Question	Answer	Marks	Partial Marks
1	$\frac{\sin\theta}{\cos\theta}+\frac{\cos\theta}{\sin\theta}$	**M1**	
	$\frac{\sin^2\theta+\cos^2\theta}{\cos\theta\sin\theta}$	**A1**	
	$\frac{1}{\cos\theta\sin\theta}$ oe **and** completion to given answer $\sec\theta\operatorname{cosec}\theta$	**A1**	
	Alternative		
	$\left[\tan\theta+\frac{1}{\tan\theta}=\right]=\frac{\tan^2+1}{\tan\theta}$	**(M1)**	
	$\frac{\sec^2\theta}{\tan\theta}$	**(A1)**	
	$\frac{\sec^2\theta\cos\theta}{\sin\theta}$ oe **and** completion to given answer $\sec\theta\operatorname{cosec}\theta$	**(A1)**	
2(a)	$\left[\frac{dy}{dx}=\right]$ $\tan^2 x$ nfww	**B2**	**B1** for $\sec^2 x-1$
2(b)	$[\tan x-x]_0^{\frac{\pi}{4}}$	**M1**	
	$1-\frac{\pi}{4}$ or exact equivalent	**A1**	
3(a)	$\left(8^{\frac{1}{x}}\right)^2-8^{\frac{1}{x}}-2\ [=0]$ oe or $\left(2^{\frac{3}{x}}\right)^2-2^{\frac{3}{x}}-2\ [=0]$ oe	**B1**	
	$(8^{\frac{1}{x}}-2)(8^{\frac{1}{x}}+1)=0$ oe or $(2^{\frac{3}{x}}-2)(2^{\frac{3}{x}}+1)=0$ oe	**M1**	**FT** *their* 3-term quadratic in $8^{\frac{1}{x}}$ oe
	$8^{\frac{1}{x}}=2\ \left[8^{\frac{1}{x}}=-1\right]$ or $2^{\frac{3}{x}}=2\ \left[2^{\frac{3}{x}}=-1\right]$ oe	**A1**	
	$x=3$ nfww	**A1**	

Question	Answer	Marks	Partial Marks
3(b)	$a^2 - 2\sqrt{3}a + 3$ [= $b + (3 - b)\sqrt{3}$]	**B1**	
	Equates coefficients to form two equations	**M1**	**FT** *their*($a^2 - 2\sqrt{3}a + 3$) = $b + (3 - b)\sqrt{3}$ providing of equivalent difficulty
	$a^2 + 3 = b$ and $-2a = 3 - b$ oe	**DM1**	**FT** *their*($a^2 - 2\sqrt{3}a + 3$) = $b + (3 - b)\sqrt{3}$
	$a^2 - 2a$ [= 0] or $b^2 - 10b + 21$ [= 0]	**DM1**	
	$a = 2, 0$ or $b = 3$ or 7	**A1**	
	$a = 2, b = 7$ **and** $a = 0, b = 3$	**A1**	
4	$\mathbf{b} - \mathbf{a} = \dfrac{p}{p+q}(\mathbf{c} - \mathbf{a})$ oe AND Correct completion to given answer $\mathbf{b} = \dfrac{q\mathbf{a} + p\,\mathbf{c}}{q + p}$	**5**	**B4** for $\mathbf{b} - \mathbf{a} = \dfrac{p}{p+q}(\mathbf{c} - \mathbf{a})$ OR **B1** for $\overrightarrow{AB} = \dfrac{p}{p+q}\overrightarrow{AC}$ soi **B1** for $\overrightarrow{AB} = \mathbf{b} - \mathbf{a}$ soi **B1** for $\overrightarrow{AC} = \mathbf{c} - \mathbf{a}$ soi
	Alternative 1		
	$q(\mathbf{b} - \mathbf{a}) = p(\mathbf{c} - \mathbf{b})$ oe AND Correct completion to given answer $\mathbf{b} = \dfrac{q\mathbf{a} + p\,\mathbf{c}}{q + p}$	**(5)**	**B4** for $q(\mathbf{b} - \mathbf{a}) = p(\mathbf{c} - \mathbf{b})$ OR **B1** for $q\overrightarrow{AB} = p\overrightarrow{BC}$ soi **B1** for $\overrightarrow{AB} = \mathbf{b} - \mathbf{a}$ soi **B1** for $\overrightarrow{BC} = \mathbf{c} - \mathbf{b}$ soi
	Alternative 2		
	$\mathbf{b} = \mathbf{a} + \dfrac{p}{p+q}(\mathbf{c} - \mathbf{a})$ oe or $\mathbf{b} = \mathbf{c} + \dfrac{q}{p+q}(\mathbf{a} - \mathbf{c})$ oe AND Correct completion to given answer $\mathbf{b} = \dfrac{q\mathbf{a} + p\,\mathbf{c}}{q + p}$	**(5)**	**B4** for $\mathbf{b} = \mathbf{a} + \dfrac{p}{p+q}(\mathbf{c} - \mathbf{a})$ oe or $\mathbf{b} = \mathbf{c} + \dfrac{q}{p+q}(\mathbf{a} - \mathbf{c})$ oe OR **B1** for $\overrightarrow{OB} = \overrightarrow{OA} + \overrightarrow{AB}$ or $\overrightarrow{OB} = \overrightarrow{OC} + \overrightarrow{CB}$ soi **B1** for $\overrightarrow{AB} = \dfrac{p}{p+q}\overrightarrow{AC}$ or $\overrightarrow{CB} = \dfrac{q}{p+q}\overrightarrow{CA}$ soi **B1** for $\overrightarrow{AC} = \mathbf{c} - \mathbf{a}$ **or** $\overrightarrow{CA} = \mathbf{a} - \mathbf{c}$ soi

