PHYSICS

DPP
DAILY PRACTICE PROBLEMS

DPP No. 1

Total Marks : 32

Max. Time : 32 min.

Topics : Kinetic Theory of Gases and Thermodynamics, Motion in Two Dimensions, Newton's Law of Motion, Sound Wave, Projectile Motion, Simple Harmonic Motion

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.5	(3 marks, 3 min.)	[15, 15]
Multiple choice Objective ('–1' negative marking) Q.6 to Q.7	(4 marks, 4 min.)	[8, 8]
Comprehension ('–1' negative marking) Q.8 to Q.10	(3 marks, 3 min.)	[9, 9]

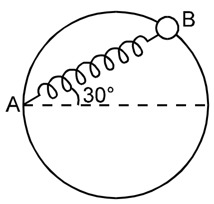
1. One mole of an ideal gas at a temperature T_1 expands slowly according to the law $\frac{p}{V}$ = constant. Its final temperature is T_2. The work done by the gas is

(A) $R(T_2 - T_1)$ (B) $2R(T_2 - T_1)$ (C) $\frac{R}{2}(T_2 - T_1)$ (D) $\frac{2R}{3}(T_2 - T_1)$

2. A particle moves along the parabolic path $y = ax^2$ in such a way that the y-component of the velocity remains constant, say c. The x and y coordinates are in meters. Then acceleration of the particle at x = 1 m is

(A) $ac\hat{k}$ (B) $2ac^2\hat{j}$ (C) $-\frac{c^2}{4a^2}\hat{i}$ (D) $-\frac{c}{2a}\hat{i}$

3. A bead of mass m is attached to one end of a spring of natural length R and spring constant $k = \frac{(\sqrt{3}+1)mg}{R}$. The other end of the spring is fixed at point A on a smooth vertical ring of radius R as shown in figure. The normal reaction at B just after it is released to move is

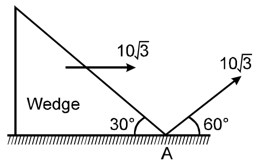


(A) $\frac{mg}{2}$ (B) $\sqrt{3}mg$ (C) $3\sqrt{3}mg$ (D) $\frac{3\sqrt{3}mg}{2}$

4. A sounding body emitting a frequency of 150 Hz is dropped from a height. During its fall under gravity it crosses a balloon moving upwards with a constant velocity of 2m/s one second after it started to fall. The difference in the frequency observed by the man in balloon just before and just after crossing the body will be: (given that -velocity of sound = 300m/s; g = 10m/s^2)

(A) 12 (B) 6 (C) 8 (D) 4

5. A particle is projected at angle 60° with speed $10\sqrt{3}$, from the point 'A' as shown in the fig. At the same time the wedge is made to move with speed $10\sqrt{3}$ towards right as shown in the figure. Then the time after which particle will strike with wedge is (g = 10 m/sec^2) :

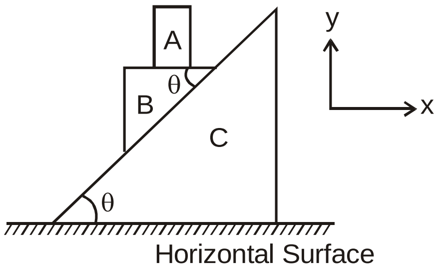


(A) 2 sec (B) $2\sqrt{3}$ sec (C) $\frac{4}{\sqrt{3}}$ sec (D) none of these

6. A particle performing S.H.M. undergoes displacement of $\frac{A}{2}$ (where A = amplitude of S.H.M.) in one second. At t = 0 the particle was located at either extreme position or mean position. The time period of S.H.M. can be : (consider all possible cases)

(A) 12s (B) 2.4 (C) 6s (D) 1.2s

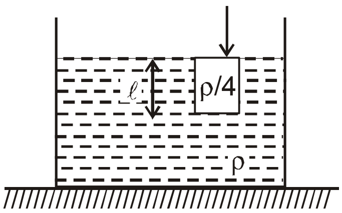
7. In the figure shown all the surface are smooth. All the blocks A, B and C are movable, x-axis is horizontal and y-axis vertical as shown. Just after the system is released from the position as shown.



