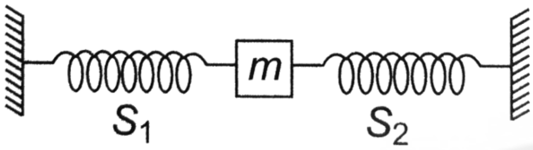
ULTIMATE KCET CRASH COURSE 2026

PHYSICS

DPP: 1

Oscillations

Q1 In the figure S_1 and S_2 are identical springs. The oscillation frequency of the mass m is f. If one spring is removed, the frequency will become



(A) f
(B) $f/\sqrt{2}$
(C) f × 2
(D) $f \times \sqrt{2}$

Q2 What is the maximum acceleration of the particle doing the SHM $y = 2\sin\left[\frac{\pi t}{2} + \phi\right]$ where, 2 is in cm?

(A) $\frac{\pi}{2} cm/s^2$
(B) $\frac{\pi^2}{2} cm/s^2$
(C) $\frac{\pi}{4} cm/s^2$
(D) $\frac{\pi}{4} cm/s^2$

Q3 A particle executes simple harmonic oscillation with an amplitude a . The period of oscillation is T .The minimum time taken by the particle to travel half of the amplitudes from the equilibrium position is

(A) $\frac{T}{8}$
(B) $\frac{T}{12}$
(C) $\frac{T}{2}$
(D) $\frac{T}{4}$

Q4 The phase difference between displacement and acceleration of a particle in a simple harmonic motion

(A) $\pi\ rad$
(B) $\frac{3\pi}{2} rad$
(C) $\frac{\pi}{2} rad$
(D) zero

Q5 If the metal bob of a simple pendulum is replaced by a wooden bob, then its time period will

(A) increase
(B) decrease
(C) remain the same
(D) first increases then decreases

Q6 **The equation y = a sin $\frac{2\pi}{\lambda}$ (vt - x) is the equation of**

a. stationary wave of single frequency along x-axis.
b. a simple harmonic motion.
c. a progressive wave of single frequency along x-axis.
d. the resultant of two S.H.M's of slightly different frequencies.

(A) Option (a)
(B) Option (d)
(C) Option (b)
(D) Option (c)

Q7 Distance between nodes on a string is 5 cm. Velocity of transverse wave is 2 m/s. Then the frequency is

(A) 5 Hz
(B) 10 Hz
(C) 20 Hz
(D) 15 Hz

Q8 A certain simple harmonic vibrator of mass 0.1 kg has a total energy of 10 J . Its displacement from the mean position is 1 cm when it has equal kinetic and potential energies. The amplitude A and frequency v of vibration of the vibrator are

(A) $A = \sqrt{2} cm, \upsilon = \frac{500}{\pi} Hz$

(B) $A = \sqrt{2} cm, \upsilon = \frac{1000}{\pi} Hz$

(C) $A = \frac{1}{\sqrt{2}} cm, \upsilon = \frac{500}{\pi} Hz$

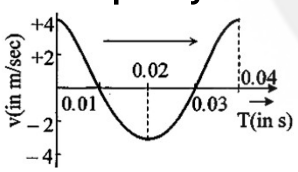
(D) $A = \frac{1}{\sqrt{2}} cm, \upsilon = \frac{1000}{\pi} Hz$

Q9 **A body of mass m is attached to the lower end of a spring whose upper end is fixed. The spring has negligible mass. When the mass m is slightly pulled down and released, it oscillates with a time period of 3 s. When the mass m is increased by 1 kg, the time period of oscillations becomes 5s. The value of m in kg is**

(A) 3/4 (B) 4/3

(C) 16/9 (D) 9/16

Q10 **The velocity-time diagram of a harmonic oscillator is shown in the adjoining figure. The frequency of oscillation is**



(A) 33.3 Hz (B) 12.25 Hz

(C) 25 Hz (D) 50 Hz

Q11 **The potential energy of a particle executing SHM varies sinusoidally with frequency f . The frequency of oscillation of the particle will be**

(A) f/2

(B) f√2

(C) f

(D) 2f

Q12 A point charge q with mass m is placed in between two fixed charges each of charge $2q$. The distance between the charges is $2d$. If the charge q is displaced by a small distance along the line joining the two charges, it executes SHM with a time period of

