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## **4.1 Oscillations**

Hard



# **PHYSICS**

## **IB HL**

# 4.1 Oscillations

## Question Paper

Course	DPIB Physics
Section	4. Waves
Topic	4.1 Oscillations
Difficulty	Hard

EXAM PAPERS PRACTICE

Time allowed: 20  
Score: /10  
Percentage: /100

### Question 1

A mass is attached to a spring from above and the spring is secured to a clamp. The mass is pulled down and released resulting in a simple harmonic oscillation.

Which one of the following statements is true?

- A. The tension,  $T$ , in the spring is at a minimum as the mass passes through the equilibrium position
- B. The total potential energy,  $E_p$ , in the system is at a maximum when the mass is at the highest point of its oscillation
- C. The acceleration,  $a$ , of the mass is at a maximum as it passes through the equilibrium position
- D. The kinetic energy,  $E_k$ , is at a minimum when the mass is at the lowest point in its oscillation

[1 mark]

### Question 2

A pendulum bob on a string oscillates in SHM with a frequency,  $f$ .

The period,  $T$ , of a simple pendulum is related to the length of the string,  $l$ , and the acceleration of free fall,  $g$ , by the following equation:

$$T = 2\pi\sqrt{\frac{l}{g}}$$

What would the ratio be of the original frequency to the new frequency if the length of the string was increased by a factor of 4?

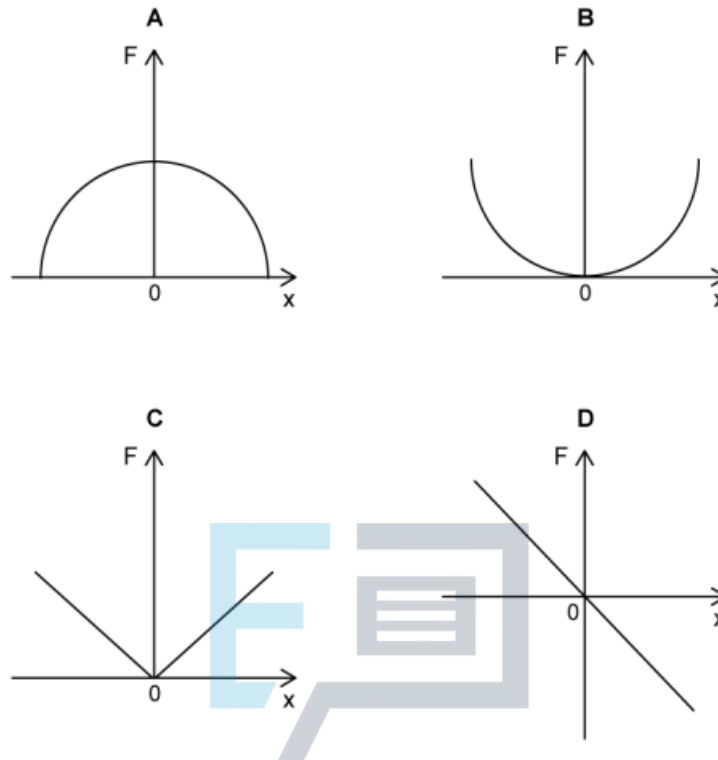
- A.  $\frac{1}{\sqrt{2}}$
- B.  $\frac{1}{2}$
- C.  $\sqrt{2}$
- D. 4

[1 mark]

### Question 3

When an object oscillates in simple harmonic motion, a restoring force acts toward the equilibrium position.

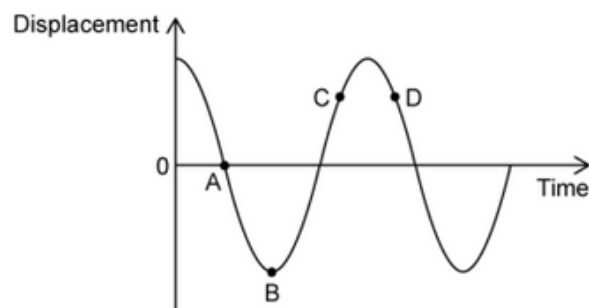
Which graph shows the restoring force,  $F$ , as a function of displacement,  $x$ ?