(A) Acceleration of 'A' relative to ground is in negative y-direction
(B) Acceleration of 'A' relative to B is in positive x-direction
(C) The horizontal acceleration of 'B' relative to ground is in negative x-direction.
(D) The acceleration of 'B' relative to ground along the inclined surface of 'C' is greater than g sin θ.

COMPREHENSION

A large tank of cross-section area A contains liquid of density ρ. A cylinder of density $\rho/4$ and length ℓ, and cross- section area a (a <<A) is kept in equilibrium by applying an external vertically downward force as shown. The cylinder is just submerged in liquid. At t = 0 the external force is removed instantaneously. Assume that water level in the tank remains constant.



8. The acceleration of cylinder immediately after the external force is removed is

(A) g (B) 2g (C) 3g (D) zero

9. The speed of the cylinder when it reaches its equlibrium position is

(A) $\frac{1}{2}\sqrt{g\ell}$ (B) $\frac{3}{2}\sqrt{g\ell}$ (C) $\sqrt{2g\ell}$ (D) $2\sqrt{g\ell}$

10. After its release at t = 0, the time taken by cylinder to reach its equilibrium position for the first time is

(A) $\frac{\pi}{8}\sqrt{\frac{\ell}{g}}$ (B) $\frac{\pi}{3}\sqrt{\frac{\ell}{g}}$ (C) $\frac{\pi}{4}\sqrt{\frac{\ell}{g}}$ (D) $\frac{\pi}{2}\sqrt{\frac{\ell}{g}}$

Answers Key

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

Hints & Solutions

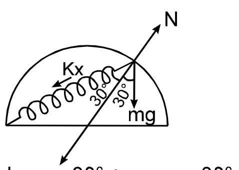
2. $y = ax^2 \qquad \frac{dy}{dt} = c = 2ax\frac{dx}{dt}$

$$\frac{d^2y}{dt^2} = 0 = 2a\left(\frac{dx}{dt}\right)^2 + 2ax\frac{d^2x}{dt^2}$$

$$\frac{d^2x}{dt^2} = -\left(\frac{dx}{dt}\right)^2\frac{1}{x} = -\left(\frac{c}{2ax}\right)^2\frac{1}{x} = -\frac{c^2}{4a^2x^3}$$

$$= -\frac{c^2}{4a^2}$$

3. **(D)** The extension is spring is $x = 2R\cos 30° - R = (\sqrt{3}-1)R$



Applying Newton's second law to the bead normal to circular ring at point B

$N = k(\sqrt{3}-1)R\ \cos 30° + mg\cos 30°$

$$= \frac{(\sqrt{3}+1)}{R}mg(\sqrt{3}-1)R\cos 30° + mg\cos 30°$$

$$N = \frac{3\sqrt{3}\,mg}{2}.$$

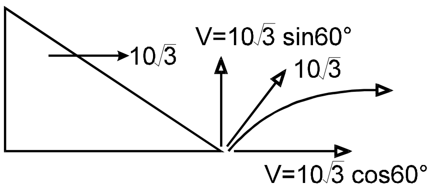
4. $f = f_0\left(\frac{v \pm v_0}{v \pm v_s}\right)$

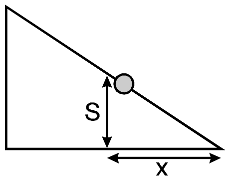
when approaching : $f_a = 150\left[\frac{300+2}{300-10}\right]$

when receding : $f_r = 150\left[\frac{300-2}{300+10}\right]$

$\Rightarrow$ $f_a - f_r \cong 12$ Hence (A).

