MARKSCHEME

MAY 2016

MYP MATHEMATICS

ON-SCREEN EXAMINATION

22 pages

The markscheme may make use of the following abbreviations:

RM Assessor has the following annotations that should be used to award marks:

A0 only use to award a zero mark for an answer that has no merit e.g. awarded for the candidate that has a wrong answer with no working

NR only use when the candidate has not made any response also stamp the response with SEEN

 Marks awarded by stamping the tick

 Seen; must be stamped on all blank response areas and on concatenated responses

 unclear

- Bullet notation means award 1 mark – see example 1 below

ECF Marks that can be awarded as **error carried forward** from previous results in the question
BOD Benefit of the doubt
MR misread
NWS no working shown
SC special case
OE or equivalent
WTTE or words to that effect
AG Answer given

Example 1
- 1 mark awarded and corresponding notes are aligned

b	• Show clear line of reasoning in the method • 4	45 & 49 seen **OE** *e.g.* $49 = 45 + x$ **ACCEPT** 45+X/10=4.9 **and** Ans 4	**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 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

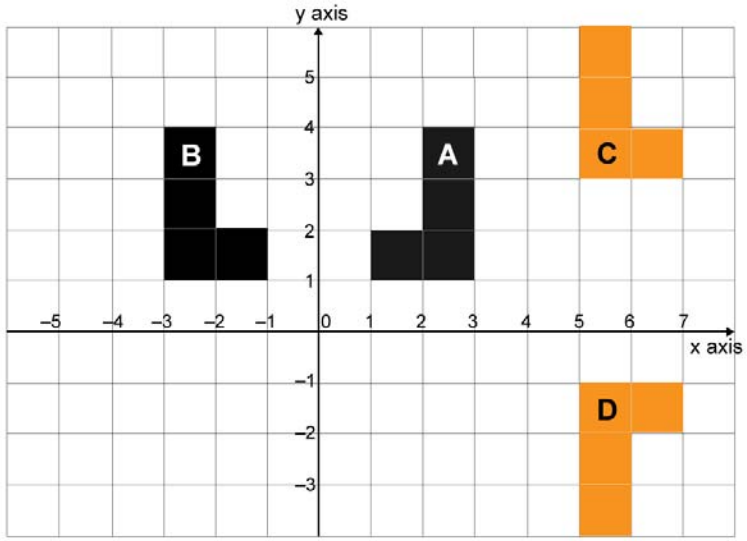
a) As this is an international examination, accept all alternative forms of **notation,** for example 1.9 and 1,9 or 1 000 or 1.000. However **DO NOT ACCEPT** incorrect mathematical notation e.g x^2 for x^2 unless noted otherwise in the MS.
b) Ignore further working after a correct answer **unless** it indicates a lack of mathematical understanding **i.e. if the further working contradicts the correct answer,** then the last mark cannot be awarded.
c) Where candidates have written two solutions to a question, mark the response that deserves more marks.
d) 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 $1 \div 2$ and $\frac{x}{2}$ $x / 2$ or $x \div 2$
e) 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.
f) Special case marks **SC** can be allocated instead of but not in addition to the marks prescribed in the markscheme.

Questions marked using Holistic markscheme in task 3 questions.

Some questions in the markscheme are indicated to be marked holistically. In these questions follow the following procedure to award the marks:

1) Best-fit the work in a certain band by taking an overview of the first two columns, the strand and the specified criteria.
2) Use best judgement to award the work the specific mark within the band; whether in lower, middle (if appropriate), or highest.

Task 1

		Answers	Notes	Total
1	a	•[1] x = 0	Accept the y axis	**1**
	b	•[1] translation of shape B correctly placed (labelled C **or** not) •[2] the two orange shapes have a horizontal line of reflection •[3] the two orange shapes have a horizontal line of reflection in the line y=1  	The shapes must be correct within tolerance of half a square, otherwise no mark Allow **ECF** for •[2] and •[3] 3 **or** more unlabelled shapes mark •[1] only In case there are labelled and unlabelled shapes, only mark the labelled shapes and ignore unlabelled shapes	**3**
	c	•[1] 180 (degree clockwise or anticlockwise) •[2] centre (4,0)	•[1] The requirement is description of **rotation** of **their** shape D into A (It has to be description of rotation) •[2] "Centre 4" award no marks **Note:** if **their** rotation is by 90 degrees Accept 90^- for anticlockwise **or** 90^+ for clockwise Do not accept left **or** right for direction.	**2**

