Question	Answer	Marks	Guidance
1	[3] $\left[(x-2)^2\right]$ [–5]	**B1B1B1**	OR $a = 3$, $b = -2$, $c = -5$. 1st mark is dependent on the form $(x+a)^2$ following 3
		3	

Question	Answer	Marks	Guidance
2	${}_5C_3\ x^2\left(\frac{-2}{x}\right)^3$ SOI	**B2,1,0**	–80 www scores B3. Accept ${}_5C_2$.
	–80 Accept $\frac{-80}{x}$	**B1**	+80 without clear working scores SCB1
		3	

Question	Answer	Marks	Guidance
3	$\left[\frac{a\left(1-r^n\right)}{1-r}\right][\div]\left[\frac{a}{1-r}\right]$	M1M1	Correct formulae **used** with/without r = 0.99 or n = 100.
		DM1	Allow numerical a (M1M1). 3rd M1 is for division $\frac{S_n}{S_\infty}$ (or ratio) SOI
	$1-0.99^{100}$ SOI OR $\frac{63(a)}{100(a)}$ SOI	A1	Could be shown multiplied by 100(%). Dep. on DM1
	63(%) Allow 63.4 or 0.63 but not 2 infringements (e.g. 0.634, 0.63%)	A1	n = 99 used scores Max M3. Condone a = 0.99 throughout $S_n = S_\infty$ (without division shown) scores 2 / 5
		5	

Question	Answer	Marks	Guidance
4	$f(x)=\left[\dfrac{(3x-1)^{\frac{2}{3}}}{\frac{2}{3}}\right][\div 3]\quad(+c)$	**B1B1**	
	$1=\dfrac{8^{\frac{2}{3}}}{2}+c$	**M1**	Sub $y=1, x=3$ Dep. on attempt to integrate and c present
	$c=-1 \rightarrow y=\dfrac{1}{2}(3x-1)^{\frac{2}{3}}-1$ SOI	**A1**	
	When $x=0$, $y=\dfrac{1}{2}(-1)^{\frac{2}{3}}-1 \quad =-\dfrac{1}{2}$	**DM1A1**	Dep. on previous M1
		6	

Question	Answer	Marks	Guidance
5	Angle $AOC = \frac{6}{5}$ or 1.2	M1	Allow 68.8º. Allow $\frac{5}{6}$
	AB = 5 × tan(*their* 1.2) OR by e.g. Sine Rule Expect 12.86	DM1	OR $OB = \frac{5}{\cos their 1.2}$. Expect 13.80
	Area $\Delta OAB = \frac{1}{2} \times 5 \times their\,12.86$ Expect 32.15	DM1	OR $\frac{1}{2} \times 5 \times$ *their OB* × sin *their* 1.2
	Area sector $\frac{1}{2} \times 5^2 \times their\,1.2$ Expect 15	DM1	All DM marks are dependent on the first M1
	Shaded region = 32.15 – 15 = 17.2	A1	Allow degrees used appropriately throughout. 17.25 scores A0
		5	

Question	Answer	Marks	Guidance
6(i)	Gradient, m, of $AB = \frac{3k+5-(k+3)}{k+3-(-3k-1)}$ OE $\left(=\frac{2k+2}{4k+4}\right) = \frac{1}{2}$	M1A1	Condone omission of brackets for M mark
		2	
6(ii)	Mid-pt = $[\frac{1}{2}(-3k-1+k+3), \frac{1}{2}(3k+5+k+3)] = \left(\frac{-2k+2}{2}, \frac{4k+8}{2}\right)$ SOI	B1B1	B1 for $\frac{-2k+2}{2}$, B1 for $\frac{4k+8}{2}$ (ISW) or better, i.e. $(-k+1, 2k+4)$
	Gradient of perpendicular bisector is $\frac{-1}{their\ m}$ SOI Expect –2	M1	Could appear in subsequent equation and/or could be in terms of k
	Equation: $y-(2k+4)=-2[x-(-k+1)]$ OE	DM1	Through *their* mid-point and with *their* $\frac{-1}{m}$ (now numerical)
	$y+2x=6$	A1	Use of numerical k in **(ii)** throughout scores SC2/5 for correct answer
		5	

