4.1 Oscillations

Question Paper

Course	DP IB Physics
Section	4. Waves
Topic	4.1 Oscillations
Difficulty	Easy

Time allowed: 60

Score: /46

Percentage: /100

Question 1a

(a)

Complete the table by adding the correct key terms to the definitions.

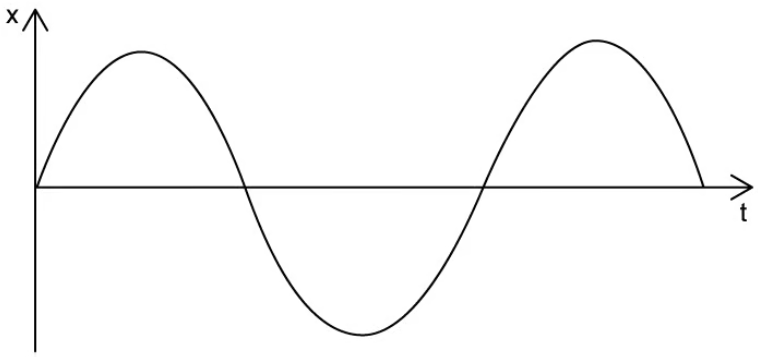
Definition	Key Term
The time interval for one complete oscillation	
The distance of a point on a wave from its equilibrium position	
The number of oscillations per second	
The repetitive variation with time of the displacement of an object about its equilibrium position	
The maximum value of displacement from the equilibrium position	
The oscillations of an object have a constant period	

[3]

[3 marks]

Question 1b

The graph shows the displacement of an object with time.



(b)
On the graph, label the following:

(i)
the time period T

[1]

(ii)
the amplitude x_0

[1]

[2 marks]

Question 1c

An object oscillates isochronously with a frequency of 0.4 Hz.

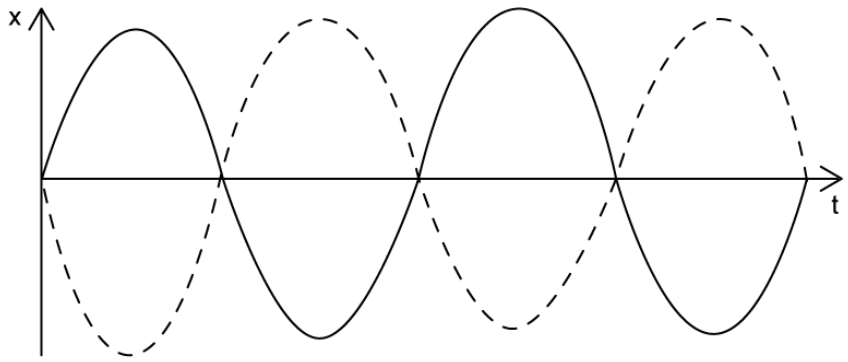
(c)
Calculate the period of the oscillation.

[1]

[1 mark]

Question 1d

The graph shows the oscillations of two different waves.



(d)
For the two oscillations, state:

(i)
The phase difference in terms of wavelength λ, degrees and radians.

[3]

(ii)
Whether the oscillations are in phase or in anti-phase.

[1]

[4 marks]

Question 2a

(a)
Fill in the blank spaces with a suitable word.

Objects in simple harmonic motion _____ about an equilibrium point. The restoring force and _____ always act toward the equilibrium, and are _____ to _____, but act in the opposite direction.

[3]

[3 marks]

Question 2b

Hooke's law can be used to describe a mass-spring system performing simple harmonic oscillations. Hooke's Law states that;

$$F = -kx$$

(b)
State the definition of the following variables and an appropriate unit for each:

(i)
F

[1]

(ii)
k

[1]

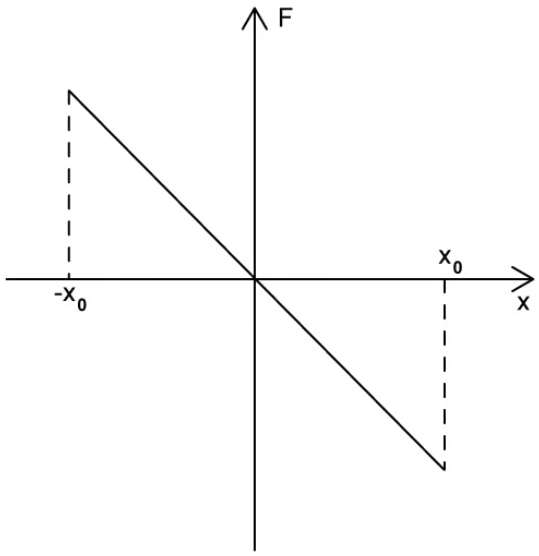
(iii)
x

[1]

[3 marks]

Question 2c

The graph shows the restoring force on a bungee cord.



