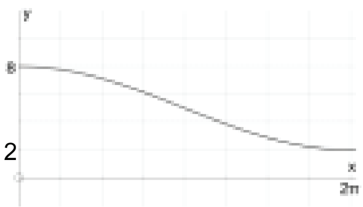
1	θ is obtuse , $\sin\theta = k$		
(i)	$\cos\theta = -\sqrt{(1-k^2)}$	B1 [1]	cao
(ii)	$\tan\theta = \dfrac{\sin\theta}{\cos\theta}$ used	M1	Used, attempt at cosine seen in (i)
	$\to \tan\theta = -\dfrac{k}{\sqrt{(1-k^2)}}$ aef	A1√ [2]	Ft for their cosine as a function of k only, from part (i)
(iii)	$\sin(\theta + \pi) = -k$	B1 [1]	cao
2	$y = 2x^2$, $X(-2, 0)$ and $P(p, 0)$		
(i)	$A = \dfrac{1}{2} \times (2+p) \times 2p^2$ $(= 2p^2 + p^3)$	M1 A1 [2]	Attempt at base and height in terms of p and use of $\dfrac{bh}{2}$
(ii)	$\dfrac{dA}{dp} = 4p + 3p^2$	B1	cao
	$\dfrac{dA}{dt} = \dfrac{dA}{dp} \times \dfrac{dp}{dt} = 0.02 \times 20 = 0.4$	M1 A1	any correct method, cao
	or $\dfrac{dA}{dt} = 4p\dfrac{dp}{dt} + 3p^2\dfrac{dp}{dt}$	[3]	
3	$(1-x)^2(1+2x)^6$.		
(i) (a)	$(1-x)^6 = 1 - 6x + 15x^2$	B2,1 [2]	−1 each error
(b)	$(1+2x)^6 = 1 + 12x + 60x^2$	B2,1 [2]	−1 each error **SC** B1 only, in each part, for all 3 correct descending powers **SC** only one penalty for omission of the '1' in each expansion
(ii)	Product of **(a)** and **(b)** with >1 term $\to 60 - 72 + 15 = 3$	M1 DM1A1 [3]	Must be 2 or more products M1 exactly 3 products. cao, condone $3x^2$

4	$\overrightarrow{OA}=\begin{pmatrix}3\\0\\-4\end{pmatrix}, \overrightarrow{OB}=\begin{pmatrix}6\\-3\\2\end{pmatrix}, \overrightarrow{OC}=\begin{pmatrix}k\\-2k\\2k-3\end{pmatrix}$		
(i)	$OA \cdot OB = 18 - 8 = 10$ Modulus of $OA = 5$, of $OB = 7$ Angle $AOB = \cos^{-1}\left(\frac{10}{35}\right)$ aef $\rightarrow \frac{10}{35}$ or $\frac{2}{7}$	M1 M1 A1 [3]	Use of $x_1x_2 + y_1y_2 + z_1z_2$ All linked with modulus cao, (if angle given, no penalty), correct angle implies correct cosine
(ii)	$\overrightarrow{AB} = \mathbf{b} - \mathbf{a} = \begin{pmatrix}3\\-3\\6\end{pmatrix}$ $k^2 + 4k^2 + (2k-3)^2 = 9 + 9 + 36$ $\rightarrow 9k^2 - 12k - 45 (= 0)$ $\rightarrow k = 3$ or $k = -\frac{5}{3}$	B1 M1 DM1 A1 [4]	allow for **a** – **b** Correct use of moduli using their AB obtains 3 term quadratic. cao
5 (i)	$24 = r + r + r\theta$ $\rightarrow \theta = \frac{24-2r}{r}$ $A = \frac{1}{2}r^2\theta = \frac{24r}{2} - r^2 = 12r - r^2$. aef, ag	 M1 M1A1 [3]	(May not use θ) Attempt at $s = r\theta$ linked with 24 and r Uses A formula with θ as f(r). cao
(ii)	$(A =) 36 - (r-6)^2$	B1 B1 [2]	cao
(iii)	Greatest value of $A = 36$ $(r = 6) \rightarrow \theta = 2$	B1√ B1 [2]	Ft on **(ii).** cao, may use calculus or the discriminant on $12r - r^2$