Question	Answer	Marks	Guidance
7(a)(i)	$\frac{\tan^2\theta-1}{\tan^2\theta+1} = \frac{\frac{\sin\theta^2}{\cos\theta^2}-1}{\frac{\sin\theta^2}{\cos\theta^2}+1}$	M1	
	$= \frac{\sin\theta^2-\cos\theta^2}{\sin\theta^2+\cos\theta^2}$	A1	multiplying by $\cos\theta^2$ Intermediate stage can be omitted by multiplying directly by $\cos\theta^2$
	$= \sin\theta^2-\cos\theta^2 = \sin\theta^2-\left(1-\sin\theta^2\right) = 2\sin^2\theta-1$	A1	Using $\sin\theta^2+\cos\theta^2=1$ twice. Accept $a=2,\ b=-1$
	ALT 1 $\frac{\sec^2\theta-2}{\sec^2\theta}$	M1	ALT 2 $\frac{\tan^2\theta-1}{\sec^2\theta}$
	$1-\frac{2}{\sec^2\theta} = 1-2\cos^2\theta$	A1	$(\tan^2\theta-1)\cos^2\theta$
	$1-2\left(1-\sin^2\theta\right)=2\sin^2\theta-1$	A1	$\sin^2\theta-\cos^2\theta=\sin^2\theta-\left(1-\sin^2\theta\right)=2\sin^2\theta-1$
		3	
7(a)(ii)	$2\sin^2\theta-1=\frac{1}{4} \to \sin\theta=(\pm)\sqrt{\frac{5}{8}}$ or $(\pm)0.7906$	M1	OR $\frac{t^2-1}{t^2+1}=\frac{1}{4}\to 3t^2=5\to t=(\pm)\sqrt{\frac{5}{3}}$ or $t=(\pm)1.2910$
	$\theta=-52.2$	A1	
		2	

Question	Answer	Marks	Guidance
7(b)(i)	$\sin x = 2\cos x \rightarrow \tan x = 2$	M1	Or sin$x$ = $\sqrt{\frac{4}{5}}$ or cos$x$ = $\sqrt{\frac{1}{5}}$
	$x = 1.11$ with no additional solutions	A1	Accept 0.352π or 0.353π. Accept in co-ord form ignoring y co-ord
		2	
7(b)(ii)	Negative answer in range $-1 < y < -0.8$	B1	
	-0.894 or -0.895 or -0.896	B1	
		2	

Question	Answer	Marks	Guidance
8(i)	$\frac{dy}{dx} = 3x^2 - 18x + 24$	**M1A1**	Attempt to differentiate. All correct for A mark
	$3x^2 - 18x + 24 = -3$	**M1**	Equate *their* $\frac{dy}{dx}$ to –3
	$x = 3$	**A1**	
	$y = 6$	**A1**	
	$y - 6 = -3(x - 3)$	**A1FT**	FT on *their A*. Expect $y = -3x + 15$
		6	
8(ii)	$(3)(x-2)(x-4)$ SOI or $x = 2, 4$ Allow $(3)(x+2)(x+4)$	**M1**	Attempt to factorise or solve. Ignore a RHS, e.g. = 0 or > 0, etc.
	Smallest value of k is 4	**A1**	Allow $k \geqslant 4$. Allow $k = 4$. Must be in terms of k
		2	

Question	Answer	Marks	Guidance
9(i)	**OE** = $\frac{2}{10}(8\mathbf{i}+6\mathbf{j}) = 1.6\mathbf{i}+1.2\mathbf{j}$ **AG**	**M1A1**	Evidence of OB = 10 or other valid method (e.g. trigonometry) is required
		2	
9(ii)	**OD =** 1.6i + 1.2**j** + 7k	**B1**	Allow reversal of one or both of **OD**, **BD.**
	BD = –8**i** – 6**j** + 1.6i + 1.2**j** + 7k OE = –6.4**i** –4.8**j** + 7**k**	**M1A1**	For M mark allow sign errors. Also if 2 out of 3 components correct
	Correct method for ±**OD.**±**BD** (using *their* answers)	**M1**	Expect 1.6 × –6.4 + 1.2 × –4.8 + 49 = 33 or $\frac{825}{25}$ 825 / 25.
	Correct method for |**OD**| or |**BD**| (using *their* answers)	**M1**	Expect $\sqrt{1.6^2+1.2^2+7^2}$ or $\sqrt{6.4^2+4.8^2+7^2}$ = √53 or √113
	Cos BDO = *their* $\frac{\mathbf{OD.BD}}{\lvert\mathbf{OD}\rvert\times\lvert\mathbf{BD}\rvert}$	**DM1**	Expect $\frac{33}{77.4}$. Dep. on all previous M marks and either B1 or A1
	64.8° Allow 1.13(rad)	**A1**	Can't score A1 if 1 vector only is reversed unless explained well
		7	

