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Mark Scheme (Results)

January 2013

GCE Core Mathematics C2 (6664/01)

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Unless indicated in the mark scheme a correct answer with no working should gain full marks for that part of the question.

EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

In some instances, the mark distributions (e.g. M1, B1 and A1) printed on the candidate's response may differ from the final mark scheme.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes and can be used.

- bod – benefit of doubt
- ft – follow through
- the symbol $\surd$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- $*$ The answer is printed on the paper
- $\lfloor$ The second mark is dependent on gaining the first mark

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but incorrect answers should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. If a candidate makes more than one attempt at any question:

- If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
- If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer.

8. The maximum mark allocation for each question/part question(item) is set out in the marking grid and you should allocate a score of '0' or '1' for each mark, or "trait", as shown:

	0	1
aM		●
aA	●	
bM1		●
bA1	●	
bB	●	
bM2		●
bA2		●

January 2013
6664 Core Mathematics C2
Mark Scheme

Question Number	Scheme		Marks
1.	$(2-5x)^6$		
	$(2^6 =)\ 64$	Award this when first seen (not $64x^0$)	B1
	$+6\times(2)^5(-5x)+\frac{6\times5}{2}(2)^4(-5x)^2$	Attempt binomial expansion with correct structure for at least one of these terms. E.g. a term of the form: $\binom{6}{p}\times(2)^{6-p}(-5x)^p$ with $p = 1$ or $p = 2$ consistently. Condone sign errors. Condone missing brackets if later work implies correct structure and allow alternative forms for binomial coefficients e.g. ${}^6C_1$ or $\binom{6}{1}$ or even $\left(\frac{6}{1}\right)$	M1
	$-960x$	**Not** $+-960x$	A1 (first)
	$(+)6000x^2$		A1 (Second)
			(4)
Way 2	$64(1\pm.....)$	64 **and** (1 ± ..... – Award when first seen.	B1
	$\left(1-\frac{5x}{2}\right)^6 = 1\ \underline{-6\times\frac{5x}{2}}+\underline{\frac{6\times5}{2}\left(-\frac{5x}{2}\right)^2}$	Correct structure for at least one of the underlined terms. E.g. a term of the form: $\binom{6}{p}\times(kx)^p$ with $p = 1$ or $p = 2$ consistently and $k \neq \pm5$ Condone sign errors. Condoned missing brackets if later work implies correct structure but it must be an expansion of $(1-kx)^6$ where $k \neq \pm5$	M1
	$-960x$	**Not** $+-960x$	A1
	$(+)\,6000x^2$		A1
			(4)

Question Number	Scheme		Marks
2.			
(a)	$f(1) = a + b - 4 - 3 = 0$ **or** $a + b - 7 = 0$	Attempt f(±1)	M1
	$a + b = 7$ *	Must be f(1) and = **0** needs to be seen	A1
			(2)
(b)	$f(-2) = a(-2)^3 + b(-2)^2 - 4(-2) - 3 = 9$	Attempt f(±2) **and uses** f(±2) = 9	M1
	$-8a + 4b + 8 - 3 = 9$	Correct equation with exponents of (-2) removed	A1
	$(-8a + 4b = 4)$		
	Solves the **given equation from part (a)** and their equation in a and b from part (b) as far as a =... or b = ...		M1
	$a = 2$ **and** $b = 5$	**Both** correct	A1
			(4)
			[6]
	Long Division		
(a)	$(ax^3 + bx^2 - 4x - 3) \div (x - 1) = ax^2 + px + q$ where p and q are in terms of a or b or both and sets their remainder = 0 NB Quotient = $ax^2 + (a + b)x + (a + b - 4)$		M1
	a + b = 7 *		A1
			(2)
(b)	$(ax^3 + bx^2 - 4x - 3) \div (x + 2) = ax^2 + px + q$ where p and q are in terms of a or b or both and sets their remainder = 9 NB Quotient = $ax^2 + (b - 2a)x + (4a - 4 - 2b)$		M1
	4b – 8a + 5 = 9		A1
	Follow scheme for final 2 marks		

