9.1 Simple Harmonic Motion

Question Paper

Course	DP IB Physics
Section	9. Wave Phenomena (HL only)
Topic	9.1 Simple Harmonic Motion
Difficulty	Hard

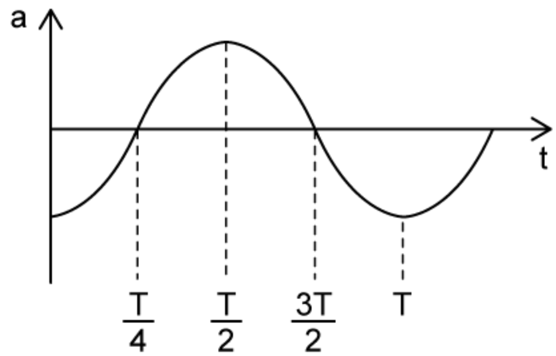
Time allowed: 20

Score: /10

Percentage: /100

Question 1

The following graph shows the acceleration as a function of time for a simple pendulum oscillating isochronously.



Which of the following gives the times at which kinetic energy is at a maximum?

A. $\frac{T}{2}, T$

B. $\frac{T}{4}, \frac{3T}{2}$

C. $\frac{T}{4}, \frac{T}{2}$

D. $\frac{3T}{2}, T$

[1 mark]

Question 2

A mass-spring system is set up horizontally on a frictionless surface. The spring is extended to the left and released so that the mass oscillates in SHM.

Taking motion to the left to be positive, which of the following statements is correct about the motion of the mass?

A. At $\frac{3T}{2}$, velocity = – maximum

B. At $\frac{T}{2}$, acceleration = – maximum

C. At $\frac{T}{4}$, Potential Energy = maximum

D. At T, Acceleration = – maximum

[1 mark]

Question 3

An object oscillates about its equilibrium position periodically. It has a total energy *E* and period *T*. The amplitude is reduced to one quarter of the original amplitude. What are the new total energy and period of the system?

	Total energy	Period
A.	$\frac{E}{16}$	$\frac{T}{4}$
B.	$\frac{E}{8}$	$\frac{T}{2}$
C.	$\frac{E}{16}$	T
D.	$\frac{E}{4}$	$4T$

[1 mark]

Question 4

A simple pendulum and a mass-spring system are set up such that the period of the oscillations are equal. The mass of the pendulum and the mass-spring system are initially identical. The set-up is repeated but this time the masses of both systems are reduced by three quarters.

What is the ratio of the time period of the pendulum to the time period of the mass-spring system after the masses have been changed?

A. 0.5

B. 1

C. 2

D. 4

[1 mark]

Question 5

A simple pendulum oscillates with a time period *T* near the surface of the Earth. The same pendulum is moved to the surface of the moon where the acceleration of free fall is 0.2 *g*. What is the best estimate for the value of *T* for the pendulum near the surface of the moon?

A. 0.2 *T*

B. 0.4 *T*

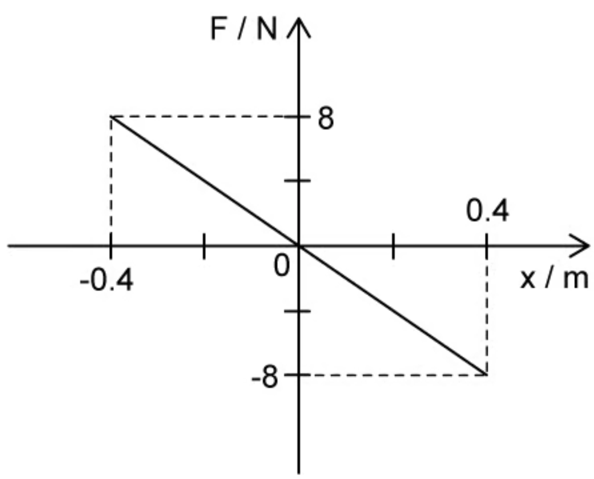
C. 1.4 *T*

D. 2.2 *T*

[1 mark]

Question 6

A body of mass 0.40 kg is subjected to a force *F* which varies with its displacement *x* from a fixed point as shown in the graph below.



What is the maximum velocity of the body?

A. 1.6 m s^{-1}

B. 2.2 m s^{-1}

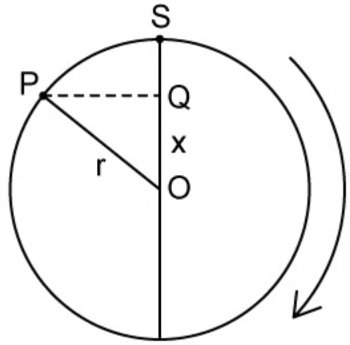
C. 2.8 m s^{-1}

D. 3.4 m s^{-1}

[1 mark]

Question 7

A satellite rotates clockwise around a planet of radius *r* with an angular velocity ω. The satellite passes position S at time zero and position P at time *t*. Q is the projection of P onto the diameter through S. Measured with respect to the origin O, the displacement, linear velocity and linear acceleration of Q in the direction OS are *x*, *v*, and *a* respectively.

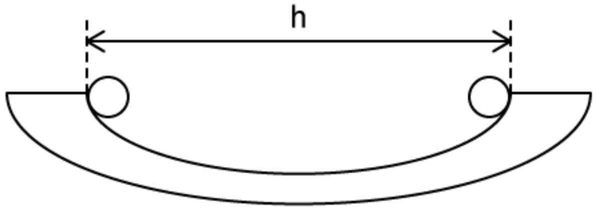


A.	$x = r\cos\omega t$	$v = -r\omega\sin\omega t$	$a = r\omega^2\cos\omega t$
B.	$x = r\cos\omega t$	$v = -r\omega\sin\omega t$	$a = -r\omega^2\cos\omega t$
C.	$x = r\sin\omega t$	$v = -r\omega\cos\omega t$	$a = r\omega^2\sin\omega t$
D.	$x = r\sin\omega t$	$v = -r\omega\cos\omega t$	$a = -r\omega^2\sin\omega t$

[1 mark]

Question 8

A small ball bearing oscillates in simple harmonic motion.



Which is a correct expression for the kinetic energy per unit mass of the ball bearing?

A. $\frac{\pi^2 h^2}{2T^2}$

B. $\frac{h\pi}{T^2}$

C. $\frac{h^2\pi}{2T}$

D. $\frac{\pi^2 h^2}{T^2}$

[1 mark]

Question 9

The table below shows the values for the acceleration and displacement of a particle moving isochronously.

a (mm s^{-2})	16	8	0	– 8	– 16
x (mm)	– 4	– 2	0	2	4

What is the period of the motion?

A. $\frac{2}{\pi}$ s

B. π s

C. 2π s

D. π^2 s

[1 mark]

Question 10

A pendulum bob is suspended by a thread. The bob is moved to the right and released so that the pendulum oscillates isochronously.

Taking motion to the left to be positive, which of the following statements is incorrect about the motion of the pendulum?

A. The potential energy of the system will reach its maximum value three times in one oscillation

B. At $\frac{T}{4}$ the kinetic energy of the system is at its maximum value and the velocity is maximum in the positive direction

C. At $\frac{3T}{4}$ the kinetic energy of the system is at a maximum and the velocity is at a maximum in the negative direction

D. At $\frac{T}{2}$, the force is acting in the negative direction and the kinetic energy is at its maximum value

[1 mark]