(c)
Identify the quantity given by the gradient, where $F = -kx$

[1]

[1 mark]

Question 2d

(d)
For an object in simple harmonic motion:

(i)
State the direction of the restoring force in relation to its displacement

[1]

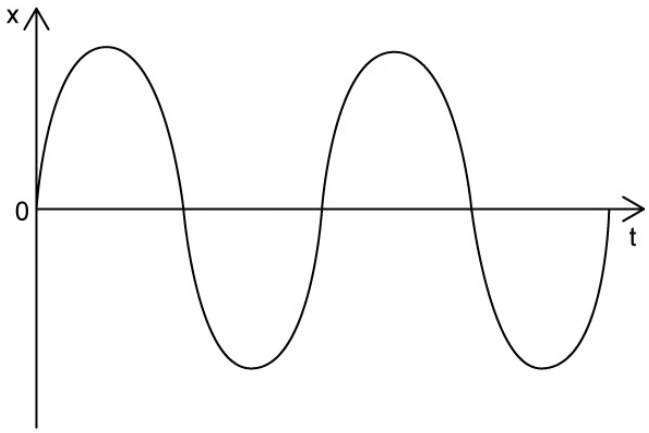
(ii)
State the relationship between force and displacement

[1]

[2 marks]

Question 3a

An object oscillates in simple harmonic motion. The graph shows the variation of displacement with time. The object starts from the equilibrium position when time t = 0.



(a)
For this object:

(i)
Describe the shape of the displacement-time graph

[1]

(ii)
Outline how the shape of the graph would change if the oscillation was measured from amplitude x_0

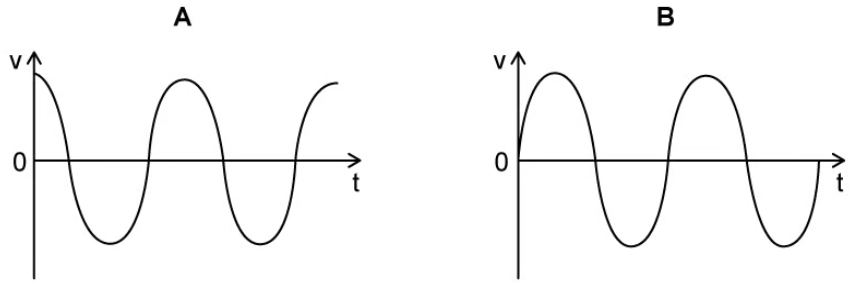
[2]

[3 marks]

Question 3b

(b)

Identify the correct *v*-*t* graph for the oscillation of the object in the *x*-*t* graph from part (a)



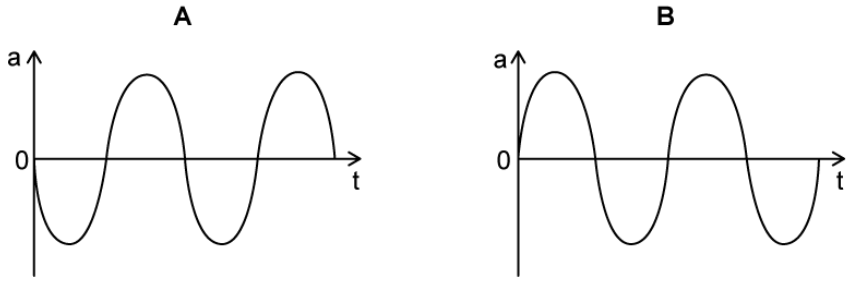
[1]

[1 mark]

Question 3c

(c)

Identify the correct a-*t* graph for the oscillation of the object in the *x*-*t* graph from part (a)



