



Rewarding Learning

ADVANCED
General Certificate of Education

Mathematics

Assessment Unit A2 1

assessing

Pure Mathematics

[AMT11]

Assessment

MARK SCHEME

(Including Supplementary Mark Scheme to support Teachers)

GCE ADVANCED/ADVANCED SUBSIDIARY (AS) MATHEMATICS

Introduction

The mark scheme normally provides the most popular solution to each question. Other solutions given by candidates are evaluated and credit given as appropriate; these alternative methods are not usually illustrated in the published mark scheme.

The marks awarded for each question are shown in the right-hand column and they are prefixed by the letters **M**, **W** and **MW** as appropriate. The key to the mark scheme is given below:

M indicates marks for correct method.

W indicates marks for working.

MW indicates marks for combined method and working.

The solution to a question gains marks for correct method and marks for an accurate working based on this method. Where the method is not correct no marks can be given.

A later part of a question may require a candidate to use an answer obtained from an earlier part of the same question. A candidate who gets the wrong answer to the earlier part and goes on to the later part is naturally unaware that the wrong data is being used and is actually undertaking the solution of a parallel problem from the point at which the error occurred. If such a candidate continues to apply correct method, then the candidate's individual working must be followed through from the error. If no further errors are made, then the candidate is penalised only for the initial error. Solutions containing two or more working or transcription errors are treated in the same way. This process is usually referred to as "follow-through marking" and allows a candidate to gain credit for that part of a solution which follows a working or transcription error.

Positive marking:

It is our intention to reward candidates for any demonstration of relevant knowledge, skills or understanding. For this reason we adopt a policy of **following through** their answers, that is, having penalised a candidate for an error, we mark the succeeding parts of the question using the candidate's value or answers and award marks accordingly.

Some common examples of this occur in the following cases:

- (a) a numerical error in one entry in a table of values might lead to several answers being incorrect, but these might not be essentially separate errors;
- (b) readings taken from candidates' inaccurate graphs may not agree with the answers expected but might be consistent with the graphs drawn.

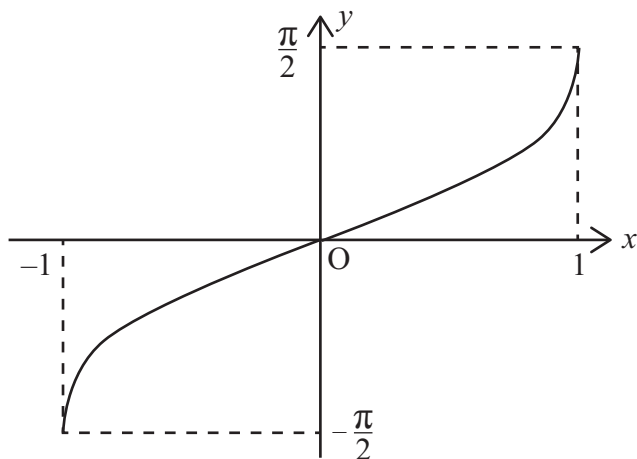
When the candidate misreads a question in such a way as to make the question easier only a proportion of the marks will be available (based on the professional judgement of the examining team).

		AVAILABLE MARKS	
1	(i) $300\pi = 4 \times (\frac{1}{2}(30)^2(\theta))$ $300\pi = 1800\theta$ $\theta = \frac{\pi}{6}$	M1 W1 W1	6
	(ii) $P = 4\left(\frac{\pi}{6}\right)(30) + 8(30)$ $P = (20\pi + 240) \text{ cm}$	M1 MW1 W1	
2	(a) (i) converges	MW1	8
	(ii) oscillates	MW1	
	(b) (i) $(1 - 3x)^{\frac{1}{2}}$ $= 1 + \left(\frac{1}{2}\right)(-3x) + \frac{\left(\frac{1}{2}\right)\left(\frac{-1}{2}\right)(-3x)^2}{2!} + \frac{\left(\frac{1}{2}\right)\left(\frac{-1}{2}\right)\left(\frac{-3}{2}\right)(-3x)^3}{3!} + \dots$ $= 1 - \frac{3}{2}x + \left(\frac{-1}{8}\right)(9x^2) + \left(\frac{1}{16}\right)(-27x^3) + \dots$ $= 1 - \frac{3}{2}x - \frac{9}{8}x^2 - \frac{27}{16}x^3 + \dots$	M1 W2 MW1	
	(ii) $ 3x < 1$ $-\frac{1}{3} < x < \frac{1}{3}$	 MW1	

