OCR
RECOGNISING ACHIEVEMENT

FSMQ

Advanced FSMQ

Additional Mathematics **6993**

Mark Scheme for June 2010

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

OCR - ADDITIONAL MATHEMATICS 6993
Marking instructions.

The total mark for the paper is **100.**

Marks for method are indicated by an **M**. A method that is dependent on previous work is **DM.**

Marks for accuracy are of two kinds:
(i) **A** mark indicates correct work only and
(ii) **F** mark indicates that a "follow through" is allowed.

If an **M** mark is not gained then nor do any of the accuracy marks associated with it.

Marks not associated with a method are denoted **B**, which should be treated as "correct only", and **E** which may be wrong because of a previous error.

Marks are not divisible except as indicated. e.g. A 2,1 means that 2 are awarded for a correct answer and 1 for an answer that is only partially correct, as agreed at the meeting of Examiners.

When the method of solution is not one that has been discussed and does not fit the existing scheme then an alternative scheme should be devised which maintains the same number of M, A, F, B and E marks. You should also bring this to the attention of the Principal Examiner.

The rubric says that the norm is for answers to be given to 3 s.f. except where indicated. Where this rubric is ignored then 1 mark should be deducted once in the paper, at the point where it is first met. This should be indicated -1, TMSF or -1TFSF. Details will be discussed at the meeting of examiners.

Misreading of a question (including the candidate's own working) should normally be penalised by the loss of the relevant accuracy mark or two marks (whichever is less); but if the question is made substantially easier then further penalties may be imposed.

Sub-marks should be shown near to the relevant work. If these are individual marks then the appropriate letter should be given. Sub-marks are given in the question paper and the mark scheme. For substantially correct solutions a number of sub-marks may be combined, even up to the total mark for the question for a totally correct question. The sum of the sub-marks are then added and ringed at the end of the question. (This means that a totally correct question has the total mark written twice - once as a "sum of sub-marks" and unringed and once ringed as the total for the question.) The total mark for the paper should be given on the front page, top right and ringed.

Work that is crossed out and not replaced should be marked. If work has been crossed out and replaced then the replacement work should be marked even if it is incorrect and the crossed out work correct.

Any notation that is understandable may be used to support your marking. In particular:
isw – ignore subsequent working
www – without wrong working
soi – seen or implied

An independent person should be used to check the summation of marks. You should add the ringed marks on the paper to check the addition and the independent checker should add the unringed marks. There is a fee paid for this checking - if you are unable to find anyone to do this work the Board and the Principal Examiner must be informed.

Please mark in red.

If examiners have any doubt about the interpretation of any instructions or if any point of difficulty arises during the marking of scripts, they should communicate with the Principal Examiner.

Section A

1		$3-x<4(x-1)$ $\Rightarrow 3-x<4x-4$ $\Rightarrow 7<5x$ $\Rightarrow x>\frac{7}{5}$	B1 B1 B1 **3**	Sight of $4x-4$ Sight of ax and b where either $a=5$ or $b=7$ oe Final answer WWW
2		$=1-\binom{12}{1}x+\binom{12}{2}x^2-\binom{12}{3}x^3$ $=1-12x+66x^2-220x^3$ *Ignore terms of higher power*	B1 B1 B1 **3**	Signs and powers 2 out of 3 coefficients worked out All coefficients and 1
3	**(i)**	Remainder is f(−1) $=-1-5-2+8=0$ *For long division x^3+x^2 in working and x^2 in quotient must be seen for M1* *Or by inspection $(x+1)(x^2+\ldots)$ for M1*	M1 A1 **2**	Or long division 0 must be seen or implied
	(ii)	$x^3-5x^2+2x+8=0$ $\Rightarrow (x+1)(x^2-6x+8)=0$ $\Rightarrow (x+1)(x-2)(x-4)=0$ $\Rightarrow x=-1,2,4$ *Allow ans with no working*	 M1 DM1 A1 **3**	 Factorise cubic to give $(x+1)(ax^2+bx+c)$ Solve their quadratic
		Alt: Trial to find one root: $x=2,4$ M1, A1 $\Rightarrow x=-1,2,4$ A1		

