Paper 2

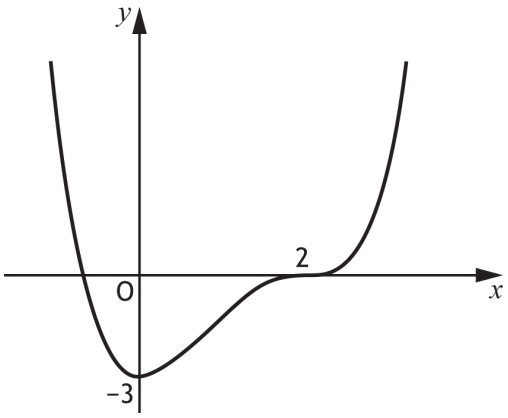
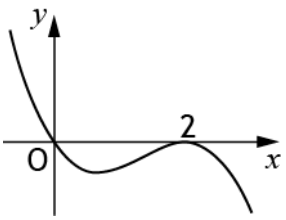
Marking instructions for each question

Question	Generic scheme	Illustrative scheme	Max mark
1. (a)	•[1] calculate gradient of AB •[2] use property of perpendicular lines •[3] determine equation of altitude	•[1] $m_{AB}=-3$ •[2] $m_{alt}=\frac{1}{3}$ •[3] $x-3y=4$	**3**
1. (b)	•[4] calculate midpoint of AC •[5] calculate gradient of median •[6] determine equation of median	•[4] $(4,5)$ •[5] $m_{BM}=2$ •[6] $y=2x-3$	**3**
1. (c)	•[7] find x or y coordinate •[8] find remaining coordinate	•[7] $x=1$ or $y=-1$ •[8] $y=-1$ or $x=1$	**2**
2.	•[1] write in integrable form •[2] integrate one term •[3] integrate other term •[4] complete integration and simplify	•[1] $4x+x^{-2}$ •[2] eg $\frac{4}{2}x^2+\ldots$ •[3] $\ldots\frac{x^{-1}}{-1}$ •[4] $2x^2-x^{-1}+c$	**4**
3.	•[1] value of a •[2] value of b •[3] calculate k	•[1] 1 •[2] -2 •[3] -1	**3**

Question	Generic scheme	Illustrative scheme	Max mark
4. (a)	●[1] state components of $\overrightarrow{DB}$ ●[2] state coordinates of M ●[3] state components of $\overrightarrow{DM}$	●[1] $\begin{pmatrix} 2 \\ 2 \\ -6 \end{pmatrix}$ ●[2] $(2,0,0)$ stated or implied by ●[3] ●[3] $\begin{pmatrix} 0 \\ -2 \\ -6 \end{pmatrix}$	**3**
4. (b)	●[4] evaluate $\overrightarrow{DB}.\overrightarrow{DM}$ ●[5] evaluate $\left\|\overrightarrow{DB}\right\|$ ●[6] evaluate $\left\|\overrightarrow{DM}\right\|$ ●[7] use scalar product ●[8] calculate angle	●[4] 32 ●[5] $\sqrt{44}$ ●[6] $\sqrt{40}$ ●[7] $\cos \mathrm{BDM} = \frac{32}{\sqrt{44}\sqrt{40}}$ ●[8] $40 \cdot 3°$ or 0.703 rads	**5**

Question	Generic scheme	Illustrative scheme	Max mark
5.	●[1] know to integrate and interpret limits ●[2] use 'upper − lower' ●[3] integrate ●[4] substitute limits ●[5] evaluate area	●[1] $\int_{-3}^{0} \ldots dx$ ●[2] $\int_{-3}^{0}\left(x^3+3x^2+2x+3\right)-\left(2x+3\right)dx$ ●[3] $\frac{1}{4}x^4+x^3$ ●[4] $0-\left(\frac{1}{4}(-3)^4+(-3)^3\right)$ ●[5] $\frac{27}{4}$ units^2	**5**

