RECOGNISING ACHIEVEMENT

FSMQ

Additional Mathematics

ADVANCED FSMQ **6993**

Mark Scheme for the Unit

June 2007

6993/MS/R/07

Oxford Cambridge and RSA Examinations

OCR (Oxford, Cambridge and RSA Examinations) is a unitary awarding body, established by the University of Cambridge Local Examinations Syndicate and the RSA Examinations Board in January 1998. OCR provides a full range of GCSE, A level, GNVQ, Key Skills and other qualifications for schools and colleges in the United Kingdom, including those previously provided by MEG and OCEAC. It is also responsible for developing new syllabuses to meet national requirements and the needs of students and teachers.

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.

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 870 6622
Facsimile: 0870 870 6621
E-mail: publications@ocr.org.uk

CONTENTS

Additional Mathematics FSMQ (6993)

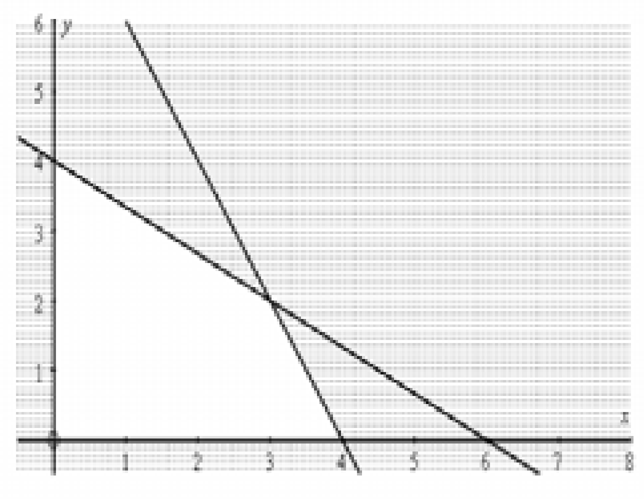
MARK SCHEME FOR THE UNIT

Mark Scheme 6993
June 2007

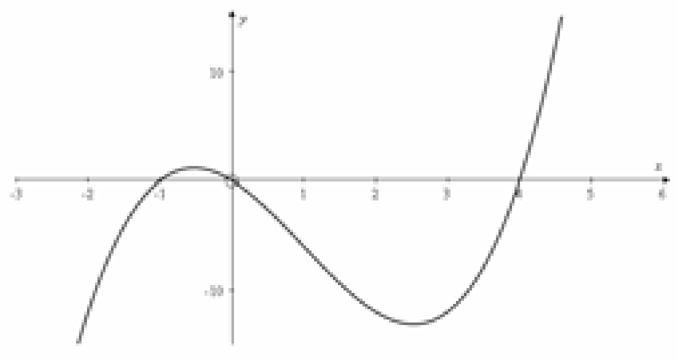
Q.		Answer	Mark	Notes
Section A				
1		$3(x+2)>2-x$ $\Rightarrow 3x+6>2-x$ $\Rightarrow 4x>-4$ $\Rightarrow x>-1$	M1 A1 A1 **3**	Expand and collect Only 2 terms
2		$v=6+3t^2 \Rightarrow s=6t+t^3+c$ Take $s=0$ when $t=1 \Rightarrow c=-7$ When $t=3,\ s=18+27-7=38$ Alternatively: $s=\int_1^3\left(6+3t^2\right)\mathrm{d}t=\left[6t+t^3\right]_1^3=(18+27)-(6+1)=38$	M1 A1 DM1 A1 **4**	Ignore *c* Either sub to find *c* or sub and subtract from definite integral M1 int A1 DM1 sub and sub A1
3		$x^2+y^2-4x-6y+3=0$ $\Rightarrow x^2-4x+y^2-6y=-3$ $\Rightarrow x^2-4x+4+y^2-6y+9=4+9-3$ $\Rightarrow (x-2)^2+(y-3)^2=10$ $\Rightarrow$ Centre (2, 3), radius $\sqrt{10}$ $(\approx 3.162...)$ SC: Penultimate line M1 A1 S.C. Centre B1 Find a point on the circle and then use Pythagoras M1 to find radius A1	M1 B1 A1 **3**	Complete the square Centre Radius *Accept correct answers with no working*
4		$\sin x=-4\cos x \Rightarrow \tan x=-4$ $\Rightarrow x=\pm 75.96^0$ $\Rightarrow x=180-75.96=104^0$ and $x=360-75.96=284^0$ Alternatively Use of $s^2+c^2=1$ M1 $\Rightarrow \cos^2 x=\frac{1}{17}$ $\Rightarrow x=\pm 75.96^0$ A1 $\Rightarrow x=180-75.96=104^0$ M1 A1 and $x=360-75.96=284^0$ A1 S.C. Graphical method $\pm 2^0$ tolerance B1 B1 S.C. Answers with no working B1 for both.	B1 B1 M1 A1 A1 **5**	 For either value from calculator For method to find a correct answer from that given on calculator -1 extra values Ignore values outside 360^0