2	a	•[1] 1st mark for two from the points below •[2] 2nd mark for four from the points below correct comment comparing median **or** LQ **or** UQ **or** min **or** max correct comment comparing IQR **or** range correct values of median or LQ or UQ or min or max correct values of IQR **or** range	A comment for comparison would have higher or lower or same in both countries **or WTTE** Any reference to mode e.g. “most/usually shoe sizes” is incorrect Accept use of average for the median Accept values of IQR given as (LQ-UQ) Accept values of range given from min to max **SC** If there is not enough comments **or** correct values but the candidate states: that the shoes sizes in Brazil are bigger than in Egypt **WTTE**: award 1mark	**2**
	b	•[1] 45 – 37 (or 37 to 45) •[2] 8	•[1] 45 **and** 37 seen: award 1 mark •[2] 8 without working: award 2 marks	**2**
	c	• 0.4 and 0.95	**OE** Allow 40 % and 95 % (not 40)	**1**
	d	•[1] one multiplication correct •[2] second multiplication and addition correct •[3] **their** 0.08 after addition	•[1] **OE** 6% **or** 0.06 seen **or** 2% **or** 0.02 •[2] **OE** 0.06+0.02 •[3] **OE** 0.08 without working: award 2 marks Allow **their** values as **ECF** from (c) only if less than 1	**3**

3	a	•1 for cross multiplication •2 for re-arranging y on one side and x in the other •3 for correct expression of y in terms of x	•1 $2y-1=2x$ •2 $2y=2x+1$ accept not seeing this step •3 $y=\frac{2x+1}{2}$ (If a further step is written as y=x+1 do not award •3) **Alternative method** $y-\frac{1}{2}=x$ •1 first term y •2 second term $-\frac{1}{2}$ •3 $y=x+\frac{1}{2}$ **SC Award 1 mark** For a correct equation written in words without working **SC Award 2 marks** $y=\frac{2x+1}{2}$ **or** $y=x+\frac{1}{2}$ without working **SC Award 3 marks** $y=\frac{2x+1}{2}$ **or** $y=x+\frac{1}{2}$ with at least one correct working step Accept seeing the equation not in-line	**3**
	b	•1 for equating $\frac{x+5}{2}$ with **their** expression for L_1 •2 a correct algebraic step leading to the value of x •3 $x=4$ **or their** value of x •4 for substituting in any of the two formulas •5 (4, 4.5) **or their** coordinate correctly evaluated	•1 (their)$\frac{2x+1}{2}=\frac{x+5}{2}$ •2 e.g. $2x+1=x+5$ accept not seeing this step •4 $y=\frac{4+5}{2}$ accept not seeing this step •4 Accept solving by elimination •5 Accept 4 **and** 4.5 **OE** •5 (4,4.5) without **any** working award 3 marks **SC** Many candidates have y = x+1 in 7a) which leads to non-intersecting lines in 7b) in this case if they recognise that lines are parallel and do not intersect: award 4 marks	**5**

4	a	• (Radius =) 5 substituted in area formula	(Area =) $\pi \times 5^2 = 25\pi$ Accept describing in words	**1**
	b	•[1] correct use of Pythagoras •[2] a correct algebraic step leading to the value of l^2 •[3] **their** l written as exact value	•[1] $(l^2 =)5^2 + 5^2$ **or** $l^2 + l^2 = 10^2$ **or** $a^2 + b^2 = 10^2$ •[2] $l^2 = 50$ **or** $l^2 = 50$ **or** $2l^2 = 100$ Accept not seeing this step •[3] $l = \sqrt{50}$ *or* $5\sqrt{2}$ without working: award 2 marks **Alternative method** •[1] Evidence of using sin45 **or** cos45 •[2] $\frac{1}{\sqrt{2}} = \frac{5}{l}$ *or* $\frac{1}{\sqrt{2}} = \frac{l}{10}$ •[3] $l = \sqrt{50}$ $(= 5\sqrt{2})$ If a further step is showing 7.07.. do not award •[3]	**3**
	c	•[1] area of square calculated =50 •[2] subtracting areas •[3] **their** value approximated to 1 decimal place	•[2] 28.53981634…or $25\pi - 50$ **or** accept 25π - area of square Accept not seeing this step •[3] 28.5 •[3] 28.53981634… without working: award 1 mark •[3] 28.5 without working: award 2 marks	**3**
	d	•[1] recognising radius is 25 m •[2] correctly substituting **their** radius into perimeter formula •[3] calculating **their** value using the circumference formula	•[1] Accept not seeing this step •[2] $(c =)2\pi \times$ **their** radius **or** $(c =)\pi \times$ **their** diameter •[3] 50π **or** 157.0796… exact **or** correctly rounded	**3**

5	a	•1 (the maximum height occurs at $x=$)15 •2 $(h(15)=)9(m)$	•1 Can be seen as substitution in the equation •2 **ECF** only for x values [13,17] •2 9 without working: award 1 mark	**2**
	b	•1 $x=26$ **or** any evidence of substituting it •2 $h=4.16$ •3 **Their** 4.16 > 3 m **(**therefore score)	•1 Accept not seeing this step •2 4.16 without working: award 2 marks •3 4.16 > 3 m, without working award 3 marks **Their** 4.16 must be greater than 3	**3**
	c	•1 for setting numerator = 0 •2 for correct factorisation **or** evidence of correct substitution into the quadratic formula •3 for **both** correct values of x	•1 $-x^2+30x-125=0$ accept not seeing this step •2 $(x-5)(x-25)=0$ accept not seeing this step •3 $x=5,\ x=25$ accept (5,0) (25,0) •3 $x=5$, $x=25$ without working: award 3 marks	**3**
	d	•1 no •2 correct justification with correct values	•2 because it hits the ground before the post at 25 m **or** •2 x = 26 to $h(26)=-0.84$ •2 **ECF** for **their** x values only	**2**

Task 2

Answers			Notes	Total
6	a	• the values increase	**WTTE**: Accept: the values double	**1**
	b	• 440 880	Both correct	**1**
	c	•[1] evaluates 3520 •[2] because **their** values are above 20 and below 20 000	•[1] 3520 must be seen •[2] Accept "because 20<**their** A<20 000" **OE** •[2] Accept **their** 3520 is less than 20 000 :Award 2 marks	**2**
	d	•[1] $\frac{220}{27.5}=8$ •[2] $8=2^3$ •[3] $k=3$	•[1] 27.5 seen •[3] 2^3 **or** 3 **or** k=3 without working: award 2 marks	**3**
	e	•[1] 1 term correct •[2] both terms correct and multiplied $(F_n=)\,27.5\times 2^n$	•[1] $F_n = F_0 \times 2^n$ award 1 mark •[2] Allow alternative fully correct formula i.e. $55\times 2^{n-1}$ **OE**	**2**
	f	•[1] continuing the pattern **or** using the formula •[2] yes	•[1] 27.5×2^8 **or** 7040 **or** 14 080 **or** 28 160/27.5 **or** $14080\times 2=28160$ **or** 2^{10} •[2] Yes **or** No without working: award A0 marks	**2**

g

This table gives some key values which might be seen – the table goes over two pages

Aspect	1 mark	2 marks
IR: Identification of relevant information	One numerical factor mentioned from: – Octave (either width 194.5mm **or** number of octaves 9) – Keys (either width 23mm **or** number 63-66) – Arm span 1.65m – Width of the piano as shown 148cm – Room/door size (eg. average room 3x4) – Human hearing 20HZ to 20 000HZ	More than one numerical factor mentioned
CM: Calculation of measurements including width	Relevant calculation without mentioning gaps **or** extra width Example: Calculating the number of keys ie 52 + 2 x7 Accept answer is in the range 63-66 **OR** Calculating the width of the piano keys (63-66)x 23 ACCEPT any reasonable value	Calculating width including gap **or** adding extra width Examples: 9 x 194.5 9 octaves and includes gap between keys gap width: (194.5 – 8x23)/ 7 **or** 8 gaps = 1.5 / ----mm Key + its gap = 23 + 1.5=24.5 Hence width = 66x24.5 + 1.5 (1 extra gap at the end) =1618.5 mm **OR** Calculating extra width at the end in the original piano: In normal piano of width 1480mm there are 52 keys so extra width both sides is 1480 – (52x24.5 + 1.5)=204.5 mm So the 66 keys piano needs to be 1618.5 mm + 204.5 = 1823mm
JD: Justification of degree of accuracy	Rounding used in any element	Justifies **their** choice of rounding
PD: Practicality of new design	Limited argument: Some examples: Not acceptable because people are used to smaller pianos Acceptable as it will include all octaves that people can hear	Justified argument Some examples: Referring to price in anyway: Not acceptable because the added octaves will increase the price of the machine and at the same time 2 octaves will not add much Referring to the difference in width between normal piano and this one in any way: Acceptable because the added width will be only about 30 cm which can fit in a standard room width
QD: Quality of overall discussion (Holistic judgement on the whole response)	Limited discussion	Balanced discussion

10

7	a	•1 $24+6$ or $30(m)$ •2 $30(cm)$ *etc*	•1 Accept not seeing this step •2 30 cm without working award 2 marks	**2**
	b	•1 $24\div 9$ •1 2.6666666666 (m/cm) •3 2.7	•2 2.66 **or** 2.67 (m/cm) without working award 1 mark •3 2.7 (m/cm) without working award 2 marks	**3**
	c	•1 use of a trigonometric function /rule correctly •2 correct rearrangement of **their** trigonometric function •3 calculating **their** value of *d* •4 round **their** 2.03... to the nearest cm	•1 e.g. $\tan(53)=\frac{2.7}{d}$ Accept not seeing this step •2 e.g. $\frac{2.7}{\tan(53)}$ seen •3 $d=2.03\ldots$ •4 2 with 1 correct algebraic step: award 4 marks •4 2 without working: award 3 marks •4 2.03 without working: award 2 marks	**4**
	d	•1 for subtracting from 55.3 •2 for multiplying by 8 •3 **their** 22.82 **or** 23.3	•1 Attempt to subtract at least one depth *d* from 55.3 •2 Award 2 marks if: 55.3 – 8 x 2 x **their** 2 55.3 – 16 x **their** 2 55.3 – 32 •3 22.82 **or** 23.3 without working award 2marks	**3**
For candidates that do not apply the scale 1:100 treat as a misread **MR** on the first occasion **ECF** can be awarded so candidates can gain full marks for subsequent working The final answer for 7a) 7b) 7c) should be in the answer box. If there is not a value in the answer box, award marks for final answers in the response box				

	e	**Aspect**	**1 mark**	**2 marks**		
		Identify the relevant information required	Identify one of the following: Total measurements of the model Volume of the model Elements of the pyramid (temple and platform) the scale 1:100 Practicality of the size of the model	Identify more than one of the following: Total measurements of the model Volume of the model Elements of the pyramid (temple and platform) the scale 1:100 Practicality of the size of the model		
		Consider the degree of accuracy	Consideration the implication of the degree of accuracy on the given values. Examples: Recognizing that the lengths given to the nearest cm Recognizing that the angles given to one decimal place	Consideration the implication of the degree of accuracy on the calculated values. Examples: 2.7x9+6 =30.3 and not 30cm (2.5 instead of 2.7 we get 2.5x9+6=28.5 which is far from 30 **or** 3cm instead of 2.7 we get 3x9+6=33 which is far from 30) The width of first platform 55.3cm while it could be 55 and in this case 9^{th} platform 55-2x2x8=23 cm The width of 9^{th} platform could be 23 cm instead of 23.3 and in this case the 1^{st} platform 55cm Recognizing the difficulty of using a model with dimensions more accurate than nearest mm because of measuring tools available		
		Comment on the validity	Comment not supported with evidence. Examples: The model will be close enough to look like the real pyramid The model was calculated with correct mathematical steps so it is valid	Comment supported with evidences. Examples: The model is practical and referring to overall size (height being about 30, width being about 50 cm) and can be carried/placed on a table easily The model is not very valid because the total height needs to be to the nearest mm like the height of the platform (27 mm). this will lead to inaccurate angles compared to real pyramid The erosion had an effect on the real pyramid and this is not taken into account in the model		

Task 3

		Answers	Notes	Total
8	a	•1 student shows correct method for averaging **AG** •2 8	•1 Averaging values •2 Correct limit	**2**
	b	•1 two correct from p=5 q=6 r=7 •2 all three correct	•1 Award 1 mark for two correct values	**2**
	c	•1 one correct pattern •2 another different correct pattern	For example Column A increases by 3 or multiples of 3 Column L increase by 1 Divide column a by 3 and then add 2 Adding $\boldsymbol{a}$ and $\boldsymbol{b}$ gives the next a L equals $\boldsymbol{a}$ minus 2 two times the row Accept column $\boldsymbol{b}$ are the same / all 3 Accept any correct pattern written algebraically	**2**
	d	•1 any correct working leading to the general rule •2 any correct arrangement of $L=\frac{1}{3}a+2$	examples $L=\frac{1}{3}a+$ any value or $L=$ any value of $a+2$ **or** describing in words •2 Both terms correct: award 2 marks **SC** Accept correct rule involving a, L and the row number: award 2 marks	**2**

e

Mark holistically

Strand	Holistic markscheme	Mark band
Discover patterns DIS: Describe patterns DES: Prove, verify, justify PVJ:	Nothing from below	**0**
Discover patterns DIS: Describe patterns DES: Prove, verify, justify PVJ:	One prediction made Attempt to describe a pattern in words	**1 - 3**
Discover patterns DIS: Describe patterns DES: Prove, verify, justify PVJ:	More than one prediction made A pattern correctly described in words Attempt to test **their** described pattern	**4 - 6**
Discover patterns DIS: Describe patterns DES: Prove, verify, justify PVJ:	More than one prediction made A pattern described as suggested general rule consistent with some of the findings **Their** general rule is tested correctly	**7 - 9**
Discover patterns DIS: Describe patterns DES: Prove, verify, justify PVJ:	More than one prediction made A pattern described as correct general rule consistent with findings A general rule is fully proved ***or*** verified and justified	**10 - 12**