(A) $2\pi\sqrt{\frac{md^3}{8kq^2}}$ (B) $2\pi\sqrt{\frac{8kq^2}{md^3}}$

(C) $2\pi\sqrt{\frac{3kq^2}{md^3}}$ (D) $2\pi\sqrt{\frac{4kq^2}{md^3}}$

Q13 A particle in S.H.M. has a period of 4s. It takes time t_1 to start from mean position and reach half the amplitude. In another case it takes a time t_2 to start from extreme position and reach half the amplitude. Then

(A) $\frac{t_1}{t_2} = 1$ (B) $\frac{t_1}{t_2} = \frac{1}{2}$

(C) $\frac{t_1}{t_2} = 2$ (D) $\frac{t_1}{t_2} = \frac{3}{2}$

Q14 A particle executes S.H.M. with a period of 6 second and amplitude of 3 cm. Its maximum speed in cm/sec is:

(A) π/2

(B) π

(C) 2π

(D) 3π

Q15 A simple pendulum has a time period T_1 when on the earth's surface and T_2 when taken to a height R above the earth's surface where R is the radius of the earth. The value of T_2 / T_1 is

(A) 1 (B) $\sqrt{2}$

(C) 4 (D) 2

Q16 The phase difference between displacement and acceleration of a particle in a simple harmonic motion

(A) $\pi\ rad$

(B) $\frac{3\pi}{2} rad$

(C) $\frac{\pi}{2} rad$

(D) zero

Q17 The displacement of a particle is represented by the equation

$y = 0.4\left\{\cos^2\left(\frac{\pi t}{2}\right) - \sin^2\left(\frac{\pi t}{2}\right)\right\}$ metre

The motion of a particle is

(A) a S.H.M. with amplitude 0.8 m

(B) oscillatory but not S.H.M.

(C) a S.H.M. with amplitude 0.4 m

(D) a S.H.M. with amplitude $0.4\sqrt{2}$ m

Q18 Assertion :- In a simple harmonic motion, velocity does not change uniformly with displacement. Reason: The graph between velocity and displacement for a harmonic oscillator is a parabola.

(A) Both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.

(B) Both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(C) Assertion is True but the Reason is False.

(D) Both Assertion & Reason are False

Q19 Aparticle executing simple harmonic motion of amplitude 5 cm has maximum speed of 31.4 cm/s. The frequency of its oscillation is

(A) 3 Hz (B) 2 Hz

(C) 4 Hz (D) 1 Hz

Q20 The equation of motion of a particle is $\frac{d^2y}{dt^2} + Ky = 0$, where K is positive constant. The time period of the motion is given by

(A) $\frac{2\pi}{K}$ (B) $2\pi K$

(C) $\frac{2\pi}{\sqrt{k}}$ (D) $2\pi\sqrt{K}$

Q21 The maximum velocity and maximum acceleration of a body moving in a simple harmonic oscillation are 2 m/sand 4 m/s^2. The angular velocity is

(A) 1 rad/sec (B) 4 rad/sec

(C) 5 rad/sec (D) 2 rad/sec

Q22 A linear harmonic oscillator of force constant 2×10^6 N/m and amplitude 0.01 m has a total mechanical energy of 160 J. Its

(A) maximum potential energy is 100 J

(B) maximum kinetic energy is 100 J

(C) maximum potential energy is 160 J

(D) maximum potential energy is zero

Q23 A particle executing simple harmonic motion with an amplitude A and angular frequency ω. The ratio of maximum acceleration to the amplitude of the particle is

(A) ωA (B) ω^2

(C) $\frac{\omega^2}{A}$ (D) $\omega^2 A$

Q24 A piston is performing S.H.M. in the vertical direction with a frequency of 0.5 Hz. A block of 10 kg is placed on the piston. The maximum amplitude of the system such that the block remains in contact with the piston is

(A) 0.5 m

(B) 0.1 m

(C) 1 m

(D) 1.5 m

Q25 A particle executes a linear SHM with an amplitude of 4 cm. At the mean position the velocity of the particle is 10 cm/s. What is the displacement of the particle when its speed becomes 5 cm/s?

