Question	Answer	Marks	Guidance
1	$3y-(-5y-4)y=6$ oe or $3\left(\frac{-4-x}{5}\right)-x\left(\frac{-4-x}{5}\right)=6$ or $x+5\left(\frac{6}{3-x}\right)=-4$ oe	**M1**	
	$5y^2+7y-6=0$ or $x^2+x-42=0$	**A1**	
	Factorises *their* 3-term quadratic expression or solves *their* 3-term quadratic equation, e.g. $(5y-3)(y+2)$ [= 0] or $(x-6)(x+7)$ [= 0]	**M1**	
	$x=6$, $y=-2$ $x=-7$, $y=0.6$	**A2**	**A1** for either $x=6$, $x=-7$ or $y=-2$, $y=0.6$ or for an x, y pair from a correct factorisation or correct solving of a correct equation. The method of solution **must** be seen in this case.
2	$e^{2x-3-(5-x)}=\frac{7}{4}$ oe or $e^{5-x-(2x-3)}=\frac{4}{7}$ oe	**M1**	
	$e^{3x-8}=\frac{7}{4}$ oe, soi or $e^{8-3x}=\frac{4}{7}$ oe, soi	**A1**	
	$3x-8=\ln\frac{7}{4}$ oe or $8-3x=\ln\frac{4}{7}$ oe	**M1**	**FT** expression of similar structure which has at most one sign or arithmetic slip
	$x=\frac{\ln 1.75+8}{3}$ oe or $x=\frac{8-\ln\frac{4}{7}}{3}$ oe or 2.85[32…] rot to 3 or more sf	**A1**	

Question	Answer	Marks	Guidance
2	**Alternative method**		
	$\ln 4 + \ln e^{2x-3} = \ln 7 + \ln e^{5-x}$ oe, soi	**(M1)**	
	$\ln 4 + 2x - 3 = \ln 7 + 5 - x$ oe	**(A1)**	
	$2x + x = \ln 7 + 5 - \ln 4 + 3$ or $3x - 8 = \ln\frac{7}{4}$ oe or $8 - 3x = \ln\frac{4}{7}$ oe	**(M1)**	**FT** expression of similar structure which has at most one sign or arithmetic slip
	$x = \frac{\ln 7 - \ln 4 + 8}{3}$ oe or 2.85[32…] rot to 3 or more sf	**(A1)**	
3	$\left[m_{\text{tangent}} =\right] - ax^{-2} + 3$ oe	**B1**	
	[When $x = 1$, m_{normal} =] $\frac{-1}{3-a}$ oe or gradient of tangent = 4 soi	**B1**	**FT** $\frac{-1}{\textit{their}\ \left.\frac{dy}{dx}\right\|_{x=1}}$ if appropriate
	$\frac{-1}{\textit{their}(3-a)} = -\frac{1}{4}$ oe or *their* $(3 - a) = 4$ oe	**M1**	**FT** $\frac{-1}{\textit{their}\ \left.\frac{dy}{dx}\right\|_{x=1}}$ or *their* $\left.\frac{dy}{dx}\right\|_{x=1}$ and *their* evaluation of $\frac{-1}{-\frac{1}{4}}$
	$a = -1$ nfww	**A1**	
	[When $x = 1$] *their* $0 = -\frac{1}{4}[1] + b$ oe	**M1**	**FT** y = **(***their* a) + 1 providing at least 2 of the first 3 marks awarded
	$b = \frac{1}{4}$ nfww	**A1**	

