Topic : SHM, Wave on string and Sound wave

1. $y = A\sin(\omega t + \phi_o)$ is the time – displacement equation of an SHM. At $t = 0$, the displacement of the particle is $Y = \frac{A}{2}$ and it is moving along negative $x-$direction. Then, the initial phase angle $\phi_o$ will be.

   **A.** $\frac{\pi}{6}$

   **B.** $\frac{\pi}{3}$

   **C.** $\frac{2\pi}{3}$

   **D.** $\frac{5\pi}{6}$

2. Which of the following equations represents a travelling wave?

   **A.** $y = Ae^{-x^2}(vt + \theta)$

   **B.** $y = A\sin(15x - 2t)$

   **C.** $y = Ae^{x}\cos(\omega t - \theta)$

   **D.** $y = A\sin x\cos\omega t$

3. The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. Measured value of $'L'$ is $1.0\ \mathrm{m}$ from meter scale having minimum division of $1\ \mathrm{mm}$ and time of one complete oscillation is $1.95\ \mathrm{s}$ measured from stopwatch of $0.01\ \mathrm{s}$ resolution. The percentage error in the determination of $'g'$ will be:

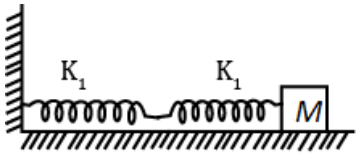
   **A.** $1.33\ \%$

   **B.** $1.30\ \%$

   **C.** $1.13\ \%$

   **D.** $1.03\ \%$

4. If two similar springs, each of spring constant $K_1$ are joined in series, the new spring constant and the time period would be changed by a factor of:




**A.** $\frac{1}{2}, \sqrt{2}$

**B.** $\frac{1}{4}, 2\sqrt{2}$

**C.** $\frac{1}{2}, 2\sqrt{2}$

**D.** $\frac{1}{4}, \sqrt{2}$

5. Amplitude of a mass spring system, which is executing simple harmonic motion decreases with time. If mass $= 500\ \text{g}$, damping constant $= 20\ \text{g/s}$ then how much time is required for the amplitude of the system to drop to half of its initial value?
$(ln2 = 0.693)$

**A.** $15.01\ \text{s}$

**B.** $17.32\ \text{s}$

**C.** $0.034\ \text{s}$

**D.** $34.65\ \text{s}$

6. Given below are two statements.

Statement $(1)$ : A second's pendulum has a time period of $1\ \text{second}$.

Statement $(2)$ : It takes precisely one second to move between the two extreme positions.

In the light of the above statements, choose the correct answer from the options given below.

**A.** Both statement $1$ and statement $2$ are false.

**B.** Statement $1$ is true, but statement $2$ is false.

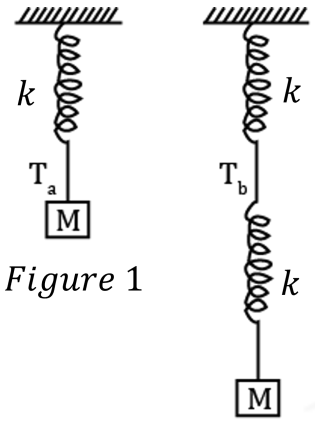
**C.** Statement $1$ is false, but statement $2$ is true.

**D.** Both statement $1$ and statement $2$ are true.

7. A particle performs simple harmonic motion with a period of $2$ second. The time taken by the particle to cover a displacement equal to half of its amplitude from the mean position is $\frac{1}{a}\text{s}$. The value of $a$ to the nearest integer is.

8. Consider two identical springs each of spring constant $k$ and negligible mass as compared to the mass $M$ are as shown in the figure. Figure $1$ shows one of them connected to mass $M$ and Figure $2$ shows their series combination connected to the same mass. The ratio of time period of oscillation of the two $SHM$ is $\frac{T_b}{T_a} = \sqrt{x}$, where value of $x$ is _____.

(Round off to the nearest integer)




$Figure\ 1$ $Figure\ 2$

9. A particle is making simple harmonic motion along the $x-\text{axis}$. If at a distance $x_1$ and $x_2$ from the mean position the velocities of the particle are $v_1$ and $v_2$ respectively. The time period of its oscillation is given as :

**A.** $T = 2\pi\sqrt{\frac{x_2^2 + x_1^2}{v_1^2 - v_2^2}}$

**B.** $T = 2\pi\sqrt{\frac{x_2^2 + x_1^2}{v_1^2 + v_2^2}}$

**C.** $T = 2\pi\sqrt{\frac{x_2^2 - x_1^2}{v_1^2 + v_2^2}}$

**D.** $T = 2\pi\sqrt{\frac{x_2^2 - x_1^2}{v_1^2 - v_2^2}}$

10. $T_0$ is the time period of a simple pendulum at a place. If the length of the pendulum is reduced to $\frac{1}{16}$ times of its initial value, the modified time period is :

