Question Number	Scheme	Marks
7	$x = 6\sin^2 2y \Rightarrow \dfrac{\mathrm{d}x}{\mathrm{d}y} = 24\sin 2y\cos 2y$	M1 A1
	Attempts to use $\dfrac{\mathrm{d}y}{\mathrm{d}x} = 1 \div \dfrac{\mathrm{d}x}{\mathrm{d}y}$	M1
	Attempts to use both $\sin 2y = \sqrt{\dfrac{x}{6}}$ and $\cos 2y = \sqrt{1-\sin^2 2y} = \sqrt{1-\dfrac{x}{6}}$	M1
	$\dfrac{\mathrm{d}y}{\mathrm{d}x} = \dfrac{1}{24\sin 2y\cos 2y} = \dfrac{1}{24\times\sqrt{\dfrac{x}{6}}\times\sqrt{1-\dfrac{x}{6}}} = \dfrac{1}{4\sqrt{6x-x^2}}$	A1
		(5)
Way 2	$x = 6\sin^2 2y = 3-3\cos 4y \Rightarrow \dfrac{\mathrm{d}x}{\mathrm{d}y} = 12\sin 4y$	M1A1
	Attempts to use $\dfrac{\mathrm{d}y}{\mathrm{d}x} = 1 \div \dfrac{\mathrm{d}x}{\mathrm{d}y}$	M1
	Attempts to use $\sin 4y = \dfrac{\sqrt{6x-x^2}}{3}$	M1
	$\dfrac{\mathrm{d}y}{\mathrm{d}x} = \dfrac{1}{12\sin 4y} = \dfrac{1}{12\times\dfrac{\sqrt{6x-x^2}}{3}} = \dfrac{1}{4\sqrt{6x-x^2}}$	A1
Way 3	$x = 6\sin^2 2y = 24\sin^2 y\cos^2 y \Rightarrow \dfrac{\mathrm{d}x}{\mathrm{d}y} = 48\sin y\cos^3 y - 48\sin^3 y\cos y$	M1A1
	Attempts to use $\dfrac{\mathrm{d}y}{\mathrm{d}x} = 1 \div \dfrac{\mathrm{d}x}{\mathrm{d}y}$	M1
	$\dfrac{\mathrm{d}y}{\mathrm{d}x} = \dfrac{1}{48\sin y\cos^3 y - 48\sin^3 y\cos y} = \dfrac{1}{48\sin y\cos y\left(\cos^2 y-\sin^2 y\right)}$ $\dfrac{\mathrm{d}y}{\mathrm{d}x} = \dfrac{1}{24\sin 2y\cos 2y} = \dfrac{1}{24\times\sqrt{\dfrac{x}{6}}\times\sqrt{1-\dfrac{x}{6}}}$	M1
	$= \dfrac{1}{4\sqrt{6x-x^2}}$	A1
		(5 marks)

In general, apply the following marking guidance for this question:

M1: Attempts to differentiate to obtain $\frac{dx}{dy}$ in a correct form

A1: Correct derivative

M1: Attempts to use $\frac{dy}{dx}=1\div\frac{dx}{dy}$.

M1: Change fully to a function of x.

A1: All correct

E.g.

M1: Attempts to use the chain rule on the rhs to achieve $k\sin 2y\cos 2y$

A1: Fully correct derivative $\frac{dx}{dy}=24\sin 2y\cos 2y$

M1: Attempts to use $\frac{dy}{dx}=1\div\frac{dx}{dy}$.

Condone a slip on the coefficient. E.g. $\frac{dx}{dy}=24\sin 2y\cos 2y\Rightarrow\frac{dy}{dx}=\frac{24}{\sin 2y\cos 2y}$

Do not condone slips/errors on the variable. E.g. $\frac{dx}{dy}=24\sin 2y\cos 2y\Rightarrow\frac{dy}{dx}=\frac{1}{24\sin 2x\cos 2x}$

M1: Attempts to change both $\sin 2y$ and $\cos 2y$ to functions in x.

Expect to see $\sin 2y=p\sqrt{x}$ and $\cos 2y=\sqrt{1-qx}$

A1: CSO $\frac{dy}{dx}=\frac{1}{4\sqrt{6x-x^2}}$

Way 2

M1: Differentiates to obtain $k\sin 4y$

A1: Fully correct derivative $\frac{dx}{dy}=12\sin 4y$

M1: Attempts to use $\frac{dy}{dx}=1\div\frac{dx}{dy}$.

Condone a slip on the coefficient. E.g. $\frac{dx}{dy}=12\sin 4y\Rightarrow\frac{dy}{dx}=\frac{12}{\sin 4y}$

M1: Attempts to change both $\sin 4y$ to a function in x.