3.			
(a)	$120000\times(1.05)^3=138915*$	Or $120000\times1.05\times1.05\times1.05=138915$ Or 120000, 126000, 132300, 138915 Or a = 120000 and $a\times(1.05)^3=138915$	B1
			(1)
(b)	$120000\times(1.05)^{n-1}>200000$	Allow n or $n-1$ and ">", "<", or "=" etc.	M1
	$\log1.05^{n-1}>\log\left(\frac{5}{3}\right)$	Takes logs correctly Allow n or $n-1$ and ">", "<", or "=" etc.	M1
	$(n-1>)\frac{\log\left(\frac{5}{3}\right)}{\log1.05}$ or equivalent e.g $(n>)\frac{\log\left(\frac{7}{4}\right)}{\log1.05}$	Allow n or $n-1$ and ">", "<", or "=" etc. Allow $1.\dot{6}$ or awrt 1.67 for 5/3.	A1
	2024	M1: Identifies a calendar year using their value of n or n - 1 A1: 2024	M1A1
			(5)
(c)	$\frac{a(1-r^n)}{1-r}=\frac{120000\left(1-1.05^{11}\right)}{1-1.05}$	M1: Correct sum formula with n = 10, 11 or 12 A1: Correct numerical expression with n = 11	M1 A1
	1704814	Cao (Allow 1704814.00)	A1
			(3)
			[9]

	Listing or trial/improvement in (b)
	U_{10} = 186 159.39, U_{11} = 195 467.36, U_{12} = 205 240.72
	Attempt to find at least the 10th or 11th or 12th terms correctly using a common ratio of 1.05 (all the terms need **not** be listed) M1
	Forms the geometric progression correctly to reach a term > 200 000 M1
	Obtains an "11th" term of awrt 195 500 **and** a "12th" term of awrt 205 200 A1
	Uses their number of terms to identify a calendar year M1
	2024 A1
	(5)

4.			
	$\cos^{-1}(-0.4) = 113.58\ (\alpha)$	Awrt 114	B1
	$3x-10=\alpha \Rightarrow x=\dfrac{\alpha+10}{3}$	Uses their α to find *x*. Allow $x=\dfrac{\alpha\pm10}{3}$ **not** $\dfrac{\alpha}{3}\pm10$	M1
	$x = 41.2$	Awrt	A1
	$(3x-10=)360-\alpha\ \ (246.4....)$	$360-\alpha$ (can be implied by 246.4...)	M1
	x = 85.5	Awrt	A1
	$(3x-10=)360+\alpha\ (=473.57....)$	$360+\alpha$ (Can be implied by 473.57...)	M1
	x = 161.2	Awrt	A1

5.			
(a)			
(i)	The centre is at (10, 12)	B1: $x = 10$ B1: $y = 12$	B1 B1
(ii)	Uses $(x-10)^2+(y-12)^2 = -195+100+144 \Rightarrow r = ...$		M1
	Completes the square for both x and y in an attempt to find r. $(x \pm "10")^2 \pm a$ and $(y \pm "12")^2 \pm b$ and $+195 = 0, (a, b \neq 0)$ Allow errors in obtaining their r^2 but must find square root		
	$r = \sqrt{10^2+12^2-195}$	A correct numerical expression for r including the square root and can implied by a correct value for r	A1
	$r = 7$	Not $r = \pm 7$ unless -7 is rejected	A1
			(5)
(a) Way 2	Compares the given equation with $x^2+y^2+2gx+2fy+c=0$ to write down centre $(-g,-f)$ i.e. (10, 12)	B1: $x = 10$ B1: $y = 12$	B1B1
	Uses $r = \sqrt{(\pm "10")^2+(\pm "12")^2-c}$		M1
	$r = \sqrt{10^2+12^2-195}$	A correct numerical expression for r	A1
	$r = 7$		A1
			(5)
(b)	$MN = \sqrt{(25-"10")^2+(32-"12")^2}$	Correct use of Pythagoras	M1
	$MN\left(=\sqrt{625}\right) = 25$		A1
			(2)
(c)	$NP = \sqrt{("25"^2-"7"^2)}$	$NP = \sqrt{(MN^2-r^2)}$	M1
	$NP\left(=\sqrt{576}\right) = 24$		A1
			(2)
(c) Way 2	$\cos(NMP) = \frac{7}{"25"} \Rightarrow NP = "25"\sin(NMP)$	Correct strategy for finding NP	M1
	$NP = 24$		A1
			(2)
			[9]

