Markscheme

May 2021

Extended Mathematics

On-screen examination

This markscheme is **confidential** and for the exclusive use of examiners in this examination session.

The markscheme may make use of the following abbreviations:

OE or equivalent
WTTE or words to that effect or accept incomplete calculator display
AG Answer given

• Bullet notation means award 1 mark – see example below

Example
•^{1} mark awarded and corresponding notes are aligned

b	•^{1} Show clear line of reasoning in the method	•^{1} 45 & 49 seen **OE** eg, $49 = 45 + x$	2
	•^{2} their correct result	•^{2} their 4	

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.
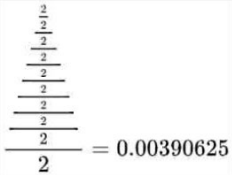f) A misread (**MR**) is an error**. ECF** is normally awarded.

General points

a) As this is an international examination, accept all **alternative forms of notation,** for example 1,9 as 1.9 ; 12,000 or 12 000 as 12000
b) Accept notation errors in intermediate steps.
c) Ignore further working after a correct answer **unless** noted otherwise.
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. $\frac{1}{2}$ OE means we accept 1/2 or 0.5 or 2÷4 or 2^-1 ; $\frac{x}{2}$ OE means we accept x / 2 or $x \div 2$ or 0.5x ; 0.23 OE means we accept 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.

Question		Answers	Notes	Total
1	a	$\frac{4}{7}$ OE	Only accept $\frac{4}{7}$ OE as the final answer.	**1**
	b	.1 multiply correct probabilities for first selected numbers without replacement	.1 $\frac{4}{10} \times \frac{6}{9}$ OE ACCEPT 0,266(66…) or 0,267	**3**
		.2 multiply correct probabilities for second selected numbers without replacement	.2 $\frac{6}{10} \times \frac{4}{9}$ OE ACCEPT 0,266(66…) or 0,267	
		.3 correctly add their multiplied probabilities	.3 their $\frac{8}{15}$ OE , ACCEPT their 0.533(33…)	

Question		Answers	Notes	Total
2	a	.1 Correctly write a in a simplified exact form .2 Correctly write b in a simplified exact form .3 Correctly write c in a simplified exact form	.1 $\log(\frac{1}{2})$ or $\log(1/2)$ or $\log(0.5)$ or $-\log 2$ seen .2 $\log 12$ seen DO NOT ACCEPT log(6x2) as their answer .3 $\log 32$ or $5\log 2$ seen ACCEPT $\log 2^5$ DO NOT ACCEPT log(16x2) as their answer	**3**
	b	.1 Correctly write a in a simplified index form .2 Correctly write b in a simplified index form .3 Correctly write c in a simplified index form	.1 $2x^{-\frac{1}{2}}y^2$ or $\dfrac{2y^2}{x^{\frac{1}{2}}}$ or $2x^{-1/2}y^2$ seen DO NOT ACCEPT y^2 written as y^2 and DO NOT ACCEPT $x^{-\frac{1}{2}}$ written as $\sqrt{x}$ or sqrt(x) or x^-1/2 .2 $2xy$ seen .3 $\dfrac{1}{2}$ or $1/2$ or 0.5 or 2^{-1} seen	**3**

Question		Answers	Notes	Total
3	a	.1 Equate $f(x)$ and 2 .2 Correct value of a	.1 $4^x = 2$ or $4^a = 2$ ACCEPT $x = \log_4 2$ or $x\log 4 = \log 2$ .2 ($a =$) 0.5 OE DO NOT ACCEPT 0.5 written in log form as final answer ACCEPT as coordinates (0.5, 2) or (0.5,0)	**2**
	b	**AM1** .1 Equate $g(x)$ and 2 .2 Correctly apply log rule .3 Correctly rearrange for their x *or* their $-x$ .4 The correct value of x **AM2** .1 Equate $g(x)$ and 2 .2 Correctly apply laws of exponents .3 Correctly rearrange for their x .4 The correct value of x	**AM1** .1 $3^{5-x} = 2$ or $\log 3^{5-x} = \log 2$ ACCEPT not seeing this step .2 $\log_3 2 = 5 - x$ or $(5-x)\log 3 = \log 2$ OE ACCEPT 5-x = 0.63(09…) .3 $(x =)5 - \dfrac{\log 2}{\log 3}$ or $\dfrac{5\log 3 - \log 2}{\log 3}$ or $5 - \log_3 2$ or $-x = \dfrac{\log 2}{\log 3} - 5$ or $-x = \dfrac{\log(\frac{2}{243})}{\log 3}$ **The** correct .3 implies .2 and .1 .4 (x=) 4.369(070….) ACCEPT 4.37 or 4.4 or as coordinates (4.37,2) or (4.37,0) with or without brackets **AM2** .1 $3^{5-x} = 2$ ACCEPT not seeing this step .2 $\dfrac{3^5}{3^x} = 2$ .3 $3^x = \dfrac{3^5}{2}$ or $(x =)\log_3(\dfrac{3^5}{2})$ **The** correct .3 implies .2 and .1 .4 (x=) 4.369(070….) ACCEPT 4.37 or 4.4 or as coordinates (4.37,2) or (4.37,0) with or without brackets In all .1, .2,.3, .4 ACCEPT using any symbol x or b ,..etc	**4**
	c	Correctly subtract their **a** from their **b**	($x =$) their 3.869(070….) ACCEPT 3.869 or 3.87 or 3.9 DO NOT ACCEPT their 3.869(070…) written in log form	**1**

