1 $\int_1^2 x^2 \ln x dx \quad u = \ln x \quad dv/dx = x^2 \Rightarrow v = \frac{1}{3}x^3$	M1	Parts with $u = \ln x$ $dv/dx = x^2 \Rightarrow v = x^3/3$
$= \left[\frac{1}{3}x^3 \ln x\right]_1^2 - \int_1^2 \frac{1}{3}x^3.\frac{1}{x}dx$	A1	
$= \frac{8}{3}\ln 2 - \int_1^2 \frac{1}{3}x^2 dx$		
$= \frac{8}{3}\ln 2 - \left[\frac{1}{9}x^3\right]_1^2$	A1	$\left[\frac{1}{9}x^3\right]$
$= \frac{8}{3}\ln 2 - \frac{8}{9} + \frac{1}{9}$	M1	substituting limits
$= \frac{8}{3}\ln 2 - \frac{7}{9}$	A1 cao [5]	o.e. – not ln 1

2(i) Asymptote when $1 + 2x^3 = 0$ $\Rightarrow$ $2x^3 = -1$ $\Rightarrow$ $x = -\frac{1}{\sqrt[3]{2}}$ $= -0.794$	M1 A1 A1cao [3]	 oe, condone $\pm\frac{1}{\sqrt[3]{2}}$ if positive root is rejected must be to 3 s.f.
(ii) $\frac{dy}{dx} = \frac{(1+2x^3).2x - x^2.6x^2}{(1+2x^3)^2}$ $= \frac{2x+4x^4-6x^4}{(1+2x^3)^2}$ $= \frac{2x-2x^4}{(1+2x^3)^2}$ * dy/dx = 0 when $2x(1 - x^3) = 0$ $\Rightarrow$ $x = 0, y = 0$ or $x = 1$, $y = 1/3$	M1 A1 E1 M1 B1 B1 B1 B1 [8]	Quotient or product rule: (udv–vdu M0) $2x(1+2x^3)^{-1} + x^2(-1)(1+2x^3)^{-2}.6x^2$ allow one slip on derivatives correct expression – condone missing bracket if if intention implied by following line derivative = 0 x = 0 or 1 – allow unsupported answers y = 0 and 1/3 SC–1 for setting denom = 0 or extra solutions (e.g. x = –1)
(iii) $A = \int_0^1 \frac{x^2}{1+2x^3}dx$	M1	Correct integral and limits – allow $\int_1^0$
either $= \left[\frac{1}{6}\ln(1+2x^3)\right]_0^1$ $= \frac{1}{6}\ln 3$ *	M1 A1 M1 E1	$k\ln(1 + 2x^3)$ $k = 1/6$ substituting limits dep previous M1 www
or let $u = 1 + 2x^3 \Rightarrow du = 6x^2dx$ $\Rightarrow$ $A = \int_1^3 \frac{1}{6}.\frac{1}{u}du$ $= \left[\frac{1}{6}\ln u\right]_1^3$ $= \frac{1}{6}\ln 3$ *	 M1 A1 M1 E1 [5]	 $\frac{1}{6u}$ $\frac{1}{6}\ln u$ substituting correct limits (but must have used substitution) www

3 (i) $x \cos 2x = 0$ when $x = 0$ or $\cos 2x = 0$ $\Rightarrow$ $2x = \pi/2$ $\Rightarrow$ $x = \frac{1}{4}\pi$ $\Rightarrow$ P is $(\pi/4, 0)$	M1 M1 A1 [3]	$\cos 2x = 0$ or $x = \frac{1}{2} \cos^{-1} 0$ $x = 0.785..$ or 45 is M1 M1 A0
(ii) $f(-x) = -x \cos(-2x)$ $= -x \cos 2x$ $= -f(x)$ Half turn symmetry about O.	M1 E1 B1 [3]	$-x \cos(-2x)$ $= -x \cos 2x$ Must have two of: rotational, order 2, about O, (half turn = rotational order 2)
(iii) $f'(x) = \cos 2x - 2x \sin 2x$	M1 A1 [2]	product rule
(iv) $f'(x) = 0 \Rightarrow \cos 2x = 2x \sin 2x$ $\Rightarrow$ $2x \frac{\sin 2x}{\cos 2x} = 1$ $\Rightarrow$ $x \tan 2x = \frac{1}{2}$ *	 M1 E1 [2]	 $\frac{\sin}{\cos} = \tan$ www
(v) $f'(0) = \cos 0 - 2.0.\sin 0 = 1$ $f''(x) = -2 \sin 2x - 2\sin 2x - 4x\cos 2x$ $= -4\sin 2x - 4x\cos 2x$ $\Rightarrow$ $f''(0) = -4\sin 0 - 4.0.\cos 0 = 0$	B1ft M1 A1 E1 [4]	allow ft on (their) product rule expression product rule on (2)$x \sin 2x$ correct expression – mark final expression www
(vi) Let $u = x$, $dv/dx = \cos 2x$ $\Rightarrow v = \frac{1}{2} \sin 2x$ $\int_0^{\pi/4} x \cos 2x dx = \left[\frac{1}{2} x \sin 2x\right]_0^{\pi/4} - \int_0^{\pi/4} \frac{1}{2} \sin 2x dx$ $= \frac{\pi}{8} + \left[\frac{1}{4} \cos 2x\right]_0^{\pi/4}$ $= \frac{\pi}{8} - \frac{1}{4}$ Area of region enclosed by curve and x-axis between $x = 0$ and $x = \pi/4$	M1 A1 A1 M1 A1 B1 [6]	Integration by parts with $u = x$, $dv/dx = \cos 2x$ $\left[\frac{1}{4} \cos 2x\right]$ - sign consistent with their previous line substituting limits – dep using parts www or graph showing correct area – condone P for $\pi/4$.