Question Number	Scheme	Marks
6 (a)	$\frac{\mathrm{d}}{\mathrm{d}x}(12y) = 12\frac{\mathrm{d}y}{\mathrm{d}x}$	B1
	$4y^2 + 8xy\frac{\mathrm{d}y}{\mathrm{d}x} + 12\frac{\mathrm{d}y}{\mathrm{d}x} + 6 = 0$	M1, A1
	$\Rightarrow \frac{\mathrm{d}y}{\mathrm{d}x} = \frac{-4y^2 - 6}{8xy + 12} = \frac{-2y^2 - 3}{4xy + 6}$	M1, A1
		(5)
(b)	Deduces that $4xy + 6 = 0$	B1ft
	Substitutes $y = -\frac{3}{2x}$ into $4xy^2 + 12y + 6x = 53$	M1
	$\Rightarrow \frac{9}{x} - \frac{18}{x} + 6x = 53 \Rightarrow 6x^2 - 53x - 9 = 0$	A1
	$\Rightarrow (6x+1)(x-9) = 0 \Rightarrow x = ...$	dM1
	$\Rightarrow a = 9, b = -\frac{1}{6}$ but allow $P = \left(9, -\frac{1}{6}\right)$	A1
		(5)
		(10 marks)

(a)

B1: Correct differentiation $\frac{\mathrm{d}}{\mathrm{d}x}(12y) = 12\frac{\mathrm{d}y}{\mathrm{d}x}$ but allow equivalents such as $12y'$

M1: Correct attempt at the product rule on $4xy^2 \rightarrow pxy\frac{\mathrm{d}y}{\mathrm{d}x} + qy^2$

A1: Correct differentiation.

If they write $\frac{\mathrm{d}y}{\mathrm{d}x} = 4y^2 + 8xy\frac{\mathrm{d}y}{\mathrm{d}x} + 12\frac{\mathrm{d}y}{\mathrm{d}x} + 6$ it is A0 unless further work suggests that this is not what they meant. Allow y' or $\dot{y}$ for $\frac{\mathrm{d}y}{\mathrm{d}x}$. You may also see $4y^2\mathrm{d}x + 8xy\,\mathrm{d}y + 12\,\mathrm{d}y + 6\mathrm{d}x = 0$ which is fine.

M1: Collects exactly two $\frac{\mathrm{d}y}{\mathrm{d}x}$ terms together, one from each from the differentiation of $4xy^2$ and $12y$, and makes $\frac{\mathrm{d}y}{\mathrm{d}x}$ the subject. Note that the differentiation of the product rule could be incorrect e.g. $4xy^2 \rightarrow 8xy\frac{\mathrm{d}y}{\mathrm{d}x}$

A1: $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{-2y^2 - 3}{4xy + 6}$ o.e such as $\frac{\mathrm{d}y}{\mathrm{d}x} = -\frac{2y^2 + 3}{4xy + 6}$ but must be in simplest form

(b) Via HENCE

B1ft: Correctly deduces that $4xy+6=0$. Condone if they set $2y^2+3=0$ as well as $4xy+6=0$

Follow through on their denominator of $\frac{\mathrm{d}y}{\mathrm{d}x}$ as long as it is of the form $axy+b \quad a,b\neq 0$

M1: Substitutes their $y=-\frac{3}{2x}$ into $4xy^2+12y+6x=53$ to set up a 3TQ equation in x.

Alternatively substitutes their $x=-\frac{3}{2y}$ into $4xy^2+12y+6x=53$ to set up a 3TQ equation in y.

The denominator in (a) needs to be of the form $axy+b$ but the rearrangement may be incorrect.

A1: Correct 3TQ equation in x or y. FYI the correct simplified equation in y is $6y^2-53y-9=0$

dM1: It is dependent upon the previous M. Solves their 3TQ equation in x or y by a correct method.

Condone the use of a calculator here but the solution(s) must be correct for their equation

A1: CSO a or $x=9$, b or $y=-\frac{1}{6}$ but allow $P=\left(9,-\frac{1}{6}\right)$. Note that if $P=\left(-\frac{1}{6},9\right)$ is also found it must be rejected. All previous marks must have been awarded in (b). Note also that this mark can only be awarded following a correct simplified or unsimplified $\frac{\mathrm{d}y}{\mathrm{d}x}$ under this method.

