Question	Answer	Marks	Guidance
1	For $\left(\frac{2}{x}-3x\right)^5$ term in x is 10 or $5C_3$ or $5C2 \times \left(\frac{2}{x}\right)^2 \times (-3x)^3$ or $\left(\frac{2}{x}\right)^5 \frac{5.4.3}{3!}\left(-\frac{3}{2}x^2\right)^3$ or $(-3x)^5 \frac{5.4}{2!}\left(\frac{2}{3x^2}\right)^2$	B2,1	3 elements required. –1 for each error with or without x's. Can be seen in an expansion.
	−1080 identified	B1	Allow $-1080x$ Allow if expansion stops at this term. Allow from expanding brackets.
		3	

Question	Answer	Marks	Guidance
2	Midpoint of AB is (5, 1)	B1	Can be seen in working, accept $\left(\frac{10}{2},\frac{2}{2}\right)$.
	$m_{AB} = -½$ oe	B1	
	C to (5, 1) has gradient 2	*M1	Use of $m_1 \times m_2 = -1$.
	Forming equation of line ($y = 2x - 9$)	DM1	Using their perpendicular gradient and their midpoint to form the equation.
	C (0, −9) **or** $y = -9$	A1	
		5	

Question	Answer	Marks	Guidance
3(i)	$\frac{dy}{dt} = \frac{dy}{dx} \times \frac{dx}{dt} = 7 \times -0.05$	M1	Multiply numerical gradient at $x = 2$ by ±0.05.
	−0.35 (units/s) **or** Decreasing at a rate of (+) 0.35	A1	Ignore notation and omission of units
		2	
3(ii)	$(y) = \frac{x^4}{4} + \frac{4}{x}$ $(+c)$ oe	B1	Accept unsimplified
	Uses (2, 9) in an integral to find c.	M1	The power of at least one term increase by 1.
	$c = 3$ **or** $(y =) \frac{x^4}{4} + \frac{4}{x} + 3$ oe	A1	A0 if candidate continues to a final equation that is a straight line.
		3	

Question	Answer	Marks	Guidance
4(i)	$a^2+2ab+b^2, a^2-2ab+b^2$	B1	Correct expansions.
	$\sin^2 x + \cos^2 x = 1$ used $\to (a+b)^2+(a-b)^2=1$	M1	Appropriate use of $\sin^2 x + \cos^2 x = 1$ with $(a+b)^2$ and $(a-b)^2$
	$a^2 + b^2 = ½$	A1	No evidence of $\pm 2ab$, scores 2/3
	Alternative method for question 4(i)		
	$2a = (s+c)$ & $2b = (s-c)$ or $a = ½(s+c)$ & $b = ½(s-c)$	B1	
	$a^2+b^2 = \frac{1}{4}(s+c)^2+\frac{1}{4}(s-c)^2 = ½(s^2+c^2)$	M1	Appropriate use of $\sin^2 x + \cos^2 x = 1$
	$a^2 + b^2 = ½$	A1	Method using only $(\sin x - b)^2$ and $(a-\cos x)^2$ scores 0/3.
		3	SC B1 for assuming θ is acute giving $a = \frac{1}{\sqrt{5}} + b$ or $2\sqrt{5} - b$

Question	Answer	Marks	Guidance
4(ii)	$\tan x = \frac{\sin x}{\cos x} \rightarrow \frac{a+b}{a-b} = 2$	M1	Use of $\tan x = \frac{\sin x}{\cos x}$ to form an equation in a and b only
	$a = 3b$	A1	
		2	

Question	Answer	Marks	Guidance
5	Perimeter of $AOC = 2r + r\theta$	B1	
	Angle $COB = \pi - \theta$	B1	Could be on the diagram. Condone $180 - \theta$.
	Perimeter of $BOC = 2r + r(\pi - \theta)$	B1	**FT** on angle COB if of form $(k\pi - \theta)$, $k > 0$.
	$(2r +)\ \pi r - r\theta = 2((2r) + r\theta)$ $(2 + \pi - \theta = 4 + 2\theta \rightarrow \theta = \frac{\pi - 2}{3}$)	M1	Sets up equation using $r(k\pi - \theta)$ and ×2 on correct side. Condone any omissions of OA, OB and/or OC.
	$\theta = 0.38$	A1	Equivalent answer in degrees scores A0.
		5	

Question	Answer	Marks	Guidance
6(i)	3, –3	**B1**	Accept ± **3**
	–½	**B1**	
	2½	**B1**	
		3	Condone misuse of inequality signs.
6(ii)			Only mark the curve from 0 → 2π. If the *x* axis is not labelled assume that 0 → 2π is the range shown. Labels on axes are not required.
	2 complete oscillations of a cosine curve starting with a maximum at (0,a), a>0	**B1**	
	Fully correct curve which must appear to level off at 0 and/or 2π.	**B1**	
	Line starting on positive *y* axis and finishing below the *x* axis at 2π. Must be straight.	**B1**	
		3	
6(iii)	4	**B1**	
		1	

