Question Number	Scheme	Marks
4(a)	$y = 4x^{\frac{1}{2}} + 9x^{-\frac{1}{2}} + 3$ $\Rightarrow \left(\frac{dy}{dx} =\right) 2x^{-\frac{1}{2}} - \frac{9}{2}x^{-\frac{3}{2}}$	M1A1
		(2)
(b)	$\frac{dy}{dx} = 0 \Rightarrow 2x^{-\frac{1}{2}} - \frac{9}{2}x^{-\frac{3}{2}} = 0 \Rightarrow 4x - 9 = 0 \Rightarrow x = ...$	M1
	$x = \frac{9}{4}$ oe e.g. 2.25	A1
		(2)

4(c)(i)	$\left(\frac{d^2y}{dx^2} =\right) -x^{-\frac{3}{2}} + \frac{27}{4}x^{-\frac{5}{2}}$ oe e.g. $-x^{-\frac{3}{2}} + 6.75x^{-\frac{5}{2}}$	B1ft
(ii)	$\left(\left(\frac{d^2y}{dx^2}\right)_{x=\frac{9}{4}} =\right) -\left(\frac{9}{4}\right)^{-\frac{3}{2}} + \frac{27}{4}\left(\frac{9}{4}\right)^{-\frac{5}{2}} \left(= \frac{16}{27}(0.5925...)\right)$ $\left(\frac{d^2y}{dx^2}\right) > 0$ so (local) minimum	B1
		(2)
(d)	$0 < x < \frac{9}{4}$	B1ft
		(1)
		Total 7

Question Number	Scheme		Marks
	OPEN TOPPED	**CLOSED CONTAINER**	
3.(a)	$120 = 3x^2y \Rightarrow y = \frac{40}{x^2}$	$120 = 3x^2y \Rightarrow y = \frac{40}{x^2}$	M1, A1
	$A = 3x^2 + 8xy$ $= 3x^2 + 8x \times \frac{40}{x^2} = 3x^2 + \frac{320}{x}$	$A = 6x^2 + 8xy$ $= 6x^2 + 8x \times \frac{40}{x^2} = 6x^2 + \frac{320}{x}$	dM1, A1
			(4)
(b)	$\frac{dA}{dx} = 6x - \frac{320}{x^2}$	$\frac{dA}{dx} = 12x - \frac{320}{x^2}$	M1, A1ft
	$\frac{dA}{dx} = 6x - \frac{320}{x^2} = 0$ $\Rightarrow x^3 = \frac{160}{3} \Rightarrow x =$ awrt 3.76	$\frac{dA}{dx} = 12x - \frac{320}{x^2} = 0$ $\Rightarrow x^3 = \frac{80}{3} \Rightarrow x =$ awrt 2.99	dM1, A1
			(4)
(c)	Attempts $\left.\frac{d^2A}{dx^2}\right\vert_{x=3.76} = 6 + \frac{640}{x^3}$ $= 6 + \frac{640}{3.76^3} = ..$	Attempts $\left.\frac{d^2A}{dx^2}\right\vert_{x=2.99} = 12 + \frac{640}{x^3}$ $= 12 + \frac{640}{2.99^3} = ..$	M1
	$\left.\frac{d^2A}{dx^2}\right\vert_{x=3.76} =$ awrt $18 > 0$ MINIMUM*	$\left.\frac{d^2A}{dx^2}\right\vert_{x=2.99} =$ awrt $36 > 0$ MINIMUM*	A1*
			(2) **(10 marks)**

Question Number	Scheme	Marks
6 (i) (a)	Uses $\sin^2\theta+\cos^2\theta=1$ with $\cos\theta=\frac{1}{\sqrt{5}}\Rightarrow\sin^2\theta=\frac{4}{5}$	M1
	$\Rightarrow\sin\theta=-\frac{2}{\sqrt{5}}$	A1
(b)	Uses $\tan\theta=\frac{\sin\theta}{\cos\theta}$ with $\cos\theta=\frac{1}{\sqrt{5}}$ and their $\sin\theta=-\frac{2}{\sqrt{5}}$	M1
	$\Rightarrow\tan\theta=-2$	A1
		(4)
(ii) (a)	1 (m)	B1
		(1)
(b)	$30t-40=180\Rightarrow t=7.33$ Hence 7:20 **am**	M1, A1, A1
		(3)
(c)	$4+3\cos(30T-40)°=3.5\Rightarrow\cos(30T-40)°=-\frac{1}{6}$	M1
	$\Rightarrow 30T-40=99.6,\ 260.4,\ \underline{\underline{459.6}}$	A1
	$\Rightarrow T=\frac{"459.6"+40}{30}=16.65$	dM1, A1
		(4)
		(12 marks)