Question	Generic scheme	Illustrative scheme	Max mark
6. (a)	**Method 1** •[1] identify common factor •[2] complete the square •[3] process for c and write in required form	**Method 1** •[1] $3(x^2+8x\ldots\ldots$ stated or implied by •[2] •[2] $3(x+4)^2\ldots\ldots$ •[3] $3(x+4)^2+2$	**3**
	Method 2 •[1] expand completed square form •[2] equate coefficients •[3] process for b and c and write in required form	**Method 2** •[1] $ax^2+2abx+ab^2+c$ •[2] $a=3,\ 2ab=24,\ ab^2+c=50$ •[3] $3(x+4)^2+2$	**3**
6. (b)	•[4] differentiate two terms •[5] complete differentiation	•[4] $3x^2+24x\ldots.$ •[5] $\ldots.+50$	**2**
6. (c)	**Method 1** •[6] link with (a) and identify sign of $(x+4)^2$ •[7] communicate reason	**Method 1** •[6] $f'(x)=3(x+4)^2+2$ and $(x+4)^2\geq 0\ \forall\ x$ •[7] $\therefore 3(x+4)^2+2>0\ \Rightarrow$ always strictly increasing	**2**
	Method 2 •[6] identify minimum value of $f'(x)$ •[7] communicate reason	**Method 2** •[6] eg minimum value $=2$ or annotated sketch •[7] $2>0\therefore(f'(x)>0)\Rightarrow$ always strictly increasing	**2**

Question	Generic scheme	Illustrative scheme	Max mark
7. (a)	●[1] evidence of reflecting in x-axis ●[2] vertical translation of 2 units identifiable from graph	●[1] reflection of graph in x-axis ●[2] graph moves parallel to y-axis by 2 units upwards 	**2**
7. (b)	●[3] identify roots ●[4] interpret point of inflexion ●[5] complete cubic curve	●[3] 0 **and** 2 only ●[4] turning point at $(2,0)$ ●[5] cubic passing through origin with negative gradient 	**3**

Question	Generic scheme	Illustrative scheme	Max mark
8. (a)	•[1] use compound angle formula •[2] compare coefficients •[3] process for k •[4] process for a and express in required form	•[1] $k\cos x\cos a - k\sin x\sin a$ **stated explicitly** •[2] $k\cos a = 5, k\sin a = 2$ **stated explicitly** •[3] $k = \sqrt{29}$ •[4] $\sqrt{29}\cos(x + 0\cdot 38)$	**4**
8. (b)	•[5] equate to 12 and simplify constant terms •[6] use result of part (a) and rearrange •[7] solve for $x + a$ •[8] solve for x	•[5] $5\cos x - 2\sin x = 2$ or $5\cos x - 2\sin x - 2 = 0$ •[6] $\cos(x + 0\cdot 3805\ldots) = \frac{2}{\sqrt{29}}$ •[7] $1\cdot 1902\ldots,$ •[8] $5\cdot 0928\ldots$ •[7] $0\cdot 8097\ldots,$ •[8] $4\cdot 712\ldots$	**4**

Question	Generic scheme	Illustrative scheme	Max mark
9. (a)	•[1] equate volume to 100 •[2] obtain an expression for h •[3] demonstrate result	•[1] $V = \pi r^2 h = 100$ •[2] $h = \frac{100}{\pi r^2}$ •[3] $A = \pi r^2 + 2\pi r^2 + 2\pi r \times \frac{100}{\pi r^2}$ leading to $A = \frac{200}{r} + 3\pi r^2$	**3**
9. (b)	•[4] start to differentiate •[5] complete differentiation •[6] set derivative to zero •[7] obtain r •[8] verify nature of stationary point •[9] interpret and communicate result	•[4] $A'(r) = 6\pi r \ldots$ •[5] $A'(r) = 6\pi r - \frac{200}{r^2}$ •[6] $6\pi r - \frac{200}{r^2} = 0$ •[7] $r = \sqrt[3]{\frac{100}{3\pi}}$ $(\approx 2 \cdot 20)$ metres •[8] table of signs for a derivative when $r = 2 \cdot 1974 \ldots$ •[9] minimum when $r \approx 2 \cdot 20$ (m) or •[8] $A''(r) = 6\pi + \frac{400}{r^3}$ •[9] $A''(2 \cdot 1974 \ldots) > 0 \therefore$ minimum when $r \approx 2 \cdot 20$ (m)	**6**

