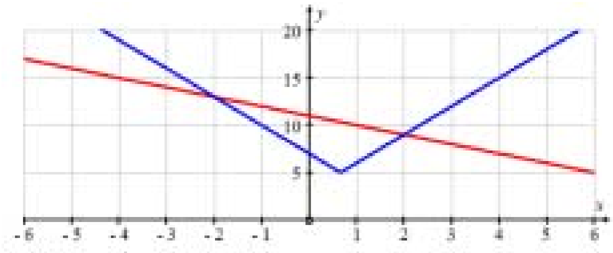
Question	Answer	Marks	Partial Marks
1(a)		4	**M1** for ∨ shape of $y=5+\|3x-2\|$ with vertex at $\left(\frac{2}{3},5\right)$ **A1** for correct graph with y-intercept $(0,7)$ **M1** for correct straight line for $y=11-x$ **A1** for correct straight line with y-intercept $(0,11)$
1(b)	$x>2$ or $x<-2$	**B2**	Mark final answer for **B2** **B1 FT** for exactly two correct critical values or correct FT critical values soi, FT dependent on at least M1 in **(a)**
2(a)	$16-96x+216x^2-216x^3+81x^4$	**B4**	Mark final answer for **B4** **B3** for any 4 correct simplified terms in a sum or for all 5 simplified terms listed but not summed or for a correct simplified expansion that is not their final answer or **B2** for any 3 correct simplified terms in a sum or for 4 correct simplified terms listed but not summed or **B1** for any 2 correct simplified terms in a sum or for 3 correct simplified terms listed but not summed or **M1** for correct unsimplified expansion $2^4+4\times2^3(-3x)+6\times2^2(-3x)^2$ $+4\times2(-3x)^3+(-3x)^4$

Question	Answer	Marks	Partial Marks
2(b)	*their* $\left(16-96x+216x^2 .....\right)\times\left(1+\frac{a}{x}\right)$ $=16-96x+16\frac{a}{x}-96a+216ax\ldots$ soi	**B1**	**FT** Expansion using *their* **(a)**
	$a=2$	**B1**	**FT** *their* $16\frac{a}{x}$
	$b=-176$	**B1**	
	$c=336$	**B1**	
3(a)	$\frac{\cos x}{1-\cos x}+\frac{\cos x}{1+\cos x}$ or $\frac{\sec x+1+\sec x-1}{\sec^2 x-1}$	**M1**	
	$\frac{\cos x+\cos^2 x+\cos x-\cos^2 x}{1-\cos^2 x}$ or $\frac{2\sec x}{\tan^2 x}$	**A1**	
	$\frac{2\cos x}{\sin^2 x}$ or $\frac{2\cos^2 x}{\cos x\sin^2 x}$ oe	**A1**	
	Fully correct justification of given answer: $2\cot x\operatorname{cosec}x$	**A1**	
3(b)	$3\tan^2 x=2$ oe or better, soi or $5\cos^2 x=3$ oe or better, soi or $5\sin^2 x=2$ oe or better, soi	**B1**	
	$\tan x=[\pm]\sqrt{\frac{2}{3}}$ oe or [±] 0.816[4…] or $\cos x=[\pm]\sqrt{\frac{3}{5}}$ oe or [±] 0.774[5…] or $\sin x=[\pm]\sqrt{\frac{2}{5}}$ oe or [±] 0.632[4…]	**M1**	**FT** an equation of the form $a\tan^2 x=b$, $a>0$, $b>0$ or $p\sin^2 x=q$ or $p\cos^2 x=q$ where $p>0$, $q>0$ and $p>q$
	39.2° or 39.2315… rot to 2 or more dp 140.8° or 140.7684… rot to 2 or more dp 219.2° or 219.2315… rot to 2 or more dp 320.8° or 320.7684… rot to 2 or more dp	**A2**	no extras in range **A1** for any two correct answers

Question	Answer	Marks	Partial Marks
4(a)	$\frac{dy}{dx} = \frac{3}{x} + 2x - 7$	B2	**B1** for the first term correct and one other term correct or for all terms correct with extra terms seen
	Equates *their* $\frac{dy}{dx}$ to zero and rearranges to 3-term quadratic in x	M1	
	Solves *their* 3-term quadratic	M1	**Dep** on previous M1
	$x = 0.5,\ 3$ nfww isw	A1	no extra solutions
4(b)	$\frac{d^2y}{dx^2} = -\frac{3}{x^2} + 2$	M1	**FT** *their* $\frac{dy}{dx}$ providing B1 earned in **(a)**
	$x = 0.5$, $\frac{d^2y}{dx^2} < 0 \to$ max or $\frac{d^2y}{dx^2} = -10 \to$ max	A1	
	$x = 3$, $\frac{d^2y}{dx^2} > 0 \to$ min or $\frac{d^2y}{dx^2} = \frac{5}{3} \to$ min	A1	
	Alternative method		
	Considers gradient at $x - h$ and $x + h$ for $x = 0.5$ or $x = 3$ [where h is small] or Considers y-values at $x - h$ and $x + h$ for $x = 0.5$ or $x = 3$ [where h is small]	(M1)	**FT** *their* $\frac{dy}{dx}$ providing B1 earned in **(a)**
	Correct conclusion for one turning point max at $x = 0.5$ or min at $x = 3$	(A1)	
	Correct method and conclusion for second turning point	(A1)	