[1 mark]

### Question 4

The graph below shows the displacement as a function of time for a particle in SHM.



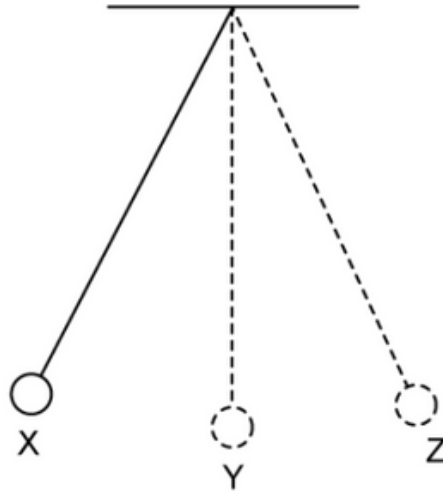
At certain points in the oscillation, the acceleration and velocity act in opposite directions.

Which letter indicates such a point?

[1 mark]

### Question 5

A simple pendulum oscillates in SHM.



Which row correctly describes the force,  $F$ , acceleration,  $a$ , and velocity,  $v$ , at position Y?

	Force	Acceleration	Velocity
A.	zero	zero	max
B.	max	max	zero
C.	max	zero	max
D.	zero	max	zero

[1 mark]



### Question 6

The total energy,  $E_T$ , of a mass-spring system in SHM is related to the mass,  $m$ , angular speed,  $\omega$ , and the amplitude,  $A$ , by the following equation:

$$E_T = \frac{1}{2} m \omega^2 A^2$$

What is the ratio of the original amplitude to the new amplitude if the mass is reduced by a factor of 4 and the angular speed is halved?

- A.  $\frac{1}{2}$
- B. 1
- C.  $\frac{1}{\sqrt{8}}$
- D. 4

[1 mark]



### Question 7

A mass spring system is set up so that the mass glides on a frictionless surface between two springs on a horizontal bench. The mass-spring system performs SHM

Which of the following statements is true?

- A. As the mass oscillates about the equilibrium position, the kinetic energy of the mass is zero when the displacement from equilibrium is zero
- B. As the mass oscillates about the equilibrium position, the kinetic energy of the mass is zero when the restoring force acting on the mass is zero
- C. As the mass oscillates about the equilibrium position, the potential energy of the spring is at a maximum when the kinetic energy of the mass is zero
- D. As the mass oscillates about the equilibrium position, the potential energy of the mass is at a maximum when the acceleration of the mass is zero

[1 mark]

### Question 8

A mass-spring system has a period,  $T$ , mass,  $m$ , and a spring constant,  $k$ . These quantities are related by the following equation:

$$T = 2\pi\sqrt{\frac{m}{k}}$$

A new spring has a spring constant of 3 times the original value.

Using this new spring, which mass would cause the period,  $T$ , to decrease by a factor of 6?

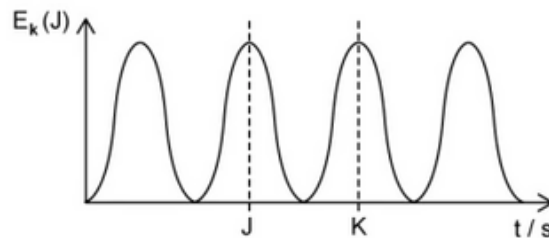
- A.  $\frac{1}{6}m$
- B.  $\frac{1}{3}m$
- C.  $8m$
- D.  $12m$

[1 mark]

### Question 9

The graph below shows the kinetic energy of a simple pendulum as a function of time. The time period of the pendulum is  $T$ .

What does the length of the line JK represent?



- A.  $\frac{T}{4}$
- B.  $\frac{T}{2}$
- C.  $T$
- D.  $2T$

[1 mark]

### Question 10

The period,  $T$ , of a simple pendulum depends upon the length of the string,  $l$ , and the acceleration of free fall,  $g$ , as defined by the following equation:

$$T = 2\pi\sqrt{\frac{l}{g}}$$

If the length of the string was reduced by a factor of 5, what would be the resulting period of the new oscillator?

- A.  $0.2T$
- B.  $0.45T$
- C.  $2T$
- D.  $8T$

[1 mark]