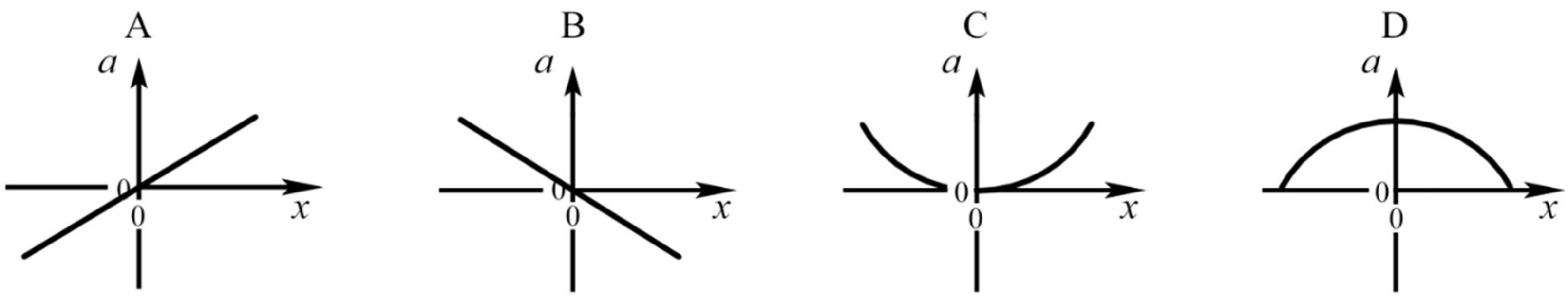
SHM Video Activities File

Intro to Oscillations and SHM

Question 1

For a simple oscillating pendulum, which one of the following graphs correctly shows how its acceleration *a* varies with displacement *x*?



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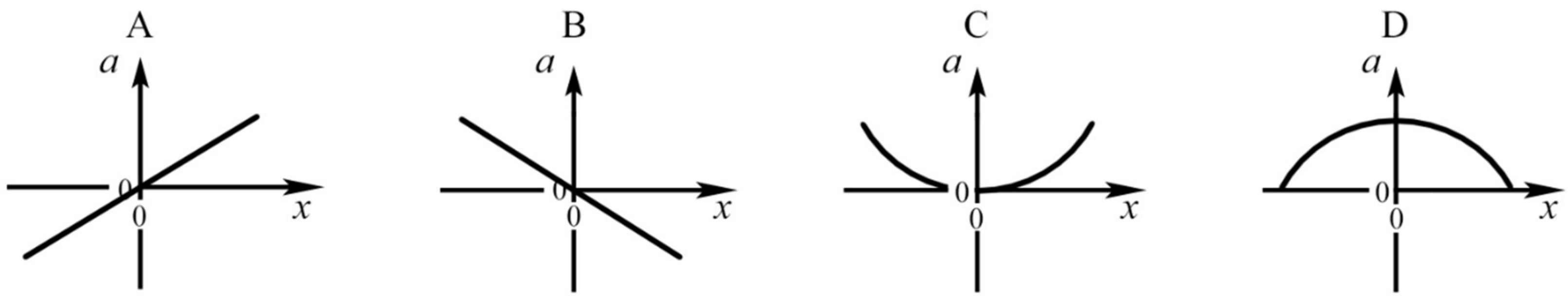

ANSWER: B

$$a = -\omega^2 x$$

Intro to Oscillations and SHM

Question 2

Which list consists of quantities that remain constant when a body moves in undamped simple harmonic motion?

A. Acceleration, force, total energy

B. Amplitude, angular frequency, acceleration

C. Angular frequency, acceleration, force

D. Total energy, amplitude, angular frequency

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ANSWER: D

Question 3
An object is moving in simple harmonic motion with an amplitude of 0.020 m and frequency 2.5 Hz. What is its maximum speed?

A. 0.008 m s^{-1}

B. 0.050 m s^{-1}

C. 0.125 m s^{-1}

D. 0.314 m s^{-1}

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ANSWER: D

$$v_{\max} = \omega x_0 = (2\pi f)x_0 = (2\pi)(2.5)(0.020) = 0.314 \text{ m s}^{-1}$$