Question	Generic scheme	Illustrative scheme	Max mark
10.	$\bullet^1$ start to integrate	$\bullet^1$ $-\frac{1}{4}\cos\ldots$	**6**
	$\bullet^2$ complete integration	$\bullet^2$ $-\frac{1}{4}\cos\left(4x-\frac{\pi}{2}\right)$	
	$\bullet^3$ process limits	$\bullet^3$ $-\frac{1}{4}\cos\left(4a-\frac{\pi}{2}\right)+\frac{1}{4}\cos\left(\frac{4\pi}{8}-\frac{\pi}{2}\right)$	
	$\bullet^4$ simplify numeric term and equate to $\frac{1}{2}$	$\bullet^4$ $-\frac{1}{4}\cos\left(4a-\frac{\pi}{2}\right)+\frac{1}{4}=\frac{1}{2}$	
	$\bullet^5$ start to solve equation	$\bullet^5$ $\cos\left(4a-\frac{\pi}{2}\right)=-1$	
	$\bullet^6$ solve for a	$\bullet^6$ $a=\frac{3\pi}{8}$	
11.	**Method 1**	**Method 1**	**3**
	$\bullet^1$ substitute for $\sin 2x$	$\bullet^1$ $\frac{2\sin x\cos x}{2\cos x}-\sin x\cos^2 x$ stated explicitly as above or in a simplified form of the above	
	$\bullet^2$ simplify and factorise	$\bullet^2$ $\sin x\left(1-\cos^2 x\right)$	
	$\bullet^3$ substitute for $1-\cos^2 x$ and simplify	$\bullet^3$ $\sin x\times\sin^2 x$ leading to $\sin^3 x$	
	Method 2	**Method 2**	**3**
	$\bullet^1$ substitute for $\sin 2x$	$\bullet^1$ $\frac{2\sin x\cos x}{2\cos x}-\sin x\cos^2 x$ stated explicitly as above or in a simplified form of the above	
	$\bullet^2$ simplify and substitute for $\cos^2 x$	$\bullet^2$ $\sin x-\sin x\left(1-\sin^2 x\right)$	
	$\bullet^3$ expand and simplify	$\bullet^3$ $\sin x-\sin x+\sin^3 x$ leading to $\sin^3 x$	

Question	Generic scheme	Illustrative scheme	Max mark
12. (a)	**Method 1** •1 calculate m_{AB} •2 calculate m_{BC} •3 interpret result and state conclusion	**Method 1** •1 eg $m_{AB}=\frac{3}{9}=\frac{1}{3}$ •2 eg $m_{BC}=\frac{5}{15}=\frac{1}{3}$ •3 $\ldots\Rightarrow$ AB and BC are parallel (common direction), B is a common point, hence A, B and C are collinear.	**3**
	Method 2 •1 calculate an appropriate vector, eg $\overrightarrow{AB}$ •2 calculate a second vector, eg $\overrightarrow{BC}$ and compare •3 interpret result and state conclusion	**Method 2** •1 eg $\overrightarrow{AB}=\begin{pmatrix}9\\3\end{pmatrix}$ •2 eg $\overrightarrow{BC}=\begin{pmatrix}15\\5\end{pmatrix}\therefore\ \overrightarrow{AB}=\frac{3}{5}\overrightarrow{BC}$ •3 $\ldots\Rightarrow$ AB and BC are parallel (common direction), B is a common point, hence A, B and C are collinear.	**3**
	Method 3 •1 calculate m_{AB} •2 find equation of line and substitute point •3 communication	**Method 3** •1 $m_{AB}=\frac{3}{9}=\frac{1}{3}$ •2 eg, $y-1=\frac{1}{3}(x-2)$ leading to $6-1=\frac{1}{3}(17-2)$ •3 since C lies on line A, B and C are collinear	**3**
12. (b)	•4 find radius •5 determine an appropriate ratio •6 find centre •7 state equation of circle	•4 $6\sqrt{10}$ •5 eg $2:3$ or $\frac{2}{5}$ (using B and C) or $3:5$ or $\frac{8}{5}$ (using A and C) •6 $(8,3)$ •7 $(x-8)^2+(y-3)^2=360$	**4**

Question	Generic scheme	Illustrative scheme	Max mark
13. (a)	•[1] interpret half-life •[2] process equation •[3] write in logarithmic form •[4] process for k	•[1] $\frac{1}{2}P_0 = P_0e^{-25k}$ **stated or implied by •[2]** •[2] $e^{-25k} = \frac{1}{2}$ •[3] $\log_e \frac{1}{2} = -25k$ •[4] $k \approx 0 \cdot 028$	**4**
13. (b)	•[5] interpret equation •[6] process •[7] state percentage decrease	•[5] $P_t = P_0e^{-80\times0\cdot028}$ •[6] $P_t \approx 0 \cdot 1065P_0$ •[7] 89%	**3**

[END OF SPECIMEN MARKING INSTRUCTIONS]