Question	Answer	Marks	Guidance
1	$7C1 \times 2^6 \times a(x)$, $7C2 \times 2^5 \times [a(x)]^2$	B1 B1	SOI Can be part of expansion. Condone ax^2 only if followed by a^2. ALT $2^7[1+ax/2]^7 \to 7C1[a(x)/2] = 7C2[a(x)/2]^2$
	$a = \dfrac{7\times 2^6}{21\times 2^5} = \dfrac{2}{3}$	B1	Ignore extra soln $a = 0$. Allow $a = 0.667$. Do not allow an extra x in the answer
	Total:	3	

Question	Answer	Marks	Guidance
2(i)	$S = \dfrac{r^2 - 3r + 2}{1 - r}$	M1	
	$S = \dfrac{(r-1)(r-2)}{1-r} = \dfrac{-(1-r)(r-2)}{1-r} = 2 - r$ OR $\dfrac{(1-r)(2-r)}{1-r} = 2 - r$ OE	A1	**AG** Factors must be shown. Expressions requiring minus sign taken out must be shown
	Total:	2	
2(ii)	Single range $1 < S < 3$ or (1, 3)	B2	Accept $1 < 2 - r < 3$. Correct range but with $S = 2$ omitted scores SR **B1** $1 \leqslant S \leqslant 3$ scores SR **B1**. [$S > 1$ and $S < 3$] scores SR **B1**.
	Total:	2	

Question	Answer	Marks	Guidance
3	**EITHER** Elim y to form 3-term quad eqn in $x^{1/3}$ (or u or y or even x)	**(M1**	Expect $x^{2/3}-x^{1/3}-2(=0)$ or $u^2-u-2\ (=0)$ etc.
	$x^{1/3}$ (or u or y or x) = 2, −1	***A1**	Both required. But $\underline{x}$ = 2,–1 and not then cubed or cube rooted scores **A0**
	Cube solution(s)	**DM1**	Expect x = 8, – 1. Both required
	(8, 3), (–1,0)	**A1)**	
	OR Elim x to form quadratic equation in y	**(M1**	Expect $y+1=(y-1)^2$
	$y^2-3y=0$	***A1**	
	Attempt solution	**DM1**	Expect y = 3, 0
	(8, 3), (–1,0)	**A1)**	
	Total:	**4**	

Question	Answer	Marks	Guidance
4(i)	$\overrightarrow{OB}-\overrightarrow{OA}\left(=\overrightarrow{AB}\right)=\begin{pmatrix}5\\4\\-3\end{pmatrix}-\begin{pmatrix}5\\1\\3\end{pmatrix}=\begin{pmatrix}0\\3\\-6\end{pmatrix}$	**B1**	
	$\overrightarrow{OP}=\begin{pmatrix}5\\1\\3\end{pmatrix}+\frac{1}{3}\begin{pmatrix}0\\3\\-6\end{pmatrix}=\begin{pmatrix}5\\2\\1\end{pmatrix}$	**M1 A1**	If $\overrightarrow{OP}$ not scored in (i) can score SR **B1** if seen correct in (ii). Other equivalent methods possible
	Total:	**3**	
4(ii)	Distance $OP=\sqrt{5^2+2^2+1^2}=\sqrt{30}$ or 5.48	**B1 FT**	FT on *their* $\overrightarrow{OP}$ from (i)
	Total:	**1**	
4(iii)	Attempt $\overrightarrow{AB}.\overrightarrow{OP}$. Can score as part of $\overrightarrow{AB}.\overrightarrow{OP}=(AB)(OP)\cos\theta$ Rare ALT: Pythagoras $\lvert\overrightarrow{OP}\rvert^2+\lvert\overrightarrow{AP}\rvert^2=5+30=\lvert\overrightarrow{OA}\rvert^2$	**M1**	Allow any combination of $\overrightarrow{AB}.\overrightarrow{PO}$ etc. and also if $\overrightarrow{AP}$ or $\overrightarrow{PB}$ used instead of $\overrightarrow{AB}$ giving 2–2 = 0 & 4–4 = 0 respectively. Allow notation × instead of **.**
	(0 + 6 – 6) = 0 hence perpendicular. (Accept 90º)	**A1 FT**	If result not zero then 'Not perpendicular' can score **A1**FT if value is 'correct' for *their* values of $\overrightarrow{AB},\overrightarrow{OP}$ etc. from (i).
	Total:	**2**	