Question	Answer	Marks	Partial Marks
5	$\log_a\left(\frac{5(p+1)p}{p+2}\right) = \log_a 12$ oe, nfww or $\frac{5(p+1)p}{p+2} = 12$ oe, nfww	**M2**	**M1** for correct use of one log law in a correct equation e.g. $\log_a(p+1)+\log_a p-\log_a(p+2)$ $+\log_a 5=\log_a 12$ or $\log_a p(p+1)-\log_a(p+2)$ $=\log_a 12-\log_a 5$ or $\log_a \frac{p+1}{p+2}+\frac{1}{\log_p a}$ $+\log_a 5=\log_a 12$
	$5p^2 - 7p - 24 = 0$	**A1**	
	$(5p + 8)(p - 3) = 0$ or formula	**DM1**	**FT** *their* 3-term quadratic
	$p = 3$ and no other solution nfww	**A1**	
6(a)	OA: $2\sqrt{3}$ or $\sqrt{12}$ soi	**B1**	
	Correct method to find angle AOE e.g. $2\tan(\ldots) = \frac{3}{\sqrt{3}}$ oe or $36 = 12 + 12 - 2(12)\cos AOE$ oe or $\pi - 2\tan^{-1}\frac{\sqrt{3}}{3}$ oe	**M1**	
	Angle AOE: $\frac{2\pi}{3}$ soi, isw	**A1**	
	Arc AFE: *their* $2\sqrt{3}$ × *their* $\frac{2\pi}{3}$ soi or $\frac{4\sqrt{3}}{3}\pi$	**M1**	**FT** *their* $\frac{2\pi}{3}$ and *their* $2\sqrt{3}$
	Perimeter: $10 + 2\sqrt{3} + \frac{4\sqrt{3}}{3}\pi$ or exact equivalent, cao	**A1**	

Question	Answer	Marks	Partial Marks
6(b)	Sum of three correct areas $4\pi + 12 + 3\sqrt{3}$ cao	3	**M2 FT** *their* $\frac{2\pi}{3}$ and *their* $2\sqrt{3}$ for sector *AOE*: $\frac{1}{2} \times (their\ 2\sqrt{3})^2 \times their\ \frac{2\pi}{3}$ oe or 4π **and** $\frac{1}{2}\times 6\times 4$ or $2\times\frac{1}{2}\times 3\times\sqrt{3}$ oe or **M1 FT** *their* $\frac{2\pi}{3}$ and *their* $2\sqrt{3}$ for sector *AOE*: $\frac{1}{2} \times (their\ 2\sqrt{3})^2 \times their\ \frac{2\pi}{3}$ oe or 4π
7	Attempts product rule	**M1**	
	$\frac{dy}{dx} = 2\cos x - 2x\sin x$ oe	**A1**	
	When $x = \pi$, $\frac{dy}{dx} = -2$	**DM1**	**FT** *their* $\left.\frac{dy}{dx}\right\|_{x=\pi}$
	Gradient of normal: $\frac{1}{2}$	**M1**	**FT** $\frac{-1}{their\ \left.\frac{dy}{dx}\right\|_{x=\pi}}$
	$y + 2\pi = \frac{1}{2}(x - \pi)$ oe	**A1**	**FT** *their* normal gradient
	$(5\pi, 0)$ or $(0, -\frac{5}{2}\pi)$ oe, soi	**A1**	
	Area of triangle *POQ*: $\frac{25}{4}\pi^2$ nfww	**A1**	
8(a)	$3t^2 + 2t - 1$	**B1**	
	$(3t - 1)(t + 1)$	**M1**	**FT** *their* 3-term quadratic in $t = 0$ soi
	$t = \frac{1}{3}$ and no other solutions	**A1**	
8(b)	At $t = 0$, $x = 8$ and $v = -1$	**B2**	**B1** for $t = 0$, $x = 8$ or $t = 0$, $v = -1$
	Conclusion: Since x is positive and v is negative [the particle is moving towards *O*.]	**B1**	

