Question	Answer	Marks	Guidance
1(i)	$\left[(x-2)^2\right]$ [+4]	B1 DB1	2nd B1 dependent on 2 inside bracket
		2	
1(ii)	$(x-2)^2 < 5 \;\rightarrow\; -\sqrt{5} < x-2$ and/or $x-2 < \sqrt{5}$	M1	Allow e.g. $x-2 < \pm\sqrt{5}$, $x-2 = \pm\sqrt{5}$ and decimal equivalents for √5 For M1, ft from *their*(i). Also allow √13 instead of √5 for clear slip
	$2-\sqrt{5} < x < 2+\sqrt{5}$	A1A1	A1 for each inequality – allow two separate statements but there must be 2 inequalities for *x*. Non-hence methods, if completely correct, score SC 1/3. Condone $\leqslant$
		[3]	

Question	Answer	Marks	Guidance
2(i)	$\frac{-5}{x}+\frac{5}{8x^3}-\frac{1}{32x^5}$ (or $-5x^{-1}+\frac{5}{8}x^{-3}-\frac{1}{32}x^{-5}$)	B1B1B1	B1 for each correct term SCB1 for both $\frac{+5}{x}$ & $\frac{+1}{32x^5}$
		3	
2(ii)	$1\times 20+4\times their(-5)=0$	M1A1	Must be from exactly 2 terms SCB1 for $20+20=40$
		2	

Question	Answer	Marks	Guidance
3(i)	Angle EAD = Angle $ACD = \frac{3\pi}{10}$ or 54° or 0.942 soi **or** Angle $DAC = \frac{\pi}{5}$ or 36° or 0.628 soi	B1	
	$AD = 8\sin(\frac{3\pi}{10})$ **or** $8\cos(\frac{\pi}{5})$	M1	Angles used must be correct
	(AD =) 6.47	A1	
	Alternative method for question 3(i)		
	$AB = \frac{8}{\tan\left(\frac{\pi}{5}\right)}$ or $AB = \frac{8\sin\left(\frac{3\pi}{10}\right)}{\sin\left(\frac{\pi}{5}\right)}$ or $11.(01)$	B1	Angles used must be correct
	$AD = 11.0(1)\sin\frac{\pi}{5}$ **oe**	M1	
	(AD =) 6.47	A1	
		3	
3(ii)	Area sector $= \frac{1}{2}(theirAD)^2 \times their\left(\frac{\pi}{2} - \frac{\pi}{5}\right)$	M1	19.7(4)
	Area $\Delta ADC = \frac{1}{2} \times 8 \times theirAD \times \sin\frac{\pi}{5}$ or $\frac{1}{2} \times 8\cos\left(\frac{3\pi}{10}\right) \times 8\sin\left(\frac{3\pi}{10}\right)$	M1	Or e.g. ½ $theirAD \times \sqrt{8^2 - theirAD^2}$. 15.2(2)
	(Shaded area =) 35.0 or 34.9	A1	
		3	

Question	Answer	Marks	Guidance
4(i)	Max(***a***) is 8	**B1**	Allow $a = 8$ or $a \leqslant 8$
	Min(***b***) is 24	**B1**	Allow $b = 24$ or $b \geqslant 24$
		2	SCB1 for 8 and 24 seen
4(ii)	$\text{gf}(x) = \frac{96}{x-1} - 4$ **or** $\text{gf}(x) = \frac{100-4x}{x-1}$	**B1**	$2\left(\frac{48}{x-1}\right) - 4$ is insufficient Apply ISW
		1	
4(iii)	$y = \frac{96}{x-1} - 4 \rightarrow y + 4 = \frac{96}{x-1} \rightarrow x - 1 = \frac{96}{y+4}$	**M1**	**FT** from *their***(ii)** provided **(ii)** involves algebraic fraction. Allow sign errors
	$(\text{gf})^{-1}(x) = \frac{96}{x+4} + 1$	**A1**	OR $\frac{100+x}{x+4}$. Must be a function of x. Apply ISW
		2	

Question	Answer	Marks	Guidance
5(i)	$\frac{x}{2}\left[2 + (x-1)(-/+0.02)\right]$ or $1.01x - 0.01x^2$ or $0.99x + 0.01x^2$ **oe**	**B1**	Allow – or + 0.02. Allow n used
		1	