Question	Answer	Marks	Guidance
7(i)	$(f^{-1}(x)) = \frac{x+2}{3}$ oe	B1	
	$y = \frac{2x+3}{x-1} \rightarrow (x-1)y = 2x+3 \rightarrow x(y-2) = y+3$	M1	Correct method to obtain $x =$, (or $y =$, if interchanged) but condone $+/-$ sign errors
	$(g^{-1}(x)$ or $y) = \frac{x+3}{x-2}$ oe $\left(eg \frac{5}{x-2}+1\right)$	A1	Must be in terms of x
	$x \neq 2$ only	B1	**FT** for value of x from their denominator = 0
		4	
7(ii)	$\left(fg(x)=\right) \frac{3(2x+3)}{x-1} - 2 \ (= \frac{7}{3})$	B1	
	$18x + 27 = 13x - 13$ or $3(4x + 11) = 7(x - 1)$ $(5x = -40)$	M1	Correct method from their $fg = \frac{7}{3}$ leading to a linear equation and collect like terms. Condone omission of $2(x-1)$.
	Alternative method for question 7(ii)		
	$(f^{-1}(\frac{7}{3})) = \frac{13}{9}$	B1	
	$\frac{2x+3}{x-1} = \frac{13}{9} \rightarrow 9(2x+3) = 13(x-1)$ $(\rightarrow 5x = -40)$	M1	Correct method from $g(x) =$ their $\frac{13}{9}$ leading to a linear equation and collect like terms.
	$x = -8$	A1	
		3	

Question	Answer	Marks	Guidance
8(i)	$6\times3+-2\times k+-6\times-3 = 0$ $(18 - 2k + 18 = 0)$	M1	Use of scalar product = 0. Could be $\overrightarrow{AO}.\overrightarrow{OB}$, $\overrightarrow{AO}.\overrightarrow{BO}$ or $\overrightarrow{OA}.\overrightarrow{BO}$
	$k = 18$	A1	
	Alternative method for question 8(i)		
	$76 + 18 + k^2 = 18 + (k + 2)^2$	M1	Use of Pythagoras with appropriate lengths.
	$k = 18$	A1	
		2	
8(ii)	$36 + 4 + 36 = 9 + k^2 + 9$	M1	Use of modulus leading to an equation and solve to $k=$ or $k^2 =$
	$k = \pm\sqrt{58}$ or ±7.62	A1	Accept exact or decimal answers. Allow decimals to greater accuracy.
		2	

Question	Answer	Marks	Guidance
8(iii)	$\overrightarrow{AB} = \begin{pmatrix}-3\\6\\3\end{pmatrix} \rightarrow \overrightarrow{AC} = \begin{pmatrix}-2\\4\\2\end{pmatrix}$ then $\overrightarrow{OA} + \overrightarrow{AC}$	**M1**	Complete method using $\overrightarrow{AC} = \pm \frac{2}{3}\overrightarrow{AB}$ And then $\overrightarrow{OA} + their\ \overrightarrow{AC}$
	$\overrightarrow{OC} = \begin{pmatrix}4\\2\\-4\end{pmatrix}$	**A1**	
	$\div \sqrt{(their\ 4)^2 + (their\ 2)^2 + (their\ -4)^2}$	**M1**	Divides by modulus of their $\overrightarrow{OC}$
	$= \frac{1}{6}\begin{pmatrix}4\\2\\-4\end{pmatrix}$ **or** $\frac{1}{6}(4i + 2j - 4k)$	**A1**	
	Alternative method for question 8(iii)		
	Let $\overrightarrow{OC} = \begin{pmatrix}p\\q\\r\end{pmatrix} \rightarrow \overrightarrow{AC} = \begin{pmatrix}p-6\\q+2\\r+6\end{pmatrix}$ & $\overrightarrow{CB} = \begin{pmatrix}3-p\\4-q\\-3-r\end{pmatrix}$	**M1**	Correct method. Equates coefficients leading to values for p, q, r
	$p - 6 = 2(3 - p)$; $q+2 = 2(4 - q)$; $r + 6 = 2(-3 - r)$ $\rightarrow p=4$, $q=2$ & $r=-4$	**A1**	
	$\div \sqrt{(their\ 4)^2 + (their\ 2)^2 + (their\ -4)^2}$	**M1**	Divides by modulus of their $\overrightarrow{OC}$
	$= \frac{1}{6}\begin{pmatrix}4\\2\\-4\end{pmatrix}$ **or** $\frac{1}{6}(4i + 2j - 4k)$	**A1**	

