Question	Answer	Marks	Guidance
1(i)	$(1-2x)^5 = 1 - 10x + 40x^2$ (no penalty for extra terms)	**B2,1**	Loses a mark for each incorrect term. Treat $-32x^5 + 80x^4 - 80x^3$ as MR –1
		2	
1(ii)	$\rightarrow (1 + ax + 2x^2)(1 - 10x + 40x^2)$		
	3 terms in $x^2 \rightarrow 40 - 10a + 2$	**M1 A1FT**	Selects 3 terms in x^2. FT from **(i)**
	Equate with 12 $\rightarrow$ a = 3	**A1**	CAO
		3	

Question	Answer	Marks	Guidance
2	$y = 2x + \frac{5}{x} \rightarrow \frac{dy}{dx} = 2 - \frac{5}{x^2} = -3$ (may be implied) when $x = 1$.	**M1 A1**	Reasonable attempt at differentiation CAO (−3)
	$\frac{dy}{dt} = \frac{dy}{dx} \times \frac{dx}{dt} \rightarrow -0.06$	**M1 A1**	Ignore notation, but needs to multiply $\frac{dy}{dx}$ by 0.02.
		4	

Question	Answer	Marks	Guidance
3	$\frac{dy}{dx}=\frac{12}{(2x+1)^2} \rightarrow y=\frac{-12}{2x+1} \div 2 \ (+c)$	B1 B1	Correct without " ÷ 2". For " ÷ 2". Ignore "c".
	Uses (1, 1) $\rightarrow c=3 \ (\rightarrow y=\frac{-6}{2x+1}+3)$	M1 A1	Finding "c" following integration. CAO
	Sets y to 0 and attempts to solve for $x \rightarrow x=\frac{1}{2} \rightarrow ((\frac{1}{2}, 0))$	DM1 A1	Sets y to 0. $x=\frac{1}{2}$ is sufficient for A1.
		6	

Question	Answer	Marks	Guidance
4(i)	$(\sin\theta + \cos\theta)(1 - \sin\theta\cos\theta) \equiv \sin^3\theta + \cos^3\theta$.		Accept abbreviations s and c
	LHS = $\sin\theta + \cos\theta - \sin^2\theta\cos\theta - \sin\theta\cos^2\theta$	M1	Expansion
	$= \sin\theta(1 - \cos^2\theta) + \cos\theta(1 - \sin^2\theta)$ or $(s + c - c(1 - c^2) - s(1 - s^2))$	M1A1	Uses identity twice. Everything correct. AG
	Uses $\sin^2\theta + \cos^2\theta = 1 \rightarrow \sin^3\theta + \cos^3\theta$ (RHS)		or from RHS: M1 for use of trig ID twice
	Or		
	LHS = $(\sin\theta+\cos\theta)(\sin^2\theta+\cos^2\theta-\sin\theta\cos\theta)$	M1	M1 for factorisation
	$= \sin^3\theta+\sin\theta\cos^2\theta-\sin^2\theta\cos\theta+\cos\theta\sin^2\theta+\cos^3\theta-\sin\theta\cos^2\theta=\sin^3\theta+\cos^3\theta$	M1A1	
		3	

Question	Answer	Marks	Guidance
4(ii)	$(\sin\theta + \cos\theta)(1 - \sin\theta\cos\theta) = 3\cos^3\theta \rightarrow \sin^3\theta = 2\cos^3\theta$	**M1**	
	$\rightarrow \tan^3\theta = 2 \rightarrow \theta = 51.6^\circ$ or 231.6° (only)	**A1A1FT**	Uses $\tan^3 = \sin^3 \div \cos^3$. A1 CAO. A1FT, 180 + their acute angle. $tan^3\theta = 0$ gets M0
		3	

Question	Answer	Marks	Guidance
5(i)	Eqn of AC $y = -\frac{1}{2}x + 4$ (gradient must be $\Delta y / \Delta x$)	**M1A1**	Uses gradient and a given point for equa. CAO
	Gradient of $OB = 2 \rightarrow y = 2x$ (If y missing only penalise once)	**M1 A1**	Use of $m_1 m_2 = -1$, answers only ok.
		4	

