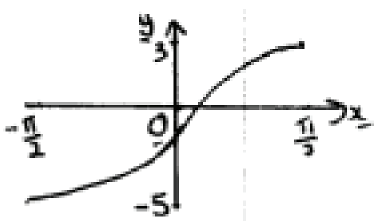
1	$\left(x-\frac{3}{2x}\right)^6$ Term is $^6C_3 \times x^3 \times \left(\frac{-3}{2x}\right)^3$ $\rightarrow -67.5$ oe	 **B1 B1** **B1** [3]	 B1 for Bin coeff. B1 for rest.
2	$3\sin^2\theta = 4\cos\theta - 1$ Uses $s^2 + c^2 = 1$ $\rightarrow 3c^2 + 4c - 4\ (= 0)$ $(\rightarrow c = \frac{2}{3}$ or $-2)$ $\rightarrow \theta = 48.2°$ or $311.8°$ 0.841, 5.44 rads, **A1** only (0.268π, 1.73π)	 **M1 A1** **A1 A1**√ [4]	 Equation in $\cos\theta$ only. All terms on one side of (=) For 360° − 1st answer.
3	$x = \frac{12}{y^2} - 2.$ Vol = $(\pi) \times \int x^2\,dy$ $\rightarrow \left[\frac{-144}{3y^3} + 4y + \frac{48}{y}\right]$ Limits 1 to 2 used $\rightarrow 22\pi$	 **M1** **3 × A1** **A1** [5]	 Ignore omission of π at this stage Attempt at integration Un-simplified only from correct integration
4 (i)	$\frac{dy}{dx} = 2 - 8(3x+4)^{-½}$ $(x = 0, \rightarrow \frac{dy}{dx} = -2\ )$ $\frac{dy}{dt} = \frac{dy}{dx} \times \frac{dx}{dt} \rightarrow -0.6$	 **M1A1** [2]	 Ignore notation. Must be $\frac{dy}{dx} \times 0.3$
(ii)	$y = \{2x\}\left\{-\frac{8\sqrt{3x+4}}{\frac{1}{2}} \div 3\right\}\ (+c)$ $x = 0, y = \frac{4}{3} \rightarrow c = 12.$	**B1 B1** **M1 A1** [4]	No need for $+c$. Uses x, y values after ∫ with c
5 (i)	$A = 2y \times 4x(= 8xy)$ $10y + 12x = 480$ $\rightarrow A = 384x - 9.6x^2$	**B1** **B1** **B1** [3]	 answer given

(ii)	$\frac{dA}{dx} = 384 - 19.2x$ $= 0$ when $x = 20$ $\rightarrow x = 20, y = 24.$ Uses $x = -\frac{b}{2a} = \frac{-384}{-19.2} = 20$, **M1, A1** $y = 24$, A1 From graph: **B1** for $x = 20$, **M1, A1** for $y = 24$	**B1** **M1** **A1** [3]	 Sets to 0 and attempt to solve oe Might see completion of square Needs both x and y Trial and improvement **B3**.
6 (a)	$y = 2x^2 - 4x + 8$ Equates with $y = mx$ and selects a, b, c Uses $b^2 = 4ac$ $\rightarrow m = 4$ or -12.	**M1** **M1** **A1** [3]	 Equate + solution or use of dy/dx Use of discriminant for both.
(b) (i)	$f(x) = x^2 + ax + b$ Eqn of form $(x-1)(x-9)$ $\rightarrow a = -10, b = 9$ (or using 2 sim eqns **M1 A1**)	**M1** **A1** [2]	Any valid method allow $(x+1)(x+9)$ for **M1** must be stated
(ii)	Calculus or $x = \frac{1}{2}(1 + 9)$ by symmetry $\rightarrow (5, -16)$	**M1** **A1** [2]	Any valid method
7 (i)	$CD = r\cos\theta$, $BD = r - r\sin\theta$ oe Arc $CB = r(\frac{1}{2}\pi - \theta)$ oe $\rightarrow P = r\cos\theta + r - r\sin\theta + r(\frac{1}{2}\pi - \theta)$ oe	**B1 B1** **B1** **B1**√ [4]	allow degrees but not for last B1 √ sum – assuming trig used
(ii)	Sector $= \frac{1}{2}.5^2.(\frac{1}{2}\pi - 0.6)$ (12.135) Triangle $= \frac{1}{2}.5\cos0.6.5\sin0.6$ (5.825) $\rightarrow$ Area = 6.31 (or $\frac{1}{4}$ circle − triangle – sector)	**M1** **M1** **A1** [3]	Uses $\frac{1}{2}r^2\theta$ Uses $\frac{1}{2}bh$ with some use of trig.