3	(a)	x	2	3	4	MW1	AVAILABLE MARKS
						MW1	
		y	-0.8322...	-2.9699...	-2.6145...		
		$\int_2^4 x \cos x \, dx \approx \frac{1}{2}(-0.8322 \dots + 2(-2.9699 \dots) + -2.6145 \dots)$				M1 MW1	
		$\approx \frac{1}{2}(-9.386823 \dots)$					
		$\approx -4.69 \quad (3 \text{ sf})$				W1	
	(b)	$x^2 - 6 = 4x - x^2$				M1	
		$2x^2 - 4x - 6 = 0$					
		$2(x - 3)(x + 1) = 0$					
		$x = 3, x = -1$				W1	
		$\int_{-1}^3 (4x - x^2) - (x^2 - 6) \, dx$				M1 W1	
		$\int_{-1}^3 (4x - 2x^2 + 6) \, dx$					
		$= \left[2x^2 - \frac{2x^3}{3} + 6x \right]_{-1}^3$				W1	
		$= (18 - 18 + 18) - \left(2 + \frac{2}{3} - 6 \right)$				M1	
		$= \frac{64}{3}$					
		$= 21.3 \quad (3 \text{ sf})$				W1	12
4	(a) (i)	$5 \sec^4(2x)(2) \sec(2x) \tan(2x)$				M1 W2	
		$10 \sec^5(2x) \tan(2x)$				W1	
	(ii)	$\frac{e^{4x}(-\operatorname{cosec}^2 x) - 4e^{4x}(\cot x)}{(e^{4x})^2}$				M1 W2	
		$\frac{-e^{4x}(\operatorname{cosec}^2 x + 4 \cot x)}{(e^{4x})^2}$					
		$\frac{-(\operatorname{cosec}^2 x + 4 \cot x)}{e^{4x}}$				MW1	
	(b)	$V = \pi \int_0^4 (\sqrt{x} + 2)^2 \, dx$				M1	
		$= \pi \int_0^4 (x + 4\sqrt{x} + 4) \, dx$				W1	
		$= \pi \int_0^4 (x + 4x^{\frac{1}{2}} + 4) \, dx$					
		$= \pi \left[\frac{x^2}{2} + \frac{4x^{\frac{3}{2}}}{\frac{3}{2}} + 4x \right]_0^4$				M1 W2	
		$= \pi \left[\left(\frac{16}{2} + \frac{8(8)}{3} + 16 \right) - (0) \right]$				M1	
		$= \frac{136\pi}{3}$				W1	15

5	(i)	$\frac{3x^2 - 10x + 5}{(x+1)(x-2)^2} \equiv \frac{A}{(x+1)} + \frac{B}{(x-2)} + \frac{C}{(x-2)^2}$	M1 W1	
		$3x^2 - 10x + 5 \equiv A(x-2)^2 + B(x+1)(x-2) + C(x+1)$	M1	
		$x = 2: \quad 3C = 12 - 20 + 5$ $C = -1$	M1	
		$x = -1: \quad 9A = 3 + 10 + 5$ $A = 2$		
		$x = 0: \quad 4A - 2B + C = 5$ $B = 1$		
		$\frac{2}{(x+1)} + \frac{1}{(x-2)} - \frac{1}{(x-2)^2}$	W2	
	(ii)	$\int_0^1 \frac{3x^2 - 10x + 5}{(x+1)(x-2)^2} dx$		
		$= \int_0^1 \frac{2}{(x+1)} + \frac{1}{(x-2)} - \frac{1}{(x-2)^2} dx$	M1	
		$= \left[2 \ln x+1 + \ln x-2 - \frac{(x-2)^{-1}}{-1} \right]_0^1$	M1 W2	
		$= (2 \ln 2 + \ln 1 - 1) - (2 \ln 1 + \ln 2 - \frac{1}{2})$	M1	
		$= \ln 2 - \frac{1}{2}$	MW1	12

