



Cambridge International AS & A Level

MATHEMATICS

9709/11

Paper 1 Pure Mathematics 1

May/June 2020

MARK SCHEME

Maximum Mark: 75

Published

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This mark scheme is published to support teachers and students and should be read together with the question paper. It shows the requirements of the exam. The answer column of the mark scheme shows the proposed basis on which Examiners would award marks for this exam. Where appropriate, this column also provides the most likely acceptable alternative responses expected from students. Examiners usually review the mark scheme after they have seen student responses and update the mark scheme if appropriate. In the June series, Examiners were unable to consider the acceptability of alternative responses, as there were no student responses to consider.

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This document consists of **13** printed pages.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- Marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Mathematics-Specific Marking Principles	
1	Unless a particular method has been specified in the question, full marks may be awarded for any correct method. However, if a calculation is required then no marks will be awarded for a scale drawing.
2	Unless specified in the question, answers may be given as fractions, decimals or in standard form. Ignore superfluous zeros, provided that the degree of accuracy is not affected.
3	Allow alternative conventions for notation if used consistently throughout the paper, e.g. commas being used as decimal points.
4	Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored (isw).
5	Where a candidate has misread a number in the question and used that value consistently throughout, provided that number does not alter the difficulty or the method required, award all marks earned and deduct just 1 mark for the misread.
6	Recovery within working is allowed, e.g. a notation error in the working where the following line of working makes the candidate's intent clear.

Mark Scheme Notes

The following notes are intended to aid interpretation of mark schemes in general, but individual mark schemes may include marks awarded for specific reasons outside the scope of these notes.

Types of mark

- M** Method mark, awarded for a valid method applied to the problem. Method marks are not 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. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.
- 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).
- B** Mark for a correct result or statement independent of method marks.
- DM or DB** When a part of a question has two or more “method” steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly, when there are several B marks allocated. The notation DM or DB is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.
- FT** Implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only.

Abbreviations

AEF/OE	Any Equivalent Form (of answer is equally acceptable) / Or Equivalent
AG	Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
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WWW	Without Wrong Working
AWRT	Answer Which Rounds To

Question	Answer	Marks
1	$117 = \frac{9}{2}(2a + 8d)$	B1
	Either $91 = S_4$ with ‘ a ’ as $a + 4d$ or $117 + 91 = S_{13}$ (M1 for overall approach. M1 for S_n)	M1M1
	Simultaneous Equations $\rightarrow a = 7, d = 1.5$	A1
		4

Question	Answer	Marks
2	$\left(kx + \frac{1}{x}\right)^5 + \left(1 - \frac{2}{x}\right)^8$ Coefficient in $\left(kx + \frac{1}{x}\right)^5 = 10 \times k^2$ (B1 for 10. B1 for k^2)	B1B1
	Coefficient in $\left(1 - \frac{2}{x}\right)^8 = 8 \times -2$	B2,1,0
	$10k^2 - 16 = 74 \rightarrow k = 3$	B1
		5

Question	Answer	Marks
3(a)	$\$36\,000 \times (1.05)^n$ (B1 for $r = 1.05$. M1 method for r th term)	B1M1
	\$53 200 after 8 years.	A1
		3
3(b)	$S_{10} = 36\,000 \frac{(1.05^{10} - 1)}{(1.05 - 1)}$	M1
	\$453 000	A1
		2

Question	Answer	Marks
4(a)	$-1 \leq f(x) \leq 2$	B1 B1
		2
4(b)	$k = 1$	B1
	Translation by 1 unit upwards parallel to the y-axis	B1
		2
4(c)	$y = -\frac{3}{2}\cos 2x - \frac{1}{2}$	B1
		1

Question	Answer	Marks
5(a)	$x(mx + c) = 16 \rightarrow mx^2 + cx - 16 = 0$	B1
	Use of $b^2 - 4ac = c^2 + 64m$	M1
	Sets to 0 $\rightarrow m = \frac{-c^2}{64}$	A1
		3
5(b)	$x(-4x + c) = 16$ Use of $b^2 - 4ac \rightarrow c^2 - 256$	M1
	$c > 16$ and $c < -16$	A1 A1
		3

Question	Answer	Marks
6(a)	$3(3x+b)+b=9x+4b \rightarrow 10=18+4b$	M1
	$b=-2$	A1
	Either $f(14)=2$ or $f^{-1}(x)=2(x+a)$ etc.	M1
	$a=5$	A1
		4
6(b)	$gf(x)=3\left(\frac{1}{2}x-5\right)-2$	M1
	$gf(x)=\frac{3}{2}x-17$	A1
		2

