Mark Scheme 4723
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1	**(i)**	State $f(x) \le 10$	B1	**1** [Any equiv but must be or imply $\le$]
	(ii)	Attempt correct process for composition of functions	M1	[whether algebraic or numerical]
		Obtain 6 or correct expression for $ff(x)$	A1	
		Obtain -71	A1	**3**
2		Either Obtain $x = 0$	B1	[ignoring errors in working]
		Form linear equation with signs of $6x$ and x different	M1	[ignoring other sign errors]
		State $6x - 1 = -x + 1$	A1	[or correct equiv with or without brackets]
		Obtain $\frac{2}{7}$ and no other non-zero value	A1	**4** [or exact equiv]
	Or	Obtain $36x^2 - 12x + 1 = x^2 - 2x + 1$	B1	[or equiv]
		Attempt to solve quadratic equation	M1	[as far as factorisation or subn into formula]
		Obtain $\frac{2}{7}$ and no other non-zero value	A1	[or exact equiv]
		Obtain 0	B1	**(4)** [ignoring errors in working]
3	**(i)**	Attempt solution involving (natural) logarithm	M1	
		Obtain $-0.017t = \ln\frac{25}{180}$	A1	[or equiv]
		Obtain 116	A1	**3** [or greater accuracy rounding to 116]
	(ii)	Differentiate to obtain $k\,e^{-0.017t}$	M1	[any constant k different from 180; solution must involve differentiation]
		Obtain correct $-3.06e^{-0.017t}$	A1	[or unsimplified equiv; accept + or –]
		Obtain 1.2	A1	**3** [or greater accuracy; accept + or – answer]
4	**(a)**	State or imply $\int \pi\, y^2\, dx$	B1	
		Integrate to obtain $k \ln x$	M1	[any constant k, involving π or not; or equiv such as $k \ln 4x$]
		Obtain $4\pi \ln x$ or $4 \ln x$	A1	[or equiv]
		Obtain $4\pi \ln 5$	A1	**4** [or similarly simplified equiv]

	(b)	Attempt calculation involving attempts at y values	**M1**	[with each of 1, 4, 2 present at least once as coefficients]
		Attempt $\frac{1}{3} \times 1(y_0 + 4y_1 + 2y_2 + 4y_3 + y_4)$	**M1**	[with attempts at five y values]
		Obtain $\frac{1}{3}(\sqrt{2} + 4\sqrt{5} + 2\sqrt{10} + 4\sqrt{17} + \sqrt{26})$	**A1**	[or exact equiv or decimal equivs]
		Obtain 12.758	**A1**	**4** [or greater accuracy]
5	**(i)**	Obtain $R = \sqrt{13}$, or 3.6 or 3.61 or greater accuracy	**B1**	
		Attempt recognisable process for finding α	**M1**	[allow sine/cosine muddles]
		Obtain $\alpha = 33.7$	**A1**	**3** [or greater accuracy]
	(ii)	Attempt to find at least one value of $\theta + \alpha$	***M1**	
		Obtain value rounding to 76 or 104	**A1√**	[following their R]
		Subtract their α from at least one value	**M1**	[dependent on ***M**]
		Obtain one value rounding to 42 or 43, or to 70	**A1**	
		Obtain other value 42.4 or 70.2	**A1**	**5** [or greater accuracy; no other answers between 0 and 360; ignore answers outside 0 to 360]
6	**(a)**	Attempt use of product rule	***M1**	
		Obtain $\ln x + 1$	**A1**	[or unsimplified equiv]
		Equate attempt at first derivative to zero and obtain value involving e	**M1**	[dependent on ***M**]
		Obtain e^{-1}	**A1**	**4** [or exact equiv]
	(b)	Attempt use of quotient rule	**M1**	[or equiv using product rule or …]
		Obtain $\frac{(4x-c)4 - 4(4x+c)}{(4x-c)^2}$	**A1**	[or equiv]
		Show that first derivative cannot be zero	**A1**	**3** [**AG**; derivative must be correct]
7	**(i)**	State $2\cos^2 x - 1$	**B1**	**1**
	(ii)	Attempt to express left hand side in terms of $\cos x$	**M1**	[using expression of form $a\cos^2 x + b$]
		Identify $\frac{1}{\cos x}$ as $\sec x$	**M1**	[maybe implied]

		Confirm result	A1	**3** [**AG**; necessary detail required]
	(iii)	Use identity $\sec^2 x = 1 + \tan^2 x$	B1	
		Attempt solution of quadratic equation in tan x	M1	[or equiv]
		Obtain $2\tan^2 x + 3\tan x - 9 = 0$ and hence tan x = –3, $\frac{3}{2}$	A1	
		Obtain at least two of 0.983, 4.12, 1.89, 5.03 (or of 0.313π, 1.31π, 0.602π, 1.60π)	A1	[allow answers with only 2 s.f.; allow greater accuracy; allow 0.983 + π, 1.89 + π allow degrees: 56, 236, 108, 288]
		Obtain all four solutions	A1	**5** [now with at least 3 s.f.; must be radians; no other solutions in the range 0 - 2π; ignore solutions outside range 0 - 2π]
8	**(i)**	Attempt relevant calculations with 5.2 and 5.3	M1	
		Obtain correct values	A1	x y_1 y_2 $y_1 - y_2$ 5.2 2.83 2.87 – 0.04 5.3 2.89 2.88 0.006
		Conclude appropriately	A1	**3** [**AG**; comparing y values or noting sign change in difference in y values or equiv]
	(ii)	Equate expressions and attempt rearrangement to x =	M1	
		Obtain $x = \frac{5}{3}\ln(3x+8)$	A1	**2** [**AG**; necessary detail required]
	(iii)	Obtain correct first iterate	B1	
		Carry out correct process to find at least two iterates in all	M1	
		Obtain 5.29	A1	**3** [must be exactly 2 decimal places; 5.2→5.2687→5.2832→5.2863→5.2869; 5.25→5.2793→5.2855→5.2868→5.2870; 5.3→5.2898→5.2877→5.2872→5.2871]
	(iv)	Obtain integral of form $k(3x+8)^{\frac{4}{3}}$	M1	
		Obtain integral of form $k\,\mathrm{e}^{\frac{1}{5}x}$	M1	

		Obtain $\frac{1}{4}(3x+8)^{\frac{4}{3}} - 5e^{\frac{1}{5}x}$	A1	[or equiv]
		Apply limits 0 and their answer to **(iii)**	M1	[applied to difference of two integrals]
		Obtain 3.78	A1	**5** [or greater accuracy]
9	**(i)**	Indicate stretch and (at least one) translation	M1	[… in general terms]
		State translation by 7 units in negative x direction	A1	[or equiv; using correct terminology]
		State stretch in x direction with factor $1/m$	A1	[must follow the translation by 7; or equiv; using correct terminology]
		Indicate translation by 4 units in negative y direction	B1	**4** [or equiv; at any stage; the two translations may be combined]
	(ii)	Refer to each y value being image of unique x value	B1	[or equiv]
		Attempt correct process for finding inverse	M1	
		Obtain expression involving $(x+4)^2$ or $(y+4)^2$	M1	
		Obtain $\frac{(x+4)^2-7}{m}$	A1	**4** [or equiv]
	(iii)	Refer to fact that curves are reflections of each other in line $y = x$	B1	[or equiv]
		Attempt arrangement of either $f(x) = x$ or $f^{-1}(x) = x$	M1	
		Apply discriminant to resulting quadratic equati on	M1	
		Obtain $(m-2)(m-14) < 0$	A1	[or equiv]
		Obtain $2 < m < 14$	A1	**5**