6 (a)



MW2

AVAILABLE
MARKS

(b) $R \cos(x + \alpha) = R \cos x \cos \alpha - R \sin x \sin \alpha$

M1

$$R \cos \alpha = 1 \quad R \sin \alpha = \sqrt{3}$$

M1

$$\frac{R \sin \alpha}{R \cos \alpha} = \sqrt{3}$$

M1

$$\tan \alpha = \sqrt{3}$$

$$\alpha = 60^\circ$$

W1

$$R^2(\sin^2 \alpha + \cos^2 \alpha) = 4$$

M1

$$R = 2$$

W1

$$\cos x - \sqrt{3} \sin x = 2 \cos(x + 60^\circ)$$

MW1

(c) $\sin 3\theta = \sin(2\theta + \theta)$

M1

$$= \sin 2\theta \cos \theta + \cos 2\theta \sin \theta$$

M1

$$= 2 \sin \theta \cos \theta \cos \theta + (1 - 2 \sin^2 \theta) \sin \theta$$

M1

$$= 2 \sin \theta \cos^2 \theta + \sin \theta - 2 \sin^3 \theta$$

W1

$$= 2 \sin \theta (1 - \sin^2 \theta) + \sin \theta - 2 \sin^3 \theta$$

$$= 2 \sin \theta - 2 \sin^3 \theta + \sin \theta - 2 \sin^3 \theta$$

$$= 3 \sin \theta - 4 \sin^3 \theta$$

W1

14

Alternate solution

$$\sin 3\theta = \sin(2\theta + \theta)$$

M1

$$= \sin 2\theta \cos \theta + \cos 2\theta \sin \theta$$

M1

$$= 2 \sin \theta \cos \theta \cos \theta + (\cos^2 \theta - \sin^2 \theta) \sin \theta$$

M1

$$= 2 \sin \theta \cos^2 \theta + \sin \theta \cos^2 \theta - \sin^3 \theta$$

W1

$$= 2 \sin \theta (1 - \sin^2 \theta) + \sin \theta (1 - \sin^2 \theta) - \sin^3 \theta$$

$$= 2 \sin \theta - 2 \sin^3 \theta + \sin \theta - \sin^3 \theta - \sin^3 \theta$$