5. Suppose particle strikes wedge at height 'S' after time t. S = 15t – $\frac{1}{2}$10 t^2 = 15t – 5 t^2. During this time distance travelled by particle in horizontal direction = $5\sqrt{3}$ t. Also wedge has travelled travelled extra distance





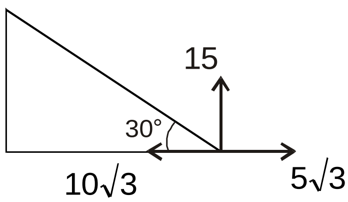
$$x = \frac{S}{\tan 30^\circ} = \frac{15t - 5t^2}{1/\sqrt{3}}$$

Total distance travelled by wedge in time t = $10\sqrt{3}$ t.

= $5\sqrt{3}$ t + $\sqrt{3}$ (15 – 5t^2) $\Rightarrow$ t = 2 sec.

Alternate Sol.

(by Relative Motion)

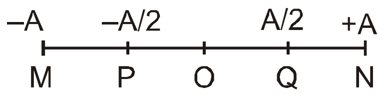


$$T = \frac{2u\sin 30^\circ}{g\cos 30^\circ} = \frac{2x10\sqrt{3}}{10} \times \frac{1}{\sqrt{3}} = 2 \text{ sec.}$$

$\Rightarrow$ t = 2 sec.

6. It T be the time period ; time to go from O to Q is $\frac{T}{12}$

and from M to P is $\frac{T}{6}$.



The displacement is $\frac{A}{2}$ when particle goes from O to Q, from O to N to Q, from O to N to O to P, and so on

$$\therefore \quad t = \frac{T}{12} \text{ or } t = \frac{T}{4} + \frac{T}{6} = \frac{5T}{12}$$

$$\text{or} \quad t = \frac{T}{2} + \frac{T}{12} = \frac{7T}{12}$$

Hence possible time period T is

$$T = 12 \text{ s} \qquad \text{or} \quad T = \frac{12 \times 1}{5} = 2.4 \text{ s}$$

$$\text{or} \quad T = \frac{12 \times 1}{7} \text{ s}$$

similarly displacement is $\frac{A}{2}$ when particle goes from M to P or M to N to P

Hence the possible time period T is

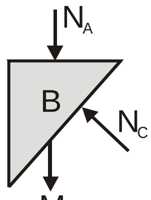
$$T = 1 \times 6 = 6 \text{ s} \quad \text{or} \quad T = \frac{6 \times 1}{5} \text{ s} = 1.2 \text{ s}$$

Ans. T = 1.2 s, 6s, 2.4s, 12s

7. There is no horizontal force on block A, therefore it does not move in x-direction, whereas there is net downward force (mg – N) is acting on it, making its acceleration along negative y-direction.

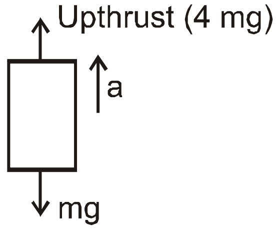
Block B moves downward as well as in negative x-direction. Downward acceleration of A and B will be equal due to constrain, thus w.r.t. B, A moves in positive x-direction.

Due to the component of normal exterted by C on B, it moves in negative x-direction.



The force acting vertically downward on block B are mg and N_A(normal reaction due to block A). Hence the component of net force on block B along the inclined surface of B is greater than mg sinθ. Therefore the acceleration of 'B' relative to ground directed along the inclined surface of 'C' is greater than g sin θ.

8.



9. The density of liquid is four times that of cylinder, hence in equlibrium postion one fourth of the cylinder is submerged.

So as the cylinder is released from initial postion, it moves by $\frac{3\ell}{4}$ to reach its equlibrium position. The upward motion in this time is SHM. Therefore required velocity is $v_{max} = \omega A$. $\omega = \sqrt{\frac{4g}{\ell}}$ and $A = \frac{3\ell}{4}$. Therefore

$$v_{max} = \frac{3}{2}\sqrt{g\ell}$$

10. The require time is one fourth of time period of SHM.

Therefore $t = \frac{\pi}{2\omega} = \frac{\pi}{4}\sqrt{\frac{\ell}{g}}$