Mark Scheme (Results)

January 2014

Pearson Edexcel International Advanced Level

Core Mathematics 2 (6664A/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.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

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.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes.

- bod – benefit of doubt
- ft – follow through
- the symbol $\sqrt{}$ 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
- ⌐ 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 manifestly absurd 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.

General Principles for Core Mathematics Marking

(But note that specific mark schemes may sometimes override these general principles).

Method mark for solving 3 term quadratic:

1. Factorisation

$(x^2 + bx + c) = (x + p)(x + q)$, where $|pq| = |c|$, leading to x = …

$(ax^2 + bx + c) = (mx + p)(nx + q)$, where $|pq| = |c|$ and $|mn| = |a|$, leading to x = …

2. Formula

Attempt to use the correct formula (with values for a, b and c).

3. Completing the square

Solving $x^2 + bx + c = 0$: $\left(x \pm \frac{b}{2}\right)^2 \pm q \pm c = 0,\ \ q \neq 0$, leading to x = …

Method marks for differentiation and integration:

1. Differentiation

Power of at least one term decreased by 1. ($x^n \rightarrow x^{n-1}$)

2. Integration

Power of at least one term increased by 1. ($x^n \rightarrow x^{n+1}$)

Use of a formula

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.

Normal marking procedure is as follows:

Method mark for quoting a correct formula and attempting to use it, even if there are mistakes in the substitution of values.

Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.

Exact answers

Examiners' reports have emphasised that where, for example, an exact answer is asked for, or working with surds is clearly required, marks will normally be lost if the candidate resorts to using rounded decimals.

Answers without working

The rubric says that these may not gain full credit. Individual mark schemes will give details of what happens in particular cases. General policy is that if it could be done "in your head", detailed working would not be required.

Question Number	Scheme	Notes	Marks
1.	$(1+px)^{12}$		
	$1+\underline{\binom{12}{1}\times px+\binom{12}{2}\times(px)^2}$ or $1+\underline{12px+\frac{12.11}{2}(px)^2}$	Correct structure for at least 1 of the underlined terms, including coefficients. Could be implied by e.g. $12p = 18$	M1
	$=\left(1+12px+66p^2x^2\right)$		
	$12p=18\Rightarrow p=$	Compare coefficients of x and solve for p	M1
	$p=\frac{18}{12}\left(=\frac{3}{2}\right)$	Correct value for p	A1
	$q=66\times\left(\text{their }\frac{3}{2}\right)^2$	Substitutes their value of p into their coefficient of x^2 to find q	M1
	$q=148.5$ or equivalent	cao	A1
			(5)
	Note failing to square p in the x^2 term could score M1M1A1M1A0 (4/5) (Gives q = 99)		
			Total 5

Question Number	Scheme	Notes	Marks
2	$f(x) = 2x^3 + x^2 + ax + b$		
(a) Way 1	$f(2) = 2(2)^3 + (2)^2 + 2a + b = 25$	$f(\pm 2) = 25$	M1
	$16 + 4 + 2a + b = 25 \Rightarrow 2a + b = 5$ *	Correct completion to printed answer. If f(2) is not seen explicitly and "$16 + 4 + 2a + b = 25$" is incorrect, score M0	A1
			(2)
(a) Way 2	Alternative by long division:		
	$2x^3 + x^2 + ax + b \div (x-2)$ Quotient $= 2x^2 + 5x + a + 10$ Remainder $= 2a + b + 20$	Attempt Quotient & Remainder: Needs a quotient of the form $2x^2 + kx + f(a)$ and a remainder that is a function of *a* and *b*	M1
	$2a + b + 20 = 25 \Rightarrow 2a + b = 5$ *	Correct completion to printed answer	A1
			(2)
(b)	$f(-3) = 2(-3)^3 + (-3)^2 - 3a + b = 0$	$f(\pm 3) = 0$	M1
	$2a + b = 5, \quad b - 3a = 45 \rightarrow a = or\ b =$	Solves simultaneously to *a* = or *b* =	M1
	a = -8, *b* = 21	**First** A1: One correct constant **Second** A1: Both constants correct	A1, A1
			(4)
			Total 6