$$= 3 \sin \theta - 4 \sin^3 \theta$$

W1

7 (a) $2x - 1 > 5$ $2x - 1 < -5$

$x > 3$ or $x < -2$

Alternate solution

$(2x - 1)^2 > 25$

$4x^2 - 4x + 1 > 25$

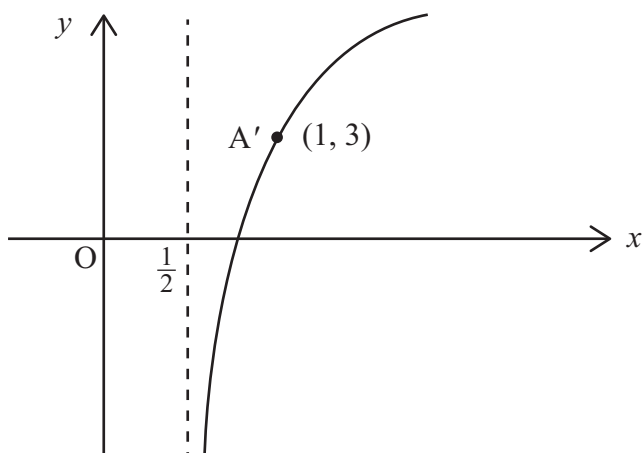
$4x^2 - 4x - 24 > 0$

$4(x^2 - x - 6) > 0$

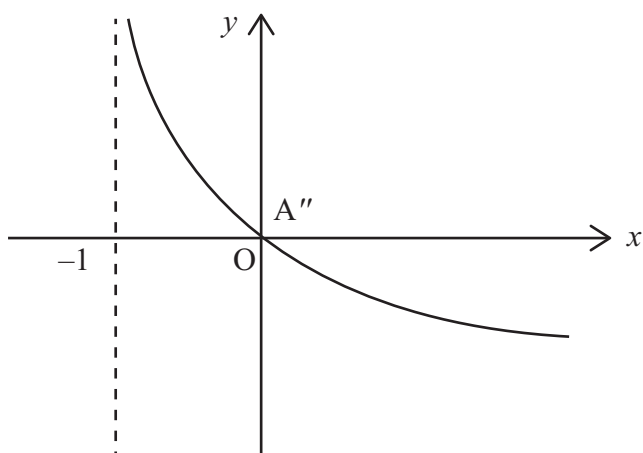
$4(x - 3)(x + 2) > 0$

$x > 3, x < -2$

(b) (i)



(ii)



M1

W2MW1

M1

W2MW1

MW3

MW3

AVAILABLE
MARKS

8	(c) (i) $f(x) > 0$ $g(x) > 1$	MW1 MW1	AVAILABLE MARKS
	(ii) $y = \frac{10}{x-1}$ $y(x-1) = 10$ $yx - y = 10$ $x = \frac{10+y}{y}$ $f^{-1}(x) = \frac{10+x}{x}$ Domain $x \in \mathbb{R}, x > 0$	M1 W1 MW1 MW1	
	(iii) $fg(x)$ $f(e^{3x})$ $= \frac{10}{e^{3x}-1}$ Domain $x \in \mathbb{R}, x > 0$	M1 W1 MW1	
	$2x + 5y \left(\frac{1}{x}\right) + 5 \frac{dy}{dx} \ln x - (1)y^2 - x(2y) \frac{dy}{dx} = 0$ At $(1, -1)$ $2 - 5 - 1 + 2 \frac{dy}{dx} = 0$ $\frac{dy}{dx} = 2$ $y + 1 = 2(x - 1)$ $y = 2x - 3$	M2W5 M1 W1 M1 W1	19 11

	AVAILABLE MARKS
9 (a) $\int 1 \times \ln x \, dx$ $= x \ln x - \int x \left(\frac{1}{x} \right) dx$ $= x \ln x - x + c$	M1 M1 W2 MW1
(b) $x = \frac{2}{3} \sin \theta$ $\frac{dx}{d\theta} = \frac{2}{3} \cos \theta$ $x = 0, \theta = 0$ $x = \frac{1}{3}, \theta = \frac{\pi}{6}$	M1 W1
$\int_0^{\frac{\pi}{6}} \sqrt{4 - 9 \left(\frac{2}{3} \sin \theta \right)^2} \left(\frac{2}{3} \cos \theta \right) d\theta$	M1 W2
$\int_0^{\frac{\pi}{6}} \sqrt{4 - 4 \sin^2 \theta} \left(\frac{2}{3} \cos \theta \right) d\theta$	
$\int_0^{\frac{\pi}{6}} \sqrt{4 \cos^2 \theta} \left(\frac{2}{3} \cos \theta \right) d\theta$	
$\int_0^{\frac{\pi}{6}} \frac{4}{3} \cos^2 \theta \, d\theta$	W1
$\int_0^{\frac{\pi}{6}} \frac{4}{3} \left(\frac{1}{2} (\cos 2\theta + 1) \right) d\theta$	M1 W1
$\frac{2}{3} \int_0^{\frac{\pi}{6}} (\cos 2\theta + 1) d\theta$	
$= \frac{2}{3} \left[\frac{\sin 2\theta}{2} + \theta \right]_0^{\frac{\pi}{6}}$	MW1
$= \frac{2}{3} \left(\left(\frac{\sqrt{3}}{4} + \frac{\pi}{6} \right) - (0 + 0) \right)$	
$= \frac{\sqrt{3}}{6} + \frac{\pi}{9}$	
$= 0.638 \quad (3 \text{ sf})$	MW1