Question	Answer	Marks	Guidance
4	$\log_3\left(\frac{11x-8}{x^2}\right)=1$ or $\log_3(11x-8)=\log_3(3x^2)$ soi OR $\log_x\left(\frac{11x-8}{3}\right)=2$ or $\log_x(11x-8)=\log_x(3x^2)$ soi	**M2**	**M1** for correct use change of base in a correct equation so that all logs have consistent base: $\log_x 3=\frac{\log_3 3}{\log_3 x}$ or $\log_x 3=\frac{1}{\log_3 x}$ oe, soi **OR** $\log_3(11x-8)=\frac{\log_x(11x-8)}{\log_x 3}$ oe, soi
	$3x^2-11x+8\,[=0]$ oe, nfww	**A1**	
	$(3x-8)(x-1)$ [= 0]	**M1**	**FT** *their* 3-term quadratic **dep** on at least **M1** previously awarded
	$x=\frac{8}{3}$ or 2.67 or 2.666[6…] rot to 3 or more dp as only solution	**A1**	
5	$6x^3-5x^2-13x+12\quad[=0]$	**B1**	
	Uses the correct factor $x-1$ to find a quadratic factor with at least 2 terms correct	**M1**	
	$6x^2+x-12$	**A1**	
	Factorises or solves *their* 3-term quadratic: $(2x+3)(3x-4)$ [= 0] or $[x=]\frac{-1\pm\sqrt{1-4(6)(-12)}}{2(6)}$ oe	**M1**	**dep** on previous **M1**
	$x=1, -1.5, \frac{4}{3}$ nfww	**A1**	**dep** on all previous marks awarded

Question	Answer	Marks	Guidance
6(a)	510	**3**	**M2** for a fully correct method e.g. [starts with 5, 7, 9 and ends in 3 or two of 5, 7, 9] $3 \times 6 \times 5 \times 3$ or 270 **and** [starts with 6, 8 and ends in 3,5,7, 9] $2 \times 6 \times 5 \times 4$ or 240 **OR** [ends with 3 and starts with 5, 6, 7, 8, 9] $5 \times 6 \times 5 \times 1$ or 150 **and** [ends with 5, 7, 9 and starts with 6, 8 or two of 5, 7, 9] $4 \times 6 \times 5 \times 3$ or 360 or **M1** for a partially correct method equivalent to one of the above two steps
6(b)	540	**3**	**M2** for a fully correct method e.g. [starts with 5, 7 and ends with 2, 3 and 5 or 7] $2 \times 6 \times 5 \times 3 = 180$ **and** [starts with 6, 8, 9 and ends with 2, 3, 5, 7] $3 \times 6 \times 5 \times 4 = 360$ OR [ends with 2, 3 and starts with 5, 6, 7, 8, 9] $5 \times 6 \times 5 \times 2$ or 300 **and** [ends with 5, 7 and starts with 6, 8, 9 and 5 or 7] $2 \times 6 \times 5 \times 4$ or 240 or **M1** for a partially correct method equivalent to one of the above two steps

Question	Answer	Marks	Guidance
7(a)	$\dfrac{\sin^2 x + (1-\cos x)^2}{(1-\cos x)\sin x}$ or $\dfrac{\sin^2 x}{(1-\cos x)\sin x} + \dfrac{(1-\cos x)^2}{(1-\cos x)\sin x}$	**M1**	
	$\dfrac{\sin^2 x + 1 - 2\cos x + \cos^2 x}{(1-\cos x)\sin x}$	**A1**	OR $\dfrac{1-\cos^2 x + (1-\cos x)^2}{(1-\cos x)\sin x}$
	$\dfrac{1+1-2\cos x}{(1-\cos x)\sin x}$ or $\dfrac{1-\cos^2 x + 1 - 2\cos x + \cos^2 x}{(1-\cos x)\sin x}$	**A1**	OR $\dfrac{(1-\cos x)(1+\cos x) + (1-\cos x)^2}{(1-\cos x)\sin x}$
	Fully correct justification of given answer: $\dfrac{2(1-\cos x)}{(1-\cos x)\sin x} = 2\operatorname{cosec} x$ or $\dfrac{2-2\cos x}{(1-\cos x)\sin x} = \dfrac{2}{\sin x} = 2\operatorname{cosec} x$ or equivalent	**A1**	All steps correct and final step justified OR $\dfrac{1+\cos x + 1 - \cos x}{\sin x} = 2\operatorname{cosec} x$
	Alternative		
	$\dfrac{\sin x(1+\cos x)}{(1-\cos x)(1+\cos x)} + \dfrac{(1-\cos x)\sin x}{\sin x \sin x}$ or $\dfrac{\sin x(1+\cos x)}{1-\cos^2 x} + \dfrac{(1-\cos x)\sin x}{\sin^2 x}$	**(M1)**	
	$\dfrac{\sin x + \sin x \cos x}{\sin^2 x} + \dfrac{\sin x - \cos x \sin x}{\sin^2 x}$	**(A1)**	
	$\dfrac{2\sin x}{\sin^2 x}$	**(A1)**	
	Fully correct justification of given answer: $\dfrac{2}{\sin x} = 2\operatorname{cosec} x$	**(A1)**	All steps correct and final step justified

