PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 85

Total Marks : 25

Max. Time : 26 min.

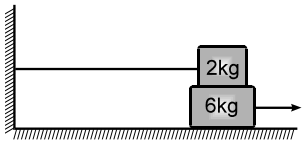
Topics : Work, Power and Energy, Friction, Wave on a String , Rigid Body Dynamics

Type of Questions		**M.M., Min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.4	**(3 marks, 3 min.)**	**[12, 12]**
Subjective Questions ('–1' negative marking) Q.5	**(4 marks, 5 min.)**	**[4, 5]**
Comprehension ('–1' negative marking) Q.6 to Q.8	**(3 marks, 3 min.)**	**[9, 9]**

1. A block of mass 1kg is pushed on a movable wedge of mass 2kg and height h = 30 cm with a velocity u = 6m/sec. Before striking the wedge it travels 2 m on a rough horizontal portion. Velocity is just sufficient for the block to reach the top of the wedge. Assuming all surfaces are smooth except the given horizontal part and collision of block and wedge is jerkless, the friction coefficient of the rough horizontal part is :

(A) 0.125 (B) 0.377 (C) 0.675 (D) 0.45

2. With reference to the figure shown, if the coefficient of friction at the surfaces is 0.42, then the force required to pull out the 6.0 kg block with an acceleration of 1.50 m/s^2 will be:



(A) 36 N (B) 24 N (C) 84 N (D) 51 N

3. A string of length 'ℓ' is fixed at both ends. It is vibrating in its 3rd overtone with maximum amplitude 'a'. The amplitude at a distance $\frac{\ell}{3}$ from one end is :

(A) a (B) 0 (C) $\frac{\sqrt{3}\,a}{2}$ (D) $\frac{a}{2}$

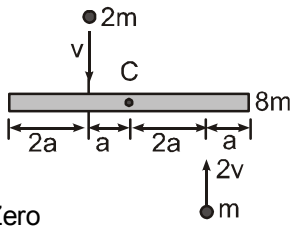
4. What is the percentage change in the tension necessary in a sonometer of fixed length to produce a note one octave lower (half of original frequency) than before

(A) 25% (B) 50% (C) 67% (D)75%

5. A rope, under tension of 200 N and fixed at both ends, oscillates in a second harmonic standing wave pattern. The displacement of the rope is given by y = (0.10 m) $\sin\left(\frac{\pi x}{3}\right)$ sin(12 πt), where x = 0 at one end of the rope, x is in meters and t is in seconds. Find the length of the rope in meters.

COMPREHENSION

A uniform bar of length 6 a & mass 8 m lies on a smooth horizontal table. Two point masses m & 2 m moving in the same horizontal plane with speeds 2 v and v respectively strike the bar as shown & stick to the bar after collision.



6. Velocity of the centre of mass of the system is

(A) $\frac{v}{2}$ (B) v (C) $\frac{2v}{3}$ (D) Zero

7. Angular velocity of the rod about centre of mass of the system is

(A) $\frac{v}{5a}$ (B) $\frac{v}{15a}$ (C) $\frac{v}{3a}$ (D) $\frac{v}{10a}$

8. Total kinetic energy of the system, just after the collision is

(A) $\frac{3}{5}mv^2$ (B) $\frac{3}{25}mv^2$ (C) $\frac{3}{15}mv^2$ (D) $3\,mv^2$

Answers Key

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1. (C) **2.** (D) **3.** (C) **4.** (D)
5. 06 m **6.** (D) **7.** (A)

Hint & Solutions

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1. velocity of the block after passing through the rough surface is $v = \sqrt{36 - 2\mu g(2)} = \sqrt{36 - 40\mu}$

Apply work energy theorem

$\mu mg\,(2) + mgh = KE_i - KE_f$ .....(1)

at the highest point

$V_{block} = V_{wedge}$

$$20\mu + 3 = \frac{1}{2}1(6)^2 - \frac{1}{2}3v^2$$

$$\mu = \frac{54}{80} = 0.675$$

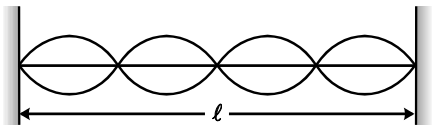
2. $F - 8(0.42)(10) - 2(0.42)(10) = 6(1.5)$

$F - 42 = 9$

$F = 51$ N

3. For a string vibrating in its n^{th} overtone ($(n + 1)^{th}$ harmonic)

$$y = 2A \sin\left(\frac{(n+1)\pi x}{L}\right)\cos\omega t$$



For $x = \frac{\ell}{3}$, $2A = a$ and $n = 3$;

$$y = \left[a\sin\left(\frac{4\pi}{\ell}\cdot\frac{\ell}{3}\right)\right]\cos\omega t$$

$= a.\sin\frac{4\pi}{3}\cos\omega t$

$= -a.\left(\frac{\sqrt{3}}{2}\right)\cos\omega t$

i.e. at $x = \frac{\ell}{3}$; the amplitude is $\frac{\sqrt{3}a}{2}$.

4. In Sonometer

$V \alpha \sqrt{T}$

$\therefore \quad \frac{V_1}{V_2} = 2 = \sqrt{\frac{T_1}{T_2}}$

$\Rightarrow \quad T_2 = \frac{T_1}{4}$

$\frac{T_1 - T_2}{T_1} \times 100 = \frac{T_1 - \frac{T_1}{4}}{T_1} \times 100 = 75\%$

5. $y = 0.10 \sin\left(\frac{\pi x}{3}\right) \sin(12\,\pi t)$

[M.Bank_S.W._4.60]

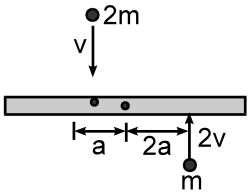
$k = \frac{\pi}{3}$

$\Rightarrow \quad \lambda = 6m$

Length of the rope $= \lambda = 6m$.

6 TO 8.

(i) Cons. linear momentum



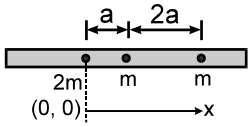
$-2m.v + 2v.m = 0 = MV_{cm}$

$V_{cm} = 0$

(ii) As ball sticks to Rod

Conserving angular momentum about C

$2v.m.\,2a + 2mva = I\omega$



$$= \left(\frac{8m.\ 36a^2}{12} + 2m.\ a^2 + m.4a^2 \right)$$

$6mv.a = 30\ ma^2.\omega$

$$\Rightarrow \quad \omega = \frac{v}{5a}$$

$$\text{(iii) KE} = \frac{1}{2}\ I\omega^2 = \frac{1}{2}.\ 30\ ma^2 \times \frac{v^2}{25a^2}$$

$$= \frac{3mv^2}{5}.$$