[1]

[1 mark]

Question 3d

(d)

State the phase difference in radians between the displacement-time graph from part (a) and the correct velocity-time graph from part (b)

[2]

[2 marks]

Question 4a

(a)

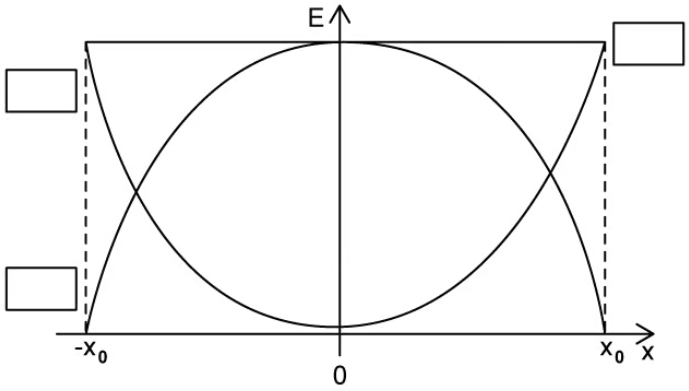
Define the term 'total energy' for a system oscillating in simple harmonic motion.

[1]

[1 mark]

Question 4b

The graph shows the potential energy E_P, kinetic energy E_K and total energy E_T of a system in simple harmonic motion.



(b)

Add the following labels to the correct boxes on the graph:

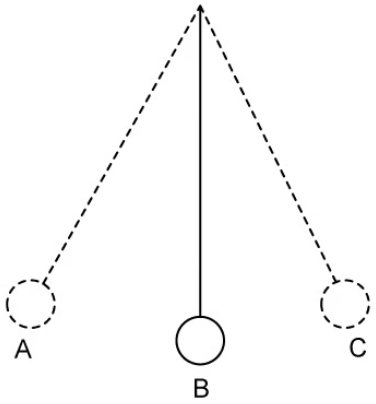
- E_T
- E_P
- E_K

[3]

[3 marks]

Question 4c

The diagram indicates the positions of a simple pendulum in simple harmonic motion.



(c)
Identify the position of the pendulum when:

(i)
Kinetic energy is zero

[1]

(ii)
Potential energy is at a maximum

[1]

(iii)
Kinetic energy is at a maximum

[1]

(iv)
Potential energy is zero

[1]

[4 marks]

Question 4d

The period of the oscillation shown in part (c) is 2.2 s.

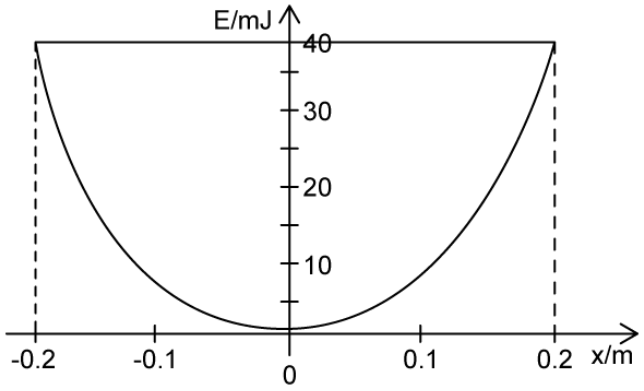
(d)
Calculate the frequency of the oscillation

[2]

[2 marks]

Question 5a

A mass-spring system oscillates with simple harmonic motion. The graph shows how the potential energy of the spring changes with displacement.



(a)
For the mass-spring system, determine:

(i)
The maximum potential energy

[1]

(ii)
The total energy

[1]

[2 marks]

Question 5b

(b)
Using the graph in part (a), determine:

(i)
The amplitude x_0 of the oscillation

[1]

(ii)
The potential energy in the spring when the displacement $x = 0.1$ m

[1]

[2 marks]

Question 5c

The block used in the same mass-spring system has a mass m of 25 g. The maximum kinetic energy of the block is 40 mJ.

(c)
Calculate the maximum velocity of the oscillating block

[4]

[4 marks]

Question 5d

The spring constant k of the spring used is 1.8 N m^{-1}

(d)
Calculate the restoring force acting on the mass-spring system at amplitude x_0

[2]

[2 marks]