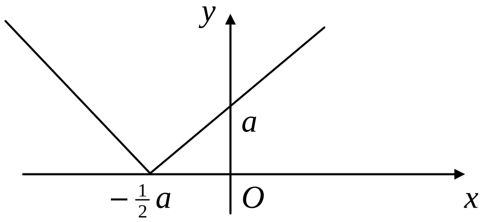
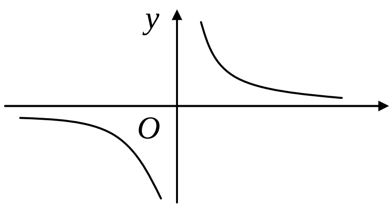
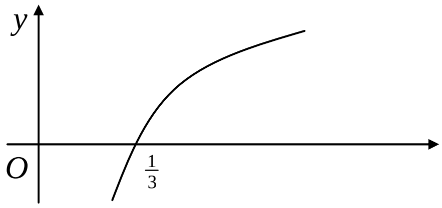
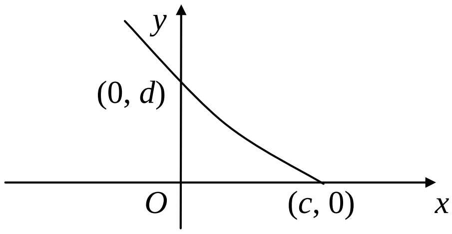
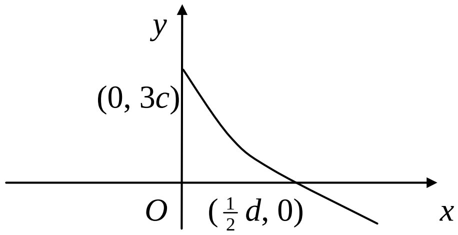
Question number	Scheme	Marks
1.	$x^2 - 9 = (x-3)(x+3)$ seen	B1
	Attempt at forming single fraction	
	$\dfrac{x(x-3)+(x+12)(x+1)}{(x+1)(x+3)(x-3)};= \dfrac{2x^2+10x+12}{(x+1)(x+3)(x-3)}$	M1; A1
	Factorising numerator = $\dfrac{2(x+2)(x+3)}{(x+1)(x+3)(x-3)}$ or equivalent = $\dfrac{2(x+2)}{(x+1)(x-3)}$	M1 M1 A1 **(6)**
		(6 marks)
2.	$(1+px)^n \equiv 1 + npx, + \dfrac{n(n-1)p^2x^2}{2} + \ldots$	B1, B1
	Comparing coefficients: $np = -18$, $\dfrac{n(n-1)}{2} = 36$	M1, A1
	Solving $n(n-1) = 72$ to give $n = 9$; $p = -2$	M1 A1; A1 ft **(7)**
		(7 marks)
3. (*a*)	 V graph with 'vertex' on x-axis	M1
	$\{-\frac{1}{2}a, (0)\}$ and $\{(0), a\}$ seen	A1 **(2)**
	 Correct graph (could be separate)	B1 **(1)**
(*c*)	Meet where $\dfrac{1}{x} = \lvert 2x+a \rvert \Rightarrow x\lvert 2x+a \rvert - 1 = 0$; only one meet	B1 **(1)**
(*d*)	$2x^2 + x - 1$	B1
	Attempt to solve; $x = \frac{1}{2}$ (no other value)	M1; A1 **(3)**
		(7 marks)

Question number	Scheme	Marks
4.	Volume = $\pi\int_1^4\left(1+\frac{1}{2\sqrt{x}}\right)^2 dx$	M1
	$\int\left(1+\frac{1}{2\sqrt{x}}\right)^2 dx = \int\left(1+\frac{1}{\sqrt{x}}+\frac{1}{4x}\right) dx$	B1
	$=\left[x+2\sqrt{x}+\frac{1}{4}\ln x\right]$	M1 A1 A1ft
	Using limits correctly	M1
	Volume = $\pi\left[\left(8+\frac{1}{4}\ln 4\right)+3\right]$	A1
	$=\pi\left[5+\frac{1}{2}\ln 2\right]$	A1 **(8)**
		(8 marks)
5. (*a*)	see table below	
	"y" = 7.80 when "x" = 4 or 6	B1
	Symmetry	B1 ft **(2)**
(*b*)	Estimate area = $\frac{2}{2}$ [0 + 2(6.13 + 7.80 + 7.80 + 6.13)]	B1 M1 A1ft
	= 55.7 m^2	A1 **(4)**
(*c*)	140 – (*b*) = 84.3 m^2	A1 ft **(1)**
(*d*)	Over-estimate;	B1
	reason, e.g. area under curve is under-estimate (due to curvature)	B1 **(2)**
		(9 marks)