4	**(i)**	$\left(\frac{5}{6}\right)^4 = \frac{625}{1296} = 0.4823$	M1 A1 **2**	 Either form or 0.482 isw
	(ii)	$1-\left(\frac{5}{6}\right)^4 - 4\left(\frac{5}{6}\right)^3\left(\frac{1}{6}\right)$ $= 1-\frac{625}{1296}-\frac{500}{1296} = 1-0.4823-0.3858$ $= \frac{171}{1296} = \frac{19}{144} = 0.1319$	M1 B1 B1 A1 **4**	1 − 2 terms 4 soi Powers Ans in either form or 0.132
		Alt: Add three terms $6\left(\frac{5}{6}\right)^2\left(\frac{1}{6}\right)^2 + 4\left(\frac{5}{6}\right)\left(\frac{1}{6}\right)^3 + \left(\frac{1}{6}\right)^4$ $= 0.11574 + 0.01543 + 0.00077$ $= 0.1319$	M1 B1 both coeffs B1 powers A1 ans	

<table>
<tr><td>5</td><td>(i)</td><td>$\frac{dy}{dx} = 3x^2 - 6x - 9$
$= 0$ when $3x^2 - 6x - 9 = 0 \Rightarrow x^2 - 2x - 3 = 0$
$\Rightarrow (x-3)(x+1) = 0 \Rightarrow x = 3, -1$
When $x = -1, y = 12$
$\frac{d^2y}{dx^2} = 6x - 6 < 0$ when $x = -1$ so maximum

Allow SC1 for (–1, 12) with no working</td><td>M1

A1

A1

M1
A1

5</td><td>Diffn and set = 0

Derived fn

Stationary point

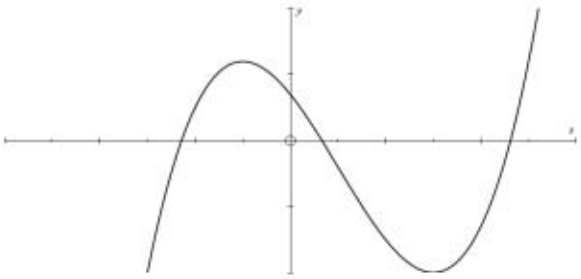
To find nature of turning points</td></tr>
<tr><td></td><td></td><td>Alternative ways to demonstrate maximum at $x = -1$
Value of y

<table><tr><td>– 1 –</td><td>– 1</td><td>–1 +</td></tr><tr><td>$y < 12$</td><td>$y = 12$</td><td>$y < 12$</td></tr></table>
Gradient of tangent

<table><tr><td>– 1 –</td><td>– 1</td><td>–1 +</td></tr><tr><td>$\frac{dy}{dx} > 0$</td><td>$\frac{dy}{dx} = 0$</td><td>$\frac{dy}{dx} < 0$</td></tr><tr><td>/</td><td>—</td><td>\</td></tr></table></td><td>M1

A1

M1

A1</td><td>Allow at most one integer either side (typically, $x = -2, 0$ if turning point is correct)</td></tr>
<tr><td></td><td>(ii)</td><td>  </td><td>B1

1</td><td>General shape: turning points in correct quadrants
Intercept on y axis in [0,12]
Does not turn back on itself.</td></tr>
<tr><td>6</td><td>(i)</td><td>$u = 90, v = 6, s = 2016$
$\Rightarrow 6^2 = 90^2 + 2a \times 2016$
$\Rightarrow a = -\frac{90^2 - 6^2}{4032} = -\frac{8064}{4032} = -2$ m s^{-2}</td><td>M1
A1
A1

3</td><td>Using correct formula
Correct substitution</td></tr>
<tr><td></td><td>(ii)</td><td>$u = 90, v = 6, a = -2$
$\Rightarrow 6 = 90 - 2t$
$\Rightarrow t = \frac{84}{2} = 42$ secs
The two parts can be the other way round</td><td>M1

