PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 77

Total Marks : 29

Max. Time : 33 min.

Topics : Wave on a String, Circular Motion, Rigid Body Dynamics, Friction, Center of Mass

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.3	(3 marks, 3 min.)	[9, 9]
Multiple choice objective ('–1' negative marking) Q.4	(4 marks, 4 min.)	[4, 4]
Subjective Questions ('–1' negative marking) Q.5 to Q.8	(4 marks, 5 min.)	[16, 20]

1. A sine wave of wavelength λ is travelling in a medium. The minimum distance between the two particles, always having same speed, is -

(A) $\lambda/4$ (B) $\lambda/3$ (C) $\lambda/2$ (D) λ

2. When a harmonic wave is propagating through a medium, the displacement 'y' of a particle of the medium is represented by $y = 10 \sin \frac{2\pi}{5}(1800\,t - x)$. The time period will be

(A) $\frac{1}{360}$ s (B) $\frac{1}{36}$ s (C) 36 s (D) 360 s

3. A transverse wave described by equation y = 0.02sin (x + 30t) (where x and t are in metres and sec.respectively) is travelling along a wire of area of cross–section $1 mm^2$ and density $8000 kg/m^3$. What is the tension in the string ?

(A) 20 N (B) 7.2 N (C) 30 N (D) 14.4 N

4. A ball tied to the end of the string swings in a vertical circle under the influence of gravity.

(A) When the string makes an angle 90º with the vertical, the tangential acceleration is zero and radial acceleration is somewhere between minimum and maximum

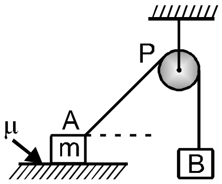
(B) When the string makes an angle 90º with the vertical, the tangential acceleration is maximum and radial acceleration is somewhere between maximum and minimum

(C) At no place in circular motion, tangential acceleration is equal to radial acceleration (in magnitude)

(D) When radial acceleration has its maximum value, the tangential acceleration is zero

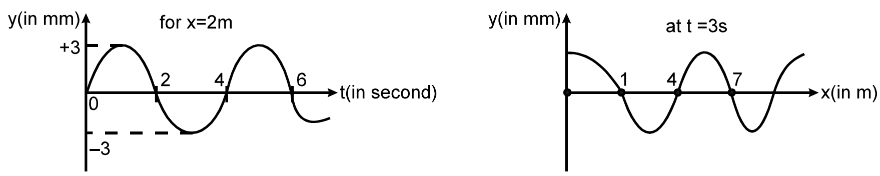
5. A uniform rod of length 75 cm is hinged at one of its ends and is free to rotate in vertical plane. It is released from rest when rod is horizontal. When the rod becomes vertical, it is breaks at mid–point and lower part now moves freely. The distance of centre of lower part from hinge, when it again becomes vertical for the first time is r. Find the approximate value of 2r.

6. In figure shown minimum mass of block B (at a particular angle between horizontal and string AP) to just slide the block A on rough horizontal surface is $\frac{m}{2}$ as shown in figure. If μ is the coefficient of friction between block A and ground then $\frac{1}{\mu^2}$ will be :



7. Body 1 experiences a perfectly elastic collision with a stationary Body 2. Determine the mass ratio $\left(\frac{m_2}{m_1}\right)$, if after a head-on collision the particles fly apart in the opposite directions with equal speeds.

8. A sinusoidal wave propagates along a string. In figure (a) and (b) 'y' represents displacement of particle from the mean position. 'x' & 't' have usual meanings. Find:



(a) wavelength, frequency and speed of the wave.

(b) maximum velocity and maximum acceleration of the particles

(c) the magnitude of slope of the string at x = 2 at t = 4 sec.

Answers Key

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1. (C) **2.** (A) **3.** (B) **4.** (B)(D) **5.** 5

6. 3 **7.** $\frac{m_2}{m_1} = 3$ **8.** (a) 6m, 0.25 Hz, 1.5m/s

(b) 1.5π mm/s, $0.75\pi^2$ mm/s (c) π

Hint & Solutions

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1. The minimum distance between the two particles having same speed is $\lambda/2$.