Question		Answers	Notes	Total
4	a	Correctly write the value of r.	$\frac{1}{\sqrt{2}}$ OE DO NOT ACCEPT in words ACCEPT 0.707(10.6…) or 0.71 or 0.7 DO NOT ACCEPT $\div\sqrt{2}$	1
	b	.1 correctly write at least two more terms	.1 $(4, 2\sqrt{2}, 2,)\sqrt{2},1,(\frac{\sqrt{2}}{2}$ OE) Equation with their $\frac{1}{\sqrt{2}}$ doesn't get .1	2
		.2 correct value of n	.2 $(n=)6$ ACCEPT U_6	
	c	.1 correctly substitute 4 and 21 and their *r* into the nth term of G.S formula	.1 $(U_{21}=)4\times\text{their}(\frac{1}{\sqrt{2}})^{21-1}$ OE ACCEPT their0.0039(…) .1 DO NOT ACCEPT if their r ≥ 1	3
		.2 at least one correct intermediate step for their k using any method	.2 Examples of correct intermediate steps : Using powers of 2 : $\dfrac{2^2}{\text{their}2^{10}}$ or $\dfrac{2^2}{\text{their}2^{(\frac{1}{2})20}}$ or $2^2\times\text{their}2^{-10}$ Using logs : $\log_2(4\times\text{their}(\frac{1}{\sqrt{2}})^{21-1})=k$ OE ACCEPT not seeing k Listing powers of 2 : see image $\dfrac{\frac{\frac{\frac{\frac{\frac{\frac{\frac{\frac{2}{2}}{2}}{2}}{2}}{2}}{2}}{2}}{2}}{2}=0.00390625$	
		.3 the correct value of k from their .1	.3 $(k=)$ their-8 ACCEPT $2^{\text{their}-8}$ ACCEPT only if their -8 $\in Z$	

4	d	.1 substitute 4 and their r into the sum to infinity formula	.1 $\dfrac{4}{1-\text{their}\dfrac{1}{\sqrt{2}}}$ OE	4
		.2 correctly write their answer as one radical fraction	.2 their $\dfrac{4\sqrt{2}}{\sqrt{2}-1}$ OE, DO NOT AWARD if their r is $\sqrt{2}$	
		.3 correctly rationalize their denominator	.3 their $\dfrac{4\sqrt{2}(\sqrt{2}+1)}{1}$	4
		.4 correct simplified sum to infinity	.4 $8+4\sqrt{2}$ ACCEPT only if their8 and their4 $\in \mathbb{N}$	