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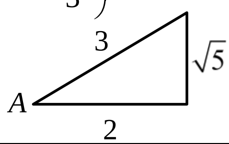
Question	Answer	Marks	Guidance
7(b)	$3\sin^2 x - \sin x - 2 \quad [=0]$ soi	**B1**	
	$(3\sin x + 2)(\sin x - 1)$ [= 0] oe	**M1**	
	$\sin x = -\frac{2}{3}$, $\sin x = 1$	**A1**	
	90 221.8 or 221.81[03…] rot to 2 or more dp 318.2 or 318.18[96…] rot to 2 or more dp	**A1**	and no extras in range If **B1 M1 A0 A0** allow **SC1** for 221.8 or 221.81[03…] rot to 2 or more dp **and** 318.2 or 318.18[96…] rot to 2 or more dp and no extras in range
8(a)	$2\pi rh + 2\pi r^2 + \pi r^2$ [= 300] oe	**M1**	
	$h = \frac{300 - 3\pi r^2}{2\pi r}$ oe, isw	**A1**	
8(b)	$V = \pi r^2 \left(their\, \frac{300 - 3\pi r^2}{2\pi r} \right) + \frac{2}{3}\pi r^3$ oe	**M2**	**FT** *their h* providing in terms of *r* and derived from a dimensionally correct equation in **(a)**; **M1** for $V = \pi r^2 \left(their\, \frac{300 - 3\pi r^2}{2\pi r} \right) + k\pi r^3$, $k \neq \frac{2}{3}$ oe
	Correct completion to given answer: $150r - \frac{5}{6}\pi r^3$ nfww	**A1**	
8(c)	Derivative of V: $150 - \frac{5}{2}\pi r^2$ oe, soi, isw	**B1**	
	$their \left(150 - \frac{5}{2}\pi r^2 \right) = 0$ and solves as far as $r = \ldots$	**M1**	**FT** *their* $\frac{dV}{dr}$ providing that at least one term is correct
	$r = \sqrt{\frac{300}{5\pi}}$ oe or 4.37 (cm)	**A1**	
	$150(their\, 4.37) - \frac{5}{6}\pi(their\, 4.37)^3$	**M1**	**FT** *their* 4.37
	437 or awrt 437 (cm^3) isw	**A1**	

Question	Answer	Marks	Guidance
9(a)	$\frac{1}{2}(\sqrt{5}-1)(\sqrt{5}+1)\sin A = \frac{2\sqrt{5}}{3}$	**M1**	OR $\frac{1}{2}\times(\sqrt{5}+1)\times \text{height} = \frac{2\sqrt{5}}{3}$ **and** $\sin A = (\textit{their}\ \text{height}) \div (\sqrt{5}-1)$
	Simplifies to $\frac{1}{2}\times(5-1)\times\sin A = \frac{2\sqrt{5}}{3}$ oe	**A1**	OR $\sin A = \frac{4\sqrt{5}}{3(\sqrt{5}+1)} \div (\sqrt{5}-1)$ or $\sin A = \frac{5-\sqrt{5}}{3} \div (\sqrt{5}-1)$
	$\frac{\sqrt{5}}{3}$ isw	**A1**	
9(b)	$\cos A = \frac{2}{3}$ or exact equivalent	**B2**	**B1** for $\cos A = \sqrt{1 - \textit{their}\left(\frac{\sqrt{5}}{3}\right)^2}$ or for $\cos A = \cos\left(\sin^{-1}\frac{\sqrt{5}}{3}\right)$ or for a sketch 
	$(\sqrt{5}-1)^2 + (\sqrt{5}+1)^2 - 2(\sqrt{5}-1)(\sqrt{5}+1)\times\cos A$ soi	**M1**	
	$(\sqrt{5}-1)^2 + (\sqrt{5}+1)^2 - 2(\sqrt{5}-1)(\sqrt{5}+1)\times\frac{2}{3}$ soi	**A1**	
	$x = \sqrt{\frac{20}{3}}$ or $\frac{2}{3}\sqrt{15}$ or $2\sqrt{\frac{5}{3}}$ oe, isw	**A1**	

