PHYSICS

DPP
DAILY PRACTICE PROBLEMS

DPP No. 80

Total Marks : 22

Max. Time : 23 min.

Topics :Circular Motion, Center of Mass, Rigid Body Dynamics, Work, Power and Energy, String Waves

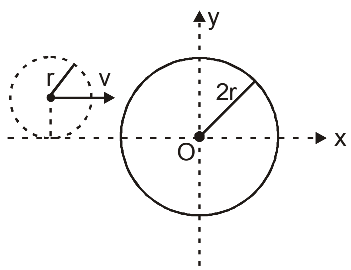
Type of Questions		**M.M., Min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.3	**(3 marks, 3 min.)**	**[9, 9]**
Subjective Questions ('–1' negative marking) Q.4	**(4 marks, 5 min.)**	**[4, 5]**
Comprehension ('–1' negative marking) Q.5 to Q.7	**(3 marks, 3 min.)**	**[9, 9]**

1. A boy of mass 30 kg starts running from rest along a circular path of radius 6 m with constant tangential acceleration of magnitude 2 m/s^2. After 2 sec from start he feels that his shoes started slipping on ground. The friction coefficient between his shoes and ground is : (Take g = 10 m/s^2)

(A) $\frac{1}{2}$ (B) $\frac{1}{3}$

(C) $\frac{1}{4}$ (D) $\frac{1}{5}$

2. A small smooth disc of mass m and radius r moving with an initial velocity 'v' along the positive x-axis collided with a big disc of mass 2m and radius 2r which was initially at rest with its centre at origin as shown in figure.

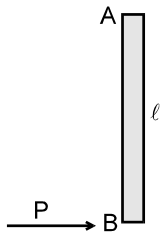


If the coefficient of restitution is 0 then velocity of larger disc after collision is

(A) $\frac{8v}{27}\hat{i} - \frac{2\sqrt{2}}{27}v\hat{j}$ (B) $\frac{8v}{27}\hat{i} + \frac{2\sqrt{2}}{27}v\hat{j}$

(C) $\frac{v}{3}\hat{i}$ (D) $\frac{2\sqrt{2}}{27}v\hat{i} - \frac{8v}{27}\hat{j}$

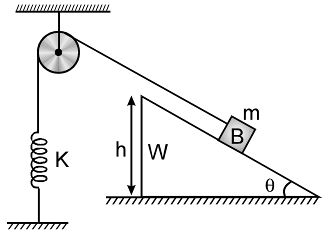
3. A uniform rod AB of mass m and length l at rest on a smooth horizontal surface. An impulse P is applied to the end B. The time taken by the rod to turn through a right angle is:



(A) $\frac{2\pi ml}{P}$ (B) $\frac{\pi ml}{3P}$

(C) $\frac{\pi ml}{12P}$ (D) $\frac{2\pi ml}{3P}$

4. In the figure shown the pulley is smooth. The spring and the string are light. The block 'B' slides down from the top along the fixed rough wedge of inclination θ. Assuming that the block reaches the end of the wedge. Find the speed of the block at the end. Take the coefficient of friction between the block and the wedge to be μ and the spring was relaxed when the block was released from the top of the wedge.



COMPREHENSION

A sinusoidal wave travels along a taut string of linear mass density 0.1 g/cm. The particles oscillate along y-direction and wave moves in the positive x-direction. The amplitude and frequency of oscillation are 2mm and 50 Hz respectively. The minimum distance between two particles oscillating in the same phase is 4m.

5. The tension in the string is (in newton)
(A) 4000 (B) 400 (C) 25 (D) 250

6. The amount of energy transferred (in Joules) through any point of the string in 5 seconds is

(A) $\frac{\pi^2}{10}$

(B) $\frac{\pi^2}{50}$

(C) $\frac{\pi^2}{5}$

(D) Cannot be calculated because area of cross-section of string is not given.