Question		Answers	Notes	Total
5	a	**AM1** (using sin or cos ratios) .1 correctly divide by two the 150 AND 5.4	**AM1** (using sin or cos ratios) .1 75 AND 2.7 seen. ACCEPT 15 AND 2.7 seen	
		.2 correctly substitute into trig ratio	.2 $\sin 75 = \dfrac{2.7}{r}$ OR $\cos 15 = \dfrac{2.7}{r}$ OE ACCEPT $\dfrac{2.7}{\sin 75}$ OR $\dfrac{2.7}{\cos 15}$ seen	
		.3 correct value of r before rounding AG 2.80	.3 (r =)2.79(52....) .3 ACCEPT their correct r due to earlier rounding provided it rounds to 2.8	
		AM2 (using sine rule) .1 correctly substitute into sine rule	**AM2** (using sine rule) .1 $\dfrac{5.4}{\sin 150} = \dfrac{r}{\sin 15}$ OE ACCEPT not seeing this step	
		.2 correctly rearrange for r on one side	.2 (r =)$\dfrac{5.4 \times \sin 15}{\sin 150}$ OE	
		.3 correct value of r before rounding AG 2.80	.3 (r =)2.79(52....) .3 ACCEPT their correct r due to earlier rounding provided it rounds to 2.8	
		AM3 (using cos rule) .1 correctly substitute into cosine rule	**AM3** (using cos rule) .1 $5.4^2 = 2r^2 - 2r^2 \cos 150$ OE ACCEPT not seeing this step	3
		.2 correctly rearrange for r^2 on one side	.2 (r^2 =)$\dfrac{5.4^2}{2 - 2\cos 150}$ OE , or 7.81(33..) seen or $2r^2$=15.62(68…)	
		.3 correct value of r before rounding AG 2.80	.3 (r =)2.79(52....) .3 ACCEPT their correct r due to earlier rounding provided it rounds to 2.8	
		AM4 (using tan ratio) .1 correctly calculate the angle and correctly divide 5.4 by two	**AM4** (using tan ratio) .1 15 and 2.7 or 15 and 2.7 seen	
		.2 correctly substitute tan15 or tan75 ratio into Pythagoras	.2 $r^2 = 2.7^2 + 2.7^2 \tan^2 15$ or (r^2 =)$2.7^2 + \dfrac{2.7^2}{\tan^2 75}$OE or 7.81(33..) seen	
		.3 correct value of r before rounding AG 2.80 Award any VALID method using same marking principles	.3 (r =)2.79(52....) .3 ACCEPT their correct r due to earlier rounding provided it rounds to 2.8	

5	b	.1 correct trig ratio using R and h	.1 $\tan15 = \dfrac{R}{h}$ or $\tan75 = \dfrac{h}{R}$ or $\dfrac{R}{\sin15} = \dfrac{h}{\sin75}$	
		.2 correctly write R in terms of h OR correctly write h in terms of R	.2 $R = h\tan15$ or $R = \dfrac{h}{\tan75}$ or $h = \dfrac{R}{\tan15}$ or $h = R\tan75$ or $R = \dfrac{h\sin15}{\sin75}$ or $h = \dfrac{R\sin75}{\sin15}$ ACCEPT h=3.73R or R=0.27h .2 implies .1	
		.3 substitute 2.8 into volume of sphere formula OR substitute .2 into volume of cone formula	.3 $(V =)\dfrac{4\pi 2.8^3}{3}$ OR $\dfrac{\pi \text{their}(h\tan15)^2 h}{3}$ or $\dfrac{\pi R^2 \frac{\text{their}R}{\tan15}}{3}$ or any from their .2 OE ACCEPT if r=2.795 for the sphere ACCEPT 91.95(23…)	
		.4 evidence of equating their two volumes	.4 $\dfrac{4\pi 2.8^3}{3} = \dfrac{\pi \text{their}(h\tan15)^2 h}{3}$ OE or $\dfrac{4\pi 2.8^3}{3} = \dfrac{\pi \text{their}R^3}{3\tan15}$ or any from their .3 OE	**6**
		.5 correctly rearrange their equated volumes to have h or h^3 on one side OR to have R^3 of R on one side	.5 $(h^3 =)\dfrac{4\pi 2.8^3}{\pi(\tan15)^2}$ OE OR $(R^3 =)4(2.8)^3(\tan15)$ OE .5 implies .4	
		.6 correctly calculate their h after their rearrangement of their equated volumes	.6 (h =) 10.69(407…) DO NOT AWARD the last mark if their R=2.8 or their R=2.7	

Question		Answers	Notes	Total
6	a	8 to 10 hours within the interval 6 pm to 6 am	Ex: 8pm to 5am ACCEPT correct 24-hour format ignoring am/pm	1
	b	**AM1** (using the 12-hour clock) .1 Maximum at 12:00 pm .2 Minimum at 12:00 am **AM2** (using the 24-hour clock) .1 Maximum at 12:00 (am/pm) .2 Minimum at 24:00 (am/pm)	**AM1** (using the 12-hour clock) .2 ACCEPT 0:00 am **AM2** (using the 24-hour clock) .2 ACCEPT 0:00	2
	c	.1 Amplitude 0.5 OE .2 Period 24	.1 ACCEPT .5 DO NOT ACCEPT −0.5	2
	d	.1 Maximum 37 .2 Minimum 36		2

