 \le A < 40$ or $30 \le A \le 40$ 30 - 40 30 to <math>40 DO NOT ACCEPT $31 \le A \le 40$ OE</math></td><td>1</td>	ACCEPT in any notation Ex: $30 < A < 40$ or $30 \le A < 40$ or $30 \le A \le 40$ 30 - 40 30 to $40DO NOT ACCEPT 31 \le A \le 40 OE$	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 products by 331 	.1 5,15,25,35,45,55 ACCEPT seeing only four correct .2 $5 \times 59 + 15 \times 72 + 25 \times 54 + 35 \times 126 + 45 \times 15 + 55 \times 5$ 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)</their24.(425)<60 	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

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

6 e

	1	2	3	4	5
Calc. (C)	Weak attempt to calculate maintenance cost for area of playground (involves one correct operation)	Good attempt to calculate maintenance cost for area of playground (involves two correct operations)	Correctly calculate the maintenance cost for the area of playground	Correctly calculate the maintenance cost for the area of playground monthly or yearly	Correctly calculate the total cost for recreation area monthly or yearly
ACCEPT rounding in calculatio ns	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 • $15 \times 115 = 1725$ • Multiply area by 2 Ex: $15 \times 2 = 30$ Ex: $115x2=230$ OR Correct number of fitness centre users	EX. • $(\frac{15}{6} \times 115 \text{ or } \frac{115}{0.4} =)287.5$ ACCEPT [285,300] • $(\frac{115}{6} \times 2 =)38.33$ ACCEPT [38,40] • $(15 \times 115 \times 2 =) (\$)3450$ • $(30/6=)(\$)5$ Note: For all the above, only one more remaining operation is needed to reach the maintenance cost. OR Correctly identify the maintenance cost for area of fitness (\$)1200	$(\frac{15}{6} \times 115 \times 2 =)(\$)575$ Ex: $(15 \times 2 \times 19 =)(\$)570$ $(15 \times 2 \times 20 =)(\$)600$ $(290 \times 2 =)(\$)580$ ACCEPT [570,600] OR Good attempt to calculate maintenance cost for area of	(monthly) ACCEPT [570,600] (yearly) ACCEPT [1770,1800] AND Correctly identify the maintenance cost for area of fitness (\$)1200	(monthly) (600+1200=) ACCEPT [1770,1800] (yearly) (600x12+1200x12=) ACCEPT [21240,21600]
	(331–115 =)216 OR Correctly identify the maintenance cost for area of fitness based on their number of adults Their(\$)1200 (for their216 adult)		playground (involves two correct operations) AND Correctly identify the maintenance cost for area of fitness (\$) 1200		

Mar	1	2
k		
Acc	Correct sensible rounding seen in any calculation and ACCEPT not seeing the value before	
ura	rounding Ex:	
CV	Round their 19 1666 to their 19 2 or their 19 or their 20 ACCEPT 115/6=19 2	
(Δ)	Round their 287 5 to 285 or 288 or 290 or 300	
(~)		
	ACCEPT	
	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	
	Insensible rounding. In particular, rounding to two decimal places.	
	Ex: 19.16666 = 19.17	

Mar k	1	2
ĸ		
Jus tifv	ACCEPT ONLY IF C1 is achieved	ACCEPT ONLY IF C4 is achieved
(J)	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 their1800 × 12 = (\$)their21600 per year WTTE The suitable budget should be $(\frac{\text{their1800}}{90} =)($)$ their20 per apartment per month WTTE ACCEPT Incorrect justification by comparing correct monthly maintenance cost with their yearly budget Ex: 1800 less than 18900, <u>so it is suitable</u>	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 $1800 \times 12 = (\$)21600$ per year WTTE The suitable budget should be $(\frac{1800}{90} =)(\$)20$ per apartment per month WTTE
	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	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</u> <u>suitable</u> DO NOT ACCEPT
	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	Justification by comparing monthly value with yearly value Ex: 1800 less than 18900 so it is suitable
	NOTE ACCEPT Seeing just the word "budget" when comparing instead of their actual value in part (d). Cl	heck their value in part (d) when marking the justification

