Q	Marking instructions	AO	Marks	Typical solution
20(a)	Models the rate of change of depth using an equation of the form $\frac{\mathrm{d}h}{\mathrm{d}t} = \pm k(h-5)$	3.3	M1	$\frac{\mathrm{d}h}{\mathrm{d}t} = -k(h-5)$ when $h = 130$, $\frac{\mathrm{d}h}{\mathrm{d}t} = -1.5$ $\Rightarrow -1.5 = -k \times 125$ $k = 0.012$ $\frac{\mathrm{d}h}{\mathrm{d}t} = -0.012(h-5)$
	Substitutes $h = 130$ and $\frac{\mathrm{d}h}{\mathrm{d}t} = \pm 1.5$ into $\frac{\mathrm{d}h}{\mathrm{d}t} = \pm k(h-5)$	3.1b	M1	
	Completes argument with no sign slips to show $\frac{\mathrm{d}h}{\mathrm{d}t} = -0.012(h-5)$	2.1	R1	
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
20(b)	Separates variables to obtain an equation of the form $\int \frac{A}{h-5}\,\mathrm{d}h = \int B\,\mathrm{d}t$ PI by $\ln(h-5) = -0.012t$ OE	3.1a	M1	$\frac{1}{h-5}\frac{\mathrm{d}h}{\mathrm{d}t} = -0.012$ $\int \frac{1}{h-5}\,\mathrm{d}h = \int -0.012\,\mathrm{d}t$ $\ln(h-5) = -0.012t + c$ $h-5 = A\mathrm{e}^{-0.012t}$ $t = 0, h = 130 \Rightarrow A = 125$ $h = 5 + 125\mathrm{e}^{-0.012t}$
	Integrates one of their integrals of the form $\int \frac{A}{h-5}\,\mathrm{d}h$ or $\int B\,\mathrm{d}t$ correctly. PI by $\ln(h-5) = -0.012t$ OE	1.1a	M1	
	Obtains correct integrated equation. Condone missing $+ c$	1.1b	A1	
	Uses $t = 0, h = 130$ to obtain their constant of integration.	3.1b	M1	
	Obtains $5 + 125\mathrm{e}^{-0.012t}$ OE Accept $5 + \mathrm{e}^{-0.012t+p}$ where p =ln125 or AWRT 4.83	3.3	A1	
	Subtotal		**5**	

Q	Marking instructions	AO	Marks	Typical solution
20(c)	Uses h = 65 in their answer from part (b) and obtains a final positive value	3.4	M1	$5+125e^{-0.012t}=65$ $t=61.164$
	Obtains AWRT 61 minutes Accept 62 minutes Must have correct units	3.2a	A1	61 minutes
	Subtotal		**2**	

	Question 20 Total		**10**	