Question Number	Scheme	Notes	Marks
3(a)	$y = 2\sqrt{x} + \frac{18}{\sqrt{x}} - 1 = 2x^{\frac{1}{2}} + 18x^{-\frac{1}{2}} - 1$		
(i)	$\frac{dy}{dx} = x^{-\frac{1}{2}} - 9x^{-\frac{3}{2}}$	M1: $x^n \to x^{n-1}$ A1: $x^{-\frac{1}{2}}$ A1: $-9x^{-\frac{3}{2}}$ and $-1 \to 0$	M1A1A1
(ii)	$\frac{d^2y}{dx^2} = -\frac{1}{2}x^{-\frac{3}{2}} + \frac{27}{2}x^{-\frac{5}{2}}$	M1: $x^n \to x^{n-1}$ A1: $-\frac{1}{2}x^{-\frac{3}{2}} + \frac{27}{2}x^{-\frac{5}{2}}$	M1A1ft
			(5)
(b)	$x^{-\frac{1}{2}} - 9x^{-\frac{3}{2}} = 0$	Set $\frac{dy}{dx} = 0$ and proceed to $x =$	M1
	$x - 9 = 0 \Rightarrow x = 9$ **only**	Cso	A1
	$y = 2\sqrt{"9"} + \frac{18}{\sqrt{"9"}} - 1$	Substitutes their x value(s) into the given equation	M1
	$y = 11$	Cao. **There must be no other turning points for this mark but allow recovery if $x = 9$ is obtained by the invalid method shown below**	A1
	Allow correct answers only from a correct derivative otherwise apply the scheme		
			(4)
(c)	$f''(9) = -\frac{1}{2}("9")^{-\frac{3}{2}} + \frac{27}{2}("9")^{-\frac{5}{2}}$	Substitutes their x value(s) into their second derivative	M1
	$f''(9) = \frac{1}{27} > 0 \therefore$ Minimum	Fully correct solution including a correct numerical second derivative (awrt 0.04) and a reference to positive or > 0 **There must be no other turning points for this mark i.e. $x = 9$ only used but allow recovery as above.**	A1
	Accept full valid alternative arguments for the minimum e.g. finds gradient either side of $x = 9$		(2)
			Total 11
(b)	$x^{-\frac{1}{2}} - 9x^{-\frac{3}{2}} = 0 \Rightarrow \frac{1}{\sqrt{x}} - \frac{9}{x\sqrt{x}} = 0$		
	$\Rightarrow \frac{1}{x} - \frac{81}{x^3} = 0 \Rightarrow x^2 = 81 \Rightarrow x = 9$		M1A0
	Then allow remaining marks to be recovered		

Question Number	Scheme	Notes	Marks
4(a)(i)	$t_{20} = 5\times1.2^{19} = 159.7$	M1: Use of $t_n = ar^{n-1}$ A1: Cao	M1A1
(ii)	$S_{20} = \frac{5\left(1-1.2^{20}\right)}{1-1.2} = 933.4$	M1: Use of a correct sum formula with n = 19 or n = 20 NB if n = 19 is used and no formula is quoted, score M0 A1: Cao	M1A1
			(4)
(b)	$\frac{5\left(1-1.2^{n}\right)}{1-1.2}(>\text{or}=)3000$	Correct statement (allow ‘a’ and/or ‘r’ instead of 5 and 1.2)	B1
	$1.2^n > 121$	1.2^n (> or < or =) k	M1
	$\log1.2^n > \log121$ or $n > \log_{1.2}121$	Takes logs correctly	M1
	$n > \frac{\log121}{\log1.2}$ i.e. $n = 27$	cao	A1
	Ignore symbols e.g. ‘=’ throughout with no errors getting n = 27 scores full marks		
	In (b) Treat $5\times1.2^{n-1} > 3000$ as a misread and allow the M’s if scored (gives n = 37)		
			(4)
			Total 8