Question	Answer	Marks	Partial Marks
5(a)	Solves $3e^x + 3e^y = 15$ and $2e^x - 3e^y = 8$ oe by elimination as far as $3e^x + 2e^x = 23$ or substitutes $e^y = 5 - e^x$ into $2e^x - 3e^y = 8$ oe OR Solves $2e^x + 2e^y = 10$ and $2e^x - 3e^y = 8$ oe by elimination as far as $2e^y + 3e^y = 2$ or substitutes $e^x = 5 - e^y$ into $2e^x - 3e^y = 8$ oe	**M1**	
	$e^x = \frac{23}{5}$ or $e^y = \frac{2}{5}$ oe	**A1**	
	$x = \ln 4.6 [= 1.53]$ oe or $y = \ln 0.4 [= -0.916]$ oe	**A1**	If M0 scored **SC1** for using *their* expression of the form $ce^x = d$ to give $x = \ln\frac{d}{c}$ provided $\frac{d}{c} > 0$
	Finds the other value, e^y or e^x, by substituting *their* e^x or e^y	**M1**	**FT** *their* e^x or e^y
	$y = \ln 0.4 [= -0.916]$ oe or $x = \ln 4.6 [= 1.53]$ oe	**A1**	

Question	Answer	Marks	Partial Marks
5(b)	$e^{2t-1-(5t-3)} = 5$ or $e^{5t-3-(2t-1)} = \frac{1}{5}$ oe	M1	
	$e^{2-3t} = 5$ or $e^{3t-2} = \frac{1}{5}$	A1	
	$2-3t = \ln 5$ or $3t-2 = \ln\frac{1}{5}$	M1	**FT** *their* $e^{a-bt} = 5$ or *their* $e^{ct-d} = \frac{1}{5}$ where a, b, c and d are positive integers
	$t = \frac{2-\ln 5}{3}$ or $t = \frac{2+\ln 0.2}{3}$ or 0.13[0] oe	A1	
	Alternative method		
	$\ln e^{2t-1} = \ln 5 + \ln e^{5t-3}$ oe	(M1)	
	$(2t-1)[\ln e] = \ln 5 + (5t-3)[\ln e]$ oe	(A1)	
	$5t - 2t = 3 - 1 - \ln 5$ oe	(M1)	**Dep** on one correct log law applied with at most one sign error
	$t = \frac{2-\ln 5}{3}$ or $t = \frac{2+\ln 0.2}{3}$ or 0.13[0] oe	(A1)	
6(a)	$\left(\sqrt{6}-\sqrt{2}\right)^2 + \left(\sqrt{6}+\sqrt{2}\right)^2 - 2\left(\sqrt{6}-\sqrt{2}\right)\left(\sqrt{6}+\sqrt{2}\right)\cos 60$	M1	
	$6+2-2\sqrt{12}+6+2+2\sqrt{12}-2\times(6-2)\times\frac{1}{2}$	M1	Condone one error in expansion of brackets
	$[BC =]2\sqrt{3}$ isw	A1	
6(b)	$\frac{their\ 2\sqrt{3}}{\sin 60} = \frac{\sqrt{6}+\sqrt{2}}{\sin ACB}$ or $\frac{their\ 2\sqrt{3}}{\frac{\sqrt{3}}{2}} = \frac{\sqrt{6}+\sqrt{2}}{\sin ACB}$	M1	Condone other letters for *ACB*
	$\sin ACB = \left(\sqrt{6}+\sqrt{2}\right)\times\frac{\sqrt{3}}{2}\times\frac{1}{2\sqrt{3}} = \frac{\sqrt{6}+\sqrt{2}}{4}$	A1	**A0** if necessary brackets missing unless clearly recovered

Question	Answer	Marks	Partial Marks
6(c)	$\frac{\sqrt{6}+\sqrt{2}}{4}=\frac{x}{\sqrt{6}-\sqrt{2}}$ or $\frac{1}{2}\times \textit{their}\, 2\sqrt{3}\times x=$ $\frac{1}{2}\times\left(\sqrt{6}-\sqrt{2}\right)\times\left(\sqrt{6}+\sqrt{2}\right)\times\sin 60$ [where x is the perpendicular from A to BC]	**M1**	Complete method
	$x=\frac{\left(\sqrt{6}-\sqrt{2}\right)\left(\sqrt{6}+\sqrt{2}\right)}{4}=\frac{6-2}{4}=1$ or $x=\frac{(6-2)}{2\sqrt{3}}\times\frac{\sqrt{3}}{2}=\frac{4}{4}=1$	**A1**	
7(a)	$\left[\frac{dy}{dx}=\right]\frac{1}{2}e^{2x}-(x+1)^{-1}+\frac{5}{2}$ oe	**B3**	**M2** for $\frac{1}{2}e^{2x}-(x+1)^{-1}+c$ oe or **M1** for any two terms correct from $\frac{1}{2}e^{2x}$, $-(x+1)^{-1}$, $+c$
7(b)	$[y=]\frac{1}{4}e^{2x}-\ln(x+1)$	**M1**	
	$+\textit{their}\,\frac{5}{2}\times x+d$	**M1**	**FT** *their c* from **(a)**, providing $c\neq 0$
	$[y=]\frac{1}{4}e^{2x}-\ln(x+1)+\frac{5}{2}x+\frac{15}{4}$ oe	**A1**	

