Question Number	Scheme	Marks
6. (a)	$f'(x) = 6(2x-3)^2 e^{4x-2} + 4(2x-3)^3 e^{4x-2}$	M1 A1
	$= 2(2x-3)^2 e^{4x-2}\{3+2(2x-3)\} = 2(4x-3)(2x-3)^2 e^{4x-2}$	dM1 A1
		(4)
(b) (i)	$x = \frac{3}{2}, \frac{3}{4}$	B1 ft
(ii)	Attempts $f\left(\frac{3}{4}\right) = \left(-\frac{3}{2}\right)^3 e^1 = -\frac{27}{8}e, \Rightarrow g\left(\frac{3}{4}\right) = -27e$	M1, A1
	$-27e \leqslant g(x) \leqslant 0$ g g ş	A1
		(4)
		(8 marks)

(a)

M1: Attempts the product rule and achieves $f'(x) = \alpha(2x-3)^2 e^{4x-2} + \beta(2x-3)^3 e^{4x-2}$ where $\alpha > 0, \beta > 0$

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

dM1: Correctly takes out a common factor of $(2x-3)^2 e^{4x-2}$ out of $\alpha(2x-3)^2 e^{4x-2} + \beta(2x-3)^3 e^{4x-2}$

Look for $f'(x) = \alpha(2x-3)^2 e^{4x-2} + \beta(2x-3)^3 e^{4x-2} = (2x-3)^2 e^{4x-2}\{\alpha + \beta(2x-3)\}$

A1: $2(4x-3)(2x-3)^2 e^{4x-2}$ following M1, A1, dM1. The order of the terms is not important.

Allow the dM1 to be implied for candidates who go directly from

$6(2x-3)^2 e^{4x-2} + 4(2x-3)^3 e^{4x-2} \rightarrow 2(4x-3)(2x-3)^2 e^{4x-2}$

Marks in part (b) can only be scored following a correct method of differentiation in part (a)

So only allow if $f'(x)$ was of the form $\alpha(2x-3)^2 e^{4x-2} + \beta(2x-3)^3 e^{4x-2}$

They cannot be scored following made up values for *P* and *Q*.

They cannot just appear as this would be relying entirely upon a calculator.

(b)(i)

B1ft: $x = \frac{3}{2}$ and $\frac{3}{4}$ following $f'(x) = 2(4x-3)(2x-3)^2 e^{4x-2}$

Alternatively, candidates can set

$f'(x) = 6(2x-3)^2 e^{4x-2} + 4(2x-3)^3 e^{4x-2} = 0$ and solve to reach $x = \frac{3}{2}$ and $\frac{3}{4}$

If part (a) is not correct follow through on their

- factorised $2(Px+Q)(2x-3)^2 e^{4x-2}$ following M1 and some attempt to combine the terms (not necessarily correctly) in part(a), so award for $x = \frac{3}{2}$ and $-"\frac{Q}{P}"$
- solution of $\alpha(2x-3)^2 e^{4x-2} + \beta(2x-3)^3 e^{4x-2} = 0$ **leading** to the solutions $x = \frac{3}{2}, \frac{3\beta - \alpha}{2\beta}$

(b)(ii)

M1: Attempts to find $f\left("\frac{3}{4}"\right)=\left(-\frac{27}{8}e\right)$ but allow decimal approximation e.g. AWRT -9.17

or attempts to find $g\left("\frac{3}{4}"\right)=\left(-27e\right)$ but allow decimal approximation e.g. AWRT -73.4.

The mark is implied by correct or rounded values following the correct method of differentiation This can only be awarded following a correct method in part (a) and of finding the $f\left(-"\frac{Q}{P}\right)'$ or $g\left(-"\frac{Q}{P}\right)'$

A1: Correct exact value for $g\left(\frac{3}{4}\right)=-27e$ which must be exact

A1: Correct range for g. Look for $-27e \leqslant g \leqslant 0$ or equivalent such as $g \in [-27e,\ 0]$ or $-27e \leqslant y \leqslant 0$

Note that $-27e \leqslant g < 0$ and $-27e < g < 0$ are incorrect

Question Number	Scheme	Marks
7 (a)	$\sin 4\theta \equiv 2\sin 2\theta\cos 2\theta$	M1
	$\equiv 2\left(2\sin\theta\cos\theta\right)\left(1-2\sin^2\theta\right)$	dM1
	$\equiv 4\sin\theta\cos\theta - 8\sin^3\theta\cos\theta$	
	$\equiv \sin\theta\cos\theta\left(4-8\sin^2\theta\right)$	A1
		(3)
(b)	$\sec x\sin 4x = 5\sin^3 x\cot x$	
	$\frac{1}{\cos x}\times\cos x\sin x\left(4-8\sin^2 x\right) = 5\sin^3 x\cot x$	B1
	$\div\sin x \Rightarrow\ 4-8\sin^2 x = 5\sin^2 x\cot x$	
	$\div\cos^2 x \Rightarrow\ 4\sec^2 x - 8\tan^2 x = 5\tan^2 x\cot x$	M1
	$\Rightarrow 4\sec^2 x - 5\tan x - 8\tan^2 x = 0$ *	A1*
		(3)
(c)	Uses $\sec^2 x = 1+\tan^2 x$	M1
	$\Rightarrow 4\tan^2 x + 5\tan x - 4 = 0$	A1
	$\Rightarrow \tan x = \frac{-5\pm\sqrt{89}}{8} \Rightarrow x = ...$	dM1
	$\Rightarrow x =$ awrt 0.506, 2.08	A1
		(4)
		(10 marks)

(a)

M1: Uses the double angle formula for $\sin 4\theta$ to get $2\sin 2\theta\cos 2\theta$ o.e. such as $\sin 2\theta\cos 2\theta + \cos 2\theta\sin 2\theta$

dM1: Uses the double angle formulae $\sin 2\theta = K\sin\theta\cos\theta$ and $\cos 2\theta = \pm 1\pm 2\sin^2\theta$ to obtain $\sin 4\theta$ in terms of just $\sin\theta$ and $\cos\theta$. If they use one of the other identities for $\cos 2\theta$, either $\pm 2\cos^2\theta \pm 1$ or $\cos^2\theta - \sin^2\theta$, they must subsequently change the $\cos^2\theta$ terms to $1-\sin^2\theta$

A1: Reaches $\sin 4\theta \equiv \sin\theta\cos\theta\left(4-8\sin^2\theta\right)$

Withold this mark if there are mixed variables e.g. $\sin 4\theta \equiv 2\sin 2x\cos 2x$ and incorrect notation e.g. $\cos 2\theta \equiv 1-2\sin\theta^2$ used within the body of the proof.

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You may well see more complicated versions of this proof.

For example,

$\sin 4\theta \equiv \sin\left(3\theta+\theta\right) = \sin 3\theta\cos\theta + \cos 3\theta\sin\theta$

followed by $= \sin\left(2\theta+\theta\right)\cos\theta + \cos\left(2\theta+\theta\right)\sin\theta$

$= \sin 2\theta\cos^2\theta + \cos 2\theta\sin\theta\cos\theta + \cos 2\theta\cos\theta\sin\theta - \sin 2\theta\sin\theta\sin\theta$

In this method the M1 is scored for the line above but you can condone sign slips