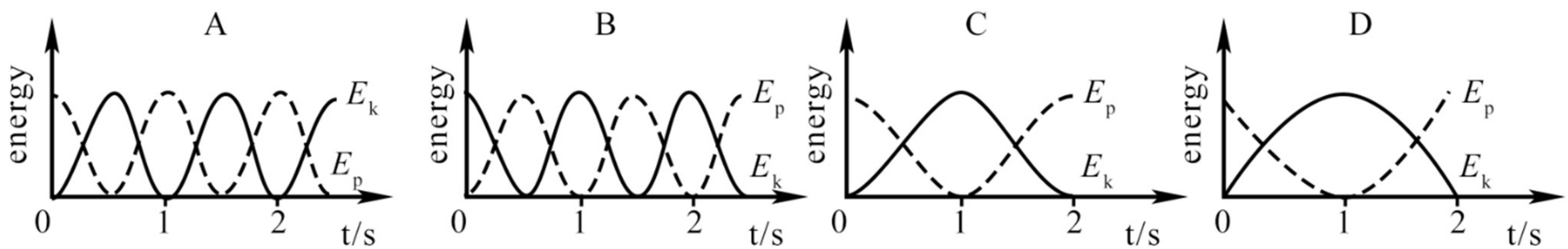
Variation with time and displacement

Question 4

A simple pendulum is swinging with a period of 2 s.

The pendulum's bob is given a small displacement and released at time t = 0 s.

Which diagram correctly shows how the bob's kinetic energy, E_k, and its potential energy E_p, varies with time t?



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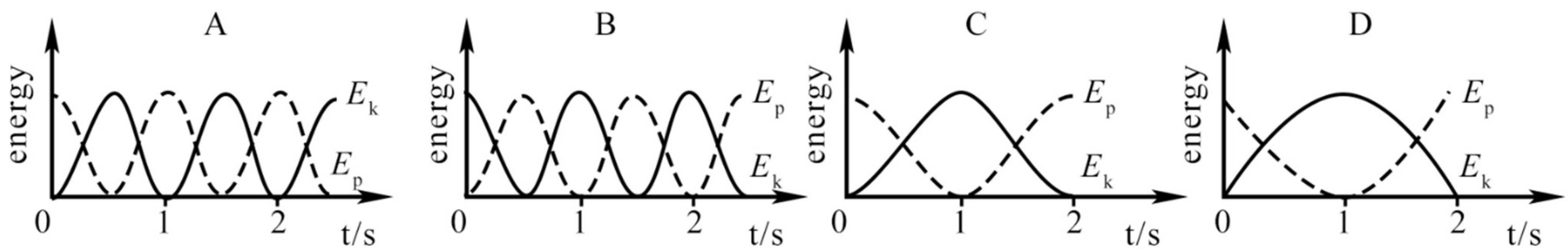


ANSWER: A

- Bob released at amplitude at t = 0 , hence use $x = x_0 \cos \omega t \Rightarrow v = -x_0 \omega \sin \omega t$

  $$E_k = \frac{1}{2}mv^2 = \frac{1}{2}mx_0{}^2\omega^2 \sin^2 \omega t = \frac{1}{2}mx_0{}^2\omega^2 \sin^2\left(\frac{2\pi}{T}\right)t$$

  Since, T = 2 s, Kinetic Energy $E_k = \frac{1}{2}mx_0{}^2\omega^2 \sin^2\left(\frac{2\pi}{2}\right)t = \frac{1}{2}mx_0{}^2\omega^2 \sin^2 \pi t$

- Total energy: $E_{Total} = \frac{1}{2}mx_0{}^2\omega^2$ Constant & does not change with time t
- Potential energy: $E_p = E_{Total} - E_k = \frac{1}{2}mx_0{}^2\omega^2 - \frac{1}{2}mx_0{}^2\omega^2 \sin^2 \pi t = \frac{1}{2}mx_0{}^2\omega^2\left(1-\sin^2 \pi t\right)$

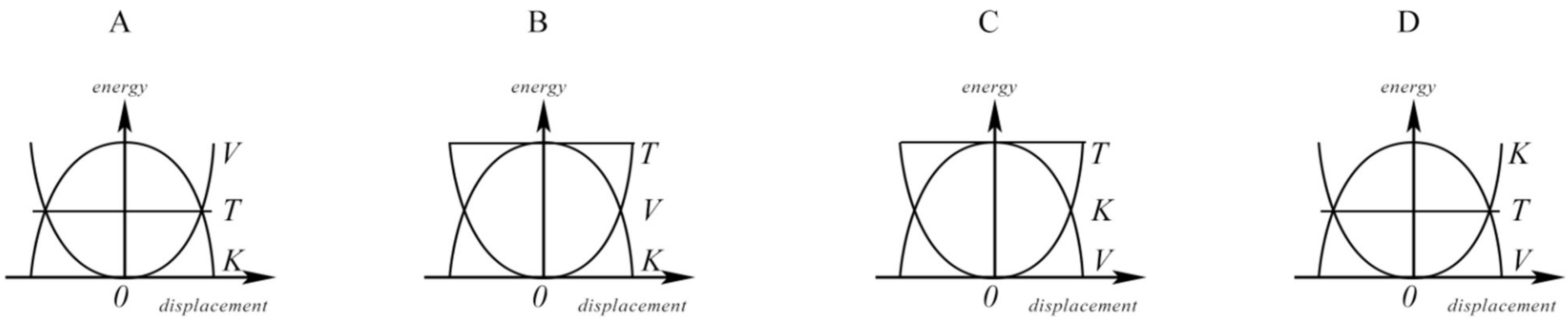
  $$\Rightarrow E_p = \frac{1}{2}mx_0{}^2\omega^2 \cos^2 \pi t$$

Variation with time and displacement

Question 5

A particle moves along a straight line with simple harmonic motion.