Question Number	Scheme	Marks
3(a)	Attempts $(8-3)^2+(5--7)^2=...$	M1
	Writes $(x-3)^2+(y-5)^2=k$	M1
	$(x-3)^2+(y-5)^2=169$	A1
		(3)
(b)	Attempts $d^2+\left(2\sqrt{22}\right)^2=169\Rightarrow d=...$	M1
	States or uses $(y=)\ 5+d$	dM1
	$y=14$	A1
		(3)
		(6 marks)

Question Number	Scheme	Marks
6(a)	$\dfrac{3\sin\theta\cos\theta}{2\sin\theta-1}=5\tan\theta \Rightarrow \dfrac{3\sin\theta\cos\theta}{2\sin\theta-1}=5\dfrac{\sin\theta}{\cos\theta}$	M1
	$\dfrac{3\sin\theta\cos\theta}{2\sin\theta-1}=5\dfrac{\sin\theta}{\cos\theta}\Rightarrow 3\sin\theta\cos^2\theta=5\sin\theta(2\sin\theta-1)$	M1
	$3\sin\theta\cos^2\theta=10\sin^2\theta-5\sin\theta\Rightarrow 3\sin\theta(1-\sin^2\theta)=10\sin^2\theta-5\sin\theta$ *	M1
	$\Rightarrow 3\sin^3\theta+10\sin^2\theta-8\sin\theta=0$	A1*
		(4)
(b)	$3\sin^3 2x+10\sin^2 2x-8\sin 2x=0\Rightarrow \sin 2x(3\sin^2 2x+10\sin 2x-8)=0$ $(3\sin 2x-2)(\sin 2x+4)=0\Rightarrow \sin 2x=...$	M1
	$\sin 2x=\dfrac{2}{3}$	A1
	$(x=)0.365$	A1
	$x=0$	B1
		(4)
		(8 marks)

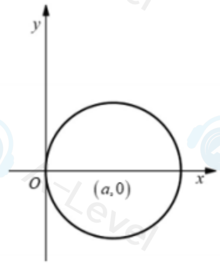
Question	Answer	Marks	Guidance
8(a)	Use $\sin 2\theta=2\sin\theta\cos\theta$ and $\sec\theta=\dfrac{1}{\cos\theta}$ to obtain $6\sin\theta$	**B1**	
	Expand second term to obtain $5\sqrt{3}\cos\theta+5\sin\theta$	**B1**	
	Simplify to obtain $11\sin\theta+5\sqrt{3}\cos\theta$	**B1**	
	State $R=14$	**B1 FT**	FT *their* $k_1\cos\theta+k_2\sin\theta$
	Use appropriate trigonometry to find α	**M1**	
	Obtain $\alpha=38.21$	**A1**	AWRT
		6	
8(b)	State or imply $14\sin(2\beta+38.21)=2$	**B1 FT**	FT *their* R and α
	Carry out correct process to find value of β between 0° and 90°	**M1**	
	Obtain 66.8	**A1**	AWRT
		3	

Question	Answer	Marks	Guidance
5(a)	Carry out division at least as far as $x^2 + kx$ or equivalent …	M1	OE, e.g. comparing coefficients with coefficient of x^2 equal to 1 and attempt at a second coefficient.
	Obtain quotient $x^2 + 4x + 12$	A1	
	Confirm remainder is 7	A1	AG
		3	
5(b)	Include $(x-2)^2$ as a factor	M1	Must be a product of factors only **SC B1** for $(x^2-4x+4)(x^2+4x+12)$
	Conclude $(x-2)^2(x^2+4x+12)$	A1	isw any attempt to factorise the quotient.
		2	
5(c)	Apply logarithms and use power law for $e^{-3y} = k$ where $k > 0$	M1	
	Obtain $y = -\frac{1}{3}\ln 2,\ \frac{1}{3}\ln\frac{1}{2}$	A1	Or exact equivalent Must be simplified e.g. not lne or $\frac{6}{3}$ ISW extra solutions but A0 if undefined solutions are included.
		2	

Question Number	Scheme	Marks
	$\mathrm{f}(x) = (3x^2-4x-5)(x-k)-5$	
3 (a)	States -5	B1
		(1)
(b)	Sets $\mathrm{f}(-2) = 25 \rightarrow (3\times4-4\times-2-5)(-2-k)-5 = 25$	M1
	$15(-2-k) = 30 \Rightarrow -2-k = 2 \Rightarrow k = -4$ *	A1*
		(2)
(c)	$(3x^2-4x-5)(x+4)-5 = 3x^3+8x^2-21x-25$	B1
	Attempts $3x-1\overline{)3x^3+8x^2-21x-25}$ to achieve quotient of $\ldots x^2 + \ldots x + \ldots$ and a remainder that is a constant	M1
	Quotient = x^2+3x-6 OR Remainder = -31	A1ft
	Quotient = x^2+3x-6 AND Remainder = -31	A1
		(4)
		(7 marks)