8	$y = 3x - \frac{4}{x}$		
	$\frac{dy}{dx} = 3 + \frac{4}{x^2}$	**B1**	
	m of $AB = 4$	**B1**	
	Equate $\rightarrow x = \pm 2$ $\rightarrow C\,(2, 4)$ and $D\,(-2, -4)$	**M1 A1**	Equating + solution.
	$\rightarrow M\,(0, 0)$ or stating M is the origin m of $CD = 2$	**B1**$\sqrt{}$	$\sqrt{}$ on their C and D
	Perpendicular gradient $(= -\frac{1}{2})$ $\rightarrow y = -\frac{1}{2}x$	**M1** **A1** [7]	Use of $m_1 m_2 = -1$, must use m_{CD} (not m = 4)
9 (a)	$a = 50$, $ar^2 = 32$	**B1**	seen or implied
	$\rightarrow r = \frac{4}{5}$ (allow $-\frac{4}{5}$ for M mark)	**M1**	Finding r and use of correct S_∞ formula
	$\rightarrow S_\infty = 250$	**A1** [3]	Only if $\|r\| < 1$
(b) (i)	$2\sin x$, $3\cos x$, $(\sin x + 2\cos x)$. $3c - 2s = (s + 2c) - 3c$ (or uses a, $a + d$, $a + 2d$)	**M1**	Links terms up with AP, needs one expression for d.
	$\rightarrow 4c = 3s \rightarrow t = \frac{4}{3}$	**M1 A1** [3]	Arrives at $t = k$. ag
	SC uses $t = \frac{4}{3}$ to show $u_1 = \frac{8}{5}, u_2 = \frac{9}{5}, u_3 = \frac{10}{5}$, **B1** only		
(ii)	$\rightarrow c = \frac{3}{5}$, $s = \frac{4}{5}$ or calculator $x = 53.1°$	**M1**	
	$\rightarrow a = 1.6$, $d = 0.2$	**M1**	Correct method for both a and d.
	$\rightarrow S_{20} = 70$	**A1** [3]	(Uses S_n formula)
10 (i)	$\overrightarrow{OA} = \begin{pmatrix} 2 \\ 1 \\ -2 \end{pmatrix}$, $\overrightarrow{OB} = \begin{pmatrix} 5 \\ -1 \\ k \end{pmatrix}$, $\overrightarrow{OC} = \begin{pmatrix} 2 \\ 6 \\ -3 \end{pmatrix}$		
	$10 - 1 - 2k = 0 \rightarrow k = 4\frac{1}{2}$	**M1 A1** [2]	Use of scalar product = 0.

(ii)	$\overrightarrow{AB} = \begin{pmatrix} 3 \\ -2 \\ k+2 \end{pmatrix}$,	**B1**	
	$\lvert\overrightarrow{OC}\rvert = 7$ (seen or implied)	**B1**	
	$3^2 + (-2)^2 + (k+2)^2 = 49$ $\rightarrow k = 4$ or -8	**M1 A1** [4]	Correct method. Both correct. Condone sign error in $\overrightarrow{AB}$
(iii)	$\lvert\overrightarrow{OA}\rvert = 3$		
	$\overrightarrow{OD} = 3\overrightarrow{OA} = \begin{pmatrix} 6 \\ 3 \\ -6 \end{pmatrix}$ and $\overrightarrow{OE} = 2$	**M1 A1**	Scaling from magnitudes / unit vector – oe.
	$\overrightarrow{OC} = \begin{pmatrix} 4 \\ 12 \\ -6 \end{pmatrix}$		
	$\overrightarrow{DE} = \overrightarrow{OE} - \overrightarrow{OD} = \begin{pmatrix} -2 \\ 9 \\ 0 \end{pmatrix}$,	**M1**	Correct vector subtraction.
	$\rightarrow$ Magnitude of $\sqrt{85}$.	**A1** [4]	
11 (i)	$f : x \rightarrow 4\sin x - 1$ for $-\frac{\pi}{2} \leqslant x \leqslant \frac{\pi}{2}$	**B1**	–5 and 3
	Range $-5 \leqslant f(x) \leqslant 3$	**B1** [2]	Correct range
(ii)	$4s - 1 = 0 \rightarrow s = \frac{1}{4} \rightarrow x = 0.253$	**M1 A1**	Makes sin$x$ subject. Degrees **M1 A0**, (14.5°)
	$x = 0 \rightarrow y = -1$	**B1** [3]	
(iii)		**B1**√ **B1** [2]	Shape from their range in (i) Flattens, curve.
(iv)	range $-\frac{1}{2}\pi \leqslant f^{-1}(x) \leqslant \frac{1}{2}\pi$	**B1**	
	domain $-5 \leqslant x \leqslant 3$	**B1**√	√ on part (i) (only for 2 numerical values)
	Inverse $f^{-1}(x) = \sin^{-1}\left(\frac{x+1}{4}\right)$	**M1 A1** [4]	Correct order of operations