Simple Harmonic Motion 2

Have a go at the following exam questions.

OCR, G484, JANUARY 2011

4   (a) For a body undergoing simple harmonic motion describe the difference between

      (i) *displacement* and *amplitude*

      In your answer, you should use appropriate technical terms spelled correctly.

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      .... **[2]**

      (ii) *frequency* and *angular frequency*.

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      .... **[2]**

  (b) A harbour, represented in Fig. 4.1, has vertical sides and a flat bottom. The surface of the water in the harbour is calm.
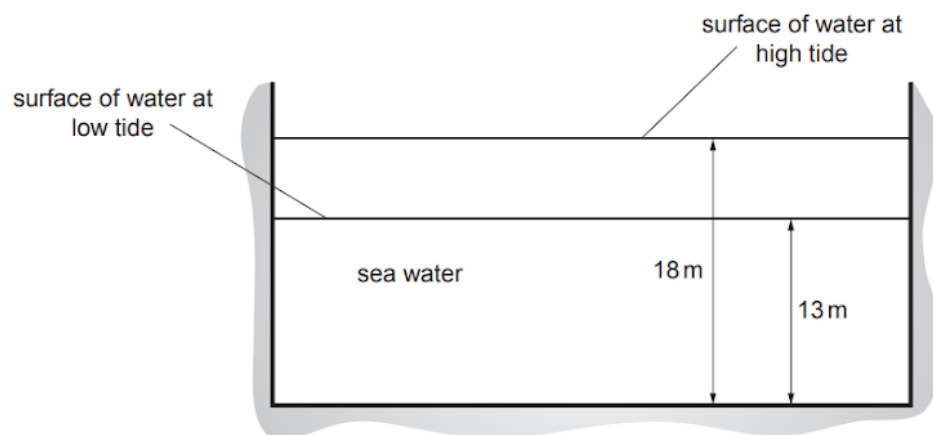

Fig. 4.1

The tide causes the surface of the water to perform simple harmonic motion with a period of 12.5 hours. The maximum depth of the water is 18 m and the minimum depth is 13 m.

(i) For the oscillation of the water surface, calculate

1 the amplitude

amplitude = ... m **[1]**

2 the frequency.

frequency = ... Hz **[2]**

(ii) Calculate the maximum vertical speed of the water surface.

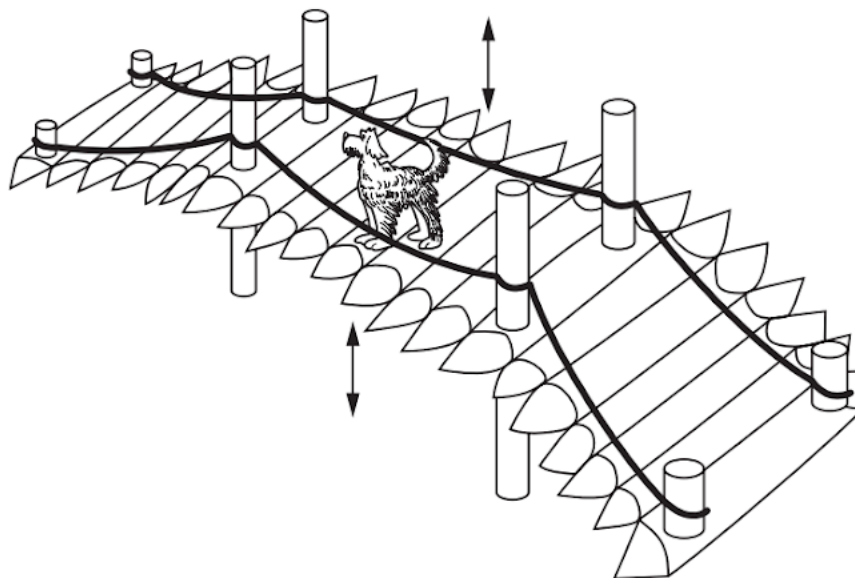maximum speed = ... m s⁻¹ **[2]**

(iii) Write an expression for the depth *d* in metres of water in the harbour in terms of time *t* in seconds.