(A) $2\left(\sqrt{2}\right)cm$ (B) $2\left(\sqrt{5}\right)cm$

(C) $2\left(\sqrt{3}\right)cm$ (D) $\sqrt{3}cm$

Q26 Average value of K.E. and P.E. over entire time period is

(A) $0, \frac{1}{2}m\omega^2A^2$

(B) $\frac{1}{4}m\omega^2A^2, \frac{1}{4}m\omega^2A^2$

(C) $\frac{1}{2}m\omega^2A^2, \frac{1}{2}m\omega^2A^2$

(D) $\frac{1}{2}m\omega^2A^2, 0$

Q27 A particle in SHM is described by the displacement function x(t)=Acos(ωt+), If the initial (t=0) position of the particle is 1 cm , its initial velocity is πcms^(-1) and its angular frequency is πs^(-1), then the amplitude of its motion is

(A) πcm (B) 2 cm

(C) $\sqrt{2}$cm (D) 1 cm

Q28 A transverse wave is represented by the equation $y = y_o \sin \frac{2\pi}{\lambda}(\upsilon t - x)$

For what value of λ, is the maximum particle velocity equal to two times the wave velocity?

(A) $\lambda = \frac{\pi y_o}{2}$

(B) $\lambda = \frac{\pi y_o}{3}$

(C) $\lambda = 2\pi y_o$

(D) $\lambda = \pi y_o$

Q29 A particle is performing S.H.M. starting from mean position. The phase difference between displacement and velocity is

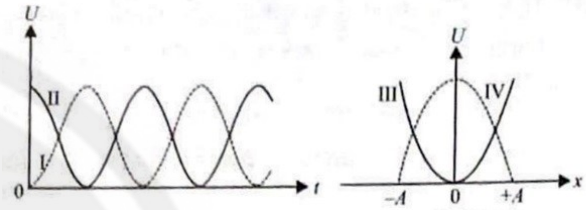
(A) $\frac{\pi}{4} rad$

(B) $\frac{\pi}{2} rad$

(C) $\pi\, rad$

(D) $0\, rad$

Q30 For a particle executing simple harmonic motion, the displacement *x* is given by $x = A\cos\omega t$. Identify the graph, which represents the variation of potential energy (*U*) as a function of time *t* and displacement *x*.



(A) I, III (B) II, III

(C) I. IV (D) II, IV

Answer Key

Q1	B	Q16	A
Q2	B	Q17	C
Q3	B	Q18	C
Q4	A	Q19	D
Q5	C	Q20	C
Q6	D	Q21	D
Q7	C	Q22	A
Q8	A	Q23	B
Q9	A	Q24	C
Q10	C	Q25	C
Q11	A	Q26	B
Q12	A	Q27	C
Q13	B	Q28	D
Q14	B	Q29	B
Q15	D	Q30	A

Hints & Solutions

Note: scan the QR code to watch video solution

Q1 Text Solution:

In case of spring, frequency = $\frac{1}{2\pi}\sqrt{\frac{K}{m}}$

As per question, the two springs are in parallel in horizontal position, effective force constant = 2K.

$f=\frac{1}{2\pi}\sqrt{\frac{2K}{m}};\quad f'=\frac{1}{2\pi}\sqrt{\frac{K}{m}}$

when one spring is removed, $f' = \frac{f}{\sqrt{2}}$

Video Solution:

Q2 Text Solution:

$y=2\sin(\omega t+\phi)$

$A=2cm$

$W=\frac{\pi}{2}$

$\therefore Q_{\max}=W^2A=\left(\frac{\pi}{2}\right)^2\times 2$

$=\frac{\pi^2}{2}cm^{-2}$

Video Solution:

Q3 Text Solution:

T/12

Video Solution:

Q4 Text Solution:

$\pi\ rad$

Video Solution:

Q5 Text Solution:

Time period of a simple pendulum is, $T=2\pi\sqrt{\frac{l}{g}}$

Time period of a simple pendulum is independent of the material of the bob. Hence when a metal bob is replaced by a wooden bob its time period remains the same

Video Solution:

Q6 Text Solution:

Option (c)

Progressive wave: This equation iS the standard form for a traveling wave, where the wave profile moves in a single direction along the x-axis With a constant velocity 'v'. Single frequency: The "sin" function indicates a single frequency oscillation.

