Question Number	Scheme	Marks
8. (a)	$f'(x) = 6(2x+1)^2 e^{-4x} - 4(2x+1)^3 e^{-4x}$	M1 A1
	$= 2(2x+1)^2 e^{-4x}\{3-2(2x+1)\}$	dM1
	$= 2(2x+1)^2(1-4x)e^{-4x}$	A1
		(4)
(b)	Sets $f'(x) = 0 \Rightarrow x = -\frac{1}{2}, \frac{1}{4}$	B1
	Either $f\left("-\frac{1}{2}"\right) = ...$ or $f\left("\frac{1}{4}"\right) = ...$	M1
	Both $\left(-\frac{1}{2}, 0\right)$ and $\left(\frac{1}{4}, \frac{27}{8e}\right)$	A1
		(3)
(c)	$\left(\frac{9}{4}, \frac{27}{e}\right)$	B1ft B1ft
		(2)
		9 marks

Notes

(a)

M1 Attempts the product rule to achieve $P(2x+1)^2 e^{-4x} \pm Q(2x+1)^3 e^{-4x}$
May also be attempted by the quotient rule - equivalent form after e terms cancel.

A1 $f'(x) = 6(2x+1)^2 e^{-4x} - 4(2x+1)^3 e^{-4x}$ which may be unsimplified

dM1 Correctly takes out a common factor of $(2x+1)^2 e^{-4x}$ from their expression with an intermediate step before the final answer. Allow if there are minor slips in the $(2x+1)^2 e^{-4x}$ as a factor (such as $(2x+)^2 e^{-4x}$) if recovered - look for the correct remaining terms in the bracket { }. Allow going from an expanded cubic to a factorised form for this mark:
$e^{-4x}\left(2-24x^2-32x^3\right) \rightarrow 2(2x+1)^2(1-4x)e^{-4x}$.

A1 Achieves $2(2x+1)^2(1-4x)e^{-4x}$ with no incorrect algebra. Accept with the brackets in either order.

(b)

B1 $x = -\frac{1}{2}, \frac{1}{4}$ o.e. Both required.

M1 Attempts to substitute one of $x = \pm\frac{1}{2}, \pm\frac{1}{4}$ into f(x). If substitution not seen may be implied by either of $\left(-\frac{1}{2}, 0\right)$ or $\left(\frac{1}{4}, \frac{27}{8e}\right)$ o.e (accept awrt 1.24 for this mark) or by either of $\left(\frac{1}{2}, \frac{8}{e^2}\right)$ (awrt 1.08) or $\left(-\frac{1}{4}, \frac{e}{8}\right)$ (awrt 0.340) o.e.

A1 For $\left(-\frac{1}{2}, 0\right)$ and $\left(\frac{1}{4}, \frac{27}{8e}\right)$ o.e. must be exact but isw after exact coordinates given.
Allow as x = .., y =… as long as clearly paired.
Allow the M and A marks if seen in part (c) - mark (b) and (c) together.

(c)

B1ft One correct aspect applied correctly to one of their points. So for either 2 added to one of their x coordinates, or a non-zero y coordinate multiplied by 8. E.g. either $\left(\frac{9}{4},...\right)$ or $\left(...,\frac{27}{e}\right)$ or follow through on $\left("\frac{1}{4}"+2,...\right)$ or $\left(...,8\times"\frac{27}{8e}"\right)$ etc.

B1ft $\left(\frac{9}{4},\frac{27}{e}\right)$ only or follow through on the y coordinate only so $\left(\frac{9}{4},8\times"\frac{27}{8e}"\right)$ (oe) **only**. B0 if another point is given. Accept awrt 9.93 for second ordinate but note 9.92 is a correct follow through on 1.24. Allow as $x = \frac{9}{4}$, $y =\ldots$.

SC allow B1B0 if coordinates given wrong way round.

Question Number	Scheme	Marks
9(a)	$\frac{\cos 2x}{\sin x}+\frac{\sin 2x}{\cos x}=\frac{\cos 2x}{\sin x}+\frac{2\sin x\cos x}{\cos x}$ (One Correct identity)	B1
	$=\frac{1-2\sin^2 x}{\sin x}+\frac{2\sin x\cancel{\cos x}}{\cancel{\cos x}}$	M1
	$=\frac{1}{\sin x}-\frac{2\sin\cancel{^2}x}{\cancel{\sin x}}+2\sin x=\frac{1}{\sin x}=\text{cosec } x$ *	A1*
		(3)
(b)	E.g. Equation is $\text{cosec}^2\theta=6\cot\theta-4\Rightarrow 1+\cot^2\theta=6\cot\theta-4$	M1
	E.g. $\cot^2\theta-6\cot\theta+5=0$	A1
	E.g. $\tan\theta=\frac{1}{5},1$	dM1
	$\theta=0.197,\frac{\pi}{4}$	A1, A1
		(5)
(c)	$\int_{\frac{\pi}{6}}^{\frac{\pi}{4}}\text{cosec}x\cot x\,\text{d}x=\left[-\text{cosec}x\right]_{\frac{\pi}{6}}^{\frac{\pi}{4}}$	M1
	$=2-\sqrt{2}$	A1
		(2)
		10 marks

Notes

(a) **There are lots of ways of proving this statement. In general score as follows**

B1 For applying at least one CORRECT double or compound angle identity during the proof or for forming a CORRECT single fraction initially.

M1 For a correct overall strategy, e.g. applying double angle identities to reduce terms to single angle arguments and cancelling down terms to eliminate cos *x* terms (score at the stage cos *x* terms could be eliminated), or attempting a single fraction and applying relevant identities to achieve single angle argument with common factor cos *x* in the numerator. Allow slips in signs, such as $\cos 2x=1\pm 2\sin^2 x$ for the M but otherwise identities used must be correct.

A1* Fully correct proof showing all necessary steps, though the left hand side may be implied (and may follow initial lines of aside working). Must see the $\frac{1}{\sin x}\rightarrow \text{cosec } x$ during the proof . Do not penalise minor notational slips such as missing an *x* in one term.

(b)

M1 Correctly applies the result of (a) and attempts to use relevant identities, allowing sign errors e.g. $\pm 1\pm\cot^2\theta=\text{cosec}^2\theta$ to produce an equation in $\cot\theta$ or other single trig term only. An alternative is

$$\frac{1}{\sin^2\theta}=6\frac{\cos\theta}{\sin\theta}-4\Rightarrow 1=6\sin\theta\cos\theta-4\sin^2\theta\Rightarrow\left(1+4\sin^2\theta\right)^2=36\sin^2\theta\left(1-\sin^2\theta\right)$$

A1 Correct quadratic $\cot^2\theta-6\cot\theta+5=0$ or $5\tan^2\theta-6\tan\theta+1=0$. In the alternative, a correct quadratic in $\sin^2\theta$ or $\cos^2\theta$ e.g. $52\sin^4\theta-28\sin^2\theta+1=0$. The "=0" may be implied by an attempt to solve. May be implied by correct solutions following an unsimplified quadratic.

dM1 Attempts to solve quadratic to find at least one value for their trig term used. Usual rules, may use calculator.

A1 One correct value for θ following from a correct value for the trig term they are working in — must have solved a correct quadratic in the dM. Accept awrt 0.197 or 0.785. Degrees answer are A0A0.