

9 The depth of the water, d metres, in a tidal river during a given day is modelled by the equation

$$d = 1.9 + 1.1 \cos(30t - 60)^\circ$$

where t is the number of hours after midnight.

(A tidal river is one whose level is influenced by tides.)

(a) (i) Find the minimum depth of water given by this model. [1]

(ii) Find the value of t when the minimum depth first occurs. [2]

(b) A boat can only enter the river when the depth of water is at least 1 metre.

Determine the two periods of time during the day between which this boat will **not** be able to enter the river. Give your answers correct to the **nearest minute**. [5]

In reality the depth of the river decreases as this boat travels along the river. An improved model uses the equation

$$d = e^{-cp}(1.9 + 1.1 \cos(30t - 60)^\circ)$$

where c is a positive constant and p is the distance, in kilometres, travelled along the river after entering it.

(c) Explain how this new equation could give an improved model. [1]