**A.** $T_0$

**B.** $8\pi T_0$

**C.** $4T_0$

**D.** $\frac{1}{4}T_0$

11. A transverse wave travels on a taut steel wire with a velocity of $v$ when tension in it is $2.06 \times 10^4$ N. When the tension is changed to $T$ the velocity changed to $v/2$. The value of $T$ is close to:

**A.** $2.50 \times 10^4$ N

**B.** $5.15 \times 10^3$ N

**C.** $30.5 \times 10^4$ N

**D.** $10.2 \times 10^2$ N

12. Three harmonic waves, having equal frequency $f$ and intensity $I_0$, have phase angles $0, \frac{\pi}{4} \text{and } -\frac{\pi}{4}$ respectively. When they are superimposed, the intensity of the resultant wave is close to:

**A.** $5.8I_0$

**B.** $0.2I_0$

**C.** $3I_0$

**D.** $I_0$

13. A wire of length $L$ and mass per unit length $6.0 \times 10^{-3}\ \mathrm{kgm^{-1}}$ is put under tension of $540\ \mathrm{N}$. Two consecutive frequencies that resonates with it are : $420\ \mathrm{Hz}$ and $490\ \mathrm{Hz}$. Then the value of $L$ (in meters) is:

**A.** $2.1\ \mathrm{m}$

**B.** $1.1\ \mathrm{m}$

**C.** $8.1\ \mathrm{m}$

**D.** $5.1\ \mathrm{m}$

14. A wire of density $9 \times 10^{-3}\mathrm{kg\ cm^{-3}}$ is stretched between two clamps $1\ \mathrm{m}$ apart. The resulting strain in the wire is $4.9 \times 10^{-4}$. The lowest frequency of the transverse vibrations in the wire is (Young's modulus of wire $Y = 9 \times 10^{10}\ \mathrm{Nm^{-2}}$), (to the nearest integer),

15. Two identical strings $X$ and $Z$ made of same material have tension $T_X$ and $T_Z$ in them. If their fundamental frequencies are $450\ \mathrm{Hz}$ and $300\ \mathrm{Hz}$, respectively, then the ratio $\frac{T_X}{T_Z}$ is:

**A.** $2.25$

**B.** $0.44$

**C.** $1.25$

**D.** $1.5$

16. A uniform thin rope of length $12\ \mathrm{m}$ and mass $6\ \mathrm{kg}$ hangs vertically from a rigid support and a block of mass $2\ \mathrm{kg}$ is attached to its free end. A transverse short wave-train of wavelength $6\ \mathrm{cm}$ is produced at the lower end of the rope. What is the wavelength of the wave train (in $\mathrm{cm}$) when it reaches the top of the rope?

**A.** $3$

**B.** $6$

**C.** $12$

**D.** $9$

17. The amplitude of wave disturbance propagating in the positive $x$-direction is given by $y = \frac{1}{(1+x)^2}$ at time $t = 0$ and $y = \frac{1}{1+(x-2)^2}$ at $t = 1\ \text{s}$, where $x$ and $y$ are in meter. The shape of wave does not change during the propagation. The velocity of the wave in $(\text{m/s})$ will be _____.

18. Two travelling waves produces a standing wave represented by equation, $y = 1.0\ \text{mm} \cos[(1.57\ \text{cm}^{-1})x] \sin[(78.5\ \text{s}^{-1})t]$. The node closest to the origin in the region $x > 0\ \text{cm}$ will be at $x =$____$\text{cm}$.

19. Two waves are simultaneously passing through a string and their equations are : $y_1 = A_1 \sin\ k(x - vt),\ y_2 = A_2 \sin\ k(x - vt + x_0)$ Given amplitudes $A_1 = 12\ \text{mm}$ and $A_2 = 5\ \text{mm}$, $x_0 = 3.5\ \text{cm}$ and wave number $k = 6.28\ \text{cm}^{-1}$. The amplitude of resulting wave will be _____ mm.

20. A tuning fork is vibrating at $250\ \text{Hz}$. The length of the shortest closed organ pipe that will resonate with the tuning fork will be _____ $\text{cm}$.

    (Take speed of sound in air as $340\ \text{ms}^{-1}$)

21. Two cars are approaching each other at an equal speed of $7.2\ \text{km/hr}$. When they see each other, both blow horns having frequency of $676\text{Hz}$. The beat frequency heard by each driver will be $\text{Hz}$.