Question	Answer	Marks	Guidance
5(i)	$\frac{2\sin\theta+\cos\theta}{\sin\theta+\cos\theta}=\frac{2\sin\theta}{\cos\theta}$	M1	Replace $\tan\theta$ by $\sin\theta/\cos\theta$
	$2\sin\theta\cos\theta+\cos^2\theta=2\sin^2\theta+2\sin\theta\cos\theta \Rightarrow c^2=2s^2$	M1 A1	Mult by c(s + c) or making this a common denom.. For **A1** simplification to **AG** without error or omission must be seen.
	Total:	**3**	
5(ii)	$\tan^2\theta=1/2$ or $\cos^2\theta=2/3$ or $\sin^2\theta=1/3$	B1	Use $\tan\theta=s/c$ or $c^2+s^2=1$ and simplify to one of these results
	$\theta=35.3°$ or $144.7°$	B1 B1 FT	FT for 180 – other solution. SR **B1** for radians 0.615, 2.53 (0.196π, 0.804π) Extra solutions in range amongst solutions of which 2 are correct gets **B1B0**
	Total:	**3**	

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Question	Answer	Marks	Guidance
6	Gradient of normal is – 1/3 → gradient of tangent is 3 SOI	**B1 B1 FT**	FT from *their* gradient of normal.
	$dy/dx = 2x - 5 = 3$	**M1**	Differentiate and set = *their* 3 (numerical).
	$x = 4$	***A1**	
	Sub $x = 4$ into line → $y = 7$ & sub *their* (4, 7) into curve	**DM1**	OR sub $x = 4$ into curve → $y = k - 4$ and sub *their*$(4, k - 4)$ into line OR other valid methods deriving a linear equation in k (e.g. equating curve with either normal or tangent and sub $x = 4$).
	$k = 11$	**A1**	
	Total:	**6**	

Question	Answer	Marks	Guidance
7(i)	$\sin ABC = 8/10 \rightarrow ABC = 0.927(3)$	**B1**	Or cos = 6/10 or tan = 8/6. Accept 0.295π.
	Total:	**1**	
7(ii)	$AB = 6(\text{Pythagoras}) \rightarrow \Delta BCD = 8\times 6 = 48.0$	**M1A1**	**OR** 8×10sin0.6435 or ½×10×10sin((2)×0.927)=48. 24or 40or80 gets **M1A0**
	Area sector $BCD = ½\times 10^2\times(2)\times \textit{their}\,0.9273$	***M1**	Expect 92.7(3). 46.4 gets **M1**
	Area segment = 92.7(3) – 48	***A1**	Expect 44.7(3). Might not appear until final calculation.
	Area semi-circle – segment = $½\times\pi\times 8^2 - \textit{their}(92.7-48)$	**DM1**	Dep. on previous **M1A1** OR $\pi\times 8^2 - (½\times\pi\times 8^2 + \textit{their}\,44.7)$.
	Shaded area = 55.8 – 56.0	**A1**	
	Total:	**6**	

Question	Answer	Marks	Guidance
8(i)	$(b-1)/(a+1)=2$	M1	OR Equation of AP is $y-1=2(x+1)\rightarrow y=2x+3$
	$b=2a+3$ CAO	A1	Sub $x=a$, $y=b$ $\rightarrow b=2a+3$
	Total:	**2**	
8(ii)	$AB^2=11^2+2^2=125$ oe	B1	Accept $AB=\sqrt{125}$
	$(a+1)^2+(b-1)^2=125$	B1 FT	FT on *their* 125.
	$(a+1)^2+(2a+2)^2=125$	M1	Sub from part (i) → quadratic eqn in a (or possibly in b → $b^2-2b-99=0$)
	$(5)(a^2+2a-24)=0\rightarrow \text{eg}(a-4)(a+6)=0$	M1	Simplify and attempt to solve
	$a=4$ or -6	A1	
	$b=11$ or -9	A1	OR (4, 11), (–6, –9) If **A0A0**, SR1 for either (4, 11) or (–6, –9)
	Total:	**6**	

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Question	Answer	Marks	Guidance
9(i)	$(3x-1)^2+5$	B1B1B1	First 2 marks dependent on correct $(ax+b)^2$ form. OR $a=3,\ b=-1,\ c=5$ e.g. from equating coefs
	Total:	3	
9(ii)	Smallest value of p is 1/3 seen. (Independent of (i))	B1	Allow $p \geqslant 1/3$ or $p=1/3$ or 1/3 seen. But not in terms of x.
	Total:	1	
9(iii)	$y=(3x-1)^2+5 \Rightarrow 3x-1=(\pm)\sqrt{y-5}$	B1 FT	OR $y=9\left(x-\frac{1}{3}\right)^2+5 \Rightarrow (y-5)/9=\left(x-\frac{1}{3}\right)^2$ (Fresh start)
	$x=(\pm)\frac{1}{3}\sqrt{y-5}+\frac{1}{3}$ OE	B1 FT	Both starts require 2 operations for each mark. FT for *their* values from part (i)
	$f^{-1}(x)=\frac{1}{3}\sqrt{x-5}+\frac{1}{3}$ OE domain is $x \geq their 5$	B1B1 FT	Must be a function of x and $\pm$ removed. Domain must be in terms of x. Note: $\sqrt{y-5}$ expressed as $\sqrt{y}-\sqrt{5}$ scores Max **B0B0B0B1** [See below for general instructions for different starts]
	Total:	4	
9(iv)	$q<5$ CAO	B1	
	Total:	1	

