Question	Scheme	Marks	AOs
13 (a)	$R = 2.5$	B1	1.1b
	$\tan\alpha = \dfrac{1.5}{2}$ o.e.	M1	1.1b
	$\alpha = 0.6435$, so $2.5\sin(\theta - 0.6435)$	A1	1.1b
		(3)	
(b)	e.g. D 6 + $2\sin\left(\dfrac{4\pi(0)}{25}\right)$ $1.5\cos\left(\dfrac{4\pi(0)}{25}\right)$ 4.5m or D 6 + $2.5\sin\left(\dfrac{4\pi(0)}{25}$ 0.6435$\right)$ 4.5m	B1	3.4
		(1)	
(c)	$D_{max} = 6 + 2.5 = 8.5$ m	B1ft	3.4
		(1)	
(d)	Sets $\dfrac{4\pi t}{25}$ − "0.6435" = $\dfrac{5\pi}{2}$ or $\dfrac{\pi}{2}$	M1	1.1b
	Afternoon solution $\Rightarrow \dfrac{4\pi t}{25}$ "0.6435" = $\dfrac{5\pi}{2}$ $\Rightarrow t = \dfrac{25}{4\pi}\left(\dfrac{5\pi}{2} + \text{"0.6435"}\right)$	M1	3.1b
	$\Rightarrow t = 16.9052... \Rightarrow$ **Time** = 16:54 or 4:54 pm	A1	3.2a
		(3)	
(e)(i)	• An attempt to find the depth of water at 00:00 on 19th October 2017 for at least one of either Tom's model or Jolene's model.	M1	3.4
	• At 00:00 on 19th October 2017, Tom: $D = 3.72...$ m and Jolene: $H = 4.5$ m and e.g. • As $4.5 \neq 3.72$ then Jolene's model is not true • Jolene's model is not continuous at 00:00 on 19th October 2017 • Jolene's model does not continue on from where Tom's model has ended	A1	3.5a
(ii)	To make the model continuous, e.g. • $H = 5.22 + 2\sin\left(\dfrac{4\pi x}{25}\right) - 1.5\cos\left(\dfrac{4\pi x}{25}\right), \quad 0 \leqslant x < 24$ • $H = 6 + 2\sin\left(\dfrac{4\pi(x+24)}{25}\right) - 1.5\cos\left(\dfrac{4\pi(x+24)}{25}\right), \quad 0 \leqslant x < 24$	B1	3.3
		(3)	
			(11 marks)

Question	Scheme	Marks	AOs
13 (d) Alt 1	Sets $\frac{4\pi t}{25}$ "0.6435" $= \frac{\pi}{2}$	M1	1.1b
	Period $= 2\pi \div \left(\frac{4\pi}{25}\right) = 12.5$ Afternoon solution $\Rightarrow t = 12.5 + \frac{25}{4\pi}\left(\frac{\pi}{2} + \text{"0.6435"}\right)$	M1	3.1b
	$\Rightarrow t = 16.9052... \Rightarrow$ Time $= 16:54$ or 4:54 pm	A1	3.2a
		(3)	

Question 13 Notes:

(a)

B1: $R = 2.5$ Condone $R = \sqrt{6.25}$

M1: For either $\tan\alpha = \frac{1.5}{2}$ or $\tan\alpha = -\frac{1.5}{2}$ or $\tan\alpha = \frac{2}{1.5}$ or $\tan\alpha = -\frac{2}{1.5}$

A1: $\alpha =$ awrt 0.6435

(b)

B1: Uses Tom's model to find $D = 4.5\,(\text{m})$ at 00:00 on 18th October 2017

(c)

B1ft: Either 8.5 or follow through "6 + their R" (by using their R found in part (a))

(d)

M1: Realises that $D = 6 + 2\sin\left(\frac{4\pi t}{25}\right) - 1.5\cos\left(\frac{4\pi t}{25}\right) = 6 + \text{"2.5"}\sin\left(\frac{4\pi t}{25} - \text{"0.6435"}\right)$ and so maximum depth occurs when $\sin\left(\frac{4\pi t}{25} - \text{"0.6435"}\right) = 1 \Rightarrow \frac{4\pi t}{25} - \text{"0.6435"} = \frac{\pi}{2}$ or $\frac{5\pi}{2}$

M1: Uses the model to deduce that a p.m. solution occurs when $\frac{4\pi t}{25} - \text{"0.6435"} = \frac{5\pi}{2}$ and rearranges this equation to make $t = ...$

A1: Finds that maximum depth occurs in the afternoon at 16:54 or 4:54 pm

(d) Alt 1

M1: Maximum depth occurs when $\sin\left(\frac{4\pi t}{25} - \text{"0.6435"}\right) = 1 \rightarrow \frac{4\pi t}{25} - \text{"0.6435"} = \frac{\pi}{2}$

M1: Rearranges to make $t = ...$ and adds on the period, where period $2\pi \div \left(\frac{4\pi}{25}\right)\{= 12.5\}$

A1: Finds that maximum depth occurs in the afternoon at 16:54 or 4:54 pm

Question 13 Notes Continued:	
(e)(i)	
M1:	See scheme
A1:	See scheme **Note:** Allow Special Case M1 for a candidate who just states that Jolene's model is not continuous at 00:00 on 19th October 2017 o.e.
(e)(ii)	
B1:	Uses the information to set up a new model for H. (See scheme)