Expect to see $\sin 4y=p\sqrt{6x-x^2}$ or equivalent e.g. $\sin 4y=p\sqrt{9-\left(9-6x+x^2\right)}$

A1: CSO $\frac{dy}{dx}=\frac{1}{4\sqrt{6x-x^2}}$

Way 3

M1: Differentiates to obtain $A\sin y\cos^3 y + B\sin^3 y\cos y$

A1: Fully correct derivative $\dfrac{\mathrm{d}x}{\mathrm{d}y} = 48\sin y\cos^3 y - 48\sin^3 y\cos y$

M1: Attempts to use $\dfrac{\mathrm{d}y}{\mathrm{d}x} = 1 \div \dfrac{\mathrm{d}x}{\mathrm{d}y}$.

M1: Attempts to change both $\sin 2y$ and $\cos 2y$ to functions in x.

Expect to see $\sin 2y = p\sqrt{x}$ and $\cos 2y = \sqrt{1-qx}$

A1: CSO $\dfrac{\mathrm{d}y}{\mathrm{d}x} = \dfrac{1}{4\sqrt{6x - x^2}}$

A possible alternative:

$$x = 6\sin^2 2y \Rightarrow \sin 2y = \sqrt{\frac{x}{6}} \Rightarrow 2y = \sin^{-1}\sqrt{\frac{x}{6}} \Rightarrow y = \frac{1}{2}\sin^{-1}\sqrt{\frac{x}{6}}$$

M1: For a correct attempt to make y or $2y$ the subject

A1: Correct rearrangement

$$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{1}{2} \times \frac{1}{\sqrt{1-\frac{x}{6}}} \times \frac{1}{12}\left(\frac{x}{6}\right)^{-\frac{1}{2}}$$

M1: For $\dfrac{A}{\sqrt{1-\frac{x}{6}}} \times ...$ M1: For $... \times B\left(\dfrac{x}{6}\right)^{-\frac{1}{2}}$

A1: CSO $\dfrac{\mathrm{d}y}{\mathrm{d}x} = \dfrac{1}{4\sqrt{6x - x^2}}$

Question Number	Scheme	Marks
8(a)	200	B1
		(1)
(b)	600	B1
		(1)
(c)	$500 = \dfrac{600\mathrm{e}^{0.3t}}{2+\mathrm{e}^{0.3t}} \Rightarrow 100\mathrm{e}^{0.3t} = 1000, \Rightarrow \mathrm{e}^{0.3t} = 10$	M1, A1
	$\Rightarrow t = \dfrac{\ln 10}{0.3} = 7$ years 8 months	dM1 A1
		(4)
(d)	$N = \dfrac{600\mathrm{e}^{0.3t}}{2+\mathrm{e}^{0.3t}} \Rightarrow \dfrac{\mathrm{d}N}{\mathrm{d}t} = \dfrac{\left(2+\mathrm{e}^{0.3t}\right)\times 180\mathrm{e}^{0.3t} - 180\mathrm{e}^{0.3t}\times\mathrm{e}^{0.3t}}{\left(2+\mathrm{e}^{0.3t}\right)^2}$	M1 A1
	$\Rightarrow \dfrac{\mathrm{d}N}{\mathrm{d}t} = \dfrac{360\mathrm{e}^{0.3t}}{\left(2+\mathrm{e}^{0.3t}\right)^2}$	A1 **(3)**
(e)	$8 = \dfrac{360\mathrm{e}^{0.3t}}{\left(2+\mathrm{e}^{0.3t}\right)^2} \Rightarrow 8\left(\mathrm{e}^{0.3t}\right)^2 - 328\left(\mathrm{e}^{0.3t}\right) + 32 = 0$	M1
	$\mathrm{e}^{0.3t} = \dfrac{41+\sqrt{1665}}{2}$	dM1
	$(t=)\dfrac{\ln\left(\dfrac{41+\sqrt{1665}}{2}\right)}{0.3}$	ddM1
	$(T=)$awrt 12.4	A1
		(4)
		(13 marks)

(a)

B1: 200

(b)

B1: 600

(c)

M1: Sets $N = 500$ and proceeds to $C\mathrm{e}^{0.3t} = D$ or equivalent

A1: $\mathrm{e}^{0.3t} = 10$. If ln's are taken earlier it would be for $\ln 100 + 0.3t = \ln 1000$

dM1: Full method to find a value for *t* using correct log work.

A1: 7 years 8 months. Accept 7 years 9 months following a correct value of *t*.