PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 79

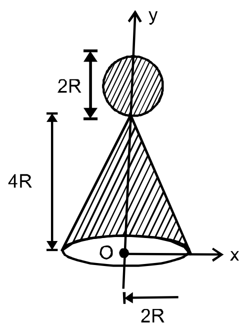
Total Marks : 22

Max. Time : 23 min.

Topics : Center of Mass, Relative Motion, Wave on a String, Friction

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 carpenter has constructed a toy as shown in figure. If the density of the material of the sphere is 12 tirnes that of cone, the y-coordinate of COM of toy from point O



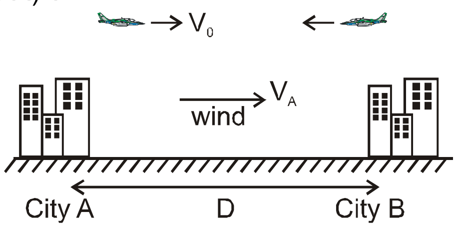
(A) 3R

(B) $\frac{9R}{2}$

(C) $\frac{7R}{2}$

(D) 4R

2. An airplane flies between two cities separated by a distance D. Assume the wind blows directly from one city to the other at a speed V_A (as shown) and the speed of the airplane is V_o relative to the air. Find the time taken by the airplane to make a round trip between the two cities (that is, to fly from city A to city B and then back to City A) ?



(A) $\frac{2DV_o}{V_0^2 - V_A^2}$

(B) $\frac{DV_o}{V_0^2 - V_A^2}$

(C) $\frac{2DV_o}{V_0^2 + V_A^2}$

(D) $\frac{DV_o}{V_0^2 + V_A^2}$

3. A travelling wave $y = A \sin (kx - \omega t + \theta)$ passes from a heavier string to a lighter string. The reflected wave has amplitude 0.5 A. The junction of the strings is at x = 0. The equation of the reflected wave is:

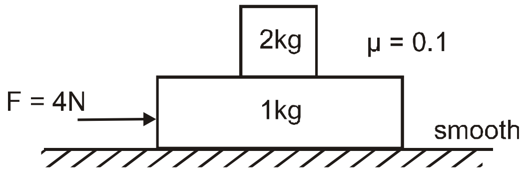
(A) $y' = 0.5 A \sin (kx + \omega t + \theta)$

(B) $y' = -0.5 A \sin (kx + \omega t + \theta)$

(C) $y' = -0.5 A \sin (\omega t - kx - \theta)$

(D) $y' = 0.5 A \sin (kx + \omega t - \theta)$

4. 2 kg block is kept on 1 kg block as shown. The friction between 1 kg block and fixed surface is absent and the coefficient of friction between 2 kg block and 1 kg block is $\mu = 0.1$. A constant horizontal force F = 4 N is applied on 1 kg block. If the work done by the friction on 1 kg block in 2 s is $-$ X J, then find X. Take $g = 10\ m/s^2$.



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

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

Answers Key

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1. (D) **2.** (A) **3.** (D) **4.** 8 **5.** (B)
6. (C) **7.** (D)

Hint & Solutions

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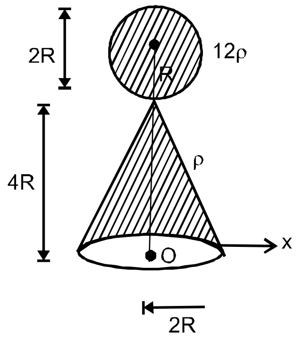
1.



Mass of cone $M_1 = \rho\left(\frac{1}{3}\pi(2R^2)4R\right)$

$c = \frac{\rho}{3}\pi(16R^3)$

mass of sphere M_2

$= 12\rho\left(\frac{4}{3}\pi R^3\right) = \rho 16\pi\,(R^3)$

$y_1 = y_{com}(\text{Cone}) = \frac{H}{4} = \frac{4R}{4} = R$

$y_2 = y_{com}\,(\text{sphere}) = 4R + R = 5R$

$y_{com}(\text{toy}) = \frac{M_1y_1 + M_2y_2}{M_1 + M_2}$

$= \frac{16\rho\pi R^3}{3}(R) + 16\rho\pi\,(R^3)\,5R$

$16\,\pi\rho R^3\left[\frac{1}{3}+1\right]$

$\Rightarrow \frac{16\rho\pi R^3\left[\frac{R}{3}+5R\right]}{16\rho\pi R^3\left[\frac{1}{3}+1\right]} = 4R$

2. The speed of the plane as it goes from city A to city B is $V_o + V_A$ and the speed of the plane as it goes from city B to city A is $V_o - V_A$. Therefore the time taken by the plane to go once round the trip is

$$t = \frac{D}{V_o - V_A} + \frac{D}{V_o + V_A} = \frac{2DV_o}{V_0^2 - V_A^2}$$

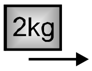
3. As wave has been reflected from a rarer medium, therefore there is no change in phase. Hence equation for the opposite direction can be written as

$y = 0.5A \sin(-kx - \omega t + \theta)$

$= -\,0.5A \sin(kx + \omega t - \theta)$

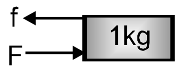
FBD

4.



$f = \mu N = 0.1 \times 2 \times 10N = 2N$

$a_{2kg} = \frac{f}{m} = \frac{2N}{2kg} = 1\ m/s^2$



$F - f = ma$

$\Rightarrow\ 4 - 2 = 1 \times a_{1kg}$

$\Rightarrow\ a_{1kg} = 2\ m/s^2$

Distance travelled by 1 kg in t = 2 s,

$S = \frac{1}{2} \times at^2 = \frac{1}{2} \times 2 \times 2^2 = 4\ m$

Velocity of the 1 kg block after t = 2 s,

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

$\therefore$ work done by F $= F.S. = 4 \times 4J = 16\ J$

KE of 1 kg block $= \frac{1}{2} \times m \times v^2 = \frac{1}{2} \times 1 \times 4^2$

$= 8\ J$

Using work energy theorem

$W_{net} = \Delta KE$

$W_F + W_{friction} = \Delta KE$

$16 + W_{friction} = 8$

$\Rightarrow\ W_{friction} = -8J$

Ans. **8**

5. to 7 $\lambda = 4m$ and $f = 500$ Hz.

$\therefore\ V = f\lambda = 200\ m/s$

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

$= 400\ N$

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 $\phi_0 = -30°$

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