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10 (i)	$\frac{dy}{dx} = -\sqrt{2} e^{-x} \sin x - \sqrt{2} e^{-x} \cos x$	M1 W2	AVAILABLE MARKS
	Stationary points		
	$-\sqrt{2} e^{-x} \sin x - \sqrt{2} e^{-x} \cos x = 0$	M1	
	$e^{-x} \neq 0$	MW1	
	$\sin x + \cos x = 0$	M1	
	$\tan x = -1 \quad (\text{provided } \cos x \neq 0)$	MW1	
	$x = \frac{3\pi}{4}, \frac{7\pi}{4}, \frac{11\pi}{4}, \frac{15\pi}{4}$	W1	
(ii)	$y = -e^{-\frac{3\pi}{4}}, e^{-\frac{7\pi}{4}}, -e^{-\frac{11\pi}{4}}, e^{-\frac{15\pi}{4}}$	M1 W1	
	$r = \frac{e^{-\frac{7\pi}{4}}}{-e^{-\frac{3\pi}{4}}} = -e^{-\pi}$		
	$r = \frac{e^{-\frac{15\pi}{4}}}{-e^{-\frac{11\pi}{4}}} = -e^{-\pi}$	M1 W1	
(iii)	$S_{\infty} = \frac{-e^{-\frac{3\pi}{4}}}{1 + e^{-\pi}}$	M1	
	$= \frac{-e^{\frac{\pi}{4}}}{e^{\pi} + 1}$	W1	14

			AVAILABLE MARKS
11 (i)	$\frac{dx}{dt} = 4t + 4$		
	$\frac{dy}{dt} = 2 \cos 2t$	MW2	
	$\frac{dy}{dx} = \frac{2 \cos 2t}{4t + 4}$	M1	
	At stationary point:		
	$\frac{2 \cos 2t}{4t + 4} = 0$	M1	
	Since $0 < t < \frac{\pi}{2} \Rightarrow t \neq -1$		
	$2 \cos 2t = 0$		
	$t = \frac{\pi}{4}$	W1	
	$x = \frac{\pi^2}{8} + \pi, y = 1$		
	$x = 4.38, y = 1$	MW1	
(ii)	$\frac{d^2y}{dx^2} = \frac{d}{dx} \left(\frac{2 \cos 2t}{4t + 4} \right)$	M1	
	$= \frac{d}{dt} \left(\frac{2 \cos 2t}{4t + 4} \right) \times \frac{dt}{dx}$	M1	
	$= \left(\frac{(-4 \sin 2t)(4t + 4) - 4(2 \cos 2t)}{(4t + 4)^2} \right) \times \frac{1}{4t + 4}$	M1 W2	
	$t = \frac{\pi}{4} :$		
	$\frac{d^2y}{dx^2} = \left(\frac{-4(\pi + 4)}{(\pi + 4)^2} \right) \times \frac{1}{\pi + 4}$		
	$= \frac{-4}{(\pi + 4)^2} < 0$		
	$\left(\frac{\pi^2}{8} + \pi, 1 \right)$ Maximum stationary point.	MW1	12

