PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 82

Total Marks : 23

Max. Time : 25 min.

Topics : Wave on a String , Circular Motion

Type of Questions		**M.M., Min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.2	(3 marks, 3 min.)	[6, 6]
Subjective Questions ('–1' negative marking) Q.3 to Q.4	(4 marks, 5 min.)	[8, 10]
Comprehension ('–1' negative marking) Q.5 to Q.7	(3 marks, 3 min.)	[9, 9]

1. The particle displacement (in cm) in a stationary wave is given by $y(x, t) = 2 \sin (0.1\pi x) \cos (100 \pi t)$. The distance between a node and the next antinode is :

(A) 2.5 cm (B) 7.5 cm (C) 5 cm (D) 10 cm

2. A string of length 1.5 m with its two ends clamped is vibrating in fundamental mode. Amplitude at the centre of the string is 4 mm. Minimum distance between the two points having amplitude 2 mm is:

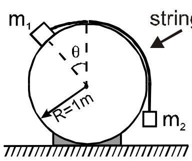
(A) 1 m (B) 75 cm (C) 60 cm (D) 50 cm

3. A string is fixed at both ends. The tension in the string and density of the string are accurately known but the length and the radius of cross section of the string are known with some error. If maximum errors made in the measurement of length and radius are 1% and 0.5% respectively then what is the maximum possible percentage error in the calculation of fundamental frequency of that string.

4. A mass m_1 lies on fixed, smooth cylinder. An ideal cord attached to m_1 passes over the cylinder and is connected to mass m_2 as shown in the figure.

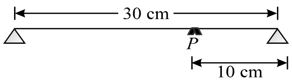
(a) Find the value of θ (shown in diagram) for which the system is in equilibrium

(b) Given $m_1 = 5$ kg, $m_2 = 4$kg . The system is released from rest when $\theta = 30^o$. Find the magnitude of acceleration of mass m_1 just after the system is released.



COMPREHENSION

Figure shows a clamped metal string of length 30 cm and linear mass density 0.1 kg/m. which is taut at a tension of 40 N. A small rider (piece of paper) is placed on string at point *P* as shown. An external vibrating tuning fork is brought near this string and oscillations of rider are carefully observed.



5. At which of the following frequencies of turning fork, rider will not vibrate at all :

(A) $\frac{100}{3}$ Hz (B) 50 Hz (C) 200 Hz (D) None of these

6. At which of the following frequencies the point *P* on string will have maximum oscillation amplitude among all points on string :

(A) $\frac{200}{3}$ Hz (B) 100 Hz (C) 200 Hz (D) None of these

7. Now if the tension in the string is made 160 N, at which of the following frequencies of turning fork, rider will not vibrate at all

(A) $\frac{100}{3}$ Hz (B) 50 Hz (C) 200 Hz (D) None of these

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Answers Key

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1. (C) **2.** (A) **3.** 1.5% **4.** $\sin\theta = \frac{m_2}{m_1}$

(b) $\frac{15}{9}$ m/s^2 **5.** (C) **6.** (D) **7.** (C)

Hint & Solutions

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1. $y(x, t) = 2 \sin(0.1\,\pi x) \cos(100\,\pi t)$

compare with

$y = A \sin(Kx) \cos \omega t$

$K = 0.1\,\pi = \frac{2\pi}{\lambda}$

$\lambda = 20$ cm

$\frac{\pi}{4} = \frac{20}{4} = 5$ cm

2. $\lambda = 2\ell = 3$m

Equation of standing wave

$y = 2A \sin kx \cos \omega t$

$y = A$ as amplitude is 2A.

$A = 2A \sin kx$

$\frac{2\pi}{\lambda} x = \frac{\pi}{6}$

$\Rightarrow x_1 = \frac{1}{4}$m

and $\frac{2\pi}{\lambda} . x = \frac{5\pi}{6}$

$\Rightarrow x_2 = 1.25$ m

$\Rightarrow x_2 - x_1 = 1$m

3. $f = \frac{1}{2\ell}\sqrt{\frac{T}{\mu}} = \frac{1}{2\ell}\sqrt{\frac{T}{\rho s}} = \frac{1}{2\ell}\sqrt{\frac{T}{\rho \cdot \pi r^2}}$

$= \frac{1}{2\ell r}\sqrt{\frac{T}{\rho\pi}}$

$\therefore \frac{\Delta f}{f} = -\frac{\Delta \ell}{\ell} - \frac{\Delta r}{r}$

$\left(\frac{\Delta f}{f}\right)_{max} = 1 + 0.5 = 1.5\%$ **Ans.**

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4. (a) The system is in equilibrium when

$m_1 g\sin\theta = m_2 g$

or $\sin\theta = \frac{m_2}{m_1}$

(b) Let the tangential acceleration of m_1 be a.

$\therefore$ $m_2 g - m_1 g \sin\theta = (m_1 + m_2)$ a

$a = \frac{40 - 25}{9} = \frac{15}{9}$ m/s²

the normal acceleration of m_1 is zero.

$\because$ speed of m_1 is zero.

$\therefore$ The magnitude of acceleration of $m_1 = \frac{5}{3}$ m/s²

5. to 7. Wave velocity in string is

$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{40}{0.1}} = 20 \text{ m/s}$$

Fundamental frequency of string oscillations is

$$n_0 = \frac{v}{2e} = \frac{20}{0.6} = \frac{100}{3} \text{ Hz}$$

Thus string will be in resonance with a turning fork of frequency.

$$n_f = \frac{100}{3} \text{ Hz}, \frac{200}{3} \text{ Hz}, 100 \text{ Hz}, \frac{400}{3} \text{ Hz}, ...$$

Here rider will not oscillate at all only if it is at a node of stationary wave in all other cases of resonance and non-resonance it will vibrate at the frequency of tuning fork. At a distance $\frac{l}{3}$ from one end node will appear at 3rd, 6th, 9th or similar higher Harmonics i.e. at frequencies 100 Hz, 200 Hz, ...

If string is divided in odd no. of segments, these segments can never resonate simultaneously hence at the location of rider, antinode is never obtained at any frequency.

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