Q	Marking Instructions	AO	Marks	Typical Solution
3(a)	Translates proportionality into a differential equation involving $\frac{dA}{dt}$, A and a constant of proportionality.	AO3.3	M1	$\frac{dA}{dt} \propto A$ $\Rightarrow \frac{dA}{dt} = kA$ $\Rightarrow \int \frac{1}{A}\, dA = \int k\, dt$ $\Rightarrow \ln A = kt + c$ $\Rightarrow A = e^{kt+c}$ $\Rightarrow A = Be^{kt}$ **AG**
	Separates variables	AO1.1a	M1	
	Integrates both of 'their' sides correctly	AO1.1b	A1F	
	Constructs a rigorous mathematical argument that supports use of the given model. **AG** Only award if they have a completely correct solution, which is clear, easy to follow and contains no slips.	AO2.1	R1	
(b)(i)	States correct value of B	AO1.1b	B1	$B = 0.25$ or $B = \frac{1}{4}$
(b)(ii)	Uses $t = 20$ and $A = 0.5$ to find k	AO3.1b	M1	When $t = 20$, $A = 0.5$ $\Rightarrow 0.5 = 0.25e^{20k}$ $\Rightarrow 20k = \ln 2$ $\Rightarrow k = \frac{1}{20}\ln 2$ $\Rightarrow A = \frac{1}{4}(e^{\ln 2})^{\frac{t}{20}}$ $\Rightarrow A = 2^{-2} \times 2^{\frac{t}{20}}$ $\Rightarrow A = 2^{\frac{t}{20}-2}$ **AG**
	Finds correct value of k	AO1.1b	A1	
	Substitutes 'their' k to get A in terms of t	AO1.1a	M1	
	Constructs rigorous and convincing argument to show $A = 2^{\frac{t}{20}-2}$ Using correct notation throughout. **AG**	AO2.1	R1	
(b)(iii)	Uses the model to set up correct equation and attempt to find t	AO3.4	M1	$2\pi = 2^{\frac{t}{20}-2}$ $t = 93.03$ days
	Finds correct value of t	AO1.1b	A1	
(c)	States any sensible and relevant limitation of the model that is specified in terms of the pond, area, weed, rate of change or time.	AO3.5b	E1	Model predicts that the area of weed will increase without limit and this is not possible since the area of the pond is 4π
(d)	Any sensible and relevant refinement to the model that is specified in terms of the pond, area, weed, rate of change or time	AO3.5c	E1	Introduce a limiting factor such as fish eating weed or rate of growth decreases as surface area covered
	Total		**13**	