			AVAILABLE MARKS
12	$\frac{dV}{dt} \propto -\sqrt{V}$		
	$\frac{dV}{dt} = -k \sqrt{V}$	M1	
	$\int \frac{1}{\sqrt{V}} dV = \int -k dt$	M1 W1	
	$2V^{\frac{1}{2}} = -kt + c$	M1 W1	
	$t = 0, V = V_0: \quad 2\sqrt{V_0} = c$	MW1	
	$2\sqrt{V} = -kt + 2\sqrt{V_0}$		
	$t = 1, V = \frac{4}{9}V_0:$	M1	
	$2\sqrt{\frac{4V_0}{9}} = -k + 2\sqrt{V_0}$		
	$k = \frac{2\sqrt{V_0}}{3}$	W1	
	$\sqrt{V} = \sqrt{V_0} - \frac{\sqrt{V_0}}{3}t$		
	When empty, $V = 0$:	M1	
	$\sqrt{V_0} - \frac{\sqrt{V_0}}{3}t = 0$		
	$t = 3 \text{ hours}$	W1	10
	Total		150

			AVAILABLE MARKS
1	(i)	Tries equation for area – must have evidence of using $\frac{1}{2}r^2\theta$ in equation	M1
		Correct equation for θ	W1
		Correct θ (must be in radians)	W1
	(ii)	Tries equation for arc length i.e. evidence of using $r\theta$ (allow ft for their θ in radians)	M1
		Uses $8r$	MW1
		Correct answer	W1
			6
2	(a) (i)	Converges	MW1
	(ii)	Oscillates	MW1
	(b) (i)	Writes as $(1 - 3x)^{\frac{1}{2}}$	MW1
		Correct structure of binomial	M1
		Coefficients all correct – not necessary to be simplified at this stage	W1
		Powers of $(-3x)$ all correct	W1
		All terms correct	MW1
	(ii)	Correct range	MW1
			8
3	(a)	Correct x values	MW1
		Correct y values	MW1
		Tries to use trapezium rule	M1
		h correct	MW1
		Correct answer	W1
Note			
[A] Incorrect value for h – can only award M1 provided the set-up of the trapezium rule is correct for their x, y, h values i.e. max 1/5			
(b)		Tries to find x values by equating $x^2 - 6$ and $4x - x^2$	M1
		Correct x values	W1
		Tries to integrate	M1
		Subtracts equations	W1
		Integration correct	W1
		Tries to use limits	M1
		Correct area	W1
			12
Notes			
[A] Limits substituted in opposite order and leaves answer as -21.3			
Lose final W1 mark only i.e. max 6/7			
[B] Subtracts equations in wrong order and leaves answer as -21.3			
M1 W1 M1 W1 W1(ft) M1 W0 i.e. 6/7 max			
[C] Incorrect limits found – M1 W0 M1 W1 W1 M1 W0 i.e. 5/7 max			

			AVAILABLE MARKS		
4	(a) (i)	Tries to use function of a function	M1	15	
		$5\sec^4(2x)$	W1		
		$2\sec(2x) \tan(2x)$	W1		
		Correct answer	W1		
	(ii)	Tries to use quotient rule correctly	M1		
		$4e^{4x}$	W1		
		$-\operatorname{cosec}^2x$	W1		
		Correct answer in simplified form	MW1		
	(b)	Tries to use volume formula	M1		
		Correct expansion	W1		
		Tries to integrate their expansion (conditional on 1st M1 being awarded)	M1		
		2 terms correct	W1		
		All terms correct	W1		
		Substitutes limits	M1		
		Correct answer in exact form	W1		
Notes					
[A] If use $V = \pi \int x^2 dy$, can award M1 and nothing further					
5	(i)	Tries to write as partial fractions	M1	12	
		Correct	W1		
		Equates numerators	M1		
		Substitutes x values	M1		
		2 values correct (cao)	W1		
		3rd value correct (cao)	W1		
	Notes				
	[A] If omit $\frac{B}{x-2}$ can potentially award M1 W0 M1 M1 W0 W0 i.e. 3/6 max				
	(ii)	Sets up integration as partial fractions	M1		
		Tries to integrate	M1		
		Both ln terms correct	W1		
		$(x-2)^{-1}$	W1		
		Tries to substitute limits	M1		
		Correct answer as shown	MW1		
	Notes				
[A] Incorrect answer from (i)					
Award M1 M1 W1(if there are two correctly integrated ln terms)					
W1 (provided similar form of reciprocal term) M1 MW0 i.e. max of 5/6					
[B] If correct answer just appears and no working, then assume calculator was used – can award M1 for trying to use calculator and MW1 for correct answer i.e. 2/6 max					
[C] If incorrect answer just appears without working then 0/6					

