Question	Answer	Marks	Guidance
1	$2x^2-8x+3x-12*3x^2-3x+4x-4$	**B1**	Correctly expands all brackets * is any inequality or equals sign
	$[0*]\ x^2+6x+8$	**B1**	Collects terms to correct 3-term quadratic in solvable form
	$[0*](x+2)(x+4)$	**M1**	Factorises or solves *their* 3-term quadratic
	–4 and –2	**A1**	Correct critical values
	$-4 < x < -2$ mark final answer	**A1**	
2	$\frac{dy}{dx}=2ax-5$	**B1**	
	$2a\times2-5=7$ oe	**M1**	**FT** *their* $\left(\left.\frac{dy}{dx}\right\|_{x=2}\right)=7$
	$a=3$	**A1**	
	$7\times2+b=\textit{their}\ 4$ or $b=2-4\times\textit{their}\ a$	**M1**	**dep** on previous **M1** where *their* 4 is an attempt to evaluate $y=ax^2-5x+2$ using $x=2$ and *their a*
	$b=-10$	**A1**	
	Alternative		
	$(-12)^2-4a(2-b)=0$ oe	**(B1)**	for use of discriminant on $ax^2-12x+2-b=0$
	$144-8a+4a(4a-22)=0$ oe or $144-(b+22)(2-b)=0$ oe	**(M1)**	Condone one sign or arithmetic error
	$a^2-6a+9\ [=0]$ oe or $b^2+20b+100\ [=0]$ oe	**(A1)**	for correct 3-term quadratic in solvable form
	$a=3$ and $b=-10$	**(A2)**	**A1** for $a=3$ or $b=-10$

Question	Answer	Marks	Guidance
3	$\lg((2x-1)(x+2)) = \lg\frac{100}{4}$ oe or $10^2 = 4(2x-1)(x+2)$ oe	**M2**	**M1** for one log law correctly applied within a correct equation e.g. $\lg 4(2x-1)(x+2) \quad = 2$
	$2x^2+3x-27[=0]$	**A1**	Collects terms to correct 3-term quadratic in solvable form
	$(2x+9)(x-3)[=0]$	**M1**	**dep** on at least **M1** previously awarded Factorises *their* $2x^2+3x-27$ or solves *their* $2x^2+3x-27=0$
	x = 3 indicated as only valid solution	**A1**	nfww
4(a)	$2k+6=8-16+6k+2$ oe	**M1**	For equating line to curve and substituting x = 2, or vice versa
	k = 3	**A1**	
4(b)	$x^3-4x^2+(2\times \textit{their } k)x-4 \ [=0]$ or $x^3-4x^2+6x-4 \ [=0]$	**M1**	**FT** *their k* in correct cubic
	x^2-2x+2	**A2**	Correct quadratic factor from correct cubic **A1** for a quadratic factor with two terms correct, from correct cubic
	$(-2)^2-4(1)(2) < 0$ oe or $4-8<0$ oe [and so x = 2 is the only solution]	**A1**	Uses discriminant correctly on the correct quadratic factor

Question	Answer	Marks	Guidance
5(a)	$\dfrac{\cos^2 x+(1-\sin x)^2}{(1-\sin x)\cos x}$ or $\dfrac{\cos^2 x}{(1-\sin x)\cos x}+\dfrac{(1-\sin x)^2}{(1-\sin x)\cos x}$	**M1**	Correctly takes common denominator
	$\dfrac{\cos^2 x+1-2\sin x+\sin^2 x}{(1-\sin x)\cos x}$	**A1**	OR $\dfrac{1-\sin^2 x+(1-\sin x)^2}{(1-\sin x)\cos x}$
	$\dfrac{1+1-2\sin x}{(1-\sin x)\cos x}$ or $\dfrac{1-\sin^2 x+1-2\sin x+\sin^2 x}{(1-\sin x)\cos x}$	**A1**	OR $\dfrac{(1-\sin x)(1+\sin x)+(1-\sin x)^2}{(1-\sin x)\cos x}$
	$\dfrac{2(1-\sin x)}{(1-\sin x)\cos x}=2\sec x$ or $\dfrac{2-2\sin x}{(1-\sin x)\cos x}=\dfrac{2}{\cos x}=2\sec x$ or equivalent	**A1**	All steps correct and final step justified OR $\dfrac{1+\sin x+1-\sin x}{\cos x}=2\sec x$
	Alternative ***Must work with LHS only***		
	$\dfrac{(\cos x)(1+\sin x)}{(1-\sin x)(1+\sin x)}+\dfrac{(1-\sin x)\cos x}{(\cos x)\cos x}$	**(M1)**	Forms fractions with common denominator in different form
	$\dfrac{(\cos x)(1+\sin x)}{\cos^2 x}+\dfrac{(1-\sin x)\cos x}{\cos^2 x}$	**(A1)**	Uses difference of two squares and $\sin^2 x+\cos^2 x=1$ to write fractions with a common denominator in the same form
	$\dfrac{2\cos x}{\cos^2 x}$	**(A1)**	Combine as a single fraction and collects terms
	$\dfrac{2}{\cos x}=2\sec x$	**(A1)**	All steps correct and final step justified
5(b)	$\cos^3\dfrac{\theta}{2}=\dfrac{1}{4}$	**B1**	
	$\cos\dfrac{\theta}{2}=\sqrt[3]{their\ \dfrac{1}{4}}$ soi	**M1**	**dep** on starting with $2\sec\dfrac{\theta}{2}=8\cos^2\dfrac{\theta}{2}$
	±101.9 awrt	**A2**	and no extras in range **A1** for either, ignoring extras in range If **A0** then **SC1** for ±102 with no extras in range

