Question number	Mark Scheme	Marks
1(a)	$2+\frac{3}{x+2}\ \left(=\frac{2(x+2)+3}{x+2}\right) \quad \therefore \quad \underline{\underline{\frac{2x+7}{x+2}}}$ or $\frac{2(x+2)+3}{x+2}$	B1 **(1)**
(b)	$y = 2+\frac{3}{x+2}$ OR $y = \frac{2x+7}{x+2}$	
	$y-2 = \frac{3}{x+2}$ | $y(x+2) = 2x+7$; $yx-2x = 7-2y$	M1
	$x+2 = \frac{3}{y-2}$ | $x(y-2) = 7-2y$	M1
	$x = \frac{3}{y-2} - 2$ | $x = \frac{7-2y}{y-2}$	
	$\therefore\ f^{-1}(x) = \underline{\underline{\frac{3}{x-2}-2}}$ | $f^{-1}(x) = \underline{\underline{\frac{7-2x}{x-2}}}$ o.e	A1 **(3)**
(c)	Domain of $f^{-1}(x)$ is $x \in \mathbb{R}, x \neq 2$ [NB $x \neq +2$]	B1 (1) **(5)**

Notes

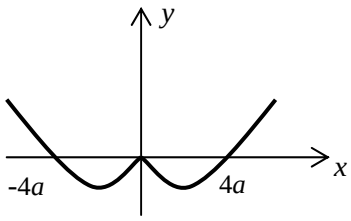
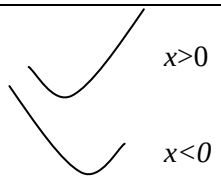
1(b)	M1	y = f (x) and 1st step towards x = .
	M1	One step from x = .
	A1	y or f^{-1} (x) = in terms of x.

Question number	Mark scheme	Marks
2(a)	$u_2 = \sqrt{\left(\frac{3}{2}+\frac{20}{3}\right)}$ $= 2.85773\ldots$ $= \underline{\underline{2.86}}$	M1
	$u_3 =$ $2.90300\ldots$ $= \underline{\underline{2.90}}$	A1 c.a.o
	$u_4 =$ $2.88806\ldots$ $= \underline{\underline{2.89}}$	A1 c.a.o
S.C.	[If u_3 = AWRT 2.90 and u_4 = AWRT 2.89 penalise once only]	(3)
(b)	(i) $3 = \sqrt{\left(\frac{3}{2}+\frac{a}{3}\right)}$ or $9 = \frac{3}{2}+\frac{a}{3}$	M1
	$\frac{a}{3} = 9-\frac{3}{2}$ or $a = 3\left(9-\frac{3}{2}\right)$	M1
	$\underline{\underline{a = 22.5}}$	A1
		(3)
	(ii) (If $u_1 = u_2$, then $u_2 = u_3$.....) $u_5 = \underline{\underline{3}}$	B1
		(1)
		(7)

	Notes	
2(a)	M1	Correct expression or AWRT 2.86
(b)(i)	M1	A correct equation for a, with or without $\sqrt{}$.
	M1	Attempt correct manipulation to $ka = \ldots, (k > 0)$.

Question number	Mark Scheme	Marks
3(a)	$\log_2(16x) = \log_2 16 + \log_2 x$ $= \underline{\underline{4 + a}}$	M1 A1 c.a.o (2)
(b)	$\log_2\left(\frac{x^4}{2}\right) = \log_2 x^4 - \log_2 2$ $= 4\log_2 x - \log_2 2$ $= \underline{\underline{4a-1}}$ (accept $\underline{\underline{4\log_2 x - 1}}$)	M1 M1 A1 (3)
(c)	$\frac{1}{2} = 4 + a - (4a - 1)$ $a = \frac{3}{2}$ $\log_2 x = \frac{3}{2} \Rightarrow x = 2^{\frac{3}{2}}$ $\underline{\underline{x = \sqrt{8} \text{ or } 2\sqrt{2}}}$ or $\underline{\underline{\sqrt{2^3} \text{ or } (\sqrt{2})^3}}$	M1 A1 M1 A1 √ (4) **(9)**

	Notes	
3(a)	M1	Correct use of $\log(ab) = \log a + \log b$
(b)	M1	Correct use of $\log\left(\frac{a}{b}\right) = \cdots$
	M1	Use of $\log x^n = n \log x$
(c)	M1	Use their (a) & (b) to form equ in a
	M1	Out of logs: $x = 2^a$
	A1 √	Must write x in surd form, follow through their rational a.