Which graph correctly shows the relationship between its kinetic energy K, its potential energy V and total energy T?



Variation with time and displacement

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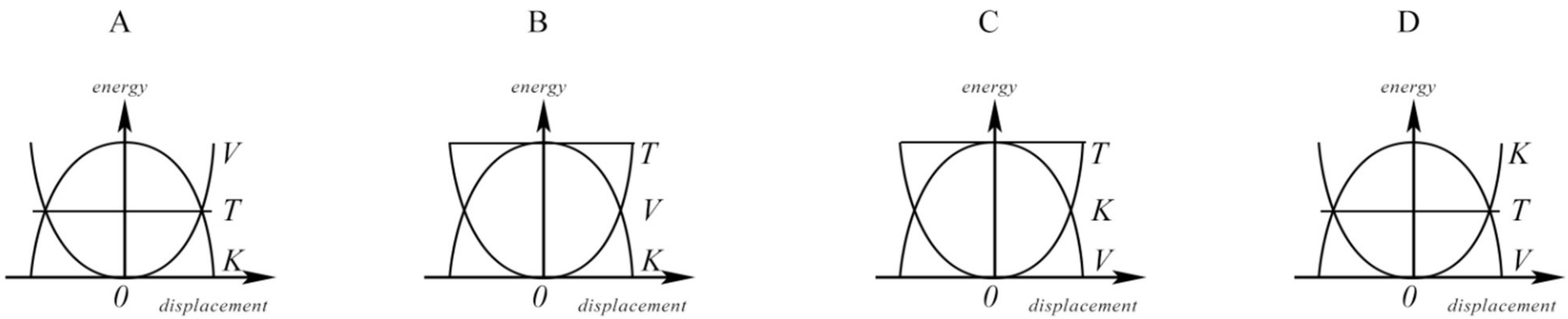

ANSWER: B

$T = V + K$ Horizontal line: constant

At the 2 amplitudes, $K = 0$ and $V = T$

$$\boxed{T = \frac{1}{2} m x_0^{\ 2} \omega^2}$$

Taking reference from Question 4 (Slide 9):

$$V = \frac{1}{2} m\omega^2 \left(x_0^{\ 2} \cos^2 \pi t \right) = \frac{1}{2} m\omega^2 x^2$$

$$\boxed{x = x_0 \cos \omega t}$$

$$K = \frac{1}{2} m\omega^2 x_0^{\ 2} - \frac{1}{2} m\omega^2 x^2$$

Variation with time and displacement

Question 6

A particle moves along a straight line with simple harmonic motion.

At time = 0 s, its displacement from its equilibrium position is 0 m.

By sketching its displacement-time graph and velocity-time graph, deduce the phase-difference between its displacement and velocity.

A. $\frac{\pi}{4}$ rad.	B. $\frac{\pi}{2}$ rad.	C. $\frac{3\pi}{4}$ rad.	D. π rad.

Variation with time and displacement

Question 6

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A. $\frac{\pi}{4}$ rad.	B. $\frac{\pi}{2}$ rad.	C. $\frac{3\pi}{4}$ rad.	D. π rad.

ANSWER: B

$$x = x_0 \sin \omega t$$

$$v = \frac{dx}{dt} = x_0 \omega \cos \omega t$$

From your 2 graphs (equations above), cosine graph will lead sine graph by $\frac{\pi}{2}$ rad.

hence velocity leads displacement by $\frac{\pi}{2}$ rad.

Damped oscillations

Question 7

Damped oscillation is also Forced Oscillation

TRUE/ FALSE

Damped oscillations

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Damped oscillation is also Forced Oscillation

TRUE/ FALSE

ANSWER: FALSE

Damped oscillations

Question 8

Statement: The best suspension for car or motorcycle is a heavily damped suspension.

TRUE/ FALSE

Damped oscillations

Question 8

Statement: The best suspension for car or motorcycle is a heavily damped suspension.

TRUE/ FALSE

ANSWER: FALSE

Go back to the video to watch the part on motorcycle going over a hump again!

Forced oscillations

Question 9

An object can undergo resonance even in the absence of a periodic driving force.

TRUE/ FALSE

Forced oscillations

Question 9

An object can undergo resonance even in the absence of a periodic driving force.