Video Solution:

Q7 Text Solution:

$\frac{\lambda}{2} = 5cm \quad \lambda = 10cm$

$v = \lambda f$

$f = \frac{v}{\lambda} = \frac{2}{1.0} = 20Hz$

Video Solution:

Q8 Text Solution:

For a displacement *x*, the kinetic and poptential energies are

$K = \frac{1}{2}m\left(A^2 - x^2\right)\omega^2$ and $U = \frac{1}{2}mx^2\omega^2$

Each of these $= \frac{10}{2} = 5$ J when $x = 1$ cm

$\therefore \quad \frac{1}{2}\mathrm{mx}^2\,\omega^2 = \frac{1}{2} \times 0.1 \times \left(1 \times 10^{-2}\right)^2 \omega^2$

$= 5$

or $\omega^2 = \frac{10}{0.1 \times 10^{-4}} = 10^6$ or $\omega = 10^3 = 1000$

$\therefore \quad$ Frequency, $v = \frac{\omega}{2\pi} = \frac{1000}{2\pi}\ \mathrm{s}^{-1} = \frac{500}{\pi}$

Hz

$K = 5 = \frac{1}{2} \times 0$

$.1\left[A^2 - \left(1 \times 10^{-2}\right)^2\right]\left(10^6\right)$ or $A^2 - 10^{-4}$

$= 10^{-4}$

or $A^2 = 2 \times 10^{-4}$ or $A = \sqrt{2} \times 10^{-2}$ m

$= \sqrt{2}$ cm

Video Solution:

Q9 Text Solution:

3/4

Video Solution:

Q10 **Text Solution:**

To complete one oscillation it takes 0.04secs

So the time period of oscillation is T = 0.04secs

So, the frequency of the oscillation is n = 1/T = 1/0.04 = 25Hz

Video Solution:

Q11 **Text Solution:**

f/2

Video Solution:

Q12 **Text Solution:**

$$m\omega^2 x = k\left(2q\right)\left(q\right)\left[\frac{1}{(x-d)^2} - \frac{1}{(x+d)^2}\right]$$

$$= 2kq^2\left[\frac{4xd}{d^4}\right]x \ll d$$

$$m\omega^2 x = \frac{8kq^2}{d^3}x$$

$$\therefore \omega^2 = \frac{8kq^2}{md^3}$$

$$\therefore T = 2\pi\sqrt{\frac{md^3}{8kq^2}}$$

Shortcut, $T = 2\pi\sqrt{\frac{m}{K(\text{ restoring factor })}}$ hence mass must be in the numerator.

Video Solution:

Q13 **Text Solution:**

y = A sin(ωt)

In the first case

$$\frac{A}{2} = A\sin(\omega t_1)) \Rightarrow \omega t_1 = \frac{\pi}{6} \Rightarrow t_1 = \frac{T}{12}$$

In the second case, $\frac{T}{4} - t_2 = \frac{T}{12} \Rightarrow t_2 = \frac{T}{6}$

$$\frac{t_1}{t_2} = \frac{6}{12} = \frac{1}{2}$$

Video Solution:

Q14 **Text Solution:**

$$v_m = A\omega$$

$$= 3 \times \frac{2\pi}{T} = \frac{6\pi}{6} = \pi$$

Video Solution:

Q15 **Text Solution:**

$$T_1 = 2\pi\sqrt{\frac{I}{g}}, T_2 = 2\pi\sqrt{\frac{I}{g/4}} = 2 \times 2\pi\sqrt{\frac{I}{g}}$$

$$= 2T_1$$

$$\Rightarrow T_2 = 2T_1 \Rightarrow \frac{T_2}{T_1} = 2$$

Video Solution:

Q16 Text Solution:

$\pi\ rad$

Video Solution:

Q17 Text Solution:

Given, $y=0.4\left(\cos^2\frac{\pi t}{2}-\sin^2\frac{\pi t}{2}\right)$

$y=0.4(\cos\pi t)$

$y=0.4(\sin(\pi-\pi t)) \Rightarrow y=0.4\sin\pi(1-t)$

We know the equation of SHM is $y=A\sin\omega t$

It is SHM with amplitude, A = 0.4

Video Solution:

Q18 Text Solution:

In S.H.M

$V=\omega\sqrt{A^2-y^2}$

$V^2=\omega^2\left(A^2-y^2\right)$

$\frac{V^2}{\omega^2A^2}+\frac{y^2}{\omega^2A^2}=1$

This is equation for ellipse velocity does not change uniformly with displacement.