Question number	Mark Scheme	Marks
4(a)	  $(4a,0)$ & $(-4a,0)$ and shape at $(0,0)$	B1 B1 √ B1 (3)
(b)	$f(2a) = (2a)^2 - 4a(2a) \quad = 4a^2 - 8a^2 = \underline{\underline{-4a^2}}$ $f(-2a)[= \quad f(2a)\ (\because \textit{even function}) \quad] = \underline{\underline{-4a^2}}$	B1 B1 √ (2)
(c)	$a = 3$ and $f(x) = 45 \Rightarrow 45 = x^2 - 12x \qquad (x > 0)$ $0 = x^2 - 12x - 45$ $0 = (x-15)(x+3)$ $x = 15 \quad (or\ -3)$ $\therefore$Solutions are $\underline{\underline{x = \pm 15}}$ $\underline{\text{only}}$	M1 M1 A1 A1 (4) **(9)**

Notes

4(b)	B1 √	their $f(2a)$
(c)	M1	Attempt 3TQ in x
	M1	Attempt to solve
	A1	At least $x=15$ can ignore $x=-3$
	A1	To get final A1 must make clear <u>only</u> answers are ± 15.

Question number	Mark Scheme	Marks
5(a)(i)	$x = a^y$	B1 (1)
(ii)	In both sides of (i) i.e $\ln x = \ln a^y$ $= y \ln a$ * or $(y =) \log_a x = \frac{\ln x}{\ln a}$ $\Rightarrow y \ln a = \ln x$	$B1_{cso}$ (1)
(b)	$y = \frac{1}{\ln a} \bullet \ln x \ ,\Rightarrow \ \frac{dy}{dx}, = \frac{1}{\ln a} \times \frac{1}{x}$ *	M1, $A1_{cso}$
ALT.	$\left[or \ \ \frac{1}{x} = \frac{dy}{dx} \cdot \ln a \ \ ,\Rightarrow \ \ \frac{dy}{dx} = \frac{1}{x \ln a} \ * \right]$	(2)
(c)	$\log_{10} 10 = 1 \ \Rightarrow$ A is $(10, 1)$ $y_A = 1$	B1
	from(b) $m = \frac{1}{10 \ln a}$ *or* $\frac{1}{10 \ln 10}$ *or* 0.043 (or better)	B1
	equ of target $y - 1 = m(x - 10)$	M1
	i.e $y - 1 = \frac{1}{10 \ln 10}(x - 10)$ *or* $y = \frac{1}{10 \ln 10} x + 1 - \frac{1}{\ln 10}$ (o.e)	A1 (4)
(d)	$y = 0 \ in \ (c) \ \Rightarrow \ 0 = \frac{x}{10 \ln 10} + 1 - \frac{1}{\ln 10} \ \Rightarrow x, = 10 \ln 10 \left(\frac{1}{\ln 10} - 1 \right)$	M1
	$x = 10 - 10 \ln 10$ *or* $10(1 - \ln 10)$ or $10 \ln 10 (\frac{1}{\ln 10} - 1)$	A1 (2) **(10)**

	Notes	
5(a)	B1	$x = e^{y \ln a}$ *is BO*
	B1	Must see $\ln a^y$ or use of change of base formula.
(b)	M1, $A1_{cso}$	M1 needs some correct attempt at differentiating.
(c)	B1 M1	Allow either $\surd$ their y_A and m
(d)	M1	Attempt to solve correct equation. Allow if a not = 10.

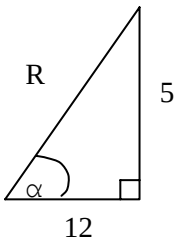
Question number	Mark Scheme	Marks
6(a)	$f^1(x)=0$ for maximum (or stationary point or turning point) $f^1(1.48) = e^{1.48} - 2\times 1.48^2 = 0.0121\ldots$ $f^1(1.49) = = -0.0031\ldots$ change of sign $\therefore$ root / maximum in range	B1 M1 A1 (3)
(b)	$y = e^x - \frac{2}{3}x^3 \ (+c)$ at $(0,5)$ $5 = e^0 - 0 + c$ $\underline{c=4}$ $\left(y = e^x - \frac{2}{3}x^3 + 4\right)$ $(c=4)$	M1 A1 M1 A1 (4)
(c)	Area $= \int_0^2 \left(e^x - \frac{2}{3}x^3 + 4\right)dx$ $= \left[e^x - \frac{2}{12}x^4 + 4x\right]_0^2$ $= \left(e^2 - \frac{16}{6} + 8\right) - (e^0 - 0 + 0)$ $= \underline{\underline{e^2 + 4\frac{1}{3} \ \text{or} \ e^2 + \frac{13}{3}}}$	M1 A1 √ M1 A1 cao (4) **(11)**