Question	Answer	Marks
7(a)	$\frac{(1 + \sin \theta)^2 + \cos^2 \theta}{\cos \theta (1 + \sin \theta)}$	M1
	Use of $\sin^2 \theta + \cos^2 \theta = 1 \rightarrow \frac{2 + 2 \sin \theta}{\cos \theta (1 + \sin \theta)} \rightarrow \frac{2}{\cos \theta}$	M1A1
		3
7(b)	$\frac{2}{\cos \theta} = \frac{3}{\sin \theta} \rightarrow \tan \theta = 1.5$	M1
	$\theta = 0.983$ or 4.12 (FT on second value for 1st value + π)	A1 A1FT
		3

Question	Answer	Marks
8	Angle $AOB = 15 \div 6 = 2.5$ radians	B1
	Angle $BOC = \pi - 2.5$ (FT on angle AOB)	B1FT
	$BC = 6(\pi - 2.5)$ ($BC = 3.850$)	M1
	$\sin(\pi - 2.5) = BX \div 6$ ($BX = 3.59$)	M1
	Either $OX = 6 \cos(\pi - 2.5)$ or Pythagoras ($OX = 4.807$)	M1
	$XC = 6 - OX$ ($XC = 1.193$) $\rightarrow P = 8.63$	A1
		6

Question	Answer	Marks
9(a)	$\frac{dy}{dx} = 3(3-2x)^2 \times -2 + 24 = -6(3-2x)^2 + 24$ (B1 without $\times -2$. B1 for $\times -2$)	B1B1
	$\frac{d^2y}{dx^2} = -12(3-2x) \times -2 = 24(3-2x)$ (B1FT from $\frac{dy}{dx}$ without -2)	B1FT B1
		4
9(b)	$\frac{dy}{dx} = 0$ when $6(3-2x)^2 = 24 \rightarrow 3-2x = \pm 2$	M1
	$x = \frac{1}{2}, y = 20$ or $x = 2\frac{1}{2}, y = 52$ (A1 for both x values or a correct pair)	A1A1
		3
9(c)	If $x = \frac{1}{2}$, $\frac{d^2y}{dx^2} = 48$ Minimum	B1FT
	If $x = 2\frac{1}{2}$, $\frac{d^2y}{dx^2} = -48$ Maximum	B1FT
		2

Question	Answer	Marks
10(a)	Centre is (3, 1)	B1
	Radius = 5 (Pythagoras)	B1
	Equation of C is $(x-3)^2 + (y-1)^2 = 25$ (FT on <i>their</i> centre)	M1 A1FT
		4
10(b)	Gradient from (3, 1) to (7, 4) = $\frac{3}{4}$ (this is the normal)	B1
	Gradient of tangent = $-\frac{4}{3}$	M1
	Equation is $y-4 = -\frac{4}{3}(x-7)$ or $3y+4x=40$	M1A1
		4
10(c)	B is centre of line joining centres $\rightarrow (11, 7)$	B1
	Radius = 5 New equation is $(x-11)^2 + (y-7)^2 = 25$ (FT on coordinates of B)	M1 A1FT
		3

Question	Answer	Marks
11(a)	Simultaneous equations $\frac{8}{x+2} = 4 - \frac{1}{2}x$	M1
	$x = 0$ or $x = 6 \rightarrow A(0, 4)$ and $B(6, 1)$	B1A1
	At C $\frac{-8}{(x+2)^2} = -\frac{1}{2} \rightarrow C(2, 2)$	B1
	(B1 for the differentiation. M1 for equating and solving)	M1A1
		6
11(b)	Volume under line $= \pi \int \left(-\frac{1}{2}x + 4\right)^2 dx = \pi \left[\frac{x^3}{12} - 2x^2 + 16x \right] = (42\pi)$ (M1 for volume formula. A2,1 for integration)	M1 A2,1
	Volume under curve $= \pi \int \left(\frac{8}{x+2}\right)^2 dx = \pi \left[\frac{-64}{x+2} \right] = (24\pi)$	A1
	Subtracts and uses 0 to 6 $\rightarrow 18\pi$	M1A1
		6



