Question Number	Scheme	Marks
6(i)	$\left(\frac{\mathrm{d}y}{\mathrm{d}x}=\right)\ \frac{4x}{2x^2+5}$	M1A1
		(2)
(ii)	$\int \frac{21x}{3x^2+k}\mathrm{d}x=\frac{7}{2}\ln(3x^2+k)\ \ (+c)$	M1A1
	$\left[\frac{7}{2}\ln(3x^2+k)\right]_1^k<7\ln 8\Rightarrow\frac{7}{2}\ln\left(\frac{3k^2+k}{3+k}\right)<7\ln 8\Rightarrow\frac{3k^2+k}{3+k}<64$	M1
	$\frac{3k^2+k}{3+k}(<)64\Rightarrow 3k^2-63k-192\ \ (<0)\Rightarrow k=\ldots$	dM1
	$k=23$	A1
		(5)
		(7 marks)

awarded if subsequent working was correct.

(i)

M1: $\frac{\ldots}{2x^2+5}$. Allow with anything for the …

A1: $\left(\frac{\mathrm{d}y}{\mathrm{d}x}=\right)\ \frac{4x}{2x^2+5}$ o.e. and isw

(ii)

M1: Attempts to integrate to an expression of the form $A\ln(3x^2+k)$ or $B\ln\left(x^2+\frac{k}{3}\right)$. Allow for cancelling x's e.g $\frac{Ax\ln(3x^2+k)}{x}$ (Allow A or B to be 1)

A1: $\frac{7}{2}\ln(3x^2+k)$ o.e. with or without the constant of integration. Condone missing brackets for this mark and condone if extra integral symbols are left in.

M1: Attempts to substitute in the limits into their changed expression (which must involve ln), sets the expression less than $7\ln 8$ (condone an equation)

and uses correct log laws to remove lns – including correct bracketing used. You may allow ln 8 to be written as a decimal but any ln or exponential work must be correct. Note the form for their integral must be such that they are able to use log laws to remove lns.

dM1: Rearranges their inequality (may be an equation), proceeds to a three-term quadratic in k and attempts to find a value for k (usual rules apply for solving a quadratic – if using a calculator the value(s) must be correct for their equation). It is dependent on the previous method mark.

A1: 23 cao

Question Number	Scheme	Marks
7	$\left(\dfrac{\mathrm{d}y}{\mathrm{d}x}=\right) 2\mathrm{e}^{x^2+(3k-2)x}+2x\mathrm{e}^{x^2+(3k-2)x}\times\left(2x+(3k-2)\right)$ $\Rightarrow 2x^2+(3k-2)x+1=0 \Rightarrow (3k-2)^2-4\times2\times1$ $9k^2-12k-4\left(>0\right)$ $9k^2-12k-4=0 \Rightarrow k=\dfrac{12\pm\sqrt{(-12)^2-4\times9\times(-4)}}{2\times9} \Rightarrow k=\ldots$ $k<\dfrac{2-2\sqrt{2}}{3}$ or $k>\dfrac{2+2\sqrt{2}}{3}$	M1A1A1 dM1A1 M1A1
		(7 marks)

M1: Attempts the product rule achieving $\left(\dfrac{\mathrm{d}y}{\mathrm{d}x}=\right) A\mathrm{e}^{\left(x^2+(3k-2)x\right)}+\mathrm{e}^{\left(x^2+(3k-2)x\right)}\times\mathrm{f}(x)$ where f(x) is a quadratic function of x, condone missing/misplaced brackets for the M.

A1: One of $2\mathrm{e}^{x^2+(3k-2)x}$ or $2x\mathrm{e}^{x^2+(3k-2)x}\times\left(2x+(3k-2)\right)$ (unsimplified)

A1: Correct unsimplified derivative

dM1: Sets their derivative equal to zero (may be implied), collects terms and attempts b^2-4ac on a 3 term quadratic – must be extracted not just part of the quadratic formula. It is dependent on the previous method mark.

A1: $(3k-2)^2-8(>0)$ or equivalent quadratic expression or multiple thereof. Need not be simplified.

M1: Must have attempted $\dfrac{\mathrm{d}y}{\mathrm{d}x}=0$ and reached a quadratic in k. Attempts to solve their quadratic in k (including via a calculator) and attempts the outside region for their critical values (accept with endpoints included.). Accept with decimals answer correct to 3 s.f. for this mark.

A1: $k<\dfrac{2-2\sqrt{2}}{3}$ or $k>\dfrac{2+2\sqrt{2}}{3}$ or exact equivalent. Allow with "and" instead of "or" when given as two ranges, but use of set notation must use union, not intersection. E.g. $k\in\left(-\infty,\dfrac{2-2\sqrt{2}}{3}\right)\cup\left(\dfrac{2+2\sqrt{2}}{3},\infty\right)$

Alternative method via implicit differentiation scores the same way with M1A1A1 for correct differentiation. M1 for a correct form of derivative statement up to constant/sign errors.