A1

2</td><td>Using correct formula</td></tr>
</table>

7	**(i)**	$\frac{\sin\theta}{\cos\theta}+\frac{\cos\theta}{\sin\theta}=\frac{\sin^2\theta+\cos^2\theta}{\sin\theta\cos\theta}$ $=\frac{1}{\sin\theta\cos\theta}$	B1 **1**	
		Alt: $\sin^2\theta+\cos^2\theta=1$ $\Rightarrow \sin\theta+\frac{\cos^2\theta}{\sin\theta}=\frac{1}{\sin\theta}$ $\Rightarrow \frac{\sin\theta}{\cos\theta}+\frac{\cos\theta}{\sin\theta}=\frac{1}{\sin\theta\cos\theta}$		
	(ii)	$\sin\theta\cos\theta=\frac{1}{4}\Rightarrow \frac{\sin\theta}{\cos\theta}+\frac{\cos\theta}{\sin\theta}=4$ $\Rightarrow \tan\theta+\frac{1}{\tan\theta}=4$	M1 A1 **2**	Using **(i)** and tan
	(iii)	$\tan\theta+\frac{1}{\tan\theta}=4\Rightarrow \tan^2\theta+1=4\tan\theta$ $\Rightarrow t^2-4t+1=0$ $t=\frac{4\pm\sqrt{16-4}}{2}=2\pm\sqrt{3}\ \ (=3.732 \text{ and } 0.268)$ $\Rightarrow \theta=15^0$ and 75^0 *Sp Case B1 for 15 and B1 for 75 with no supporting working*	M1 M1 A1 A1 **4**	Clear fractions to give 3 term quadratic Sub numbers into correct quadratic 3sf or more Rounds to these
8		$v=60\left(t^4-10t^3+25t^2\right)$ $\Rightarrow s=\int_0^5\left(60t^4-600t^3+1500t^2\right)\mathrm{d}t$ $=\left[12t^5-150t^4+500t^3\right]_0^5$ $=6250$ m If 60 is left out then 4/5 only.	 M1 A2,1 DM1 A1 **5**	 Integrate Terms 1 each error Sub $t=5$ Cao

9	**(i)**	Centre is $\left(\frac{1+15}{2}, \frac{3+1}{2}\right) = (8, 2)$ Nb Working with vectors to give diameter = [14,2] and so radius = [7,1] giving centre (15 – 7, 3 –1) is correct.	B1 B1 **2**	For 8 WWW For 2 WWW
	(ii)	$\lvert PC \rvert = \sqrt{(8-1)^2 + (2-3)^2} = \sqrt{50} = 5\sqrt{2}$	M1 A1 **2**	For $\sqrt{50}$
		Alt: Length of diameter = $\sqrt{(15-1)^2 + (3-1)^2} = \sqrt{14^2 + 2^2}$ $= \sqrt{200} = 10\sqrt{2}$ $\Rightarrow$ Radius = $5\sqrt{2}$		
	(iii)	$(x-8)^2 + (y-2)^2 = 50$ $\Rightarrow x^2 + y^2 - 16x - 4y + 64 + 4 - 50 = 0$ $\Rightarrow x^2 + y^2 - 16x - 4y + 18 = 0$	M1 A1 **2**	Correct use of formula including 50 and using their midpoint.
10	**(i)**	Sub (0,4) Gives $k = \frac{1}{2}$	M1 A1 **2**	
	(ii)	Sub (0, 4) Gives $c = -\frac{1}{4}$	M1 A1 **2**	
	(iii)	When $x = 3$ $y = -\frac{1}{4}(3-2)^2(3-4) = 0.25$ for cubic Or when $x = 3$, $y > 0$ for cubic John's model is better	B1 DB1 **2**	