Question	Answer	Marks	Guidance
8(iii)	**Alternative method for question 8(iii)**		
	$\overrightarrow{CB} = \overrightarrow{OB} - \overrightarrow{OC}$ $\therefore 2\left(\overrightarrow{OB} - \overrightarrow{OC}\right) = \overrightarrow{OC} - \overrightarrow{OA}$ $\rightarrow 2\overrightarrow{OB} + \overrightarrow{OA} = 3\overrightarrow{OC} \therefore\ 3\overrightarrow{OC} = \begin{pmatrix} 12 \\ 6 \\ -12 \end{pmatrix}$	**M1**	Correct method. Gets to a numerical expression for k$\overrightarrow{OC}$ from $\overrightarrow{OA}$ & $\overrightarrow{OB}$.
	$\overrightarrow{OC} = \begin{pmatrix} 4 \\ 2 \\ -4 \end{pmatrix}$	**A1**	
	$\div \sqrt{(their\,4)^2 + (their\,2)^2 + (their\,-4)^2}$	**M1**	Divides by modulus of their $\overrightarrow{OC}$
	$= \frac{1}{6}\begin{pmatrix} 4 \\ 2 \\ -4 \end{pmatrix}$ **or** $\frac{1}{6}\ (4i + 2j - 4k)$	**A1**	
		4	

Question	Answer	Marks	Guidance
9	For C_1: $\frac{dy}{dx} = 2x - 4 \rightarrow m = 2$	B1	
	$y -$ '*their 4*' = '*their* m' $(x - 3)$ or using $y = mx + c$	M1	Use of : $\frac{dy}{dx}$ and (3, their 4) to find the tangent equation.
	$y - 4 = 2(x - 3)$ or $y = 2x - 2$	A1	If using $= mx + c$, getting $c = -2$ is enough.
	$2x - 2 = \sqrt{4x+k}$ $(\rightarrow 4x^2 - 12x + 4 - k = 0)$	*M1	Forms an equation in one variable using tangent & C_2
	Use of $b^2 - 4ac = 0$ on a 3 term quadratic set to 0.	*DM1	Uses 'discriminant = 0'
	$144 = 16(4 - k) \rightarrow k = -5$	A1	
	$4x^2 - 12x + 4 - k = 0 \rightarrow 4x^2 - 12x + 9 = 0$	DM1	Uses k to form a 3 term quadratic in x
	$x = \frac{3}{2}\left(or \frac{1}{2}\right), y = 1(\text{or} - 1).$	A1	Condone 'correct' extra solution.
	Alternative method for question 9		
	For C_1: $\frac{dy}{dx} = 2x - 4 \rightarrow m = 2$	B1	
	$y -$ '*their 4*' = '*their* m' $(x - 3)$ or using $y = mx + c$	M1	Use of : $\frac{dy}{dx}$ and (3, their 4) to find the tangent equation.
	$y - 4 = 2(x - 3)$ or $y = 2x - 2$	A1	If using $= mx + c$, getting $c = -2$ is enough.
	For C_2: $\frac{dy}{dx} = A(4x + k)^{-\frac{1}{2}}$	*M1	Finds $\frac{dy}{dx}$ for C_2 in the form $A(4x + k)^{-\frac{1}{2}}$

Question	Answer	Marks	Guidance
9	At P: '*their* 2' = $A(4x+k)^{-\frac{1}{2}}$" $\to$ ($x = \frac{1-k}{4}$ or $4x+k=1$)	*DM1	Equating '*their* 2' to '*their* $\frac{dy}{dx}$' and simplify to form a linear equation linking $4x+k$ and a constant.
	$(2x-2)^2 = 4x+k \to (2x-2)^2 = 1 \to (4x^2-8x+3=0)$	DM1	Using *their* $y = 2x-2$, $y^2 = 4x+k$ and *their* $4x+k=1$ (but not =0) to form a 3 term quadratic in x.
	$x = \frac{3}{2}\left(or\ \frac{1}{2}\right)$ and from $k = -5(or\ -1)$	A1	Needs correct values for x and k.
	from $y^2 = 4x + k$, $y = 1$(or – 1).	A1	Condone 'correct' extra solution.
	Alternative method for question 9		
	For C_1: $\frac{dy}{dx} = 2x - 4 \to m = 2$	B1	
	y – '*their 4*' = '*their* m' $(x - 3)$ or using $y = mx + c$	M1	Use of : $\frac{dy}{dx}$ and (3, their 4) to find the tangent equation.
	$y - 4 = 2(x-3)$ or $y = 2x - 2$	A1	If using $= mx + c$, getting $c = -2$ is enough.
	For C_2: $\frac{dy}{dx} = A(4x+k)^{-\frac{1}{2}}$	*M1	Finds $\frac{dy}{dx}$ for C_2 in the form $A(4x+k)^{-\frac{1}{2}}$
	At P: '*their* 2' = $A(4x+k)^{-\frac{1}{2}}$" $\to$ ($x = \frac{1-k}{4}$ or $4x+k=1$)	*DM1	Equating '*their* 2' to '*their* $\frac{dy}{dx}$' and simplify to form a linear equation linking $4x+k$ and a constant.
	From $4x + k = 1$ and $y^2 = 4x + k \to y^2 = 1$	DM1	Using *their* $4x + k = 1$ (but not =0) and C_2 to form y^2 = a constant