Question	Answer	Marks	Guidance
6	$81+108ax+54a^2x^2+12a^3x^3$ soi or $12a^3=\frac{3}{2}$ $b=108a$ $c=54a^2$ soi	M3	**M2** for any 3 correct terms or 2 correct equations or **M1** for any 2 correct terms, 1 correct equation or for correct but insufficiently simplified expansion e.g. $3^4+4\times3^3\times ax+\frac{4\times3}{2}\times3^2\times(ax)^2$ $+\frac{4\times3\times2}{3\times2}\times3\times(ax)^3$
	$a=\frac{1}{2}$ oe	A1	
	$b = 54$	A1	**FT** 108 × *their a*, providing at least **M1** awarded
	$c=\frac{27}{2}$ oe	A1	**FT** 54 × (*their a*)^2, providing at least **M1** awarded
7	${}^nC_4=\frac{n!}{(n-4)!4!}$ and ${}^nC_2=\frac{n!}{(n-2)!2!}$ soi	B1	
	$\frac{n(n-1)(n-2)(n-3)}{24}=\frac{13n(n-1)}{2}$ or $(n-2)(n-3)=\frac{13\times24}{2}$ oe, soi	M1	Writes in a correct form, free of factorials
	$n^2-5n-150\ [=0]$	A1	
	$n = 15$ only, nfww	A1	**dep** on previous A1
	${}^{15}C_8=6435$ only	B1	
8(a)	(Velocity vector =) $\frac{26}{\sqrt{12^2+5^2}}\begin{pmatrix}12\\5\end{pmatrix}$ oe	M2	**M1** for $\sqrt{12^2+5^2}$ or 13 or 2 seen
	(Position vector =) $\begin{pmatrix}3\\-2\end{pmatrix}+t\begin{pmatrix}24\\10\end{pmatrix}$ oe	A1	

Question	Answer	Marks	Guidance
8(b)	(Direction vector =) $\begin{pmatrix}4\\3\end{pmatrix}$ soi or x component: $\cos\alpha = \frac{4}{5}$ y component: $\sin\alpha = \frac{3}{5}$ soi	**B1**	
	(Velocity vector =) $\frac{20}{\sqrt{4^2+3^2}} \times their \begin{pmatrix}4\\3\end{pmatrix}$ oe soi or $20\begin{pmatrix}their\cos\alpha\\their\sin\alpha\end{pmatrix}$ soi	**M1**	
	(Position vector =) $\begin{pmatrix}67\\-18\end{pmatrix} + t\begin{pmatrix}16\\12\end{pmatrix}$ oe	**A2**	**A1 FT** $\begin{pmatrix}67\\-18\end{pmatrix} + t \times their\begin{pmatrix}16\\12\end{pmatrix}$ If zero scored, **SC2** for one correct component, either $67+16t$ or $-18+12t$
8(c)	$3+24t = 67+16t$ oe or $-2+10t = -18+12t$ oe	**M1**	**FT** Equates *their x* components, or *their y* components from parts **(a)** and **(b)**, providing of equivalent difficulty, e.g. $a+bt = c+dt$
	t = 8	**A1**	**dep** on full marks in **(a)** and **(b)**
	(Position of meeting =) $\begin{pmatrix}195\\78\end{pmatrix}$	**A1**	**dep** on full marks in **(a)** and **(b)**
9(a)	$\frac{d}{dx}\left(e^{-2x}\right) = -2e^{-2x}$ soi	**B1**	
	$\frac{dy}{dx} = ke^{-2x} - 2kxe^{-2x}$ oe, isw	**B1**	**FT** for use of product rule $k.e^{-2x} + kx.\left(their\frac{d}{dx}\left(e^{-2x}\right)\right)$
	Alternative		
	$\frac{d}{dx}\left(e^{2x}\right) = 2e^{2x}$ soi	**(B1)**	
	$\frac{dy}{dx} = \frac{ke^{2x} - 2kxe^{2x}}{\left(e^{2x}\right)^2}$ oe, isw	**(B1)**	**FT** for use of quotient rule $\frac{k.e^{2x} - kx.\left(their\ 2e^{2x}\right)}{\left(e^{2x}\right)^2}$