Video Solution:

Q19 Text Solution:

V=aω

$\Rightarrow \omega=2\pi f$

$\Rightarrow V=a2\pi f$

$\Rightarrow f=\frac{V}{2\pi a} \Rightarrow f=\frac{31.4}{2\pi\times5}=1Hz$

Video Solution:

Q20 Text Solution:

$\frac{d^2y}{dt^2}=-ky=-\omega^2y$

$\omega=\sqrt{k}$

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

Video Solution:

Q21 Text Solution:

Given that :- $v_{max}=a\omega=2$ m/s

$a_{max}=a\omega^2=4$ m/s^2

On dividing the two, we get $=2$ radians / sec

Video Solution:

Q22 Text Solution:

maximum potential energy is 100 J

Video Solution:

Q23 Text Solution:

In SHM, Maximum acceleration,

$a_{\max} = \omega^2 A$

$\therefore \frac{a_{\max}}{Amplitude} = \frac{\omega^2 A}{A} = \omega^2$

Video Solution:

Q24 Text Solution:

f = 0.5 Hz

$\omega = 2\pi f = 2 \times \pi \times \frac{1}{2} = \pi$

For block to remain in contact with the piston, at amplitude position of SHM,

Weight of block = force due to oscillation

$mg = ma$

$mg = m\,(w^2A)$

$A = \frac{g}{\omega^2} = \frac{10}{\pi^2}$

$\therefore A \cong 1m$

Video Solution:

Q25 Text Solution:

Amplitude of the particle is SHM,

A = 4 cm

At mean position velocity,

$v_{\max}$ = 10 cm/s

$A\omega = 10$

$\Rightarrow \omega = \frac{10}{A} = \frac{10}{4} = 2.5 rad/s$

Again when v = 5 cm/s, then displacement, x=?

We know that,

$v = \omega\sqrt{A^2 - x^2}$

$\Rightarrow 5 = 2.5\sqrt{4^2 - x^2}$

$\Rightarrow 2 = \sqrt{A^2 - x^2}$

$\Rightarrow 4 = A^2 - x^2$

$\Rightarrow 4 = 4^2 - x^2$

$\Rightarrow x^2 = 16 - 4 = 12$

$x = \sqrt{12} = 2\sqrt{3} cm$

Video Solution:

Q26 Text Solution:

$E_{k_{av}} = E_{p_{av}} = \frac{1}{4} m\omega^2 A^2$

Video Solution:

Q27 Text Solution:

$x = A\cos(\omega t + \phi)$

$Where\ A\ is\ the\ amplitude$

$At\ t = 0, x = 1cm$

$\therefore 1 = A\cos\phi$

$Velocity,\ v = \frac{dx}{dt} = \frac{d}{dt}(A\cos(\omega t + \phi))$

$= -A\omega A\sin(\omega t + \phi)$

$At\ t = 0,\ \ v = \pi cms^{-1}$

$\therefore \pi = A\omega\sin\ or\ \frac{\pi}{\omega} = -A\sin\phi$

$\omega = \pi s^{-1}$

$\therefore I = -A\sin\phi$

Squaring and adding (i) and (ii), we get

$A^2\cos^2\phi + A^2\sin^2\phi = 2$

$A^2 = 2 \qquad \left(\sin^2\phi + \cos^2\phi = 1\right)$

$A = \sqrt{2}cm$

Video Solution:

Q28 Text Solution:

The given equation of wave is

$y = y_0 \sin\frac{2\pi}{\lambda}\left(vt - x\right)$

Particle velocity $= \frac{dy}{dt}$

$= y_0 \cos\frac{2\pi}{\lambda}\left(vt - x\right)\cdot\frac{2\pi v}{\lambda}$

$\left(\frac{dy}{dt}\right)_{\max} = y_0\cdot\frac{2\pi}{\lambda}v$

$\therefore \quad y_0\cdot\frac{2\pi}{\lambda}v = 2v \text{ or } \lambda = \pi y_0$

Video Solution:

Q29 Text Solution:

$\frac{\pi}{2}rad$

Video Solution:

Q30 Text Solution:

Given: $U = \frac{1}{2}m\omega^2x^2 = \frac{1}{2}m\omega^2A^2\cos^2\omega t$

On plotting a graph between potential energy *U* and time *t*, we shall get a curve II and graph between *U* and *x*, we shall get curve III.

Video Solution: