OCR
Oxford Cambridge and RSA

…day June 20XX – Morning/Afternoon

Level 3 Free Standing Mathematics Qualification: Additional Maths
6993 Paper 1

SAMPLE MARK SCHEME

Duration: 2 hours

MAXIMUM MARK 100

This document consists of 16 pages

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Text Instructions

1. Annotations and abbreviations

Annotation in RM Assessor	**Meaning**
✓and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
^	Omission sign
MR	Misread
Highlighting	
Other abbreviations in mark scheme	**Meaning**
E1	Mark for explaining a result or establishing a given result
dep*	Mark dependent on a previous mark, indicated by *
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working
AG	Answer given
awrt	Anything which rounds to
BC	By Calculator
DR	The statement "**In this question you must show detailed reasoning"** applies to this question.

2 Subject-specific Marking Instructions for Level 3 FSMQ: Additional Maths

A Annotations should be used whenever appropriate during your marking. The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded. For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

B An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct solutions leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly. Correct but unfamiliar or unexpected methods are often signalled by a correct result following an apparently incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
If you are in any doubt whatsoever you should contact your Team Leader.

C The following types of marks are available.

M
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B
Mark for a correct result or statement independent of Method marks.

E
A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

d When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep*' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

e The abbreviation FT implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only – differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, what is acceptable will be detailed in the mark scheme. If this is not the case please, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

f Unless units are specifically requested, there is no penalty for wrong or missing units as long as the answer is numerically correct and expressed either in SI or in the units of the question. (e.g. lengths will be assumed to be in metres unless in a particular question all the lengths are in km, when this would be assumed to be the unspecified unit.) We are usually quite flexible about the accuracy to which the final answer is expressed; over-specification is usually only penalised where the scheme explicitly says so. When a value is given in the paper only accept an answer correct to at least as many significant figures as the given value. This rule should be applied to each case. When a value is not given in the paper accept any answer that agrees with the correct value to 2 s.f. Follow through should be used so that only one mark is lost for each distinct accuracy error, except for errors due to premature approximation which should be penalised only once in the examination. There is no penalty for using a wrong value for *g*. E marks will be lost except when results agree to the accuracy required in the question.

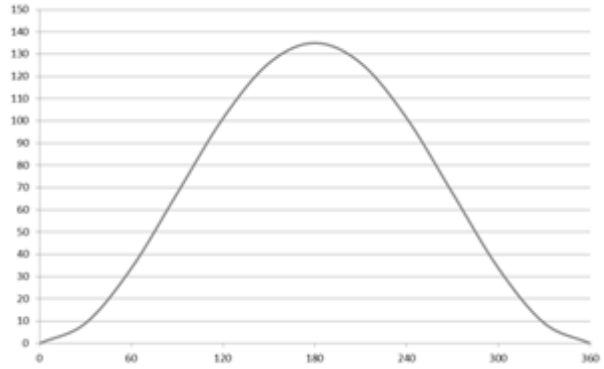
g Rules for replaced work: if a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests; if there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others. NB Follow these maths-specific instructions rather than those in the assessor handbook.

h For a genuine misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A mark in the question. Marks designated as cao may be awarded as long as there are no other errors. E marks are lost unless, by chance, the given results are established by equivalent working. 'Fresh starts' will not affect an earlier decision about a misread. Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

i If a graphical calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers (provided, of course, that there is nothing in the wording of the question specifying that analytical methods are required). Where an answer is wrong but there is some evidence of method, allow appropriate method marks. Wrong answers with no supporting method score zero. If in doubt, consult your Team Leader.

j If in any case the scheme operates with considerable unfairness consult your Team Leader.

Question			Answer	Marks	AOs	Guidance	
1			$u_4 = 23,\ u_5 = 45,$ $u_6 = 89$	M1 A1	AO2 AO1		
				[2]			
2			$2^2(3x)^3\ {}^5C_3$ $4\times27\times10$ $=1080$	M1 A1 A1 A1	AO3 AO1 AO1 AO1	Choose correct term 4 and 27 soi 10 soi	
				[4]			
3	(a)		$\frac{dy}{dx} = 3x^2 + 2$	M1 A1	AO1 AO1		
				[2]			
3	(b)		$3x^2 + 2 \neq 0$ for any x, so no turning points	B1 B1	AO2 AO2		
				[2]			
4			DR $\left[\frac{x^3}{3} + 3x\right]_1^2$ $=\left(\frac{8}{3}+6\right) - \left(\frac{1}{3}+3\right)$ $=5\frac{1}{3}$	M1 M1 A1 A1	AO2 AO1 AO1 AO1	Integrate – powers increased by 1 – ignore limits Subtract in correct order and substitute limits	
				[4]			

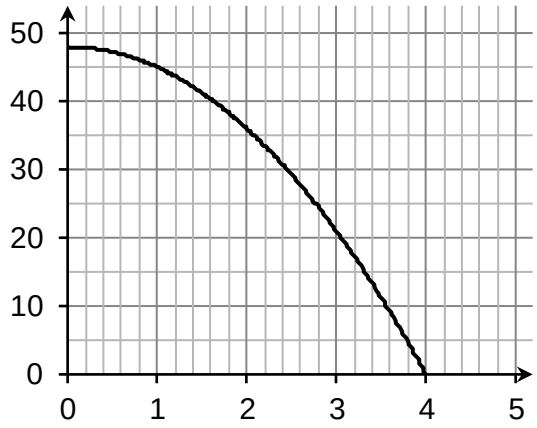
Question			Answer	Marks	AOs	Guidance	
5	(a)			B1 B1	AO3 AO2	Max point at 180 degrees and 0 height at 0 and 360 degrees correct shaped curve	
				[2]			
5	(b)		$h = 67.5(1-\cos\theta)$	B1 B1	AO3 AO1	attempt to use cos ratio correct expression	
				[2]			
5	(c)		$\cos\theta = 1-\frac{h}{67.5}$ $\cos\theta = 1-\frac{100}{67.5} \Rightarrow \cos\theta = -0.481$ $\theta = 119$ and 241	M1 A1 A1	AO1 AO1 AO1		
				[3]			

Question			Answer	Marks	AOs	Guidance	
6	(a)		$\frac{x(x-1)-6(x+2)}{(x+2)(x-1)}$	M1	AO1		
			$\equiv \frac{x^2-x-6x-12}{(x+2)(x-1)}$	A1	AO1		
			$\equiv \frac{x^2-7x-12}{(x+2)(x-1)}$	A1	AO1		
				[3]			
6	(b)		DR $x^2-7x-12=4(x+2)(x-1)$	M1	AO3		
			$0=3x^2+11x+4$	A1	AO1		
			$x=\frac{-11\pm\sqrt{11^2-4\times3\times4}}{2\times3}$	M1	AO2	oe completing the square method	
			$x=\frac{-11-\sqrt{73}}{6}$ or $x=\frac{-11+\sqrt{73}}{6}$	A1	AO1	For both	
				[4]			
7	(a)		DR $=2\left(x^2+4x-6\right)$	M1	AO1	Taking out factor of 2	
			$=2\left(\left(x^2+4x+4\right)-10\right)$	M1	AO1		
			$=2\left(\left(x+2\right)^2-10\right)$	A1	AO1	+4 and -10 soi	
			$=2(x+2)^2-20$	A1	AO1		
				[4]			
7	(b)		DR (When $x=-2$) $=-20$	B1	AO2		
				[1]			

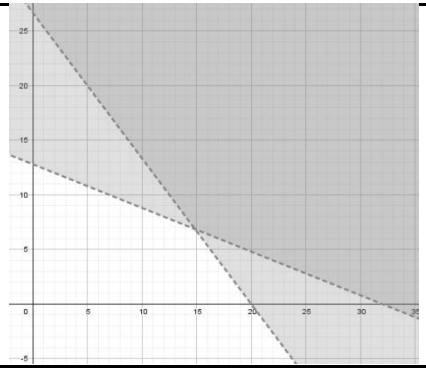
Question			Answer	Marks	AOs	Guidance	
8			Triangle is not equilateral and so the angle required is middle angle	B1	AO3	Award if cosine rule applied more than once	
			$\cos B = \frac{5^2 + 8^2 - 7^2}{2.5.8} = \frac{40}{80} = \frac{1}{2}$	M1 A1	AO2 AO1		
			$\Rightarrow B = 60$	A1	AO1		
				[4]			
9	(a)		DR $f(3) = 3^3 - 5\times3^2 + 1\times3 + 15 = 0$	B1	AO1		
				[1]			
9	(b)		DR $(x-3)(x^2-2x-5)$	M1 A1	AO3 AO1	attempt to divide by $(x-3)$	
			$= x^2 - 2x - 5 = 0 \Rightarrow x = \frac{2 \pm \sqrt{24}}{2}$	M1	AO1	Solve quadratic	
			$\Rightarrow x = 3,\ 3.45,\ -1.45$	A1	AO1	Must have all three roots	
				[4]			
10	(a)		7^4 (= 2401)	B1	AO1		
				[1]			
10	(b)		2 letters = 3 2 digits = 6 Total selection = 18	B1	AO2	For 3 and 6 soi	
			These can be arranged in 4! Ways	B1	AO1	For 4! soi Dep on both previous B	
			No of possibilities = 4! ×18 = 432	B1	AO1		
				[3]			

Question			Answer	Marks	AOs	Guidance	
11	(a)		x y 2 2 3 2.82843 4 4 Area $= \frac{1}{2}\times 1\times(2+2\times \textit{their } y_3+4)$ Area $= 5.83$ Overestimate	B1 M1 A1 A1	AO1 AO2 AO1 AO3	All values in table correct	
				[4]			
11	(b)	(i)	Grad chord $= \frac{4-2}{4-2}=1$	B1	AO1		
				[1]			
11	(b)	(ii)	Choose any pair of values of x either side of $x=3$ in range [2,4] Grad chord $= \frac{\textit{their } y_1-\textit{their } y_2}{\textit{their } x_1-\textit{their } x_2}$ (Actual answer is $2^{\frac{1}{2}}.\ln(2)=0.980$	M1 A1	AO3 AO1	Any answer from correct method nearer to value than in (i)	
				[2]			

Question			Answer	Marks	AOs	Guidance	
12	(a)		$10\left(\frac{1}{8}\right)\left(\frac{7}{8}\right)^9$ ≈ 0.376	M1 A1 A1	AO3 AO1 AO1	Binomial term with correct powers Coefficient soi	
				[3]			
12	(b)		$P(X \geq 2) = 1 - P(0) - P(1)$ $P(X \geq 2) = 1 - (0.263 + 0.376)$ ≈ 0.361	M1 M1 A1 A1	AO2 AO2 AO1 AO1	Subtract two terms from 1 oe For attempt at P(0) both soi	
				[4]			
13	(a)		AE = 40 AD = 40cos20 = 37.59 Area ABCD = *their* AD ×40 = 1500 m^2 (3sf)	B1 M1 A1	AO2 AO1 AO1		
				[3]			
13	(b)		By Pythagoras' theorem $EX = \sqrt{40^2 + 12^2}$ $EX = \sqrt{1744}$ m Similarly $FX = \sqrt{40^2 + 28^2} = \sqrt{2384}$ Cosine Rule $\cos EXF = \frac{2384 + 1744 - 1600}{2\sqrt{2384}\sqrt{1744}}$ $\cos EXF = 0.6199$ $EXF = 51.7°$	M1 A1 A1 M1 A1	AO3 AO1 AO1 AO3 AO1		
				[5]			

Question			Answer	Marks	AOs	Guidance	
14	(a)	(i)	$v = \frac{ds}{dt}$	M1	AO3		
			$v = 48 - 3t^2$	A1	AO1		
			$a = \frac{dv}{dt}$	M1	AO1		
			$a = -6t$	A1	AO1		
			$a = -6$ cms^{-2}	A1	AO1		
				[5]			
14	(a)	(ii)	$v = 48 - 3t^2; v = 0$	M1	AO3	FT their expression for v	
			$3t^2 = 48 \Rightarrow t = 4$ seconds	A1	AO1		
				[2]			
14	(a)	(iii)	$s = 48t - t^3; t = 4$	M1	AO3		
			$s_4 = 48(4) - (4)^3 = 128$ cm	A1	AO1	Must include units	
				[2]			
14	(b)			B1	AO2	Shape and intercepts and nothing outside range	
				[1]			

Question			Answer	Marks	AOs	Guidance	
15	(a)		$k = 28000$	B1	AO1		
				[1]			
15	(b)		Take logs $\log v = \log(ka^t) = \log k + \log a^t$ $= \log k + t\log a$	M1 A1	AO2 AO2	One of the log laws must be seen AG	
				[2]			
15	(c)		Attempt to find gradient Log$a$ in range [-0.1, -0.09] a in range [0.79, 0.81]	M1 A1 A1	AO3 AO1 AO1		
				[3]			
15	(d)		Using their equation When $v = 3000$ $3000 = 28000(0.8)^t \Rightarrow (0.8)^t = 0.107$ $\Rightarrow t = \frac{\log 0.107}{\log 0.8} = 10$ So 10 years	B1 M1 A1	AO3 AO1 AO2		
				[3]			

Question			Answer	Marks	AOs	Guidance	
16	(a)	(i)	Number of unskilled labour hours for Model A $20x$ Number of unskilled labour hours for Model B $15y$	B1	AO3		
			Total number of available unskilled labour hours is $10\times40=400$	B1	AO1		
			$20x+15y\le400\Rightarrow4x+3y\le80$	A1	AO2	AG	
				[3]			
16	(a)	(ii)	Number of skilled labour hours for Model A $10x$ Number of skilled labour hours for Model B $25y$	M1	AO3		
			Total number of available unskilled labour hours is $8\times40=320$				
			$10x+25y\le320\Rightarrow2x+5y\le64$	A1	AO2		
				[2]			
16	(b)			B1 B1 B1	AO1 AO1 AO3	$4x+3y\le80$ $2x+5y\le64$ shading	
				[3]			
16	(c)		(15,5) is within feasible region	B1	AO3		
				[1]			

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AOs</th><th colspan="2">Guidance</th></tr>
<tr><td>16</td><td>(d)</td><td>(i)</td><td>$P = 40x + 60y$</td><td>B1</td><td>AO1</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td>[1]</td><td></td><td></td><td></td></tr>
<tr><td>16</td><td>(d)</td><td>(ii)</td><td>
<table>
<tr><td>x</td><td>y</td><td>$4x+3y$</td><td>$2x+5y$</td><td>P</td></tr>
<tr><td>2</td><td>12</td><td>44</td><td>64</td><td>800</td></tr>
<tr><td>14</td><td>7</td><td>77</td><td>63</td><td>980</td></tr>
<tr><td>15</td><td>6</td><td>78</td><td>60</td><td>960</td></tr>
<tr><td>20</td><td>0</td><td>80</td><td>40</td><td>800</td></tr>
</table>
14 model A and 7 Model B
</td><td>M1

M1

A1</td><td>AO3

AO2

AO3</td><td>Attempt to consider vertices of feasible region

Attempt at considering integer points close to vertices</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td>[3]</td><td></td><td></td><td></td></tr>
</table>

Question	AO1	AO2	AO3
1	1	1	
2	3		1
3 a	2		
3 b		2	
4	3	1	
5 a		1	1
5 b	1		1
5 c	2	1	
6 a	3		
6 b	2	1	1
7 a	4		
7 b		1	
8	2	1	1
9 a	1		
9 b	3		1
10 a	1		
10 b	2	1	
11 a	2	1	1
11 b i	1		
11 b ii	1		1
12 a	2		1
12 b	2	2	
13 a	2	1	
13 b	3		2
14 a i	4		1
14 a ii	1		1
14 a iii	1		1
14 b		1	
15 a	1		
15 b		2	
15 c	2		1
15 d	1	1	1
16 a i	1	1	1
16 a ii		1	1
16 b	2		1
16 c			1
16 d i	1		
16 d ii		1	2
Total	57	21	22

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