6	e	.1 evidence of substituting 7.25 into the formula	.1 $(B =) -0.5\cos(\frac{\pi}{12} \times 7.25) + 36.5$ ACCEPT $(B =) -0.5\cos(15 \times 7.25) + 36.5$	3
		.2 the correct value of B	.2 36.66(071973….) DO NOT ACCEPT the using degrees answer (36.00027433)	
		.3 correctly round their value of B in .2 to 1 dp	.3 their 36.7	
	f	.1 correctly write the equation modelling Ray's temperature	.1 $R = -0.5\cos\frac{\pi}{12}t + 36.75$ using R or any other letter ACCEPT $B = -0.5\cos\frac{\pi}{12}t + 36.75$ ACCEPT $-0.5\cos\frac{\pi}{12}t + 36.75$	
6	g	.1 evidence of correctly equating their expression in terms of t with 36.5	.1 $36.5 = $ their $-0.5\cos\frac{\pi}{12}t + 36.75$ or $36.5 = -0.5\cos\frac{\pi}{12}t + $ their36.75 ACCEPT using x instead of t	4
		.2 correctly rearrange for their $\cos\frac{\pi}{12}t$ on one side	.2 $\cos\frac{\pi}{12}t = \frac{their(-0.25)}{-0.5}$ OE .2 ACCEPT correctly rearrange linear equation for t but DO NOT AWARD .3 and .4 e.g $(t =)$ their $\dfrac{36.5 - 36.75}{-0.5\cos\left(\frac{\pi}{12}\right)}$ .but do not award .3 and .4	
		.3 correctly inverse their cosine in radians	.3 their $\frac{\pi}{12}t = 1.047(197551...)$ OE or $\frac{\pi}{12}t = \frac{\pi}{3}$ ACCEPT not seeing this step	
		.4 correct value of <u>their first</u> t after correctly inverse their cosine	.4 (t=) their4 (**am**) or 04:00 OE ignore incorrect time of day after seeing their 4	

Question		Answers	Notes	Total
7	a	.1 mode 0.78 .2 median 0.77		**2**
	b	.1 add the product of grade and frequency .2 divide the sum of products by 20 0.77 AG	.1 $4 \times 0.75 + 3 \times 0.76 + 5 \times 0.77 + 6 \times 0.78 + 1 \times 0.79 + 1 \times 0.8$ OE .1 ACCEPT 15.4 seen .1 ACCEPT not seeing the whole operation from calculator screenshot provided it shows at least 4 correct products. Ex: Screenshot $(4 \times 0.75 + 3 \times 0.76 + 5 \times 0.77 + 6 \times 0.78 + 1 \times 0.$ Or Screenshot $3 \times 0.76 + 5 \times 0.77 + 6 \times 0.78 + 1 \times 0.79 + 1 \times 0.8$ .2 $\dfrac{4 \times 0.75 + 3 \times 0.76 + 5 \times 0.77 + 6 \times 0.78 + 1 \times 0.79 + 1 \times 0.8}{4 + 3 + 5 + 6 + 1 + 1}$ ACCEPT $\dfrac{15.4}{20}$ seen .2 ACCEPT not seeing the whole operation from calculator screenshot Ex: Screenshot $(4 \times 0.75 + 3 \times 0.76 + 5 \times 0.77 + 6 \times 0.78 + 1 \times 0.$ $\dfrac{ans}{20} = 0.77$	**2**

| 7 | c | .1 any two from

   i.   line within the zone
   ii.   fairly passing through points Ex: at least two points above and two points below the line
   iii. line domain at least [5.5.10.5]

.2 the third from

   i.   line within the zone
   ii.   fairly passing through points. Ex: at least two points above and two points below the line
   iii. line domain at least [5.5.10.5]

DO NOT award any marks for horizontal line

DO NOT award any marks if they have more than one line drawn

DO NOT award any marks if their line has positive gradient | Line must be in the zone indicated

Fairly passing between points - at least two points above and below the line
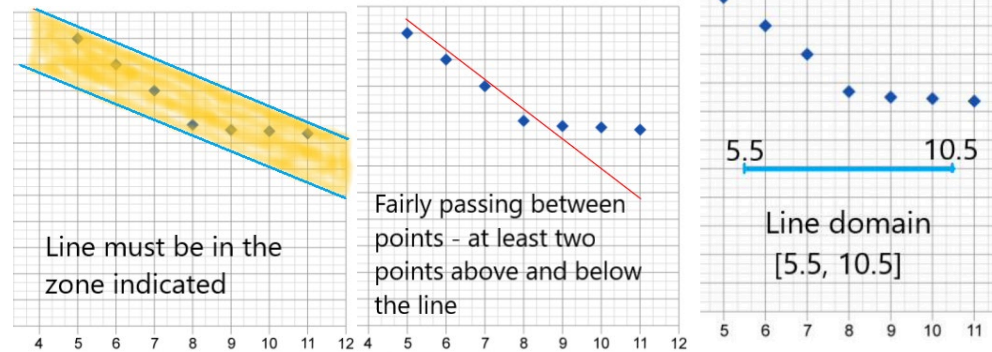
Line domain [5.5, 10.5]
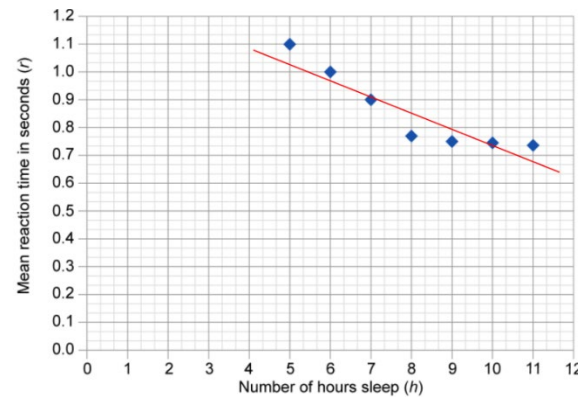
Ex:
 | 2 |