Question Number	Scheme	Notes	Marks
5(a)	$H=10+5\sin\left(\frac{\pi(1)}{6}\right)=12.5$ * Or just $H=10+5\sin\left(\frac{\pi}{6}\right)=12.5$ *	12.5 oe	B1
			(1)
(b)	$9=10+5\sin\left(\frac{\pi t}{6}\right)\Rightarrow 5\sin\left(\frac{\pi t}{6}\right)=-1$	Proceed to $5\sin\left(\frac{\pi t}{6}\right)=k$ May be implied by e.g. $\sin\left(\frac{\pi t}{6}\right)=-\frac{1}{5}$	M1
	$\sin\left(\frac{\pi t}{6}\right)=-\frac{1}{5}\Rightarrow\left(\frac{\pi t}{6}\right)=\arcsin\left(\pm\frac{1}{5}\right)$	$\arcsin\left(\pm\frac{k}{5}\right)$	M1
	$\alpha=\pm0.2(0135792)$ (or 11.536….degrees)	May be implied. Given the similarity between $-\frac{1}{5}$ and $\arcsin\left(-\frac{1}{5}\right)$ allow $\alpha=$ awrt ±0.2	B1
	$\left(\frac{\pi t}{6}\right)=\pi+0.201...$ or $\left(\frac{\pi t}{6}\right)=2\pi-0.201...$ $\left(\frac{\pi t}{6}\right)=3.34295...$ or $\left(\frac{\pi t}{6}\right)=6.08127...$ = 6.384565.... or 11.615434....	May be implied. Do not allow mixing of degrees and radians but allow working in just degrees.	M1
	$t=$ 0623, 1137	Accept 6hrs 23mins, 11hrs 37mins Or 5hrs 37mins, 23 mins before midday	A1, A1
			(6)
			Total 7

Question Number	Scheme	Notes	Marks
6	$\log_x(7y+1)-\log_x 2y=\log_x\left(\frac{7y+1}{2y}\right)$	Combines logs correctly	B1
	$1=\log_x x$	Correct statement (may be implied)	B1
	$\frac{7y+1}{2y}=x$	Remove logs to obtain this equation or equivalent.	M1
	$2yx=7y+1\Rightarrow y(2x-7)=1$	Isolate y correctly to give y as a function of x. Allow sign errors only. Dependent on the previous method mark.	dM1
	$y=\frac{1}{2x-7}$ or $\frac{-1}{7-2x}$	cao	A1
			(5)
			Total 5
Way 2	$\log_x(7y+1)=1+\log_x 2y$		
	$\log_x(7y+1)=\log_x x+\log_x 2y$	$1=\log_x x$ (may be implied)	B1
	$\log_x x+\log_x 2y=\log_x 2xy$	Combines logs correctly	B1
	$7y+1=2xy$	Remove logs to obtain this equation or equivalent.	M1
	$2yx=7y+1\Rightarrow y(2x-7)=1$	Isolate y correctly to give y as a function of x. Allow sign errors only. Dependent on the previous method mark.	dM1
	$y=\frac{1}{2x-7}$ or $\frac{-1}{7-2x}$	cao	A1
Way 3	$\log_x(7y+1)-\log_x 2y=\log_x\left(\frac{7y+1}{2y}\right)$	Combines logs correctly	B1
	$\log_x\left(\frac{7y+1}{2y}\right)=\frac{\log_{10}\left(\frac{7y+1}{2y}\right)}{\log_{10}x}$	Correct change of base	B1
	$\log_{10}\left(\frac{7y+1}{2y}\right)=\log_{10}x$		
	$\frac{7y+1}{2y}=x$	Remove logs to obtain this equation or equivalent.	M1
	Then as above		

