Question	Scheme	Marks	AOs
13 (a)	Substitutes $t = 8 \Rightarrow N = 65 - 3e^{0.8} = (58.32)$	M1	3.4
	Reduction in level of nitrate in first 8 hours $= 62 - 58.32$	dM1	3.1b
	$= 3.68$ (ppm)	A1	1.1b
		(3)	
(b)	Substitutes $N = 20 \Rightarrow 20 = 65 - 3e^{0.1t} \Rightarrow 3e^{0.1t} = 45$	M1	3.4
	Correct use of ln's $\Rightarrow 0.1t = \ln(15) \Rightarrow t = ...$	dM1	1.1b
	$t =$ awrt 27.1 hours	A1	1.1b
		(3)	
(c)	Any valid limitation e.g. • If it rains then the concentration will be reduced naturally • The treatment might not be uniform throughout the pond so the fish may not be safe in some areas of the pond even after 27.1 hours • When $t > 30.76$ the concentration becomes negative which cannot happen • The model predicts negative concentration levels for certain values of t. E.g. $t = 40 \Rightarrow N \approx -99$ ppm	B1	3.5b
		(1)	
		(7 marks)	

Notes:

(a)

M1: Substitutes $t = 8 \Rightarrow N = 65 - 3e^{0.8} = (58.3)$

dM1: Attempts $N_{t=8} - N_{t=0}$ but accept $N_{t=0} - N_{t=8}$

A1: Awrt 3.68 (ppm)

(b)

M1: Substitutes $N = 20$ and proceeds to a form $Pe^{0.1t} = Q$

dM1: Uses correct ln work and proceeds to a value for t.

A1: For awrt 27.1 (hours)

(c)

B1: For stating any valid limitation of the model

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Solutions in (b) via trial and improvement or other numerical methods.
Any correct answer following a solution not involving lns can be awarded SC 100
E.g. $N = 20 \Rightarrow 20 = 65 - 3e^{0.1t} \Rightarrow 3e^{0.1t} = 45 \Rightarrow t = 27.1$