[2]

[Total: 11]

6. A poorly-designed bridge oscillates up and down at its natural period of 0.81 s.

(a) Calculate the natural frequency of oscillation. [2]

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(b) Show that the angular velocity of the oscillations is approximately 7.8 rad s⁻¹. [2]

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(c) When people walk across this bridge, oscillations of large amplitude occur. Explain the cause of the large-amplitude oscillations and the possible consequences. [3]

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(d) A dog standing in the middle of the bridge moves up and down with simple harmonic motion with an amplitude of 10.4 cm (and period 0.81 s). At time $t = 0$ s, the dog is at the centre of its motion moving upwards. Calculate the displacement of the dog at time $t = 1.40$ s.   [2]
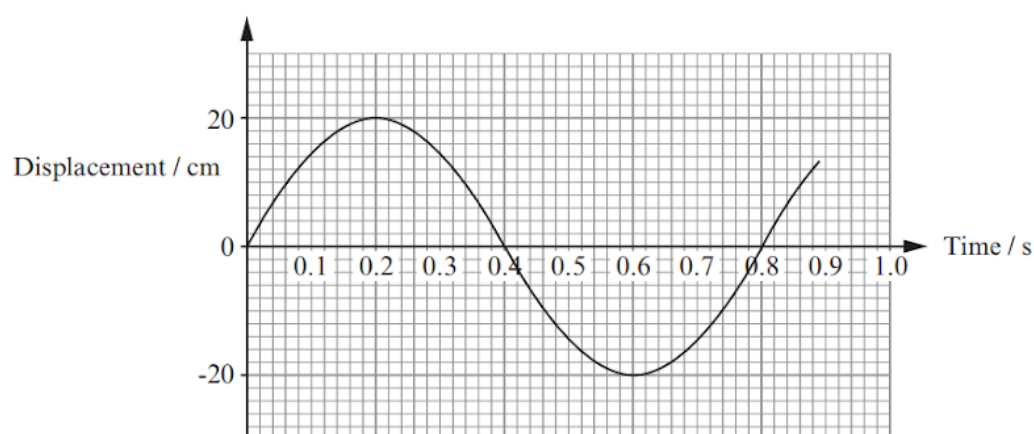
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(e) The amplitude of oscillation is increased and is now so great that the dog temporarily loses contact with the bridge. The displacement of the bridge where the dog is standing varies as shown.

(i) Calculate the dog's displacement when it loses contact with the bridge. [Hint: The downward acceleration of the dog cannot be greater than g.]   [3]

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(ii) **Without further calculation** indicate, on the graph above, the point at which the dog loses contact with the bridge and the **approximate point** at which it makes contact with the bridge again.   [2]
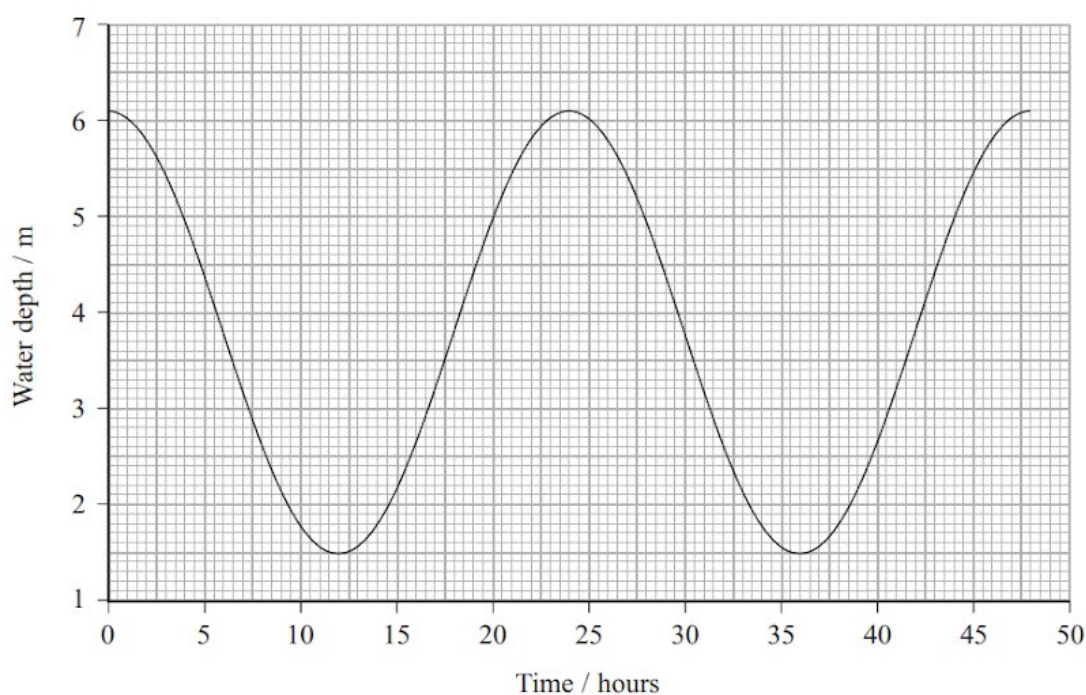
13 (a) Define simple harmonic motion.