    [Velocity of sound in air is $340\text{m/s}$]

22. A student is performing the experiment of resonance column. The diameter of the column tube is $6\ \text{cm}$. The frequency of the tuning fork is $504\ \text{Hz}$. The speed of the sound at the given temperature is $336\ \text{m/s}$. The zero of the meter scale coincides with the top end of the resonance column tube. The reading of the water level in the column when the first resonance occurs is -

**A.** $13\ \text{cm}$

**B.** $14.8\ \text{cm}$

**C.** $16.6\ \text{cm}$

**D.** $18.4\ \text{cm}$

23. A tuning fork $A$ of unknown frequency produces $5\ \text{beats/s}$ with a fork of known frequency $340\ \text{Hz}$. When fork $A$ is filed, the beat frequency decreases to $2\ \text{beats/s}$. What is the frequency of fork $A$?

**A.** $342\ \text{Hz}$

**B.** $335\ \text{Hz}$

**C.** $338\ \text{Hz}$

**D.** $345\ \text{Hz}$

24. The frequency of a car horn encountered a change from $400\ \text{Hz}$ to $500\ \text{Hz}$, when the car approaches a vertical wall. If the speed of sound is $330\ \text{m/s}$. Then the speed of car is _____ $\text{km/h}$.

25. A stationary observer receive sound from two identical tuning forks, one of which approaches and the other one recedes with the same speed (much less than the speed of sound). The observer hears $2$ beats per second. The oscillation frequency of each tuning fork is $f_0 = 1400\ \mathrm{Hz}$ and the velocity of sound in air is $350\ \mathrm{ms}^{-1}$. The speed of each tuning fork is close to:

**A.** $\frac{1}{2}\mathrm{ms}^{-1}$

**B.** $1\ \mathrm{ms}^{-1}$

**C.** $\frac{1}{4}\mathrm{ms}^{-1}$

**D.** $\frac{1}{8}\mathrm{ms}^{-1}$

26. One meter long (both ends open) organ pipe is kept in a gas that has double the density of air at $\mathrm{STP}$. Assuming the speed of sound of air at $\mathrm{STP}$ is $300\ \mathrm{ms}^{-1}$, the frequency difference between the fundamental and second harmonic of the pipe is_____$\mathrm{Hz}$.

27. Assume that the displacement $(s)$ of air is proportional to the pressure difference $(\Delta p)$ created by a sound wave. Displacement $(s)$ further depends on the speed of sound $(v)$, density of air $(\rho)$ and the frequency $(f)$. If $\Delta p \sim 10\ \mathrm{Pa}, v \sim 300\ \mathrm{m/s}, \rho \sim 1\ \mathrm{kg/m}^3$ and $f \sim 1000\ \mathrm{Hz}$, then $s$ will be of the order of (take the multiplicative constant to be $1$)

**A.** $\frac{3}{100}\mathrm{mm}$

**B.** $10\ \mathrm{mm}$

**C.** $\frac{1}{10}\mathrm{mm}$

**D.** $1\ \mathrm{mm}$

28. In a resonance tube experiment when the tube is filled with water up to a height of $17.0\ \mathrm{cm}$ from bottom, it resonates with a given tuning fork. When the water level is raised the next resonance with the same tuning fork occurs at a height of $24.5\ \mathrm{cm}$. If the velocity of sound in air is $330\ \mathrm{m/s}$, the tuning fork frequency is

**A.** $2200\ \mathrm{Hz}$

**B.** $550\ \mathrm{Hz}$

**C.** $1100\ \mathrm{Hz}$

**D.** $3300\ \mathrm{Hz}$

29. The driver of a bus, approaching a big wall, notices that the frequency of his bus's horn changes from $420\ \mathrm{Hz}$ to $490\ \mathrm{Hz}$ when he hears it after it gets reflected from the wall. Find the speed of the bus, if the speed of the sound is $330\ \mathrm{ms}^{-1}$

**A.** $91\ \mathrm{km\ h}^{-1}$

**B.** $81\ \mathrm{km\ h}^{-1}$

**C.** $61\ \mathrm{km\ h}^{-1}$

**D.** $71\ \mathrm{km\ h}^{-1}$

30. Two cars $X$ and $Y$ are approaching each other with velocities $36\ \mathrm{km/h}$ and $72\ \mathrm{km/h}$ respectively. The frequency of a whistle sound as emitted by a passenger in car $X$, heard by the passenger in car $Y$ is $1320\ \mathrm{Hz}$. If the velocity of sound in air is $340\ \mathrm{m/s}$, the actual frequency of the whistle sound produced is $\mathrm{Hz}$.