6 **(i)**	$y-2t=-2(x-3t)(y+2x=8t)$ Set x to 0 $\rightarrow$ $B(0, 8t)$ Set y to 0 $\rightarrow A(4t, 0)$ $\rightarrow$ Area = $16t^2$	M1 M1 A1 [3]	Unsimplified or equivalent forms Attempt at both A and B, then using cao
(ii)	$m=\frac{1}{2}$ $\rightarrow y-2t=\frac{1}{2}(x-3t)(2y=x+t)$ Set y to 0 $\rightarrow$ $C(-t, 0)$ Midpoint of CP is (t, t) This lies on the line $y=x$.	B1 M1 A1 A1 [4]	cao Unsimplified or equivalent forms co correctly shown.
7 **(a)**	$ar^2=\frac{1}{3}$, $ar^3=\frac{2}{9}$ $\rightarrow r=\frac{2}{3}$ aef Substituting $\rightarrow$ $a=\frac{3}{4}$ $\rightarrow S_\infty=\frac{\frac{3}{4}}{\frac{1}{3}}$ $=2\frac{1}{4}$ aef	 M1 A1 M1 A1 [4]	 Any valid method, seen or implied. Could be answers only. Both a and r Correct formula with $\lvert r\rvert<1$, cao
(b)	$4a=a+4d$ $\rightarrow$ $3a=4d$ $360=S_5=\frac{5}{2}(2a+4d)$ or $12.5a$ $\rightarrow a=28.8°$ aef Largest = $a+4d$ or $4a=115.2°$ aef	B1 M1 A1 B1 [4]	May be implied in $360=5/2(a+4a)$ Correct S_n formula or sum of 5 terms cao, may be implied (may use degrees or radians)

8	f : $x \mapsto 5 + 3\cos\left(\frac{1}{2}x\right)$ for $0 \leqslant x \leqslant 2\pi$.		
(i)	$5 + 3\cos\left(\frac{1}{2}x\right) = 7$ $\cos\left(\frac{1}{2}x\right) = \frac{2}{3}$ $\frac{1}{2}x = 0.84$ $x = 1.68$ only, aef (in given range)	B1 M1A1 [3]	Makes $\cos\left(\frac{1}{2}x\right) = \frac{2}{3}$ Looks up $\cos^{-1}$ first, then ×2
(ii)		B1 B1 [2]	y always +ve, m always –ve. from (0, 8) to (2π, 2) (may be implied)
(iii)	No turning point on graph or 1:1	B1 [1]	cao, independent of graph in (ii)
(iv)	$y = 5 + 3\cos\left(\frac{1}{2}x\right)$ Order; −5, ÷3, $\cos^{-1}$, ×2 $x = 2\cos^{-1}\left(\frac{x-5}{3}\right)$	M1 M1 A1 [3]	Tries to make x subject. Correct order of operations cao

9	$y = x^3 + px^2$		
(i)	$\frac{dy}{dx} = 3x^2 + 2px$	B1	cao
	Sets to 0 → $x = 0$ or $-\frac{2p}{3}$	M1	Sets differential to 0
	→ (0, 0) or $\left(-\frac{2p}{3}, \frac{4p^3}{27}\right)$	A1 A1 [4]	cao cao, first A1 for any correct turning point or any correct pair of x values. 2nd A1 for 2 complete TPs
(ii)	$\frac{d^2y}{dx^2} = 6x + 2p$	M1	Other methods include; clear demonstration of sign change of gradient, clear reference to the shape of the curve
	At (0, 0) → $2p$ +ve Minimum	A1	www
	At $\left(-\frac{2p}{3}, \frac{4p^3}{27}\right)$ → $-2p$ –ve Maximum	A1 [3]	
(iii)	$y = x^3 + px^2 + px$ → $3x^2 + 2px + p$ (= 0)	B1	
	Uses $b^2 - 4ac$ → $4p^2 - 12p < 0$	M1	Any correct use of discriminant
	→ $0 < p < 3$ aef	A1 [3]	cao (condone ⩽)

10	$y = \dfrac{8}{\sqrt{3x+4}}$		
(i)	$\dfrac{dy}{dx} = \dfrac{-4}{(3x+4)^{\frac{3}{2}}} \times 3$ aef	B1 B1	Without the "×3" For "×3" even if 1st B mark lost.
	$\rightarrow m_{(x=0)} = -\dfrac{3}{2}$ Perpendicular $m_{(x=0)} = \dfrac{2}{3}$	M1	Use of $m_1m_2 = -1$ after attempting to find $\dfrac{dy}{dx}_{(x=0)}$
	Eqn of normal $y - 4 = \dfrac{2}{3}(x - 0)$	M1	Unsimplified line equation
	Meets $x = 4$ at B $\left(4, \dfrac{20}{3}\right)$	A1 [5]	cao
(ii)	$\displaystyle\int \frac{8}{\sqrt{(3x+4)}}\,dx = \frac{8\sqrt{(3x+4))}}{\frac{1}{2}} \div 3$	B1 B1	Without "÷3". For "÷3"
	Limits from 0 to 4 $\rightarrow$ Area $P = \dfrac{32}{3}$	M1 A1	Correct use of correct limits. cao
	Area Q = Trapezium – P Area of Trapezium = $\dfrac{1}{2}\left(4 + \dfrac{20}{3}\right) \times 4 = \dfrac{64}{3}$	M1	Correct method for area of trapezium
	$\rightarrow$ Areas of P and Q are both $\dfrac{32}{3}$	A1 [6]	All correct.