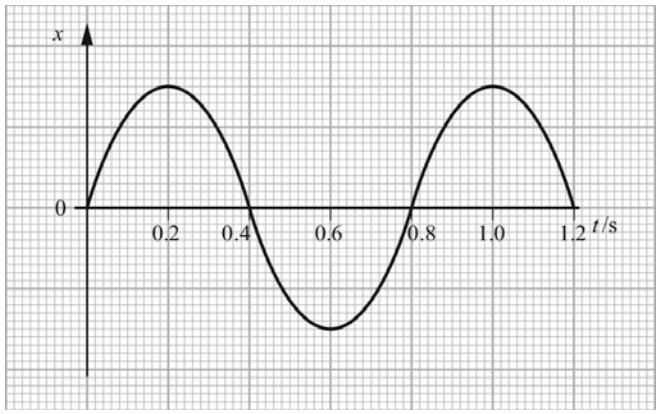
20 Worksheet (A2)

1 For an oscillating mass, define:

a the period [1]

b the frequency. [1]

2 The graph of displacement x against time t for an object executing simple harmonic motion (s.h.m.) is shown here.



a State a time at which the object has maximum speed. Explain your answer. [2]

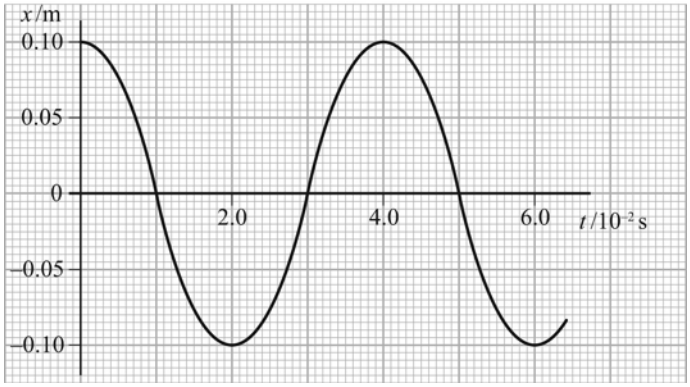
b State a time at which the magnitude of the object's acceleration is a maximum. Explain your answer. [2]

3 An apple is hung vertically from a length of string to form a simple pendulum. The apple is pulled to one side and then released. It executes 12 oscillations in a time of 13.2 s.

a Calculate the period of the oscillations. [2]

b Calculate the frequency of the oscillations. [2]

4 This is the graph of displacement x against time t for an oscillating object.



Use the graph to determine the following:

a the amplitude of the oscillation [1]

b the period [1]

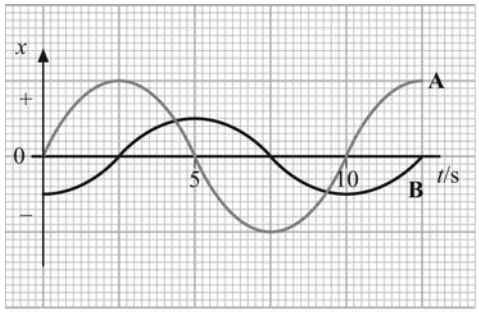
c the frequency in hertz (Hz) [2]

d the angular frequency in radians per second (rad s^{-1}). [2]

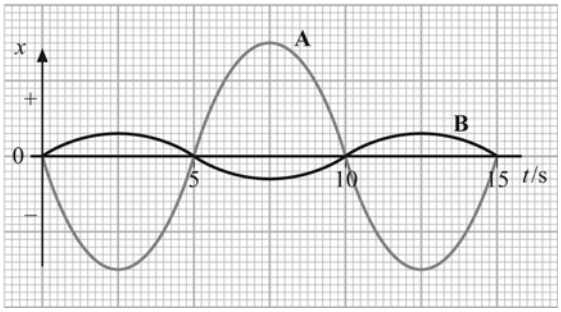
e the maximum speed of the oscillating mass. [2]

5 Two objects **A** and **B** have the same period of oscillation. In each case **a** and **b** below, determine the phase difference between the motions of the objects **A** and **B**.

a [2]



b [2]



6 A mass at the end of a spring oscillates with a period of 2.8 s.
The maximum displacement of the mass from its equilibrium position is 16 cm.

