Oscillations

1. If x, v and a denote the displacement, the velocity and the acceleration of a particle executing simple harmonic motion of time period T, then, which of the following does not change with time ? **[AIEEE-2009]**

(1) aT/x (2) $aT + 2\pi v$
(3) aT/v (4) $a^2T^2 + 4\pi^2v^2$

2. A wooden cube (density of wood d) of side l floats in a liquid of density ρ with its upper and lower surfaces horizontal. If the cube is pushed slightly down and released, it performs simple harmonic motion of period T. Then, T is equal to **[AIEEE-2011]**

(1) $2\pi\sqrt{\dfrac{ld}{(\rho-d)g}}$ (2) $2\pi\sqrt{\dfrac{l\rho}{(\rho-d)g}}$

(3) $2\pi\sqrt{\dfrac{ld}{\rho g}}$ (4) $2\pi\sqrt{\dfrac{l\rho}{dg}}$

3. If a simple pendulum has significant amplitude (up to a factor of 1/e of original) only in the period between $t = 0$ s to $t = \tau$ s, then τ may be called the average life of the pendulum. When the spherical bob of the pendulum suffers a retardation (due to viscous drag) proportional to its velocity, with 'b' as the constant of proportionality, the average life time of the pendulum is (assuming damping is small) in seconds **[AIEEE-2012]**

(1) b (2) $\dfrac{1}{b}$

(3) $\dfrac{2}{b}$ (4) $\dfrac{0.693}{b}$

4. The amplitude of a damped oscillator decreases to 0.9 times its original magnitude in 5 s. In another 10 s it will decrease to α times its original magnitude, where α equals **[JEE (Main)-2013]**

(1) 0.7 (2) 0.81
(3) 0.729 (4) 0.6

5. A particle moves with simple harmonic motion in a straight line. In first τ s, after starting from rest it travels a distance a, and in next τ s it travels $2a$ in same direction then **[JEE (Main)-2014]**

(1) Amplitude of motion is $3a$
(2) Time period of oscillations is 8τ
(3) Amplitude of motion is $4a$
(4) Time period of oscillations is 6τ

6. A pendulum made of a uniform wire of cross-sectional area A has time period T. When an additional mass M is added to its bob, the time period changes to T_M. If the Young's modulus of the material of the wire is Y then $\dfrac{1}{Y}$ is equal to

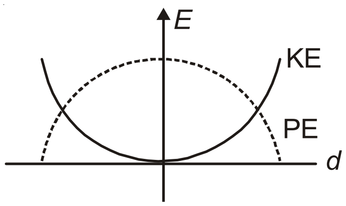
(g = gravitational acceleration) **[JEE (Main)-2015]**

(1) $\left[\left(\dfrac{T_M}{T}\right)^2 - 1\right]\dfrac{A}{Mg}$ (2) $\left[\left(\dfrac{T_M}{T}\right)^2 - 1\right]\dfrac{Mg}{A}$

(3) $\left[1 - \left(\dfrac{T_M}{T}\right)^2\right]\dfrac{A}{Mg}$ (4) $\left[1 - \left(\dfrac{T}{T_M}\right)^2\right]\dfrac{A}{Mg}$

7. For a simple pendulum, a graph is plotted between its kinetic energy (KE) and potential energy (PE) against its displacement d. Which one of the following represents these correctly? **[JEE (Main)-2015]**

(Graphs are schematic and not drawn to scale)

(1)


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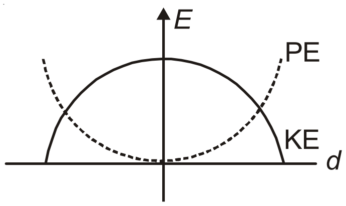
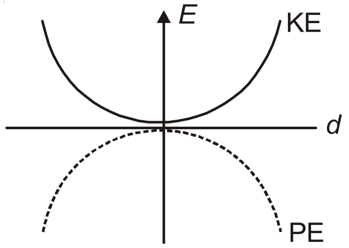
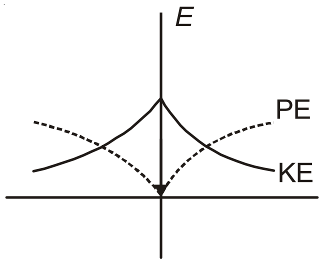


(3) 

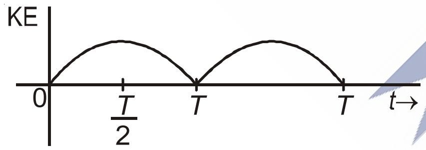
(4) 

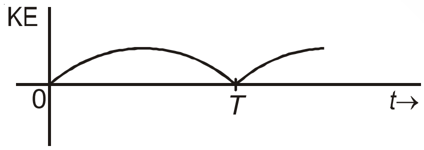
8. A particle performs simple harmonic motion with amplitude A. Its speed is trebled at the instant that it is at a distance $\frac{2A}{3}$ from equilibrium position. The new amplitude of the motion is **[JEE (Main)-2016]**