	AVAILABLE MARKS
6 (a) Correct shape $\pm \frac{\pi}{2}$ labels MW1 MW1 (b) Tries to use $\cos(x + \alpha) \equiv \cos x \cos \alpha - \sin x \sin \alpha$ M1 Tries to equate coefficients M1 Tries to find α M1 Correct value of α W1 Tries to find R M1 Correct value of R W1 Written in correct form MW1 Notes [A] If 1st 2 lines not explicitly stated but remainder of working correct, can award all marks [B] If 1st 2 lines not explicitly stated and $\tan \alpha$ incorrect – M0 M0 M0 W0 Then award M1 W1 if R found correctly using Pythagoras M0 W0 if R found incorrectly using incorrect trig MW0 since final answer incorrect i.e. max of 2/7 (c) Writes as $(2\theta + \theta)$ M1 Tries to use $\sin(A + B)$ M1 Uses double angle formulae for sine and cosine M1 Changes all terms to powers of $\sin \theta$ W1 Correct final answer W1	
	14

			AVAILABLE MARKS
7	(a)	Splits modulus into 2 inequalities or squares both sides [1] for each correct x value Correct inequalities (cao)	M1 W2 MW1
	(b) (i)	Correct x value	MW1
		Correct y value	MW1
		Correct asymptote	MW1
	(ii)	Crosses at origin	MW1
		Correct asymptote	MW1
		Correct shape i.e. evidence of reflection in x -axis	MW1
	(c) (i)	Correct range for f	MW1
		Correct range for g	MW1
	Notes [A] Must be written as $f(x) > 0$ and $g(x) > 1$ i.e. $x > 0$ or $y > 0$ is awarded MW0		
(ii)	Writes as $y = \dots$ and then tries to change subject	M1	
	Correct $x =$	W1	
	Correct answer and notation	MW1	
	Correct domain	MW1	
Notes [A] Accept either $f^{-1}(x) = \dots$ or $f^{-1}: x \rightarrow \dots$ formats [B] Award final MW1 even if $x \in \mathbb{R}$ is omitted in domain			
(iii)	Tries to find composite	M1	
	Correct $fg(x)$	W1	
	Correct domain	MW1	
Notes [A] Accept either $fg(x) = \dots$ or $fg: x \rightarrow \dots$ formats [B] Award final MW1 even if $x \in \mathbb{R}$ is omitted in domain			