(2)

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(b) The graph shows the variation in water level displacement with time for the water in a harbour. The water level displacement varies with simple harmonic motion.

(i) Use the graph to calculate the amplitude and the time period of the variation in the water level displacement.

(2)

Amplitude = ...

Time period = ...

(ii) Show that the maximum rate of change of water level displacement is about 0.6 m hour⁻¹.

(3)

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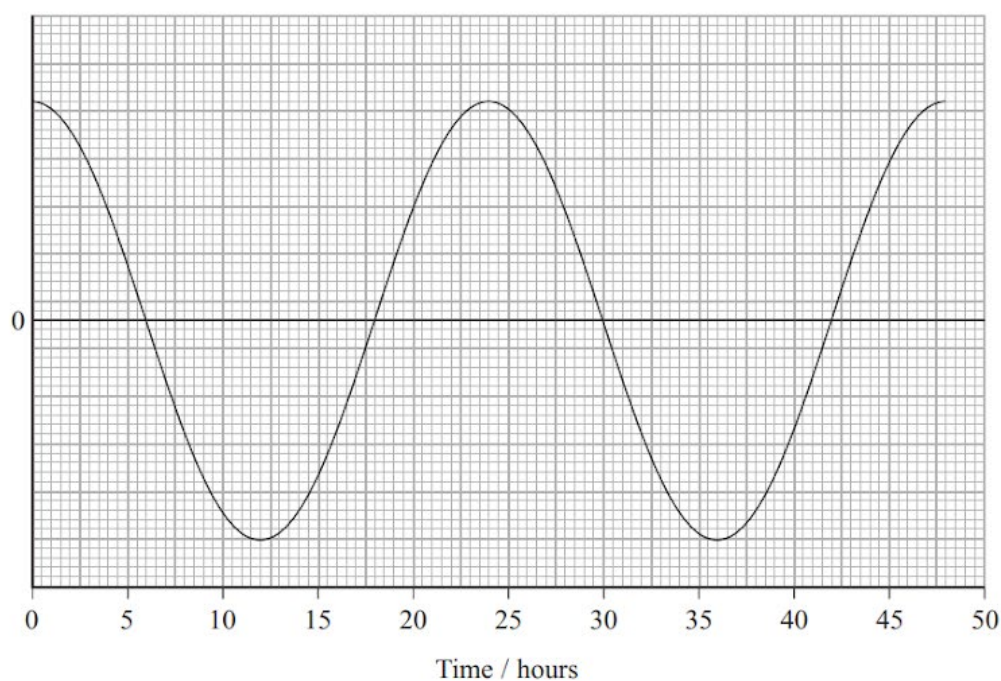
(iii) On the axis below sketch how the rate of change of water level displacement varies with time for the interval 0–30 hours. The variation in water level displacement with time has been drawn for you. You need not add any numerical values to the y-axis.

(2)

Time / hours

(Total for Question 13 = 9 marks)