3. $y = 0.02 \sin(x + 30t)$

for the given wave :

$$v = \frac{dx}{dt} = -30$$

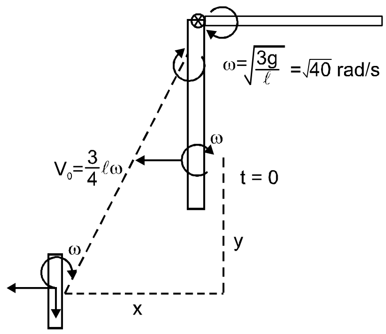
($\because$ x + 30t = constant)

we have : $v = \sqrt{\frac{T}{\mu}} \Rightarrow T = \mu v^2 = A.\rho\, V^2$

$$= (10^{-6}\ m^2)\left(8 \times 10^3 \frac{kg}{m^3}\right)(30)^2$$

$\Rightarrow$ T = 7.2 N **Ans.**

5.



$$t = \frac{\pi}{\omega} = \frac{\pi}{\sqrt{40}} \text{ sec.}$$

$x = v_0 t$

$$y = \frac{1}{2} g t^2$$

$$r = \sqrt{x^2 + \left(y + \frac{3\ell}{4}\right)^2} \simeq 2.5\text{m}.$$

6. Minimum for required,

$$\Rightarrow \frac{\mu mg}{\sqrt{1+\mu^2}} = \frac{mg}{2}$$

$$\mu = \frac{1}{\sqrt{3}}$$

$$\mu^2 = \frac{1}{3}$$

$$\frac{1}{\mu^2} = 3.$$

7. Collision is perfectly elastic collision, particle 2 is at rest $(u_2 = 0)$

$V_1 = -V_2$ (given)

(A) $$\frac{(m_1 - m_2)u_1}{(m_1 + m_2)} = \frac{-2m_1 \; u_1}{(m_1 + m_2)}$$

$m_1 - m_2 = -2m_1 = 3m_1 = m_2$

$$\frac{m_1}{m_2} = \frac{1}{3}$$

8. (a) from y – x graph

wavelength = λ = 6m

from y – t graph

Time period = T = 4 sec

$\Rightarrow$ frequency = f = $\frac{1}{4}$ = 0.25 Hz

wave speed = $f\lambda$ = 0.25 × 6 = 1.50 m/s

(b) maximum velocity = 3mm × $\frac{\pi}{2}$ rad/sec

= 1.5 π mm/sec

maximum accelesation = w^2A = $\frac{\pi^2}{4} \times 3\text{mm}$

= 0.75 p^2 mm/sec^2.

(c) $k = \frac{2\pi}{\lambda} = \frac{\pi}{3}$ m^{-1}

$\Rightarrow$ $w = \frac{2\pi}{T} = \frac{\pi}{2}$ rad/sec

$$y = 3 \sin\left(\frac{\pi}{3}x - \frac{\pi}{2}t + \theta_o\right)$$

y(x = 2, t = 0) = 0

$$\Rightarrow \sin\left(\frac{2\pi}{3}+\theta_0\right) = 0$$

$$\Rightarrow \theta_0 = -\frac{2\pi}{3} \text{ or } \frac{\pi}{3}$$

and $\frac{\partial y}{\partial t}$ (t = 0 , x = 2) > 0

$$\Rightarrow \frac{-3\pi}{2} \cos\left(\frac{\pi}{3}x-\frac{\pi t}{2}+\theta_0\right) > 0$$

(For x = 2, t = 0)

$$\Rightarrow \cos\left(\frac{2\pi}{3}+\theta_0\right) < 0$$

$$\Rightarrow \theta_0 = \frac{\pi}{3}$$

$$y = (x,t) = 3\sin\left(\frac{\pi x}{3}-\frac{\pi t}{2}+\frac{\pi}{3}\right)$$

$$\frac{\partial y}{\partial x} = \pi \cos\left(\frac{\pi x}{3}-\frac{\pi t}{2}+\frac{\pi}{3}\right)$$

$\Rightarrow$ at x = 2 and t = 4 sec ; $\frac{\partial y}{\partial x} = \pi$