TRUE/ FALSE

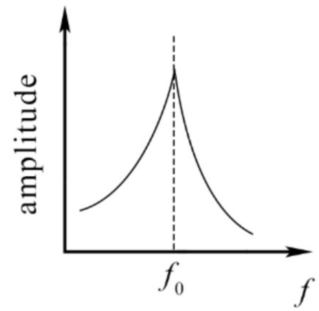
ANSWER: FALSE

A periodic driving force is required to cause resonance.

Forced oscillations

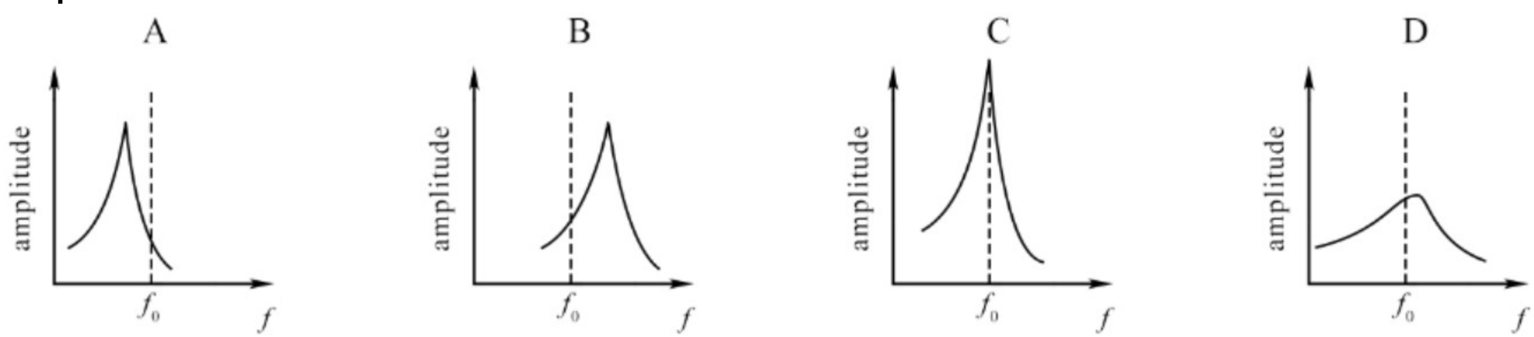
Question 10

In an experiment, a pendulum is forced to oscillate at different frequencies *f* and the response (variation of the amplitude of oscillation with *f*) is as shown.



The experiment is then repeated in a partial vacuum where damping is much less.

Which one of the following graphs correctly show the new amplitude versus response of the pendulum?



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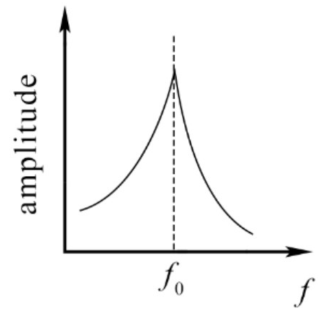

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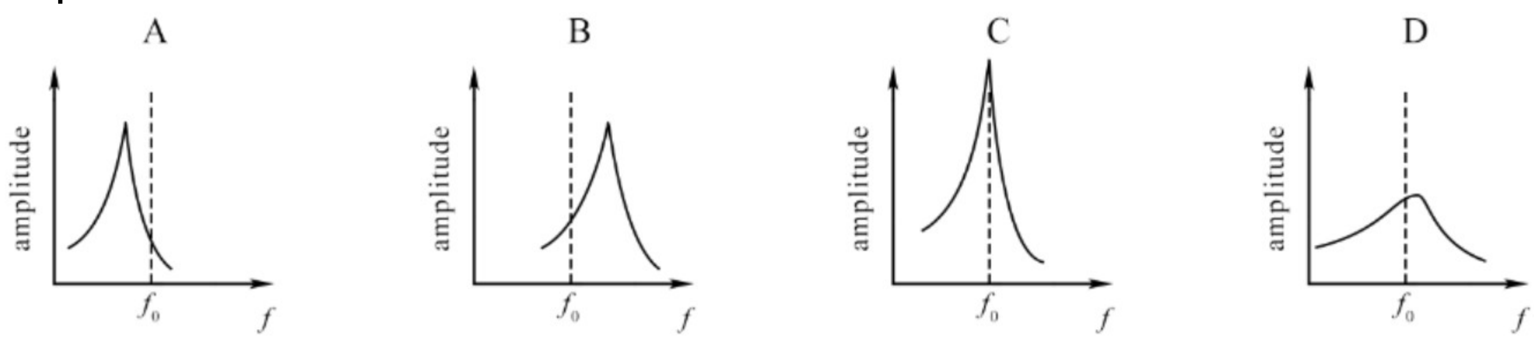

ANSWER: C

With less damping, amplitude of oscillation especially at f_0 will be **greater**.