

Q	Marking instructions	AO	Marks	Typical solution
10(a)	Obtains $\ln Ae^{-kt} = \ln(21 \pm \theta)$ or $\ln e^{-kt} = \ln \frac{21 \pm \theta}{A}$ or $-kt = \ln \frac{21 \pm \theta}{A}$	3.1a	M1	$\theta = 21 - Ae^{-kt}$ $Ae^{-kt} = 21 - \theta$ $\ln Ae^{-kt} = \ln(21 - \theta)$ $\ln A + \ln e^{-kt} = \ln(21 - \theta)$ $\ln A - kt = \ln(21 - \theta)$
	Obtains $\ln Ae^{-kt} = \ln A + \ln e^{-kt}$ or $\ln \frac{21 \pm \theta}{A} = \ln(21 \pm \theta) - \ln A$	1.1a	M1	
	Completes reasoned argument to obtain $\ln(21 - \theta) = -kt + \ln A$ AG	2.1	R1	
	Subtotal		3	

Q	Marking instructions	AO	Marks	Typical solution
10(b)(i)	States $\ln A = 3.676$	3.4	M1	$\ln A = 3.676$ $A = e^{3.676} = 39.5$
	Obtains AWRT 39.5	1.1b	A1	
	Subtotal		2	

Q	Marking instructions	AO	Marks	Typical solution
10(b)(ii)	Obtains $\pm \frac{3.676}{19.98}$ Or Substitutes their value of A or $\ln A = 3.676$, $t = 19.98$ and $\ln(21 - \theta) = 0$ to form an equation for k	3.4	M1	$-k = -\frac{3.676}{19.98}$ $k = 0.1839\dots$ $= 0.184$
	Obtains AWRT $k = 0.184$	1.1b	A1	
	Subtotal		2	

Q	Marking instructions	AO	Marks	Typical solution
10(b)(iii)	Uses the model $\theta = 21 - Ae^{-kt}$ with their A or $\ln A = 3.676$ and $t = 0$ Or Equates $\ln(21 - \theta)$ to 3.676	3.4	M1	$\theta = 21 - 39.5e^0$ $= -18.5^\circ\text{C}$
	Obtains AWRT -18.5°C Condone missing units CAO	1.1b	A1	
	Subtotal		2	

Q	Marking instructions	AO	Marks	Typical solution
10(c)	Uses either version of the model with their A from (b)(i) or $\ln A = 3.676$, and their k from their (b)(ii) and $\theta = 4$	3.4	M1	$4 = 21 - 39.5e^{-0.184t}$ $t = 4.581996\dots$ Time = 4 hrs 30 mins
	Obtains AWRT 4.58 PI by 4 hrs 30 mins (270min) or 4 hrs 40 mins (280 min)	1.1b	A1	
	Obtains 4 hrs 30 mins or 4 hrs 40 mins Accept 270 min or 280 min Answer must not come from an incorrect value of t	3.2a	A1	
	Subtotal		3	

	Question 10 Total		12	
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