11	**(a)**		$2u\mathrm{d}u = 2x\mathrm{d}x$	**B1**	**1.1a**	Any correct expression linking du and dx	Could be $\mathrm{d}u = \frac{1}{2}2x\left(x^2+3\right)^{-\frac{1}{2}}\mathrm{d}x$ or equiv in terms of u
			$\int \frac{4u\left(u^2-3\right)}{\sqrt{u^2}}\mathrm{d}u$	**M1***	**2.1**	Attempt to rewrite integrand in terms of u	Not just dx = du, unless from a clear attempt at du eg using $u = x + \sqrt{3}$
			$\int\left(4u^2-12\right)\mathrm{d}u$	**A1**	**1.1**	Obtain correct integrand	Allow unsimplified expression
			$\frac{4}{3}u^3 - 12u\left(+c\right)$	**M1dep***	**1.1**	Attempt integration	Simplify to form that can be integrated, then increase all powers by 1
			$\frac{4}{3}u(u^2-9)+c = \frac{4}{3}\left(x^2-6\right)\sqrt{x^2+3}+c$ **A.G.**	**A1** **[5]**	**2.1**	Obtain given answer, with at least one intermediate step seen	Need evidence of common factor (in terms of u or x) being taken out Condone omission of +c
	(b)		**DR** $\frac{4}{3}\left(\left(-5\times 2\right)-\left(-6\times\sqrt{3}\right)\right)$	**M1**	**2.1**	Attempt to use limits x = 0 and x = 1, or u = √3 and u = 2 in integral in terms of u	Correct order and subtraction Attempt to use both limits in their integral to give two terms DR so just stating decimal area is M0 Either using answer from (a) or their integration attempt with +2 or +3
			= $\frac{4}{3}\left(6\sqrt{3}-10\right)$ or 0.523	**A1**	**1.1**	Obtain correct area under curve	Accept exact (inc unsimplified) or decimal Using +2 gives $\frac{4}{3}\left(4\sqrt{2}-3\sqrt{3}\right)$ or 0.614
			$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{12x^2\left(x^2+3\right)^{\frac{1}{2}} - 4x^3.2x.\frac{1}{2}\left(x^2+3\right)^{-\frac{1}{2}}}{x^2+3}$	**M1**	**3.1a**	Attempt derivative using the quotient rule	Or equiv with product rule Need difference of two terms in numerator, at least one term correct, but allow subtraction in incorrect order Using either +2 or +3 equation

Question			Answer	Marks	AO	Guidance	
				A1	1.1	Obtain correct, unsimplified, derivative	With either +2 or +3
			at $x = 1$, $m = \frac{11}{2}$ hence $m' = -\frac{2}{11}$	M1	2.1	Attempt gradient of normal at $x = 1$	Substitute $x = 1$ and use negative reciprocal Using +2 gives $m' = -\frac{3}{32}\sqrt{3}$ Can be with m found BC
			$y-2=-\frac{2}{11}(x-1)$ when $y = 0$, $x = 12$	M1	1.1	Attempt to find point of intersection of normal with x-axis	Attempt equation of normal with their gradient and either (1, 2) or $\left(1,\frac{4}{3}\sqrt{3}\right)$, and then use $y = 0$ to find x intersection
			area = $8\sqrt{3}-\frac{40}{3}+11$ $=8\sqrt{3}-\frac{7}{3}$	A1	3.1a	Obtain correct area Allow any exact (including unsimplified) or decimal equivalent	From combining a correct area under curve and a correct area of triangle (either 11 or $\frac{64}{9}\sqrt{3}$), even if inconsistent Can still get A1 following M0 for area under curve BC and/or m found BC
				[7]			