Section B

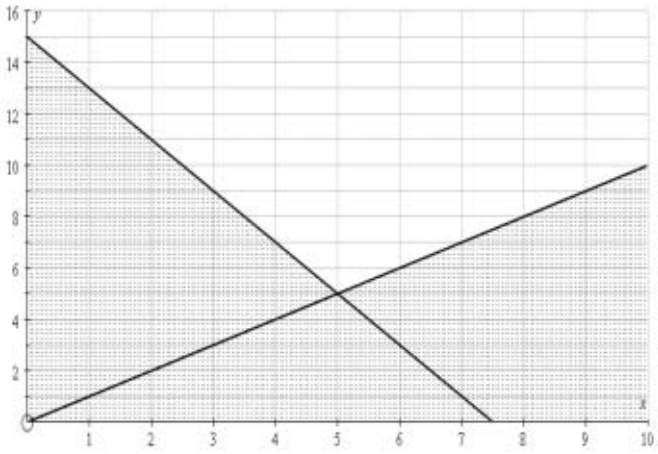
Allow 4 sf in this question

11	**(i)**	$\frac{AF}{\sin 70} = \frac{BF}{\sin 60} = \frac{100}{\sin 50}$ $\Rightarrow AF = \frac{100}{\sin 50} \times \sin 70 \ (= 122.7 \text{ m})$ $\Rightarrow BF = \frac{100}{\sin 50} \times \sin 60 = 113.1 \text{ m}$ oe	M1 A1 A1 M1 A1 **5**	Sin rule applied Sight of 50 and 70 Correct sine rule to find BF
		Alt: Cosine rule for BF: M1 $BF^2 = 100^2 + 122.7^2 - 2\times100\times122.7\times\cos60$ $= 12785$ $BF = 113.1$ A1		
	(ii)	$FT = AF \times \tan 10$ $= 122.7 \tan 10 = 21.6 \text{ m}$ *Anything that rounds to 21.6*	M1 A1 **2**	
	(iii)	$CF = 122.7\sin 60$ $= 106.3$ m Or: $=$ *their BF* $\times \sin 70$ $\Rightarrow \tan\theta = \frac{TheirFT}{TheirCF}$ $\Rightarrow \theta = 11.5^0$	M1 A1 M1 F1 A1 **5**	Accept 106.2 or 106 Using tan correctly Substituting correctly Accept 11 or 12
		Alt: to find CF. Area of triangle $= \frac{1}{2} \times AF.AB \sin 60 = 5313$ M1 $\Rightarrow \frac{1}{2} \times CF \times 100 = 5313 \Rightarrow CF = 106.3$ A1		

12	**(i)**	$y = 0.3x^2 - 1.5x$ $\frac{dy}{dx} = 0.6x - 1.5$ When $x = 5$ $g_t = 1.5$ $\Rightarrow g_n = -\frac{2}{3}$ AB: $y = -\frac{2}{3}(x-5)$ $\Rightarrow 2x + 3y = 10$	 B1 M1 A1 A1 **4**	 Derivative Find g_t and use of $m_1 \times m_2 = -1$ For g_n Line in any simplified form
	(ii)	Solve simultaneously: $3y + 2x = 10$ $2y + 3x = 0$ $6y + 4x = 20$ $6y + 9x = 0$ $5x = -20$ $\Rightarrow x = -4, y = 6$ SC1: answer with no working	M1 F1 A1 **3**	Method to eliminate one variable x and y.
	(iii)	Area of triangle = $\frac{1}{2} \times 5 \times$ *their* $y = 15$ Area under curve = $\int_0^5 (0.3x^2 - 1.5x)\,dx$ $= \left[0.1x^3 - 0.75x^2\right]_0^5$ $= -6.25$ $\Rightarrow$ Area of card = $15 + 6.25 = 21.25$ *Other methods, follow scheme* *ieE1 Area of triangle* *M1 area as integral* *A1 Integrand* *A1 value for area* *A1 Final answer*	E1 M1 A1 A1 A1 **5**	Might appear anywhere in this part Ignore limits here Condone lack of –ve sign

13	**(i)**	Ali: $\frac{72}{t}$ Beth: $\frac{72}{t+2}$	M1 A1 A1 **3**	Accept Beth: $\frac{72}{t}-3$
	(ii)	$\frac{72}{t}-\frac{72}{t+2}=3$ $\Rightarrow 72(t+2)-72t=3t(t+2)$ $\Rightarrow 72t+144-72t=3t(t+2)$ $\Rightarrow 3t(t+2)=144$	M1 A1 M1 A1 A1 **5**	Subtraction of their terms = 3 Multiply out and simplify
		Alternative (based on alternative answer to (i) $\frac{72}{\frac{72}{t}-3}=t+2$ M1 A1 $\Rightarrow 72t=(72-3t)(t+2)$ $\Rightarrow 72t=72t-3t^2+144-6t$ M1 A1 $\Rightarrow 3t^2+6t=144\Rightarrow 3t(t+2)=144$ A1		
	(iii)	$3t(t+2)=144$ $\Rightarrow 3t^2+6t-144=0$ $\Rightarrow t^2+2t-48=0$ $\Rightarrow (t+8)(t-6)=0$ $\Rightarrow t=6$ $\Rightarrow$ Ali takes 6 hours and Beth takes 8 hours. SC1 for answer with no working	M1 A1 A1 A1 **4**	For quadratic in simplified form. (See below) www

What is "simplified form"?
Either a quadratic with all three terms on left = 0 ready for the use of the formula
OR:
Divide through by 3 giving $t^2 + 2t = 48$ ready for solving by the completion of the square.

14	**(i)**	$200x + 100y \geq 1500$ oe	M1 A1 **2**	Deriving a linear inequality
	(ii)	$y \geq x$	B1 **1**	
	(iii)	 	B1 B1 E1 **3**	One line Other line Shading for both, ft their inequalities No Scales: B0, B0, E1 Condone scales not as instructed.
	(iv)	$C = 80x + 60y$ Correct point is (5, 5) Cost = £700 *In absence of OF, 80 ×5 + 60× 5 must be seen*	B1 B1 M1 A1 **4**	 Sub in OF
	(v)	Now minimum cost is at (7, 1) Giving £620 Nb (8, 0) gives £640	B1 B1 **2**	

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

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