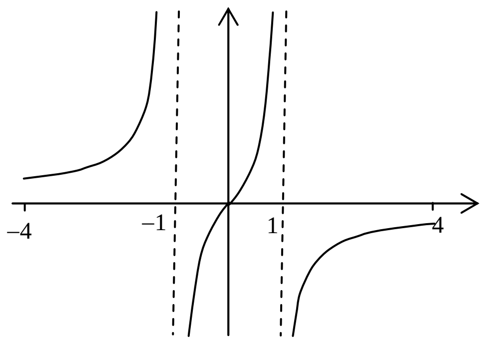
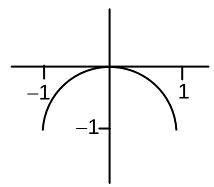
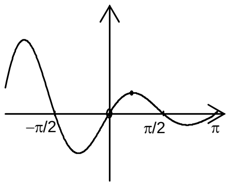
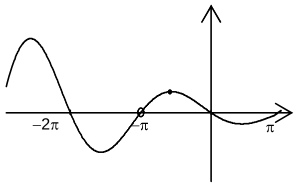
1	**(i)**		$\mathrm{f}(-x) = \dfrac{2(-x)}{1-(-x)^2}$ $= -\dfrac{2x}{1-x^2} = -\mathrm{f}(x)$	M1 A1 **[2]**	substitutin $-x$ for x in f(x)
	(ii)		 	M1 A1 **[2]**	Recognisable attempt at a half turn rotation about O Good curve starting from $x = -4$, asymptote $x = -1$ shown on graph. (Need not state – 4 and – 1 explicitly as long as graph is reasonably to scale.) Condone if curve starts to the left of $x = -4$.

2			fg(x) = ln(1+x^2) ($x \in \Re$) gf(x) = 1+(ln x)^2 ($x > 0$) ln(1+x^2) even 1 + (ln$x$)^2 neither	B1 B1 B1 B1 **[4]**	condone missing bracket, and missing or incorrect domains Penalise missing bracket Penalise missing bracket	If fg and gf the wrong way round, B1B0 not 1 + ln(x^2)

3	**(i)**		(One-way) stretch in y-direction, s.f. 2 or in x-direction s.f. ½ translation 1 to right (2 if followed by x-stretch) $y = 2\|x-1\|$	 B1 B1 B1 **[3]**	 must specify s.f. and direction o.e. e.g. $y = \|2x-2\|$ $y = \|2(x-1)\|$	Allow 'compress', 'squeeze'(for s.f. ½), but not 'enlarge', 'x-coordinates halved', etc Allow 'shift','move' or vector only, 'right 1' Don't allow misreads (e.g. transforming solid graph to dashed graph) Award B1 for one of these seen, and a second B1 if combined transformations are correct
	(ii)		Reflection in x-axis or translation right ±π or rotation of 180° [about O] translation +1 in y-direction (− 1 if followed by reflection in x-axis $y = 1 - \cos x$	 B1 B1 B1 **[3]**	 $\begin{pmatrix} \pm\pi \\ 1 \end{pmatrix}$ is B2 allow 1 + cos(x ±π) (bracket needed)	Translations as above. Reflection: must specify axis, allow 'flip' Rotation: condone no origin stated. *See additional notes for other possible solutions*. Award B1 for any one of these seen, and a second B1 if combined transformations are correct