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Question	Answer	Marks
1(a)	$(2+3x)\left(x-\frac{2}{x}\right)^6$ Term in x^2 in $\left(x-\frac{2}{x}\right)^6 = 15x^4 \times \left(\frac{-2}{x}\right)^2$	B1
	Coefficient = 60	B1
		2
1(b)	Constant term in $\left(x-\frac{2}{x}\right)^6 = 20x^3 \times \left(\frac{-2}{x}\right)^3 (-160)$	B2, 1
	Coefficient of x^2 in $(2+3x)\left(x-\frac{2}{x}\right)^6 = 120 - 480 = -360$	B1FT
		3

Question	Answer	Marks
2(a)	$3 \cos \theta = 8 \tan \theta \rightarrow 3 \cos \theta = \frac{8 \sin \theta}{\cos \theta}$	M1
	$3(1 - \sin^2 \theta) = 8 \sin \theta$	M1
	$3 \sin^2 \theta + 8 \sin \theta - 3 = 0$	A1
		3
2(b)	$(3 \sin \theta - 1)(\sin \theta + 3) = 0 \rightarrow \sin \theta = \frac{1}{3}$	M1
	$\theta = 19.5^\circ$	A1
		2

Question	Answer	Marks
3(a)	Volume after 30 s = 18000 $\frac{4}{3}\pi r^3 = 18000$	M1
	$r = 16.3$ cm	A1
		2
3(b)	$\frac{dV}{dr} = 4\pi r^2$	B1
	$\frac{dr}{dt} = \frac{dr}{dV} \times \frac{dV}{dt} = \frac{600}{4\pi r^2}$	M1
	$\frac{dr}{dt} = 0.181$ cm per second	A1
		3

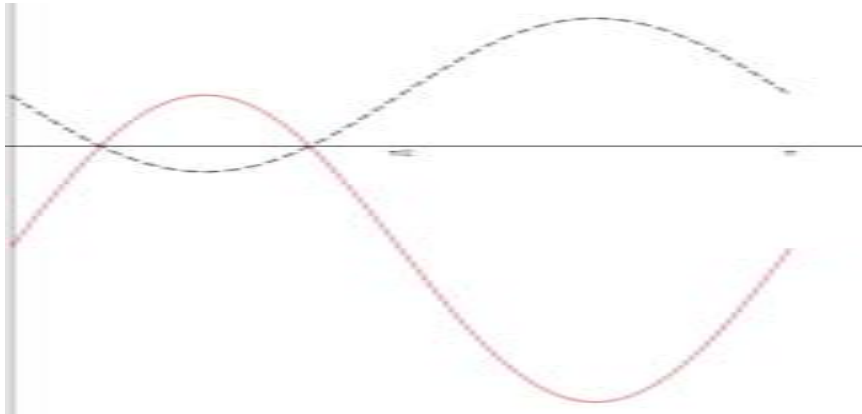
Question	Answer	Marks
4	1st term is -6 , 2nd term is -4.5 (M1 for using k th terms to find both a and d)	M1
	$\rightarrow a = -6, d = 1.5$	A1 A1
	$S_n = 84 \rightarrow 3n^2 - 27n - 336 = 0$	M1
	Solution $n = 16$	A1
		5

Question	Answer	Marks
5(a)	$ff(x) = a - 2(a - 2x)$	M1
	$ff(x) = 4x - a$	A1
	$f^{-1}(x) = \frac{a-x}{2}$	M1 A1
		4
5(b)	$4x - a = \frac{a-x}{2} \rightarrow 9x = 3a$	M1
	$x = \frac{a}{3}$	A1
		2

Question	Answer	Marks
6(a)	$2x^2 + kx + k - 1 = 2x + 3 \rightarrow 2x^2 + (k - 2)x + k - 4 = 0$	M1
	Use of $b^2 - 4ac = 0 \rightarrow (k - 2)^2 = 8(k - 4)$	M1
	$k = 6$	A1
		3
6(b)	$2x^2 + 2x + 1 = 2\left(x + \frac{1}{2}\right)^2 + 1 - \frac{1}{2}$ $a = \frac{1}{2}, b = \frac{1}{2}$	B1 B1
	vertex $\left(-\frac{1}{2}, \frac{1}{2}\right)$ (FT on a and b values)	B1FT
		3

Question	Answer	Marks
7(a)	$BC^2 = r^2 + 4r^2 - 2r \cdot 2r \times \cos\left(\frac{\pi}{6}\right) = 5r^2 - 2r^2\sqrt{3}$	M1
	$BC = r\sqrt{(5 - 2\sqrt{3})}$	A1
		2
7(b)	Perimeter = $\frac{2\pi r}{6} + r + r\sqrt{(5 - 2\sqrt{3})}$	M1 A1
		2
7(c)	Area = sector – triangle	
	Sector area = $\frac{1}{2}4r^2\frac{\pi}{6}$	M1
	Triangle area = $\frac{1}{2}r \cdot 2r \sin\frac{\pi}{6}$	M1
	Shaded area = $r^2\left(\frac{\pi}{3} - \frac{1}{2}\right)$	A1
		3