5	(i)	Using $v^2 = u^2 + 2as$ $\Rightarrow 10^2 = 30^2 + 2a.300$ $\Rightarrow 600a = -800$ $\Rightarrow a = -\frac{4}{3}$	M1 A1 A1 **3**	Got to be used! *Ignore –ve sign.*
	(ii)	Using $v = u + at$ $\Rightarrow 10 = 30 - \frac{4}{3}t$ $\Rightarrow t = 20 \times \frac{3}{4} = 15$ Or: $s = \frac{u+v}{2}t$ $\Rightarrow 300 = \frac{30+10}{2}t$ $\Rightarrow t = \frac{600}{40} = 15$	M1 F1 **2**	From their *a* This could be used in (i) to find *t* then *a*
6		$\frac{dy}{dx} = 3x^2 - 3$ At (2, 6) $\frac{dy}{dx} = 9 \Rightarrow y - 6 = 9(x-2)$ $\Rightarrow y = 9x - 12$	B1 M1 DM1 A1 **4**	Diff correctly Substitute in their gradient function Set up equation with their gradient
7		$\frac{dy}{dx} = 3x^2 - 4x - 15$ $= 0$ when $3x^2 - 4x - 15 = 0$ $\Rightarrow (3x+5)(x-3) = 0$ $\Rightarrow x = 3, -\frac{5}{3}$ $\frac{d^2y}{dx^2} = 6x - 4$: When $x = 3$, $\frac{d^2y}{dx^2} > 0$ $\Rightarrow$ minimum $\Rightarrow x = 3$ N.B. Any valid method is acceptable, but not that *x* = 3 is the right hand value or that the *y* value is lower then for the other value of *x*.	M1 A1 M1 A1 M1 F1 A1 **7**	 =0 and attempt to solve Differentiate again and substitute Providing all other marks earned