6.			
(a)	$2\log(x+15) = \log(x+15)^2$		B1
	$\log(x+15)^2 - \log x = \log\dfrac{(x+15)^2}{x}$	Correct use of $\log a - \log b = \log\dfrac{a}{b}$	M1
	$2^6 = 64$ or $\log_2 64 = 6$	64 used in the correct context	B1
	$\log_2\dfrac{(x+15)^2}{x} = 6 \Rightarrow \dfrac{(x+15)^2}{x} = 64$	Removes logs correctly	M1
	$\Rightarrow x^2 + 30x + 225 = 64x$ *or* $x + 30 + 225x^{-1} = 64$	Must see expansion of $(x+15)^2$ to score the final mark.	
	$\therefore x^2 - 34x + 225 = 0$ *		A1
			(5)
(b)	$(x-25)(x-9) = 0 \Rightarrow x = 25$ or $x = 9$	M1: Correct attempt to solve the **given** quadratic as far as x =... A1: Both 25 and 9	M1 A1
			(2)
			[7]

7.			
(a)	$9^2 = 4^2 + 6^2 - 2\times4\times6\cos\alpha \Rightarrow \cos\alpha = ...$	Correct use of cosine rule leading to a value for cos α	M1
	$\cos\alpha = \frac{4^2+6^2-9^2}{2\times4\times6}\left(= -\frac{29}{48} = -0.604..\right)$		
	$\alpha = 2.22$ *	Cso (2.22 must be seen here)	A1
	(NB $\alpha = 2.219516005$)		**(2)**
(a) Way 2	$XY^2 = 4^2 + 6^2 - 2\times4\times6\cos 2.22 \Rightarrow XY^2 = ..$	Correct use of cosine rule leading to a value for XY^2	M1
	$XY^2 = 81.01....$		
	$XY = 9.00....$		A1
			(2)
(b)	$2\pi - 2.22 (= 4.06366.....)$	$2\pi - 2.22$ or awrt 4.06	B1
	$\frac{1}{2}\times4^2\times"4.06"$	Correct method for major sector area.	M1
	32.5	Awrt 32.5	A1
			(3)
(b) Way2	**Circle – Minor sector**		
	$\pi\times4^2$	Correct expression for circle area	B1
	$\pi\times4^2 - \frac{1}{2}\times4^2\times2.22 = 32.5$	Correct method for circle - minor sector area	M1
	$= 32.5$	Awrt 32.5	A1
			(3)
(c)	Area of triangle = $\frac{1}{2}\times4\times6\times\sin 2.22 (= 9.56)$	Correct expression for the area of triangle XYZ	B1
	So area required = "9.56" + **"**32.5"	Their Triangle XYZ + (part (b) answer or correct attempt at major sector)	M1
	= 42.1 cm^2 or 42.0 cm^2	Awrt 42.1 or 42.0 (Or <u>just</u> 42)	A1
			(3)
(d)	Arc length $= 4\times4.06 (= 16.24)$ Or $8\pi - 4\times2.22$	M1: $4\times their\left(2\pi - 2.22\right)$ Or circumference – minor arc A1: Correct ft expression	M1A1ft
	Perimeter = ZY + WY + Arc Length	9 + 2 + Any Arc	M1
	Perimeter = 27.2 or 27.3	Awrt 27.2 or awrt 27.3	A1
			(4)
			[12]