Question	Answer	Marks	Guidance
9(c)	$\dfrac{their\ x}{their\sin A}=\dfrac{\sqrt{5}+1}{\sin B}$ oe, soi or $\dfrac{1}{2}\times(\sqrt{5}-1)\times their\ x\times\sin B=\dfrac{2\sqrt{5}}{3}$ oe, soi	**M1**	**FT** *their x* and *their* sin*A*
	Correct expression $\dfrac{\sqrt{\dfrac{20}{3}}}{\dfrac{\sqrt{5}}{3}}=\dfrac{\sqrt{5}+1}{\sin B}$ oe or $\dfrac{1}{2}\times(\sqrt{5}-1)\times\sqrt{\dfrac{20}{3}}\times\sin B=\dfrac{2\sqrt{5}}{3}$ oe	**A1**	
	$\dfrac{\sqrt{15}+\sqrt{3}}{6}$ or $\dfrac{\sqrt{3}}{6}(\sqrt{5}+1)$ or $\dfrac{\sqrt{5}+1}{2\sqrt{3}}$ oe, isw	**A1**	
10(a)	$ar^2=4.5$ and $ar^5=15.1875$ soi	**B1**	
	Correctly eliminates one unknown using correct equations e.g $\left(\dfrac{4.5}{r^2}\right)r^5=15.1875$ or $\sqrt{\dfrac{4.5}{a}}=\sqrt[5]{\dfrac{15.1875}{a}}$ oe, soi	**M1**	
	r = 1.5, a = 2	**A2**	**A1** for either
10(b)	$S_{15}=\dfrac{2(1-1.5^{15})}{1-1.5}$ and $S_{25}=\dfrac{2(1-1.5^{25})}{1-1.5}$ oe	**B2**	**M1 FT** *their a* and *r* for $S_{15}=\dfrac{2(1-1.5^{15})}{1-1.5}$ or $S_{25}=\dfrac{2(1-1.5^{25})}{1-1.5}$ oe
	Correct plan: $S_{25}-S_{15}$ oe attempted	**M1**	**FT** *their a* and *r*
	99 253	**A1**	