Question Number	Scheme	Notes	Marks
7(a)	$y = x^3 - 6x^2 + 9x + 5$		
	$\frac{dy}{dx} = 3x^2 - 12x + 9$	M1: $x^n \to x^{n-1}$ A1: Correct derivative	M1A1
	$f'(4) = 3(4)^2 - 12(4) + 9 = 9$	Finds $f'(4)$	M1
	$m_N = -\frac{1}{"9"}$	Perpendicular gradient rule applied to their $f'(4)$. Dependent on the previous method mark.	dM1
	$y - 9 = "-\frac{1}{9}"(x - 4)$	Correct straight line method as shown or $y = mx + c$ with an attempt to find c. Depends on both previous method marks.	ddM1
	$x + 9y = 85$ *	Correct completion to printed answer. Allow this from the previous line.	A1*
			(6)
(b) Way1	$x = 0 \Rightarrow y = \frac{85}{9}$		
	$Area\,trapezium = \frac{1}{2} \times 4 \times \left(9 + \frac{85}{9}\right) \quad \left(= \frac{332}{9} = 36.88...\right)$	M1: Correct method for trapezium A1: Correct numerical expression	M1A1
	$\int y\,dx = \frac{x^4}{4} - 2x^3 + \frac{9x^2}{2} + 5x$	M1: $x^n \to x^{n+1}$ A1: Correct integration	M1A1
	$\left[\frac{x^4}{4} - 2x^3 + \frac{9x^2}{2} + 5x\right]_0^4 = \frac{4^4}{4} - 2 \times 4^3 + \frac{9 \times 4^2}{2} + 5 \times 4 (-0)$	Use of limits 0 and 4 in a changed function and subtracts (either way round) (- 0 may be implied)	M1
	$R = \frac{332}{9} - 28 = \frac{80}{9}$	M1: Their Trapezium – Their Integral or Their Integral – Their Trapezium A1: Cso	M1A1
			(7)
	See appendix for alternative methods for part (b)		
			Total 13

Question Number	Scheme	Notes	Marks
8(a)	$x^2 + y^2 = 25\left(\text{or } 5^2\right)$	Allow $\left(x-0\right)^2 + \left(y-0\right)^2 = 25$	B1
			(1)
(b)	$\textit{Gradient OQ} = -\frac{4}{3}$	Correct gradient	B1
	$\textit{Tangent Gradient} = \frac{3}{4}$	Correct perpendicular gradient rule	M1
	$y + 4 = \frac{3}{4}\left(x-3\right)$	Correct straight line method using (3, -4) and their numerical gradient.	M1
	$3x - 4y = 25*$	Correct completion with no errors	A1
			(4)
(c)	$6^2 = 5^2 + 5^2 - 2\times5\times5\cos\theta$ or $\tan\frac{1}{2}\theta = \frac{3}{4}$	Correct statement for angle POQ	M1
	$\theta = \cos^{-1}\left(\frac{5^2+5^2-6^2}{2\times5\times5}\right)$ or $\theta = 2\tan^{-1}\left(\frac{3}{4}\right)$		
	$\theta = 1.287*$	cso	A1
			(2)
(d)	At R $y = -\frac{25}{4}$ or $OR = \frac{25}{4}$ or QR = $\frac{15}{4}$	May be implied	B1
	Area $POQR = \frac{25}{4}\times3\left(=18.75\right)$ *or* $OPQ + PQR = \frac{4\times6}{2} + \frac{6}{2}\left(\frac{25}{4}-4\right)\left(=18.75\right)$ *or* $2\times OQR = 2\times\frac{1}{2}\times5\times\frac{15}{4}\left(=18.75\right)$	Valid attempt at kite area	M1
	$\textit{Area Sector} = \frac{1}{2}\times5^2\times1.287$ (16.0875)	Attempt sector area	M1
	$18.75 - \frac{1}{2}\times5^2\times1.287 = 2.6625$	Awrt 2.66	A1
			(4)
			Total 11

Question Number	Scheme	Notes	Marks
9(a)	$5\sin x - \cos^2 x + 2\sin^2 x = 1$		
	$5\sin x - (1-\sin^2 x) + 2\sin^2 x = 1$	Use of $\cos^2 x = 1 - \sin^2 x$	M1
	$3\sin^2 x + 5\sin x - 2 = 0$ *		A1
			(2)
(b)	$(3\sin 2\theta - 1)(\sin 2\theta + 2) = 0 \Rightarrow \sin 2\theta = ...$	Attempt to solve for sin2θ or sinθ	M1
	$\sin(2\theta) / \sin\theta = \frac{1}{3} (or -2)$		A1
	$2\theta / \theta = \sin^{-1}\left("\frac{1}{3}"\right)$		M1
	$2\theta = 19.47122....$		
	$\theta = 9.74$	Awrt	A1
	$2\theta / \theta = 180 - 19.47,\ -180 - 19.47...,\ -360 + 19.47...$	At least **one** of these	M1
	θ = 80.26, -99.74, -170.26 **Allow awrt 80.3, -99.7, -170.3**	A1: Any **two** of these to the awrt accuracy indicated A1: **All** values as shown to the awrt accuracy indicated and no other values in range.	A1,A1
	For use of radians allow the method marks		
			(7)
			Total 9
	If the quadratic is solved incorrectly, the M marks are available e.g.		
	$(3\sin 2\theta + 1)(\sin 2\theta - 2) = 0 \Rightarrow \sin 2\theta = ...$		M1
	$\sin(2\theta) / \sin\theta = -\frac{1}{3} (or + 2)$		A0
	$2\theta / \theta = \sin^{-1}\left("-\frac{1}{3}"\right)$		M1
	$2\theta = -19.47122....$		
	$\theta = -9.74$		A0
	$2\theta / \theta = -180 + 19.47,\ 180 + 19.47...,\ 360 - 19.47...$	At least **one** of these	M1
			A0,A0
			(3/7)

