Question Number	Scheme	Marks
8(i)(a)	$g'(x) = 3e^{3x}\sec 2x + 2e^{3x}\sec 2x\tan 2x$	M1 A1 **(2)**
(b)	$g'(x) = 0 \Rightarrow e^{3x}\sec 2x(3 + 2\tan 2x) = 0$	M1
	$\tan 2x = -1.5 \Rightarrow x = -0.491$	dM1 A1 **(3)**
(ii)	$x = \ln(\sin y) \Rightarrow \frac{dx}{dy} = \frac{1}{\sin y} \times \cos y$	B1
	Attempts $\cos y = \sqrt{1-\sin^2 y} = \sqrt{1-e^{2x}}$ or $\frac{dy}{dx} = \frac{\sin y}{\cos y}$	M1
	Hence $\frac{dy}{dx} = \frac{\sin y}{\cos y} = \frac{e^x}{\sqrt{1-e^{2x}}}$	dM1 A1 **(4)**
		(9 marks)

(i)(a)

M1 Correct attempt at the product rule $g'(x) = Ae^{3x}\sec 2x + Be^{3x}\sec 2x\tan 2x$

For use of the quotient rule look for $\frac{A\cos 2x\, e^{3x} - Be^{3x}\sin 2x}{\cos^2 2x}$

A1 $g'(x) = 3e^{3x}\sec 2x + 2e^{3x}\sec 2x\tan 2x$ Allow in any form and then isw

For use of the quotient rule look for $\frac{3\cos 2x\, e^{3x} + 2e^{3x}\sin 2x}{\cos^2 2x}$

(i)(b)

M1 Sets $g'(x) = 0 \Rightarrow$ and takes out / factorises out $e^{3x}\sec 2x$ to identify a linear factor in tan2x

For the quotient rule they should be factorising out $\frac{e^{3x}}{\cos^2 2x}$ to leave a linear factor in $\cos 2x$ and $\sin 2x$

dM1 Correct order of operations to x = ...

For quotient rule approach they must use $\tan 2x = \frac{\sin 2x}{\cos 2x}$ (oe correct work)

You may need to check their answer if no method is shown. Accept awrt 2.s.f. for their tan 2x = …. in either radians or degrees.

A1 $x = awrt -0.491$ only in the range. If extra solutions arise from trying to solve sec2x = 0 then A0.

(ii)

B1 $\dfrac{\mathrm{d}x}{\mathrm{d}y}=\dfrac{1}{\sin y}\times\cos y$ OR $\mathrm{e}^{x}=\cos y\dfrac{\mathrm{d}y}{\mathrm{d}x}$ via $\mathrm{e}^{x}=\sin y$

M1 For one of the two operations needed to complete the proof

- Either an attempt to get $\cos y$ in terms of e^{x} look for an attempt using $\sin^2 y+\cos^2 y=1$ with $\sin y$ being replaced by e^{x}. Alternatively allow use of arcsin
- Or taking the reciprocal and making $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ the subject (variables must be consistent)

dM1 Applies both operations to obtain $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ in terms of just e^{x}

A1 $\dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{\mathrm{e}^{x}}{\sqrt{1-\mathrm{e}^{2x}}}$ or $\dfrac{\mathrm{e}^{x}}{\cos\left(\arcsin\mathrm{e}^{x}\right)}$ Allow $\dfrac{1}{\sqrt{1-\left(\mathrm{e}^{x}\right)^2}}$ or states $\mathrm{f}(x)=\sqrt{1-\mathrm{e}^{2x}}$ following a correct expression for $\dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{\mathrm{e}^{x}}{\cos y}$ or similar.

Alt:

B1 $x=\ln(\sin y)\Rightarrow y=\arcsin\left(\mathrm{e}^{x}\right)$

M1 $\Rightarrow\dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{1}{\sqrt{1-\left(\mathrm{e}^{x}\right)^2}}\times\ldots$ or $\Rightarrow\dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{1}{\sqrt{1-(\ldots)^2}}\times\mathrm{e}^{x}$

dM1 both of these

A1 $\dfrac{\mathrm{e}^{x}}{\sqrt{1-\left(\mathrm{e}^{x}\right)^2}}$

Question Number	Scheme	Marks
9 (a)	$x^2-x-12\overline{)x^4-x^3-10x^2+3x-9}$ $\quad x^2+2$ $x^4-x^3-12x^2$ $2x^2+3x-9$ $2x^2-2x-24$ $5x+15$	M1A1
	$\dfrac{x^4-x^3-10x^2+3x-9}{x^2+x-12} \equiv x^2+2+\dfrac{5(x+3)}{(x-4)(x+3)}$	M1
	$\equiv x^2+2+\dfrac{5}{(x-4)}$ or stating $P=2, Q=5$	A1
		(4)
(b)	$g'(x)=2x-\dfrac{5}{(x-4)^2}$	M1A1
	Subs $x=2$ into $g'(2)=2\times2-\dfrac{5}{(2-4)^2}=\dfrac{11}{4}$	M1
	Uses $m=g'(2)=\left(\dfrac{11}{4}\right)$ with $(2, g(2))=\left(2,\dfrac{7}{2}\right)$ to form equation of tangent	
	$y-\dfrac{7}{2}=\dfrac{11}{4}(x-2) \Rightarrow y=\dfrac{11}{4}x-2$	dM1A1
		(5)
(c)	$\int x^2+2+\dfrac{5}{(x-4)}\,dx=\dfrac{1}{3}x^3+2x,+5\ln\lvert x-4\rvert$	M1 A1ft
	Area $R=\left[\dfrac{1}{3}x^3+2x+5\ln\lvert x-4\rvert\right]_0^2=\left(\dfrac{8}{3}+4+5\ln 2\right)-\left(0+0+5\ln 4\right)$	dM1
	$=\dfrac{20}{3}+5\ln 2-5\ln 4=\dfrac{20}{3}-5\ln 2$	ddM1 A1
		(5)
		(14 marks)
Alt (a)	$x^4-x^3-10x^2+3x-9 \equiv (x^2+P)(x^2-x-12)+Q(x+3)$	M1
	Compare terms (OR sub in values) and solve simultaneously to find P and/or Q ie $x^2 \Rightarrow P-12=-10, \quad x \Rightarrow -P+Q=3, \quad \text{const} \Rightarrow -12P+3Q=-9$ $\Rightarrow P=\ldots$ or $Q=\ldots$	M1
	$P=2, Q=5$ *	A1,A1
	Award in the order shown here on ePEN.	

(a)

M1: Divides to obtain a quadratic quotient and a linear remainder. May divide by $(x-4)$ and then by $(x+3)$ or vice versa to reach these but must be a full process.

FYI: By $x+3$ first gives x^3-4x^2+2x-3 as quotient, followed by $x^2+2+\dfrac{5}{x-4}$