SC More than one prediction made with constant value for column A without any pattern description award 3 marks
Patterns need to refer to a relation involving a b and L
Predictions could be seen in the table **or** in the answer box

12

Exemplification
The candidates can populate the table using the simulator.
Candidates who restrict themselves to the pattern shown can only discover simple patterns e.g.
For ***L*** in terms of row number [***L***=*n*+3] **and** ***a*** in terms of row number [***a*** =3(*n*+1)]. Simple patterns can only gain credit up to Mark band 7–9.

Candidates who use the simulator to vary ***a*** and ***b*** will be able to described more complex patterns and find $\frac{1}{3}a+\frac{2}{3}b$.

Using random values of ***a*** and ***b*** will probably not prove useful. Some systematic approach will be more helpful. Here are some examples.
Candidates keep the same ***a*** values and change ***b*** – they will soon see that multiples of 3 are better to use.

	a	***b***	***L***
	3	6	5
	6	6	6
	9	6	7
	12	6	8

They might write down a rule and test it again using the simulator.
They might try ***b = 0***

	a	***b***	***L***
	3	0	1
	6	0	2
	9	0	3
	12	0	4

Candidates need to use other ***a*** values. They might keep ***a*** constant and vary ***b***. And again put ***a = 0***

	a	***b***	***L***
	3	3	3
	3	6	5
	3	9	7
	3	12	9

	a	***b***	***L***
	0	3	2
	0	6	4
	0	9	6
	0	12	8

<table>
<tr><td>9</td><td>a</td><td>• an explanation</td><td>$(a+b)\div 2=\frac{1}{2}a+\frac{1}{2}b$ or an equivalent written explanation</td><td>1</td></tr>
<tr><td></td><td>b</td><td>•[1] 32 in denominator for 7th term
•[2] both numerators correct for 7th term

•[3] 64 in denominator for 8th term

•[4] both numerators correct for 8th term</td><td>Accept coefficients only i.e. no sight of a and b
$\frac{11}{32}a$ and $\frac{21}{32}b$ or 11/32 a and 21/32 b

$\frac{21}{64}a$ and $\frac{43}{64}b$ or 21/64 a and 43/64 b</td><td>4</td></tr>
<tr><td></td><td>c</td><td colspan="2">
<table>
<tr><th>Strand</th><th>Holistic markscheme</th><th>Mark band</th></tr>
<tr><td>Describe patterns DES:

Prove, verify, justify PVJ:</td><td>Nothing from below</td><td>0</td></tr>
<tr><td>Describe patterns DES:

Prove, verify, justify PVJ:</td><td>Attempt to describe a pattern in words</td><td>1 - 2</td></tr>
<tr><td>Describe patterns DES:

Prove, verify, justify PVJ:</td><td>A pattern correctly described in words

Attempt to test their described pattern</td><td>3 - 5</td></tr>
<tr><td>Describe patterns DES:

Prove, verify, justify PVJ:</td><td>A pattern described as suggested general rule consistent with some of the findings

Their general rule is tested correctly</td><td>6 - 9</td></tr>
<tr><td>Describe patterns DES:

Prove, verify, justify PVJ:</td><td>A pattern described as correct general rule consistent with findings

A general rule is verified or justified</td><td>10 - 12</td></tr>
<tr><td>Describe patterns DES:

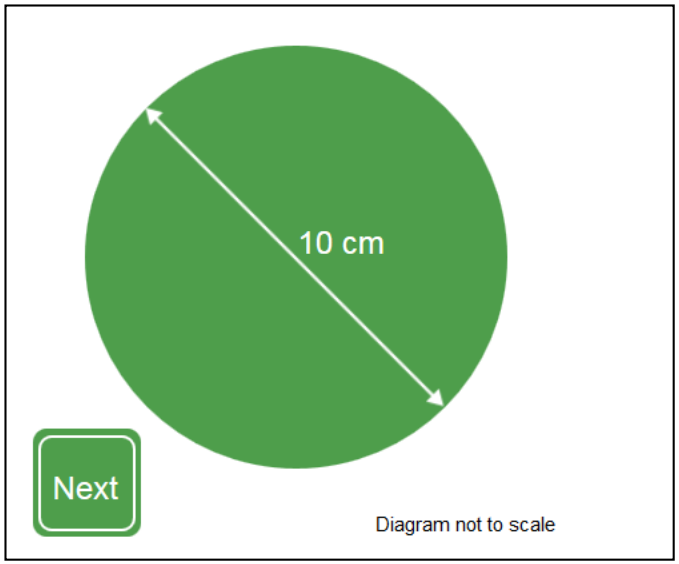
Prove, verify, justify PVJ:</td><td>A pattern described as correct general rule consistent with findings