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Some candidates will use their equation solvers to make short cuts to solve equations that are not in the 3TQ form, e.g. $-\frac{9}{x}+6x=53$. If they proceed to $x=9, y=-\frac{1}{6}$ o.e. they can score

SC: B1, M0, A0, dM1, A1

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(b) Alt via OTHERWISE. Works on the premise that y will have real roots

$4xy^2 + 12y + (6x - 53) = 0$

$(12)^2 - 4 \times 4x \times (6x - 53) \geqslant 0$

$6x^2 - 53x - 9 \leqslant 0$

$(x - 9)(6x + 1) \leqslant 0$

$-\frac{1}{6} \leqslant x \leqslant 9$

The following is a suggested way of applying the MS but if you see a solution that you feel deserves more credit then please send to review.

B1: Sets up as a quadratic in y with $a = 4x, b = 12, c = 6x - 53$ and uses within $b^2 - 4ac...0$

M1: Attempts $b^2 - 4ac \geqslant 0$ or $b^2 - 4ac > 0$ with $a = 4x, b = 12, c = 6x - 53$ condoning slips

A1: $6x^2 - 53x - 9 \geqslant 0$ or $6x^2 - 53x - 9 > 0$

dM1: Solves their $6x^2 - 53x - 9...0 \Rightarrow x = ...,...$ and finds the inside region.

A1: CSO $a = 9, b = -\frac{1}{6}$ but allow $P = \left(9, -\frac{1}{6}\right)$.

Note that, via this method, this mark can be awarded following an incorrect part (a)

Question Number	Scheme	Marks
7 (i)	Way One: $\int \mathrm{e}^{2x}\cos 4x\,\mathrm{d}x = \frac{1}{4}\mathrm{e}^{2x}\sin 4x - \int \frac{1}{2}\mathrm{e}^{2x}\sin 4x\,\mathrm{d}x$	M1, A1
	$= \frac{1}{4}\mathrm{e}^{2x}\sin 4x - \left(-\frac{1}{8}\mathrm{e}^{2x}\cos 4x + \int \frac{1}{4}\mathrm{e}^{2x}\cos 4x\,\mathrm{d}x\right)$	dM1, A1
	$\frac{5}{4}\int \mathrm{e}^{2x}\cos 4x\,\mathrm{d}x = \frac{1}{4}\mathrm{e}^{2x}\sin 4x + \frac{1}{8}\mathrm{e}^{2x}\cos 4x$	ddM1
	$\Rightarrow \int \mathrm{e}^{2x}\cos 4x\,\mathrm{d}x = \frac{1}{5}\mathrm{e}^{2x}\sin 4x + \frac{1}{10}\mathrm{e}^{2x}\cos 4x + c$	A1
		(6)
(ii)	$2x = \sin u \Rightarrow 2\mathrm{d}x = \cos u\,\mathrm{d}u$	
	$\int \frac{2x^3}{\sqrt{1-4x^2}}\,\mathrm{d}x = \int \frac{1}{8}\frac{\sin^3 u}{\sqrt{1-\sin^2 u}} \times \cos u\,\mathrm{d}u$	M1
	$= \int \frac{1}{8}\sin^3 u\,\mathrm{d}u$	A1
	$= \int \frac{1}{8}\sin u\left(1-\cos^2 u\right)\mathrm{d}u = \int \frac{1}{8}\sin u - \frac{1}{8}\sin u\cos^2 u\,\mathrm{d}u$	dM1
	$= \left[-\frac{1}{8}\cos u + \frac{1}{24}\cos^3 u\right]$	ddM1 A1
	States or uses limits $\frac{\pi}{6}$ and $\frac{\pi}{3}$ E.g. $\left(-\frac{1}{8}\cos\frac{\pi}{3} + \frac{1}{24}\cos^3\frac{\pi}{3}\right) - \left(-\frac{1}{8}\cos\frac{\pi}{6} + \frac{1}{24}\cos^3\frac{\pi}{6}\right)$	M1
	$= \frac{3}{64}\sqrt{3} - \frac{11}{192}$	A1
		(7)
		(13 marks)

(i) Condone missing dx's throughout

M1: Integrates by parts to a correct form. E.g.

$$\int \mathrm{e}^{2x}\cos 4x\,\mathrm{d}x = \pm A\mathrm{e}^{2x}\sin 4x \pm \int B\mathrm{e}^{2x}\sin 4x\,\mathrm{d}x$$

A1: Correct integration $\frac{1}{4}\mathrm{e}^{2x}\sin 4x - \int \frac{1}{2}\mathrm{e}^{2x}\sin 4x\,\mathrm{d}x$ which may be left unsimplified

dM1: Integrates again in the same direction to

$$\pm A\mathrm{e}^{2x}\sin 4x \pm B\mathrm{e}^{2x}\cos 4x \pm C\int \mathrm{e}^{2x}\cos 4x\,\mathrm{d}x$$