Question	Answer	Marks	Guidance
9	$y = 1(\text{or} - 1)$ and $x = \frac{3}{2}\left(or \frac{1}{2}\right)$	A1	Needs correct values for y and x.
	From $4x + k = 1$, $k = -5$ (or – 1)	A1	Condone 'correct' extra solution
		8	

Question	Answer	Marks	Guidance
10(a)(i)	$S_{10} = S_{15} - S_{10}$ or $S_{10} = S_{(11 \text{ to } 15)}$	M1	Either statement seen or implied.
	$5(2a + 9d)$ oe	B1	
	$7.5(2a + 14d) - 5(2a + 9d)$ or $\frac{5}{2}[(a + 10d) + (a+14d)]$ oe	A1	
	$d = \frac{a}{3}$ **AG**	A1	Correct answer from convincing working
		4	Condone starting with $d = \frac{a}{3}$ and evaluating both summations as 25a.
10(a)(ii)	$(a + 9d) = 36 + (a + 3d)$	M1	Correct use of $a + (n-1)d$ twice and addition of ±36
	$a = 18$	A1	
		2	Correct answer www scores 2/2

Question	Answer	Marks	Guidance
10(b)	$S_\infty = 9 \times S_4$; $\dfrac{a}{1-r} = 9\dfrac{a\left(1-r^4\right)}{1-r}$ or $9(a + ar + ar^2 + ar^3)$	B1	May have 12 in place of *a*.
	$9(1 - r^n) = 1$ where $n = 3,4$ or 5	M1	Correctly deals with *a* and correctly eliminates '$1 - r$'
	$r^4 = \dfrac{8}{9}$ oe	A1	
	(5^{th} term =) 10⅔ or 10.7	A1	
		4	Final answer of 10.6 suggests premature approximation – award 3/4 www.

Question	Answer	Marks	Guidance
11(i)	$\frac{dy}{dx} = \left[\frac{1}{2}(4x+1)^{-\frac{1}{2}}\right]$ [× 4] $\left[-\frac{9}{2}(4x+1)^{-\frac{3}{2}}\right]$ [× 4]	B1B1B1	B1 B1 for each, without × 4. B1 for ×4 twice.
	$\left(\frac{2}{\sqrt{4x+1}} - \frac{18}{\left(\sqrt{4x+1}\right)^3} \text{ or } \frac{8x-16}{(4x+1)^{\frac{3}{2}}}\right)$		SC If no other marks awarded award B1 for both powers of (4x +1) correct.
	$\int y\,dx = \left[\frac{(4x+1)^{\frac{3}{2}}}{\frac{3}{2}}\right]$ [÷ 4] + $\left[\frac{9(4x+1)^{\frac{1}{2}}}{\frac{1}{2}}\right]$ [÷ 4] (+C)	B1B1B1	B1 B1 for each, without ÷ 4. B1 for ÷4 twice. + C not required.
	$\left(\frac{\left(\sqrt{4x+1}\right)^3}{6} + \frac{9}{2}\left(\sqrt{4x+1}\right)(+C)\right)$		SC If no other marks awarded , B1 for both powers of (4x +1) correct.
		6	
11(ii)	$\frac{dy}{dx} = 0 \rightarrow \frac{2}{\sqrt{4x+1}} - \frac{18}{(4x+1)^{\frac{3}{2}}} = 0$	M1	Sets their $\frac{dy}{dx}$ to 0 (and attempts to solve
	$4x + 1 = 9$ or $(4x + 1)^2 = 81$	A1	Must be from correct differential.
	$x = 2$, $y = 6$ **or** M is (2, 6) only.	A1	Both values required. Must be from correct differential.
		3	

Question	Answer	Marks	Guidance
11(iii)	Realises area is $\int y \, dx$ **and** attempt to use their 2 and sight of 0.	*M1	Needs to use their integral and to see '*their 2*' substituted.
	Uses limits 0 to 2 correctly → $[4.5 + 13.5] - [\frac{1}{6} + 4.5]$ (= 13⅓)	DM1	Uses both 0 and '*their 2*' and subtracts. Condone wrong way round.
	(Area =) 1⅓ **or** 1.33	A1	Must be from a correct differential and integral.
		3	13⅓ or 1⅓ with little or no working scores M1DM0A0.