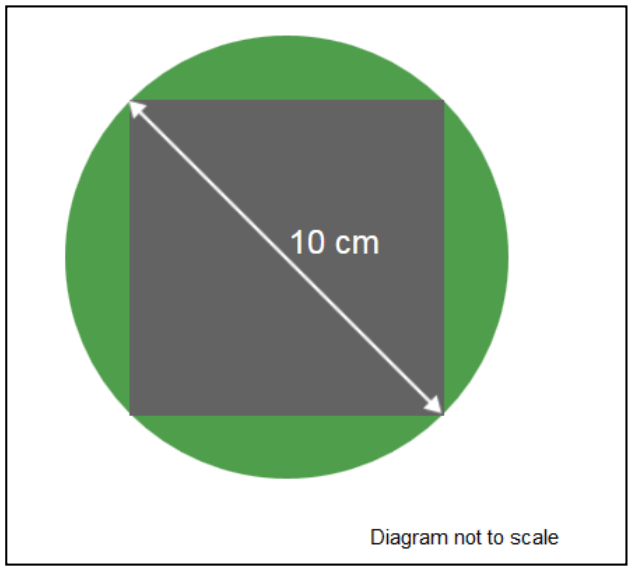
A general rule is fully proved or verified and justified</td><td>13 - 14</td></tr>
</table>
SC Pattern needs to refer to the coefficients of a and b
</td><td>14</td></tr>
</table>

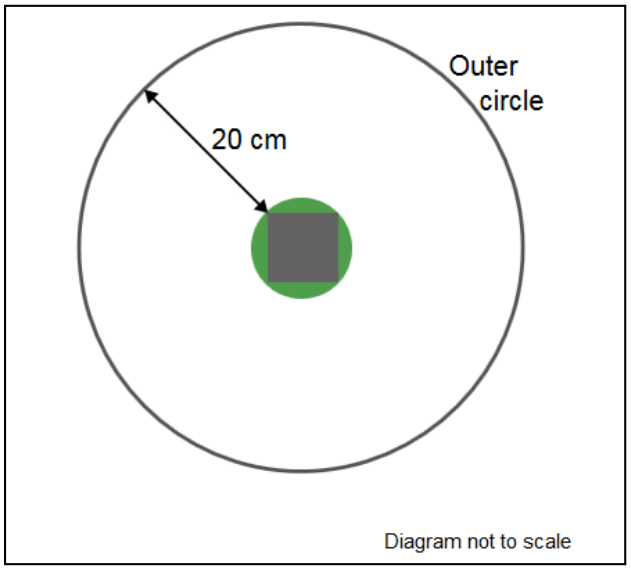
		Exemplification Candidates may look at **their** developing table and find simple and more complex patterns. Examples of patterns The denominators go 1, 2, 4, 8, 16, 32, … The denominators are 2^n The numerators always add to give the denominator e.g. 5 + 11 = 16 The coefficients always add to give 1 The coefficient of ***a*** is always smaller than that of ***b*** The coefficient of ***a*** is always nearly half that of ***b*** The numerators go 1, 3, 5, 11, 21, 43, 87, … starting at term 3 The rule for the numerator of ***b*** is double the numerator of ***a*** and then add or subtract 1 The numerators always add to the denominator The numerator of ***b*** is the numerator of a plus twice the previous numerator of ***a***	