7. If at x = 2m and t = 2s, the particle is at y = 1mm and its velocity is in positive y-direction, then the equation of this travelling wave is : (y is in mm, t is in seconds and x is in metres)

(A) $y = 2 \sin (\frac{\pi x}{2} - 100 \pi t + 30°)$ (B) $y = 2 \sin (\frac{\pi x}{2} - 100 \pi t + 120°)$

(C) $y = 2 \sin (\frac{\pi x}{2} - 100 \pi t + 150°)$ (D) None of these

Answers Key

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1. (B) **2.** (A) **3.** (C)

4. $V = \sqrt{\frac{2}{m}\left[mgh - \frac{1}{2}K\left(\frac{h}{\sin\theta}\right)^2 - \mu mgh\cot\theta\right]}$

5. (B) **6.** (C) **7.** (D)

Hint & Solutions

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1. After 2 sec speed of boy will be

$v = 2 \times 2 = 4$ m/s

At this moment centripetal force on boy is

$F_r = \frac{mv^2}{R} = \frac{30 \times 16}{6} = 80$ Nt.

Tangential force on boy is

$F_t = ma = 30 \times 2 = 60$ Nt.

Total friction acting on boy is

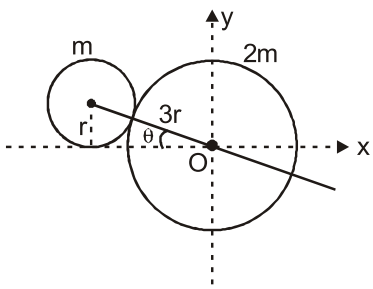
$F = \sqrt{F_r^2 + F_t^2} = 100$ Nt

At the time of slipping

$F = \mu mg$

or $100 = \mu \times 30 \times 10$

$\Rightarrow \mu = \frac{1}{3}$.

2. 

The larger sphere will move along line of impact.

AB e = 0, velocity of larger sphere

$v' = \frac{mv\cos\theta}{m + 2m} = \frac{v\cos\theta}{3}$

velocity of larger sphere

$= v'\cos\theta\,\hat{i} - v'\sin\theta\,\hat{j}$

$= \frac{v}{3}\cos^2\theta\,\hat{i} - \frac{v}{3}\sin\theta\cos\theta\,\hat{j}$

$= \frac{8}{27}\,\hat{i} - \frac{2\sqrt{2}}{27}\,\hat{j}$

3. **(C)** Impulse = change in momentum

$\therefore \quad P.\frac{\ell}{2} = \frac{m\ell^2}{12}.\omega$

(about centre of AB)

$\Rightarrow \quad \omega = \frac{6P}{m\ell}$

For $\theta = \frac{\pi}{2}$; $\frac{\pi}{2} = \omega t$

$\Rightarrow \quad t = \frac{\pi}{2\omega} = \frac{\pi m\ell}{2\times 6p}$

$\Rightarrow \quad t = \frac{\pi m\ell}{12p}$ **Ans.**

4. By energy conservation :

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}K\left(\frac{h}{\sin\theta}\right)^2 + \mu mg\cos\theta.\frac{h}{\sin\theta}$$

$\Rightarrow \quad V$

$$= \sqrt{\frac{2}{m}\left[mgh - \frac{1}{2}K\left(\frac{h}{\sin\theta}\right)^2 - \mu mgh\cot\theta\right]}$$ **Ans.**

5. to 7 λ = 4m and f = 500 Hz.

$\therefore$ V = fλ = 200 m/s

$\because \; V = \sqrt{\frac{T}{\mu}} \quad \therefore T = \mu v^2 = (0.1) \times (200)^2$

= 400 N

6. Since integral number of waves shall cross a point is 5 seconds, therefore power transmitted in 5 seconds is = $\langle P\rangle \times 5 = 2\pi^2 f^2 A^2 \mu v \times 5$

$= 2 \times \pi^2 \times (50)^2 \times (2 \times 10^{-3})^2 \times (0.01) \times 200 \times 5 = \frac{\pi^2}{5}$

7. The equation of waves is

$y = A\sin(kx - \omega t + \phi_0)$

$\therefore$ where $K = \frac{2\pi}{\lambda} = \frac{\pi}{2}$, $\omega = 2\pi f = 100\pi$ and A = 2

at x = 2 and t = 2 y = 1 mm

$\therefore 1 = 2\sin(\pi - 200\pi + \phi_0)$ solving $\phi_0 = -30°$

$\therefore y = 2\sin\left(\frac{\pi x}{2} - 100\pi t - 30°\right)$