Question	Answer	Marks	Guidance
5(ii)	Simultaneous equations $\rightarrow$ ((1.6, 3.2))	**M1**	Equate and solve for M1 and reach $\geqslant$1 solution
	This is mid-point of OB. $\rightarrow$ B (3.2, 6.4)	**M1 A1**	Uses mid-point. CAO
	or		
	Let coordinates of B (h, k) $OA = AB \rightarrow h^2 = 8k - k^2$ $OC = BC \rightarrow k^2 = 16h - h^2 \rightarrow (3.2, 6.4)$		M1 for both equations, M1 for solving with $y = 2x$
	or		
	gradients $\left(\frac{k-4}{h} \times \frac{k}{h-8} = -1\right)$		M1 for gradient product as –1, M1 solving with $y = 2x$
	or		
	Pythagoras: $h^2 + (k-4)^2 + (h-8)^2 + k^2 = 4^2 + 8^2$		M1 for complete equation, M1 solving with $y = 2x$
		3	

Question	Answer	Marks	Guidance
6(i)	$(\tan\theta = \frac{AT}{r}) \rightarrow AT = r\tan\theta$ or $OT = \frac{r}{\cos\theta}$ SOI	**B1**	CAO
	$\rightarrow A = \frac{1}{2}r^2\tan\theta \quad - \frac{1}{2}r^2\theta$	**B1 B1**	B1 for $\frac{1}{2}r^2\tan\theta$. B1 for "$-\frac{1}{2}r^2\theta$" If Pythagoras used may see area of triangle as $\frac{1}{2}r\sqrt{r^2 + r^2tan^2\theta}$ or $\frac{1}{2}r\left(\frac{r}{\cos\theta}\right)sin\theta$
		3	

Question	Answer	Marks	Guidance
6(ii)	$\tan\theta = \dfrac{AT}{3} \rightarrow AT = 7.716$	**M1**	Correct use of trigonometry and radians in rt angle triangle
	Arc length = $r\theta$ = 3.6	**B1**	Accept 3×1.2
	OT by Pythagoras or $\cos1.2 = \dfrac{3}{OT}$ $(= 8.279)$	**M1**	Correct method for OT
	Perimeter = AT + arc + OT – radius = 16.6	**A1**	CAO, www
		4	

Question	Answer	Marks	Guidance
7	$\overrightarrow{OA} = \begin{pmatrix}1\\-3\\2\end{pmatrix}$, $\overrightarrow{OB} = \begin{pmatrix}-1\\3\\5\end{pmatrix}$ and $\overrightarrow{OC} = \begin{pmatrix}3\\1\\-2\end{pmatrix}$		
7(i)	$\overrightarrow{AC} = \begin{pmatrix}2\\4\\-4\end{pmatrix}$	**B1**	B1 for $\overrightarrow{AC}$.
		1	

Question	Answer	Marks	Guidance
7(ii)	$\overrightarrow{OM}=\overrightarrow{OA}+\overrightarrow{AM}=\begin{pmatrix}2\\-1\\0\end{pmatrix}$ or $\frac{1}{2}[\begin{pmatrix}1\\-3\\2\end{pmatrix}+\begin{pmatrix}3\\1\\-2\end{pmatrix}]$	**M1**	M1 for their $\overrightarrow{OM}=\overrightarrow{OA}+\overrightarrow{AM}$ oe
	Unit vector in direction of $\overrightarrow{OM}=\frac{1}{\sqrt{5}}(\overrightarrow{OM})$	**M1 A1**	M1 for dividing their $\overrightarrow{OM}$ by their modulus
		3	
7(iii)	$\overrightarrow{AB}=\begin{pmatrix}-2\\6\\3\end{pmatrix}$, Allow ±	**B1**	
	$\lvert\overrightarrow{AB}\rvert=7, \lvert\overrightarrow{AC}\rvert=6$ $\begin{pmatrix}-2\\6\\3\end{pmatrix}.\begin{pmatrix}2\\4\\-4\end{pmatrix}=-4+24-12=8$	**M1 M1**	Product of both moduli, Scalar product of ± their AB and AC
	$7\times 6\cos\theta=8 \rightarrow \theta=79.(0)^{\circ}$	**A1**	1.38 radians ok
		4	

