Question	Scheme	Marks	AOs
12(a)(i)	$y \times \dfrac{\mathrm{d}x}{\mathrm{d}t} = 5\sin 2t \times 6\cos t$ or $5 \times 2\sin t\cos t \times 6\cos t$	M1	1.2

	(Area =) $\int 5\sin 2t \times 6\cos t \, \mathrm{d}t = \int 5 \times 2\sin t \cos t \times 6\cos t \, \mathrm{d}t$ or $\int 5\sin 2t \times 6\cos t \, \mathrm{d}t = \int 60\sin t \cos^2 t \, \mathrm{d}t$	dM1	1.1b
	(Area =) $\int_0^{\frac{\pi}{2}} 60\sin t \cos^2 t \, \mathrm{d}t$ *	A1*	2.1*
		(3)	
(a)(ii)	$\int 60\sin t \cos^2 t \, \mathrm{d}t = -20\cos^3 t$	M1 A1	1.1b 1.1b
	Area = $\left[-20\cos^3 t\right]_0^{\frac{\pi}{2}} = 0-(-20) = 20$ *	A1*	2.1
		(3)	
(b)	$5\sin 2t = 4.2 \Rightarrow \sin 2t = \frac{4.2}{5}$	M1	3.4
	$t = 0.4986..., 1.072...$	A1	1.1b
	Attempts to finds the x values at both t values	dM1	3.4
	$t = 0.4986... \Rightarrow x = 2.869...$ $t = 1.072 \Rightarrow x = 5.269...$	A1	1.1b
	Width of path = 2.40 metres	A1	3.2a
		(5)	
			(11 marks)

Notes:

(a)(i)

M1: Attempts to multiply y by $\frac{\mathrm{d}x}{\mathrm{d}t}$ to obtain $A\sin 2t\cos t$ but may apply $\sin 2t = 2\sin t\cos t$ here

dM1: Attempts to use $\sin 2t = 2\sin t\cos t$ within an integral which may be implied by

e.g. $A\int \sin 2t \times \cos t \, \mathrm{d}t = \int k\sin t\cos^2 t \, \mathrm{d}t$

A1*: Fully correct work leading to the given answer.

This must include $\sin 2t = 2\sin t\cos t$ or e.g. $5\sin 2t = 10\sin t\cos t$ seen explicitly in their proof and a correct intermediate line that includes an integral sign and the "dt"

Allow the limits to just "appear" in the final answer e.g. working need not be shown for the limits.

(a)(ii)

M1: Obtains $\int 60\sin t\cos^2 t \, \mathrm{d}t = k\cos^3 t$. This may be attempted via a substitution of $u = \cos t$ to obtain

$\int 60\sin t\cos^2 t \, \mathrm{d}t = ku^3$

A1: Correct integration $-20\cos^3 t$ or equivalent e.g. $-20u^3$

A1*: Rigorous proof with all aspects correct including the correct limits and the $0-(-20)$ and

not just: $-20\cos^3\frac{\pi}{2} - \left(-20\cos^3 0\right) = 20$

(b)

M1: Uses the given model and attempts to find value(s) of t when $\sin 2t = \frac{4.2}{5}$. Look for $2t = \sin^{-1}\frac{4.2}{5} \Rightarrow t = ...$

A1: At least one correct value for t, correct to 2 dp. FYI $t = 0.4986..., 1.072...$ or in degrees t = 28.57…, 61.42…

dM1: Attempts to find **TWO** distinct values of x when $\sin 2t = \dfrac{4.2}{5}$. Condone poor trig work and allow this mark if 2 values of x are attempted from 2 values of t.

A1: Both values correct to 2 dp. NB $x = 2.869\ldots,\ 5.269\ldots$

Or may take Cartesian approach

$$5\sin 2t = 4.2 \Rightarrow 10\sin t\cos t = 4.2 \Rightarrow 10\frac{x}{6}\sqrt{1-\frac{x^2}{36}} = 4.2 \Rightarrow x^4 - 36x^2 + 228.6144 = 0 \Rightarrow x = 2.869\ldots, 5.269\ldots$$

M1: For converting to Cartesian form A1: Correct quartic M1: Solves quartic A1: Correct values

A1: 2.40 metres or 240 cm

Allow awrt 2.40 m or allow 2.4m (not awrt 2.4 m) and allow awrt 240 cm. **Units are required**.