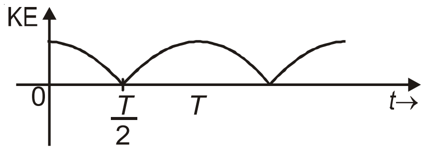
(1) $3A$ (2) $A\sqrt{3}$

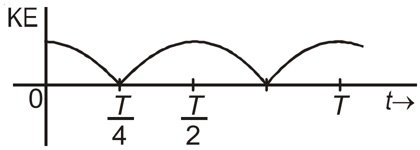
(3) $\frac{7A}{3}$ (4) $\frac{A}{3}\sqrt{41}$

9. A particle is executing simple harmonic motion with a time period T. At time t = 0, it is at its position of equilibrium. The kinetic energy-time graph of the particle will look like : **[JEE (Main)-2017]**

(1) 

(2) 

(3) 

(4) 

10. A silver atom in a solid oscillates in simple harmonic motion in some direction with a frequency of 10^{12}/second. What is the force constant of the bonds connecting one atom with the other? (Mole wt. of silver = 108 and Avagadro number = 6.02 × 10^{23} gm mole^{-1}) **[JEE (Main)-2018]**

(1) 6.4 N/m (2) 7.1 N/m

(3) 2.2 N/m (4) 5.5 N/m

11. A particle is executing simple harmonic motion (SHM) of amplitude A, along the x-axis, about x = 0. When its potential energy (PE) equals kinetic energy (KE), the position of the particle will be **[JEE (Main)-2019]**

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

(3) $\frac{A}{2\sqrt{2}}$ (4) $\frac{A}{2}$

12. A rod of mass 'M' and length '$2L$' is suspended at its middle by a wire. It exhibits torsional oscillations; if two masses each of 'm' are attached at distance '$L/2$' from its centre on both sides, it reduces the oscillation frequency by 20%. The value of ratio m/M is close to **[JEE (Main)-2019]**

(1) 0.77 (2) 0.17

(3) 0.37 (4) 0.57

13. A cylindrical plastic bottle of negligible mass is filled with 310 ml of water and left floating in a pond with still water. If pressed downward slightly and released, it starts performing simple harmonic motion at angular frequency ω. If the radius of the bottle is 2.5 cm then ω is close to: (density fo water = 10^3 kg/m^3) **[JEE (Main)-2019]**

(1) 2.50 rad s^{-1} (2) 3.75 rad s^{-1}

(3) 8.00 rad s^{-1} (4) 1.25 rad s^{-1}

14. A particle executes simple harmonic motion with an amplitude of 5 cm. When the particle is at 4 cm from the mean position, the magnitude of its velocity in SI units is equal to that of its acceleration. Then, its periodic time in seconds is **[JEE (Main)-2019]**

(1) $\frac{4\pi}{3}$ (2) $\frac{3}{8}\pi$

(3) $\frac{8\pi}{3}$ (4) $\frac{7}{3}\pi$

15. A particle undergoing simple harmonic motion has time dependent displacement given by $x(t) = A\sin\frac{\pi t}{90}$. The ratio of kinetic to potential energy of this particle at t = 210 s will be **[JEE (Main)-2019]**

(1) 1 (2) 3

(3) 2 (4) $\frac{1}{3}$

16. A simple pendulum of length 1 m is oscillating with an angular frequency 10 rad/s. The support of the pendulum starts oscillating up and down with a small angular frequency of 1 rad/s and an amplitude of 10^{-2} m. The relative change in the angular frequency of the pendulum is best given by **[JEE (Main)-2019]**

(1) 10^{-3} rad/s (2) 10^{-1} rad/s

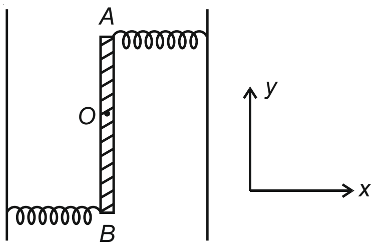
(3) 10^{-5} rad/s (4) 1 rad/s

17. A pendulum is executing simple harmonic motion and its maximum kinetic energy is K_1. If the length of the pendulum is doubled and it performs simple harmonic motion with the same amplitude as in the first case, its maximum kinetic energy is K_2. Then **[JEE (Main)-2019]**

(1) $K_2 = 2K_1$ (2) $K_2 = \frac{K_1}{4}$

(3) $K_2 = K_1$ (4) $K_2 = \frac{K_1}{2}$

18. Two light identical springs of spring constant k are attached horizontally at the two ends of a uniform horizontal rod AB of length l and mass m. The rod is pivoted at its centre 'O' and can rotate freely in horizontal plane. The other ends of the two springs are fixed to rigid supports as shown in figure. The rod is gently pushed through a small angle and released. The frequency of resulting oscillation is **[JEE (Main)-2019]**



(1) $\frac{1}{2\pi}\sqrt{\frac{k}{m}}$ (2) $\frac{1}{2\pi}\sqrt{\frac{2k}{m}}$

(3) $\frac{1}{2\pi}\sqrt{\frac{3k}{m}}$ (4) $\frac{1}{2\pi}\sqrt{\frac{6k}{m}}$

19. A simple harmonic motion is represented by :

$$y = 5(\sin 3\pi t + \sqrt{3}\cos 3\pi t)\text{cm}$$

The amplitude and time period of the motion are **[JEE (Main)-2019]**

(1) 10 cm, $\frac{2}{3}$s (2) 5 cm, $\frac{2}{3}$s

(3) 10 cm, $\frac{3}{2}$s (4) 5 cm, $\frac{3}{2}$s

20. The bob of a simple pendulum has mass 2 g and a charge of 5.0 μC. It is at rest in a uniform horizontal electric field of intensity 2000 V/m. At equilibrium, the angle that the pendulum makes with the vertical is **[JEE (Main)-2019]**

(Take, g = 10 m/s^2)

(1) $\tan^{-1}$ (0.2) (2) $\tan^{-1}$ (5.0)

(3) $\tan^{-1}$ (2.0) (4) $\tan^{-1}$ (0.5)

21. A damped harmonic oscillator has a frequency of 5 oscillations per second. The amplitude drops to half its value for every 10 oscillations. The time it will take to drop to $\frac{1}{1000}$ of the original amplitude is close to: **[JEE (Main)-2019]**

(1) 100 s (2) 10 s

(3) 50 s (4) 20 s

22. A simple pendulum oscillating in air has period T. The bob of the pendulum is completely immersed in a non-viscous liquid. The density of the liquid is $\frac{1}{16}$th of the material of the bob. If the bob is inside liquid all the time, its period of oscillation in this liquid is **[JEE (Main)-2019]**

(1) $2T\sqrt{\frac{1}{14}}$ (2) $4T\sqrt{\frac{1}{15}}$

(3) $4T\sqrt{\frac{1}{14}}$ (4) $2T\sqrt{\frac{1}{10}}$

23. The displacement of a damped harmonic oscillator is given by

$x(t) = e^{-0.1t}\cos(10\pi t + \phi)$. Here t is in seconds.

The time taken for its amplitude of vibration to drop to half of its initial value is close to : **[JEE (Main)-2019]**

(1) 7 s (2) 27 s

(3) 13 s (4) 4 s

24. A particle moves such that its position vector $\vec{r}(t) = \cos\omega t\,\hat{i} + \sin\omega t\,\hat{j}$ where ω is a constant and t is time. Then which of the following statements is true for the velocity $\vec{v}(t)$ and acceleration $\vec{a}(t)$ of the particle **[JEE (Main)-2020]**

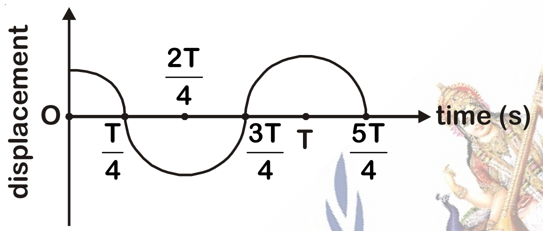
(1) $\vec{v}$ and $\vec{a}$ both are perpendicular to $\vec{r}$

(2) $\vec{v}$ is perpendicular to $\vec{r}$ and $\vec{a}$ is directed towards the origin

(3) $\vec{v}$ and $\vec{a}$ both are parallel to $\vec{r}$

(4) $\vec{v}$ is perpendicular to $\vec{r}$ and $\vec{a}$ is directed away from the origin

25. The displacement time graph of a particle executing S.H.M is given in figure (sketch is schematic and not to scale) **[JEE (Main)-2020]**



Which of the following statements is/are true for this motion?

(A) The force is zero at $t = \frac{3T}{4}$

(B) The acceleration is maximum at $t = T$

(C) The speed is maximum at $t = \frac{T}{4}$

(D) The P.E. is equal to K.E. of the oscillation at $t = \frac{T}{2}$

(1) (B), (C) and (D) (2) (A) and (D)

(3) (A), (B) and (C) (4) (A), (B) and (D)

26. A block of mass m attached to a massless spring is performing oscillatory motion of amplitude 'A' on a frictionless horizontal plane. If half of the mass of the block breaks off when it is passing through its equilibrium point, the amplitude of oscillation for the remaining system become fA. The value of f is **[JEE (Main)-2020]**

(1) $\frac{1}{\sqrt{2}}$ (2) $\sqrt{2}$

(3) 1 (4) $\frac{1}{2}$

27. When a particle of mass m is attached to a vertical spring of spring constant k and released, its motion is described by $y(t) = y_0\sin^2\omega t$, where 'y' is measured from the lower end of unstretched spring. Then ω is **[JEE (Main)-2020]**

(1) $\sqrt{\frac{2g}{y_0}}$ (2) $\frac{1}{2}\sqrt{\frac{g}{y_0}}$

(3) $\sqrt{\frac{g}{2y_0}}$ (4) $\sqrt{\frac{g}{y_0}}$

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