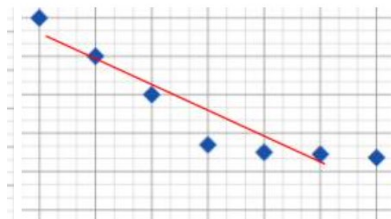| **Examples acceptable for (2 marks)** |
|---|
| |
| Further examples of different scenarios on the next page |
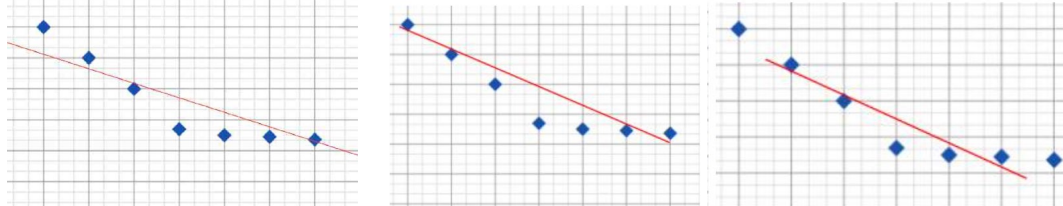
7	c	**Examples acceptable for (1 mark)**	
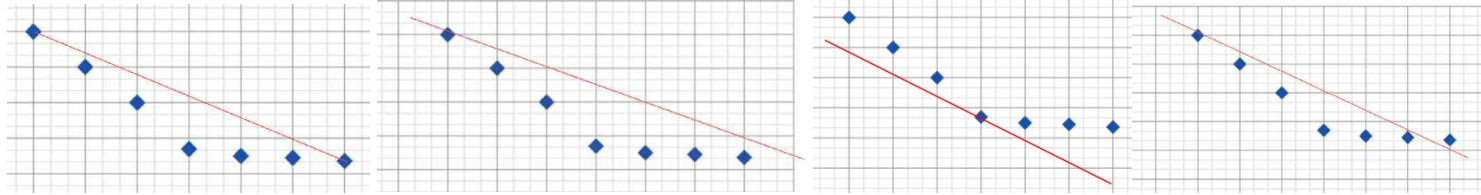
line within the zone **and** line domain at least [5.5,10.5], **but** the line is not fairly passing through points. Award 1 mark
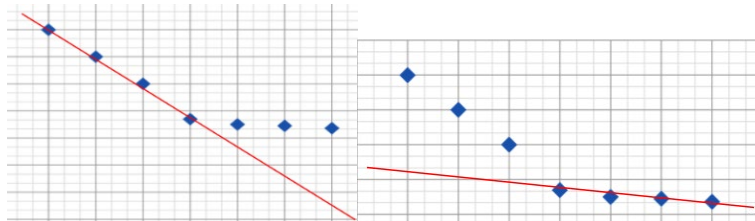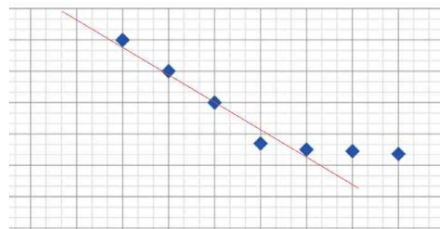

fairly passing through points **and** domain at least [5.5.10.5], **but** the line is not within the zone. Award 1 mark
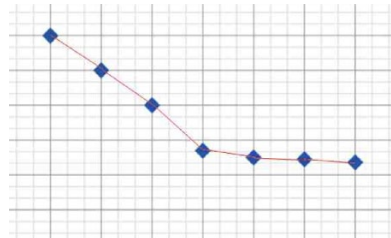

line is within the zone **and** fairly passing through points **but** domain not at least [5.5.10.5] Award 1 mark
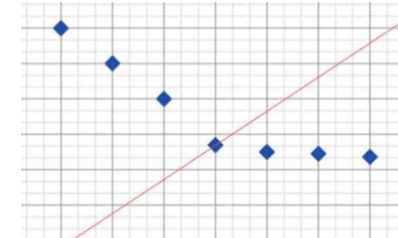
Examples not acceptable (0 marks)