Question	Answer	Marks	Guidance
10(b)	**Alternative 1**		
	first term = (*their*2)(*their*1.5)^{15} and an attempt at S_{10}	**(M1)**	**FT** *their a* and *r*
	Correct sum $S_{10}=\frac{875.7...(1-1.5^{10})}{1-1.5}$ oe	**(B2)**	**M1 FT** *their* first term and *r* for $S_{10}=\frac{their875.7...(1-their1.5^{10})}{1-their1.5}$
	99 253	**(A1)**	
	Alternative 2		
	Correct sum: $2(1.5)^{15} + 2(1.5)^{16} + 2(1.5)^{17} + 2(1.5)^{18} + 2(1.5)^{19} + 2(1.5)^{20} + 2(1.5)^{21} + 2(1.5)^{22} + 2(1.5)^{23} + 2(1.5)^{24}$ oe or $2(1.5)^{15}\{1 + 1.5 + (1.5)^2 + (1.5)^3 + (1.5)^4 + (1.5)^5 + (1.5)^6 + (1.5)^7 + (1.5)^8 + (1.5)^9\}$	**(M3)**	**M2 FT** *their a* and *r* for sum starting with $2(1.5)^{15}$ **and** ending with $2(1.5)^{24}$ with at most one omission or error or **M1 FT** *their a* and *r* for sum starting with $2(1.5)^{15}$ **or** ending with $2(1.5)^{24}$ with at most two omissions or errors
	99 253	**(A1)**	
11(a)	(–2, 2)	**B2**	**B1** for one correct coordinate nfww **M1** for $\overrightarrow{AC}=\frac{1}{3}\begin{pmatrix}9\\-12\end{pmatrix}$ or $\overrightarrow{CA}=\frac{1}{3}\begin{pmatrix}-9\\12\end{pmatrix}$ for $x = -5 + 3$ or $x = 4 - 6$ or for $y = 6 - 4$ or $y = -6 + 8$ or for $x+5=\frac{4-x}{2}$ or $6-y=\frac{y+6}{2}$ or for $2\left(\overrightarrow{OC}-\begin{pmatrix}-5\\6\end{pmatrix}\right)=\begin{pmatrix}4\\-6\end{pmatrix}-\overrightarrow{OC}$ oe

Question	Answer	Marks	Guidance
11(b)	$m_{AB} = \frac{-6-6}{4-(-5)}$ oe or $-\frac{12}{9}$ or $-\frac{4}{3}$	**B1**	
	$m_{CD} = \frac{3}{4}$	**M1**	**FT** $\frac{-1}{\textit{their } m_{AB}}$
	$y - 2 = \frac{3}{4}(x+2)$ oe or $y = \frac{3}{4}x + c$ and $2 = \left(\frac{3}{4}\right)(-2)+c$ oe soi	**M1**	**FT** *their* (–2, 2) and $\frac{-1}{\textit{their } m_{AB}}$
	$y = \frac{3}{4}x + \frac{7}{2}$ or equivalent in form $y = mx + c$	**A1**	
11(c)	$(x-4)^2 + (y+6)^2 = 125$ oe, soi	**B1**	
	Uses *their* $y = \frac{3}{4}x + \frac{7}{2}$ to eliminate one unknown	**M1**	if correct implies **B1**
	Correct equation in one unknown $[BD^2 =](x-4)^2 + \left(\frac{3}{4}x + \frac{7}{2} + 6\right)^2 = 125$ oe	**A1**	
	Writes in solvable form: $25x^2 + 100x - 300 = 0$ oe	**A1**	
	Factorises or solves a correct 3-term quadratic	**A1**	
	(2, 5) and (–6, –1)	**A1**	If **B1, M0** award: **SC2** for identifying one correct point by inspection from the length equation and testing it in the correct equation of *CD* **and** **SC2** for identifying the second correct point by inspection from the length equation and testing it in the correct equation of *CD*

Question	Answer	Marks	Guidance
11(c)	**Alternative**		
	[BC =] $\sqrt{(4-(their\ -2))^2+(-6-(their\ 2))^2}$	**(B1)**	**FT** *their C*
	$CD = \sqrt{125 - their\ 100}$	**(M1)**	**FT** *their* BC^2 providing 125 – *their* 100 > 0
	$CD = 5$	**(A1)**	
	$\begin{pmatrix}4\\3\end{pmatrix}+\begin{pmatrix}-2\\2\end{pmatrix}$ or $\begin{pmatrix}-4\\-3\end{pmatrix}+\begin{pmatrix}-2\\2\end{pmatrix}$ OR finds $25x^2 + 100x - 300 = 0$ oe	**(A2)**	**A1** for $\overrightarrow{CD_1}=\begin{pmatrix}4\\3\end{pmatrix}$ or $\overrightarrow{CD_2}=\begin{pmatrix}-4\\-3\end{pmatrix}$ soi OR **A1** for finds $(x+2)^2+\left(\frac{3}{4}x+\frac{7}{2}-2\right)^2=25$
	(2, 5) and (–6, –1)	**(A1)**	