Question	Answer	Marks	Guidance
8(a)	$ar = 12$ and $\dfrac{a}{1-r} = 54$	B1 B1	CAO, OE CAO, OE
	Eliminates a or r $\rightarrow$ $9r^2 - 9r + 2 = 0$ or $a^2 - 54a + 648 = 0$	M1	Elimination leading to a 3-term quadratic in a or r
	$\rightarrow$ $r = \dfrac{2}{3}$ or $\dfrac{1}{3}$ hence to a $\rightarrow$ $a = 18$ or 36	A1	Needs both values.
		4	
8(b)	nth term of a progression is $p + qn$		
8(b)(i)	first term $= p + q$. Difference $= q$ or last term $= p + qn$	B1	Need first term and, last term or common difference
	$S_n = \dfrac{n}{2}\left(2\left(p+q\right)+\left(n-1\right)q\right)$ or $\dfrac{n}{2}\left(2p+q+nq\right)$	M1A1	Use of S_n formula with their a and d. ok unsimplified for A1.
		3	
8(b)(ii)	Hence $2\left(2p+q+4q\right)=40$ and $3\left(2p+q+6q\right)=72$	DM1	Uses their S_n formula from **(i)**
	Solution $\rightarrow$ $p = 5$ and $q = 2$ [Could use S_n with a and d $\rightarrow$ $a = 7, d = 2$ $\rightarrow$ $p = 5, q = 2$.]	A1	Note: answers 7, 2 instead of 5, 2 gets M1A0 – must attempt to solve for M1
		2	

Question	Answer	Marks	Guidance
9	$\mathrm{f}: x \mapsto \frac{x}{2} - 2, \quad \mathrm{g}: x \mapsto 4 + x - \frac{x^2}{2}$		
9(i)	$4 + x - \frac{x^2}{2} = \frac{x}{2} - 2 \rightarrow x^2 - x - 12 = 0$	**M1**	Equates and forms 3 term quadratic
	$\rightarrow$ (4, 0) and (−3, −3.5) Trial and improvement, B3 all correct or B0	**A1 A1**	A1 For both x values or a correct pair. A1 all.
		3	
9(ii)	$\mathrm{f}(x) > \mathrm{g}(x)$ for $x > 4$, $x < -3$	**B1, B1**	B1 for each part. Loses a mark for $\leqslant$ or $\geqslant$.
		2	
9(iii)	$\mathrm{fg}(x) = 2 + \frac{x}{2} - \frac{x^2}{4} - 2 \left(= \frac{x}{2} - \frac{x^2}{4}\right)$	**B1**	CAO, any correct form
	i.e. $-\frac{1}{4}((x-1)^2 - 1)$ or $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{1}{2} - \frac{2x}{4} = 0 \rightarrow x = 1$	**M1 A1**	Completes the square or uses calculus. First A1 is for $x = 1$ or completed square form
	$\rightarrow y = \frac{1}{4} \rightarrow$ Range of fg $\leqslant \frac{1}{4}$,	**A1**	CAO, OE e.g. $y \leqslant \frac{1}{4}$, $[-\infty, \frac{1}{4})$ etc.
		4	
9(iv)	Calculus or completing square on ‘h’ $\rightarrow x = 1$	**M1**	May use a sketch or $-\frac{b}{2a}$
	$k = 1$ (accept $k \geqslant 1$)	**A1**	Complete method. CAO
		2	

Question	Answer	Marks	Guidance
10	$y = x^3 - 2x^2 + 5x$		
10(i)	$\frac{dy}{dx} = 3x^2 - 4x + 5$	B1	CAO
	Using $b^2 - 4ac \to 16 - 60 \to$ negative $\to$ some explanation or completed square and explanation	M1 A1	Uses discriminant on equation (set to 0). CAO
		3	
10(ii)	$m = 3x^2 - 4x + 5$ $\frac{dm}{dx} = 6x - 4\ (= 0)$ (must identify as $\frac{dm}{dx}$)	B1FT	FT providing differentiation is equivalent
	$\to x = \frac{2}{3},\ m = \frac{11}{3}$ or $\frac{dy}{dx} = \frac{11}{3}$ Alt1: $m = 3\left(x - \frac{2}{3}\right)^2 + \frac{11}{3},\ m = \frac{11}{3}$ Alt2: $3x^2 - 4x + 5 - m = 0,\ b^2 - 4ac = 0,\ m = \frac{11}{3}$	M1 A1	Sets to 0 and solves. A1 for correct m. Alt1: B1 for completing square, M1A1 for ans Alt2: B1 for coefficients, M1A1 for ans
	$\frac{d^2m}{dx^2} = 6$ +ve $\to$ Minimum value or refer to sketch of curve or check values of m either side of $x = \frac{2}{3}$,	M1 A1	M1 correct method. A1 (no errors anywhere)
		5	

Question	Answer	Marks	Guidance
10(iii)	Integrate → $\frac{x^4}{4} - \frac{2x^3}{3} + \frac{5x^2}{2}$	**B2,1**	Loses a mark for each incorrect term
	Uses limits 0 to 6 → 270 (may not see use of lower limit)	**M1 A1**	Use of limits on an integral. CAO Answer only 0/4
		4	