Distance from one side (m)	0	2	4	6	8	10
Height (m)	0	6.13	**7.80**	**7.80**	**6.13**	0

Question number	Scheme	Marks
6. (*a*)	 Shape	B1
	$p = \frac{1}{3}$ or $\{\frac{1}{3}, 0\}$ seen	B1 **(2)**
(*b*)	Gradient of tangent at $Q = \dfrac{1}{q}$	B1
	Gradient of normal $= -q$	M1
	Attempt at equation of OQ $[y = -qx]$ and substituting $x = q$, $y = \ln 3q$	
	or attempt at equation of tangent $[y - 3 \ln q = -q(x - q)]$ with $x = 0$, $y = 0$	
	or equating gradient of normal to $(\ln 3q)/q$	M1
	$q^2 + \ln 3q = 0$ (*)	A1 **(4)**
(*c*)	$\ln 3x = -x^2 \Rightarrow 3x = e^{-x^2}$; $\Rightarrow x = \frac{1}{3}e^{-x^2}$	M1; A1 **(2)**
(*d*)	$x_1 = 0.298280$; $x_2 = 0.304957$, $x_3 = 0.303731$, $x_4 = 0.303958$	M1; A1
	Root = 0.304 (3 decimal places)	A1 **(3)**
		(11 marks)
7. (*a*)	$\sin x + \sqrt{3} \cos x = R \sin (x + \alpha)$	
	$= R (\sin x \cos \alpha + \cos x \sin \alpha)$	M1
	$R \cos \alpha = 1$, $R \sin \alpha = \sqrt{3}$	A1
	Method for R or α, e.g. $R = \sqrt{(1 + 3)}$ or $\tan \alpha = \sqrt{3}$	M1
	Both $R = 2$ and $\alpha = 60$	A1 **(4)**
(*b*)	$\sec x + \sqrt{3} \operatorname{cosec} x = 4 \Rightarrow \dfrac{1}{\cos x} + \dfrac{\sqrt{3}}{\sin x} = 4$	B1
	$\Rightarrow \sin x + \sqrt{3} \cos x = 4 \sin x \cos x$	M1
	$= 2 \sin 2x$ (*)	M1 **(3)**
(*c*)	Clearly producing $2 \sin 2x = 2 \sin (x + 60)$	A1 **(1)**
(*d*)	$\sin 2x - \sin (x + 60) = 0 \Rightarrow \cos \dfrac{3x + 60}{2} \sin \dfrac{x - 60}{2} = 0$	M1
	$\cos \dfrac{3x + 60}{2} = 0 \Rightarrow x = 40°, 160°$	M1 A1 A1 ft
	$\sin \dfrac{x - 60}{2} = 0 \Rightarrow x = 60°$	B1 **(5)**
		(13 marks)

Question number	Scheme	Marks
8. (*a*)	 shape	B1
	intersections with axes $(c, 0)$, $(0, d)$	B1 **(2)**
(*b*)	 shape	B1
	x intersection $(\frac{1}{2}d, 0)$	B1
	y intersection $(0, 3c)$	B1 **(3)**
(*c*)(i)	$c = 2$	B1
(ii)	$-1 < \mathrm{f}(x) \leq$ (candidate's) c value	B1 B1 ft **(3)**
(*d*)	$3(2^{-x}) = 1 \Rightarrow 2^{-x} = \frac{1}{3}$ and take logs; $-x = \dfrac{\ln\frac{1}{3}}{\ln 2}$	M1; A1
	d (or x) = 1.585 (3 decimal places)	A1 **(3)**
(*e*)	$\mathrm{fg}(x) = \mathrm{f}[\log_2 x] = [3(2^{-\log_2 x}) - 1]$; $= [3(2^{\log_2 \frac{1}{x}}) - 1]$ or $\dfrac{3}{2^{\log_2 x}} - 1$	M1; A1
	$= \dfrac{3}{x} - 1$	A1 **(3)**
		(14 marks)