	Notes	
6(a)	M1 M1 A1	May be $\Rightarrow$ if maximum mentioned at A1 One value correct to 1 S.F. Both correct and comment
(b)	M1 A1 M1	Some correct $\int$ $e^x - \frac{2}{3}x^3$ Attempt to use (0,5) No + c is M0
(c)	M1 A1 √ M1	Some correct $\int$ other than $e^x \rightarrow e^x$. [ ] their $c(\neq 0)$. Attempt both limits

Question number	Mark Scheme	Marks
7(a)	4, 4.84, 7.06	B2/1/0 (2)
(b)	$I \approx \frac{1}{2} \times 0.25 \left[6.06 + 7.06 + 2(4.32 + 4 + 4.84)\right]$ $= \frac{1}{2} \times 0.25 \left[39.44\right]$ $= 4.93$ or 4.9 (AWRT 4.93 or just 4.9)	B1 [M1 A1]√ A1 (4)
(c)	$\int_{0.5}^{1.5} \left(\frac{3}{x} + x^4\right) dx = \left[3\ln x + \frac{1}{5}x^5\right]_{0.5}^{1.5}$ $= \left(3\ln 1.5 + \frac{1}{5}1.5^5\right) - \left(3\ln 0.5 + \frac{1}{5}0.5^5\right)$ $= 3\ln 3 + 1.5125$ *or* $3\ln 3 + \frac{121}{80}$	M1 A1 M1 A1 (4)
(d)	$\frac{[4.93 - (c)]}{(c)} \times 100 \ , = \ 2.53\% \ (\text{i.e} < 3\%)$ AWRT 2.5%	M1, A1 (2) **(12)**

Notes

7(b)	B1	$\frac{1}{2} \times 0.25$
	M1 A1	√[ ]
(c)	M1	Some correct ∫
	A1	$3\ln x + \frac{1}{5}x^5$
	M1	Use of limits

Question number	Mark Scheme	Marks
8(a)(i)	$12\cos\theta - 5\sin\theta = R\cos\theta\cos\alpha - R\sin\theta\sin\alpha.$  $R^2 = 5^2 + 12^2 \quad , \Rightarrow \underline{R = 13}$ $\tan\alpha = \frac{5}{12} \quad , \Rightarrow \alpha = 22.6^\circ$ (AWRT 22.6) or 0.39^c (AWRT 0.39^c)	M1, A1 M1, A1 (4)
(b)	$\cos(\theta + 22.6) = \frac{4}{13}$ $\theta + 22.6 = 72.1,$ $\underline{\underline{\theta = 49.5}}$ (only)	M1 M1 A1 (3)
(ii)	$\frac{8}{\tan\theta} - 3\tan\theta = 2$ i.e. $0 = 3\tan^2\theta + 2\tan\theta - 8$ $0 = (3\tan\theta - 4)(\tan\theta + 2)$ $\tan\theta = \frac{4}{3}$ *or* -2 $\tan\theta = \frac{4}{3} \Rightarrow \underline{\underline{\theta = 53.1}}$ [*ignore* θ *not in range e.g.* $\theta = 116.6$]	M1 M1 M1 A1 A1 (5) **(12)**

	Notes	
8(a)(i)	M1, A1 M1, A1	M1 for correct expression for R or R^2 M1 for correct trig expression for α
(b)	M1 M1	$\cos(\theta + \alpha) = \frac{4}{R}$ $\theta + \alpha = \cdots$ their R
(ii)	M1 M1 M1 A1	Use of cot $\theta = \frac{1}{\tan\theta}$ 3TQ in tan θ = 0 Attempt to solve 3TQ = 0 For Final A mark must deal with tan $\theta = -2$