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

b	Correctly place 36 and 44	Stage (<i>n</i>)	Number of new squares added (<i>P</i>)		
		1	4		
		2	12		1
		3	20		•
		4	28		
		5	36		
		6	44		
c	.1 correctly describe one pattern for <i>P</i> in words .2 correctly describe a second pattern for <i>P</i> in words	ACCEPT complete termin multiples of 4, divisible by increasing by 8, adds 8, g difference 8, common difference is zero DO NOT ACCEPT incomplete a constant, constant differ DO NOT ACCEPT generation Integers, whole numbers, DO NOT ACCEPT generation the seron minus 4, <i>n</i> multiplete DO NOT ACCEPT the rul 8 times <i>n</i> minus 4, <i>n</i> multiplete DO NOT ACCEPT <i>n</i> goes up by 1 It is increasing general rules in terms of <i>r</i> Note, in the case when t If two are accepted and the Ex: even numbers and a subtract 4. Ex: multiples of 2 and 4 and If two are accepted and and Ex: increases by 4 and Second	bology only, for example (b 4 oes up by 8, moving up by erence 8, linear with difference plete terminology, for exam- rence al description, for example positive, even numbers, d e in words or description re- plied by 8 minus 4, WTTE a, example: $P = 8n-4$ they have more than two he rest are all correct: awaidds 8 and Second difference ind linear and increases by my of the rest is incorrect: a econd difference is zero are nore the rest and award 1	elow are four different descriptions) / 8 ence 8, arithmetic with difference 8 nple: Arithmetic, linear, increasing by : livisible by 2, multiples of 2 elated to <i>n</i> for example: different patterns: rd 2 marks ence is zero and it is 8 times <i>n</i> then / 8 and divisible by 4 award 1 mark nd it is divisible by 8 mark	2

	d	.1 the correct general rule	.1 $(P =) 8n-4$ or $(P =) 4(2n-1)$ or $P = 8x-4$ or $P = 4+8(n-1)$ or $P = 8x-4$ or $P = 8x-4$	
		.2 the correct simplified general rule with correct notation	P = 8n-4 or P=4(2n-1) ACCEPT P = (8n-4) or P = -4+8n	
			ACEEPT using <i>P</i> ₅instead of <i>P</i>	
			ACCEPT P=n8-4	
			ACCEPT using p and N	•
			DO NOT ACCEPT description in words	2
			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 ${}^{{m U}_1}$ and 8 instead of d	
	е	·1 Correctly substitute $n \ge 5$ into their general rule	.1 Ex: 8x5-4	
			·2 Ex: 36	
		·2 Correctly calculate their value of <i>P</i> after		
substituting $n \ge 5$.3 "the same as when we continue the pattern" WTTE and st		.3 "the same as when we continue the pattern" WTTE and states how. Ex:		
For <i>n</i> =7, 52 is obtained from pattern of adding 8 to 44				
·3 Recognize that their result is the same as the For n=7, 52-8=44		For n=7, 52-8=44		
		correctly predicted value		
			-3 ACCEPT if their value from .2 is the same as their value in the table in part b) or seen	3
			$\frac{1}{2}$	
			EX. We see their calculated F-50 and we see F-50 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 $n \le 4$	
			SC for 1 mark	
			verify with $n \ge 5$ the correctly described pattern or recursive rule from part c) or d)	
	f	The correct operations on the numbers	7x7+4 or 7 ² +4	
			ACCEPT incorrect notation Ex: 7 ² +4	
		53 AG	ACCEPT in words Ex: seven times seven plus four or square of side 7 then add 4 WTTE	1
			DO NOT ACCEPT other operations Ex: 53x1 or 29+24	1
			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	

Glossary for task 3

Term used	Clarification
General rule	Rule in terms of only <i>n</i> (if they use <i>x</i> , it is still general rule but penalise in notation)
The general rule	The correct general rule in terms of only <i>n</i> (if they use <i>x</i> , it is still the general rule but penalise in notation)
Their general rule	Incorrect rule but in terms of only <i>n</i> (if they use <i>x</i> , it is still their general rule but penalise in notation)
Their rule	Correct rule not in terms of only <i>n</i>
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
<i>P</i> = 8 <i>n</i> - 4	linear	constant
A=(2n-1) ² +4	Qudratic or exponential	Linear or constant

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

Mark	1	2	3	4
Predictions (P)	Correctly predict two terms for A ACCEPT whether in the table or in the response box			
(-)	ACCEPT additional incorrect predictions			
Description (D)	Correctly describe a pattern in words for A (or the recursive rule for A: $A_{n+1} = A_n + 8n$)	Correctly describe two patterns in words for A (or one pattern	Correctly describe two patterns in words for A (or	Correctly describe two patterns in words for A (or
(-)	Examples of different patterns: (can be seen anywhere in the	and the recursive rule for <i>A</i>)	one pattern and the	one pattern and the
ACCEPT	Odd numbers		Valid attempt to write down	recursive rule for A)
incorrect	Difference (or increase) is multiple of 8		a general rule for A	
terminologi	Difference (or the increase) is even or multiple of 4		a general fale for M	
es.	The increase increases by 8 or what I add increases by 8			Correctly write down the
notation	Difference increases by 8, increase of the difference by 8			general rule for A
errors, non-	Second difference 8			C C C C C C C C C C C C C C C C C C C
simplified	It is quadratic			
rule, or rule				
in words	ACCEPT patterns described with incorrect terminologies or			
but .	recursive rule with incorrect notation but penalise in notation (N).			
penalize in	Ex:			
notation (N)	the odd numbers			
	uneven numbers			
lanoro	$(\Lambda -)\Lambda + 8n$ or $X - X + 8n$ or the rule is $\Lambda + 8n$			
additional		OR	OR	
incorrect	Valid attempt to write down a general rule for A	Correctly describe a pattern in	Correctly write down the	
patterns	Ex: $A = (2n-1)^2$ or $4n^2$	words for A (or the recursive	general rule for A	
•	Ex: An exponential rule that satisfies one value for n	rule for A) AND valid attempt to	5	
	•	write down a general rule for A.		
		DO NOT ACCEPT		
	Descriptions of how squares are added			
	Goes up by 8,16,24,			
	Recursive rule in words			
	Second difference constant			