8	(i)	$4x - x^2 = x^2 - 4x + 6$ $\Rightarrow 2x^2 - 8x + 6 = 0$ $\Rightarrow x^2 - 4x + 3 = 0$ $\Rightarrow (x-3)(x-1) = 0$ $\Rightarrow x = 3, 1$	M1 M1 A1 **3**	Equate and attempt to collect terms Solve a quadratic Ans only seen - B1
	(ii)	Area = $\int_1^3 (4x - x^2)\,dx - \int_1^3 (x^2 - 4x + 6)\,dx$ $= \left[2x^2 - \frac{x^3}{3}\right]_1^3 - \left[\frac{x^3}{3} - 2x^2 + 6x\right]_1^3$ $= (18-9) - \left(2 - \frac{1}{3}\right) - (9 - 18 + 18) + \left(\frac{1}{3} - 2 + 6\right)$ $= 9 - 1\frac{2}{3} - 9 + 4\frac{1}{3} = 2\frac{2}{3}$ Alternatively: Area = $\int_1^3 (8x - 2x^2 - 6)\,dx$ $= \left[4x^2 - \frac{2x^3}{3} - 6x\right]_1^3$ $= (36 - 18 - 18) - \left(4 - \frac{2}{3} - 6\right) = 0 - \left(-2\frac{2}{3}\right)$ $= 2\frac{2}{3}$	M1 A1 DM1 A1 **4**	Integrate All terms; condone one slip Substitute and subtract (even if limits wrong) M1 integrate A1 DM1 sub and sub A1
9	(i)	AB = $\sqrt{(5 - -1)^2 + (8-1)^2} = \sqrt{85}$ AC = $\sqrt{(8 - -1)^2 + (3-1)^2} = \sqrt{85}$	M1 A1 **2**	For sight of Pythagoras used at least once
	(ii)	M = $\left(\frac{5+8}{2}, \frac{8+3}{2}\right) = \left(\frac{13}{2}, \frac{11}{2}\right)$	B1 **1**	
	(iii)	Grad BC = $\frac{8-3}{5-8} = -\frac{5}{3}$ Grad AM = $\frac{{}^{11}\!/_{2} - 1}{{}^{13}\!/_{2} + 1} = \frac{{}^{9}\!/_{2}}{{}^{15}\!/_{2}} = \frac{9}{15} = \frac{3}{5}$ $\Rightarrow m_1.m_2 = -\frac{5}{3}.\frac{3}{5} = -1$ Allow a geometric argument with reference to M being midpoint and the triangle isosceles.	E1 B1 **2**	Both gradients; AM ft from their M Both and demonstration
	(iv)	$y - 1 = \frac{3}{5}(x+1)$ $\Rightarrow 5y = 3x + 8$	M1 A1 **2**	Must use (−1, 1) or their M and their g

10	**(i)**	 N.B. -1 no scales	B1 E1 B1 E1 B1 **5**	One line Shading 2^{nd} line Shading Other two lines and shading
	(ii)	Maximum value on *y*-axis (0, 4) giving 12	B1 B1 **2**	Allow B2 for 12

Section B

11	**(a)(i)**	$x^3 - 3x^2 - 4x = 0$ $\Rightarrow x\left(x^2 - 3x - 4\right) = 0$ $\Rightarrow x(x-4)(x+1) = 0$ $\Rightarrow x = 0, -1, 4$ S.C. just answers B2	M1 A1 A1 A1 **4**	Accept any valid method
	(ii)	 Must have points on axes	B1 **1**	
	(b)(i)	Remainder theorem or long division G(–1) = 12	M1 A1 **2**	For sub –1
	(ii)	g(2) = 0	B1 **1**	For sub x = 2
	(iii)	By continued trial or by division and quadratic factorisation $g(3) = 0,\ g(-2) = 0$ $\Rightarrow x = 2, 3, -2$ S.C. just answers B2 Alternatively: By division by (x – 2) and quadratic factorisation M1 (x – 2)(x^2 – x – 6) = 0 A1 ⇒(x – 2)(x + 2)(x – 3) = 0 A1 ⇒x = 2, –2, 3. A1	M1 A1 A1 A1 **4**	 3 –2 Final answer