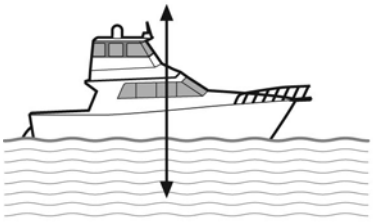
a What is the amplitude of the oscillations? [1]

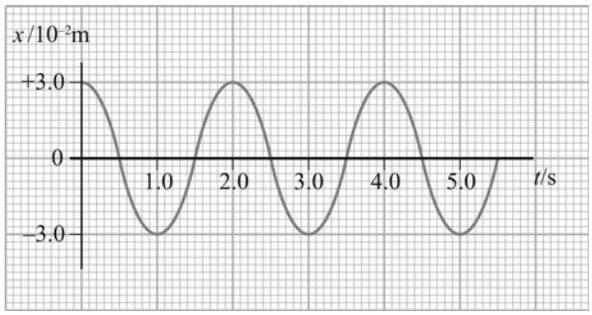
b Calculate the angular frequency of the oscillations. [2]

c Determine the maximum acceleration of the mass. [3]

d Determine the maximum speed of the mass. [2]

7 A small toy boat is floating on the water's surface. It is gently pushed down and then released. The toy executes simple harmonic motion. Its displacement–time graph is shown here.





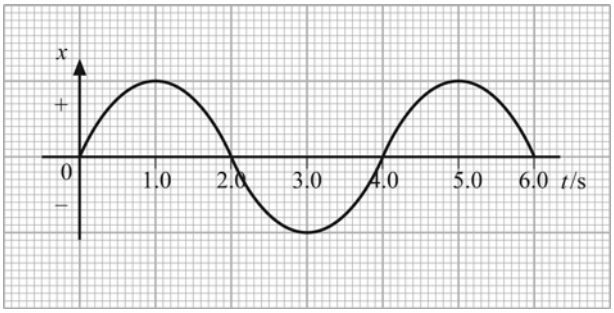
For this oscillating toy boat, calculate:

a its angular frequency [2]

b its maximum acceleration [3]

c its displacement after a time of 6.7 s, assuming that the effect of damping on the boat is negligible. [3]

8 The diagram shows the displacement–time graph for a particle executing simple harmonic motion.



Sketch the following graphs for the oscillating particle:

a velocity–time graph [2]

b acceleration–time graph [2]

c kinetic energy–time graph [2]

d potential energy–time graph. [2]

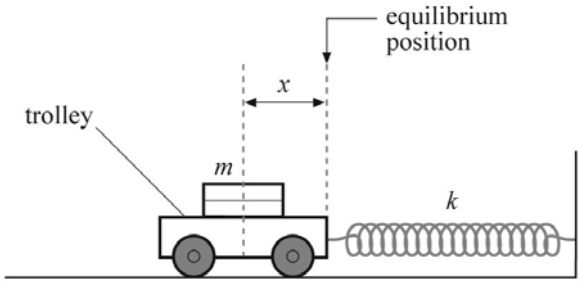
9 A piston in a car engine executes simple harmonic motion.
The acceleration a of the piston is related to its displacement x by the equation:

$$a = -6.4 \times 10^5 x$$

a Calculate the frequency of the motion. [3]

b The piston has a mass of 700 g and a maximum displacement of 8.0 cm.
Calculate the maximum force on the piston. [2]

10 The diagram shows a trolley of mass m attached to a spring of force constant k. When the trolley is displaced to one side and then released, the trolley executes simple harmonic motion.



a Show that the acceleration a of the trolley is given by the expression:

$$a = -\left(\frac{k}{m}\right)x$$

where x is the displacement of the trolley from its equilibrium position. [3]

b Use the expression in **a** to show that the frequency f of the motion is given by:

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$ [2]

c The springs in a car's suspension act in a similar way to the springs on the trolley.
For a car of mass 850 kg, the natural frequency of oscillation is 0.40 s.
Determine the force constant k of the car's suspension. [3]

Total: _____ Score: %
59