Question	Answer	Marks	Guidance
5(ii)	Equate to 13 **then** *either* simplify to a 3-term quadratic equation **or** find at least 1 solution (need not be correct) to an unsimplified quadratic	**M1**	Expect $n^2 - 101n + 1300$ (=0) or $0.99x + 0.01x^2 = 13$. Allow x used
	16	**A1**	Ignore 85.8 or 86
		2	
5(iii)	Use of $\frac{a(1-r^{n})}{1-r}$ with $a = 1$, $r = 0.92$, $n = 20$ soi	**M1**	
	(=) 10.1	**A1**	
	Use of $(S_\infty =)\frac{a}{1-r}$ with $a = 1$, $r = 0.92$	**M1**	OR $\frac{(1)(1-0.92^{n})}{1-0.92} = 13 \rightarrow 0.92^n = -0.04$ oe
	$S_\infty = 12.5$ so never reaches target or < 13	**A1**	Conclusion required – 'Shown' is insufficient No solution so never reaches target or < 13
		4	

Question	Answer	Marks	Guidance
6(i)	**MF** = –4**i** + 2**j** + 7**k**	**B1**	
		1	
6(ii)	**FN** = 2**i** – **j**	**B1**	
		1	
6(iii)	**MN** = –2**i** + **j** + 7**k**	**B1**	**FT** on *their* (**MF** + **FN**)
		1	

Question	Answer	Marks	Guidance
6(iv)	**MF.MN** $= 8 + 2 + 49 = 59$	*M1	**MF.MN** or **FM.NM** but allow if one is reversed (implied by –59)
	$\|\mathbf{MF}\| \times \|\mathbf{MN}\| = \sqrt{4^2 + 2^2 + 7^2} \times \sqrt{2^2 + 1^2 + 7^2}$	*DM1	Product of modulus. At least one methodically correct
	$\cos FMN = \dfrac{+/-59}{\sqrt{69} \times \sqrt{54}}$	DM1	All linked correctly. Note $\sqrt{69} \times \sqrt{54} = 9\sqrt{46}$
	$FMN = 14.9°$ or 0.259	A1	Do not allow if exactly 1 vector is reversed – even if adjusted finally
		4	

Question	Answer	Marks	Guidance
7(i)	$D = (5, 1)$	B1	
		1	
7(ii)	$(x-5)^2 + (y-1)^2 = 20$ **oe**	B1	**FT** on *their D*. Apply ISW, oe but not to contain square roots
		1	

Question	Answer	Marks	Guidance
7(iii)	$(x-1)^2+(y-3)^2=(9-x)^2+(y+1)^2$ **soi**	**M1**	Allow 1 sign slip For M1 allow with √ signs round both sides but sides must be equated
	$x^2-2x+1+y^2-6y+9=x^2-18x+81+y^2+2y+1$	**A1**	
	$y=2x-9$ www **AG**	**A1**	
	Alternative method for question 7(iii)		
	grad. of $AB=-½$ → grad of perp bisector $=\frac{-1}{-½}$	**M1**	
	Equation of perp. bisector is $y-1=2(x-5)$	**A1**	
	$y=2x-9$ www **AG**	**A1**	
		3	
7(iv)	Eliminate y (or x) using equations in **(ii)** and **(iii)**	***M1**	To give an (unsimplified) quadratic equation
	$5x^2-50x+105$ (= 0) **or** $5(x-5)^2=20$ **or** $5y^2-10y-75$ (= 0) **or** $5(y-1)^2=80$	**DM1**	Simplify to one of the forms shown on the right (allow arithmetic slips)
	$x=3$ and 7, **or** $y=-3$ and 5	**A1**	
	(3, –3), (7, 5)	**A1**	Both pairs of x & y correct implies A1A1. SC B2 for no working
		4	

Question	Answer	Marks	Guidance
8	$f'(-1)=0 \to 3-a+b=0 \quad f'(3)=0 \to 27+3a+b=0$	M1	Stationary points at $x=-1$ & $x=3$ gives sim. equations in a & b
	$a=-6$	A1	Solve simultaneous equation
	$b=-9$	A1	
	Hence $f'(x)=3x^2-6x-9 \to f(x)=x^3-3x^2-9x(+c)$	B1	**FT** correct integration for *their* a,b (numerical a, b)
	$2=-1-3+9+c$	M1	Sub $x=-1$, $y=2$ into *their* integrated f(x). c must be present
	$c=-3$	A1	**FT** from *their* f(x)
	$f(3)=k \to k=27-27-27-3$	M1	Sub $x=3$, $y=k$ into *their* integrated f(x) (Allow c omitted)
	$k=-30$	A1	
		8	

Question	Answer	Marks	Guidance
9(i)	$q \leqslant f(x) \leqslant p+q$	B1B1	B1 each inequality – allow two separate statements Accept $<$, $(q, p+q)$, $[q, p+q]$ Condone y or x or f in place of f(x)
		2	