Question	Answer	Marks	Partial Marks
8(a)	[Gradient =] $\frac{15.4-10.4}{4-2}$ oe soi	M1	
	10.4 = *their*2.5 × 2 + *c* or 15.4 = *their*2.5 × 4 + *c* or $\frac{y-10.4}{x-2}=their2.5$ or $\frac{y-15.4}{x-4}=their2.5$	M1	**FT** *their* gradient
	[Gradient =] 2.5 soi and [intercept =] 5.4 soi	A1	
	$\sqrt{y}=2.5\log_2(x+1)+5.4$ oe isw	A1	
	Alternative method		
	10.4 = 2*m* + *c* and 15.4 = 4*m* + *c* and solving to find *m* or *c*	**(M1)**	
	Use *their m* or *c* to find *their c* or *m*	**(M1)**	
	m = 2.5 and *c* = 5.4	**(A1)**	
	$\sqrt{y}=2.5\log_2(x+1)+5.4$ oe isw	**(A1)**	
8(b)	$\frac{5929}{25}$ or 237.16	B1	
8(c)	$5=their2.5\log_2(x+1)+their5.4$ and rearrange to make $\log_2(x+1)$ the subject	M1	**FT** *their* equation from **(a)** of correct form with $m \neq 1$ or 0, and $c \neq 0$ Condone any base
	$-\frac{4}{25}=\log_2(x+1)$ oe	A1	Condone any base
	$x=-0.105$ or $-0.1049[74\ldots]$ rot to 4 or more sf	A1	
9(a)	$\frac{dy}{dx}=3x^2+2x-4$	M2	**M1** for any two terms correct
	$x=1\rightarrow\frac{dy}{dx}=1$	A1	
	$[m_{\perp}=]\ -1$	M1	**FT** $\frac{-1}{their1}$
	y – 4 = –1(*x* – 1) oe isw	A1	**FT** *their* $m_{\perp}$

Question	Answer	Marks	Partial Marks
9(b)	$x^3 + x^2 - 4x + 6 = their\left(-x+5\right)$ $\rightarrow \quad x^3 + x^2 - 3x + 1\ [=0]$	**M1**	**FT** *their* linear equation of the form $y = mx + c$ where $m \neq 0$ and $c \neq 0$ from **(a)**
	Correct quadratic factor: $x^2 + 2x - 1$	**B2**	**B1** for any two out of three terms correct Must be from the correct cubic
	Solves *their* $(x^2 + 2x - 1) = 0$ using the formula or by completing the square	**M1**	**dep** on M1 and valid attempt at finding quadratic factor **M0** if *their* quadratic factor does not have real roots
	$\dfrac{-2 \pm \sqrt{8}}{2}$ isw or $\dfrac{-2 \pm 2\sqrt{2}}{2}$ isw	**A1**	
10(a)	Eliminate one unknown using two correct equations e.g. $d = 4x - 4$ oe $d = 3x + 6$ oe and solve as far as $x = \ldots$ or $d = \ldots$	**M2**	**B1** for one correct equation seen, e.g. $d = 4x - 4$ oe or $d = 3x + 6$ oe or $2d = 7x + 2$ oe May come from the sum of terms, e.g. $11x - 3d = 2$
	$x = 10$	**A1**	
	$d = 36$	**A1**	

Question	Answer	Marks	Partial Marks
10(b)(i)	$\frac{5y-4}{y}=\frac{8y+2}{5y-4}$ oe	M1	
	$25y^2-40y+16=8y^2+2y$ $\to 17y^2-42y+16[=0]$	M1	
	$(17y-8)(y-2)[=0]$	M1	Solves *their* 3-term quadratic
	$\frac{8}{17}$, 2	A1	Both values
	Alternative method		
	Eliminates y from $yr = 5y - 4$ and $yr^2 = 8y + 2$ and simplifies to 3-term quadratic in r $\to 2r^2+r-21[=0]$	(M1)	
	Solves *their* 3-term quadratic	(M1)	
	Substitutes *their* two r values to find two y values	(M1)	
	$\frac{8}{17}$, 2	(A1)	
10(b)(ii)	$-\frac{7}{2}$, 3	B2	**B1** for one correct