12	**(i)**	P(All males) = $\left(\frac{9}{20}\right)^8 = 0.00168$	M1 A1 **2**	
	(ii)	P(5 females) = ${}^8C_5 \left(\frac{9}{20}\right)^3\left(\frac{11}{20}\right)^5$ $= 0.2568 \approx 0.257$	M1 M1 A1 A1 **4**	powers coefficient 56 (could be implied)
	(iii)	P(full-time) = $\frac{23}{40}$ $\left(\text{Or P(PT)} = \frac{17}{40}\right)$ P(at least two part-time) = $1 - \text{P(all FT)} - \text{P(7FT,1PT)}$ $= 1 - \left(\frac{23}{40}\right)^8 - 8\left(\frac{23}{40}\right)^7\left(\frac{17}{40}\right)$ $= 1 - 0.0119 - 0.0706 = 0.917$ Alternatively: Add 7 terms M1 $28\left(\frac{23}{40}\right)^6\left(\frac{17}{40}\right)^2 + \ldots\ldots\left(\frac{17}{40}\right)^8$ A1 powers A1 Coeffs $= 0.917$ A1 Ans S.C. Read "At least two" as "exactly two" $28\left(\frac{23}{40}\right)^6\left(\frac{17}{40}\right)^2 = 28 \times 0.00653 = 0.1828$ B1	M1 A1 M1 A1 A1 A1 **6**	probability 1–2correct terms Powers coefficient Ans

13	**(i)**	Pythagoras: $OM^2 = 37^2 - 12^2 \Rightarrow OM = 35$ $CM^2 = 20^2 - 12^2 \Rightarrow CM = 16$	M1 A1 A1 **3**	Correct use of Pythagoras for at least one
	(ii)	Use cosine rule on triangle OCM $\Rightarrow \cos C = \dfrac{16^2 + 40^2 - 35^2}{2 \times 16 \times 40} \Rightarrow C = 60.5^0$	M1 M1 A1 A1 **4**	Correct angle Correct use of cosine formula Ans
	(iii)	Sight of attempt to find base area Area = $\dfrac{1}{2} \times 16 \times 24 = 192$ Sight of attempt to find height $h = 40\sin 60.5 = 34.8$ $\Rightarrow$ Volume = $\dfrac{1}{3} \times 192 \times 34.8 = 2228 \approx 2230\text{cm}^3$	M1 A1 M1 A1 A1 **5**	 Can be implied Can be implied

14	**(i)**	Apply Pythagoras to both triangles: $x^2 = y^2 + 4$ $(x + 0.95)^2 = (y + 1.05)^2 + 4$	 B1 B1 **2**	
	(ii)	Subtract: $2\times0.95x + 0.95^2 = 2\times1.05y + 1.05^2$ $\Rightarrow 2.1y = 1.9x - (1.05^2 - 0.95^2)$ $\Rightarrow 2.1y = 1.9x - 0.2$ Alternatively: Multiply out one of the brackets B1 Substitute for y^2 M1 Correct result A1	M1 A1 A1 **3**	
	(iii)	Substitute for y: $x^2 = \left(\frac{1.9x - 0.2}{2.1}\right)^2 + 4$ $\Rightarrow 2.1^2 x^2 = 1.9^2 x^2 - 2\times0.2\times1.9x + 0.2^2 + 4\times2.1^2$ $\Rightarrow 0.8x^2 + 0.76x - 17.68 = 0$ $\Rightarrow x = \frac{-0.76 \pm \sqrt{0.76^2 + 4\times0.8\times17.68}}{1.6} = \frac{-0.76 + 7.56}{1.6} = 4.25$ Substitute : $y = \left(\frac{1.9x - 0.2}{2.1}\right) = 3.75$ Withhold last mark if more than one answer given The quadratic in y is $20y^2 + 21y - 360 = 0$ Integer coefficients for x equation gives $20x^2 + 19x - 442 = 0$	M1 M1 A1 DM1 A1 DM1 F1 **7**	Get y as subject Sub expression for y Correct quadratic Solve Ignore other root

FSMQ Advanced Additional Mathematics 6993
June 2007 Assessment Session

Unit Threshold Marks

Unit	**Maximum Mark**	**A**	**B**	**C**	**D**	**E**	**U**
6993	100	70	60	50	40	30	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	**B**	**C**	**D**	**E**	**U**	**Total Number of Candidates**
6993	28.8	38.6	48.1	57.5	66.8	100	5500

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

OCR Customer Contact Centre

(General Qualifications)
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553