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8	Evidence of trying to use product rule	M1	AVAILABLE MARKS
	Evidence of trying to use implicit differentiation	M1	
	One mark for each correct term	W5	
	Tries to substitute (1, -1) into their derivative	M1	
	Correct gradient	W1	
	Tries to use equation of line using their gradient	M1	
	Correct answer only	W1	
			11
9	(a) Rewrites as $1 \times \ln x$	M1	
	Evidence of trying to use integration by parts	M1	
	Obtains $x \ln x$	W1	
	Obtains $\int x \left(\frac{1}{x}\right) dx$ – do not penalise if dx omitted	W1	
	Correct answer – do not penalise if c omitted	MW1	
	Notes		
	[A] If set $u = 1$, $\frac{dv}{dx} = \ln x$ then can award M1 only for recognising the need to use parts		
(b)	Tries to differentiate x with respect to θ	M1	
	Correct derivative	W1	
	Tries to change limits	M1	
	Correct limits	W1	
	Tries to substitute	M1	
	Obtains $\sqrt{4 - 4 \sin^2 \theta}$	W1	
	Obtains $\frac{2}{3} \cos \theta d\theta$	W1	
	Simplifies to $\int \frac{4}{3} \cos^2 \theta d\theta$	W1	
	Tries to use $\cos 2\theta$	M1	
	Correctly substituted	W1	
	Correct integration (cao)	MW1	
	Correct answer (cao)	MW1	
	Notes		
	[A] Error in $\frac{dx}{d\theta}$: M1 W0		
	May gain:	M1 W1 – for limits	M1 – tries to substitute
		W1 – $\sqrt{4 - 4 \sin^2 \theta}$ obtained	M1(ft) – if they try to use $\cos 2\theta$
		W1(ft) – if correctly substituted	Max of 7/12
	[B] If limits are not initially changed but answer converted back to x and calculated correctly at the end then all marks can be awarded		
	[C] If limits are not initially changed and answer not converted back to x at the end then M0 W0 – for limits and MW0 for final answer i.e. max 9/12		
			17

10 (i)	Evidence of trying to use product rule	M1
	[1] for each of 2 correct terms	W2
	Sets their derivative = 0	M1
	Knows $e^{-x} \neq 0$	MW1
	Sets $\sin x + \cos x = 0$	M1
	Obtains $\tan x = -1$	MW1
	Finds four x values – must be in radian format	W1

Notes

[A] Error in use of product rule	M1
	W0 or W1
	M1 possible
	MW1 possible
	M1 – ft dependent on award of both of previous M1 marks
	MW0 and W0
	Max of 5/8

(ii)	Tries to find y values (can ft their values from (i))	M1
	Four correct values	W1
	Tries to find r (can ft their values from (i))	M1
	Correct answer (must try a 2nd ratio)	W1
(iii)	Tries formula for sum to infinity (can ft their a, r)	M1
	Correct answer (either form)	W1

11 (i)	Evidence of trying to find $\frac{dy}{dx}$ using parametric differentiation	M1
	One mark for each of correct numerator and denominator	MW2
	Sets their $\frac{dy}{dx} = 0$ (conditional on award of 1st M1)	M1
	Correct value of t	W1
	Correct coordinates	MW1

Notes

[A] Correct $\frac{dx}{dt}$ and $\frac{dy}{dt}$ but no further use of parametric differentiation gives max 2/6

(ii)	Tries to find 2nd derivative	M1
	Tries to use parametric differentiation	M1
	Tries to use correct quotient rule	M1
	One mark for each term differentiated correctly	W2
	Tests that 2nd derivative is negative $\rightarrow$ maximum	MW1

Notes

[A] Incorrect $\frac{dy}{dx}$ from (i): Can award any of 1st three M1 marks as appropriate
W1 possible if one of terms is identical to that on MS
MW0
Max of 4/6

AVAILABLE
MARKS

12

12 Sets up differential equation (allow $\frac{dV}{dt} = k\sqrt{V}$)	M1	AVAILABLE MARKS
Tries to separate variables	M1	
Correctly	W1	
Tries to integrate	M1	
Both sides are correct	W1	
Finds c correctly	MW1	
Uses $\frac{4}{9}$	M1	
Finds k	W1	
Uses $V = 0$	M1	
Finds correct time	W1	10
Notes		
[A] Incorrect initial differential equation e.g. $\frac{dV}{dt} = kV$ or $\frac{dV}{dt} = kV^2$		
Award M0		
M1 W1 as ft		
M1 W0		
MW0		
M1 W0		
M1 W0		
Max of 5/10		