PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 83

Total Marks : 29

Max. Time : 32 min.

Topics : Center of Mass, 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]
Multiple choice objective ('–1' negative marking) Q.4 to Q.5	(4 marks, 4 min.)	[8, 8]
Subjective Questions ('–1' negative marking) Q.6	(4 marks, 5 min.)	[4, 5]
Match the Following (no negative marking) (2 × 4)	(8 marks, 10 min.)	[8, 10]

1. A loaded spring gun, initially at rest on a horizontal frictionless surface fires a marble of mass m at an angle of elevation θ. The mass of the gun is M, that of the marble is m and the muzzle velocity of the marble is v_0, then velocity of the gun just after the firing is :

(A) $\frac{m v_0}{M}$ (B) $\frac{m v_0 \cos\theta}{M}$ (C) $\frac{m v_0 \cos\theta}{M+m}$ (D) $\frac{m v_0 \cos 2\theta}{M+m}$

2. Equation of a standing wave is generally expressed as y = 2A sinωt coskx. In the equation, quantity ω/k represents

(A) the transverse speed of the particles of the string.

(B) the speed of either of the component waves.

(C) the speed of the standing wave.

(D) a quantity that is independent of the properties of the string.

3. A string 1m long fixed at one end is made to oscillate by a 300Hz vibrator attached to its other end. The string vibrates in 3 loops. The speed of transverse waves in the string is equal to

(A) 100 m/s (B) 200 m/s (C) 300 m/s (D) 400 m/s

4. Which of the following combinations can give standing wave.

(A) $y_1 = A \sin^2(\omega t - kx)$; $y_2 = -A \sin^2(\omega t + kx)$

(B) $y_1 = A \sin(kx - \omega t)$; $y_2 = A \cos(\omega t + kx)$

(C) $y_1 = 2A \cos^2(\omega t - kx + \pi)$; $y_2 = A[\sin 2(\omega t + kx) - 1]$

(D) $y_1 = A \sin(kx - \omega t + 30^\circ)$; $y_2 = A \cos(\omega t + kx - 60^\circ)$.

5. The vibrations of a string of length 600 cm fixed at both ends are represented by the equation

$$y = 4 \sin\left(\pi \frac{x}{15}\right) \cos(96\pi t)$$

where x and y are in cm and t in seconds.

(A) The maximum displacement of a particle at x = 5 cm is $2\sqrt{3}$ cm .

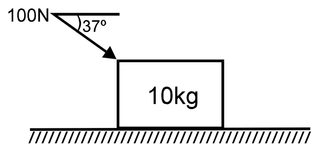
(B) The nodes located along the string are 15n where integer n varies from 0 to 40.

(C) The velocity of the particle at x = 7.5 cm at t = 0.25 sec is zero

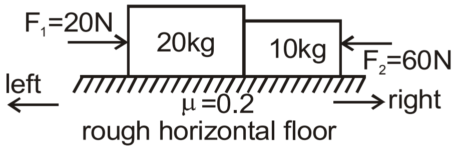
(D) The equations of the component waves whose superposition gives the above wave are

$2 \sin 2\pi\left(\frac{x}{30} + 48t\right)$, $2 \sin 2\pi\left(\frac{x}{30} - 48t\right)$.

6. In the figure shown calculate the angle of friction. The block does not slide. Take g = 10 m/s^2.



7. Two blocks of masses 20 kg and 10 kg are kept or a rough horizontal floor. The coefficient of friction between both blocks and floor is μ = 0.2. The surface of contact of both blocks are smooth. Horizontal forces of magnitude 20 N and 60 N are applied on both the blocks as shown in figure. Match the statement in column-I with the statements in column-II.



Column-I	Column-II
(A) Frictional force acting on block of mass 10 kg	(p) has magnitude 20 N
(B) Frictional force acting on block of mass 20 kg	(q) has magnitude 40 N
(C) Normal reaction exerted by 20 kg block on 10 kg block	(r) is zero
(D) Net force on system consisting of 10 kg block and 20 kg block	(s) is towards right (in horizontal direction).

Answers Key

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

5. (A) (B) (C) (D) **6.** $\theta = \tan^{-1}\frac{1}{2}$

7. (A) p,s (B) p,s (C) q,s (D) r

Hint & Solutions

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1. Muzzle velocity = $v_{m/g} = v_0$

Along x-direction ;

$v_{m(x)} - v_{g(x)} = v_0 \cos\theta$

By momentum conservation: (M + m)(0)

= m $(v_0 \cos\theta - v) - Mv$

$$\Rightarrow v = \frac{mv_0 \cos\theta}{(M+m)}$$

2. Equation of the component waves are :

y = A sin(ωt – kx) and y = A sin (ωt + kx)

where; $\omega t - kx$ = constant or $\omega t + kx$ = cosntant

Diffeentaiting w.r.t. 't' ;

$$\omega - k\frac{dx}{dt} = 0 \qquad \text{and } \omega + k\frac{dx}{dt} = 0$$

$$\Rightarrow \quad v = \frac{dx}{dt} = \frac{\omega}{k} \qquad \text{and } v = -\frac{\omega}{k}$$

i.e.; the speed of component waves is $\left(\frac{\omega}{k}\right)$.

Hence (B)

5. $y = 4\sin\left(\pi\frac{x}{15}\right)\cos 96\pi t$

At x = 5 cm, $y = 4\sin\frac{\pi}{3}\cos(96\pi t)$ and y_{max}

$= 2\sqrt{3}$ cm

Positions of nodes is given by equation

$$\sin\left(\frac{\pi x}{15}\right) = 0$$

$$\Rightarrow \frac{\pi x}{15} = n\pi$$

$\Rightarrow$ x = 15n

At x = 7.5 cm and t = 0.25 sec.

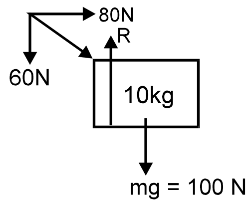
Velocity of the particle = $\frac{\partial y}{\partial t} = -344\pi\sin\left(\frac{\pi x}{15}\right)\sin$

$(96\pi t) = 0$

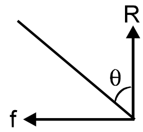
$y = 4\sin\left(\frac{\pi x}{15}\right)\cos(96\pi t) = 2\sin\left(\frac{\pi x}{15}+96\pi t\right) + 2$

$\sin\left(\frac{\pi x}{15}-96\pi t\right)$

6.



$R = mg + 60 = 160$ N



$f = 80$ N ($\because$ No sliding)

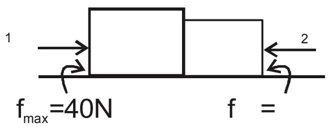
angle of friction $\theta = \tan^{-1}\dfrac{f}{R} = \tan^{-1}\dfrac{80}{160}$ θ

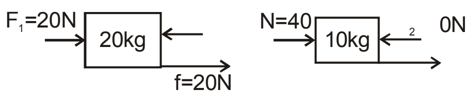
$= \tan^{-1}\dfrac{1}{2}$ Ans.

7. The minimum horizontal force required to push the two block system towards left

$= 0.2 \times 20 \times 10 + 0.2 \times 10 \times 10 = 60.$

Hence the two block system is at rest. The FBD of both of blocks is as shown. The friction force f and normal reaction N for each block is as shown.





Hence magnitude of friction force on both blocks is 20 N and is directed to right for both blocks. Normal reaction exerted by 20 kg block on 10 kg block has magnitude 40 N and is directed towards right. Net force on system of both blocks is zero.