Alt 9(iii)
For start $(ax-b)^2+c$ or $a(x-b)^2+c$ ($a \neq 0$) ft for their a, b, c
For start $(x-b)^2+c$ ft but award only **B1** for 3 correct operations
For start $a(bx-c)^2+d$ ft but award **B1** for first2 operations correct and **B1** for the next 3 operations correct

Question	Answer	Marks	Guidance
10(a)(i)	Attempt to integrate $V = (\pi)\int(y+1)\mathrm{d}y$	**M1**	Use of h in integral e.g. $\int(h+1) = \frac{1}{2}h^2 + h$ is **M0**. Use of $\int y^2\mathrm{d}x$ is **M0**
	$= (\pi)\left[\frac{y^2}{2} + y\right]$	**A1**	
	$= \pi\left[\frac{h^2}{2} + h\right]$	**A1**	**AG**. Must be from clear use of limits $0 \to h$ somewhere.
	Total:	**3**	
10(ii)	$\int(y+1)^{1/2}\mathrm{d}y$ **ALT** $6 - \int(x^2-1)\mathrm{d}x$	**M1**	Correct variable and attempt to integrate
	$\frac{2}{3}(y+1)^{3/2}$ oe **ALT** $6 - (\frac{1}{3}x^3 - x)$ CAO	***A1**	Result of integration must be shown
	$\frac{2}{3}[8-1]$ **ALT** $6 - [\left(\frac{8}{3}-1\right) - \left(\frac{1}{3}-1\right)]$	**DM1**	Calculation seen with limits $0\to3$ for y. For ALT, limits are $1\to2$ and rectangle.
	14/3 **ALT** 6 – 4/3 = 14/3	**A1**	16/3 from $\frac{2}{3}\times 8$ gets **DM1A0** provided work is correct up to applying limits.
	Total:	**4**	

Question	Answer	Marks	Guidance
10(b)	Clear attempt to differentiate wrt h	**M1**	Expect $\frac{dV}{dh} = \pi(h+1)$. Allow h + 1. Allow h.
	Derivative = 4π SOI	***A1**	
	$\frac{2}{\textit{their}\text{ derivative}}$. Can be in terms of h	**DM1**	
	$\frac{2}{4\pi}$ or $\frac{1}{2\pi}$ or 0.159	**A1**	
	Total:	**4**	

Question	Answer	Marks	Guidance
11(i)	$\text{f}'(x) = [(4x+1)^{1/2} \div ½]\ [\div 4]\ (+c)$	B1 B1	Expect $½(4x+1)^{1/2}\ (+c)$
	$\text{f}'(2) = 0 \Rightarrow \frac{3}{2} + c = 0 \Rightarrow c = -\frac{3}{2}$ (Sufficient)	B1 FT	Expect $½(4x+1)^{1/2} - \frac{3}{2}$. FT on *their* $\text{f}'(x) = k(4x+1)^{1/2} + c$. (i.e. $c = -3k$)
	Total:	**3**	
11(ii)	$\text{f}''(0) = 1$ SOI	B1	
	$\text{f}'(0) = 1/2 - 1½ = -1$ SOI	B1 FT	Substitute $x = 0$ into *their* f ′(x) but must not involve c otherwise **B0B0**
	f(0) = – 3	B1 FT	FT for 3 terms in AP. FT for 3rd **B1** dep on 1st **B1**. Award marks for the AP method only.
	Total:	**3**	
11(iii)	$\text{f}(x) = \left[½(4x+1)^{3/2} \div 3/2 \div 4\right] - \left[1½x\right]\ (+k)$	B1 FT B1 FT	Expect $(1/12)(4x+1)^{3/2} - 1½x\ (+k)$. FT from *their* f ′($x$) but c numerical.
	$-3 = 1/12 - 0 + k \Rightarrow k = -37/12$ CAO	M1A1	Sub $x = 0, y =$ *their* $\text{f}(0)$ into *their* f(x). Dep on cx & k present (c numerical)
	Minimum value = f(2) $= \frac{27}{12} - 3 - \frac{37}{12} = -\frac{23}{6}$ or -3.83	A1	
	Total:	**5**	