

- 14** Douglas wants to construct a model for the height of the tide in Liverpool during the day, using a cosine graph to represent the way the height changes.

He knows that the first high tide of the day measures 8.55 m and the first low tide of the day measures 1.75 m.

Douglas uses t for time and h for the height of the tide in metres. With his graph-drawing software set to degrees, he begins by drawing the graph of $h = 5.15 + 3.4 \cos t$.

- (a)** Verify that this equation gives the correct values of h for the high and low tide. **[1]**

Douglas also knows that the first high tide of the day occurs at 1 am and the first low tide occurs at 7.20 am. He wants t to represent the time in hours after midnight, so he modifies his equation to $h = 5.15 + 3.4 \cos(at + b)$.

- (b) (i)** Show that Douglas's modified equation gives the first high tide of the day occurring at the correct time if $a + b = 0$. **[1]**

- (ii)** Use the time of the first low tide of the day to form a second equation relating a and b . **[1]**

- (iii)** Hence show that $a = 28.42$ correct to 2 decimal places. **[2]**

- (c)** Douglas can only sail his boat when the height of the tide is at least 3 m.

Use the model to predict the range of times that morning when he cannot sail. **[3]**

- (d)** The next high tide occurs at 12.59 pm when the height of the tide is 8.91 m.

Comment on the suitability of Douglas's model. **[2]**