8.	$y = 6 - 3x - \frac{4}{x^3}$		
(a)	$\frac{dy}{dx} = -3 + \frac{12}{x^4} or -3 + 12x^{-4}$	M1: $x^n \rightarrow x^{n-1}$ ($x^1 \rightarrow x^0$ or $x^{-3} \rightarrow x^{-4}$ or $6 \rightarrow 0$) A1: Correct derivative	M1 A1
	$\frac{dy}{dx} = 0 \Rightarrow -3 + \frac{12}{x^4} = 0 \Rightarrow x = ...$ **or** $\frac{dy}{dx} = -3 + \frac{12}{\sqrt{2}^4}$	$y' = 0$ and attempt to solve for x May be implied by $\frac{dy}{dx} = -3 + \frac{12}{x^4} = 0 \Rightarrow \frac{12}{x^4} = 3 \Rightarrow x = ...$ **or** Substitutes $x = \sqrt{2}$ into their y'	M1
	So $x^4 = 4$ and $x = \sqrt{2}$ **or** $\frac{dy}{dx} = -3 + \frac{12}{\left(\sqrt{2}\right)^4}$ or $-3 + 12\left(\sqrt{2}\right)^{-4} = 0$	Correct completion to answer with no errors by solving their $y' = 0$ or substituting $x = \sqrt{2}$ into their y'	A1
			(4)
(b)	$x = -\sqrt{2}$	Awrt -1.41	B1
			(1)
(c)	$\frac{d^2y}{dx^2} = \frac{-48}{x^5}$ or $-48x^{-5}$	Follow through their first derivative from part (a)	B1ft
			(1)
(d)	An appreciation that either $y'' > 0 \Rightarrow$ a minimum or $y'' < 0 \Rightarrow$ a maximum		B1
	Maximum at P as $y'' < 0$	Cso	B1
	Need a fully correct solution for this mark. y'' need not be evaluated but must be correct and there must be reference to P or to $\sqrt{2}$ and negative or < 0 and maximum. There must be no incorrect or contradictory statements (NB allow y'' = awrt-8 or -9)		
	Minimum at Q as $y'' > 0$	Cso	B1
	Need a fully correct solution for this mark. y'' need not be evaluated but must be correct **and part (b) must be correct** and there must be reference to P or to $-\sqrt{2}$ and positive or > 0 and minimum. There must be no incorrect or contradictory statements (NB allow y'' = awrt 8 or 9)		
			(3)
			[9]
	Other methods for identifying the nature of the turning points are acceptable. The first B1 is for finding values of y or dy/dx either side of $\sqrt{2}$ or their x at Q and the second and third B1's for fully correct solutions to identify the maximum/minimum.		

9.	$y = 27 - 2x - 9\sqrt{x} - \frac{16}{x^2}$		
(a)	6.272 , 3.634		B1, B1
			(2)
(b)	$\frac{1}{2} \times \frac{1}{2}$ or $\frac{1}{4}$		B1
	$....\left\{(0+0)+2\left(5.866+"6.272"+5.210+"3.634"+1.856\right)\right\}$	Need {} or implied later for A1ft	M1A1ft
	$\frac{1}{2} \times 0.5\left\{(0+0)+2\left(5.866+"6.272"+5.210+"3.634"+1.856\right)\right\}$ = $\frac{1}{4} \times 45.676$		
	= 11.42	cao	A1
			(4)
(c)	$\int y\,\mathrm{d}x = 27x - x^2 - 6x^{\frac{3}{2}} + 16x^{-1}(+c)$	M1: $x^n \rightarrow x^{n+1}$ on any term A1: $27x - x^2$ A1: $-6x^{\frac{3}{2}}$ A1: $+16x^{-1}$	M1A1A1A1
	$\left(27(4)-(4)^2-6(4)^{\frac{3}{2}}+16(4)^{-1}\right)$ $-\left(27(1)-(1)^2-6(1)^{\frac{3}{2}}+16(1)^{-1}\right)$	**Attempt to subtract either way round using the limits 4 and 1. Dependent on the previous M1**	dM1
	= (48 – 36)		
	12	Cao	A1
			(6)
			[12]

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