Question	Answer	Marks	Guidance
10(i)	Smallest value of c is 2. Accept 2, $c = 2$, $c \geqslant 2$. Not in terms of x	B1	Ignore superfluous working, e.g. $\frac{d^2y}{dx^2} = 2$
		1	
10(ii)	$y = (x-2)^2 + 2 \to x - 2 = (\pm)\sqrt{y-2} \to x = (\pm)\sqrt{y-2} + 2$	M1	Order of operations correct. Allow sign errors
	$f^{-1}(x) = \sqrt{x-2} + 2$	A1	Accept $y = \sqrt{x-2} + 2$
	Domain of f^{-1} is $x \geqslant 6$. Allow $\geqslant 6$.	B1	Not $f^{-1}(x) \geqslant 6$. Not $f(x) \geqslant 6$. Not $y \geqslant 6$
		3	
10(iii)	$\left[(x-2)^2 + 2 - 2\right]^2 + 2 = 51$ SOI Allow 1 term missing for M mark Or $(x^2 - 4x + 6)^2 - 4(x^2 - 4x + 6) + 6 = 51$	M1A1	ALT. $f(x) = f^{-1}(51)$ (M1)= $\sqrt{51-2} + 2$ (A1)
	$(x-2)^4 = 49$ or $(x^2 - 4x + 4)^2 = 49$ OR $x^4 - 8x^3 + 24x^2 - 32x - 33 = 0$ often implied by next line	A1	$(x-2)^2 + 2 = \sqrt{49} + 2$ OR $f(x) = 9$
	$(x-2)^2 = (\pm)7$ OR $x^2 - 4x - 3 = 0$. Ignore $x^2 - 4x + 11 = 0$	A1	$(x-2)^2 = 7$ OR $x = f^{-1}(9)$
	$x = 2 + \sqrt{7}$ only CAO $x = 2 + \sqrt[4]{49}$ scores 3/5	A1	$x = 2 + \sqrt{7}$
		5	

Question	Answer	Marks	Guidance
11(i)	$\frac{dy}{dx} = 2(x+1) - (x+1)^{-2}$	B1	
	Set = 0 and obtain $2(x+1)^3 = 1$ convincingly www **AG**	B1	
	$\frac{d^2y}{dx^2} = 2 + 2(x+1)^{-3}$ www	B1	
	Sub, e.g., $(x+1)^{-3} = 2$ OE or $x = \left(\frac{1}{2}\right)^{\frac{1}{3}} - 1$	M1	Requires exact method – otherwise scores M0
	$\frac{d^2y}{dx^2} = 6$ CAO www	A1	and exact answer – otherwise scores A0
		5	

Question	Answer	Marks	Guidance
11(ii)	$y^2=(x+1)^4+(x+1)^{-2}+2(x+1)$ SOI	**B1**	OR $y^2=(x^4+4x^3+6x^2+4x+1)+(2x+2)+(x+1)^{-2}$
	$(\pi)\int y^2dx=(\pi)\left[\frac{(x+1)^5}{5}\right]+\left[\frac{(x+1)^{-1}}{-1}\right]+\left[\frac{2(x+1)^2}{2}\right]$ OR $(\pi)\left[\frac{x^5}{5}+x^4+2x^3+2x^2+x\right]+\left[x^2+2x\right]+\left[-\frac{1}{x+1}\right]$	**B1B1B1**	Attempt to integrate y^2. Last term might appear as (x^2+2x)
	$(\pi)\left[\frac{32}{5}-\frac{1}{2}+4-\left(\frac{1}{5}-1+1\right)\right]$	**M1**	Substitute limits $0\to1$ into an attempted integration of y^2. Do not condone omission of value when $x=0$
	9.7π or 30.5	**A1**	Note: omission of $2(x+1)$ in first line → 6.7π scores 3/6 Ignore initially an extra volume, e.g. $(\pi)\int(4½)^2$. Only take into account for the final answer
		6	