Question			Answer	Marks	Guidance	
4	(i)		$1 - 9a^2 = 0$ $\Rightarrow a^2 = 1/9 \Rightarrow a = 1/3$	M1 A1 **[2]**	or $1 - 9x^2 = 0$ or 0.33 or better $\sqrt{(1/9)}$ is A0	$\sqrt{(1 - 9a^2)} = 1 - 3a$ is M0 not $a = \pm 1/3$ nor $x = 1/3$
4	(ii)		Range $0 \le y \le 1$	B1 **[1]**	or $0 \le f(x) \le 1$ or $0 \le f \le 1$, not $0 \le x \le 1$ $0 \le y \le \sqrt{1}$ is B0	allow also [0,1], or 0 to 1 inclusive, but not 0 to 1 or (0,1)
4	(iii)			M1 M1 A1 **[3]**	curve goes from $x = -3a$ to $x = 3a$ (or −1 to 1) vertex at origin curve, 'centre' (0,−1), from (−1, −1) to (1, −1) (y-coords of −1 can be inferred from vertex at O and correct scaling)	must have evidence of using s.f. 3 allow also if s.f.3 is stated and stretch is reasonably to scale allow from $(-3a, -1)$ to $(3a, -1)$ provided $a = 1/3$ or $x = [\pm]\ 1/3$ in (i) A0 for badly inconsistent scale(s)
5	(i)		$s(-x) = f(-x) + g(-x)$ $= -f(x) + -g(x)$ $= -(f(x) + g(x))$ $= -s(x)$ (so s is odd)	M1 A1 **[2]**	must have $s(-x) = \ldots$	
	(ii)		$p(-x) = f(-x)g(-x)$ $=(-f(x)) \times (-g(x))$ $= f(x)g(x) = p(x)$ so p is even	M1 A1 **[2]**	must have $p(-x) = \ldots$ Allow SC1 for showing that $p(-x) = p(x)$ using two specific odd functions, but in this case they must still show that p is even	e.g. $f(x) = x$, $g(x) = x^3$, $p(x) = x^4$ $p(-x) = (-x)^4 = x^4 = p(x)$, so p even condone f and g being the same function

6 (i) f(–x) = f(x) Symmetrical about Oy.	B1 B1 [2]	
(ii) (A) even (B) nei her (C) od	B1 B1 B1 [3]	

7 (i) (A) 	B1 B1	Zeros shown every π/2. Correct shape, from –π to π
(B) 	M1 A1 [4]	Translated in x-direction π to the left

(ii) $f'(x) = -\frac{1}{5}e^{-\frac{1}{5}x}\sin x + e^{-\frac{1}{5}x}\cos x$ $f'(x) = 0$ when $-\frac{1}{5}e^{-\frac{1}{5}x}\sin x + e^{-\frac{1}{5}x}\cos x = 0$ $\Rightarrow \frac{1}{5}e^{-\frac{1}{5}x}(-\sin x + 5\cos x) = 0$ $\Rightarrow \sin x = 5\cos x$ $\Rightarrow \frac{\sin x}{\cos x} = 5$ $\Rightarrow \tan x = 5$* $\Rightarrow x = 1.37(34\ldots)$ $\Rightarrow y = 0.75$ or $0.74(5\ldots)$	B1 B1 M1 E1 B1 B1 [6]	$e^{-\frac{1}{5}x}\cos x$ $\ldots -\frac{1}{5}e^{-\frac{1}{5}x}\sin x$ dividing by $e^{-\frac{1}{5}x}$ www 1.4 or better, must be in radians 0.75 or better
(iii) $f(x+\pi) = e^{-\frac{1}{5}(x+\pi)}\sin(x+\pi)$ $= e^{-\frac{1}{5}x}e^{-\frac{1}{5}\pi}\sin(x+\pi)$ $= -e^{-\frac{1}{5}x}e^{-\frac{1}{5}\pi}\sin x$ $= -e^{-\frac{1}{5}\pi}f(x)$ * $\int_{\pi}^{2\pi} f(x)dx$ let $u = x - \pi$, $du = dx$ $= \int_0^{\pi} f(u+\pi)du$ $= \int_0^{\pi} -e^{-\frac{1}{5}\pi} f(u)du$ $= -e^{-\frac{1}{5}\pi}\int_0^{\pi} f(u)du$ * Area enclosed between π and 2π $= (-)e^{-\frac{1}{5}\pi} \times$ area between 0 and π.	M1 A1 A1 E1 B1 B1dep E1 B1 [8]	 $e^{-\frac{1}{5}(x+\pi)} = e^{-\frac{1}{5}x}.e^{-\frac{1}{5}\pi}$ $\sin(x+\pi) = -\sin x$ www $\int f(u+\pi)du$ limits changed using above result or repeating work or multiplied by 0.53 or better