Appendices

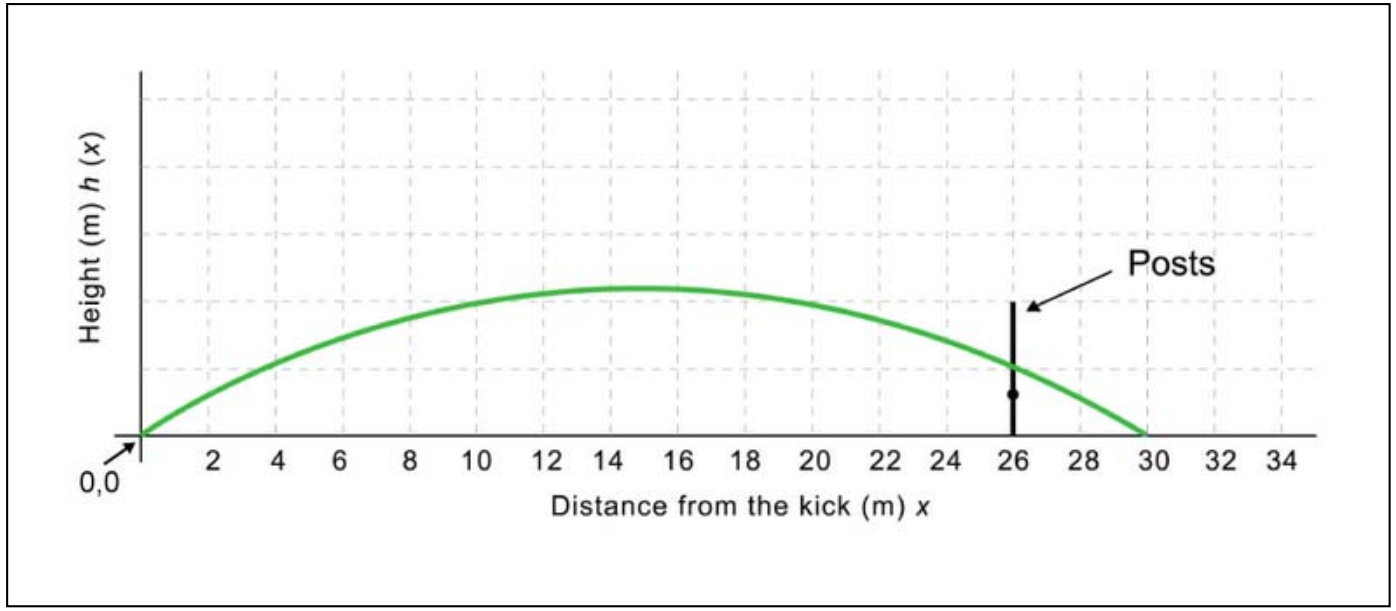
Question 4



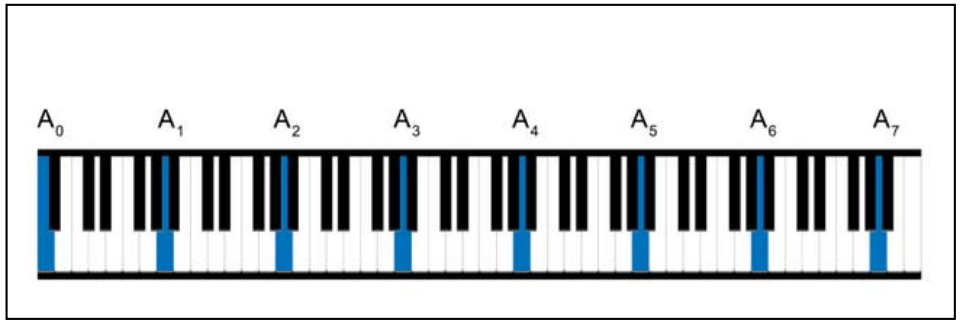




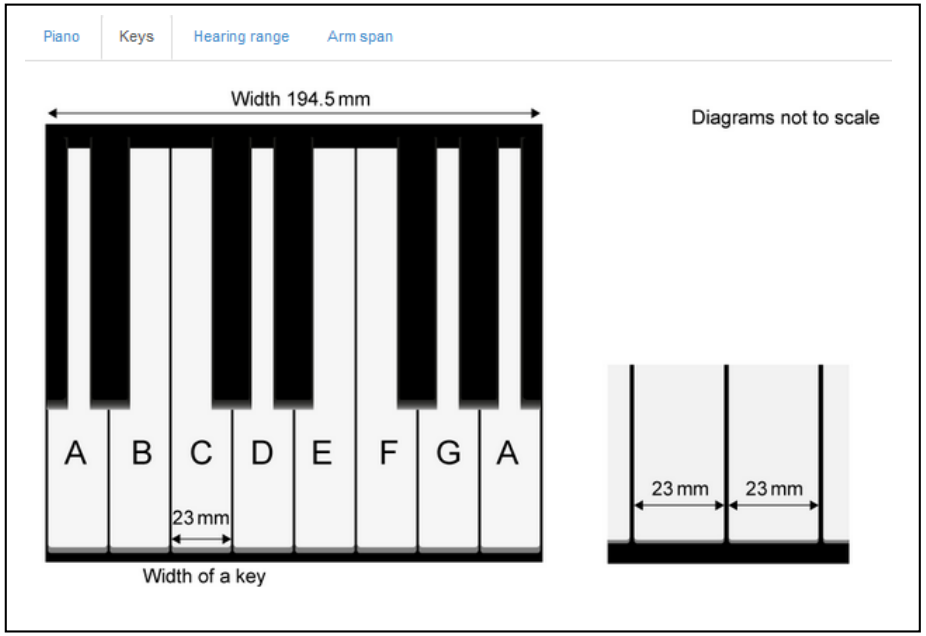
Question 5

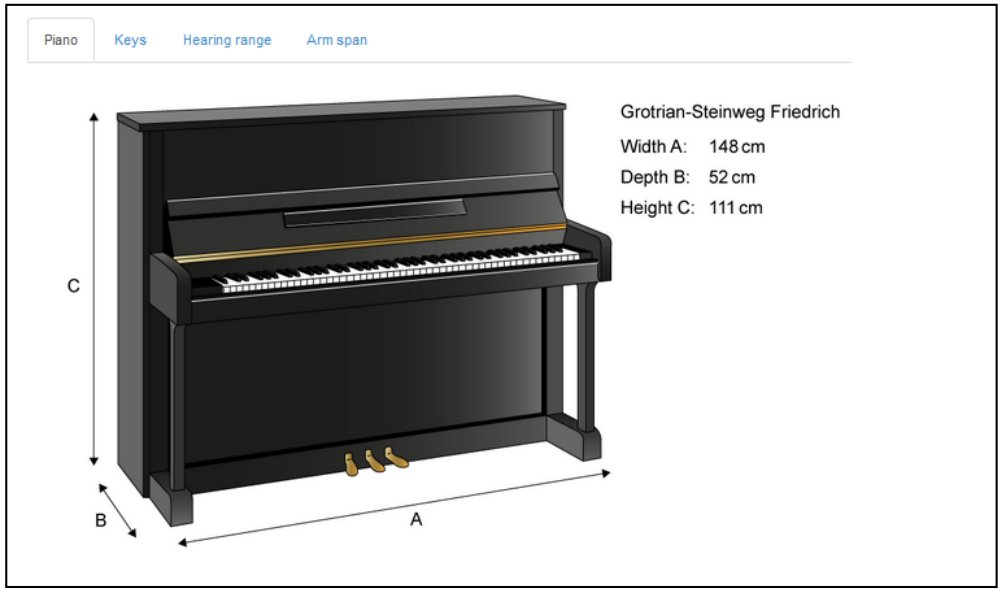

Height (m) h (x)
Posts
0,0
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