Line is not within the zone and
domain is not [5.10.5] Award 0 marks

more than one line drawn. Award 0 marks

their line has positive gradient. Award 0 marks

7	d	.1 correct value of their r for $h = 4$	.1 ACCEPT error ± 0.02 DO NOT ACCEPT if h=4 is not on their line	2
		.2 correct value of their r for $h = 7.5$	.2 ACCEPT error ± 0.02 DO NOT ACCEPT if h=7.5 is not on their line	
	e	.1 correctly substitute 0.77 into the formula	.1 $(w =) \; 24(100)^{-0.77}$	
		.2 correct value of w	.2 0.692(1675608...) ACCEPT not seeing this step	
		.3 correctly round their w to 2 sf	.3 their 0.69 OE	3

Question 7f 8 marks			
Mark	**1**	**2**	**3**
Factors (F)	**The Two** factors below identified explicitly Reaction time AND Sleeping time WTTE DO NOT ACCEPT factors embedded in working		
Calculate (C)	one correct *w* value from their *r* without working **OR** At least two incorrect *w* values from their *r* with working seen ACCEPT *w* > 1 ACCEPT *w* and its corresponding *r* value seen in the table or in the response box ACCEPT their rounding of *w* provided it correctly rounds to 1 d.p Ex: *w*=0.6867 and they write 0.68 DO NOT ACCEPT *w* for *r*=0.77	Two correct *w* values from their *r* without working ACCEPT *w* > 1 ACCEPT *w* and its corresponding *r* value seen in the table or in the response box ACCEPT their rounding of *w* provided it correctly rounds to 1 d.p Ex: *w*=0.6867 and they write 0.68 DO NOT ACCEPT *w* for *r*=0.77	Three correct *w* values from their *r* without working ACCEPT *w* > 1 ACCEPT *w* and its corresponding *r* value seen in the table or in the response box ACCEPT their rounding of *w* provided it correctly rounds to 1 d.p Ex: *w*=0.6867 and they write 0.68 DO NOT ACCEPT *w* for *r*=0.77
Comment (J)	Correct comment on the positive relationship between probability of winning and sleeping. Ex: WTTE When sleeping duration increases the probability of winning increases ACCEPT: -Good sleep increases probability of winning -Bad sleep decreases probability of winning -reaction time is better when sleeping well so probability of winning increases -sleeping 10h has probability 0.8, sleeping 4h has probability 0.2 **and** 0.8 is more than 0.2 -sleeping 10h has *w*=0.8 while sleeping 4h has *w*=0.1 **only** DO NOT ACCEPT : -comment involving only reaction time and sleeping. -sleeping 10h has probability 0.8 compared to sleeping 4h has probability 0.1	Additional correct comment realizing that probability of winning depends on more than sleeping. Ex: WTTE -Chance of winning will not just keep increasing when the number of hours of sleep increases. -Sleeping h hours does not automatically mean that the sprinter will win or will not win -Winning also depends on other factors ACCEPT Wining also depends on any of: talent or endurance or fitness or training or experience OE DO NOT ACCEPT J2 if J1 not awarded	

Mark	1	2	3
Justify degree of Accuracy (A)	Weak justification inaccurate with weak justification Ex: -inaccurate since I used line of best fit that has approximations -inaccurate as values given are not exact -inaccurate as sample size small or only 20 -accurate, however I used rounding -accurate to a certain extent, as data given was not exact -using rounding decreased the accuracy **OR** Accurate with acceptable justification Ex: -accurate since numbers I used in my calculations are rounded 2 s.f. -the accuracy of my findings comes from rounding I used which is 2 s.f. ACCEPT accurate due to rounding only if they mention the degree of accuracy of their rounding DO NOT ACCEPT -accurate because I used my line of best fit or data given or graph OE -accurate because I used exact values or because I didn't round my results OE DO NOT ACCEPT just seeing their values rounded correctly	Inaccurate with good justification inaccurate AND state that the relation between reaction time and sleeping cannot be linear WTTE **OR** inaccurate AND state that the line equation may not be valid beyond the data given WTTE	