Appendix

Question Number	Scheme	Notes	Marks
7(b) Way 2	Area trapezium $=\int_0^4\left(\frac{85-x}{9}\right)dx=\left[\frac{85x-\frac{x^2}{2}}{9}\right]$	Correct method for trapezium including limits. An attempt to integrate their rearrangement of the <u>normal</u> with the <u>limits 0 and 4</u>.	M1
	$=\frac{1}{9}\left(85(4)-\frac{4^2}{2}\right)(-0)$	Correct numerical expression	A1
	$\int y\,dx=\frac{x^4}{4}-2x^3+\frac{9x^2}{2}+5x$	M1: $x^n \to x^{n+1}$ A1: Correct integration	M1A1
	$\left[\frac{x^4}{4}-2x^3+\frac{9x^2}{2}+5x\right]_0^4=\frac{4^4}{4}-2\times4^3+\frac{9\times4^2}{2}+5\times4(-0)$	Use of limits 0 and 4 in a changed function and subtracts (either way round)	M1
	$R=\frac{332}{9}-28=\frac{80}{9}$	M1: Trapezium – Integral or Integral - Trapezium A1: Cso	M1A1
			(7)
7(b) Way 3	$Line-Curve=\frac{85-x}{9}-\left(x^3-6x^2+9x+5\right)$	Allow (Curve – Line) for both marks. In either case, the A1 should not be awarded if brackets are missing unless a correct expression is implied by later work.	M1A1 **(First 2 marks)**
	$\int(y_1-y_2)\,dx=\frac{1}{9}\int\left(40-9x^3+54x^2-82x\right)dx$		
	$=\frac{1}{9}\left[40x-\frac{9x^4}{4}+\frac{54x^3}{3}-\frac{82x^2}{2}\right]$	M2: $x^n \to x^{n+1}$ on **both** line and curve **Second and third M's, second A** A1: Correct integration	M2A1
	$\frac{1}{9}\left[40x-\frac{9x^4}{4}+\frac{54x^3}{3}-\frac{82x^2}{2}\right]_0^4=$ $\frac{1}{9}\left(40(4)-\frac{9(4)^4}{4}+\frac{54(4)^3}{3}-\frac{82(4)^2}{2}\right)(-0)$	Use of limits 0 and 4 in a changed function and subtracts (either way round)	M1
	$=\frac{80}{9}$ or any <u>exact</u> equivalent	Correct area	A1cso
	If the only error in this method is to do (Curve – Line) then only penalise the final mark – i.e. they get -80/9		
			(7)

Question Number	Scheme	Notes	Marks
8(d)	$\triangle PQR - \text{segment}:$		
	At R $y = -\frac{25}{4}$ or $OR = \frac{25}{4}$	May be implied	B1
	$\triangle PQR = \frac{1}{2}\times 6\times\left(\frac{25}{4}-4\right)\left(=\frac{27}{4}\right)$	Valid attempt at triangle area	M1
	Segment $= \frac{1}{2}\times 5^2\times 1.287 - \frac{1}{2}\times 6\times 4\left(=4.0875\right)$	Valid attempt at segment area	M1
	$\frac{27}{4} - 4.0875 = 2.6625$	Awrt 2.66	A1

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