Distance from the kick (m) x

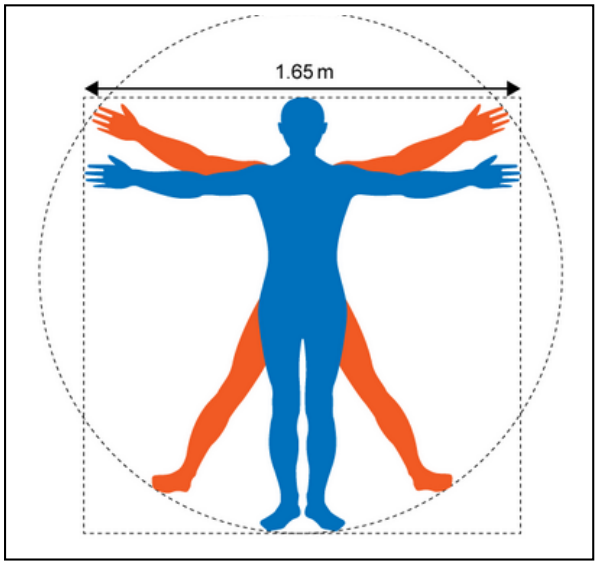
Question 6



Humans can only hear between 20 and 20 000 Hertz.







Question 7

Tab 1 Tab 2

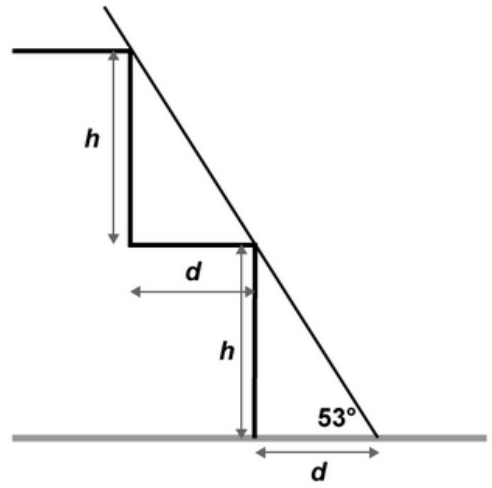


Diagram not to scale

Tab 1 Tab 2

Diagram not to scale