Question	Scheme	Marks	AOs
5(a)	$t=3,\ D=10 \Rightarrow 10=a+b\sin 90° \left(=a+b\right)$ **and** $t=5,\ D=8.5 \Rightarrow 8.5=a+b\sin 150° \left(=a+\frac{1}{2}b\right)$	M1	3.1b
	$\left(10=a+b\right)$ $\left(8.5=a+\frac{1}{2}b\right)$ $\Rightarrow a=...,\ b=...$	M1	1.1b
	$D=7+3\sin\left(30t\right)°$ oe	A1	3.3
		(3)	
(b)	Examples: Allow equivalents for "depth" e.g. "height", "level" • the depth (of water) (in m) at midnight • the depth when $t = 0$ • the depth (of water) at midday (or 6am or 6pm) • the depth every 6 hours **after midnight** • the initial depth (of water) • the depth at the start of the day • the mean/average/median depth • the depth around which the water oscillates • the mid-tide depth • the depth of the harbour at e.g. midnight	B1	3.2a
		(1)	

(a)

M1: Attempts to uses the given conditions in the given equation to produce simultaneous equations in a and b. Allow e.g. $10=a+b\sin 3\times 30$ and $8.5=a+b\sin 30\times 5$
It is for attempting to substitute $t = 3$ and $D = 10$ and $t = 5$ and $D = 8.5$ in the correct places into the given equation. Condone minor slips but the intention must be clear.
The trigonometric terms do **not** need to be evaluated for this mark.

M1: Obtains values for a and b from a pair of simultaneous equations in a and b.
You do **not** need to check their working/values as long as they reach values for a **and** b which may just be written down e.g. using a calculator.
They must be **values** for a and b and not in terms of sine but allow the simultaneous equations to be in terms of sine as long as they reach **values** for a and b.

A1: Correct **equation** for D in terms of t seen not just correct values of a and b.
If the correct equation appears later in their solution then this mark can be awarded.
The degrees symbol and/or the brackets are not required so allow e.g. $D=7+3\sin 30t$ or equivalent e.g. $D=3\sin 30t+7$
Special case: If they use $t = 15$ and $D = 10$ and $t = 17$ and $D = 8.5$ condone full marks in (a) and allow full recovery for the rest of the question.
In (a) you can condone the use of radians for the **method** marks.

For reference, this gives: $\begin{matrix}10=a+0.8939b\\8.5=a-0.7148b\end{matrix} \Rightarrow a=9.1665...,\ b=0.9323...$

(b)

B1: See scheme for some acceptable interpretations.
Do not allow mixed incorrect/contradictory statements e.g. "the initial or maximum depth". It is not dependent on them having a value for a and the value may be incorrect.
Incorrect statements could include e.g. "the depth of the harbour" (requires a time), "the minimum depth", "the maximum depth", "the depth every 6 hours"

5(c)	$D = "7" + "3"\sin(30\times 10.5)° = ...$ **or** $4.9 = "7" + "3"\sin(30t)° \Rightarrow t = ...$ **or e.g.** $\sin(30\times 10.5)° = -0.707...,\ \dfrac{4.9-"7"}{"3"} = -0.7$	M1	3.4
	$D = 7 + 3\sin(30\times 10.5)° = 4.8786...$ which is close (to 4.9) so a good model **or** $4.9 = 7 + 3\sin(30t)° \Rightarrow t = 10.519...$ which is close (to 10:30 am) so a good model	A1	3.5a
		(2)	
			(6 marks)

Notes

M1: Either substitutes t = 10.5 (not e.g. 10.3) into their equation **to find a value** for D or substitutes D = 4.9 into their equation **to find a positive value** for t.
If finding a value for t, the order of operations must be correct for their equation
e.g. $4.9 = a + b\sin(30t)° \Rightarrow t = \dfrac{1}{30}\sin^{-1}\left(\dfrac{4.9-a}{b}\right)$
If working is not shown you may need to check in degrees and radians.
Allow equivalent work e.g. finds $\sin(30\times 10.5)°$ and calculates $\dfrac{4.9-"7"}{"3"}$
Note that t = 7.4809 is the first positive value for t (for correct a and b) and could imply this mark.
Condone the use of radians for this mark.

A1: Compares values and makes a valid conclusion with a reason.
This requires

- correct values of a and b
- correct value for D or t to at least 1 dp (or an exact value)
- a statement that it is a good/valid/suitable/viable/acceptable/accurate etc. model
- a comparison e.g. the values are close which could be implied by e.g. $4.8786... \approx 4.9$ or by any other sensible comparison e.g. 4.878… rounds to 4.9 or e.g. they **only** differ by 0.02 but not e.g. they differ by 0.02 (without the "only") or e.g. they are correct to 2sf (or 1dp)

If they make a numerical comparison it must be correct for their value.
There may be more thorough reasoning e.g. via percentage error for D – allow awrt 0.4 - 0.5% or for t allow awrt 0.1 – 0.2%

Do not allow vague or contradictory statements e.g. “it is not entirely accurate but could be used” or e.g. “it is not fully accurate”

Do not allow a misinterpretation of the time e.g. reaches $t = 10.51\ldots$ and states which is only 22 minutes out so good model.