Question	Answer	Marks
8(a)	Volume = $\pi \int x^2 dy = \pi \int \frac{36}{y^2} dy$	*M1
	$= \pi \left[\frac{-36}{y} \right]$	A1
	Uses limits 2 to 6 correctly $\rightarrow (12\pi)$	DM1
	Vol of cylinder = $\pi.1^2.4$ or $\int 1^2 dy = [y]$ from 2 to 6	M1
	Vol = $12\pi - 4\pi = 8\pi$	A1
		5
8(b)	$\frac{dy}{dx} = \frac{-6}{x^2}$	B1
	$\frac{-6}{x^2} = -2 \rightarrow x = \sqrt{3}$	M1
	$y = \frac{6}{\sqrt{3}} = 2\sqrt{3}$ Lies on $y = 2x$	A1
		3

Question	Answer	Marks
9(a)	$f(x)$ from -1 to 5	B1B1
	$g(x)$ from -10 to 2 (FT from part (a))	B1FT
		3
9(b)		B2, 1
		2
9(c)	Reflect in x -axis	B1
	Stretch by factor 2 in the y direction	B1
	Translation by $-\pi$ in the x direction OR translation by $\begin{pmatrix} 0 \\ -\pi \end{pmatrix}$.	B1
		3

Question	Answer	Marks
10(a)	$\frac{dy}{dx} = 54 - 6(2x - 7)^2$	B2,1
	$\frac{d^2y}{dx^2} = -24(2x - 7)$ (FT only for omission of '×2' from the bracket)	B2,1 FT
		4
10(b)	$\frac{dy}{dx} = 0 \rightarrow (2x - 7)^2 = 9$	M1
	$x = 5, y = 243$ or $x = 2, y = 135$	A1 A1
		3
10(c)	$x = 5 \frac{d^2y}{dx^2} = -72 \rightarrow \text{Maximum}$ (FT only for omission of '×2' from the bracket)	B1FT
	$x = 2 \frac{d^2y}{dx^2} = 72 \rightarrow \text{Minimum}$ (FT only for omission of '×2' from the bracket)	B1FT
		2

Question	Answer	Marks
11(a)	Express as $(x-4)^2 + (y+2)^2 = 16 + 4 + 5$	M1
	Centre $C(4, -2)$	A1
	Radius = $\sqrt{25} = 5$	A1
		3
11(b)	$P(1,2)$ to $C(4, -2)$ has gradient $-\frac{4}{3}$ (FT on coordinates of C)	B1FT
	Tangent at P has gradient = $\frac{3}{4}$	M1
	Equation is $y - 2 = \frac{3}{4}(x - 1)$ or $4y = 3x + 5$	A1
		3
11(c)	Q has the same coordinate as P $y = 2$	B1
	Q is as far to the right of C as P $x = 3 + 3 + 1 = 7$ $Q(7, 2)$	B1
		2

Question	Answer	Marks
11(d)	Gradient of tangent at $Q = -\frac{3}{4}$ by symmetry (FT from part (b))	B1FT
	Eqn of tangent at Q is $y - 2 = -\frac{3}{4}(x - 7)$ or $4y + 3x = 29$	M1
	$T(4, \frac{17}{4})$	A1
		3



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Mathematics-Specific Marking Principles	
1	Unless a particular method has been specified in the question, full marks may be awarded for any correct method. However, if a calculation is required then no marks will be awarded for a scale drawing.
2	Unless specified in the question, answers may be given as fractions, decimals or in standard form. Ignore superfluous zeros, provided that the degree of accuracy is not affected.
3	Allow alternative conventions for notation if used consistently throughout the paper, e.g. commas being used as decimal points.
4	Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored (isw).
5	Where a candidate has misread a number in the question and used that value consistently throughout, provided that number does not alter the difficulty or the method required, award all marks earned and deduct just 1 mark for the misread.
6	Recovery within working is allowed, e.g. a notation error in the working where the following line of working makes the candidate's intent clear.

Mark Scheme Notes

The following notes are intended to aid interpretation of mark schemes in general, but individual mark schemes may include marks awarded for specific reasons outside the scope of these notes.

