Question			Answer	Marks	AO	Guidance	
5	(a)	(i)	$y=\left(x^3-2x^2\right)\ln x \Rightarrow \frac{\mathrm{d}y}{\mathrm{d}x}=...$	M1	2.1	**M1** for attempt to differentiate using the product rule (oe) – answer must be of the form $\left(x^3-2x^2\right)\times\frac{k_1}{x}+\left(k_2x^2+k_3x\right)\ln x$ for non-zero constants k_1, k_2, k_3	Condone invisible brackets for this mark
			$\frac{\mathrm{d}y}{\mathrm{d}x}=\left(x^3-2x^2\right)\left(\frac{1}{x}\right)+\left(3x^2-4x\right)\ln x$	A1	1.1	**A1** for a correct first derivative (allow un-simplified)	Condone invisible brackets but only if correctly recovered at some stage
			$\frac{\mathrm{d}^2y}{\mathrm{d}x^2}=2x-2+\frac{3x^2-4x}{x}+(6x-4)\ln x$	A1	1.1	**A1** for a correct second derivative (allow un-simplified)	Condone invisible brackets but only if correctly recovered at some stage
			$\frac{\mathrm{d}^2y}{\mathrm{d}x^2}=0 \Rightarrow 2x-2+\frac{3x^2-4x}{x}+(6x-4)\ln x=0$	M1	1.1	Setting the second derivative (which if simplified would be of the form $ax+b+(cx+d)\ln x$ with non-zero constants a, b, c and d) equal to zero	
			$5x-6=(4-6x)\ln x \Rightarrow x=\frac{6+(4-6x)\ln x}{5}$	A1	2.2a	**AG** – so sufficient working must be shown – at least one intermediate line of working from second derivative set equal to zero to given answer	**Any** errors seen (e.g. any missing/invisible brackets) is **A0**
				[5]			

Question			Answer	Marks	AO	Guidance	
5	(a)	(ii)	$x_{n+1} = \frac{6+(4-6x_n)\ln x_n}{5}$ $x_1 = 1.1$ $x_2 = 1.150438...$ $x_3 = 1.118643...$ $x_4 = 1.139191...$ $x_5 = 1.126105...$ $x_6 = 1.134521...$	**B1**	**1.1**	Uses given result and given starting value (of 1.1) to obtain correct x_2 and x_3 (so first two iterations after the initial value of 1.1) to at least 2 dp (rot) – but all stated values in these two terms must be correct	
			x-coordinate of M is 1.13	**B1** **[2]**	**2.2a**	Must be stated to **2** dp only – **not dependent on the first B mark** – can be awarded if either of x_2 and x_3 are incorrect (assume that the iterative process corrected itself or a slip in the candidate writing down an earlier value)	Must be clear that x is 1.13 (and not the final term shown in the iterative process e.g. $x_6 = 1.13$ only is **B0**) – this mark can be awarded from using alternative iterative methods e.g. Newton-Raphson

Question			Answer	Marks	AO	Guidance	
5	(b)		Curve crosses the x-axis at 1 and 2	**B1***	**3.1a**	Correct x-intercepts (soi) – ignore mention of $x = 0$	Could be seen as limits on integral(s)
			$\int\left(x^3-2x^2\right)\ln x\,\mathrm{d}x=...$	**M1***	**2.1**	**M1** for attempt at integration by parts – **must be of the form** $(ax^4+bx^3)\ln x \pm \int (cx^4+dx^3)\times\frac{1}{x}(\mathrm{d}x)$ for non-zero constants a, b, c and d	Limits not required for this and the next two **A** marks (so condone incorrect limits too for these 3 marks)
			$=\left(\frac{1}{4}x^4-\frac{2}{3}x^3\right)\ln x-\int\left(\frac{1}{4}x^4-\frac{2}{3}x^3\right)\left(\frac{1}{x}\right)\mathrm{d}x$	**A1**	**1.1**	correct first application (allow un-simplified)	dx not required and integral sign(s) can be implied
			$=\left(\frac{x^4}{4}-\frac{2x^3}{3}\right)\ln x-\frac{x^4}{16}+\frac{2x^3}{9}(+c)$	**A1**	**1.1**	cao (allow un-simplified)	
			$\left\{\left(\frac{16}{4}-\frac{16}{3}\right)\ln 2-1+\frac{16}{9}\right\}-\left\{0-\frac{1}{16}+\frac{2}{9}\right\}$	**M1dep***	**1.1**	Uses correct limits completely correctly $\pm(F(2)-F(1))$ in **their** fully integrated expression – need not be simplified (or equivalent)	Do not condone invisible brackets unless recovered
			$\int_1^2\left(x^3-2x^2\right)\ln x\,\mathrm{d}x=-\frac{4}{3}\ln 2+\frac{89}{144}$ $\Rightarrow \text{Area}=\frac{4}{3}\ln 2-\frac{89}{144}$	**A1**	**3.2a**	Must be of this form but allow exact equivalents (for example, $\frac{1}{3}\ln 16-\frac{89}{144}$) but the p and r must be positive rational numbers and q must be a positive integer **Be aware of those who consider** $\int_1^2(2x^2-x^3)\ln x\,\mathrm{d}x$ **which is correct**	For reference – one possibility is: $p=\frac{4}{3}, q=2, r=\frac{89}{144}$ **These values do not need to be stated explicitly**
				[6]			