Mark	1	2	3
Testing (T)	Attempt to test their general rule for <i>A</i> using $n \le 4$ Ex: Substitute in their general rule for <i>A</i> value of $n \le 4$	Correctly test their general rule for A using $n \le 4$ Ex: Correctly calculate their value for A in their general rule using $n \le 4$ AND	
	OR Correctly test their described pattern or their rule (e.g. the recursive rule for <i>A</i> or their linear rule for <i>A</i>)	Recognise that their correctly calculated value for <i>A</i> is the same as the given value.	
		ACCEPT seeing their correctly calculated value for <i>A</i> and the given value in the table being equal	
Verifying (V)	Attempt to verify their general rule for A using $n \ge 5$ Ex: Correctly substitute in their general rule for A value of $n \ge 5$ OR	Correctly calculate their value for <i>A</i> in their general rule using $n \ge 5$	Correctly calculate their value for A in the general rule using $n \ge 5$ AND Recognise that their correctly calculated value for A is the same as the correct predicted value obtained by continuing the pattern
	Correctly verify their described pattern or their rule (e.g. the recursive rule for <i>A</i> or their linear rule for <i>A</i>)		ACCEPT seeing their correctly calculated value for <i>A</i> 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 <i>A</i>	ACCEPT only if they have the correct general rule for <i>A</i>	ACCEPT only if they have the correct general rule for <i>A</i>
	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 <i>A</i> by correctly finding coefficients of quadratic using any method	Attempt to justify geometrically the general rule for <i>A</i> Divide the general rule of <i>P</i> by 4 or recognize (<i>L</i> =)2 <i>n</i> -1 then add 4 Divide the general rule of <i>P</i> by 4 or recognize (<i>L</i> =)2 <i>n</i> -1 and square it or	Correctly justify geometrically the general rule for <i>A</i> Divide the general rule of <i>P</i> by 4 or recognize $(L=)2n-1$, square it or multiply by itself, then add 4
	OR Weak attempt to justify <u>their</u> general rule for <i>A</i> geometrically by saying big square added to 4 squares WTTE and we see 4 added in their general rule OR Substitute at least two other values of <i>n</i> in their general rule for <i>A</i> and say they are the same or hence the rule works WTTE	OR Weak attempt to justify <u>the</u> general rule for <i>A</i> geometrically by Squaring incorrect length of square in terms of <i>n</i> and add 4 or using numbers Ex: in 5 th stage, area= $9^2 + 4 = 85$ which is the same as using my rule $4(5)^2 - 4(5) + 5 = 85$	multiply by itself but lorget to add 4	

Mark		1	2	3
Notation terminology (N)	and	ACCEPT only if D1 achieved	ACCEPT only if D3 achieved	ACCEPT only if D3 achieved
		Correct notation of <u>their g</u> eneral rule for <i>A</i>	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 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	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 ACCEPT using U_n instead of A only if they mention that $A = U_n$
		OR		DO NOT ACCEPT
		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 $(2n-1)^2+4$	using U_n instead of A only if they mention that $A = U_n$	using * for multiplication using / for division using ^ for power using <i>x</i> instead of <i>n</i>
		A = (2n - 1)(2n - 1) + 4 or the square of $(2n - 1)$ then add 4	DO NOT ACCEPT using * for multiplication using / for division using ^ for power using x instead of n	DO NOT ACCEPT if they don't have the general rule for <i>A</i>
		OR Correctly describe one pattern in words for <i>A</i> using correct terminology or correct recursive rule for A using correct notation $A_n = A_{n-1} + 8n$ or $A_{n+1} = A_n + 8n$	DO NOT ACCEPT if they don't have the general rule for <i>A</i>	

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 $n \le 4$ only • For verify: they say "verify" and they substitute in their general rule value(s) of $n \ge 5$ 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 $n \le 4$ followed by value(s) of $n \ge 5$, 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 $n \le 4$ only • For verify: they say "verify" and they substitute in the general rule for A value(s) of $n \ge 5$ 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 $n \le 4$ followed by value(s) of $n \ge 5$, consider it as only one identified process