Question		Answers	Notes	Total
8	**a**	correctly place 100 and 144		**1**
	b	.1 correctly describe one pattern for V in words with correct terminology .2 correctly describe a second pattern for V in words with correct terminology	ACCEPT complete terminology only, for example (below are different descriptions): DO NOT ACCEPT two from the same description - The increase is increasing by a constant, the number you add increases constantly, the increase goes up by a constant, second difference is constant, the difference is in pattern 12, 20, 28…, V goes up by 12, 20, 28… - Quadratic - Square numbers, square of even numbers - Multiples of 4, divisible by 4 DO NOT ACCEPT, for example: Arithmetic, increasing, increasing by a constant Even numbers, **the** square numbers, **the** multiples of 4 DO NOT ACCEPT The rule in words, for example: 2 times n squared, n multiplied by 2 squared, double of n squared, twice stage number squared, the square of n times 2 and product of n with 2 Note: More than two different patterns, all correct award **(2 marks)** Ex: multiples of 4, square numbers and it is 2 times n squared More than two different patterns, with any incorrect award **(1 mark)** Ex: multiples of 4, second difference is constant and it is 3 times n	**2**
	c	.1 the correct general rule .2 the correct simplified general rule with correct notation for V in terms of n	.1 (V =) $4n^2$ or (V =) 4n^2 or (V=) 4*n*n or (V =)$(2 \times n)^2$ or $V = 4 \times n^2$ ACCEPT $V=4x^2$ .2 $V = 4n^2$ or $V=(2n)^2$ ACCEPT $V_n = 4n^2$ or $V(n)=4n^2$ or use v for V DO NOT ACCEPT description in words **SC for 1 mark** if NR in 8c and correct general rule seen in 8b condone incorrect notation award 1 mark	**2**

| 8 | d | .1 correctly substitute $n \geq 5$ into their general rule (from 8c or 8b)
.2 correctly calculate their value of V after substituting $n \geq 5$
.3 recognise that their correctly calculated value of V is the same as their predicted value | .1 Ex: 4×5^2

.2 Ex: 100 (for $n = 5$)

.3 same as when candidate explains how the pattern continues
Ex: how 100 is obtained by adding 36 to 64
.3 ACCEPT seeing the value in the table in 8a and seeing their matching calculated V using $n \geq 5$
Ex: we find the candidate has 100 in the table for $n = 5$ | 3 |

Question 8e 22 marks

Mark	1	2	3	4
Predictions (P)	Correctly predict **two** terms for *H* **or** *A* ACCEPT whether in the table or in the response box.	Correctly predict at least **two** terms in *H* **and one** term in *A* ACCEPT whether in the table or in the response box.	Correctly predict at least **two** terms in *H* **and two** terms in *A* ACCEPT whether in the table or in the response box.	

Description (D)	Correctly describe a pattern in words for *A*
	Ex for patterns:
	Multiples of 4 / Divisible by 4
	It's a cubic sequence
	The first difference is quadratic
	The difference of the difference increases
	The second difference is linear (increasing by 24)
	The second difference is in arithmetic sequence
	The third difference is constant (24)
	
	DO NOT ACCEPT
	The multiples of 4, exponential sequence, the increase increases more, even numbers, *V* is square of *H*
	
	OR
	Attempt to describe a general rule for *A* in terms of *n*
	Ex:Rule in words
	       Four times the cube of *n*
	       Four *n* cubed
	   Incorrect rule
	     $A = 8n^3$, $A = (4n)^3$
	
	OR
	Correctly describe a general rule for *A* in terms of *V* or *H*
	Ex
	$A = V \times n$ or $A = V \times \dfrac{h}{2}$ or $A = 2H \times n^2$
	ACCEPT non-simplified and ignore incorrect notation
		Correctly describe a pattern in words for *A*
		
		AND
		
		Attempt to describe a general rule for *A* in terms of *n* **or** correctly describe a general rule for *A* in terms of *V* or *H*
		
		ACCEPT non-simplified and ignore incorrect notation
			Correctly describe a general rule for *A* in terms of *n*
			
			Rule:
			$A = 4n^3$
			
			ACCEPT
			the rule is $4n^3$
			
			ACCEPT non-simplified and ignore incorrect notation
			
			Ex $\dfrac{1}{2} \times 4n^2 \times 2n$
				Correctly describe a pattern in words for *A*
				
