Question Number	Scheme	Marks
6 (a)	For correct parameter $t=\frac{\pi}{4}$ or x coordinate at P $x=4$	B1
	$\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{\mathrm{d}y/\mathrm{d}t}{\mathrm{d}x/\mathrm{d}t}=\frac{-4\sin 2t}{3\sec^2 t}$	M1 A1
	Equation of tangent $y-0=-\frac{2}{3}\left(x-4\right)\Rightarrow y=-\frac{2}{3}x+\frac{8}{3}$	dM1 A1
		(5)
(b)	$k=1-\sqrt{3}$	B1
		(1)
(c)	$-1,,\ \mathrm{f}\ ,,\ 2$	M1 A1
		(2)
		(8 marks)

(a)

B1: Correct parameter or x coordinate at P.

The correct x coordinate $x=4$ (can even be scored following $x=45°$)

M1: Attempts to find $\frac{\mathrm{d}y}{\mathrm{d}x}$ using $\frac{\mathrm{d}y/\mathrm{d}t}{\mathrm{d}x/\mathrm{d}t}$. Condone poor differentiation.

A1: Correct $\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{-4\sin 2t}{3\sec^2 t}$. You may see other forms for this following use of identities.

If you see $\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{-4\sin 2t}{3\sec^2 \underline{x}}$ then only allow if they subsequently use this as $\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{-4\sin 2t}{3\sec^2 t}$

Other possible correct gradients are $\frac{-8\sin t\cos t}{3\sec^2 t}$ and $\frac{-8\sin t\cos^3 t}{3}$

ISW after you see a correct answer. Quite often we see candidates incorrectly adapting a correct answer.

It is also possible for candidates to find $\frac{\mathrm{d}y}{\mathrm{d}t}$ at $t="\frac{\pi}{4}"$, $\frac{\mathrm{d}x}{\mathrm{d}t}$ at $t="\frac{\pi}{4}"$ and divide the two values.

dM1: Attempts to find the equation of the tangent at $t=\frac{\pi}{4}$

It is dependent upon the previous M and use of $\left(4,0\right)$ and $t=\frac{\pi}{4}$

Allow substitution into their adapted $\frac{\mathrm{d}y}{\mathrm{d}x}$

A1: $y=-\frac{2}{3}x+\frac{8}{3}$

(b)

B1: $k=1-\sqrt{3}$

(c)

M1: Either end correct. Allow strict inequalities here. E.g f < 2 scores M1 but f > 2 is M0

A1: $-1,,\ \mathrm{f}\ ,,\ 2$ o.e such as $\left[-1,2\right]$ and $-1,,\ y\ ,,\ 2$

Question Number	Scheme	Marks
7 (i)	$u = \mathrm{e}^x - 3 \Rightarrow \dfrac{\mathrm{d}u}{\mathrm{d}x} = \mathrm{e}^x$	B1
	$\displaystyle\int \frac{4\mathrm{e}^{3x}}{\mathrm{e}^x - 3}\,\mathrm{d}x = \int \frac{4(u+3)^3}{u(u+3)}\,\mathrm{d}u = \int \frac{4(u+3)^2}{u}\,\mathrm{d}u$	M1 A1
	$\displaystyle = \int \frac{4u^2 + 24u + 36}{u}\,\mathrm{d}u$	
	$\displaystyle = \int 4u + 24 + \frac{36}{u}\,\mathrm{d}u = 2u^2 + 24u + 36\ln u$	dM1 A1
	$= \left[2u^2 + 24u + 36\ln u\right]_{u=2}^{u=4}$	M1
	$= 72 + 36\ln 2$	A1
		(7)
(ii)	$\displaystyle\int 3\mathrm{e}^x \cos 2x\,\mathrm{d}x = \frac{3}{2}\mathrm{e}^x \sin 2x - \int \frac{3}{2}\mathrm{e}^x \sin 2x\,\mathrm{d}x$	M1 A1
	$\displaystyle = \frac{3}{2}\mathrm{e}^x \sin 2x - \left(-\frac{3}{4}\mathrm{e}^x \cos 2x + \int \frac{3}{4}\mathrm{e}^x \cos 2x\,\mathrm{d}x\right)$	dM1
	Collect terms $\dfrac{15}{4}\displaystyle\int \mathrm{e}^x \cos 2x\,\mathrm{d}x = \frac{3}{2}\mathrm{e}^x \sin 2x + \frac{3}{4}\mathrm{e}^x \cos 2x$	ddM1
	$\displaystyle\int 3\mathrm{e}^x \cos 2x\,\mathrm{d}x = \frac{6}{5}\mathrm{e}^x \sin 2x + \frac{3}{5}\mathrm{e}^x \cos 2x\,(+c)$	A1
		(5)
		(12 marks)

(i) The 4 must be present to score the A marks. No misreads

B1: States or uses $\dfrac{\mathrm{d}u}{\mathrm{d}x} = \mathrm{e}^x$ o.e.such as $\dfrac{\mathrm{d}x}{\mathrm{d}u} = \dfrac{1}{u+3}$ This may be seen within the integrand.

M1: A "correct" attempt to write the integrand in terms of u.

Look for $\displaystyle\int \frac{4\mathrm{e}^{3x}}{\mathrm{e}^x - 3}\,\mathrm{d}x = \int \frac{P(u \pm 3)^3}{u(u \pm 3)}\,\mathrm{d}u$ which does not need to be simplified.

Condone a missing du but dx is M0

A1: Correct $\displaystyle\int \frac{4(u+3)^2}{u}\,\mathrm{d}u$. Condone a missing d$u$ (cannot be dx) .

dM1: Integrates by attempting to multiply out and integrating each term.

Look for two "correct" terms, one of which must be $\displaystyle\int \frac{P}{u}\,\mathrm{d}u = P\ln u$.

It is dependent upon having achieved $\displaystyle\int \frac{P(u \pm 3)^2}{u}\,\mathrm{d}u$

A1: Correct $2u^2 + 24u + 36\ln u$ o.e.

M1: Uses limits 2 and 4 within their attempted integral and subtracts . Condone poor attempts at the integration

Alternatively converts their answer in u back to x's using the correct substitution and uses the given limits.

There must have been some attempt to use the substitution $u = \mathrm{e}^x - 3$ at some point.