Question	Answer	Marks	Guidance
9(b)	Equates $\frac{dy}{dx}=0$ and finds 10 – 20x = 0 oe	**M1**	**FT** *their* (a), provided of the form $me^{-2x}+nxe^{-2x}$ or $me^{2x}+nxe^{2x}$
	$\left(\frac{1}{2}, \frac{5}{e}\right)$ oe only	**A2**	For both values: $x=$ 0.5 **and** $y=5e^{-1}$ or 1.84 or 1.839[39...] rot to 4 or more sf **A1** for $x=\frac{1}{2}$ only
9(c)	$-2xe^{-2x}-e^{-2x}+c$	**B3**	For fully correct answer or **B2** for $-2xe^{-2x}-e^{-2x}$ or $\left[\int 4xe^{-2x}dx\right]=-2xe^{-2x}+\int 2e^{-2x}dx$ or **B1** for $kxe^{-2x}=\int\left(ke^{-2x}-2kxe^{-2x}\right)dx$ or better
9(d)	$-2e^{-2}-e^{-2}-\left(0-e^{0}\right)$ oe	**M1**	Correct substitution of limits into correct expression
	$1-\frac{3}{e^2}$ or $1-3e^{-2}$	**A1**	
10(a)	$a+(3-1)d=10$ soi	**B1**	
	$\frac{8}{2}\{2a+(8-1)d\}=116$ soi	**B1**	
	Correct method to eliminate one unknown and attempt to solve to find *a* or *d*	**M1**	**dep** on at least **B1** awarded
	a = 4 and *d* = 3	**A2**	**A1** for either
10(b)	$S_{30}=\frac{30}{2}\{2(4)+29(3)\}$ and $S_{11}=\frac{11}{2}\{2(4)+10(3)\}$	**B2**	**M1 FT** *their a* and *their d* for $S_{30}=\frac{30}{2}\{2(\textit{their } 4)+29(\textit{their } 3)\}$ or $S_{11}=\frac{11}{2}\{2(\textit{their } 4)+10(\textit{their } 3)\}$
	Correct plan $S_{30}-S_{11}$ attempted	**M1**	**FT** *their a* and *their d*
	1216	**A1**	

Question	Answer	Marks	Guidance
10(b)	**Alternative 1**		
	first term = 4 + 11×3 or 37 and an attempt at S_{19}	**(M1)**	**FT** *their a* + 11×*their d*
	$\frac{19}{2}\{2(37)+(19-1)\times3\}$ oe or $\frac{19}{2}\{37+91\}$ oe	**(B2)**	**M1 FT** for *their* first term and *their d* in $\frac{19}{2}\{2(\textit{their}\,37)+(19-1)\times \textit{their}\,3\}$ or for *their* first term and *their* last term in $\frac{19}{2}\{\textit{their}\,37+\textit{their}\,91\}$
	1216	**(A1)**	
	Alternative 2		
	Correct sum of terms: 37 + 40 + 43 + 46 + 49 + 52 + 55 + 58 + 61 + 64 + 67 + 70 + 73 + 76 + 79 + 82 + 85 + 88 + 91	**(M3)**	**M2 FT** *their a* and *their d* for sum starting with *their* 37 **and** ending with *their* 91, with at most one omission or error or **M1 FT** *their a* and *their d* for sum starting with *their* 37 **or** ending with *their* 91, with at most two omissions or errors
	1216	**(A1)**	
11(a)	$2\mathbf{a}+\lambda(3\mathbf{b}-2\mathbf{a})$ oe isw or $3\mathbf{b}-(1-\lambda)(3\mathbf{b}-2\mathbf{a})$ oe isw	**B3**	**B1** for $\overrightarrow{PS}=3\mathbf{b}-2\mathbf{a}$ soi and **B1** for correct route using λ, either $\overrightarrow{OX}=\overrightarrow{OP}+\lambda\overrightarrow{PS}$ soi or $\overrightarrow{OX}=\overrightarrow{OS}-(1-\lambda)\overrightarrow{PS}$ soi
11(b)	$\mu(5\mathbf{a}+2\mathbf{b})$ isw	**B2**	**B1** for $\overrightarrow{OQ}=3\mathbf{b}+5\mathbf{a}-\mathbf{b}$ oe soi
11(c)	$2-2\lambda=5\mu$ and $3\lambda=2\mu$ oe	**M2**	for correctly equating scalars for both components **FT** *their* **(a)** and **(b)** if possible **M1 FT** for equating scalars for either component
	Solves to find $\lambda=\frac{4}{19}$ or $\mu=\frac{6}{19}$	**A1**	
	$\lambda=\frac{4}{19}$ and $\mu=\frac{6}{19}$	**A1**	
11(d)	$\frac{6}{19}$ isw	**B1**	
11(e)	$\frac{4}{15}$ isw	**B1**	