Types of mark

- M** Method mark, awarded for a valid method applied to the problem. Method marks are not 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. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.
- 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).
- B** Mark for a correct result or statement independent of method marks.
- DM or DB** When a part of a question has two or more “method” steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly, when there are several B marks allocated. The notation DM or DB is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.
- FT** Implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only.

Abbreviations

AEF/OE	Any Equivalent Form (of answer is equally acceptable) / Or Equivalent
AG	Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
CAO	Correct Answer Only (emphasising that no “follow through” from a previous error is allowed)
CWO	Correct Working Only
ISW	Ignore Subsequent Working
SOI	Seen Or Implied
SC	Special Case (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)
WWW	Without Wrong Working
AWRT	Answer Which Rounds To

Question	Answer	Marks
1	$3x^2 + 2x + 4 = mx + 1 \rightarrow 3x^2 + x(2 - m) + 3 (= 0)$	B1
	$(2 - m)^2 - 36$ SOI	M1
	$(m + 4)(m - 8) (>/= 0)$ or $2 - m >/= 6$ and $2 - m </= -6$ OE	A1
	$m < -4, m > 8$ WWW	A1
	Alternative method for question 1	
	$\frac{dy}{dx} = 6x + 2 \rightarrow m = 6x + 2 \rightarrow 3x^2 + 2x + 4 = (6x + 2)x + 1$	M1
	$x = \pm 1$	A1
	$m = \pm 6 + 2 \rightarrow m = 8$ or -4	A1
	$m < -4, m > 8$ WWW	A1
		4

Question	Answer	Marks
2	$(y) = \frac{3x^{\frac{3}{2}}}{\frac{3}{2}} - \frac{3x^{\frac{1}{2}}}{\frac{1}{2}} (+c)$	B1 B1
	$7 = 16 - 12 + c$ (M1 for substituting $x = 4, y = 7$ into <i>their</i> integrated expansion)	M1
	$y = 2x^{\frac{3}{2}} - 6x^{\frac{1}{2}} + 3$	A1
		4

Question	Answer	Marks
3(a)	$(y) = f(-x)$	B1
		1
3(b)	$(y) = 2f(x)$	B1
		1
3(c)	$(y) = f(x+4) - 3$	B1 B1
		2

Question	Answer	Marks
4(a)	$1 + 5a + 10a^2 + 10a^3 + \dots$	B1
		1
4(b)	$1 + 5(x+x^2) + 10(x+x^2)^2 + 10(x+x^2)^3 + \dots$ SOI	M1
	$1 + 5(x+x^2) + 10(x^2+2x^3+\dots) + 10(x^3+\dots) + \dots$ SOI	A1
	$1 + 5x + 15x^2 + 30x^3 + \dots$	A1
		3

Question	Answer	Marks
5	$\cos POA = \frac{5}{13} \rightarrow POA = 1.17(6)$ Allow 67.4° or $\sin = \frac{12}{13}$ or $\tan = \frac{12}{5}$	M1 A1
	Reflex $AOB = 2\pi - 2 \times \text{their } 1.17(6)$ OE in degrees or minor arc AB = $5 \times 2 \times \text{their } 1.17(6)$	M1
	Major arc = $5 \times \text{their } 3.93(1)$ or $2\pi \times 5 - \text{their } 11.7(6)$	M1
	$AP \text{ (or } BP) = \sqrt{13^2 - 5^2} = 12$	B1
	Cord length = 43.7	A1
		6

Question	Answer	Marks
6(a)	$\frac{dy}{dx} = \left[\frac{1}{2}(5x-1)^{-1/2} \right] \times [5]$	B1 B1
	Use $\frac{dy}{dt} = 2 \times \left(\text{their } \frac{dy}{dx} \text{ when } x=1 \right)$	M1
	$\frac{5}{2}$	A1
		4

Question	Answer	Marks
6(b)	$2 \times \text{their } \frac{5}{2}(5x-1)^{-1/2} = \frac{5}{8} \quad \text{oe}$	M1
	$(5x-1)^{1/2} = 8$	A1
	$x = 13$	A1
		3

Question	Answer	Marks
7(a)	$\frac{\tan \theta}{1 + \cos \theta} + \frac{\tan \theta}{1 - \cos \theta} = \frac{\tan \theta(1 - \cos \theta) + \tan \theta(1 + \cos \theta)}{1 - \cos^2 \theta}$	M1
	$= \frac{2 \tan \theta}{\sin^2 \theta}$	M1
	$= \frac{2 \sin \theta}{\cos \theta \sin^2 \theta}$	M1
	$= \frac{2}{\sin \theta \cos \theta} \quad \text{AG}$	A1
		4