				AND
				
				Correctly describe a general rule for *A* in terms of *n*
				
				Rule:
				$A = 4n^3$
				
				ACCEPT
				the rule is $4n^3$
				
				ACCEPT non-simplified and ignore incorrect notation
				
				Ex $\dfrac{1}{2} \times 4n^2 \times 2n$

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

Mark	1	2	3	4
Justify (J)	Attempt to justify their described pattern or their general rule Ex: Substitute at least two other values of n in A and say they are the same or the rule works **OR** Cubic model and valid attempt to find coefficients using any method **OR** Substitute at least two other values of V and H into area of rhombus formula **and** say they are the same or the rule works **OR** Substitute into area of rhombus formula at least one from $V = 4n^2$ and $H = 2n$ and simplify correctly Ex: $A = \dfrac{4n^2 \times H}{2} = 2n^2 H$ **OR** Spotting the general rule from the table seeing $A = (4n^2)n = 4n^3$ DO NOT ACCEPT only saying $(A=)\ Vn$ or $(A =)\dfrac{V \times H}{2}$	Justify their general rule arithmetically Cubic model and get correct values of coefficients using any method **OR** Compare values they obtain using the general rule with values they obtain using the area of rhombus or triangles formula **OR** Weak attempt to justify the general rule for A geometrically by using correct general rules for V and H in terms of n seeing $\dfrac{4n^2 \times 2n}{2}$	Attempt to justify the general rule for A geometrically by using correct general rules for V and H in terms of n seeing $\dfrac{V \times H}{2} = \dfrac{4n^2 \times 2n}{2}$ **OR** seeing $\dfrac{4n^2 \times 2n}{2} = 4n^3$ ACCEPT all of the above in a correct description in words. ACCEPT the $4n^3$ as $n(4n^2)$ or $(2n)^2$	Correctly justify the general rule for A geometrically by using correct general rules for V and H in terms of n <u>and related to the Area of a rhombus</u> seeing all of: • <u>"area</u> of <u>rhombus"</u> WTTE • $\dfrac{V \times H}{2} = \dfrac{4n^2 \times 2n}{2} = 4n^3$ ACCEPT all of the above in a correct description in words. ACCEPT the $4n^3$ as $n(4n^2)$ or $n(2n)^2$

Communication criteria

Mark	1	2	3
Notation and terminology (N)	Correct notation of <u>their</u> general rule Ex: $A = Vn$, $A = \dfrac{VH}{2}$, $A = 8n^3$ **OR** The notation of <u>the general</u> rule includes errors, ex: $A = 4n\text{^}3$, $A = 4*n^3$, $A = 4 \times n^3$ The rule for A is $4n^3$ or non-simplified general rule $A = \dfrac{1}{2} \times 4n^2 \times 2n$ **OR** Correctly describe at least one pattern in words for A DO NOT ACCEPT if they don't have any rules and they don't describe any patterns	Correct notation of <u>the general</u> rule for A $A = 4n^3$ ACCEPT $A_n = 4n^3$ or $A(n) = 4n^3$ **OR** The notation of <u>the general</u> rule includes errors (see examples in N1) **AND** Correctly describe at least one pattern in words for A DO NOT ACCEPT if they don't have a general rule	Correct notation of <u>the general</u> rule for A **AND** Correctly describe at least one pattern in words for A

Mark	1	2	3
Communication (L) Organisation and coherence Can be awarded even there are errors in their descriptions and working.	**At least three** from the following are seen: • describe a pattern or rule in words • write a general rule • test their general rule or pattern • verify their general rule or pattern • justify their general rule or pattern	**At least four** of the following are seen: • describe a pattern or rule in words • write a general rule • test their general rule or pattern • verify their general rule or pattern • justify their general rule or pattern **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 $n \le 4$ only • **For verify:** they say "verify" and they verify using value(s) of $n \ge 5$ only • **For test and for verify:** they say 'test **and** verify' and they test using value(s) of $n \le 4$ **and** then verify using value(s) of $n \ge 5$ • **For justify:** they say "justify" or "my rule works because" WTTE and their justification is seen • **For justify:** they substitute at least two values of n **and** say "the rule justified" or "it works" WTTE • **For justify:** They justify <u>the general rule</u> for A geometrically	DO NOT ACCEPT if D3 and J2 not awarded **At least four** of the following are seen: • describe a pattern or rule in words • write <u>the general rule</u> • test <u>the general rule</u> • verify <u>the general rule</u> • justify <u>the general rule</u> **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 $n \le 4$ only • **For verify:** they say "verify" and they verify using value(s) of $n \ge 5$ only • **For test and for verify:** they say 'test **and** verify' and they test using value(s) of $n \le 4$ **and** then verify using value(s) of $n \ge 5$ • **For justify:** they say "justify" or "my rule works because" WTTE and their justification is seen • **For justify:** they substitute at least two values of n **and** say "the rule justified" or "it works" WTTE • **For justify:** They justify <u>the general</u> rule for A geometrically

n	Vertical length (V)	Horizontal length (H)	Area of rhombus (A)
1	4	2	4
2	16	4	32
3	36	6	108
4	64	8	256
5	100	10	500
6	144	12	864
7	196	14	1372
n	$4n^2$	$2n$	$4n^3$