Question Number	Scheme	Marks
	$y=x^3-4x^{\frac{5}{2}}-kx^{\frac{1}{2}}+28x-44$	
7.(a)	$y=x^3-4x^{\frac{5}{2}}-kx^{\frac{1}{2}}+28x-44 \Rightarrow \left(\frac{dy}{dx}\right)=3x^2-10x^{\frac{3}{2}}-\frac{k}{2}x^{-\frac{1}{2}}+28$	M1, A1
		(2)
(b)	Subs $x=9$ into $\frac{dy}{dx}$ and sets = 0 $\Rightarrow 3\times81-10\times27-\frac{k}{6}+28=0$	M1
	$243-270-\frac{k}{6}+28=0 \Rightarrow \frac{k}{6}=1 \Rightarrow k=6$ *	A1*
		(2)
(c)	$\int x^3-4x^{\frac{5}{2}}-6x^{\frac{1}{2}}+28x-44\,dx=\frac{1}{4}x^4-\frac{8}{7}x^{\frac{7}{2}}-4x^{\frac{3}{2}}+14x^2-44x$	M1, A1, A1
	Correct value of $y=-53$ at T	B1
	Shaded area = $"53"\times9+\left[\frac{1}{4}x^4-\frac{8}{7}x^{\frac{7}{2}}-4x^{\frac{3}{2}}+14x^2-44x\right]_0^9$	dM1
	$=248$	A1
		(6)
		(10 marks)

Question Number	Scheme	Marks
9(a)	(0, 5)	B1
		(1)
(b)	$x^2-4x+5=2 \Rightarrow x^2-4x+3=0$ $\Rightarrow x=...$	M1
	$x(E)=1,\ x(F)=3$	A1
		(2)
(c)	Area $R_1 = \int_0^1 (x^2-4x+5-2)\,dx = \left[\frac{x^3}{3}-2x^2+3x\right]_0^1 = \frac{1}{3}-2+3-0=\frac{4}{3}$	M1A1
	Area $R_2 = \frac{1}{2}\times3\times3-"\frac{4}{3}"=\frac{19}{6}$ or $\int_0^1 \left(5-x-\left(x^2-4x+5\right)\right)dx+\frac{1}{2}\times2\times2=\left[\frac{3x^2}{2}-\frac{x^3}{3}\right]_0^1+2=\frac{3}{2}-\frac{1}{3}+2=\frac{7}{6}+2=\frac{19}{6}$ or $\frac{1}{2}\times3\times3-\int_0^1 (x^2-4x+5-2)\,dx=\frac{9}{2}-\left[\frac{x^3}{3}-2x^2+3x\right]_0^1=\frac{9}{2}-\left(\left(\frac{1}{3}-2+3\right)-0\right)=\frac{19}{6}$	M1A1
	$\frac{\text{area of } R_1}{\text{area of } R_2}=\frac{\frac{4}{3}}{\frac{19}{6}}=\frac{8}{19}$	A1
		(5)
		Total 8

Question Number	Scheme	Marks
9(a)	 	B1 **(1)**
(b)	$(x \pm a)^2 + y^2 = ...$	M1
	$(x \pm a)^2 + y^2 = a^2$	A1
	Uses $(5, 6)$ in $(x \pm a)^2 + y^2 = a^2$ to form and solve an equation in a E.g. $(5-a)^2 + 36 = a^2 \Rightarrow 10a = 61 \Rightarrow a = 6.1$	dM1
	$(x-6.1)^2 + y^2 = 6.1^2$	A1 **(4)** **(5 marks)**

Question Number	Scheme	Marks
1(a)	$(u_2 =)\ k - \frac{8}{1}$ and $(u_3 =)\ k - \frac{8}{k-8}$ $\left(= \frac{k^2 - 8k - 8}{k-8}\right)$ oe	M1A1 **(2)**
(b)	$u_3 = 6 \Rightarrow k - \frac{8}{k-8} = 6 \Rightarrow k^2 - 14k + 40 = 0$	M1
	$(k-4)(k-10) = 0 \Rightarrow k = ...$ or $(k =)\ \frac{14 \pm \sqrt{14^2 - 4 \times 1 \times 40}}{2 \times 1}$	dM1
	$(k =)\ 4,\ 10$	A1 **(3)**
		(5 marks)

Question Number	Scheme	Marks
5(a)	Identifies $h = 1.5$	B1
	Area $= \frac{1.5}{2}\{12 + 0.023 + 2(4.243 + 1.5 + 0.530 + 0.188 + 0.066)\}$	M1
	$= 18.8$	A1 **(3)**
(b) (i)	$\int_{-2}^{7} 3\left(\frac{1}{2}\right)^{x+2} \mathrm{d}x = \frac{1}{4}\int_{-2}^{7} 3\left(\frac{1}{2}\right)^{x} \mathrm{d}x = \frac{1}{4} \times "18.8" = 4.7$	B1ft
(ii)	$\int_{-2}^{7} (2^{-x} + 2x)\, \mathrm{d}x = \frac{1}{3} \times "18.8" + \left[x^2\right]_{-2}^{7} = 51.3$	M1, A1ft **(3)** **(6 marks)**