Question	Answer	Marks	Guidance
9(ii)	**(a)** 2	B1	Allow $\frac{\pi}{4}, \frac{3\pi}{4}$
	(b) 3	B1	Allow $0, \frac{\pi}{2}, \pi$
	(c) 4	B1	Allow $\frac{\pi}{8}, \frac{3\pi}{8}, \frac{5\pi}{8}, \frac{7\pi}{8}$
		3	
9(iii)	$3\sin^2 2x + 2 = 4 \rightarrow \sin^2 2x = \frac{2}{3}$ soi	M1	
	Sin2x = (±)0.816(5). Allow $\sin 2x = (\pm)\sqrt{\frac{2}{3}}$ or $2x = \sin^{-1}(\pm)\sqrt{\frac{2}{3}}$	A1	OR Implied by at least one correct value for x. Allow $\sin^{-1}$ form
	($2x$ =) **at least two** of 0.955(3), 2.18(6), 4.09(7) , 5.32(8)	A1	Can be implied by corresponding values of x below Allow for at least two of 0.304π, 0.696π, 1.30(4)π, 1.69(6)π **OR** at least <u>two</u> of 54.7(4)°, 125.2(6)°, 234.7(4)°, 305.2(6)°
	(x =) 0.478, 1.09, 2.05, 2.66.	A1A1	Allow 0.152π, 0.348π, 0.652π, 0.848π SC A1 for 2 or 3 correct. SC A1 for all of 27.4º, 62.6º, 117.4º, 152.6º $\text{Sin}2x = \pm\frac{2}{3} \rightarrow x = 0.365, 1.21, 1.94, 2.78$ scores SC M1A0A0A1
		5	

Question	Answer	Marks	Guidance
10(i)	$\left[\frac{1}{2}(3x+4)^{-\frac{1}{2}}\right]$	**B1**	oe
	$\frac{dy}{dx} = \left[\frac{1}{2}(3x+4)^{-\frac{1}{2}}\right] \times 3$	**B1**	Must have '×3'
	At $x = 4$, $\frac{dy}{dx} = \frac{3}{8}$ soi	**B1**	
	Line through (4, *their*4) with gradient *their* $\frac{3}{8}$	**M1**	If $y \neq 4$ is used then clear evidence of substitution of $x = 4$ is needed
	Equation of tangent is $y - 4 = \frac{3}{8}(x-4)$ or $y = \frac{3}{8}x + \frac{5}{2}$	**A1**	oe
		5	

Question	Answer	Marks	Guidance
10(ii)	Area under line $=\frac{1}{2}\left(4+\frac{5}{2}\right)\times 4=13$	B1	OR $\int_0^4 \frac{3}{8}x+\frac{5}{2}=\left[\frac{3}{16}x^2+\frac{5}{2}x\right]=\left[3+10\right]=13$
	Area under curve: $\int(3x+4)^{\frac{1}{2}}=\left[\frac{(3x+4)^{3/2}}{3/2}\right][\div 3]$	B1B1	Allow if seen as part of the difference of 2 integrals First B1 for integral without $[\div 3]$ Second B1 must have $[\div 3]$
	$\frac{128}{9}-\frac{16}{9}=\frac{112}{9}=12\frac{4}{9}$	M1	Apply limits $0\to 4$ to an integrated expression
	Area $=13-12\frac{4}{9}=\frac{5}{9}$ (or 0.556)	A1	
	Alternative method for question 10(ii)		
	Area for line $=1/2\times 4\times 3/2=3$	B1	OR $\int_{5/2}^4 \frac{1}{3}(8y-20)=\frac{1}{3}\left[4y^2-20\right]=\frac{1}{3}\left[-16+25\right]=3$
	Area for curve $=\int \frac{1}{3}(y^2-4)=\left[\frac{y^3}{9}\right]-\left[\frac{4y}{3}\right]$	B1B1	
	$\left(\frac{64}{9}-\frac{16}{3}\right)-\left(\frac{8}{9}-\frac{8}{3}\right)=\frac{32}{9}$	M1	Apply limits $2\to 4$ to an integrated expression for curve
	Area $=\frac{32}{9}-3=\frac{5}{9}$ (or 0.556)	A1	
		5	

Question	Answer	Marks	Guidance
10(iii)	$\frac{dy}{dx} = \frac{1}{2}$	B1	
	$\frac{3}{2}(3x+4)^{-\frac{1}{2}} = \frac{1}{2}$	M1	Allow M1 for $\frac{3}{2}(3x+4)^{-\frac{1}{2}} = 2$.
	$(3x+4)^{\frac{1}{2}} = 3 \rightarrow 3x+4=9 \rightarrow x = \mathbf{\frac{5}{3}}$ oe	A1	
		3	