Question	Answer	Marks
7(b)	$\frac{2}{\sin \theta \cos \theta} = \frac{6 \cos \theta}{\sin \theta}$	M1
	$\cos^2 \theta = \frac{1}{3} \rightarrow \cos \theta = (\pm) 0.5774$	A1
	54.7°, 125.3° (FT for 180° – 1st solution)	A1 A1FT
		4

Question	Answer	Marks
8(a)	$r = \cos^2 \theta$ SOI	M1
	$S_{\infty} = \frac{\sin^2 \theta}{1 - \cos^2 \theta}$	M1
	1	A1
		3
8(b)(i)	$d = \sin^2 \theta \cos^2 \theta - \sin^2 \theta$	M1
	$\sin^2 \theta (\cos^2 \theta - 1)$	M1
	$-\sin^4 \theta$	A1
		3

Question	Answer	Marks
8(b)(ii)	Use of $S_{16} = \frac{16}{2}[2a + 15d]$	M1
	With <u>both</u> $a = \frac{3}{4}$ and $d = -\frac{9}{16}$	A1
	$S_{16} = -55\frac{1}{2}$	A1
		3

Question	Answer	Marks
9(a)	$[(x-2)^2] [-1]$	B1 B1
		2
9(b)	Smallest $c = 2$ (FT on <i>their</i> part (a))	B1FT
		1
9(c)	$y = (x-2)^2 - 1 \rightarrow (x-2)^2 = y+1$	*M1
	$x = 2(\pm)\sqrt{y+1}$	DM1
	$(f^{-1}(x)) = 2 + \sqrt{x+1}$ for $x > 8$	A1
		3

Question	Answer	Marks
9(d)	$gf(x) = \frac{1}{(x-2)^2 - 1 + 1} = \frac{1}{(x-2)^2}$ OE	B1
	Range of gf is $0 < gf(x) < \frac{1}{9}$	B1 B1
		3

Question	Answer	Marks
10(a)	Mid-point is $(-1, 7)$	B1
	Gradient, m , of AB is $8/12$ OE	B1
	$y - 7 = -\frac{12}{8}(x + 1)$	M1
	$3x + 2y = 11$ AG	A1
		4
10(b)	Solve simultaneously $12x - 5y = 70$ and <i>their</i> $3x + 2y = 11$	M1
	$x = 5, y = -2$	A1
	Attempt to find distance between <i>their</i> $(5, -2)$ and either $(-7, 3)$ or $(5, 11)$	M1
	$(r) = \sqrt{12^2 + 5^2}$ or $\sqrt{13^2 + 0} = 13$	A1
	Equation of circle is $(x - 5)^2 + (y + 2)^2 = 169$	A1
		5

Question	Answer	Marks
11(a)	$\frac{dy}{dx} = 3x^2 - 4bx + b^2$	B1
	$3x^2 - 4bx + b^2 = 0 \rightarrow (3x - b)(x - b) (=0)$	M1
	$x = \frac{b}{3}$ or b	A1
	$a = \frac{b}{3} \rightarrow b = 3a$ AG	A1
	Alternative method for question 11(a)	
	$\frac{dy}{dx} = 3x^2 - 4bx + b^2$	B1
	Sub $b = 3a$ & obtain $\frac{dy}{dx} = 0$ when $x = a$ and when $x = 3a$	M1
	$\frac{d^2y}{dx^2} = 6x - 12a$	A1
	< 0 Max at $x = a$ and > 0 Min at $x = 3a$. Hence $b = 3a$ AG	A1
		4

Question	Answer	Marks
11(b)	Area under curve = $\int (x^3 - 6ax^2 + 9a^2x) dx$	M1
	$\frac{x^4}{4} - 2ax^3 + \frac{9a^2x^2}{2}$	B2,1,0
	$\frac{a^4}{4} - 2a^4 + \frac{9a^4}{2} \left(= \frac{11a^4}{4} \right)$ (M1 for applying limits $0 \rightarrow a$)	M1
	When $x = a$, $y = a^3 - 6a^3 + 9a^3 = 4a^3$	B1
	Area under line = $\frac{1}{2}a \times \text{their } 4a^3$	M1
	Shaded area = $\frac{11a^4}{4} - 2a^4 = \frac{3}{4}a^4$	A1
		7