Question	Answer	Marks	Partial Marks
8(c)	$t = \frac{1}{3}$ $x = \frac{211}{27}$ or 7.814[814…] rot to 4 or more sf	**B1**	
	Distance $t = 0$ to $t = \frac{1}{3}$: $8 - \frac{211}{27}$ or $\frac{5}{27}$ or 0.1851[85…] rot to 4 or more sf **and** Distance $t = \frac{1}{3}$ to $t = 2$: $18 - \frac{211}{27}$ or $\frac{275}{27}$ or 10.18[51…] rot to 4 or more sf	**M2**	**M1** for distance $t = 0$ to $t = \frac{1}{3}$: $8 - \frac{211}{27}$ or $\frac{5}{27}$ or 0.1851[85…] rot to 4 or more sf or $t = \frac{1}{3}$ to $t = 2$: $18 - \frac{211}{27}$ or $\frac{275}{27}$ or 10.18[51…] rot to 4 or more sf
	Total: 10.4 or 10.37[037…] rot to 4 or more sf	**A1**	
9(a)(i)	$c = 12$	**B1**	
9(a)(ii)	$\frac{dy}{dx} = 2x - 8 = 0$ or $x^2 - 8x + c = (x - 4)^2 - 16 + c$	**M1**	
	$3 = -16 + c$ or $3 = 4^2 - 8\times4 + c$	**DM1**	
	$c = 19$	**A1**	
9(b)	$c > 16$	**B2**	**B1** for c * 16 where * is = or an incorrect inequality sign
10(a)	${}^7C_3 \times {}^8C_3 + {}^7C_4 \times {}^8C_2$	**M2**	**M1** for ${}^7C_3 \times {}^8C_3$ or ${}^7C_4 \times {}^8C_2$
	2940	**A1**	
10(b)	${}^6P_4 \times 3 \times 5$ oe	**M2**	**M1** for ${}^6P_4 [\times 1]$ or ${}^6P_4 \times 3$ or ${}^6P_4 \times 5$ oe
	5400	**A1**	
11(a)(i)	Valid explanation e.g. The line $x = k$, where $-10 \leqslant k \leqslant 10$ cuts the curve in one point only	**B1**	
11(a)(ii)	$\dfrac{\frac{x}{x-1}}{\frac{x}{x-1} - 1}$	**M1**	
	Correct simplification to x	**A1**	

Question	Answer	Marks	Partial Marks
11(a)(iii)	Valid explanation e.g. f and f^{-1} are the same or f is self-inverse oe	**B1**	
11(a)(iv)	Valid explanation e.g. The curve is symmetrical about line $y = x$	**B1**	
11(b)	$1 < g \leqslant 2$	**B1**	
11(c)	$x \neq -\frac{1}{3}$	**B1**	
12(a)	$d_A = 3$ and $d_B = -3$	**B2**	**B1** for $d_A = 3$ or $d_B = -3$
	$a_n = 1 + (n - 1)\times 3$ oe, isw or $a_n = 3n - 2$	**B1**	
	$b_n = 298 + (n - 1)\times(-3)$ oe, isw or $b_n = -3n + 301$	**B1**	
	Solves $3n - 2 - (-3n + 301) = 45$ oe to find a value of n	**M1**	**FT** *their* $a_n - (-3n + 301)$ or $3n - 2 -$*their* b_n
	$n = 58$	**A1**	
12(b)	$3m - 2 * 2(-3m + 301)$ oe where * is = or any inequality sign	**M1**	**FT** *their* a_n and *their* b_n from part **(a)**
	$m * 67.1[11…]$ where * is = or any inequality sign	**A1**	
	68	**A1**	

